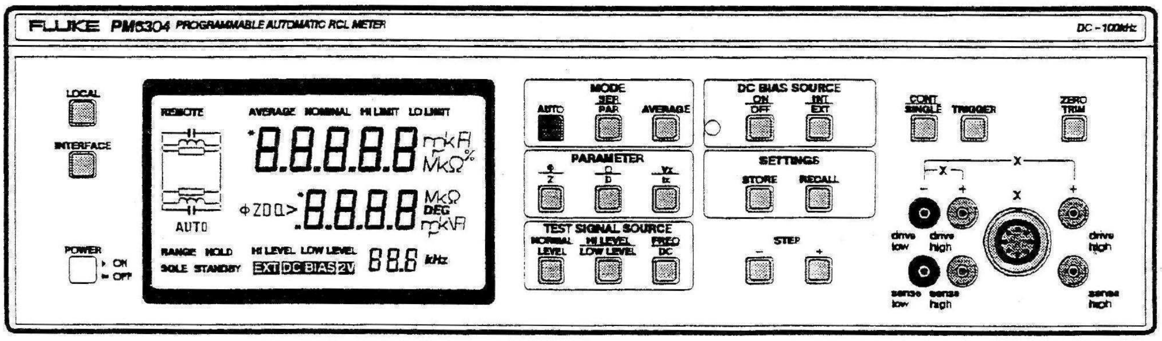
Programmable Automatic RCL Meter

PM6304

Service Manual

951111

This Service Manual is also valid for PM6304C.



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IMPORTANT

In correspondence concerning the Programmable Automatic RCL Meter please give the model number and serial number as located on the type number plate on the instrument.

For your reference:

Model number:	PM6304/xxx
Code number:	9452 063 04xxx
Serial number:	LO xxxxxx

Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

Warning These servicing intructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are fully qualified to do so.

4822 872 15169
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SERVICE CENTRES

1 SAFETY INSTRUCTIONS

WARNING

These service instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the Operating Instructions unless you are fully qualified to do so.

Read these pages carefully before installation and use of the instrument.

The following clauses contain information, cautions, and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition. Adjustment, maintenance, and repair to the instrument shall be carried out only by qualified personnel.

1.1 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.2 CAUTION AND WARNING STATEMENTS

CAUTION

Is used to indicate correct operating or maintenance procedures to prevent damage to or destruction of the equipment or other property.

WARNING

Calls attention to a potential danger that requires correct procedures or practices to prevent personal injury.

1.3 SYMBOLS

⏚	Protective earth (black symbol on yellow background) (grounding) terminal

1.4 IMPAIRED SAFETY PROTECTION

Whenever it is likely that safety protection has been impaired, the instrument must be disconnected from power and be secured against any unintended operation. The matter should then be referred to qualified technicians. Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.5 GENERAL CLAUSES

WARNING

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous.

The instrument shall be disconnected from all voltage sources before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been removed from all voltage sources.

WARNING

Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

Components which are important for the safety of the instrument may only be replaced by components obtained through your local Fluke organization (see also Chapter 13).

After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in Chapter 12, must be performed.

2 LINE VOLTAGE SETTING AND FUSES

The safety instructions in the previous chapter must be followed.

Before plugging in the power cord make sure that the instrument is set to the local line voltage.

WARNING

If the power cord has to be adapted to the local situation, such adaption should be done by a qualified person only.

On delivery from the factory the instrument is set to one of the following line voltages:

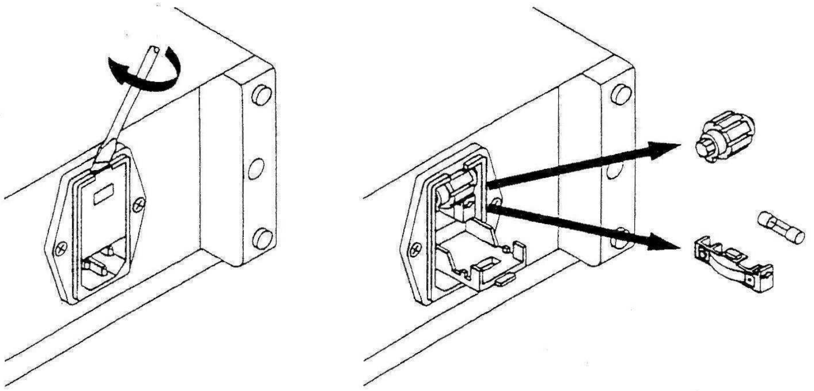
Type	Code no.	Line voltage	Delivered power cord
PM6304	9452 x63 04xx1	220 V	Universal Europe
PM6304	9452 x63 04xx3	120 V	North America
PM6304	9452 x63 04xx4	240 V	England (U.K.)
PM6304	9452 x63 04xx5	220 V	Switzerland
PM6304	9452 x63 04xx8	240 V	Australia

The set line voltage and the corresponding fuse rating are indicated on the rear panel.

Make sure that replacement fuses are of the type and current rating specified. You also may use fuses according to UL/CSA instead of the built-in type according to IEC 127. The use of repaired fuses and/or short circuiting of fuse holders are prohibited. Do not defeat this important safety feature.

The instrument can be set to the following line voltages: 100 V, 120 V, 220 V and 240 V ac. These nominal voltages can be selected via the voltage selector, located at the rear panel, adjacent to the power socket. The fuse is located in a holder at the same place. For line power voltage selection or replacement of the fuse, remove the power cord and pry open the compartment with a small screwdriver (see drawing next page).

Select one of the voltage ranges, as appropriate, by turning the selector. If necessary, insert the specified fuse (T0.2A or T0.4A according to IEC127 or T0.25A or T0.5A according to CSA/UL198G) that matches the line voltage setting into the fuse holder.



3 PRINCIPLE OF OPERATION AND MEASUREMENT

3.1 INTRODUCTION

The two-pole CUT (Component Under Test) Zx is connected to the SELECTOR section of the instrument by four wires:

- Via the HD (High Drive) wire. The sinusoidal ac or the dc test voltage from the SOURCE or the DC source is routed to one CUT terminal by means of this wire.
- Via the LD (Low Drive) wire, which is forced electronically to near ground voltage level. The current through the CUT is routed by means of this wire either to the AC/V CONVERTER or, in the dc measuring mode, to the DC/V CONVERTER.
- By the HS (High Sense) and LS (Low Sense) wires, the voltages at the CUT terminals are picked for processing.

In the dc-measuring mode, the sense voltages from the CUT and the DC/CONVERTER output voltages are converted to a 2 kHz ac voltage by the DC/AC CONVERTER in the DC UNIT. Within one measuring cycle, these voltages or, for the ac-measuring mode, the sense voltages from the CUT and the AC/V CONVERTER output voltage, are processed alternately in the AMPLIFIER-FILTER-MULTIPLYING DAC channel. In the DAC, the individual sinusoidal measuring voltage at A5 is multiplied successively by two quadrature-phase reference sine waves from the SIGNAL SYNTHESIZER, thus creating at A6 dc voltages proportional to the in-phase components of the measuring voltage. These dc terms are converted to binary numbers by a dual-slope ADC, consisting of the DUAL-SLOPE INTEGRATOR and the COUNTER, which are then read by the CPU. At the end of one measuring cycle in the ac measuring mode, seven numbers are normally in the CPU RAM:

- Two "voltage numbers" for the two quadrature-phase components of the CUT voltage.
- Two "current numbers" for the two quadrature-phase components of the CUT current.
- One "voltage reference" number for the main ac component of the CUT voltage measuring channel, short-circuited at the ac selector input.
- A "current reference" number for the main ac component of the CUT current measuring channel, short-circuited at the ac selector input.
- A quadrature-phase "voltage reference" or "current reference" number, depending on the used larger amplifier gain.

These seven numbers, the appropriate amplifier gains and reference sine wave phases, the instrument trim and calibration data, all combine to form the basis for the calculation of the CUT parameters. The calculation is performed by the CPU according to pre-defined algorithms. The results is transferred to the display.

3.2 DESCRIPTION OF THE BLOCK DIAGRAM, Figures 10, 11

SIGNAL SYNTHESIZER

The TWS (Triangle Wave Synthesizer) reads out sine wave tables loaded in the sine wave PROMs, and so creates 8-bit-word sequences of the test signal, the reference sine wave for the MULTIPLYING DAC and the DC/AC CONVERTER in the DC UNIT. The test signal is converted to an analog sine wave by the DAC. The CPU controls frequency and phase settings.

SOURCE

The test signal is filtered within the SOURCE section and set to the programmed high, normal or low level amplitude by the ac source. A bias regulator generates the dc current for fast biasing of tested capacitors. Overload protection circuits protect the test signal source and the bias source from being damaged by external load.

SELECTOR

The source resistor belonging to the selected test signal level is switched on by relays. The ac selector multiplexes the CUT voltage behind the sense buffer stages, the voltage from the AC/V CONVERTER and, for the reference measurements, the ground level. A differential amplifier pre-amplifies and buffers the multiplexed voltages in ac measuring mode. The AC/V CONVERTER converts the CUT current to a proportional ac voltage. The dc selector multiplexes the CUT terminal voltages and the voltage from the DC/V CONVERTER to the DC/AC CONVERTER in the DC UNIT. A bias selector inhibits the bias currents or routes either the EXTERNAL BIAS or the internal bias current from the SOURCE to the CUT.

DC UNIT

The DC voltage source, the DC/V CONVERTER for the CUT current and the DC/AC CONVERTER form the DC UNIT.
The DC/AC CONVERTER converts the measuring voltages from the CUT terminals and the DC/V CONVERTER output voltage to a 2 kHz sine wave voltage. This is achieved by multiplication with the 2 kHz digital wave from the SIGNAL SYNTHESIZER.

AMPLIFIER

The preamplifier equalizes the amplitude differences, depending on the test signal level. The main amplifier-voltage divider channel is controlled by the CPU and set to such an overall gain, that at the output of the FILTER section, the window detector senses the in-range condition. For very low CUT voltages or currents, i.e., very low or very high CUT impedances, the corresponding gains are set to maximum.

FILTER

Depending on the selected test frequency, the AMPLIFIER output signal is filtered by a 300 Hz LPF, a 300 Hz to 20 kHz BPF, or a 100 kHz BPF. The output is buffered and sensed by the window detector (see Section AMPLIFIER).

MULTIPLYING DAC

The FILTER output signal is multiplied by the digital reference sine wave from the SIGNAL SYNTHESIZER. For the CUT voltage signal and the CUT current signal, two quadrature-phase reference signals are successively used (see introduction). The polarity detector provides the CPU with information about the right phase settings.

DUAL-SLOPE INTEGRATOR

The DUAL-SLOPE INTEGRATOR executes for each analog/digital conversion first, for a fixed period, the dc integration and then the de-integration to zero with a fixed dc input. This is always monitored by the timer within the COUNTER section and of the CPU. The reset & hold circuit sets the initial zero output voltage condition of the integrator.

COUNTER

During the de-integration period of the DUAL-SLOPE INTEGRATOR the COUNTER accumulates the number of the count-clock pulses. The final number, which is proportional to the integrated dc input, is read out by the CPU (see introduction). The timer controls the integration period of the DUAL-SLOPE INTEGRATOR. DUAL-SLOPE INTEGRATOR and COUNTER represent the dual-slope ADC.

CPU, LCD & KEYBOARD, IR DETECTOR

The instrument is operated from the KEYBOARD, or remotely by the IEEE-488 or the RS-232 Interface, or via the IR DETECTOR from the Bin Programmer. The CPU processes these instructions as well as the information from the window and the polarity detector for controlling the various functional units in the instrument. The computation results, derived from the measurement data, are transferred to the LCD, the HANDLER Interface and the IEEE-488 or the RS-232 Interface.

POWER SUPPLY

The POWER SUPPLY provides dc supply voltages for the various functional units in the instrument, a dc current for the LCD backlight, and ac supply voltages for the IEEE-488 or the RS-232 Interface, and the HANDLER Interface. The data lines for the Handler Interface are routed through the Power Supply.

3.3 PRINCIPLE OF MEASUREMENT

The component measurement is based on the current and voltage technique. The component voltage and the component current are measured and converted into binary values. From these values the CPU calculates the electrical parameters of the component. According to the front panel parameter selection, either the dominant and secondary parameters are automatically displayed (AUTO) – resistance, capacitance or inductance, or the manual selected parameter (Q, D, Z, or Φ) is displayed.

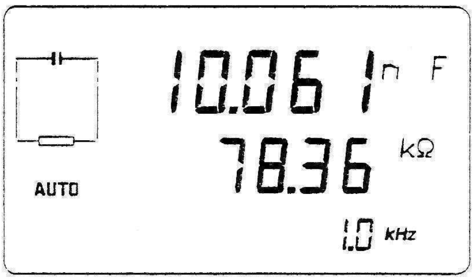
Each measurement cycle lasts approximately 0.5 seconds and consists of seven single measurements, the results of which are stored and arithmetically evaluated. Finally the result is transferred to the display. The seven single measurements are as follows:

1. **Voltage Measurement: 0°**
   and internal gain factor setting
2. **Voltage Measurement: 90°**
3. **Reference Measurement: 0°**

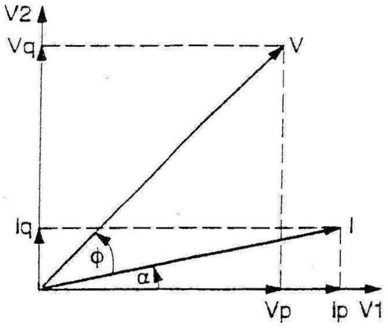
	Gain factor >1		**Gain factor = 1**	
4.	**Reference Measurement:**	**90°**	**Current Measurement:**	**0°**
5.	**Current Measurement:**	**0°**	**Current Measurement:**	**90°**
6.	**Current Measurement:**	**90°**	**Reference Measurement:**	**0°**
7.	**Reference Measurement:**	**0°**	**Reference Measurement:**	**90°**

The seven measured values are stored at the end of the single measurements. The processor uses the measured values to calculate the equivalent series resistance Rs, the equivalent series reactance Xs, and the quality factor Q = Xs/Rs of the component. In AUTO mode the processor determines the dominant and secondary parameter, calculates its value, and displays it together with the equivalent circuit symbol. If one of the other parameters is manually selected, this parameter is calculated and displayed. After that the next measurement cycle starts with the seven single measurements.

The display shows:



The following phase diagrams and formulas show the mathematic basics for internal calculation of the component value.



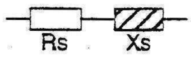
V:	voltage
I:	current
V1, V2:	0°-voltage, 90°-voltage

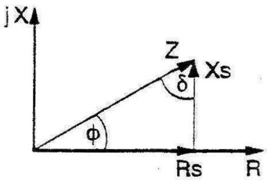
The phase angle between I and V is ϕ.
The phase angle between I and V1 is α.

In the diagram the phase relation between I and V is related to a lossy inductance.
In each measurement cycle, the following components are determined: Vp, Vq, Ip, Iq.
The series resistance and reactance are calculated from these components.

$$\boxed{Rs = \frac{VpIp + VqIq}{Ip^2 + Iq^2}} \quad (1) \qquad \boxed{Xs = \frac{VqIp - VpIq}{Ip^2 + Iq^2}} \quad (2)$$

The following equivalent circuit is valid:





Quality factor: $Q = \tan\phi = 1/D = \frac{|Xs|}{Rs}$ (3)

Dissipation factor: $D = \tan\delta = 1/Q = \frac{Rs}{|Xs|}$ (4)

The magnitude of Q and the sign of Xs determine which parameter of the component is dominant.

Xs positive = inductive Xs negative = capacitive

The formulas for the various parameters are as follows:

$Q = \frac{|Xs|}{Rs}$ see equation (3)

$D = \frac{1}{Q}$

$Rp = (1 + Q^2) \times Rs$

Rs see equation (1)

$Z = \sqrt{Rs^2 + Xs^2}$

$Cp = \frac{1}{\omega(1 + 1/Q^2)|Xs|}$ if $Xs < 0$

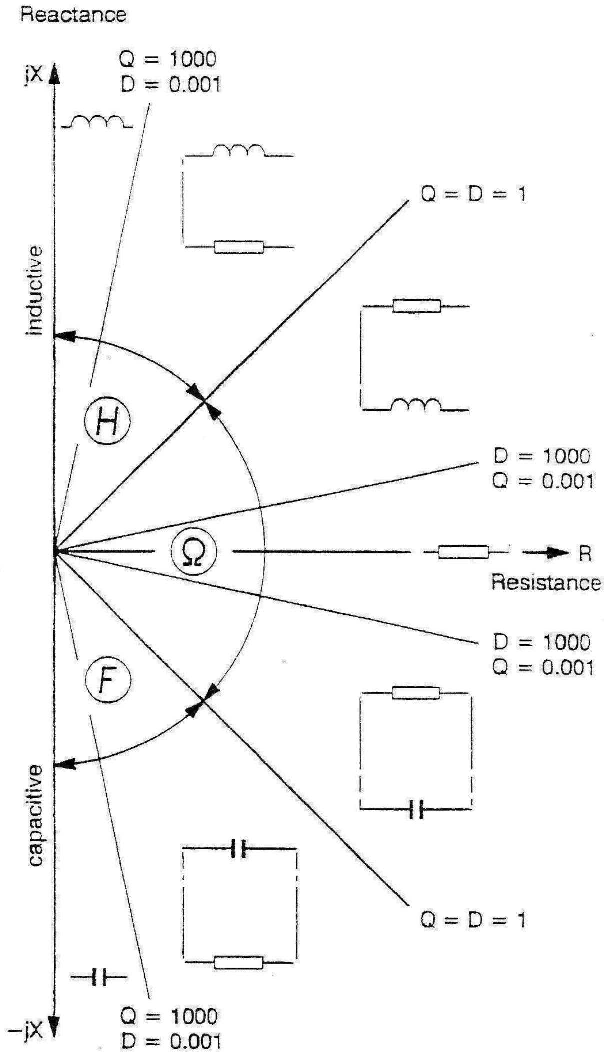
$Lp = \frac{(1 + 1/Q^2)|Xs|}{\omega}$ if $Xs > 0$

$Cs = \frac{1}{\omega|Xs|}$ if $Xs < 0$

$Ls = \frac{|Xs|}{\omega}$ if $Xs > 0$

Impedance $Z = R + jX$
Admittance $Y = 1/Z$

The decision criterion for selecting the dominant parameter is Q = D = 1. The values Q and D not only depend on the component but also on the test signal frequency used.



AUTO MODE DECISION DIAGRAM

Example:
By using the seven measurements, the instrument has calculated Rs and Xs in accordance with formulas 1 and 2, for example:

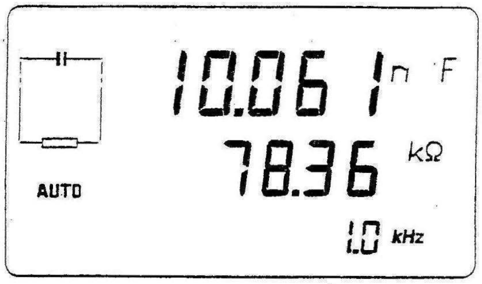
$$Rs = 3.068\ k\Omega \qquad Xs = -15.199\ k\Omega$$

From this the instrument calculated:

$$Q = \frac{|Xs|}{Rs} = 4.954$$

The instrument displays the corresponding equivalent circuit symbol with the dominant and the secondary component, according to the criteria of the Auto Mode Decision Diagram; in this case, as Xs is negative and $1 < Q < 1000$:

The display shows:



The calculation of the dominant parameter Cp was done according to the following formula:

$$Cp = \frac{1}{\omega(1 + 1/Q^2)|Xs|}$$

$$Cp = \frac{1}{2\pi \times 1\ kHz\ (1 + 1/4.954^2) \times 15.199\ k\Omega} = 10.061\ nF$$

The maximum display is five digits ±1 digit tolerance.

Calculation of the other selectable parameters are performed as follows:

$$D = \frac{1}{Q} = \frac{1}{4.954} = 0.202$$

$$Rp = (1 + Q^2) \times Rs = (1 + 4.954^2) \times 3.068\ k\Omega = 78.36\ k\Omega$$

$Rs = 3.068\ k\Omega$ (calculated by the instrument according to formula 1)

$$Z = \sqrt{Rs^2 + Xs^2} = \sqrt{(3.068\ k\Omega)^2 + (15.199\ k\Omega)^2} = 15.51\ k\Omega$$

$$Cs = \frac{1}{\omega|Xs|} = \frac{1}{2\pi \times 1\ kHz \times 15.199\ k\Omega} = 10.471\ nF$$

Φ : The instrument calculates

$$\tan \Phi = \frac{|Xs|}{Rs} = \frac{15.199\ k\Omega}{3.068\ k\Omega} = 4.954$$

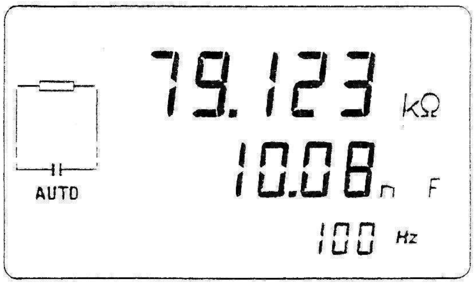
and gets Φ from an internal tangent table similar to a calculator
$\Phi = -\ 78.6$ DEG

For accurate measurement, you should select an appropriate test signal frequency, see Section 4.2 of the Users Manual.

If you measure the same component mentioned in the example before, with a test signal frequency that is too low, the resistive part of the capacitive parameter dominates.
So the instrument determines a resistor as the dominant parameter.

Example: Test signal frequency 100 Hz

The display shows:



The instrument determined:
$Rs = 63.248\ k\Omega$
$Xs = -31.680\ k\Omega$

and calculated:

$$Q = \frac{|Xs|}{Rs} = 0.501$$

Because Q<1, the display shows a resistor as the dominant parameter.

Calculation of the other parameter is performed by the same formulas:

$$D = \frac{1}{Q} = 2.00$$

$$Rp = (1 + Q^2) \times Rs = 79.123\ k\Omega$$

$$Cp = \frac{1}{\omega(1 + 1/Q^2)|Xs|} = 10.08\ nF$$

$Rs = 63.248\ k\Omega$ (calculated according to formula 1)

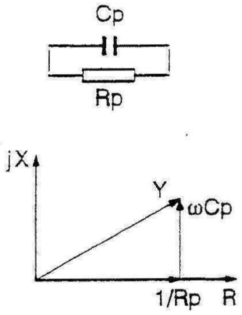
$$Cs = \frac{1}{\omega|Xs|} = 50.23\ nF$$

$$Z = \sqrt{Rs^2 + Xs^2} = 70.74\ k\Omega$$

$$\tan \Phi = \frac{|Xs|}{Rs} = 0.501$$

$$\Phi = -26.6\ DEG$$

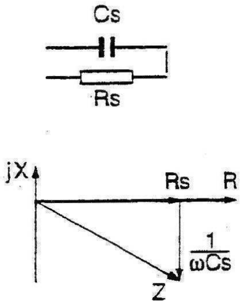
If you are interested in mathematics the next pages show the phasor diagrams and formulas for the various components.



$$Y = \frac{1}{Rp} + j\omega Cp \qquad Z = \frac{Rp\,(1 - j\omega CpRp)}{1 + (\omega CpRp)^2}$$

$$D = \frac{1}{\omega CpRp}$$

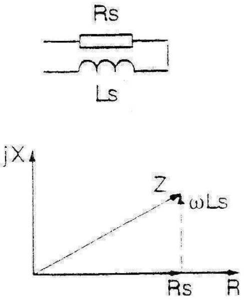
$$Cs = (1 + D^2) \times Cp \qquad Rs = \frac{D^2}{1 + D^2} \times Rp$$



$$Z = Rs - j\frac{1}{\omega Cs}$$

$$D = \omega CsRs$$

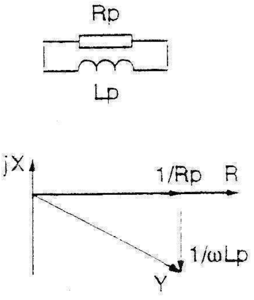
$$Cp = \frac{1}{1 + D^2} \times Cs \qquad Rp = \frac{1 + D^2}{D^2} \times Rs$$



$$Z = Rs + j\omega Ls$$

$$D = \frac{Rs}{\omega Ls}$$

$$Lp = (1 + D^2) \times Ls \qquad Rp = \frac{1 + D^2}{D^2} \times Rs$$



$$Y = \frac{1}{Rp} - j\frac{1}{\omega Lp} \qquad Z = \frac{Rp\,(1 + jRp/\omega Lp)}{1 + (Rp/\omega Lp)^2}$$

$$D = \frac{\omega Lp}{Rp}$$

$$Ls = \frac{1}{1 + D^2} \times Lp \qquad Rs = \frac{D^2}{1 + D^2} \times Rp$$

4 CIRCUIT DESCRIPTION, TROUBLESHOOTING

4.1 POWER SUPPLY, UNIT 1, Figure 16

The Power Supply on Unit 1 generates **five stabilized dc voltages:** +15 V, –15 V, +5 VA, –5 V for the analog circuitries, and +5 V for the digital circuitries.
You can check all voltages at the test socket X104.
Potentiometer R115 adjusts the +15 V supply. The stability depends on the reference diode V159.
The –15 V supply is derived from +15 V via resistors R118, R119; so there is no further adjustment.

When you switch power off or when the +5 V supply fails, the **power down signal PD** at transistor V101 and Z-diode V152 gets low before the +5 V supply is below 3.5 V output voltage. PD low and so RST high reset the processor D107 on the CPU, Unit 2, Figure 18, thus preventing any further data exchange until the internal supply voltages are completely down. Furthermore, SRAM D103 on the CPU, where the instrument settings are stored, is now backed up by the battery G150.
The same happens when you press the concealed front panel RESET switch, Figures 29, 30 (only for instruments until LO 648 884). When you switch power on, low signal at capacitor C102 in Figure 18 resets the processor.

Resistor R127 and Z-diode V160 together with the secondary ac voltage of the transformer generate the rectangular **SFR signal.** On the CPU, the instrument measures the signal period and so identifies whether there is 50 Hz or 60 Hz mains frequency.

Amplifier N106 and transistor V106 generate the **current for the backlight** of the display. Via the BLS line the **brightness** is adjusted by potentiometer R101 on Unit 4, Figure 30.

The ac voltages for the **interfaces** are fed via the power supply, connection X103.1-4.
Multi-fuse F111 protects Unit 6, Handler Interface.
For Units 8/9, IEEE-488/RS-232 Interface, there is no fuse necessary. Short cuts on these units will blow up the mains fuse.

4.2 CENTRAL PROCESSING UNIT, CPU, UNIT 2, Figure 18

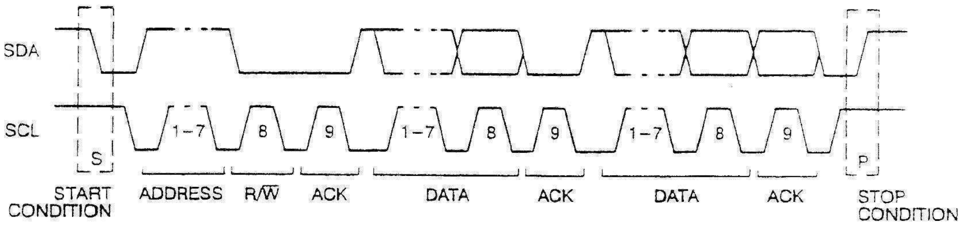
The CPU contains the 8-bit processor (microcontroller) D107, program memory (EPROM) D105, address latch D106, input port extension D108, battery buffered RAM D103 for storage of instrument settings including TRIM data, and the EEPROM D104 for storage of calibration and binning data. The processor is clocked by the 12 MHz Clock Oscillator, crystal G101. This clock is also used for the counter, Figure 20.

The multiplexed address/data bus P0 of the processor supplies the address inputs A0 to A7 of the EPROM via the address latch, switched by ALE (Address Latch Enable). The address inputs A8 to A15 of the EPROM are directly supplied from the processor port P2. Data are transferred from the EPROM outputs ACT0 to ACT7 to the processor port P0 via the multiplex bus, controlled by PSEN (Program Store Enable). Via this bus also the data from the input port D108 are read in, selected by the RD signal.

The communication between processor and the four interfaces is performed via the bidirectional I^2C**-bus** with data line SDA and clock line SCL:

- RAM for the instrument settings,
- IEEE-488 respectively RS-232 Interface,
- Display drivers on Unit 4, and
- EEPROM, for which a separate address line SDA2 is provided.

The principle of data transfer via I^2C-bus is shown in the following diagram.



The **C-bus**, lines SD, SC, and strobe lines STR1 to 4 and 6, transfers the data to the different units. The serial data SD are clocked into shift registers by the clock SC; the following assigned strobe latches the data in the selected shift register and presents the serial transmitted information in parallel form at the output of the register.

The **strobe decoder** D109 generates the strobes STR1 to 4 and 6, controlled by the processor, AD8 to 10 and WR.

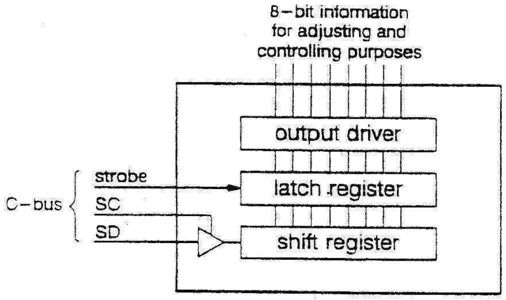


Fig. 4.1 Principle of Latch and Shift Register

For troubleshooting see also Chapter 8, Self Diagnostic and Troubleshooting, Program 6, **Strobe Test.**

The strobes control the following circuits:

STR1:	Signal Synthesizer, shift register D202 (TWS), Figure 19
STR2:	Signal Synthesizer, shift register D206, Figure 19
STR3:	Selector, shift register D201, Figure 23
STR4:	Source, shift register D101, Figure 22 Amplifier, shift register D401, Figure 25
STR6:	Handler Interface, D106/D107, Figure 35

When you switch power off or when the +5 V supply fails, SRAM D103, where the instrument settings including the TRIM data are stored, is supplied with a 3 V battery to avoid loss of stored data. Additional pin 7 (TEST) is provided with this voltage; by this the SRAM is set in a mode that reduces power consumption. For the power down signal PD, see Section 4.1, Power Supply.

4.3 SIGNAL SYNTHESIZER, UNIT 2, Figure 19

The Signal Synthesizer generates the **test frequencies 50 Hz to 100 kHz.** The outputs are the analog sine wave F_MEAS at connector X155 for the Source on Unit 3, and the digital sine wave at X108 for the Multiplying DAC on Unit 3, and for the DC/AC Converter on the DC Unit 5.

The **Triangle Wave Synthesizer,** TWS D202, is clocked by the 20.97 MHz Oscillator, crystal G201, adjusted by C210. The TWS generates a sequence of read addresses for the **Sine PROMs** D204, D207. The PROMs are loaded with binary values for the sample magnitudes of the sine wave, which are read out according to the addresses sent by the TWS. The binary values are converted into an analog sine wave by the **Digital to Analog Converter,** DAC N201, with 8 bit amplitude resolution. A **Lowpass/Bandpass Filter** in the Source on Unit 3 smooths the sine wave and suppresses clock and alias frequencies of the digital frequency synthesis.

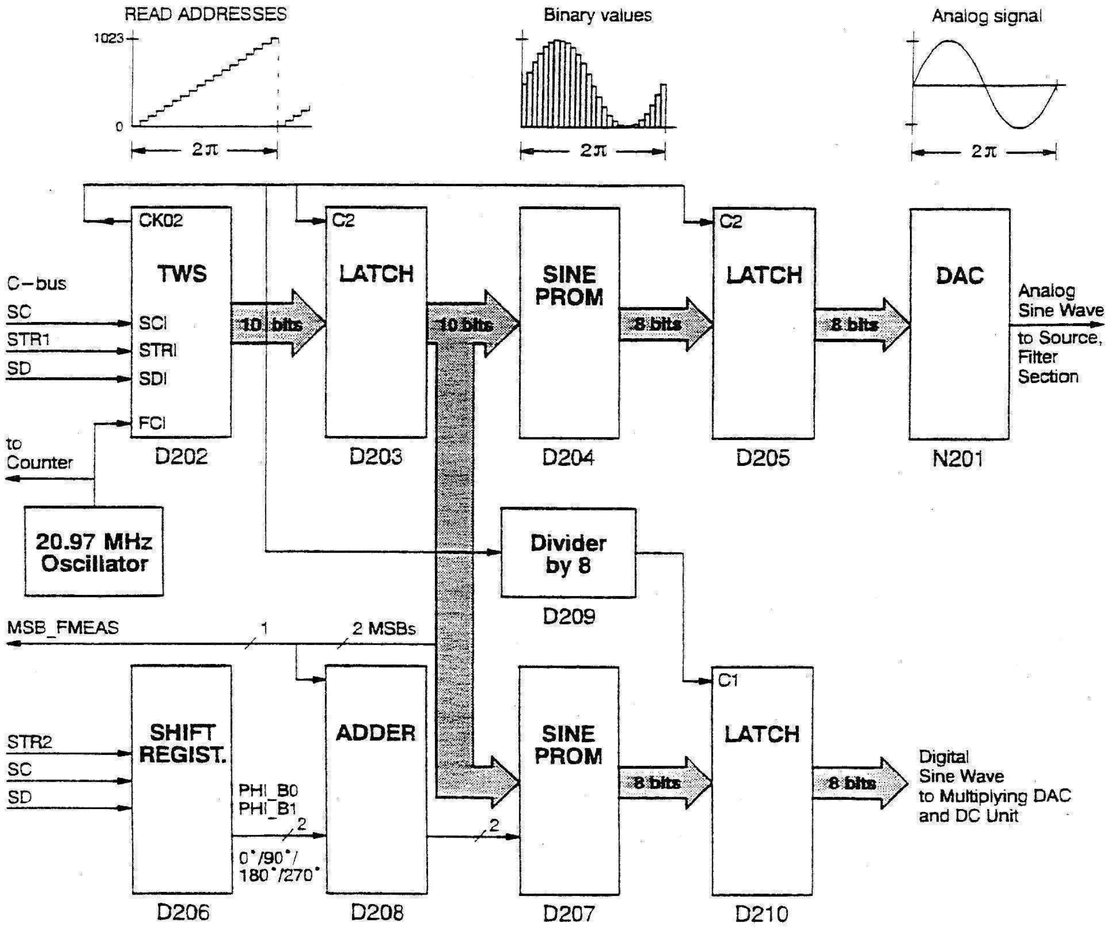


Fig. 4.2 Signal Syntheziser, Simplified Diagram

The TWS D202 contains a shift register which converts the serial control data fed in via the C-bus to parallel data. A part of this serves as a phase increment for an internal phase accumulator. This increment is accumulated with each clock pulse. The output, latched by D203, is a 10 bit word which represents the current read address for the subsequent Sine PROM D204, increasing with each clock pulse (0 to 1023).
The clock CK02 for the latches derived from the clock input FCI is 20.97 MHz for test frequencies >2 kHz; for test frequencies ≤2 kHz, CK02 is reduced by 10 to 2.097 MHz.

The DAC N201 has a separate 5 V supply, voltage regulator N202.
For DC measurements the AC signal is switched off, output AC_OFF, shift register D206.
For the digital sine wave the phase is switched from 0° to 270° in steps of 90°, adding the outputs PHI_B0, PHI_B1 of shift register D206 to the two MSBs of latch output D203.
The clock for the digital sine wave is divided by 8, counter D209. The Multiplying DAC on Unit 3 requires this reduced clock.

4.4 COUNTER, UNIT 2, Figure 20

The circuit diagram comprises three parts:
The **Timer** is clocked by the 12 MHz Clock Oscillator on the CPU. The timer defines the integration periods 5 ms, 40 ms, or 50 ms of the Dual-Slope Integrator by the Divider by 3 (D301), the selectable Divider by 2 or by 16 (D312), or by 20 (D302), and the Divider by 10000 (2 times by 100, D304, D305).
The **20 Bit Counter** counts the 20.97 MHz pulses during the de-integration period of the Dual-Slope Integrator, which together represent a dual-slope analog to digital converter (ADC). The final counter state, which is proportional to the integrator dc input, is read out by the CPU.
The **Control Logic**, flipflops D307, D314, controls the Timer and the Counter.

Figure 4.3 shows the timing diagram for one conversion period of the ADC:

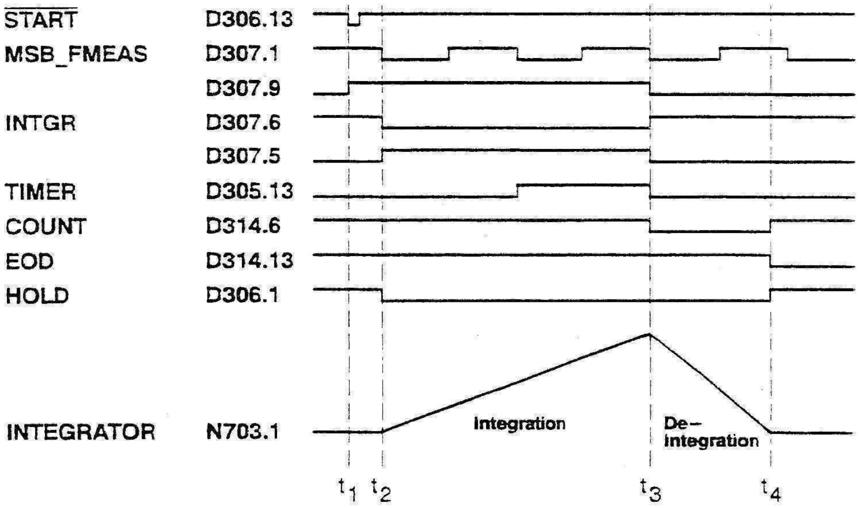


Fig. 4.3 Timing Diagram for One Conversion Period at the ADC

Low pulse START at D306.13 prepares the conversion at t1. D307.9 is set to high, the reset input D307.15 is released. For synchronization with the test voltage, the next trailing edge of the MSB_FMEAS signal starts the integration, HOLD signal D306.1 and INTGR D307.6 get low. D307.5 releases the reset for the divider and sets the 20 bit counter to 0. The carry of the timer, trailing edge D305.13 at t3, sets the output D307.9 to low, and so D307.15 resets the INTGR signal to high. At the same time, the COUNT output D314.6 gets low and starts the de-integration: NOR gate D306.4 switches the 20.97 MHz count pulses to the 20 bit counter.
Zero output voltage of the integrator N703.1 on Unit 3 switches the EOD signal D314.13, End Of De-integration, from high to low, t4. Output D314.7 gets low and via D314.15 resets the COUNT signal to high. The counter stops, and the HOLD signal D306.1, NOR gate output of the INTGR and COUNT inputs, holds the integrator output at 0 V. The counter state at t4 is proportional to the integrator output voltage at t3 and, consequently, to the input value for this conversion.

The HOLD signal, inverted to READY via D211, Figure 19, is read by the CPU and terminates the conversion. The P_LOAD low pulse from the CPU, strobe decoder D109.7, loads the counter state into the shift registers D309, D311, D313. SC clocks the counter state via the serial data output SDO to the CPU.

If the integrator output passes –0.45 V at comparator N704 on Unit 3, for example, when changing the component during measurement, the I_RES signal gets low and interrupts the conversion via D307.14 and D314.10; HOLD signal discharges the integration capacitor to 0 V.

4.5 ANALOG UNIT, Figures 22 to 28
SOURCE, UNIT 3, Figure 22

General:
The Analog Unit comprises **seven sections,** Figures 22 to 28:
Source, Selector, AC/V Converter, Amplifier, Filter, Multiplying DAC, Dual-slope Integrator.

For troubleshooting see also Chapter 8, Self Diagnostic and Troubleshooting, Program 7, Measurement Data Test, which statically checks the measurement channel from the component connector to the processor.

Figure 4.8, page 4 – 13, shows you the **Principle Overall Diagram of the Analog Measurement Section,** for AC mode.
The test signal from the Signal Synthesizer passes the **Filter** in the Source, and is set to the HIGH, NORMAL, or LOW level amplitude in the **AC Source.** A **Bias Regulator** generates the DC current for testing capacitors. **Overload Protection** circuits protect the test signal source from damages by external load. Figure 4.4 shows you the functional diagram including parts of the Selector, Figure 23.

N102 amplifies the 0.8 Vpp input to 2 V HIGH Level, adjusted by potentiometer R111. Divider chain R128 to R132 defines the 1 V NORMAL and 50 mV LOW Level. For 100 kHz test frequency, the **100 kHz Bandpass Filter BPF** is selected. For all other frequencies, the **20 kHz Lowpass Filter LPF** is selected. Buffer N105 with input lowpass filter R192/C121 and transistors V106, V107 generate the maximum 10 mA output current. Furthermore, a –0.7 V DC offset is superimposed on the AC signal for biasing the capacitor C222, Selector.

Relais K204, Selector, selects AC or DC measurement.
Diode switches V129 to V132 serve for **Source Overload Protection.** During normal operation, the positive and the negative current source are active, and the source signal is fed through. When the High Drive HD connection senses voltages above +45 V, transistor V117 switches off the positive current source and separates the diode switches from the source. The negative current source unloads the capacitor at the component connector.
For negative High Drive HD voltages below −45 V, the two current sources operate vice versa.
For high V_{CE} voltage, two transistors are cascaded, for example, V124, V125.

Capacitor C222 is switched in for AC measurement, relay K202; it is short cut for DC measurement. The internal or external DC bias voltage is fed in behind this capacitor.

The **DC Bias Source** with the **Bias Overload Protector** corresponds to the AC Source just mentioned. The additional **Bias Regulator** N103 compares the HD voltage to a reference voltage. When selecting the internal bias voltage, the BSV signal closes relay K203, and the reference voltage is set to +0.94 V corresponding to the divider R123, R124 for 2 V nominal voltage. The voltage difference at the Bias Regulator N103 controls the current source to the maximum 20 mA output current. With decreasing voltage difference at the regulator, the current decreases too; finally, with no voltage difference the current of the positive and the negative source are equal, and no current will flow into the component.

When the internal bias voltage is switched off, BSV sets the reference voltage at the Bias Regulator to 0 V; the negative current source unloads the component at the connector. BSV switches the reference voltage and also relay K203; delayed switching off the relay (RC delay R262/C223) serves for proper unloading the component. Final unload is done via the 1.9 kΩ resistance consisting of R254, R255, and R291 to R295.

For external bias, the 1.9 kΩ resistance just mentioned serves as serial resistance with the external bias source. Relay K201 separates the connection to the internal source and connects the resistor to the EXT DC BIAS + connector at the rear panel.

Relay K204 switches the source resistance to nominal 100 Ω or 400 Ω for NORMAL and LOW LEVEL, or to 400 Ω for HIGH LEVEL. The nominal values are 7.5 Ω less because of the internal source resistance, especially of the protection circuit. For 400 Ω resistance, the 200 Ω, 172 Ω, and 21.5 Ω resistances are series connected to 393.5 Ω. For 100 Ω resistance, 200 Ω and 172 Ω are parallel connected to 92.4 Ω.

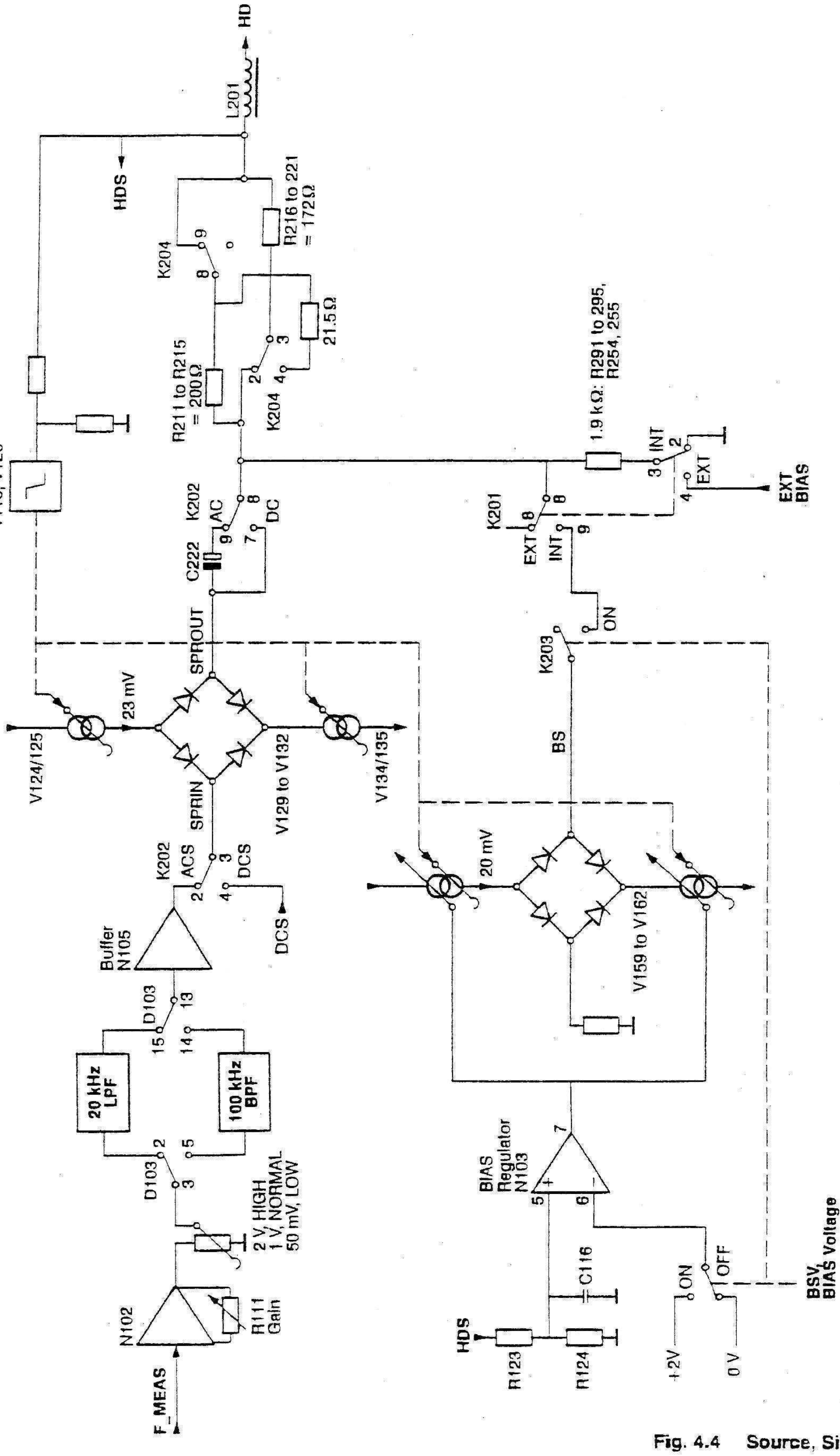


Fig. 4.4 Source, Simplified Diagram

4.6 SELECTOR, Figure 23

Source and Selector are closely related to each other; so the supply section for the component under test is described in the previous Section 4.5.
In the **Sense Buffer** of the AC Selector, see also Figure 4.5, the High Sense HS and Low Sense LS signals sense the voltage at the component. The AC/V Converter, next section, converts the component current to ACCH and ACCL (AC Converter High/Low) and feeds the signal to the sense buffer N204.
Power resistor R264 with clipping diodes D230/231 protect the buffer/amplifier N203. D204 switches between voltage and current sense buffer. In its third position, the input of the **Differential Amplifier** is switched to ground for reference measurements. In this position, potentiometer R242 adjusts the offset of the amplifier. The input buffers N205/206 can be switched from gain 1 to gain 6 for LOW Level measurement by N208. The four 2 kΩ resistors are built by the array R278, for high common mode rejection and temperature stability. Switch N202.2,3 separates the amplifier for DC measurement.

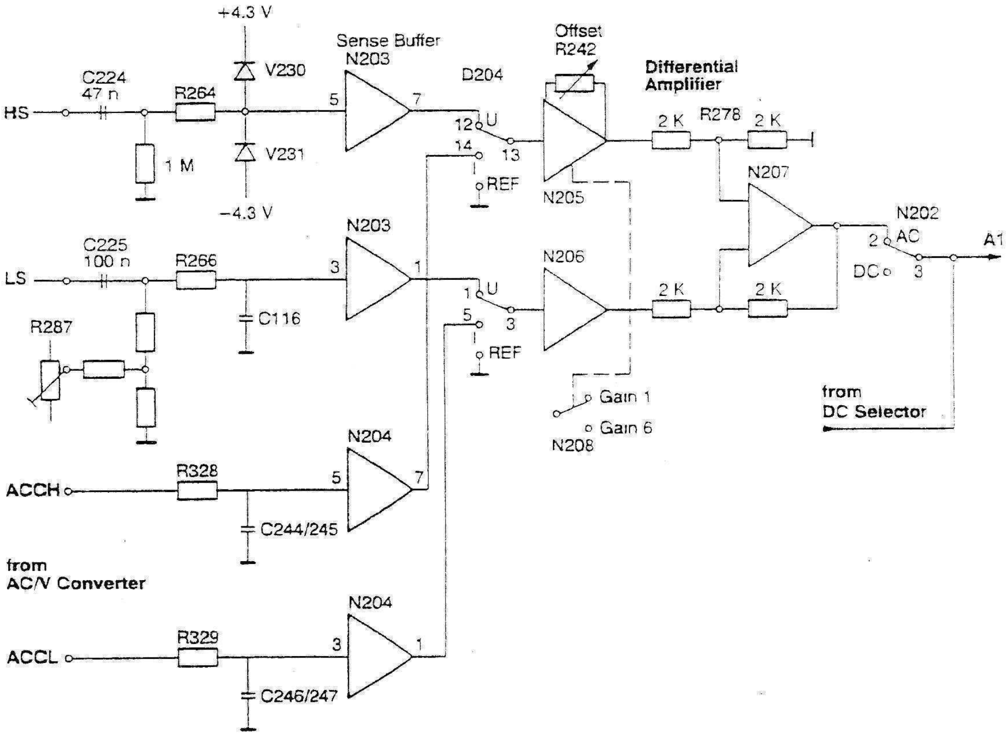


Fig. 4.5 AC Selector, Simplified Diagram

Figure 4.6 shows the **DC Selector** for DC measurement. Relay K206 selects HS. Similar, as for AC, power resistor R265 with clipping diodes D245/246 protect the buffer/amplifier N203.
During one measurement cycle, HS is switched through to the A1 output by N202.7,6, then LS is switched by N202.10,11, and finally S3IN is switched by N202.15,14, selected by shift register D201, strobe STR3. S3IN is the output of the DC/V Converter, Figure 32, where the signal is switched between High and Low.

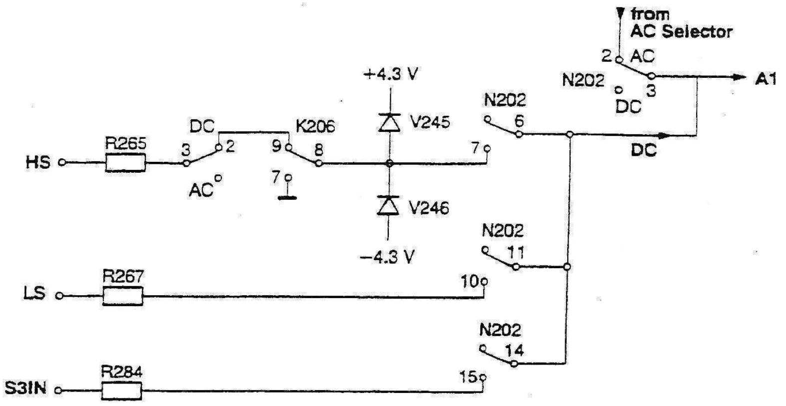


Fig. 4.6 DC Selector, Simplified Diagram

4.7 AC/V CONVERTER, Figure 24

Figure 24 also shows the connection to the **DC Unit 5.** If Unit 5 is missing jumpers between pins 7/8 and pins 33/34 must shorten the LD/LDAC and A1/A2 signals. Figure 4.7 shows the simplified diagram. The AC/V Converter converts the component current into a proportional voltage. Diodes V224/225 in the Selector limit voltage peaks at the LD connector. Additional diodes V301/302 and resistor R305 with diodes V303/304 protect the **trans-resistance amplifier N301.** Switch 303 selects gain 1 for **R303 (100 Ω)** or gain 100 for **R302 (10 kΩ).** Both resistors define the **accuracy of the instrument;** so they have 0.1 % accuracy, 5 ppm/K temperature stability, and good long-term stability. Deviations from the exact values are compensated by calibration. Separate switching the current path and the voltage sense line at the resistors eliminates the on-resistances of the HCMOS switches. The **Overload Detector, comparator N302,** monitores the output DC voltage of the amplifier. When large capacitances are reloaded at the component connection, or by low-ohmic resistance in DC Bias mode, the DC voltage at the component exceeds the comparator reference voltage ±2.5 V. The CPU monitores the Overload and interrupts the measurement.

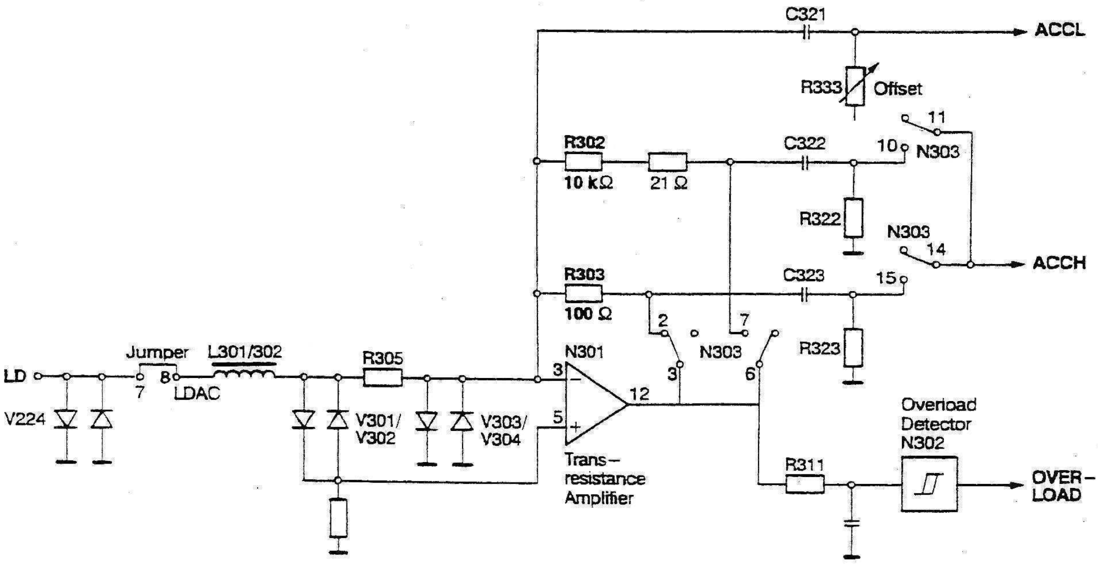


Fig. 4.7 AC/V Converter, Simplified Diagram

4.8 AMPLIFIER, Figure 25

For a general overview, please see also Figure 11, **Detailed Block Diagram**, and Figure 4.8 on page 4 – 13, **Analog Measurement Channel for AC Mode.**

The input signal of the Amplifier is either the output A1 of the Differential Amplifier of the Selector for AC measurement, or the output A2DC of the DC Unit 5 for DC measurement.

The **Pre-Amplifier** selects the gain according to the different HIGH, NORMAL, or LOW Level input, so that the output has equal voltage. Resistors R405 to R410 define the gain factors 1.11 (switch N407.14,15) for HIGH, 2.26 (N407.6,7) for NORMAL, and 7.5 (N407.3,2) for LOW Level. The additional level difference between DC Low Level (300 mV) and AC Low Level (50 mV) is compensated by the gain factor 6 in the Differential Amplifier.

The two stages in the **Main Amplifier N402, N403** with gain factors 1 and 10, respectively 1 and 4 are switched during the measurement cycle depending on the component under test. Gain factors unequal to 1 are selected only for voltage measurement at low-ohmic components or for current measurements at high-ohmic components. Both amplifier stages are similar. The amplifiers operate at their fixed gain, only the input attenuators, **Divider by 10,** or **Divider by 4** are selected by HCMOS switches D403, D404. The divider ratio influences the measurement accuracy of the instrument; therefore the ratio is measured during calibration.

4.9 FILTER, Figure 26

The circuit comprises **three selectable filters** and the **Window Detector.**

The Amplifier output passes **three selectable filters** depending on the selected test frequency:

- **300 Hz LPF** Lowpass Filter for test frequencies <400 Hz,
- **300 Hz HPF** Highpass Filter with subsequent **20 kHz LPF** Lowpass Filter for test frequencies 400 Hz to 20 kHz,
- **300 Hz BPF** Bandpass Filter for the 100 kHz test frequency.

The two 300 Hz filters are directly connected to the Amplifier output A4. The filter outputs are selected via the switch D501. The filter output resistors R529, R534, and R540 limit the current to the switch D501 operating at ±5 V.
The **Buffer N503**, gain factor 2, feeds the signal A5 to the Window Detector and to the Multiplying DAC.

The **Window Detector** senses the in-range condition of the measurement signal. It comprises two **Peak Rectifiers** for the positive and the negative peak value of the measurement signal.

In rest position, WDE (Window Detector Enable) low, all contacts of the switch D502 are closed. The input of the positive rectifier, amplifier N504.7, is held at the negative reference voltage of diode V552, and capacitor C554 is loaded via R557 to that voltage. The input of the negative rectifier, N504.2, and C555 are loaded to positive voltage, diode V551.

Before sensing the Window Detector, the CPU sets the WDE signal to high for one cycle of the measurement frequency or minimum 1 ms. All contacts of D501 are open, and both rectifiers receive the measurement signal. C554 is loaded to positive peak value, C555 to negative peak value. The output N505.7 of the positive rectifier is inverted by N506 and is added at the summing point N506.2 to the output N505.1 of the negative rectifier. So the DC output voltage N506.1 corresponds to the peak-to-peak amplitude of the measurement signal.

The **Comparator N507** compares the DC voltage to the reference voltages 3.896 V and 0.368 V set by R571 to R576, and sets the logic ABOVE or BELOW signal, or none of them. The CPU senses the outputs, and if ABOVE or BELOW is set, changes the gain factors in the Amplifier. After that the CPU resets the WDE signal to low, and so to its rest position.

4.10 MULTIPLYING DAC, Figure 27

Within one measurement cycle, the sense voltage at the component under test and the AC/V Converter output voltage are alternately processed in the Multiplying DAC. The A5 input signal of the DAC is multiplied successively by two quadrature-phase reference sine waves from the Signal Synthesizer, thus generating DC voltages A6 proportional to the in-phase component of the measurement voltage. The **Polarity Detector** provides the CPU with information about the right in-phase setting.

The OUT1 and OUT2 outputs of the DAC N601 deliver inverse currents being proportional to the product of the input signals. The OUT2 signal –DC is inverted by N603.13 and added to the OUT1 +DC signal.
The subsequent Dual-Slope Integrator can only process negative input voltages. This is achieved by selection of the phase relation between digital and analog sine wave. For this, the CPU senses the Polarity Detector and, for positive DAC output, changes the phase of the digital sine wave at the DAC input.

The Polarity Detector is similar to the Window Detector, Section 4.9. It comprises two peak detectors for the positive and the negative peak value. The addition of the peak values corresponds to the DC voltage.
In rest position, PDE (Polarity Detector Enable) high, all contacts of the switch D602 are closed. Capacitor C636 is loaded via diode V612 and resistor R648 to –5 V. Capacitor C637 is loaded via V614 and R649 to +5 V.

Before sensing the Polarity Detector, the CPU sets the PDE signal to low for one cycle of the measurement frequency or minimum 1 ms. All contacts of D601 are closed, diodes V612/614 are cut off. Amplifiers N606 load C636 to positive and C637 to negative peak value. Amplifiers N607 sense the capacitors. The outputs are summed via resistors R650 and R651 at input N604.3 of the comparator. The CPU senses the comparator outputs, and if NEGATIVE is not set, changes the phase of the digital sine wave at the DAC input. After that the CPU resets the PDE signal to high, and so to its rest position.

4.11 DUAL-SLOPE INTEGRATOR, Figure 28

The DC voltage at the output of the Multiplying DAC is converted to binary values in a dual-slope ADC, consisting of the **Dual-Slope Integrator** and the **Counter.**

For each analog-to-digital conversion the integrator performs the DC integration for a fixed period and then the de-integration to zero with the fixed DC input. The **Timer** within the Counter, Unit 2, defines the integration periods. The **Control Logic** wihin the Counter controls the process. For this see Figure 4.3, **Timing Diagram for One Conversion Period of the ADC.**

During the **HOLD period**, the switch N702.6,7 short cuts the integration capacitor C707. Switches N702.10,11 and N702.15,14 are open. Switch N702.2,3 holds the input voltage N702.15 to 0 V. By the voltage divider R710/709 and via R708 a constant input current I_E = 2.45 µA is fed to the integrator.

For the following **integration period,** switch N702.6,7 opens, N702.10,11 and N702.15,14 close. The integration current I_{int} is defined by R701/703 for 40 ms integration time t_{int}, and by R702/704 for 50 ms, selected by the T_50ms signal and switch N701. Capacitor C707 is loaded by the sum of I_{int} and I_E. At the end of the integration period the integrator output voltage is

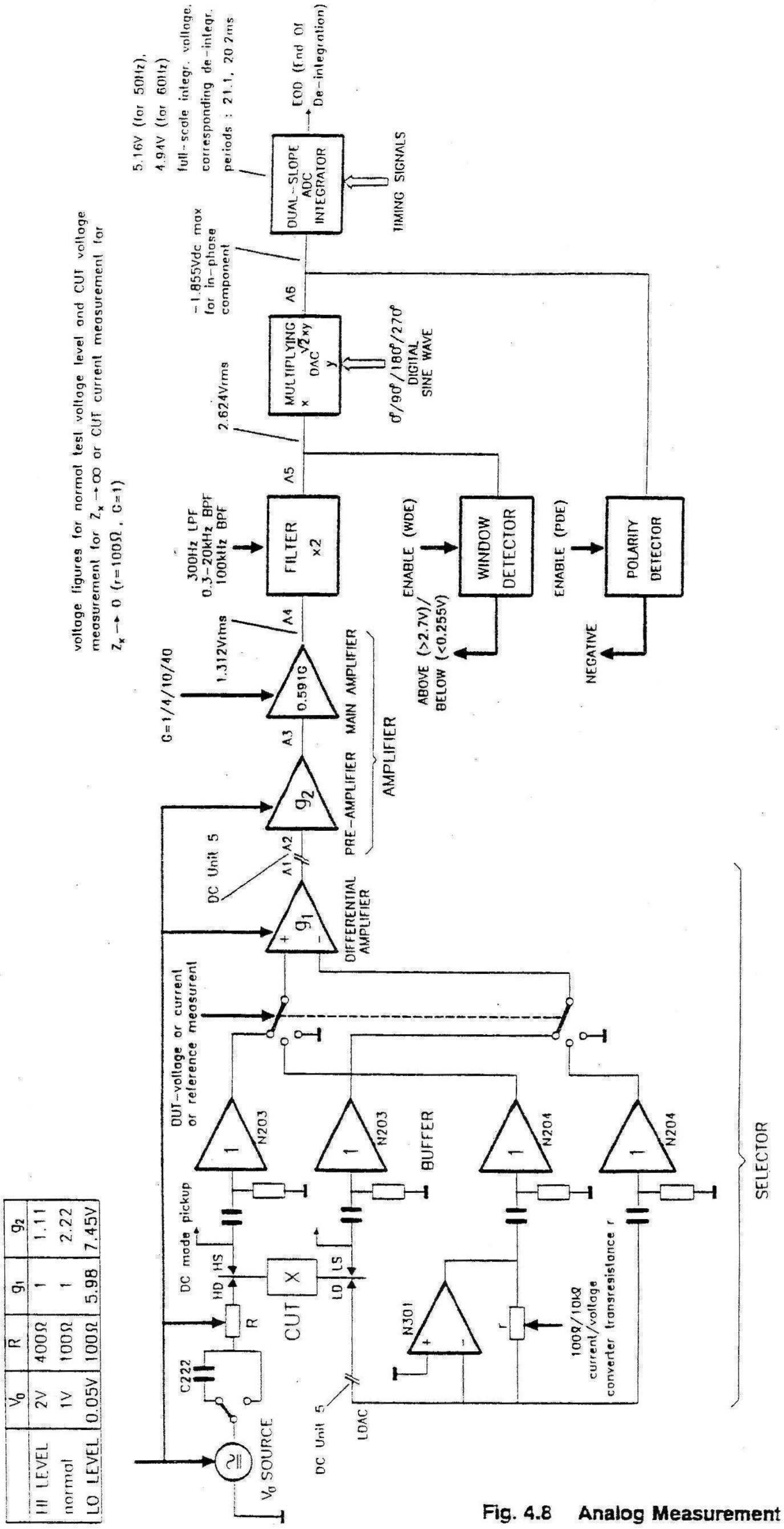
$$V_{int} = (I_{int} + I_E) \times t_{int} / C707.$$

For the maximum input voltage (−1.85 V and t_{int} = 40 ms), V_{int} is +5.15 V.
The minimum output V_{int} is +0.65 V, for I_{int} = 0.

At the end of the integration, the input current I_I is switched off by N702.15,14 and the **de-integration period** starts. For this a positive current I_D is fed to the integrator input via switch N702.10,11. Capacitor C707 is unloaded by the current difference $I_D - I_E$.

Zero output voltage of the integrator N703.1 switches the comparator output signal EOD, End Of De-integration, N703.7, from high to low and resets the COUNT signal in the Counter, Unit 2, to high, t4. The counter stops, and the HOLD signal holds the integrator output at 0 V. The counter state at t4 is proportional to the integrator output voltage at t3.
The HOLD signal is read by the CPU. So the CPU detects the end of conversion.
The maximum de-integration time is about 21 ms, the maximum counter state is about 435000.

If the integrator output passes −0.45 V at comparator N704, for example, when changing the component during measurement, the I_RES signal N704.1 gets low and interrupts the conversion via D307.14 and D314.14; HOLD signal discharges the integration capacitor to 0 V.



	V_0	R	g_1	g_2
HI LEVEL	2V	400Ω	1	1.11
normal	1V	100Ω	1	2.22
LO LEVEL	0.05V	100Ω	5.98	7.45V

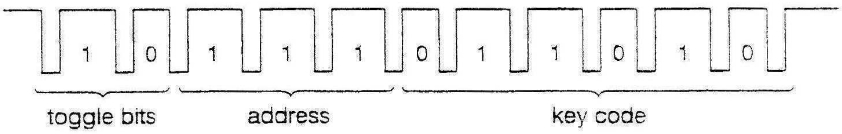
Fig. 4.8 Analog Measurement Channel for AC Mode

4.12 KEYBOARD / DISPLAY, UNIT 4, Figure 30

The unit consists of the Liquid Crystal Display (LCD) H102 with separate backlight H101, the decoder/drivers D103 and D104 for the LCD, the switches with the keyboard encoder D102, and the infrared receiver N101 with the infrared sensitive diode H103.
The data for the display are directly sent from the processor via I2C-bus (SCL, SDA) to the decoder/drivers D103 and D104. These components are Surface-Mounted Devices (SMD). If replacement is necessary and no suitable equipment for soldering is available, a complete mounted pcb can be ordered, see spare parts Chapter 13.
The function of the decoder/drivers together with the correct function of the display can be checked by the test program, step 1.
The display has 80 segments lit by two backplanes. The backplanes are controlled by D103, pin 1 (backplane 1) and pin 43 (backplane 2).
For allocation of display segments to display pins, see pages 4 – 15 to 4 – 18.

The backlight H101 consists of serial- and parallel-connected LEDs, supplied by 22 V. The components of the backlight supply are located on the Power Supply, Figure 16. The brightness can be adjusted with potentiometer R101; the brightness is normally set to 60 to 94 Lux.
When the display has been replaced, check the brightness respectively adjust it before the unit is mounted in again.

The keyboard encoder D102 controls a 7 x 3 keyboard matrix (drive lines D0 to D6 and sense lines S0 to S2). When a key is pressed the according sense line is forced to low and the encoder generates a sequence of 12 pulses, whereby the distance between the pulses means binary 0 or 1. This code is routed from the output REMO via line SKC (serial key code) to the CPU.



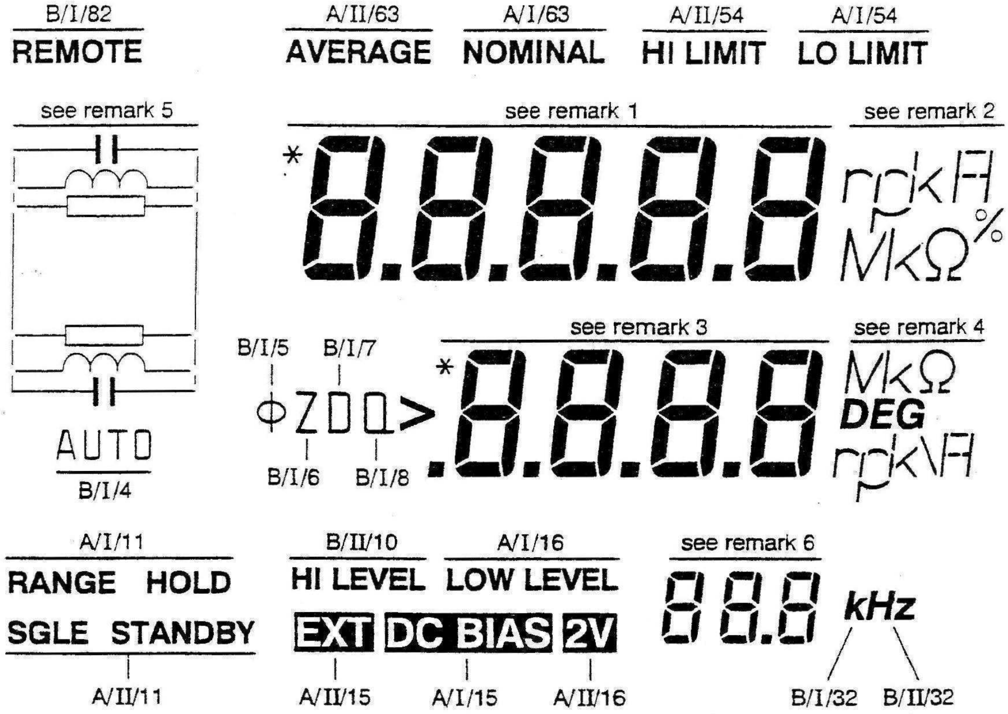
Each time a key is pressed such a bit sequence must be measurable at line SKC (pin 10 of connector X106 or pin 8 of D101. The toggle bits of this sequence change each time a key is pressed, so the processor can distinguish whether a key is pressed several times or once for a longer time.

The RES (reset) line of the switch S121 is routed to the processor (only until LO 648 884).

The diode H103 receives the amplitude modulated infrared signal from the PM 9559 bin programmer. The infrared receiver N101 amplifies this signal with an internal gain-controlled amplifier and routes it to a synchronous demodulator. The external oscillating circuit for the demodulator consists of L101 and C113. The demodulated signal is routed via an internal pulse shaper and an output buffer, which form pulses in accordance with the RC-5 standard, to pin 9. The output at pin 9 (active high) can drive a current of 75 µA; so the signal is fed to the Schmitt trigger stage D101. The output signal RC5 of the Schmitt trigger stage is directly routed via connector X106, pin 9, to the processor D107 on the CPU, Unit 2, Figure 18.

Allocation of Display Segments to Display Pins

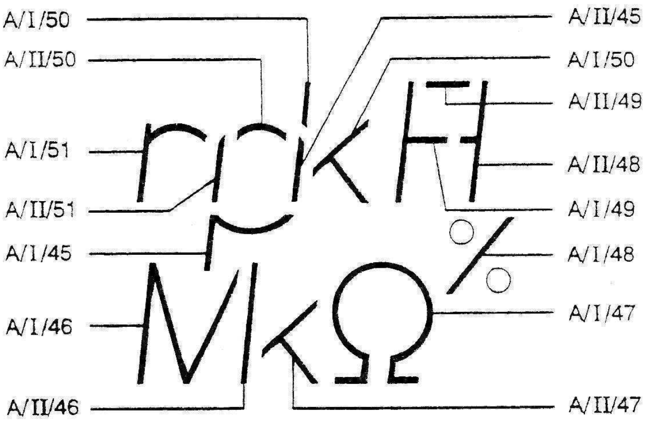
The letters A or B represent the assigned drivers (A = D103, B = D104), the digits I or II represent the assigned backplane (I = pins 1, II = pin 43). The last digits behind the slash are the pin numbers of the display.



Remarks 1 to 6:
Pin allocations are listed under following headers:

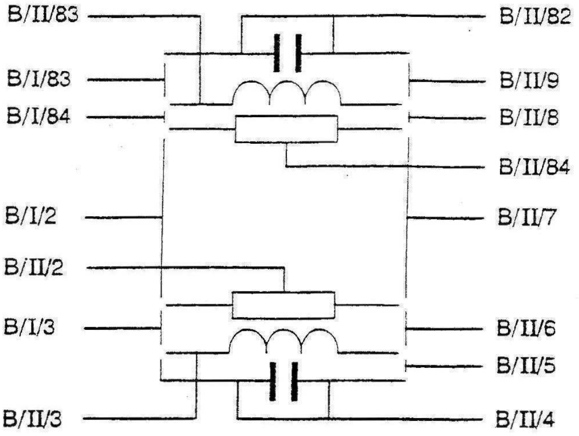
1 Digits for Value of Dominant Parameter
2 Unit of Dominant Parameter
3 Digits for Value of Secondary Parameter
4 Unit of Secondary Parameter
5 Equivalent Circuit Diagram
6 Digits for Value of Test Signal Frequency

Unit of Dominant Parameter

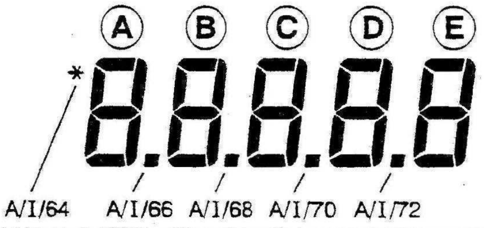


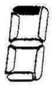
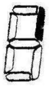
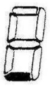
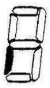
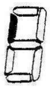
Unit of Secondary Parameter

Equivalent Circuit Diagram

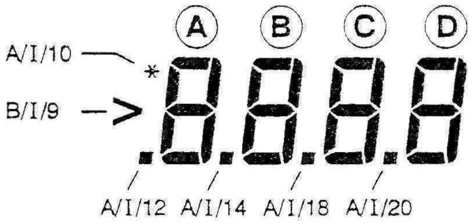


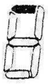
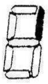
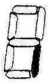
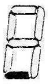
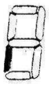
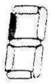
Digits for Value of Dominant Parameter



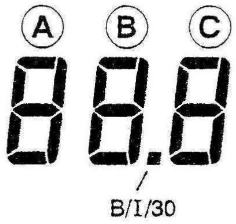
Segment / Digit							
Ⓐ	A/II/61	A/I/61	A/I/65	A/II/64	A/II/65	A/II/62	A/I/62
Ⓑ	A/II/59	A/I/59	A/I/67	A/II/66	A/II/67	A/II/60	A/I/60
Ⓒ	A/II/57	A/I/57	A/I/69	A/II/68	A/II/69	A/II/58	A/I/58
Ⓓ	A/II/55	A/I/55	A/I/71	A/II/70	A/II/71	A/II/56	A/I/56
Ⓔ	A/II/52	A/I/52	A/I/73	A/II/72	A/II/73	A/II/53	A/I/53

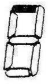
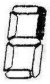
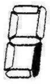
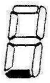
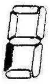
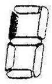
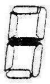
Digits for Value of Secondary Paramter



Segment / Digit							
Ⓐ	B/II/80	B/I/80	B/I/13	B/II/12	B/II/13	B/II/81	B/I/81
Ⓑ	B/II/78	B/I/78	B/I/17	B/II/14	B/II/17	B/II/79	B/I/79
Ⓒ	B/II/76	B/I/76	B/I/19	B/II/18	B/II/19	B/II/77	B/I/77
Ⓓ	B/II/74	B/I/74	B/I/21	B/II/20	B/II/21	B/II/75	B/I/75

Digits for Value of Test Signal Frequency



Segment / **Digit**							
Ⓐ	B/II/24	B/I/24	B/I/26	B/I/27	B/II/26	B/II/25	B/I/25
Ⓑ	B/II/22	B/I/22	B/I/28	B/II/29	B/II/28	B/II/23	B/I/23
Ⓒ	B/II/33	B/I/33	B/I/31	B/II/30	B/II/31	B/II/34	B/I/34

4.13 DC UNIT 5, Figures 32, 33
DC/V CONVERTER, Figure 32

The circuit diagram shows the connection to Unit 3, AC/V Converter.
If the DC Unit is built, in low signal DC_AVAIL, pin 20, is identified by the CPU.
If the DC Unit is not built in, jumpers between pins 7/8 and pins 33/34 must shorten the LD/LDAC and A1/A2 signals on the AC/V Converter.
Relays K101 and K102 switch the LD and A1 signals between AC and DC measurement.
The diagram of the DC/V Converter corresponds to the AC/V Converter, Section 4.7.
Figure 4.9 shows the simplified diagram.

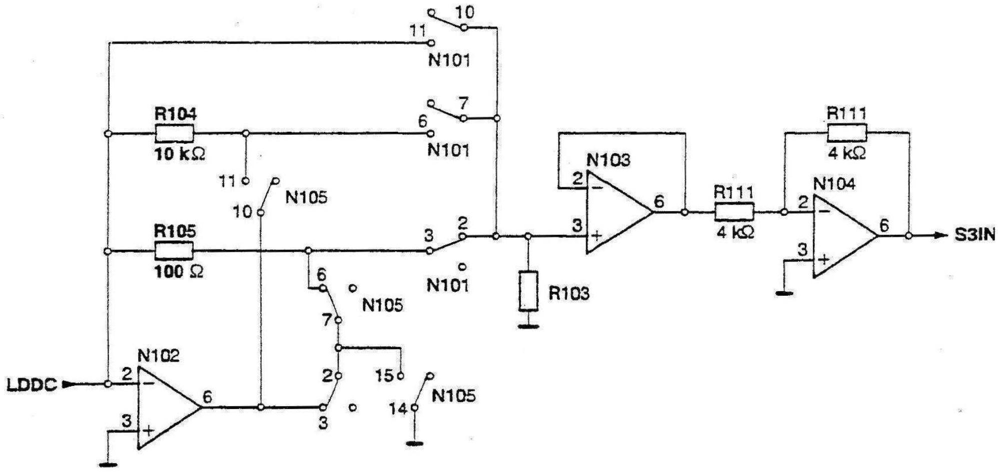


Fig. 4.9 DC/V Converter, Simplified Diagram

Amplifier N102 with transistor V105 generate the maximum −10 mA output current. Switch N105 selects **R105 (100 Ω)** or **R104 (10 kΩ).**
Amplifier N103 senses the voltage at the resistors via switch N101. Resistor R103 prevents drift of the amplifier input if during switching all switches are open.

Amplifier N102 inverts the test current to negative voltage. However, the voltage at the component under test is positive. So N104 inverts the current signal. For good temperature stability of the gain factor −1, resistor array R111 realizes the 4 kΩ resistors. The calibration takes into account the absolute value of the gain factor.

The output S3IN is fed to the Selector, and via A1, A1DC fed to the DC/AC Converter.

4.14 DC/AC CONVERTER, Figure 33

The figure comprises the **DC Source** and the **DC/AC Converter.**

From the −15 V supply in the **DC Source** the inverted −2 V, −1 V, or −300 mV HIGH, NORMAL or LOW LEVEL voltages are derived, and via multiplexer D201 fed to the inverting amplifier N201. The output DCS is fed to the Selector. Transistor V201 is necessary for the maximum 10 mA current.

The **DC/AC Converter** converts the measurement voltage of the component under test and the DC/V Converter output S3IN, A1, A1DC to 2 kHz sine wave voltages. The circuit corresponds to the Multiplying DAC, Section 4.10, but with reverse function. By multiplying the DC test voltage with a digital sine wave, a proportional AC voltage is generated which in the subsequent circuits can be processed as for AC measurement.
The peak AC voltage is proportional to the DC voltage. The gain factor of amplifier N202 is 3, resistors R212 to R214. Inverter N205 acts as 150 Hz lowpass filter for ac voltages coupled into the component under test.
The circuit DAC N203 with amplifiers N206, N207 is identical to the Multiplying DAC. The difference of output 1 and 2 causes double AC voltage and suppresses DC voltages. C224/R224 with follower N201 suppress further DC offsets.

4.15 HANDLER INTERFACE, UNIT 6, Figure 35

The Handler Interface has an electrical insulation by optocouplers to separate external connected devices and internal circuits.

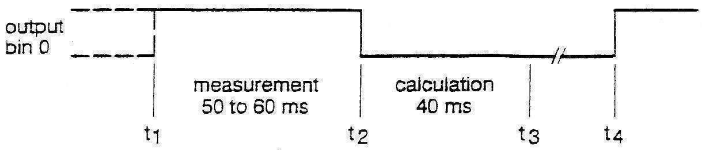
The output data for the interface, bin 0 to bin 9 and FAIL, are routed by the C-bus (SD, SC, STR6) via optocouplers H102 to H104 to the shift registers D106 and D107. Due to the optocouplers the serial data transfer is reduced to 20 kHz. The parallel outputs of the shift registers are fed by the driver stage N105 and N106 to the connector X820. The driver stage has Darlington transistor arrays with open collectors and integrated protection diodes to switch capacitive loads.

The H_TRIG input, X820, pin 13, is routed to the processor and acts as the TRIG key on the front panel. The line is pulled up to +5V with R113 and can be pulled to ground, X820, pin 14, with an external switch or relay. Contact bouncing is suppressed by the processor during normal measurements. Due to the internal timing, contact bouncing cannot be suppressed in the FAST measurement mode. The diodes V105, V106, and the capacitor C106 protect the input of the inverter D109 against voltage peaks. The signal H_TRIG is also electrically insulated, optocoupler H105.

The electrical insulated circuit (shift registers, drivers, and the inverters) has a separate power supply, rectifier diodes V101 to V104, filter capacitor C102, and regulator N101, which generates the +5 VB voltage. The ac voltage AC_S1/AC_S2 is directly derived from the transformer. The fuse for the supply, multifuse F111, is located on Unit 1.

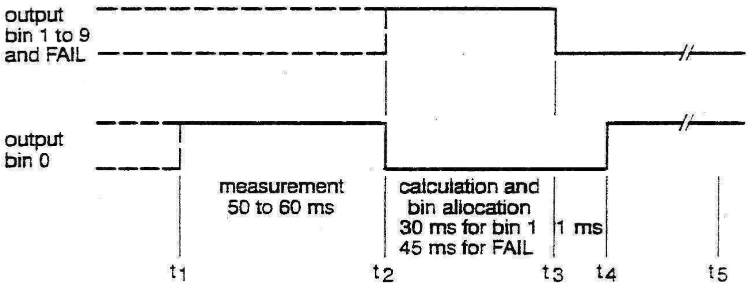
The output signal bin 0, X820, pin 10, provides a timing signal in the FAST measurement mode.

Timing Signal Bin 0 in FAST Mode



t_1: Trigger starts measurement. Measurement time depends on test signal frequency and CUT; 50 to 60 ms at 1 kHz.
t_2: End of measurement; CUT can be removed.
t_3: Measurement result available.
t_4: Trigger starts next measurement.

Timing Signal Bin 0 in FAST Mode during Binning



t_1: Trigger starts measurement. Measurement time depends on test signal frequency and CUT; 50 to 60 ms at 1 kHz.
t_2: End of measurement; CUT can be removed.
t_3: Outputs bin 1 to 9 or FAIL are set.
t_4: Outputs are valid; CUT can be handled according to the set bin.
t_5: Trigger starts next measurement.

4.16 IEEE-488 INTERFACE, Figure 39
RS-232 INTERFACE, Figure 37

The instrument can be remotely controlled via the IEEE-488 Interface or the RS-232 Interface. Only one of the two interfaces can be built in.

For troubleshooting see also Chapter 8, Self Diagnostic and Troubleshooting, Program 9, Interface Test.

The interface controls the communication between the internal I^2C-bus and the external bus or data. For this an independent **interface processor** is built in. The processor transfers the parallel IEEE-488 bus data, or the serial RS-232 data to the internal serial I^2C-bus. The instrument is in general IEEE-488.2 compatible. The IEEE-488 Interface has a mask-programmed PROM within the processor, while the RS-232 Interface has a separate EPROM.

To ensure reliable operation, and to avoid electromagnetic interference and hum pickup, the internal I^2C-bus is electrically insulated by **optocouplers** against the external bus or data. The insulated circuit has a separate power supply, +5 VA. 8 V ac, directly derived from the transformer, are routed via the Power Supply, Unit 1, Figure 16, and the CPU, Unit 2, Figure 18. On the interfaces the voltage is rectified, stabilized, and smoothed to 5 V DC.
For the Interfaces, there is no separate fuse necessary. Short cuts on these units will blow up the mains fuse.
For troubleshooting on the two interfaces please note the different positions of the optocouplers with relation to the processors and so also the different area for the two 5 V supplies.

When a device-specific message is present, the processor sends an interrupt to the CPU, line INT, 8-pole socket, pin 3, and the message is transferred via the I^2C-bus to the instrument processor.

The RESET line, 8-pole socket, pin 8, sets the instrument processor to its initials state when the power is turned on or when the RESET key is pressed.

The **IEEE-488 bus** and the interface processor communicate via the input/output buffer/driver D317 for the control lines, and via D316 for the data lines.
The I^2C-bus lines are routed via the bidirectional buffer/drivers D301, D311.

The **RS-232 signal lines** and the interface processor communicate via the drivers/receiver D105, D106. Crystal G101 generates the basic clock for the processor.
From that clock, via the SCL and SDL lines, the processor defines the Baud rate for the transmission speed. For the lowest 110 Baud rate, the divider D102 is switched in.

5 PERFORMANCE TEST

5.1 INTRODUCTION

The performance test may be used as an acceptance test upon receipt of the instrument. If the test fails, an indication is given, that repair and/or adjustment is required.
The test procedure for the key parameters of the instrument, specified in Section 5.4, refers to the Performance Specification in Chapter 1 of the Reference Manual.
The PM6304 must be warmed up with all covers in place for at least 5 minutes before starting the tests.

5.2 RECOMMENDED TEST EQUIPMENT

AC rms Voltmeter	Fluke 8920A
DC Voltmeter	Philips PM 2535
Counter	Philips PM 6665

For performance verification, Section 5.4.1, the errors of these instruments must be taken into account.

2 Single Test Posts	PM6304 standard accessory
Test post red:	5322 264 30351
Test post black:	5322 264 30352

Test Set for PM6304, PM6304C, PM6306	5322 310 32273

Test Set for PM6304 only	5322 310 32225

This Test Set (without the 1 kΩ and 20 kΩ resistors) is still available.

Used for / Component	PM6304	PM6304C	PM6306	Instrument Accuracy		Max. CUT Tolerance for Test	Component Value
				PM6304/06	PM6304C		
1 R 1 Ω	●	●	●	±0.1 %	±0.1 %	±0.02 %	CV1
1 R 4 Ω	●	●	●	±0.1 %	±0.1 %	±0.02 %	CV2
1 R 100 Ω 1)	●	●	●	±0.1 %	±0.05 %	±0.005 %	CV3
1 R 1 kΩ		●	●	±0.1 %	±0.05 %	±0.01 %	CV4
1 R 10 kΩ 1)	●	●	●	±0.1 %	±0.05 %	±0.005 %	CV5
1 R 20 kΩ		●		±0.1 %	±0.05 %	±0.01 %	CV6
1 R 500 kΩ	●	●	●	±0.1 %	±0.1 %	±0.02 %	CV7
1 R 2 MΩ	●	●	●	±0.1 %	±0.1 %	±0.02 %	CV8
1 R 100 MΩ	●	●	●	±5 %	±5 %	±1 %	CV9
1 C 10 nF	●	●	●	±0.1 %	±0.05 %	±0.02 %	CV10

1) For these resistors tighter tolerances are necessary because they are used for recalibration of the PM6304 and PM6304C.

The Test Set is supplied with the component values of the single components.
The specified component uncertainties are valid for frequencies <10 kHz.
Because of component aging, it is necessary to measure the components after two years again.

5.3 SELF-TEST ROUTINE

After power on, the instrument checks the PROM, the processor RAM, and the external RAM. After that, it displays the current software version (Vx.x) and automatically recalls its settings before power off. The instrument also generates error messages if there are faults during measurements or trimming or if there is a fault during data transfer to a printer.

A possible fault is indicated as follows,

for example: Err 2

For detailed description see Chapter 9.

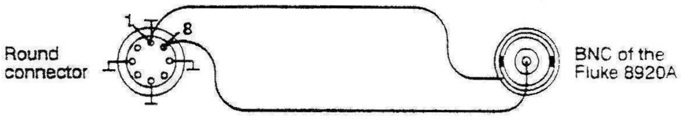
5.4 PERFORMANCE VERIFICATION

5.4.1 Test Signal Voltage

Conditions: No component connected to PM6304.

Test equipment: AC rms Voltmeter, DC Voltmeter

- Set PM6304 to AUTO and to DC BIAS OFF.
- Connect AC rms Voltmeter with tips to pin 8 (HIGH terminal) and pin 1 (circuit ground) of the round connector.
  Pin 1 must be connected to the outer part (ground) of the BNC connector of theVoltmeter.
  Use short measurement leads.



- Set test signal frequency to 1 kHz.

Test result:	1 V	±20 mV (NORMAL level)
	50 mV	± 2 mV (LOW LEVEL)
	2 V	±40 mV (NORMAL LEVEL

[illegible]

- Connect DC Voltmeter to pin 8 and pin 1.
- Set test signal source to DC.

Test result:	1 V	±40 mV (NORMAL level)
	0.3 V	±12 mV (LOW LEVEL)
	2 V	±80 mV (NORMAL LEVEL

5.4.2 Test Signal Frequency

Test equipment: Counter

- Set the counter to 1s gate time.
- Set the PM6304 to 100 kHz test signal frequency.
- Connect the counter with tips to pin 8 and pin 1 of the round connector.

Test result: 99.99 to 100.01 kHz

5.4.3 Open-Circuit Trimming

- Insert the two single test posts into the **two left** positions (logos face to face).
- Press the **ZERO TRIM** key.
- Keep the key depressed until the display changes from ***OPEN*** to ***BUSY***.

Test result: The display sequentially shows ***OPEN***, ***BUSY***, ***PASS***, and about 0.0 pF finally.

5.4.4 Short-Circuit Trimming

- Short the test posts by a clean wire, diameter approximately 1 mm.
- Press the **ZERO TRIM** key.
- Keep the key depressed until the display changes from ***SHORT*** to ***BUSY***.

Test result: The display sequentially shows ***SHORT***, ***BUSY***, ***PASS***, and about 0.000 Ω finally.

If these tests are not performed accurately, the display shows ***FAIL*** instead of ***PASS***. Check the test conditions, and in doubt, repeat the procedure.

5.4.5 AC Measurements

- Perform open-circuit and short-circuit trimming for each test frequency.
- Repeat trimming for each level at 100 kHz.
- Insert the leads of the 1 Ω, 4 Ω, and 100 Ω resistors completely into the test posts.

The **test result requirement** must be calculated in accordance with the instrument tolerance and the resolution of the display, **±1 digit** in general.

Example:

Test signal frequency:	1 kHz
Test signal level:	NORMAL
CUT:	500 kΩ (CV7 = 500.04 kΩ)
Instrument accuracy:	0.1 % (basic accuracy) ±1 digit

Test result requirement:

500.04 kΩ ±0.1 % = 500.04 kΩ ±0.50004 kΩ =	499.53996 to 500.54004 kΩ
The display rounds to 5 digit resolution:	499.54 to 500.54 kΩ
±1 digit:	**499.53 to 500.55 kΩ**

Test Signal Frequency	Test Signal Level	Test Component	Test Result Requirement
100 Hz	LOW NORMAL HIGH	4 Ω	CV2 ± 1.13 % CV2 ± 0.10 % CV2 ± 0.15 %
	LOW NORMAL HIGH	500 kΩ	CV7 ± 1.08 % CV7 ± 0.10 % CV7 ± 0.10 %
1 kHz	LOW NORMAL HIGH	1 Ω	CV1 ± 1.5 % CV1 ± 0.1 % CV1 ± 0.2 %
	LOW NORMAL HIGH	4 Ω	CV2 ± 0.5 % CV2 ± 0.1 % CV2 ± 0.1 %
	LOW NORMAL NORMAL HIGH	100 Ω	CV3 ± 0.5 % CV3 ± 0.1 % (PM6304) CV3 ± 0.05 % (PM6304C) CV3 ± 0.1 %
	LOW NORMAL NORMAL HIGH	10 kΩ	CV5 ± 0.5 % CV5 ± 0.1 % (PM6304) CV5 ± 0.05 % (PM6304C) CV5 ± 0.1 %
	LOW NORMAL HIGH	500 kΩ	CV7 ± 0.5 % CV7 ± 0.1 % CV7 ± 0.1 %
	LOW NORMAL HIGH	2 MΩ 1)	CV8 ± 1.43 % CV8 ± 0.1 % CV8 ± 0.1 %
	NORMAL HIGH	100 MΩ	CV9 ± 5.0 % CV9 ± 2.5 %
	LOW NORMAL NORMAL HIGH	10 nF 2)	CV10 ± 0.5 % CV10 ± 0.1 % (PM6304) CV10 ± 0.03 % (PM6304C) CV10 ± 0.1 %

Test Signal Frequency	**Test Signal Level**	**Test Component**	**Test Result Requirement**
10 kHz	LOW	4 Ω	CV2 ±0.5 %
	NORMAL		CV2 ±0.1 %
	HIGH		CV2 ±0.1 %
	LOW	500 kΩ	CV7 ±0.5 %
	NORMAL		CV7 ±0.1 %
	HIGH		CV7 ±0.1 %
	LOW	10 nF 2)	CV10 ±0.5 %
	NORMAL		CV10 ±0.1 %
	HIGH		CV10 ±0.1 %
100 kHz	LOW	4 Ω	CV2 ±2.0 %
	NORMAL		CV2 ±0.4 %
	HIGH		CV2 ±0.4 %
	LOW	500 kΩ	CV7 ±2.0 %
	NORMAL		CV7 ±0.4 %
	HIGH		CV7 ±0.4 %

In additon for the instrument version **PM6304C:**

Test Signal Frequency	**Test Signal Level**	**Test Component**	**Test Result Requirement**
100 Hz	NORMAL	1 kΩ	CV4 ±0.05 %
300 Hz	NORMAL	20 kΩ	CV6 ±0.05 %
2 kHz	NORMAL	1 kΩ	CV4 ±0.05 %
2 kHz	NORMAL	20 kΩ	CV6 ±0.05 %

1) If you cannot meet the test results for the 2 MΩ resistor it might be that the test resistor has drifted from its calibrated value. The resistor has a drift of max. <0.04 % in 3 years. Please check whether the resistor should be measured again.

2) If you cannot meet the test results for the 10 nF capacitor it might be that the test capacitor has drifted from its labeled original value. Please check whether the capacitor should be measured again.
The measurement uncertainty must be <0.02 %.
You can also order a new capacitor; code number 5322 126 13738.
The original measurement date is indicated on the bag for the capacitor.
The capacitance drift is specified to <0.2 % in 3 years.
According to our experience the drift is much lower: <0.04 % in 3 years.
There are no capacitors with lower drift at the low price of this capacitor on the market.
If you have access to a low-drift standard capacitor in your calibration laboratory or elsewhere, please make use of.

5.4.6 DC Measurements

(for instruments with DC Unit 5 only).

Test Signal	Test Signal Level	Test Component	Test Result Requirement
DC	LOW	1 Ω	CV1 ± 1.30 %
	NORMAL		CV1 ± 0.40 %
	HIGH		CV1 ± 0.80 %
	LOW	4 Ω	CV2 ± 0.33 %
	NORMAL		CV2 ± 0.10 %
	HIGH		CV2 ± 0.20 %
	LOW	10 kΩ	CV5 ± 0.10 %
	NORMAL		CV5 ± 0.10 %
	HIGH		CV5 ± 0.10 %
	LOW	500 kΩ	CV7 ± 0.33 %
	NORMAL		CV7 ± 0.10 %
	HIGH		CV7 ± 0.10 %
	LOW	2 MΩ	CV8 ± 1.33 %
	NORMAL		CV8 ± 0.40 %
	HIGH		CV8 ± 0.20 %

6 RECALIBRATION

6.1 GENERAL

The instrument was calibrated in the factory prior to shipment. The calibrating data are stored in an EEPROM and are taken into account during every measurement.
It is necessary to calibrate again after loss of data (replacing the EEPROM), after changing components which might influence the measuring result, or when the instrument does not meet the Technical Specifications. In normal operation, recalibration once a year is sufficient.

For reference measurements, you need a short-circuit link, a 100 Ω resistor, and a 10 kΩ resistor. These items are included in the Test Set, used for the Performance Test, see Chapter 5.

If you use own resistors, please note:

- For 100 Ω measurement, the resistor should be in a range from 99 Ω to 101 Ω; its value must be known within a tolerance of ±50 ppm (0.005 %).
- For 10 kΩ measurement, the resistor should be in a range from 9.9 kΩ to 10.1 kΩ; its value must be known within a tolerance of ±50 ppm (0.005 %). Its parallel capacitance should be about 0.5 pF, that means a dissipation factor D of about 320 at 100 kHz test signal frequency.

The recalibration procedure contains seven calibration steps:

CAL 1	Value input of the 100 Ω resistor.
CAL 2	Value input of the 10 kΩ resistor, confirmation to start measurements.
CAL 3	Short-circuit measurement.
CAL 4	Open-circuit measurement.
CAL 5	Reference measurement at 100 Ω.
CAL 6	Reference measurement at 10 kΩ.
CAL 7	Measurement at 10 kΩ with higher frequencies.

The procedure needs approximately 5 minutes, using either the PM 9559 Bin Programmer or a PC and the PM 9548 IEEE-488 Interface, or the PM 9549 RS-232 Interface.

6.2 RECALIBRATION WITH THE PM 9559 BIN PROGRAMMER

Plug test posts or the PM 9542A RCL Adapter into the front panel connector of the RCL Meter. Instrument settings do not influence the recalibration procedure.

Take the bin programmer and press the CAL 100 Ω key.

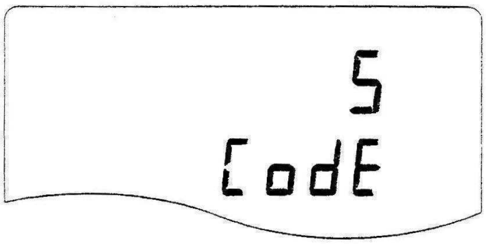
During the first three steps you can leave the procedure by pressing the NORMAL key. When step three is completed by pressing the ENTER key the instrument switches automatically to the next steps.
In general: If no action follows within 15 seconds the instruments returns to normal operation. The data of the last calibration remain valid. Only after complete recalibration (display shows PASS) the new data are stored.

You should not touch the connection sockets during measurements, otherwise the measured result could be wrong.

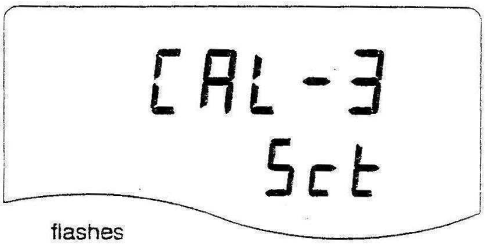
The display shows:

Input the exact value of the 100 Ω resistor you use. You can either input the real value of the resistor or its difference to 100 Ω as an absolute value, for example 0.001, instead of 100.001.
Press the ENTER key.

Input the exact value of the 10 kΩ resistor you use in the same way as described for the step before.
Press the ENTER key.



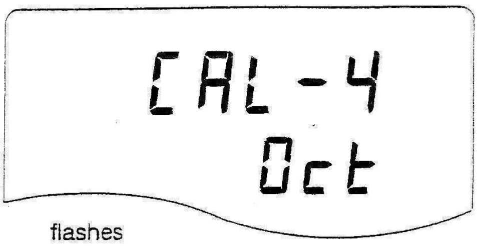
The number shown is the number of the last recalibration. Input that number and press the ENTER key to confirm.
After each calibration the number is automatically incremented by one.



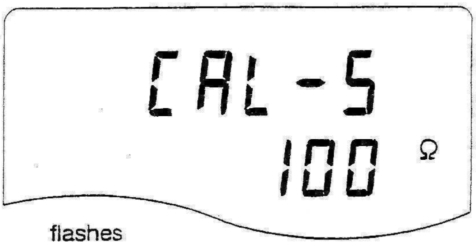
flashes

Insert the short-circuit link and press the ZERO TRIM key⋆ at the front panel of the RCL Meter.

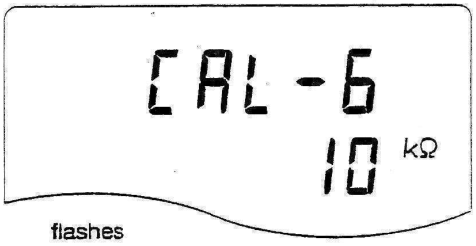
The display stops flashing. The instrument measures the short-circuit impedance. This lasts approximately 20 seconds.



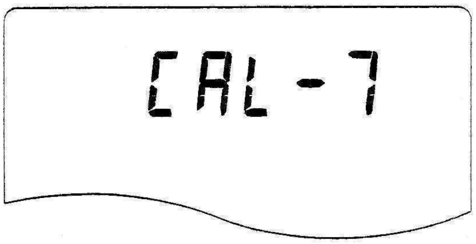
Remove the short-circuit link and press the ZERO TRIM key★. The display stops flashing. The instrument measures the open-circuit impedance and switches to the next step after 20 seconds.



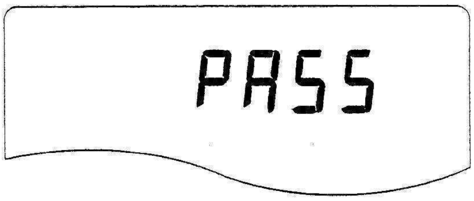
Insert the 100 Ω resistor and press the ZERO TRIM key★. The display stops flashing. The instrument measures the resistor for reference. It lasts approximately 20 seconds.



Insert the 10 kΩ resistor and press the ZERO TRIM key★. The display stops flashing. The instrument measures the resistor for reference. It lasts approximately 20 seconds.



Do not remove the resistor. The instrument measures with different test signal frequencies. When the calibration is completed successfully the display shows:



The instrument returns automatically to normal operation selected before.

★ Instead of the ZERO TRIM key you can press any other key of the keyboard, except the LOCAL key, or any key of the bin programmer.

If the short- or open-circuit trim was not successful the instrument shows FAIL.
If the values of the resistors are out of range the instrument shows Error 40 or 41.
In these cases repeat the procedure.

If other error messages appear the instrument is suspected of being defective.
See Error Messages, Chapter 9.

6.3 RECALIBRATION VIA IEEE-488 OR RS-232 INTERFACE

Recalibration via remote control implicates that you are acquainted with the interface functions, remote control commands, and message syntax. A detailed description of the remote control operation is in the Programming Manual. Before you start the recalibration, please read Section 6.1 in this manual.

Plug test posts or the PM 9542A RCL adapter into the front panel connector of the RCL Meter. You should not touch the connection sockets during measurements, otherwise the measured result could be wrong. Instrument settings do not influence the recalibration procedure. Start your remote control program.

If you want, you can ask for the current calibration status as follows:

Query:	CAL?	
Response:	CAL OFF	Means calibration data not valid or lost.
or	CAL ON;NO. <NR1>,YY/MM/DD	

<NR1> is the number of calibrations since first delivery,
YY/MM/DD (Year/Month/Date) is the date of the last recalibration via interface.

Send the commands for the new calibration date, the 100 Ω resistor value, the 10 kΩ resistor, and the command to start the recalibration.

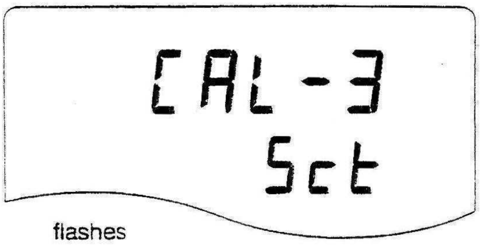
Date:	DATE YY/MM/DD	YY = Year, MM = Month, DD = Day, leading zeros can be left out.
Example:	DATE 92/9/21	Means September, 21st, 1992.

The input of the date is optional. If you do not send a new date, the old one is deleted after recalibration.

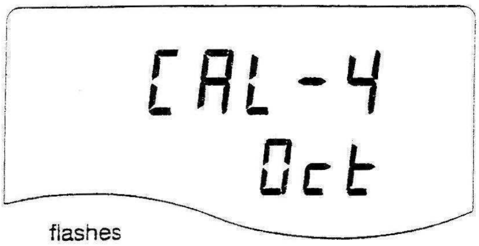
100 Ω value:	REF_RES_LO <NRf>	<NRf> = real, integer, or exponential value.
Example:	REF_RES_LO 100.002	
10 kΩ value:	REF_RES_HI <NRf>	
Example:	REF_RES_HI 9.998E3	
Recalibration:	CAL	Starts the recalibration procedure.

Same commands in single string:
DATE 92/9/21;REF_RES_LO 100.002;REF_RES_HI 9.998E3;CAL

The diplay shows:

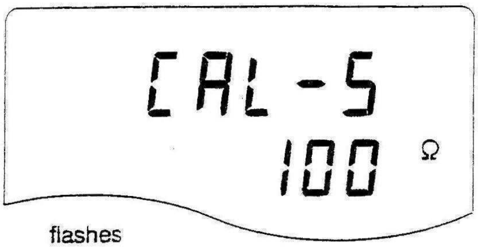


Insert the short-circuit link.
Send the command TRIG or press the TRIG key⋆ on the front panel of the RCL meter.
The display stops flashing. The instrument measures the short-circuit impedance. This lasts approximately 20 seconds.



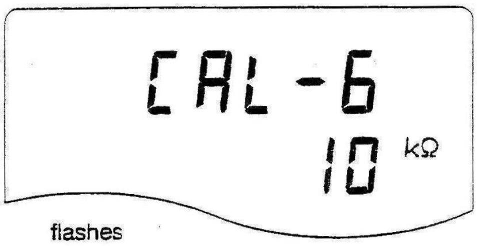
flashes

Remove the short-circuit link.
Send the command TRIG or press the TRIGGER key* on the front panel of the RCL Meter.
The display stops flashing. The instrument measures the open-circuit impedance and switches to the next step after 20 seconds.



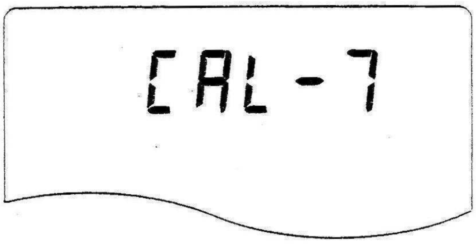
flashes

Insert the 100 Ω resistor.
Send the command TRIG or press the TRIGGER key* on the front panel of the RCL Meter.
The display stops flashing. The instrument measures the resistor for reference. It lasts approximately 20 seconds.

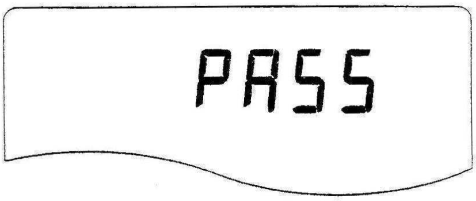


flashes

Insert the 10 kΩ resistor.
Send the command TRIG or press the TRIGGER key* on the front panel of the RCL Meter.
The display stops flashing. The instrument measures the resistor for reference. It lasts approximately 20 seconds.



Do not remove the resistor. The instrument measures with different test signal frequencies. When the calibration is completed successfully the display shows:



The instrument returns automatically to normal operation selected before.

* Instead of the TRIGGER key you can press any other key of the keyboard, except the LOCAL key.

If there is any error during the calibration procedure the instrument generates a message with an error number and a description in clear text.

7 DISASSEMBLING THE INSTRUMENT

7.1 GENERAL INFORMATION

This section provides the disassembling procedures required for the removal of components during repair operations.
All circuit boards removed from the instrument must be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.
During disassembling make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when the instrument is reassembled.

CAUTION:

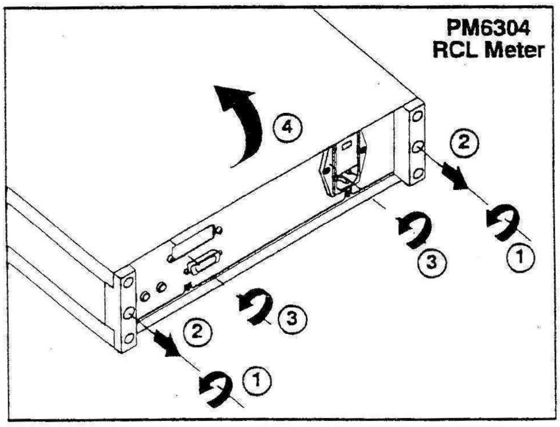
Damage may result if:

- The instrument is turned on when a circuit board has been removed.
- A circuit board is removed within one minute after turning off the instrument.

7.2 REMOVING THE COVERS

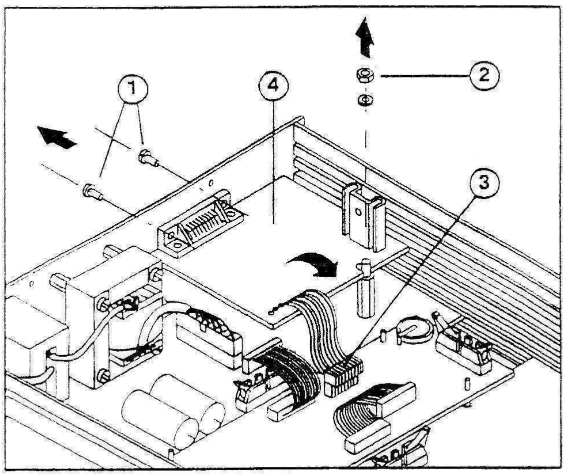
WARNING:

Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
If adjustment, maintenance or repair of the disassembled instrument under voltage is inevitable, it shall be carried out only by qualified personnel using customary precautions against electric shock.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.



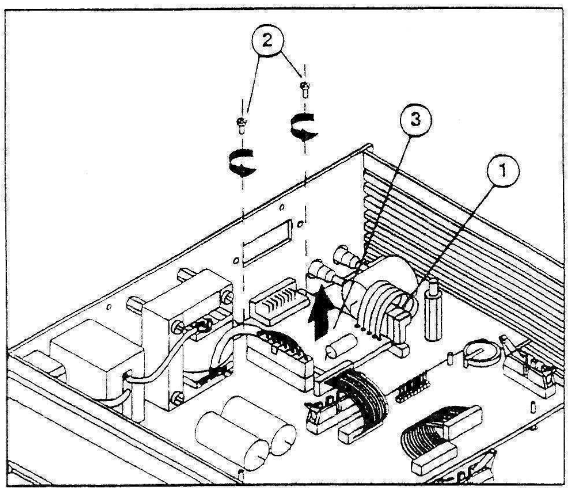
- Unscrew two screws (1) of the rear bumpers.
- Remove rear bumpers (2).
- Loosen two screws of cover (3) (3 to 4 turns).
- Remove top cover.
- Remove bottom cover in the same way.

7.3 UNIT 8 (RS-232 INTERFACE) OR UNIT 9 (IEEE-488 INTERFACE)



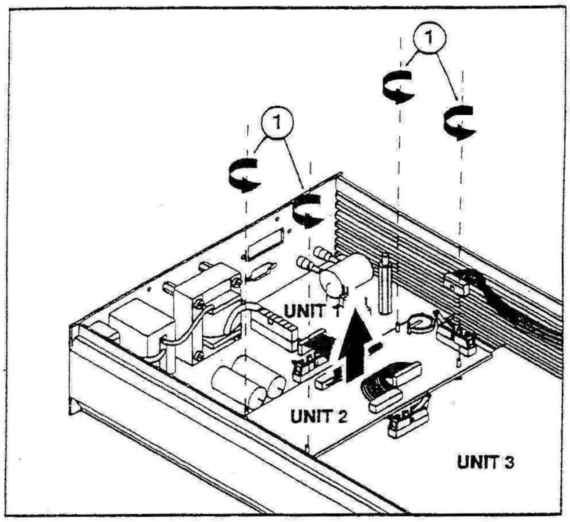
- Unscrew two screws (1) of the connector.
- Unscrew nut and whasher of the spacer (2).
- Unplug connector (3).
- Remove the interface (4).

7.4 UNIT 6, HANDLER INTERFACE



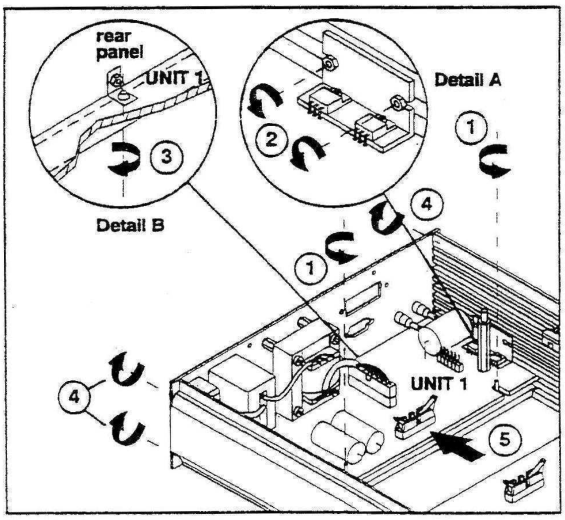
- If an IEEE-488 or RS-232 Interface is built-in remove it as described in Section 7.3.
- Unplug connector (1).
- Unscrew two screws (2) of the interface.
- Remove the interface (3).

7.5 UNIT 2, DIGITAL UNIT



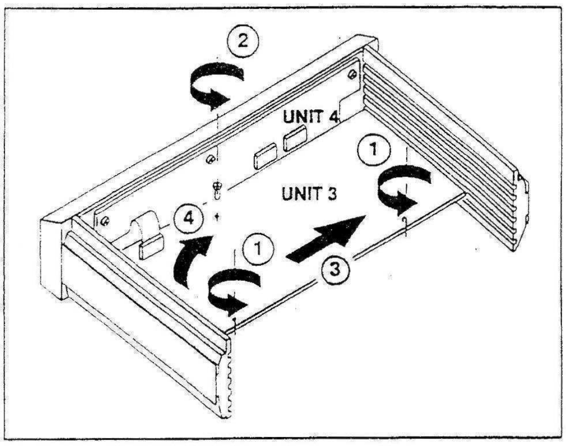
- Unplug all connectors of Unit 2.
- Unscrew four screws (**1**) with whashers.
- Remove Unit 2.

7.6 UNIT 1, POWER SUPPLY



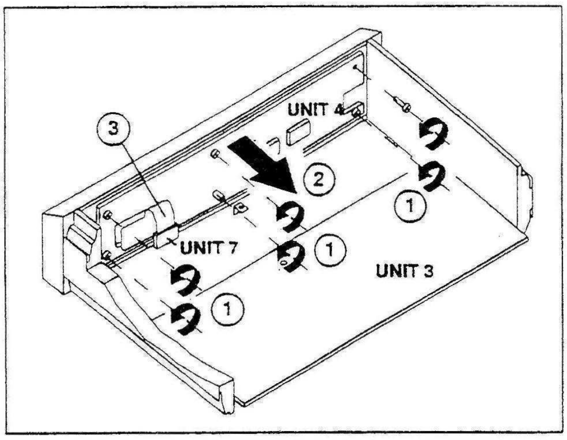
- If an IEEE-488 or RS-232 Interface is built-in remove it as described in Section 7.3.
- If a Handler Interface is built-in remove it as described in Section 7.4.
- Remove Unit 2 as described in Section 7.5.
- Unscrew two spacers (**1**).
- Unplug all connectors of Unit 1.
- Unscrew two screws (**2**) of the heatsink on the side panel as shown in Detail A.
- Unscrew the heatsink on the opposite side panel in the same way.
- Unscrew screw (**3**) of the fixing angle on the rear panel as shown in Detail B.
- Unscrew four screws (**4**) of the rear panel.
- Lift the rear panel and slide the unit to the rear (**5**).

7.7 UNIT 3, ANALOG UNIT



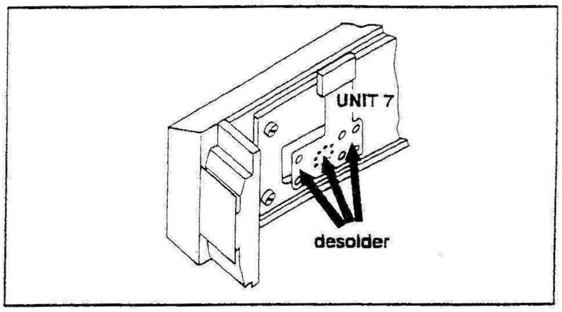
- Remove Unit 2 as described in Section 7.5.
- Unscrew two spacers (**1**) of the unit holder.
- Unscrew screw (**2**) of the fixing angle.
- Unplug all connectors of the unit.
- Desolder the capacitor between unit and housing.
- Slide the unit to the side panel (**3**).
- Remove the unit (**4**).

7.8 UNIT 4, KEYBOARD/DISPLAY



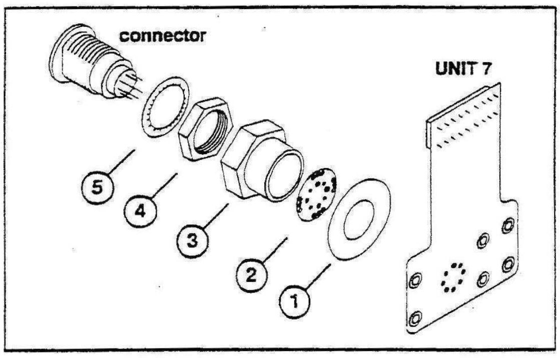
- Remove Unit 2 as described in Section 7.5.
- Unscrews two spacers of the unit holder of Unit 1.
- Unplug all connectors of Unit 1.
- Move Unit 1 slightly to the rear.
- Unscrews six screws (**1**).
- Remove Unit 4 (**2**) (Take care of the flexprint (**3**)).

7.9 UNIT 7, FLEXPRINT



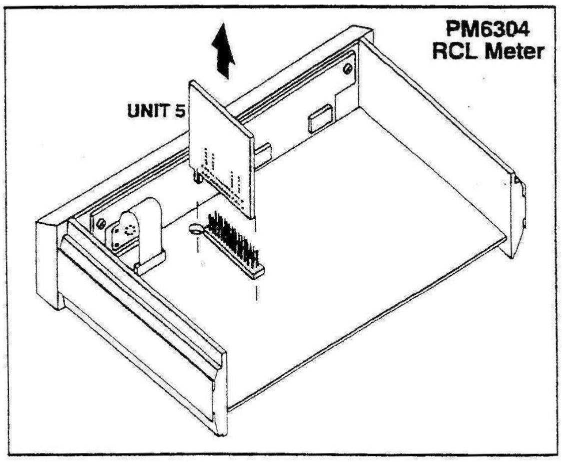
- Desolder the flexprint from the six banana sockets and from the 8-pole round connector.
- Remove Unit 7.

7.10 UNIT 10, CONNECTOR UNIT, AND ROUND CONNECTOR



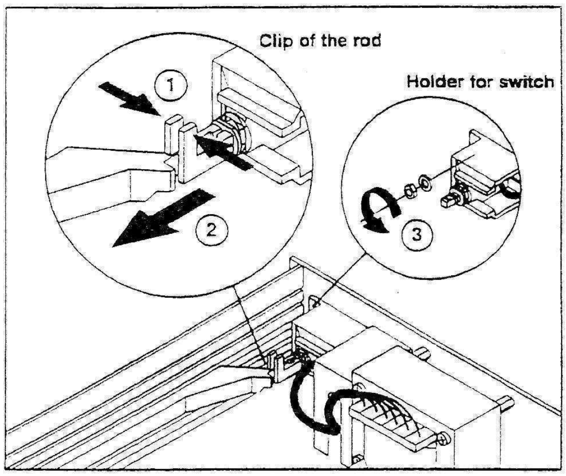
- Remove insulating pad (**1**).
- Desolder Connector Unit (**2**).
- Unscrew shielding (**3**).
- Unscrew nut (**4**).
- Remove whasher (**5**).

7.11 UNIT 5, DC UNIT



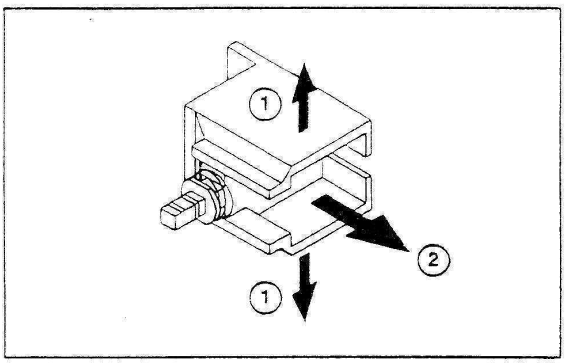
- Unplug Unit 5 as shown in the figure.

7.12 ROD AND HOLDER FOR POWER SWITCH



- Press the clip of the rod for the power switch (1).
- Pull off the rod from the switch (2).
- Unscrew the nut from the stud on the rear panel (**3**).
- Pull out the holder and the switch.

7.13 POWER SWITCH



- Remove the rod for the power switch as described in Section 7.12.
- Unscrew the holder for the power switch as shown in Section 7.12.
- Bend the holder (1) to release the inner locking clips and pull out the switch (**2**).

7.14 TEXT PLATE

The text plate is an adhesive foil strip which cannot be reattached after you have remove it. Place a small screwdriver behind the foil strip and remove it carefully.

8 SELF DIAGNOSTIC AND TROUBLESHOOTING

In addition to the test during power on a test program is installed which checks the communication from the keyboard, the remote control interface, and the PM 9559 bin programmer as well as the data transfer to the internal memories.

The test program contains the following nine subprograms:

Pro. I	Display Test
Pro. 2	Keyboard Test
Pro. 3	Bin Programmer Test
Pro. 4	Storage Register Test
Pro. 5	EEPROM Test
Pro. 6	Internal C-Bus Test (Strobe Test)
Pro. 7	Measurement Data Test for Troubleshooting
Pro. 8	Calibration Data Test
Pro. 9	Interface Test

Press the **LOCAL** key, while turning the instrument on. After the power-on routine the letters ***tESt*** are shown in the display, then the menu of the test program ***Pro I*** to ***9*** appears. Press the **LOCAL** key briefly to select and carry out the test required. Press the **LOCAL** key again for about 1 second to return to the menu of the test program. To leave the test program, turn off the instrument.

PROGRAM 1: DISPLAY TEST

The display test checks the liquid crystal display and the respective decoders/drivers. When the text ***Pro. I*** appears in the subprogram menu, press the **LOCAL** key. The text **REMOTE** appears. Press any key. All segments of the display are switched on one after the other. You can stop and release the test with any key. The instrument then waits with the total display lit up until you press the **LOCAL** key to return to the menu of the test program or until you leave the test program.

PROGRAM 2: KEYBOARD TEST

This test checks the function of each key as well as those of the keyboard encoder.
Press the **LOCAL** key when the text ***Pro. 2*** appears in the submenu; the display shows ***bCodE***. If you press any key in random, the current number of this key appears in the display alone with a control number, for example, ***3-00*** when the **AVERAGE** key is pressed. This control number is generated by the keyboard encoder and can be changed to ***00***, ***0I***, ***I0***, ***II*** by pressing this key again. The keys are numbered row by row from left to right. For example, the **ZERO TRIM** key has the number 8 and the **STORE** key has number 13.
To return to the menu of the test program, press the **LOCAL** key.

To leave the test program, turn off the instrument.

PROGRAM 3: BIN PROGRAMMER TEST

This test checks the function of the infrared transmitter and receiver, the function of the keys, and the encoder.

Press the **LOCAL** key when the text ***Pro. 3*** appears in the submenu; the display shows ***ICodE***. If you press any key of the bin programmer in random, the current number of this key appears in the display with a control number, for example, ***4-0*** when the key **BINNING** is pressed. This control number is generated by the encoder and can be toggled from ***I*** to ***0***. The keys are numbered row by row from left to right. For example, the **NOMINAL** key has the number 10, and the **RECALL** key has the number 37.
To return to the menu of the test program, press the **LOCAL** key.

To leave the test program, turn off the instrument.

PROGRAM 4: MEMORY REGISTER TEST

This test checks the memory for the storage of instrument settings and trim data (**ZERO TRIM**). The contents of this memory are not written over or deleted during the test and can be used as usual when the test has been completed.

The test runs automatically. The display shows ***rEG 0*** and shows ***PASS*** at the end of the test. If the test finds an error, the display shows ***Error***.
Press the **LOCAL** key to return to the menu of the test program.

To leave the test program, turn off the instrument.

PROGRAM 5: EEPROM TEST

This test checks the function of the EEPROM. Press the **LOCAL** key when the text ***Pro. 5*** appears. The test runs automatically. The contents of the memory is not overwritten or deleted during the test. The display shows ***EEPro*** and ***PASS*** at the end of the test. If the test finds an error the display shows ***Error***.
Press the **LOCAL** key to return to the menu of the test program.

To leave the test program, turn off the instrument.

PROGRAM 6: STROBE TEST (TEST OF THE INTERNAL INTERFACE)

This test serves to test the internal data transfer to the shift registers. The outputs can be set to 'High' or 'Low' at a touch of a key.

Press the **LOCAL** key when the text ***Pro. 6*** appears; the display shows ***C-bus*** and in the following submenu the numbers ***1*** to **6**.

Press any key (except **LOCAL**) briefly to select the strobe required. All outputs of the shift registers controlled by the selected strobe are set to 'High' or 'Low' by pressing any key.

The following table shows which shift registers are controlled by which strobe:

Circuit Diagram	Figure Number	Shift Register	Strobe Number
Unit 2, Signal Synthesizer	68	D202 (TWS)⋆	1
Unit 2, Signal Synthesizer	68	D206	2
Unit 3, Source	71	D101	4
Unit 3, Selector	72	D201	3
Unit 3, Amplifier	74	D401	4
Unit 6, Handler Interface	84	D106/D107	6

⋆ The TWS has internal shift registers, so you cannot measure the output. Check if the strobe line is 'High' for 1 ms when pressing a key.

Press the **LOCAL** key briefly to return to the strobe submenu if you want to select a different strobe line or press the key for about one second to return to the menu of the test program.

To leave the test program, turn off the instrument.

PROGRAM 7: MEASUREMENT DATA TEST

This test serves for troubleshooting in the measurement channel from the connectors to the processor.

The test has six steps which display the data during AC measurements and four steps for the optional DC measurements.

AC Measurement Data

Set the instrument to: Test Signal Frequency 1 kHz
Normal Level
Continuous Mode
DC Bias OFF

Check the voltage of the drive lines at the connectors on the front panel: 1 V_{RMS}, open circuit.

Connect a resistor with 100 Ohms ± 1 % to the test posts.

Press the **LOCAL** key while turning the instrument on to start the test program.

Press the **LOCAL** key when the display shows ***Pro. 7***.

The display shows ***ΠEAS*** (measurement) and the selected test signal frequency: ***FrEQ 1.0 kHz***. You can select a different frequency by pressing the +/– **STEP** keys; for this test 1 kHz must be set.

Check the single measurements step by step by pressing any key (except **LOCAL**). The display shows a hexadecimal value which must be within a certain range; if the result exceeds the range perform the listed checks. Otherwise select the next step.

Press the **LOCAL** key to return to the menu of the test program.
To leave the test program, turn off the instrument.

All stated measurement values, except the integration times of 40 ms and 50 ms, are typical values and can vary from instrument to instrument by ± 10 %.
If not stated otherwise all checks are done on Unit 3.
Vpp voltages should be measured with an oscilloscope; the signal must be a sine wave without visible distortion.

Press any key (except **LOCAL** and the +/–**STEP** keys) to start the first step.

Step 1: Voltage Measurement, Phase 0°

The display shows *ΠE 1* (first measurement) and a hexadecimal value between
38800 and 45200 Hex.

If the value exceeds the limits check the following:

- N203, pin 7: Vpp = 1.4 V

  If not:
  - Check the connection 'Sense High' (connector on the front panel) to IC N203, pin 5.
  - Check the drop at diodes V232 and V233: it should be 3.4 V.
  - Check diodes V230 and V231: signal must be blocked.

- N207, pin 6: Vpp = 1.4 V

  If not:
  - Check electronical switch D204.
  - Check buffers N205 and N206.
  - Check differential amplifier N207 and resistor array R278.

- N406, pin 6: Vpp = 3.1 V

  If not:
  - Check electronical switch N407.
  - Check operation amplifier N406.
  - Check resistors R405 to R410.
  - Check relay K102 on Unit 5 (if Unit 5 is installed).
  - Check jumper on X109, pins 33/34 (if Unit 5 is not installed).

- N402, pin 6: Vpp = 1.6 V

  If not:
  - Check the 1/10 voltage divider R412, transistor array N404, switch D403, amplifier N402.
  - Check signals ABOVE and BELOW at the output of the Window Detector: signals must be 'High' at the end of the WDE High pulses. If not, check the Window Detector circuit.

- D501, pin13: Vpp = 1.8 V

  If not:
  - Check the 1/4 voltage divider R426, transistor array N405, switch D404, amplifier N403.

- Signal A5 (X542): Vpp = 3.7 V

  If not:
  - Check 300 Hz Highpass Filter.
  - Check 20 kHz Lowpass Filter.
  - Check electronical switch D501.

- N603, pin 11: V_{DC} = −0.95 V with a superimposed AC voltage Vpp = 1.9 V, f = 2 kHz; noise caused by the digital signal is allowed.

  If not:
  - Check DAC N601, pin 4 (MSB), 1 kHz square wave.
  - Check connection via X108 to Unit 2.
  - Check operation amplifier N603.
  - Check the output signal NEGATIVE of the Polarity Detector: signal must be 'High' at the end of the PDE Low pulses.

- N703, pin 1: Triangle with an integration time (rise time) of:
  40 ms at 50 Hz line frequency
  50 ms at 60 Hz line frequency

  If not:
  - Check the Timer Logic on Unit 2, D301 to D305.
  - Check the 12 MHz clock frequency.

- N703, pin 1: Triangle wave, amplitude = +2.9 V

  If not:
  - Check electronic switch N702.
  - Check operation amplifier N703.
  - Check R701 and R703 (50 Hz line frequency).
  - Check R702 and R704 (60 Hz line frequency).
  - Check R708 to R710.

- N703, pin 1: Triangle with a de-integration time (fall time) of 12 ms

  If not:
  - Check voltage drop at diode V706: $V_{DC} = 4.3$ V
  - Check R707.
  - Check electronic switch N702.

- Counter Logic on Unit 2:

  - Check D308 to D312.
  - Check the signal CNT_CLK: f = 20.97152 MHz.
  - Check the serial data transfer to the microprocessor.

Step 2: Voltage Measurement, Phase +/−90°

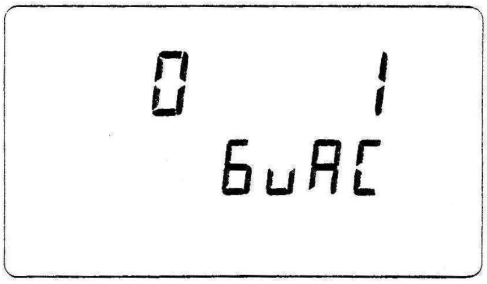
The display shows *ΠE 2* (second measurement) and a hexadecimal value between 14B00 and 19500 Hex.

If the value displayed exceeds the limits check the following:

- N603, pin 11: $V_{DC} = -0.15$ V with a superimposed. AC voltage Vpp = 1.9 V, f = 2 kHz; noise caused by the digital signal is allowed.

  If not:
  - Check the output signal NEGATIVE of the Polarity Detector: signal must be 'High' at the end of the PDE Low pulses.
  - Check whether there is a phase error in the Source Filter N101.
  - Check whether there is a phase error in the 300 Hz Highpass Filter N501 or in the Lowpass Filter N502.
  - Check phase switching; D208 on Unit 2.

Press any key (except **LOCAL**).
The display shows the gain factor and the phase setting:



Step 3: Current Measurement, Phase 0°

The display shows ***ΠE 3*** (third measurement) and a hexadecimal value between 38800 and 45200 Hex.

If the value displayed exceeds the limits check the following:

- N303, pin 2: Vpp = 1.4 V

  If not:
  - Check electronic switch N303.
  - Check connection from the connector Drive Low to N301, pin 3.
  - Check relay K102 on Unit 5 (if Unit 5 is installed).
  - Check jumper on X109, pins 7/8 (if Unit 5 is not installed).

- N207, pin 6: Vpp 1.4 V

  If not:
  - Check electronic switch D204.
  - Check buffer N204.
  - Check connection of signals ACCH and ACCL.

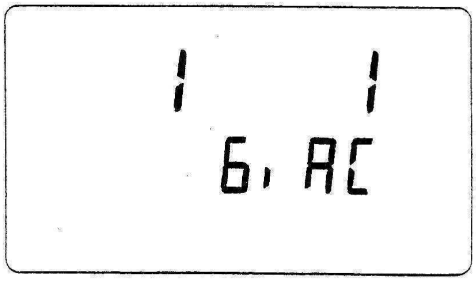
Step 4: Current Measurement, Phase +/−90°

The display shows ***ΠE 4*** (forth measurement) and a hexadecimal value between 14B00 and 19500 Hex.

If the value exceeds the limits check the following:

- Check the output signal NEGATIVE of the Polarity Detector: signal must be 'High' at the end of the PDE Low pulses.
- Check phase switching D208 on Unit 2.

Press any key (except **LOCAL**).
The display shows the gain factor and the phase setting:



Step 5: First Reference Measurement

The display shows ***ΠE 5*** (fifth measurement) and a hexadecimal value between
0D000 and 10000 Hex.

If the value exceeds the limits check the following:

- N503, pin 6: V_{DC} = < ±5 mV, no AC signal

  If not:
  - Check switch D204.
  - Check whether AC signals are coupled at the outputs of D204, pin 3 and pin 13.
  - Check the DC offset voltages of the operation amplifiers N205 and N206.

- N703, pin 1: Triangle wave, amplitude = +0.62 V, de-integration time (fall time) 2.8 ms

  If not:
  - Check diode voltage of V706.
  - Check R707.
  - Check voltage divider R709/R710.
  - Check R708.

Step 6: Second Reference Measurement

The display shows ***ΠE 6*** (sixth measurement) and a hexadecimal value between
0D000 and 10000 Hex.

The value must be the same as in step 5.

DC Measurement Data

Steps 7 to 10 are only necessary if measurements with the DC test signal are faulty.
Ensure that all AC tests are within the limits.
Switch the instrument off or to leave the test program.
If not stated otherwise all measurements are done on Unit 5.
DC voltages are measured between component and the EXT DC BIAS minus connector on the rear panel.

Set the Instrument to: Test Signal DC
Normal Level
Continuous Mode

Check the voltage of the 'High Drive' line at the connectors on the front panel: +1 V_{DC}, open circuit.

Connect a resistor with 100 Ohms ±1 % to the test posts.

Press the **LOCAL** key while turning the instrument on to start the test program.

Press the **LOCAL** key when the display shows ***Pro. 7***.
Skip steps 1 to 6 by pressing any key (except **LOCAL**).

Step 7: Voltage Measurement High

The display shows **ΠE 7** (seventh measurement) and a hexadecimal value between 38800 and 45200 Hex.

If the value exceeds the limits check the following:

- N202, pin 3 (signal A1DC): $V_{DC} = +0.5$ V

  If not:
  - Check electronic switch N202 on Unit 3.
  - Check relay K202 on Unit 3.
  - Check Source Overload Protector V129 to V132 on Unit 3.
  - Check connectors X801/110.
  - Check X110, pin 3: $V_{DC} = < +15$ mV.
    If not:
    Check connection to the DC/V Converter N102, pin 2.
    Check amplifier N102.
    Check transistor V105.

- N203, pin 15: $V_{DC} = -1.5$ V

  If not:
  - Check amplifiers N202 and N205.

- Unit 3, N406, pin 3 (signal A2): Vpp = 1.5 V, f = 2 kHz

  If not:
  - Check DAC N203.
  - Check amplifiers N206, N207, and N201.
  - Check connection via relay K102 to Unit 3.
  - Check latch D601 on Unit 3.

Step 8: Voltage Measurement Low

The display shows **ΠE 8** (eighth measurement) and a hexadecimal value between 0C000 and 11000 Hex.

If the value exceeds the limits check the following:

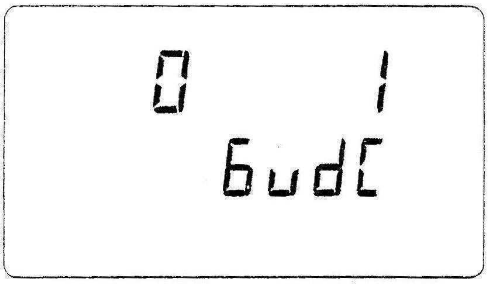
- N202, pin 3: $V_{DC} = <+15$ mV

  If not:
  - Check connection from the Low Sense connector on the front panel.
  - Check amplifier N102.
  - Check transistor V105.

- N203, pin 15: V_{DC} = 0 to −50 mV

  If not:
  - Check the offset voltage at the amplifiers N202 and N205.
  - Check the reverse current of diodes V245 and V246 on Unit 3.

Press any key (except LOCAL).
The display shows the gain factor and the phase setting:



Step 9: Current Measurement High

The display shows ΠE 9 (ninth measurement) and a hexadecimal value between 38800 and 45200 Hex.

If the value exceeds the limits check the following:

- N103, pin 3: V_{DC} = −0.5 V

  If not:
  - Check amplifier N102.
  - Check transistor V105.
  - Check electronic switches N101 and N105.

- N104, pin 6: V_{DC} = +0.5 V

  If not:
  - Check amplifiers N103 and N104.
  - Check resistor array R111.

Step 10: Current Measurement Low

The display shows ***ΠE 10*** (tenth measurement) and a hexadecimal value between 0C000 and 11000 Hex.

If the value exceeds the limits check the following:

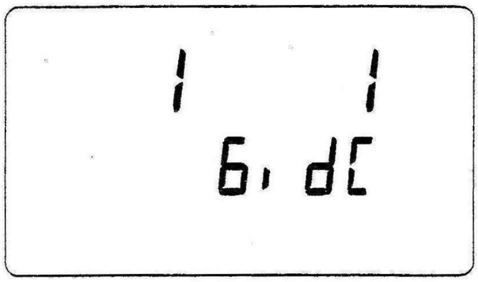
- N103, pin 3: V_{DC} = < ±3 mV

  If not:
  - Check offset voltage of N102.
  - Check electronic switch N101.

- N104, pin 6: V_{DC} = < ±5 mV

  If not:
  - Check offset voltages of N103 and N104.

Press any key (except LOCAL).
The display shows the gain factor and the phase setting:

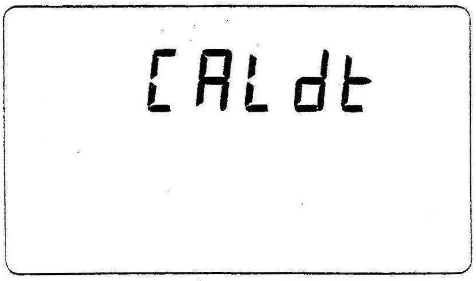


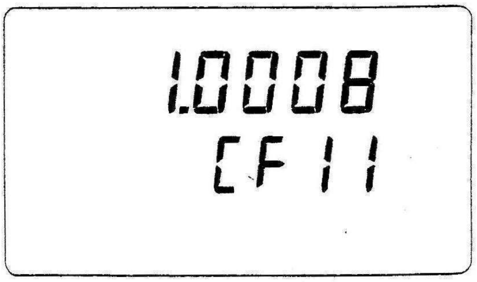
Press the **LOCAL** key for about one second to return to the menu of the test program.
To leave the test program, or turn off the instrument.

PROGRAM 8: CALIBRATION DATA TEST

This test displays the calculated and stored calibration factors.

Press the **LOCAL** key when the text ***Pro. 8*** appears. The display shows the value and the calibration factor number, for example:





The following table shows the internal settings at which the factors were calculated and the typical values. You also can compare the values with another PM6304.

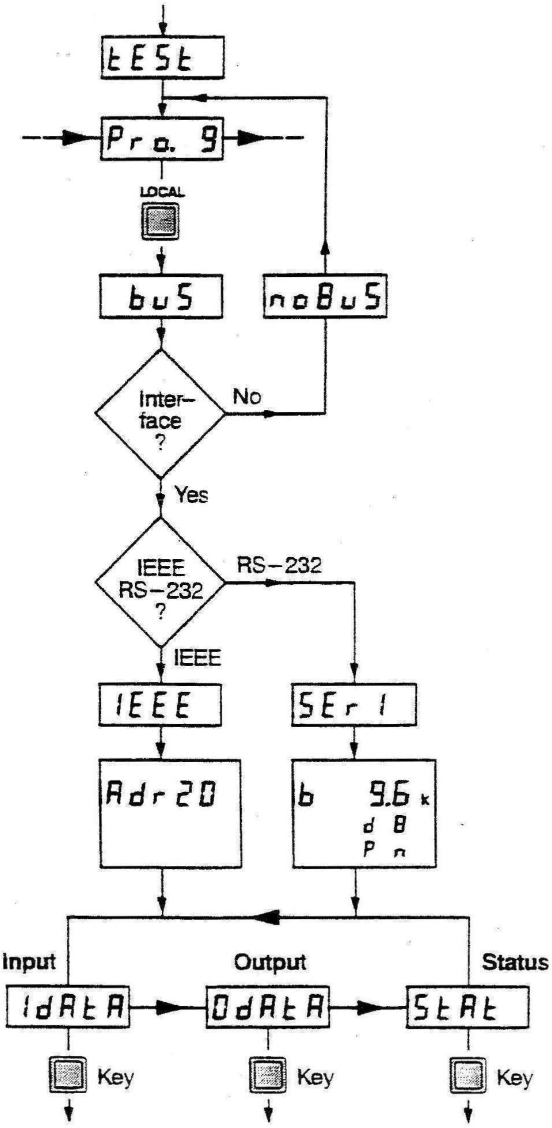
Instrument Settings			Internal Transresistance	Factor Number	Typical Calibration Factor (CF)
Test Signal	Voltage Gain	Current Gain			
1 kHz	40	1	100 Ω	11	0.8000 to 1.2000
1 kHz	10	1	100 Ω	12	0.8000 to 1.2000
1 kHz	1	1	100 Ω	13	0.8000 to 1.2000
1 kHz	1	4	100 Ω	14	0.8000 to 1.2000
1 kHz	1	10	100 Ω	15	0.8000 to 1.2000
1 kHz	1	40	100 Ω	16	0.8000 to 1.2000
1 kHz	40	1	10 kΩ	21	0.8000 to 1.2000
1 kHz	10	1	10 kΩ	22	0.8000 to 1.2000
1 kHz	1	1	10 kΩ	23	0.8000 to 1.2000
1 kHz	1	4	10 kΩ	24	0.8000 to 1.2000
1 kHz	1	10	10 kΩ	25	0.8000 to 1.2000
1 kHz	1	40	10 kΩ	26	0.8000 to 1.2000
DC	40	1	100 Ω	31	0.8000 to 1.2000
DC	10	1	100 Ω	32	0.8000 to 1.2000
DC	1	1	100 Ω	33	0.8000 to 1.2000
DC	1	4	100 Ω	34	0.8000 to 1.2000
DC	1	10	100 Ω	35	0.8000 to 1.2000
DC	1	40	100 Ω	36	0.8000 to 1.2000
DC	40	1	10 kΩ	41	0.8000 to 1.2000
DC	10	1	10 kΩ	42	0.8000 to 1.2000
DC	1	1	10 kΩ	43	0.8000 to 1.2000
DC	1	4	10 kΩ	44	0.8000 to 1.2000
DC	1	10	10 kΩ	45	0.8000 to 1.2000
DC	1	40	10 kΩ	46	0.8000 to 1.2000
100 kHz	–	–	10 kΩ	51	0.9800 to 1.0000
100 kHz	–	–	10 kΩ	52	$<60\ e^{-6}$; display 0.0000
50 Hz	–	–	100 Ω	53	<0.0200
50 Hz	–	–	10 kΩ	54	<0.200
100 kHz	–	–	100 Ω	55	0.9950 to 1.0050

Press the **LOCAL** key for about one second to return to the menu of the test program.
To leave the test program, turn off the instrument.

Program 9: INTERFACE TEST (RS-232 or IEEE-488)

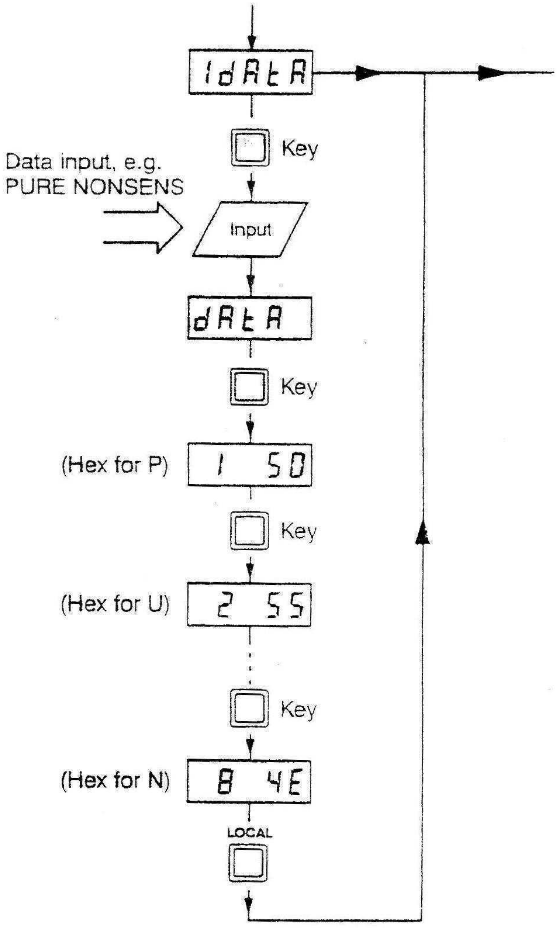
This test checks the built-in interface, its inputs and output buffers, and the correct coding and decoding of the data transferred.

Press the **LOCAL** key when the text ***Pro. 9*** appears. The test automatically checks which interface is actually available; if none, ***noBuS*** appears in the display and the instrument automatically returns to the menu of the test program. In instruments with interface, there is a choice between an input test (***IdAtA***), an output test (***OdAtA***), and a read-out of the device status (***StAt***). Selection is done by pressing any key (except **LOCAL**). For the IEEE-488 Interface, the device address is set to 20. The configuration for the RS-232 interface is: Baud rate 9600, data bits 8, parity no. Using the RS-232 Interface the instrument must be set to remote with ESC 2.



Input Test:

When the instrument received data via interface the display shows ***dAtA***. The first eight figures of the string can be displayed individually in hexadecimal form by pressing any key (except **LOCAL**). The data input can be repeated as often as desired.



Press the **LOCAL** key to return to the selection between input, output, and status. Press the key again to return to the menu of the test program.

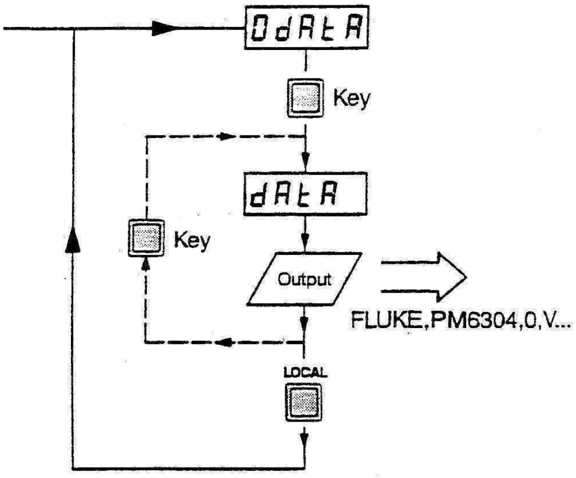
To leave the test program, turn off the instrument.

Output Test:

When the output test is selected the display shows ***dAtA*** and the identification string

`'FLUKE,PM6304,0,Vx.x'`

can be read out by a controller. This test can be repeated so often as desired by pressing any key (except **LOCAL**).



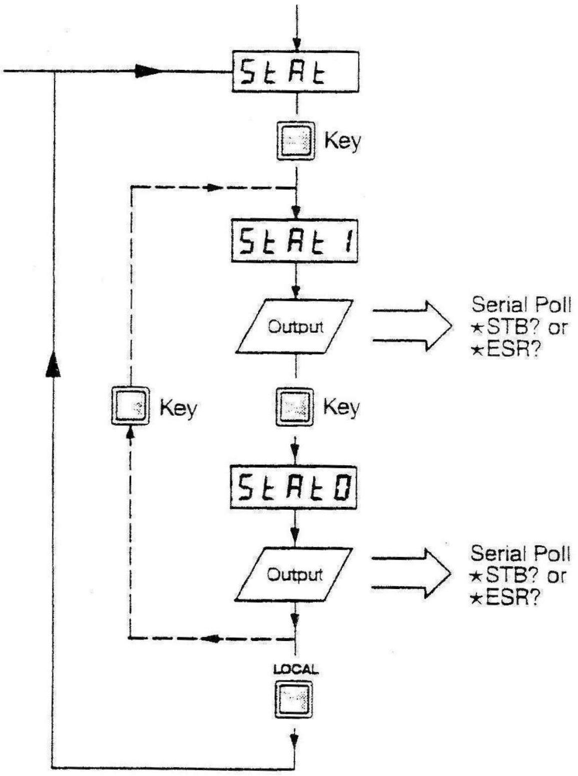
Press the **LOCAL** key to return to the selection between input, output, and status. Press the key again to return to the menu of the test program.

To leave the test program, turn off the instrument.

Device-Status Test:

This test checks the data transfer from the instrument to the Standard Event Status Register and to the Status Byte Register.

Pressing any key (except **LOCAL**) when the display shows ***StAt*** sets the bits of the Standard Event Status Register (ESR) to 1 or 0. The display shows ***StAt 0*** or ***StAt I***. If the bits of the Standard Event Status Enable Register (ESE) was set to 1 with the command ⋆ESE 255 the controller can read out the Status Byte Register with serial poll or with the query ⋆STB? (IEEE-488) respectively with ESC 7 for the RS-232 Interface. The result is 0 or 32 decimal, see Programmers Manual, Section 3.3. The Standard Event Status Register also can be read out by a controller with the query ⋆ESR?.



Press the **LOCAL** key to return to the selection between input, output, and status. Press the key again to return to the menu of the test program.

To leave the test program, turn off the instrument.

9 ERROR MESSAGES

After power on, the instrument checks the PROM, the processor RAM, and the external RAM. Additionally the instrument generates error messages if there are faults during measurements, trimming, recalibration, or if there is a fault during data transfer to a printer.

Errors are indicated as follows:

Err 1	Program memory checksum error
Err 2	Processor RAM defective
Err 3	External RAM defective
Err 4	External RAM, backup (current instrument settings) destroyed
Err 5	External RAM, stored instrument settings 1 to 9 destroyed
Err 6	Error during analog to digital conversion of the test signal
Err 7	EEPROM defective
Err 8	Error in trim data (EEPROM)
Err 9	Error in calibration data (EEPROM)
Err 10	Error in binning data (EEPROM)
Err 11	Error during line frequency detection
Err 14	Test signal out of limits during trimming
Err 19	Test signal out of limits during recalibration
Err 20	Calibration factor 11 or 31 out of limits
Err 21	Calibration factor 12 or 32 out of limits
Err 22	Calibration factor 13 or 33 out of limits
Err 23	Calibration factor 14 or 34 out of limits
Err 24	Calibration factor 15 or 35 out of limits
Err 25	Calibration factor 16 or 36 out of limits
Err 26	Calibration factor 21 or 41 out of limits
Err 27	Calibration factor 22 or 42 out of limits
Err 28	Calibration factor 23 or 43 out of limits
Err 29	Calibration factor 24 or 44 out of limits
Err 30	Calibration factor 25 or 45 out of limits
Err 31	Calibration factor 26 or 46 out of limits
Err 35	Calibration factor 51 out of limits
Err 36	Calibration factor 52 out of limits
Err 37	Calibration factor 53 or 54 out of limits
Err 38	Calibration factor 55 out of limits
Err 40	Value of 100 Ω reference resistor out of range
Err 41	Value of 10 kΩ reference resistor out of range
Err 48	Communication error to the printer (time-out)

For troubleshooting hints see Chapters 4 and 8.

10 INSTALLATION INSTRUCTIONS FOR OPTIONS

10.1 PM 9548 IEEE-488 INTERFACE

The PM 9548 Interface consists of a complete circuit board with mounted IEEE-488 connector, wired connector to the RCL meter, and mounting hardware, ready for installation.
The instrument is already prepared for installation.
It is only necessary to open the top cover and to install the interface as shown below.
For technical data and a description of how to use the instrument via remote control,see the Programmers Manual PM6304, order no. 4822 872 10167, and the
Reference Manual PM6304, order no. 4822 872 10166.

WARNING

Removing the instrument covers is likely to expose live parts, and also accessible terminals may be live. To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.

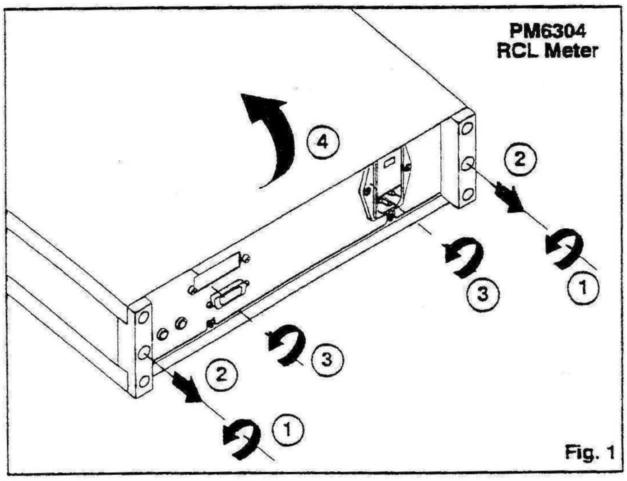


Fig. 1

- Remove 2 screws (**1**) from the rear bumpers.
- Remove rear bumpers (**2**).
- Loosen 2 screws of cover (**3**) (3 to 4 turns).
- Remove top cover (**4**).

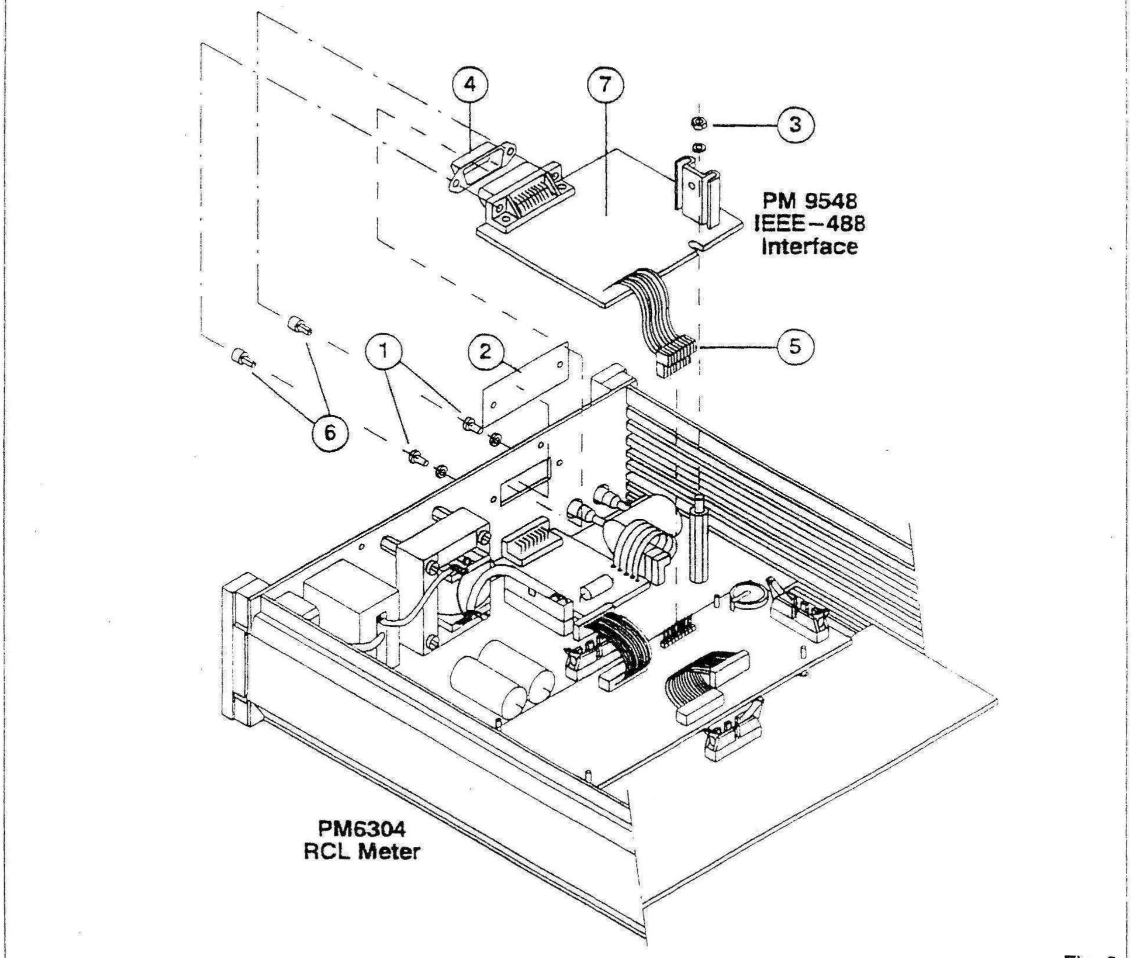


Fig. 2

- Remove 2 special screws (**6**) from the IEEE-488 connector.
- Remove 2 screws fixing the cover sheet of the slot for the IEEE-488 connector at the rear panel (**1**).
- Remove cover sheet (**2**).
- Remove nut and spring washer from the spacer (**3**),
  it will be used to fix the IEEE-488 Interface board (**7**) later on.
- Insert IEEE-488 connector into the slot (**4**).
- Plug in the wired connector of the interface (**5**) as shown.
- Fasten special screws previously removed from the connector (**6**).
- Fasten printed circuit board (**7**) on the spacer with nut and washer (**3**) previously removed.
- Re-assemble the instrument cover and rear bumpers in opposite sequence as shown in Figure 1.
- The IEEE-488 Interface is now ready to use.

10.2 PM 9549 RS-232 INTERFACE

The PM 9549 Interface is an option for the PM 6304 RCL Meter. It consists of a complete circuit board with mounted RS-232 connector, wired connector to the RCL meter, and mounting hardware, ready for installation.
The instrument is already prepared for installation.
It is only necessary to open the top cover and to install the interface as shown below.
For technical data and a description of how to use the instrument via remote control, see the Programmers Manual PM6304, order no. 4822 872 10167, and the
Reference Manual PM6304, order no. 4822 872 10166.

WARNING

Removing the instrument covers is likely to expose live parts, and also accessible terminals may be live. To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.

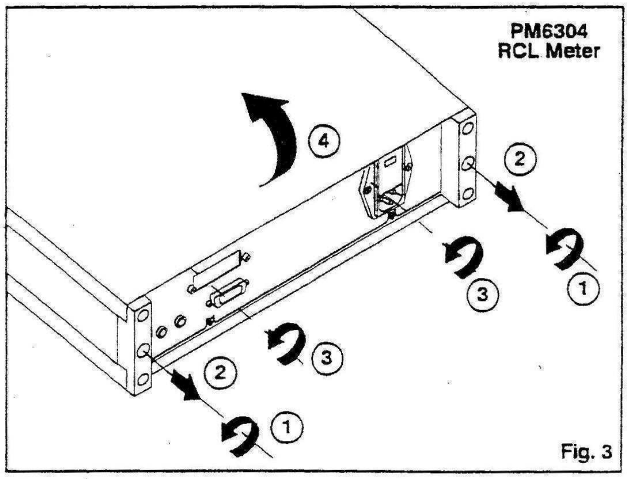


Fig. 3

- Remove 2 screws (**1**) from the rear bumpers.
- Remove rear bumpers (**2**).
- Loosen 2 screws of cover (**3**) (3 to 4 turns).
- Remove top cover (**4**).

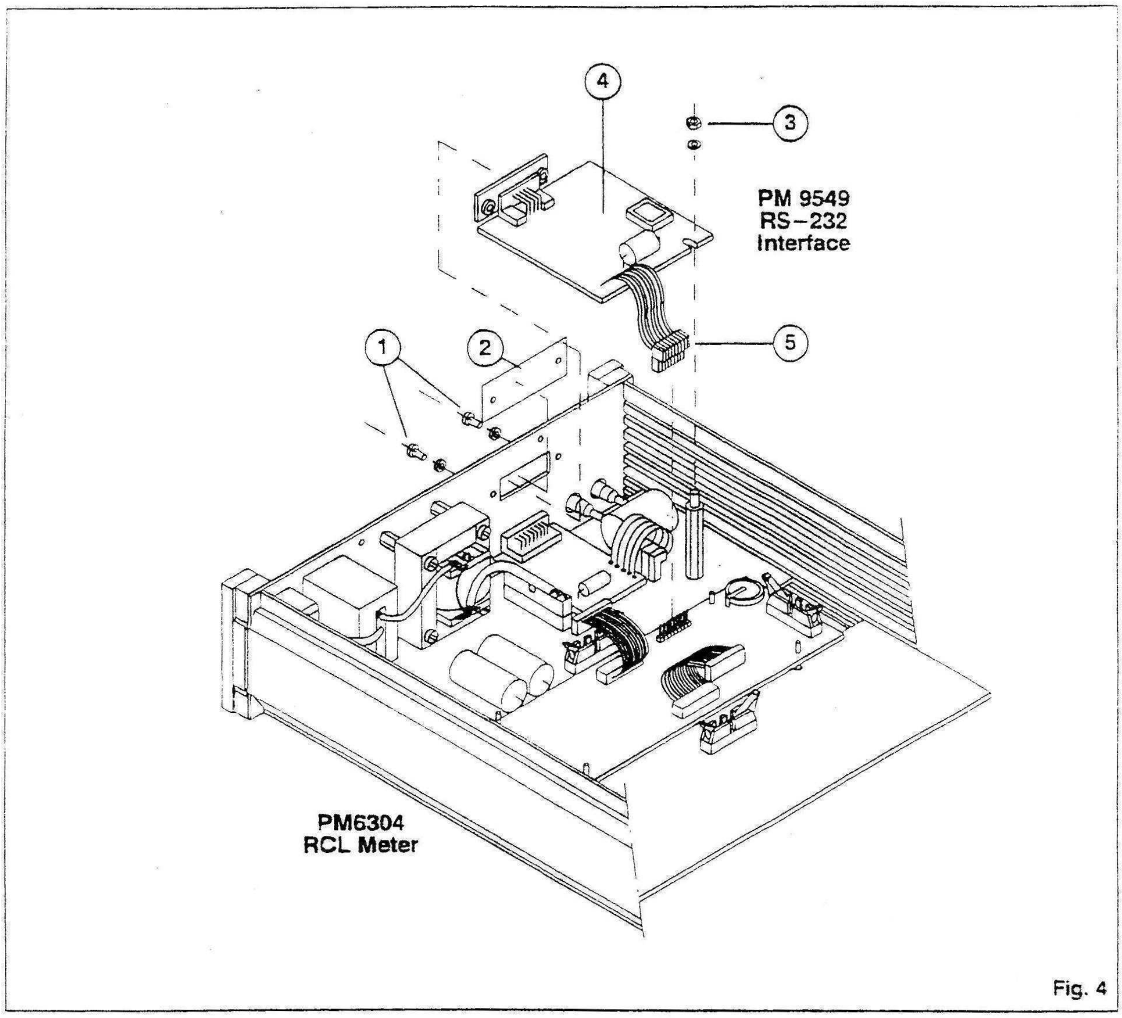


Fig. 4

- Remove 2 screws and spring washers fixing the cover sheet of the slot for the RS-232 connector at the rear panel (**1**).
- Remove cover sheet (**2**).
- Remove nut and spring washer from the spacer (**3**), it will be used to fix the RS-232 Interface board (**4**) later on.
- Insert RS-232 connector into the slot.
- Plug in the wired connector of the interface (**5**) as shown.
- Fasten screws and washers (**1**) previously removed from rear panel.
- Fasten printed circuit board (**4**) on the spacer with nut and washer (**3**) previously removed.
- Re-assemble the instrument cover and rear bumpers in opposite sequence as shown in Figure 3.
- The RS-232 Interface is now ready to use.

10.3 PM 9565 DC UNIT

The PM 9565 DC Unit is an option for the PM6304 RCL Meter. It consists of a complete circuit board with mounted connector; ready for built in.
The instrument is already prepared for installation.
It is only necessary to open the top cover and to plug in the unit as shown in Figures 5 and 6.

After installation, the instrument will require recalibration. The procedure is described in the Service Manual PM6304. To recalibrate the instrument, you must have the following:

Test Set	order no. 5322 310 32273
PM 9559 Bin Programmer	or
PM 9548 IEEE-488 Interface	or
PM 9549 RS-232 Interface	and
Service Manual	order no. 4822 872 15169

For technical data and a description how to measure with DC, see the

Programmers Manual PM6304	order no. 4822 872 10167 and the
Reference Manual PM6304	order no. 4822 872 10166.

WARNING

Removing the instrument covers is likely to expose live parts, and also accessible terminals may be live. To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.

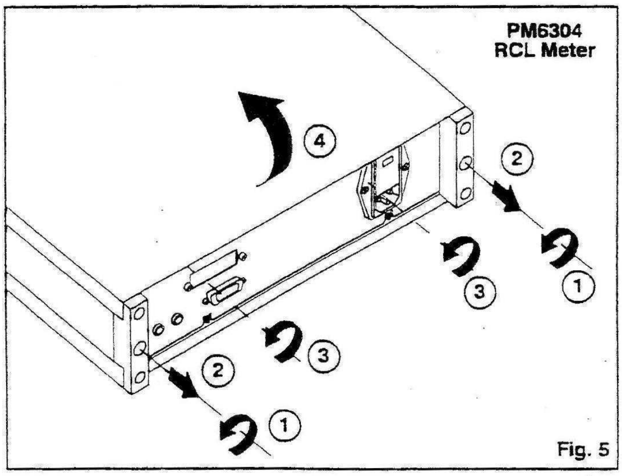


Fig. 5

- Remove 2 screws (**1**) from the rear bumpers.
- Remove rear bumpers (**2**).
- Loosen 2 screws of cover (**3**) (3 to 4 turns).
- Remove top cover (**4**).

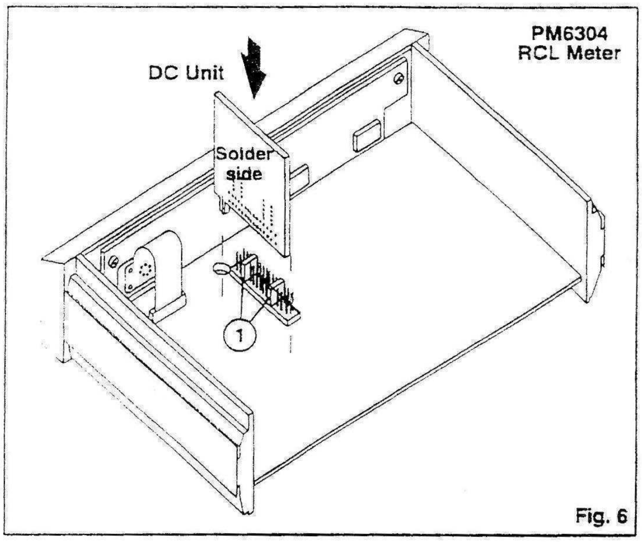


Fig. 6

- Remove the two jumpers (1).
- Plug in the DC Unit as shown in Figure 6.
- Close instrument in opposite sequence as described in Figure 5.
- Re-assemble the instrument cover and rear bumpers in opposite sequence as shown in Figure 5.

10.4 PM 9566 HANDLER INTERFACE

The PM 9566 Interface is an option for the PM6304 RCL Meter. It consists of a complete circuit board with mounted connector, wired connector to the RCL meter, mounting hardware, ready for installation.
The instrument is already prepared for installation.
It is only necessary to open the top cover and to install the interface as shown below.
For technical data and a description of how to use the Handler Interface, see the Users Manual PM6304, order no. 4822 872 10162 and the Reference Manual PM6304, order no. 4822 872 10166.

WARNING

Removing the instrument covers is likely to expose live parts, and also accessible terminals may be live. To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.
Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.

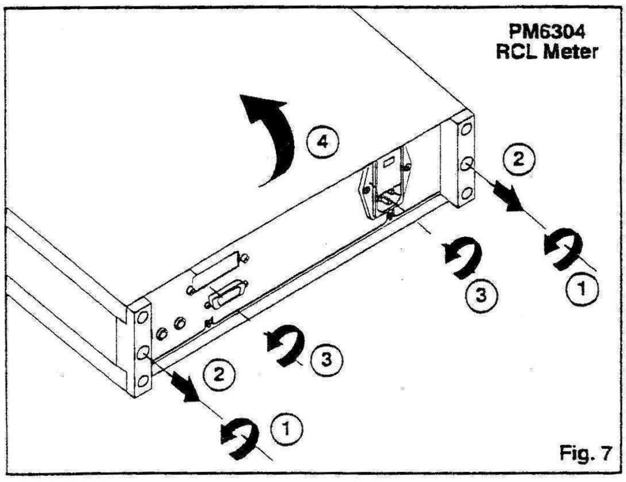


Fig. 7

- Remove 2 screws (**1**) from the rear bumpers.
- Remove rear bumpers (**2**).
- Loosen 2 screws of cover (**3**) (3 to 4 turns).
- Remove top cover (**4**).

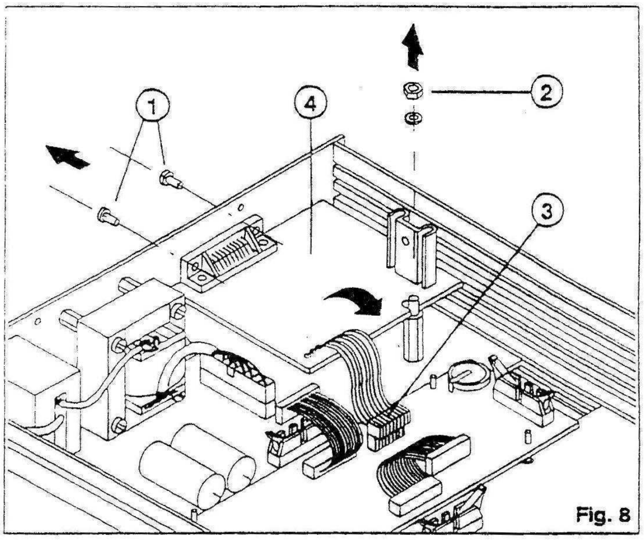


Fig. 8

If an IEEE-488 or RS-232 Interface is installed, proceed as follows:

- Remove 2 screws (**1**) from the connector.
- Remove nut and washer of the spacer (**2**).
- Unplug connector (**3**).
- Remove interface (**4**).

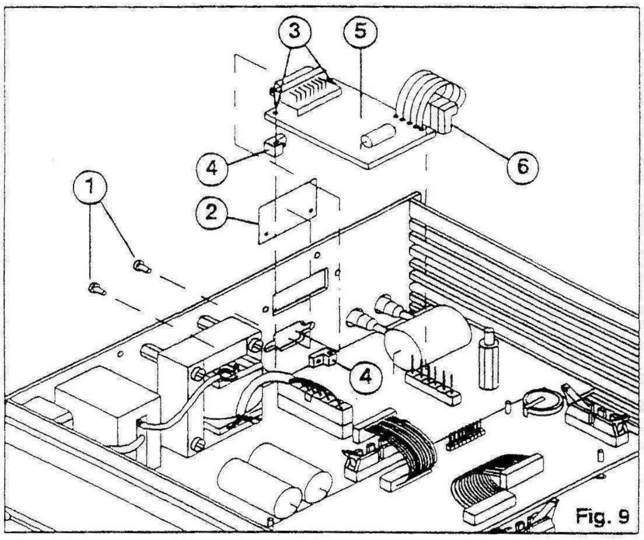


Fig. 9

- Remove 2 screws (**1**) fixing the cover sheet from the slot at the rear panel.
- Remove the cover sheet (**2**).
- Remove 2 screws (**3**) from the interface holder (**4**).
- Fix interface holders (**4**) at the rear panel with screws (**1**) previously removed.
- Insert plug of the interface (**5**) into the slot and fix the interface with screws (**3**) on the holders (**4**).
- Plug in connector (**6**) of the interface.

- If you have removed a built in IEEE-488 respectively RS-232 Interface refit it in opposite sequence as described in Figure 8.
- Re-assemble the instrument cover and rear bumpers in opposite sequence as shown in Figure 7.
- The Handler Interface is now ready to use.

10.5 PM 9564 19" RACK MOUNT ADAPTER

This rack mount adapter (19", 2 units high) is suited for the generators PM 5135, PM 5136, PM 5138A, PM 5139, PM 5150, and the RCL Meters PM6303A, PM6304, and PM6306; valid for instruments which have two holes in the side panels covered with plastic plates (from autumn 1992 onwards).

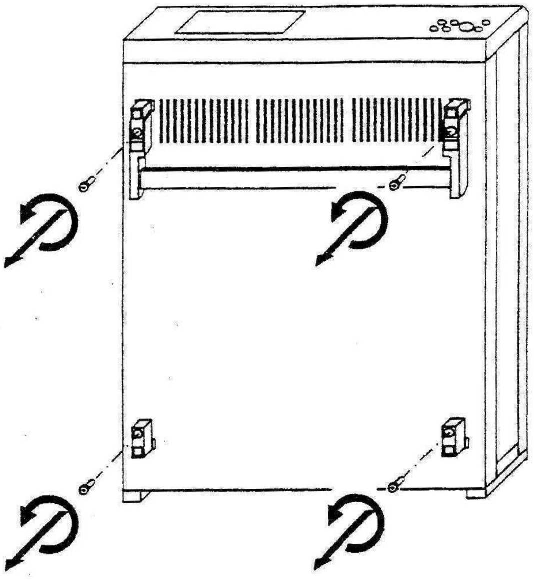


Fig. 10

If necessary, unscrew feet and handle of the instrument.

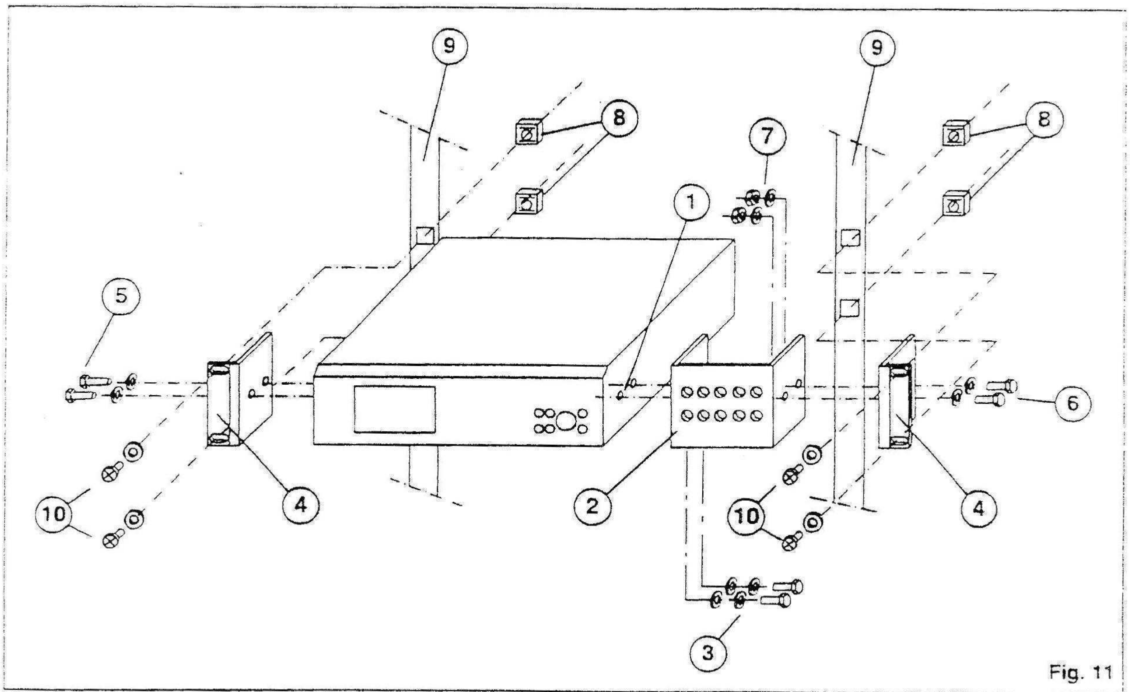


Fig. 11

For assembling use the attached fixing material:

6	hex-head screws M6x25
2	hexagonal nuts M6x25
4	cross-slot screws M6x25
6	spring washers
8	washers
4	cage-nuts

- Remove the two plastic cover plates at the right and left side panels of the instrument (1).
- Screw the distance piece (**2**) to the right-hand or left-hand side of the instrument with two screws M6x25, washers, and spring washers (**3**).
- Screw the right and left brackets (**4**) to the instrument respectively to the distance piece. Use two screws M6x25 with spring washers (**5**) for the instrument.
  Use two screws M6x25 with spring washers (**6**) and two nuts with washers (**7**) for the distance piece.
- Clip the four cage-nuts (**8**) into the rack-posts (**9**) and fasten the instrument with four cross-slotted screws M6x25 with washers (**10**).

Ten holes of the distance piece are covered by a foil. You may use the holes for BNC sockets in order to connect those to rear side connections of the instrument. For this purpose perforate the cover foil. If necessary use the attached plastic spacing pieces to fix the BNC socket insulated from the housing.

Note: Take care for sufficient airflow within the rack, in order to prevent overheating the instrument.

11 CHECKING AND ADJUSTING

11.1 GENERAL INFORMATION

This chapter provides the complete adjustment procedure for the instrument. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is, therefore, presented in a sequence best suited to particular adjustment.

- Warm-up time under average conditions is 15 minutes.
- Ambient temperature (23 ±1) °C
- Line voltage, nominal value ± 2 %
- Instrument performance should be checked before any adjustment is done.
- All limits and tolerances given in this section are calibration guides, and should not be interpreted as instrument specifications.

WARNING

High voltages exist at several points inside the instrument. To avoid injury, do not touch exposed connections and components while power is on. Disconnect line power before removing protective panels, soldering, or replacing components.

11.2 RECOMMENDED TEST EQUIPMENT

AC rms Voltmeter	Fluke 8920A
DC Voltmeter	Philips PM 2535
Counter	Philips PM 6665
One of the interfaces built in:	
IEEE-488 Interface	PM 9548 or
RS-232 Interface	PM 9549
Bin Programmer	PM 9559
PC Personal Computer	

Two single test posts, red and black, are a standard accessory with every PM6304.

Test post red:	5322 264 30351
Test post black:	5322 264 30352

Test Set for 5322 310 32273
PM6304, PM6304C, PM6306;
for contents and details, see Section 5.2.

11.3 CHECKING AND ADJUSTING PROCEDURE

Turn the instrument PM6304 on.
Set PM6304 to AUTO, 1 kHz, DC BIAS OFF, CONT, NORMAL LEVEL.
Wait 15 minutes with all covers in place.
Remove top cover.
For measurement ground ⊥ take the rear panel EXT DC BIAS minus connector for all tests, except Section 11.3.4.

11.3.1 Internal Supply Voltages

Test	**PM6304 Setting**	**Adjusting Element**	**Test Point**	**Value to set**	**Value min. to max.**
1	see above	Unit 1 R115 Fig. 13, 16	Unit 1 X104/4 Fig. 13, 16	DC, +15 V	14.98 to 15.02 V

11.3.2 Clock Frequency

2	100 kHz	Unit 2 C210 Fig. 17, 19	Front panel +	100 kHz	99.999 to 100.001 kHz

11.3.3 AC Voltage

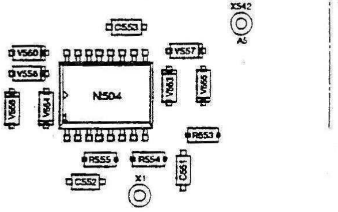
3	1 kHz	Unit 3 R111 Fig. 21, 22	Front panel +	AC, 1 V rms	0.995 to 1.005 V rms

11.3.4 DC Offset Voltage

Set PM6304 to 200 Hz and to SINGLE measurement.
Send commands via PC and interface to PM6304: BK_TEST, SET_SOURCE 3100, SET_GAIN xxxx.
Check that REMOTE at the front panel is lit.
Test 4 must be done before test 5 and 6.

Test	**PM6304 setting**	**Adjusting Element**	**Test Point**	**Value to set**	**Value min. to max.**
4	SET_GAIN 2007	Unit 3 R242 Fig. 21, 23	A5, X542 to ⊥ X1	DC, 0 V	0 ± 15 mV
5	SET_GAIN 1007	Unit 3 R287 Fig. 21, 23		DC, 0 V	0 ± 15 mV
6	SET_GAIN 3007	Unit 3 R333 Fig. 21, 23		DC, 0 V	0 ± 15 mV

After this press the **LOCAL** key.



FILTER, FIG. 26

The **DC offset voltage** can also be adjusted **without PC and interface.**

- Set PM6304 to 200 Hz, Low Level.

- Press the **LOCAL** key, while turning the instrument on to start the test program.
- Press the **LOCAL** key when the display shows ***Pro. 7*** (Program 7).
- Short circuit the test posts.
- Press any key except **LOCAL** so often until the display shows ***ΠE 5*** (measurement 5).
- Perform adjustment with R242 according to Test 4.

- Press the **LOCAL** key twice to start the Program 7 again.
- Press any key except **LOCAL** so often until the display shows ***ΠE 2*** (measurement 2).
- Perform adjustment with R287 according to Test 5.

- Press the **LOCAL** key twice to start the Program 7 again.
- Remove the short circuit from the test posts.
  The following step must be performed with open measurement circuit.
- Press any key except **LOCAL** so often until the display shows ***ΠE 4*** (measurement 4).
- Perform adjustment with R333 according to Test 6.

11.3.5 DC Supply Voltages

Test	PM6304 Setting	Adjusting Element	Test Point	Value to check	Value min. to max.
8	AUTO 1 kHz	–	Unit1 Fig. 62, 65	DC, –15 V	–14.85 to –15.15 V
		–	X104/7	DC, +5 V	+4.75 to +5.25 V
9		–	X104/5	DC, –5 V	–4.75 to –5.25 V
10		–	X104/8	DC, +5 V	+4.75 to +5.25 V
11			X104/1		

11.3.6 Functional Check

Connect resistor 100 Ω ±0.1 % via the test posts to PM6304.
Set PM6304 to AUTO, 1 kHz.

12 Display shows
- in upper field : 99 to 101 Ω
- in middle numeric field : no display
- as equivalent circuit diagram : R symbol

13	AUTO 1 kHz	–	Front panel +	AC, 0.5 V rms	0.495 to 0.505 V rms
14	AUTO 1 kHz	–	Front panel –	AC, 0 V rms	0 to 10 mV rms
15	DC ON	–		display as in Test 12	

No component connected to PM6304.

16	AUTO 20 kHz NORMAL	–	Front panel +	AC, 1 V rms	0.984 to 1.016 V rms
17	100 kHz		Front panel +	AC, 1 V rms	0.92 to 1.08 V rms

Apply 5.00 V DC to EXT DC BIAS connector at the rear.

18	AUTO 1 kHz DC BIAS ON DC BIAS EXT CONT NORMAL	–	Front panel +	DC, +5 V	+4.9 to +5.1 V

11.3.7 Recalibration

Perform Recalibration according to Chapter 6 of this manual.

11.3.8 Measurement Accuracy

Make **Performance Test** according to Chapter 5 of this manual.

11.3.9 Dissipation Factor

Connect resistor 10 kΩ and capacitor 10 nF of the Test Set in parallel to PM6304.
Set PM6304 to D, 1 kHz, CONT, NORMAL.

Test result: Display must read D = 1.58 to 1.60

11.3.10 Short-Time Deviation of Measurements

This test must be done after repair work on the analog Unit 3, or on the DC Unit 5.
Connect resistor 2 MΩ ±0.5 % to PM6304.

Short-Time Deviation AC

Set PM6304 to AUTO, 1 kHz, NORMAL.
Perform N = 10 succeeding measurements in SINGLE MODE and note the results Mn.

From the average result $\overline{Mn} = (1/N) * \sum_{n=1}^{N} Mn$ the single results should not exceed $\overline{Mn}$ ±2 kΩ.

For improved results, calculate the standard deviation $\sigma_M = \sqrt{(1/N) * \sum_{n=1}^{10} (Mn - Mn)^2}$

Test result: σ_M = 200 Ω min. σ_M = 2 kΩ max.

For calculation, please take a pocket calculator.

The measurement can conveniently be done using the PM 2272 INSPECTOR software.

If the test fails, repeat same measurements with a 10 kΩ resistor.
If now the test shows much lower deviations σ_M, replace amplifier N301 in the AC/V Converter on Unit 3, Figures 21, 24.

Short-Time Deviation DC

Set PM6304 to AUTO, DC, NORMAL.

Perform the same measurements as for AC.
If the test fails, repeat same measurements with a 10 kΩ resistor.
If now the test shows much lower deviations σ_M, replace amplifier N102 on the DC Unit 5, Figures 31 and 32.

11.3.11 Fast Mode via IEEE-488 or RS-232 Interface

Apply resistor 100 Ω ±0.01 % to PM6304.
Perform FAST measurement via interface, see Programmers Manual 4822 872 10167, Section 3.5.1.6.

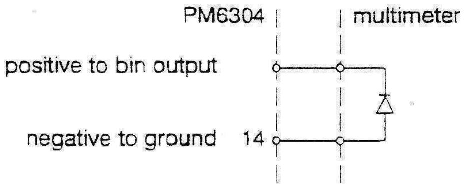
Level	Frequency	Test Result
NORMAL	1 kHz	100 Ω ±0.2 %, 99.8 to 100.2 Ω
	0.4 kHz	100 Ω ±0.4 %, 99.6 to 100.4 Ω
	10 kHz	100 Ω ±0.4 %, 99.6 to 100.4 Ω
	DC	100 Ω ±0.2 %, 99.8 to 100.2 Ω

11.3.12 PM 9566 Handler Interface, PM 9559 Bin Programmer

For pin assignment of the Handler Interface, Unit 6, see Users Manual 4822 872 10162 (english), 4822 872 10163 (german), or 4822 872 10164 (french), Section 4.6.3.

The outputs 1 = bin 9 to 10 = bin 0 have open collector outputs.

Connect multimeter with Diode Test, e.g. PM 2518X, to the single bin outputs:



Program the single bin outputs via IEEE-488 or RS-232 Interface:

BK_TEST

SORTER X X = 0 to 9 for bin 0 to 9

X = 10 for FAIL

Test result: bin OFF: multimeter display open, "OL"

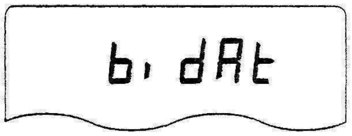
bin ON: multimeter display <700 mV

If there is no interface in the PM6304, you can set the bins with the PM 9559 Bin Programmer and measure 10 resistor values out of a resistor decade, e.g. 100 Ω, 110 Ω, 120 Ω, ...
You may also take only one resistor and program that value successively for bin 0 to bin 10.

PM 9559 Bin Programmer

Press the DATA INPUT key of PM 9559.

Check response of the LCD display of PM6304:



12 SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

12.1 GENERAL DIRECTIVES

- Take care that creepage distance and clearances have not been reduced.
- Before soldering, bend the wires through the holes of the solder tags or wrapp the wires round the tag in the form of an open U, or maintain wiring rigidity by using cable clamps or cable lacing.
- Replace all insulating guards and plates.

12.2 SAFETY COMPONENTS

Components in the primary circuit may only be replaced by components selected by Fluke, see also Section 13.3.

12.3 CHECKING THE PROTECTIVE GROUND CONNECTION

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω. During measurement the power cord should be moved. Resistance variations indicate a defect.

12.4 CHECKING THE INSULATING RESISTANCE

Measure the insulation resistance at U = 500 Vdc between the power connections and the protective lead connections. For this purpose set the power switch to ON. The insulation resistance shall not be less than 2 MΩ; 2 MΩ is a minimum requirement at 40 °C and 95 % relative humidity. Under normal conditions, the insulation resistance should be much higher (10 to 20 MΩ).

13 SPARE PARTS, Figures 13.1, 13.2

13.1 GENERAL

The PM 6304 Programmable Automatic RCL Meter is repaired preferably to component level.
If the fault cannot be found at the component level, the single units can be ordered; or preferably the complete instrument can be sent to Hamburg.
Spare Parts must be ordered via Consumer Service PCS Eindhoven.

13.2 STANDARD PARTS

Electrical and mechanical parts replacements can be obtained through your local Philips organization or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

13.3 SPECIAL PARTS

In addition to the standard electronic components, the following special components are used:

- Components, manufactured or selected by Fluke to meet specific performance requirements.
- Components that are important for the safety of the instrument are marked with 'S' in the parts list.

NOTE: Both type of components may only be replaced by components obtained through your local Fluke/Philips organization or representative.

13.4 TRANSISTORS AND INTEGRATED CIRCUITS

- If removed during routine maintenance, return transistors and IC's to their original positions.
- Do not replace or switch semiconductor devices unnecessarily, because this may affect the calibration of the instrument.
- Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket or pcb holes and cut the leads to the same lenght as on the component being replaced.
- When a part has been replaced, check the operation of the part of the instrument that may be affected.
- When reinstalling power-supply transistors, use heat-sink compound to increase the heat-transfer capabilities.

WARNING

To avoid skin irritation or injury, handle heat-sink compound with care. Avoid contact with the eyes. Wash hands thoroughly after use.

13.5 STATIC-SENSITIVE COMPONENTS

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

13.6 HANDLING MOS DEVICES

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental overvoltages. In storing and handling them, the following precautions are recommended.

CAUTION

To avoid electric shock testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should wear a ground strap.

13.6.1 Storage and Transport

Store and transport the circuits in their original packing. Alternatively, you can use a conductive material or a special IC carrier that either short-circuits all leads or insulates them from external contact.

13.6.2 Testing or Handling

Personnel must wear a ground strap and work on a conductive surface (e.g., metal table top) when testing the circuits or transferring them from one carrier to another. Connect all testing and handling equipment to the same surface.
Signals should not be applied to the inputs while the device power supply is off. All unused input leads should be connected either to the supply voltage or to ground.

13.6.3 Mounting

Mount MOS integrated circuits on printed circuit boards after all other components have been mounted. Take care that the circuits themselves, metal parts of the board, mounting tools, and the person doing the mounting are kept at the same electric (ground) potential. If it is impossible to ground the printed circuit board, the person mounting the circuits should touch the board before bringing the MOS circuits into contact with it.

13.6.4 Soldering

Soldering iron tips, including those of low voltage irons, or soldering baths should also be kept at the same potential as the MOS circuits and the board.

13.6.5 Static Charges

After the MOS circuits have been mounted, the proper handling precautions should still be observed. Until the subassemblies are inserted into the complete system in which the proper voltages are supplied, the board is no more than an extension of the leads of the devices mounted on the board. To prevent static charges from being transmitted through the board wiring to the device, it is recommended that conductive clips or conductive tape is put on the circuit board terminals.

13.6.6 Transient Voltages

To prevent permanent damage due to transient voltages, do not insert or remove MOS devices (or printed circuit boards with MOS devices) from test sockets or systems with power on.

13.7 SOLDERING TECHNIQUES

Working method:

- Carefully unsolder one after the other the soldering tags of the semiconductor.
- Remove all superfluous soldering material.
- Check that the tags of the replacement part are clean and pretinned in the areas where they are to be soldered.
- Locate the replacement semiconductor exactly in its place, and solder each tag to the relevant printed conductor on the circuit board.

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 °C. The use of solder with a low melting point is therefore recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150 °C).

WARNING

When you are soldering inside the instrument, it is essential to use a low-voltage soldering iron, the tip of which must be grounded to the instrument.

Suitable soldering irons should have temperature control and different types of nozzles (pin point tips), e.g., Weller Magnastat WTCP or WECP, Ersa TC 70/24V.
If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material. In general use short-time heating with tip temperature at a small point; avoid long time heating.

13.7.1 Surface Mounted Devices (SMD) Handling and Replacement

Tools and Materials:

The removal and attachment method of SMD components mainly employs convection heating. This involves the application of hot air to the solder joints. For removing, nozzles are available for different size and shaped components. This permits the heat to be placed directly on the leads.
There are always two settings on the hot-air tool, one for temperature (50 ... 500 °C) and the other for the air flow.
Next, a mini soldering iron can be used to prepare the solder pads before attachment and to do any touchup work.

To ensure proper repair of the surface mounted devices, the following tools have been carefully selected and are therefore recommended:
- A hot-air solder tool: Leister Hot-Jet
- Nozzles for the different packages
- Micro Electronic Systems (MES) repair kit, containing dispenser, vacuum pipette and different caplettes
- Mini soldering iron station: WEPC-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron)

The following materials are recommended:
- Soldering tin, dia 0.8 mm, SnPb 60/40 with a Resin Midly Activated (RMA) flux.
  Ordering code: 4822 390 80133
- Solder past 026
- Non-corrosive and Resin Midly Activated (RMA) Flux-Colophony.
  Ordering code: 4822 390 50025
- Desolder braided wire; ordering code: 4822 321 40042
- Magnifying glass 3x ... 10x

NOTE: The recommended Leister tools and Weller mini soldering iron can be ordered via your local dealer.

Handling SMD

Electrostatic Discharge (ESD):
All integrated circuits and many semi-conductors are susceptible to ESD. Careless handling during repair can reduce life drastically. To prevent any failure which is caused by static damage, some precautions must be taken for
- Transportation: Use static shielding bags and containers
- Working area: Use anti-static mat and wristband, connected to earth potential.

Replacement of SMD:

CAUTION

Components once removed must NOT be used again.

Fluxing and Cleaning:

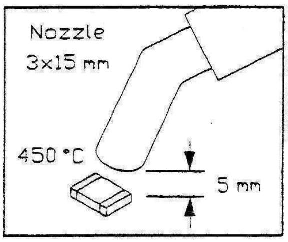
For optimal soldering result, solder flux must be used to chemically clean the metals and the solder. The flux removes oxide from the metals and acts as a wetting agent. Because the use of flux can cause electrical leakage problems in high-ohmic circuits, it is important to use non-corrosive and Resin Midly Activated (RMA) flux, such as Colophony.
The flux residue left over after attachment the SMD components must be removed. To ensure proper cleaning of the board, this must be done IMMEDIATELY after repair. The longer the flux remains on the board, the harder it is to clean.

Replacement of SMDs with up to four connections

NOTE: Before removing the component, observe very carefully its position to avoid that the new component is installed upside-down. This is especially important for capacitors and four-leads SOTs.

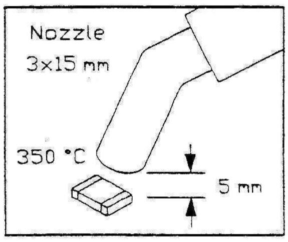
REMOVING:

ATTENTION: Be careful that the adjacent components are not damaged by the hot-air flow.



- Prepare the hot-air tool; attach a 3 x 1.5 mm oval tip nozzle, set the temperature of the hot gas to 450 °C and the air flow to 'high'.
- Hold the nozzle 5 mm above the component to be removed.
- Heat the component up equally for about 5 seconds.
- When the solder becomes molten, remove the component from the board using the vacuum pipette.
- Remove the hot-air tool.
- Clean all pads with the braided wire.

ATTACHING:

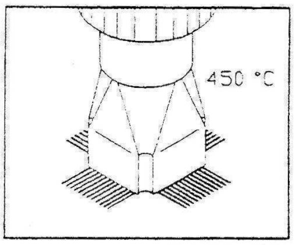


- Apply new solder paste in small dots to all soldering pads.
- Prepare the hot-air tool; use a 3 x 1.5 mm oval tip nozzle, set the hot gas to 350 °C and the air flow to 'low'.
- Place the new component with a pair of tweezers on the sticky solder paste of the contact pads.
- Position the component well.
- Apply the heat from a distance of 5 mm in the direction of the solder paste.
- Allow even reflow of the solder, the soldering time per joint should be not more than about 10 seconds.
- Remove the hot-air tool.
- Clean the pcb very carefully; be sure to remove all flux residue.
- Inspect the solder joints and, if necessary, remove superfluous solder rests with the use of braided wire.

Replacement of SMDs with more connections

REMOVING:

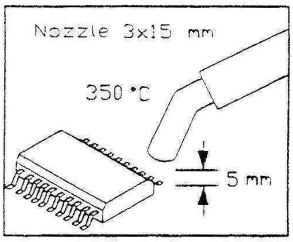
ATTENTION: Be careful that the adjacent components are not damaged by the hot-air flow.



- Prepare the hot-air tool; attach the correct nozzle, set the temperature of the hot gas to 450 °C and the air flow to 'high'.
- Hold the nozzle on the component to be removed.
- Heat all connections of the component equally up for about 10 seconds.
- When the solder becomes molten, remove the component from the board using the vacuum pipette. Use a small screwdriver to break the glue bond when necessary.
- Remove the hot-air tool.
- Clean all pads with the braided wire.

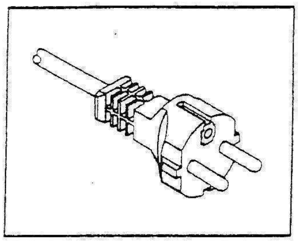
ATTACHING:

NOTE: It is very helpful to use a magnifying glass having a magnification of 3 to 10 to check the correct position of all leads.

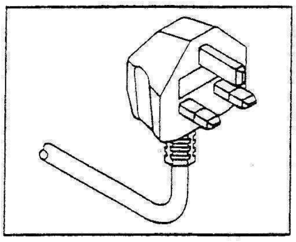


- Apply a certain amount of flux to the solder pads.
- Apply new solder paste in a straight line to the soldering pads.
- Prepare the hot-air tool; attach a 3 x 1.5 mm oval tip nozzle, set the temperature of the hot gas to 350 °C and the air flow to 'low'.
- Place the new component with a pair of tweezers on the sticky solder paste of the contact pads. Use the pin no. 1 location for reference.
- Fix the component with a small soldering tip by briefly heating soldering pads in two diagonally opposite corners.
- Apply the heat from a distance of 5 mm in the direction of the solder paste.
- Slowly move the nozzle over the row of solder joints.
- Allow even reflow of the solder, the soldering time per joint should be not more than about 10 seconds.
- Remove the hot-air tool.
- Clean the pcb very carefully; be sure to remove all flux residue.
- Inspect the solder joints for good connections or short-circuits and, if necessary, remove superfluous solder rests with the use of braided wire.

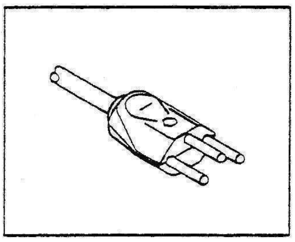
13.8 MAINS CABLES



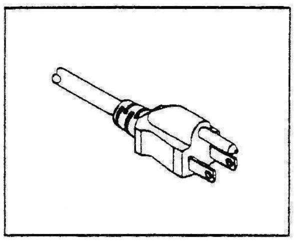
Universal Europe
5322 321 10755



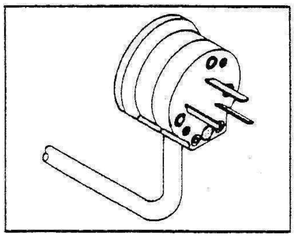
England, U.K.
5322 321 10756



Switzerland
5322 321 10753



North America
5322 321 10752



Australia
5322 321 10754

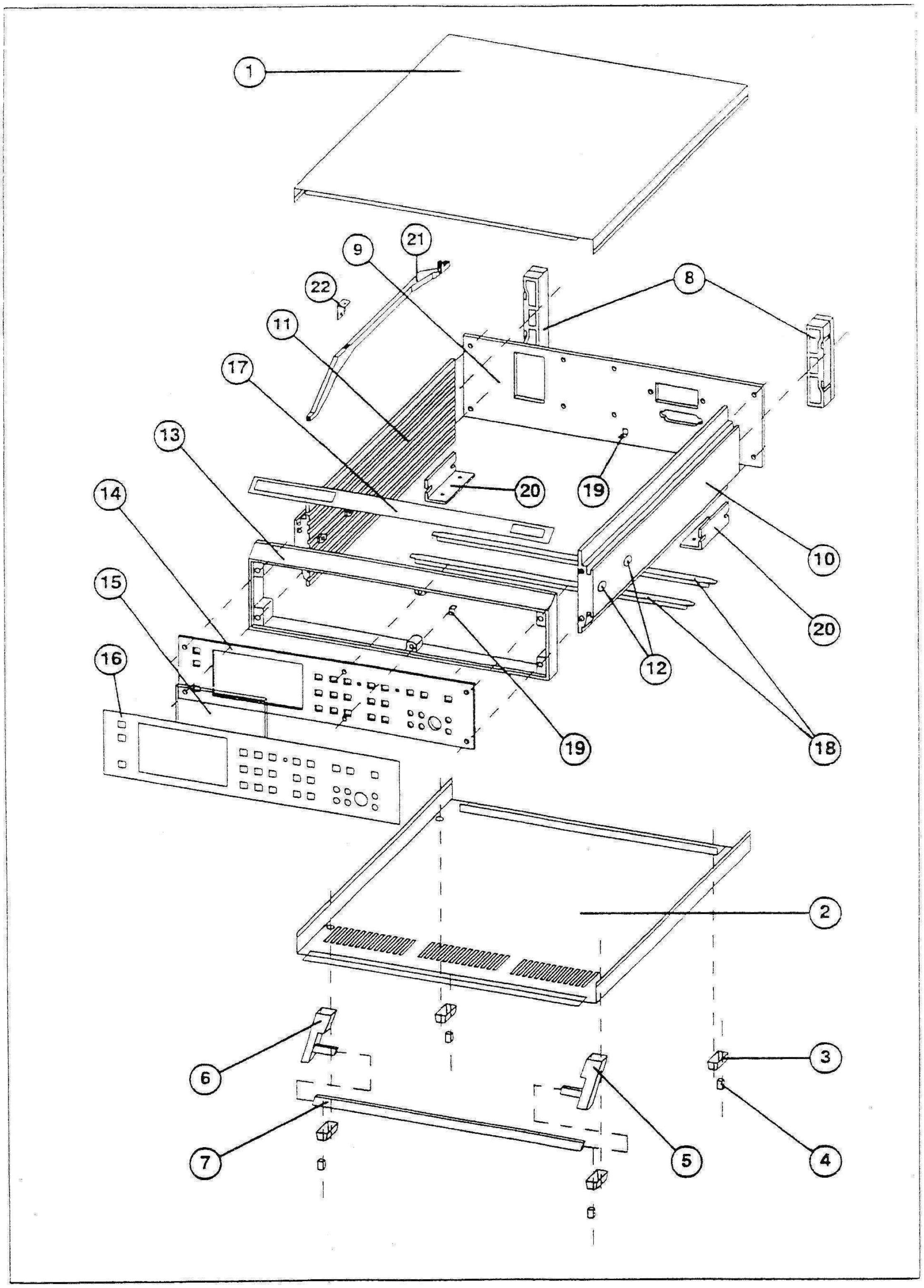


Fig. 13.1 **Mechanical parts, housing**

13.9 MECHANICAL PARTS, HOUSING (Figure 13.1)

Item	Quantity		Description	Order number
1	1		TOP COVER	5322 447 91915
2	1		BOTTOM COVER	5322 447 91818
3	4		PLASTIC FOOT	5322 462 41712
4	4		RUBBER FOOT	5322 462 44148
5	1		HOLDER FOR HANDLE RIGHT	5322 256 91648
6	1		HOLDER FOR HANDLE LEFT	5322 256 91647
7	1		HANDLE	5322 498 50311
8	2		REAR BUMPER	5322 462 41711
9	1	⋆	REAR PANEL	5322 447 92408
	1	⋆⋆	REAR PANEL	5322 447 92217
10	1		SIDE PANEL RIGHT	5322 447 92164
11	1		SIDE PANEL LEFT	5322 447 92163
12	4		COVER PAD FOR SIDE PANEL	5322 466 62439
13	1		FRAME FOR FRONT PLATE	5322 464 90663
14	1	⋆	FRONT PLATE	5322 447 92407
	1	⋆⋆	FRONT PLATE	5322 447 92166
15	1		WINDOW FOR DISPLAY	5322 381 11127
16	1	⋆	TEXT FOIL	5322 456 90465
	1	⋆⋆	TEXT FOIL	5322 456 90456
17	1	⋆	LOGO STRIP	5322 466 93528
	1	⋆⋆	LOGO STRIP	5322 466 93343
18	2		UNIT HOLDER	5322 535 93098
19	2		ANGLE BRACKET	5322 462 41707
20	2		HEATSINK/HOLDER U1	5322 255 41324
21	1	⋆	ROD FOR POWER SWITCH	5322 535 93565
22	1	⋆	GUIDE FOR ROD	5322 462 30639

⋆	ONWARDS	LO 648 885
⋆⋆	UNTIL	LO 648 884

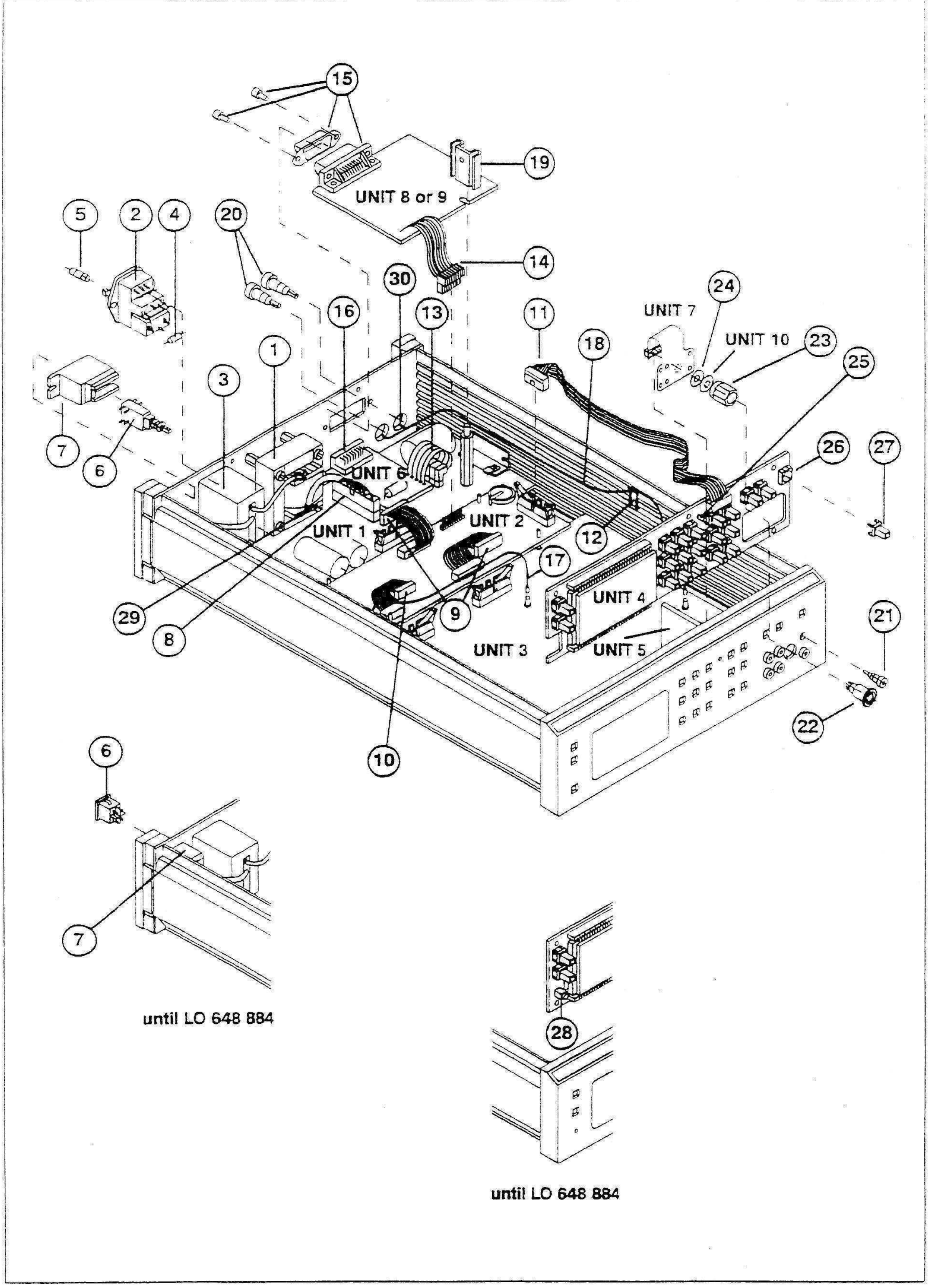


Fig. 13.2 **Mechanical parts on units, cables, miscellaneous**

13.10 MECHANICAL PARTS ON UNITS, CABLES, PARTS NOT ON UNITS, MISCELLANEOUS (Figure 13.2)

Item	Quantity		Description		Order number
1	1		MAINS TRANSFORMER	*S*	5322 148 20036
2	1		MAINS SOCKET WITH VOLTAGE SELECTOR AND MAINS FILTER	*S*	5322 121 43938
3	1		PROTECTION COVER FOR MAINS SOCKET	*S*	5322 462 41708
4	1		RESISTOR VR25 4.7 MΩ		4822 053 20475
5	1		FUSE 400 MAT/250 V	*S*	4822 070 34001
	1		FUSE 200 MAT/250 V	*S*	4822 070 32001
6	1	⋆	POWER SWITCH	*S*	5322 276 13632
	1	⋆⋆	POWER SWITCH	*S*	5322 276 12029
7	1	⋆	COVER/HOLDER FOR POWER SWITCH	*S*	5322 462 42218
	1	⋆⋆	COVER/HOLDER FOR POWER SWITCH	*S*	5322 462 41708
8	1		CONNECTION CABLE POWER SUPPLY, WIRED		5322 321 62435
	1		PLUG FOR ITEM 8		5322 265 40465
9	2		CONNECTION CABLE U2, 26-POLE, WIRED		5322 321 62434
	2		PLUG FOR ITEM 9		5322 265 51146
10	1		CONNECTION CABLE U2, 14-POLE, WIRED		5322 321 62433
	1		PLUG FOR ITEM 10		5322 265 41361
11	1		CONNECTION CABLE U4 TO U2, 14-POLE, WIRED		5322 321 62432
	1		PLUG FOR ITEM 11		5322 265 41361
12	1		HOLDER FOR CABLE		5322 401 11521
13	1		CONNECTION CABLE U6 TO U1		5322 321 60757
	1		PLUG FOR ITEM 13		5322 265 64091
14	1		CONNECTION CABLE INTERFACE TO U2		5322 321 60757
	1		PLUG FOR ITEM 14		5322 265 64091
15	1		IEEE-488 CONNECTOR		5322 267 60162
	1		RS-232 CONNECTOR		5322 267 41137
16	1		CONNECTOR FOR HANDLER INTERFACE		5322 267 41138
17	1		MINI-COAX CABLE WITH PLUG, U2 TO U3		5322 321 62357
18	1		MINI-COAX CABLE WITH PLUG, FROM U3		5322 321 62358
	2		SOCKET FOR MINI-COAX CABLE		5322 265 10266
	2		PIN FOR SOCKET		5322 268 14141
19	1		HEAT SINK (IEEE-488 INTERFACE ONLY)		5322 255 40439
20	2		BANANA SOCKET 4 MM, BLACK		5322 267 30532
21	2		BANANA SOCKET 2 MM, BLACK		5322 264 30354
	4		BANANA SOCKET 2 MM, RED		5322 264 30355

S = SAFETY COMPONENT
⋆ ONWARDS LO 648 885
⋆⋆ UNTIL LO 648 884

Item	Quantity		Description	Order number
22	1		ROUND CONNECTOR 8-POLE, FEMALE	5322 264 50271
	1		PLUG 8-POLE, MALE	5322 264 50269
23	1		SHIELDING FOR ITEM 22	5322 505 11169
24	1		INSULATING DISK	5322 532 52574
25	1		TUBE FOR IR RECEIVER	5322 131 81027
26	20		PUSHBUTTON	4822 276 11076
27	19		CAP FOR PUSHBUTTON, GREY	5322 414 60707
	1		CAP FOR PUSHBUTTON, GREEN	5322 414 70181
28	1	★★	RESET PUSHBUTTON	5322 276 12919
29 L802-5	4		DAMPING BEAD TRANSFORMER	5322 526 10506
30 C503-4	2		CAPACITOR DC CONNECTOR – ⊥	5322 122 20041
C501	1		CAPACITOR UNIT 3 – ⊥	5322 122 20041

★ ONWARDS LO 648 885
★★ UNTIL LO 648 884

13.11 ACCESSORIES, ADAPTERS (Figures 1 to 9)

TEST POST RED	5322 264 30351
TEST POST BLACK	5322 264 30352
DOUBLE TEST POST	5322 264 30185
PLUG 8-POLE MALE	5322 264 50269
TEST SET FOR PM6304, PM6304C, PM6306	5322 310 32273
10NF CAPACITOR CALIBRATED; PART OF THE TEST SET	5322 126 13738
SMD RESISTOR SET FOR SMD ADAPTER R → 0 Ω AND R → ∞ Ω	5322 310 32275

PM 9540/TWE	▪ SMD TWEEZERS
PM 9540/BAN	▪ 4-WIRE TEST CABLE WITH BANANA PLUGS
PM 9541A	▪ 4-WIRE TEST CABLE
PM 9542A	▪ RCL ADAPTER
PM 9542SMD	▪ SMD ADAPTER
PM 9559	▪ BIN PROGRAMMER (INFRARED REMOTE CONTROL)

▪ = ONLY COMPLETE ITEMS AVAILABLE (NO SINGLE SPARE PARTS);
TO BE ORDERED WITH COMMERCIAL TYPE NUMBER

13.12 ELECTRICAL PARTS ON UNITS AND COMPLETE UNITS

The units are repaired on component level. Complete units can also be ordered.
Complete units PM 9548, PM 9549, PM 9565, PM 9566 as spare part can only be orders via commercial channel.
Spare parts must be ordered via Consumer Service PCS, Eindhoven.
Resistors not listed are of type MRS 16T 1 % 0.4 W (ordering code see end of this list).

POS.No.	DESCRIPTION				ORDERING CODE
UNIT 1, POWER SUPPLY, Fig. 13, 16					**5322 214 91363**
INTEGRATED CIRCUITS/UNIT 1					
N101	POS VOLT REG	LM7805CT			5322 209 86445
N102,103	JFET INP OPAMP	TL071ACP			5322 209 32989
N104	4 X LINE REC	LM78L05ACZ			5322 499 00682
N105	NEG VOLT REG	LM79L05ACZ			5322 183 20682
N106	JFET INP OPAMP	TL071ACP			5322 209 32989
TRANSISTORS/UNIT 1					
V101	LF TRANSISTOR	BC557B			4822 026 20116
V102	LF TRANSISTOR	BD645			5322 699 50112
V103	LF TRANSISTOR	BC547B			4822 976 30116
V104	LF TRANSISTOR	BD646			4822 130 41212
V105	LF TRANSISTOR	BC557B			4822 026 20116
V106	LF TRANSISTOR	BUT11A			5322 130 63691
DIODES/UNIT 1					
V151	BRIDGE RECT	SKB2/08L5A			4822 130 81278
V152	VOLT REG DIODE	BZX79-B4V7			4822 130 34174
V153	SIL DIODE	BAW62			4822 130 30613
V154	BRIDGE RECT	SKB2/08L5A			4822 130 81278
V155	VOLT REG DIODE	BZX79-B8V2			4822 130 34382
V156	VOLT REG DIODE	BZX79-B10			4822 130 61219
V157	VOLT REG DIODE	BZX79-B8V2			4822 130 34382
V158	VOLT REG DIODE	BZX79-B16			4822 130 34268
V159	VOLT REF DIODE	BZV12			5322 130 34269
V160	VOLT REG DIODE	BZX79-B4V7			4822 130 34174
CAPACITORS/UNIT 1					
C101	CER CAP	100V	10%	100NF	5322 126 11584
C102	ELCAP	16V	20%	10000UF	5322 124 22332
C103-109	ELCAP	16V	20%	100UF	4822 124 21912
C110-111	ELCAP	40V	20%	4700UF	5322 124 22218
C112-114	CER CAP	100V	10%	100NF	5322 126 11584
C115-118	ELCAP	50V	20%	100UF	5322 124 42408
C119-120	CER CAP	100V	10%	100NF	5322 126 11584
C121	CER CAP	100V	2%	220PF	4822 122 31348
C122,124	ELCAP	50V	20%	100UF	5322 124 42408
C123	CER CAP	100V	2%	220PF	4822 122 31348
C125-127	CER CAP	100V	10%	100NF	5322 126 11584
C129	CER CAP	100V	10%	100NF	5322 126 11584

POS.No.	DESCRIPTION	ORDERING CODE
RESISTORS/UNIT 1		
R106,107	MTL FILM RST MBA0204 1% 2E15	5322 116 83064
R112,113	MTL FILM RST MBA0204 1% 2E15	5322 116 83064
R115	POTMETER 20% 500E	5322 101 11076
MISCELLANEOUS/UNIT 1		
F111	MULTIFUSE 0.25 AMP.	5322 252 20324
UNIT 2, DIGITAL UNIT, Fig. 17 to 20		**5322 214 91364**
INTEGRATED CIRCUITS/UNIT 2		
D101	4 X 2-INP SCHM PC74HC132T	5322 209 60428
D102	HEX INVERTER PC74HCU04T	5322 209 11517
D103	256 X 8 SRAM PCF8570CT	4822 209 61059
D104	2KX8 SERIAL EEPROM X24C16S	5322 209 33201
D105	PROM (LOADED)	5322 209 52544
D106	8 X TPR D-LATCH PC74HC573T	5322 209 60424
D107	MICROPROCESSOR P80C652FBA	5322 209 33173
D108	8 X BUS TRANSC PC74HC245T	5322 209 60425
D109	3 TO 8 DECODER PC74HC237T	5322 209 33211
D201	HEX INVERTER PC74HCU04T	5322 209 11517
D202	TWS PCF1842P	5322 209 62544
D203	BUS INTERF REG N74F821D	5322 209 33215
D204	2K X 8 PROM N82S191CA	5322 209 52545
D205	8 X D-FF N74F574D	5322 209 63943
D206	8-ST SH/ST REG PC74HC4094T	5322 209 12171
D207	2K X 8 PROM N82S191CA	5322 209 52545
D208	4-BIT ADDER PC74HC283T	4822 209 12497
D209	2 X 4B-BIN.CNT PC74HC393T	5322 209 60427
D210	8 X D-FF N74F574D	5322 209 63943
D211	HEX INVERTER PC74HCU04T	5322 209 11517
D301	2X JK-FF PC74HC112T	4822 209 30544
D302	2 X DEC CNTR PC74HC390T	5322 209 11997
D303	ANAL MULTIPLEX PC74HC4053T	4822 209 60792
D304,305	2 X DEC CNTR PC74HC390T	5322 209 11997
D306	4 X 2-INP NOR PC74HC02T	5322 209 71563
D307	2X JK-FF PC74HC112T	4822 209 30544
D308	2 X 4B-BIN.CNT PC74HC393T	5322 209 60427
D309,311	PAR/SER SH REG PC74HC165T	5322 209 12169
D310,312	2 X 4B-BIN.CNT PC74HC393T	5322 209 60427
D313	PAR/SER SH REG PC74HC165T	5322 209 12169
D314	2X JK-FF PC74HC112T	4822 209 30544
N201	8-BIT DA CONV TDA8702T/C1	5322 209 33216
N202	POS VOLT REG LM78L05ACM	4822 209 30867

POS.No.	DESCRIPTION	ORDERING CODE

TRANSISTORS/UNIT 2

V101	LF TRANSISTOR BC847B	4822 130 60511
V201	HF TRANSISTOR BF840	4822 130 60887

DIODES/UNIT 2

V151-155	SIL DIODE BAS32L	4822 130 80446

CAPACITORS/UNIT 2

C101	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C102	ELCAP 35V -20+20% 10UF	5322 124 81239
C103	CER CHIP CAP 63V 5% 33PF	4822 126 10324
C104	CER CHIP CAP 63V 5% 47PF	4822 122 31772
C105	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C106	CER CHIP CAP 63V 10% 470NF	5322 122 40892
C107-110	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C111	ELCAP 10V -20+20% 22UF	5322 124 11421
C112	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C113-116	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C201-104	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C205,206	ELCAP 35V -20+20% 10UF	5322 124 81239
C207-209	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C210	CER TRI CAP 0.5-15 PF	5322 101 11165
C211	CER CHIP CAP 63V 5% 15PF	4822 122 32504
C212	CER CHIP CAP 63V 5% 220PF	4822 122 31965
C213	CER CHIP CAP 63V 5% 100PF	4822 122 31765
C214	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C215	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C216	ELCAP 25V 20% 1UF	5322 124 11422
C217-219	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C220,221	CAP CERAMIC 63V 2% 33PF	5322 122 32072
C301-308	CER CHIP CAP 63V 10% 100NF	4822 122 33496

RESISTORS/UNIT 2

R101,102	MTL FILM RST MMA0204 1% 21K5	5322 117 10933
R103,105	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R104	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R106-111	MTL FILM RST MMA0204 1% 51K1	5322 117 10914
R112	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R113-133	MTL FILM RST MMA0204 1% 5K11	5322 117 10913
R201	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R202	MTL FILM RST MMA0204 1% 75E	5322 117 10924
R203	MTL FILM RST MMA0204 1% 51K1	5322 117 10914
R204	MTL FILM RST MMA0204 1% 7K5	5322 117 10923
R205	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R206	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R207	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R208	MTL FILM RST MMA0204 1% 215E	5322 117 10888
R301	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R302	MTL FILM RST MMA0204 1% 2K15	5322 116 83693

POS.No.	DESCRIPTION	ORDERING CODE

MISCELLANEOUS/UNIT 2

POS.No.	DESCRIPTION	ORDERING CODE
G101	QUARTZ CRYSTAL 12.0MHZ	5322 242 81733
G201	QUARTZ CRYSTAL 20.97152MHZ	5322 242 81734
G150	LITHIUM BATTERY 3V	5322 138 10088
----	DIL-IC-SOCKET 28-P	5322 255 44234

UNIT 3, ANALOG UNIT, Fig. 21 to 28 5322 214 91365

INTEGRATED CIRCUITS/UNIT 3

POS.No.	DESCRIPTION	ORDERING CODE
D101	8-ST SH/ST REG PC74HC4094T	5322 209 12171
D102,103	2X 4-IN AN MUX PC74HC4052T	5322 209 12278
D201	8-ST SH/ST REG PC74HC4094T	5322 209 12171
D202	6 X INV SMTR PC74HC14T	5322 209 11548
D203	4 X BIL SWITCH PC74HC4316T	4822 209 63764
D204	2X 4-IN AN MUX PC74HC4052T	5322 209 12278
D401	8-ST SH/ST REG PC74HC4094T	5322 209 12171
D403,404	4 X BIL SWITCH PC74HC4316T	4822 209 63764
D501	2X 4-IN AN MUX PC74HC4052T	5322 209 12278
D502	4 X BIL SWITCH PC74HC4316T	4822 209 63764
D601	8X TPR D-LATCH PC74HC573T	5322 209 60424
D602	4 X BIL SWITCH PC74HC4316T	4822 209 63764
N101	LW NOISE OPAMP NE5532D	4822 209 30803
N102,103	DUAL JF OPAMP TL072ACD	4822 209 30833
N105	LW NOISE OPAMP NE5532D	4822 209 30803
N202	ANALOG SWITCH DG413DY	5322 209 33203
N203,204	DUAL JF OPAMP TL072ACD	4822 209 30833
N205-207	LW NOISE OPAMP NE5534AD	5322 209 33212
N216	TRANSIST-ARRAY CA3183M	5322 209 33204
N301	OP AMP C.FB. AD844JR	5322 209 33205
N302	2 X VOLT COMP LM393D	5322 209 70225
N303	ANALOG SWITCH DG413DY	5322 209 33203
N402,403	LW NOISE OPAMP NE5534AD	5322 209 33212
N404,405	TRANSIST-ARRAY CA3183M	5322 209 33204
N406	LW NOISE OPAMP NE5534AD	5322 209 33212
N407	ANALOG SWITCH DG413DY	5322 209 33203

POS.No.	DESCRIPTION		ORDERING CODE
N501	DUAL JF OPAMP	TL072ACD	4822 209 30833
N502,504	LW NOISE OPAMP	NE5532D	4822 209 30803
N503	LW NOISE OPAMP	NE5534AD	5322 209 33212
N505,506	DUAL JF OPAMP	TL072ACD	4822 209 30833
N507	2 X VOLT COMP	LM393D	5322 209 70225
N601	8-BIT CMOS DAC	AD7524JR	5322 209 33207
N603	LW NOISE OPAMP	NE5532D	4822 209 30803
N604	VOLTAGE COMP	LM311D	5322 209 84156
N606,607	DUAL JF OPAMP	TL072ACD	4822 209 30833
N701,702	ANALOG SWITCH	DG413DY	5322 209 33203
N703,704	DUAL JF OPAMP	TL072ACD	4822 209 30833

TRANSISTORS/UNIT 3

V106	LF TRANSISTOR	BC847B	4822 130 60511
V107	LF TRANSISTOR	BC857B	5322 130 42012
V117,120	LF TRANSISTOR	BC847B	4822 130 60511
V118,119	LF TRANSISTOR	BC857B	5322 130 42012
V124-126	SW TRANSISTOR	BST16	5322 130 63537
V133-135	SW TRANSISTOR	BST39	4822 130 60141
V145	LF TRANSISTOR	BC857B	5322 130 42012
V146	LF TRANSISTOR	BC847B	4822 130 60511
V151-153	SW TRANSISTOR	BST16	5322 130 63537
V154-156	SW TRANSISTOR	BST39	4822 130 60141

DIODES/UNIT 3

V101	SIL DIODE	BAS32L	4822 130 80446
V102	SCHOTTKY DIODE	BAS85	4822 130 82334
V103,104	VOLT REG DIODE	BZV55-B3V3	5322 130 83621
V111,112	VOLT REG DIODE	BZV55-B3V3	5322 130 83621
V113,316	SIL DIODE	BAS32L	4822 130 80446
V122,123	SIL DIODE	BAS32L	4822 130 80446
V127-132	RECT DIODE	BYD37J	5322 130 83619
V147,148	VOLT REG DIODE	BZV55-B12	5322 130 83623
V149,150	SIL DIODE	BAS32L	4822 130 80446
V157-162	RECT DIODE	BYD37J	5322 130 83619
V171	SIL DIODE	BAS32L	4822 130 80446
V210,215	SIL DIODE	BAS32L	4822 130 80446
V218,219	SIL DIODE	BAS32L	4822 130 80446
V220-225	RECT DIODE	BYD37J	5322 130 83619
V229	SIL DIODE	BAS32L	4822 130 80446
V230,231	SIGNAL DIODE	FDH300	5322 130 32407
V232,233	VOLT REG DIODE	BZV55-B4V3	5322 130 83622
V236,244	SIL DIODE	BAS32L	4822 130 80446
V245,246	SIGNAL DIODE	FDH300	5322 130 32407
V301,302	SCHOTTKY DIODE	BAT17	5322 130 31554
V303,304	SIL DIODE	BAS32L	4822 130 80446
V309	SCHOTTKY DIODE	BAS85	4822 130 82334

POS.No.	DESCRIPTION	ORDERING CODE
V551-560	SIL DIODE BAS32L	4822 130 80446
V571,572	SCHOTTKY DIODE BAS85	4822 130 82334
V611-614	SIL DIODE BAS32L	4822 130 80446
V621-624	SIL DIODE BAS32L	4822 130 80446
V701,704	VOLT REG DIODE BZV55-B4V3	5322 130 83622
V702,705	SCHOTTKY DIODE BAS85	4822 130 82334
V706	VOLT REG DIODE BZV55-B4V3	5322 130 83622

CAPACITORS/UNIT 3

C102-109	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C111	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C112-114	CER CHIP CAP 63V 5% 270PF	4822 122 32142
C115-120	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C121-125	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C131	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C207-208	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C210,213	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C222	ELCAP 50V 20% 100UF	5322 124 42408
C223	CER CHIP CAP 63V 10% 470NF	5322 122 40892
C224	KP/MMKP CAP 630V 3.5% 47NF	5322 121 70522
C225-229	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C236-237	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C241,243	CER CAP 500V 5% 22PF	5322 126 13137
C242,244	CER CHIP CAP 63V 0.5PF 5.6PF	4822 122 32506
C245,247	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C246	CER CHIP CAP 63V 0.5PF 5.6PF	4822 122 32506
C249,250	CER CHIP CAP 63V 5% 470PF	4822 122 31727
C251,252	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C253	CER CHIP CAP 63V 0.25PF 4.7PF	4822 122 32082
C261	CER CAP 2 500V 10% 2.7NF	4822 122 31174
C271	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C301	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C305,306	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C307	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C308	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C321	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C322,323	MKT FILM CAP 63V 5% 100NF	5322 121 42386
C326,327	ELCAP 35V 20% 47UF	4822 124 40846
C331,332	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C341	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C446	CER CHIP CAP 63V 0.25PF 3.3PF	4822 122 32079
C447	CER CHIP CAP 63V 0.25PF 4.7PF	4822 122 32082
C402,403	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C405	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C406,407	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C411,412	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C413	CER CHIP CAP 63V 0.25PF 3.3PF	4822 122 32079
C414,415	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C417-423	CER CHIP CAP 63V 10% 100NF	4822 122 33496

POS.No.	DESCRIPTION	ORDERING CODE
C431	CER CHIP CAP 63V 0.25PF 4.7PF	4822 122 32082
C434	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C442-445	CER CHIP CAP 63V 10% 470NF	5322 122 40892
C451	CER CHIP CAP 63V 5% 270PF	4822 122 32142
C452,453	CER CHIP CAP 63V 5% 22PF	4822 122 15229
C454	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C501,502	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C507,508	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C513,514	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C517,518	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C521-523	MKT FILM CAP 100V 10% 33NF	5322 121 42489
C524	MKT FILM CAP 250V 10% 10NF	4822 121 41857
C531	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C532-534	CER CHIP CAP 63V 5% 270PF	4822 122 32142
C541	CER CHIP CAP 63V 0.25PF 1.2PF	4822 122 33013
C551-523	CER CHIP CAP 63V 5% 100PF	4822 122 31765
C554,555	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C556,557	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C571	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C581	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C582	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C605,606	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C607-609	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C612,613	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C633	CER CHIP CAP 63V 5% 100PF	4822 122 31765
C634,635	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C636,637	CER CHIP CAP 63V 10% 10NF	4822 122 32442
C638,639	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C640	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C641	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C701,702	CER CHIP CAP 63V 5% 3.3NF	5322 122 33897
C703-706	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C707	KS FILM CAP 63V 1% 150NF	5322 121 54118
C708	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C709	ELCAP 35V 20% 47UF	4822 124 40846
C710,711	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C712	ELCAP 35V 20% 47UF	4822 124 40846

RESISTORS/UNIT 3

R101	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R102	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R103	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R104	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R105	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R106	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R107	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R108	MTL FILM RST MMA0204 1% 316E	5322 117 10895
R109	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R110	MTL FILM RST MMA0204 1% 619E	5322 116 83701

POS.No.	DESCRIPTION	ORDERING CODE
R111	POTMETER 20% 10K	5322 101 11306
R112	MTL FILM RST MMA0204 1% 2K87	5322 117 10894
R113	MTL FILM RST MMA0204 1% 31K6	5322 116 83695
R114	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R115	MTL FILM RST MMA0204 1% 82K5	5322 117 11043
R116	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R117	MTL FILM RST MMA0204 1% 7K5	5322 117 10923
R118	MTL FILM RST MMA0204 1% 82K5	5322 117 11043
R119,121	MTL FILM RST MMA0204 1% 7K5	5322 117 10923
R120,122	MTL FILM RST MMA0204 1% 147K	5322 117 11026
R123	MTL FILM RST MMA0204 1% 316K	5322 117 11034
R124	MTL FILM RST MMA0204 1% 287K	5322 117 11033
R125	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R128,129	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R130	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R131,132	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R133,134	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R135,136	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R137	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R141	MTL FILM RST MMA0204 1% 348K	5322 117 10899
R142,142	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R144,146	MTL FILM RST MMA0204 1% 2K15	5322 116 83693
R145	MTL FILM RST MMA0204 1% 215E	5322 117 10888
R151	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R152	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R153	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R154	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R155	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R156,157	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R159	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R160	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R161	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R162	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R163	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R171	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R172	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R173	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R174	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R175	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R176	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R177	MTL FILM RST MMA0204 1% 2K15	5322 116 83693
R179	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R180	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R181	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R182	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R183	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R184	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R191,192	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R193,194	MTL FILM RST MMA0204 1% 7K5	5322 117 10923
R195-198	MTL FILM RST MMA0204 1% 316E	5322 117 10895

POS.No.	DESCRIPTION	ORDERING CODE
R205-208	MTL FILM RST MMA0204 1% 3K83	5322 117 10901
R211-215	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R216	MTL FILM RST MMA0204 1% 1K1	5322 117 10875
R217-220	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R221	MTL FILM RST MMA0204 1% 1K1	5322 117 10875
R222	MTL FILM RST MMA0204 1% 21E5	5322 117 11032
R226,229	MTL FILM RST MMA0204 1% 100K	5322 116 81258
R236,237	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R241	MTL FILM RST MMA0204 1% 21K5	5322 117 10933
R242	POTMETER 20% 100K	5322 100 12126
R243,244	MTL FILM RST MMA0204 1% 4K64	5322 117 11552
R245,246	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R247,248	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R249,250	MTL FILM RST MMA0204 1% 750E	5322 116 81302
R254,255	MTL FILM RST PR03 5% 4K7	4822 053 12472
R261	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R262	MTL FILM RST MMA0204 1% 4M64	5322 117 11037
R263	MTL FILM RST MMA0204 1% 3K83	5322 117 10901
R264,265	MTL FILM RST PR03 5% 4K7	4822 053 12472
R266,267	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R268	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R269	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R270	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R271-273	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R274	MTL FILM RST MMA0204 1% 4M64	5322 117 11037
R275	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R276	MTL FILM RST MMA0204 1% 4M64	5322 117 11037
R277	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R278	RST NETWORK 8X1K	5322 116 90875
R279,280	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R281-283	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R284	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R285	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R286	MTL FILM RST MMA0204 1% 215K	5322 117 11031
R287	POTMETER 20% 100K	5322 100 12126
R288	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R291-295	MTL FILM RST MMA0204 1% 51K1	5322 117 10914
R302	PREC RST MPR24 1/4W 0.1% 10K	5322 116 53102
R303	PREC RST MPR34 0.4W 0.1% 100E	5322 117 11126
R304	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R305	MTL FILM RST MMA0204 1% 14E7	5322 117 11027
R306	MTL FILM RST MMA0204 1% 422E	5322 117 10906
R311	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R312	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R313,314	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R315	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R316,317	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R318	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R321-323	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R324,325	MTL FILM RST MMA0204 1% 42E2	5322 117 11035
R326,327	MTL FILM RST MMA0204 1% 5E11	5322 117 11038
R328,329	MTL FILM RST MMA0204 1% 4K64	5322 116 83698

POS.No.	DESCRIPTION	ORDERING CODE
R331	MTL FILM RST MMA0204 1% 215K	5322 117 11031
R332,333	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R341	MTL FILM RST MMA0204 1% 1E	5322 117 11013
R401	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R403,404	MTL FILM RST MMA0204 1% 21K5	5322 117 10933
R405	MTL FILM RST MMA0204 1% 215E	5322 117 10888
R406	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R407	MTL FILM RST MMA0204 1% 1K33	5322 117 10881
R408	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R409	MTL FILM RST MMA0204 1% 422E	5322 117 10906
R410	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R411	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R412	RST NETWORK 8X1K	5322 116 90875
R414,415	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R416	MTL FILM RST MMA0204 1% 348K	5322 117 10899
R417	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R418	MTL FILM RST MMA0204 1% 178K	5322 117 10886
R419-422	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R424	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R425	MTL FILM RST MMA0204 1% 26K1	5322 117 10892
R426	RST NETWORK 8X1K	5322 116 90875
R428,429	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R430	MTL FILM RST MMA0204 1% 348K	5322 117 10899
R431	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R432	MTL FILM RST MMA0204 1% 178K	5322 117 10886
R433-436	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R437	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R438	MTL FILM RST MMA0204 1% 26K1	5322 117 10892
R441-444	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R445	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R451	MTL FILM RST MMA0204 1% 42E2	5322 117 11035
R452	MTL FILM RST MMA0204 1% 147K	5322 117 11026
R453	MTL FILM RST MMA0204 1% 42E2	5322 117 11035
R454,455	MTL FILM RST MMA0204 1% 147K	5322 117 11026
R456	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R521	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R522	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R523	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R524	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R525	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R526	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R527	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R528	MTL FILM RST MMA0204 1% 7K5	5322 117 10923
R529	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R531	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R532	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R533	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R534	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R535	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R536	MTL FILM RST MMA0204 1% 16K2	5322 117 11028
R537	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R538	MTL FILM RST MMA0204 1% 316E	5322 117 10895
R539	MTL FILM RST MMA0204 1% 38K3	5322 117 10902

POS.No.	DESCRIPTION	ORDERING CODE
R540	MTL FILM RST MMA0204 1% 619E	5322 116 83701
R541,542	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R551-455	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R556,558	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R557,559	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R560,561	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R562	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R563,564	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R565	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R566	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R571	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R572	MTL FILM RST MMA0204 1% 1K47	5322 116 83691
R573	MTL FILM RST MMA0204 1% 75K	5322 117 11042
R574,575	MTL FILM RST MMA0204 1% 3K83	5322 117 10901
R576	MTL FILM RST MMA0204 1% 422E	5322 117 10906
R577,578	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R601,602	MTL FILM RST MMA0204-25 10K	5322 116 81249
R603	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R611	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R622	MTL FILM RST MMA0204 1% 51E1	5322 116 83699
R623	MTL FILM RST MMA0204 1% 21K5	5322 117 10933
R641,642	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R645	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R646,647	MTL FILM RST MMA0204 1% 464E	5322 116 83697
R648-651	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R652	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R653	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R701	MTL FILM RST MMA0204 1% 75K	5322 117 11042
R702	MTL FILM RST MMA0204 1% 75K	5322 117 11042
R703	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R704	MTL FILM RST MMA0204 1% 75K	5322 117 11042
R705	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R707	MTL FILM RST MMA0204 1% 110K	5322 117 10877
R708	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R709	MTL FILM RST MMA0204 1% 2K87	5322 117 10894
R710	MTL FILM RST MMA0204 1% 14K7	5322 117 10882
R711	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R712	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R713	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R714	MTL FILM RST MMA0204 1% 100E	5322 116 81305
R715	MTL FILM RST MMA0204 1% 100K	5322 116 81258
R716	MTL FILM RST MMA0204 1% 38K3	5322 117 10902
R717	MTL FILM RST MMA0204 1% 316E	5322 117 10895

MISCELLANEOUS/UNIT 3

K201-206	MINI RELAIS TQ2-5V	5322 280 80716
L101,201	BC-CHOKE 33UH 10%	5322 157 71141
L301,302	HF-CHOKE FXC 3B,3.5X3.5 AX.GEG	5322 526 10605
X109	MALE HEADER 2X20-P STR	5322 265 51375
X110	MALE HAEDER 1X50-P STR	5322 267 41136

POS.No.	DESCRIPTION	ORDERING CODE

UNIT 4, KEYBOARD/DISPLAY, Fig. 29, 30

★ 5322 214 91879
★★ 5322 214 91366

INTEGRATED CIRCUITS/UNIT 4

D101	4 X 2NAND SMTR	PC74HC132P	5322 209 11194
D102	KEY ENCODER	SAA3007P	5322 209 72061
D103,104	LCD DRIVER	PCF8576T	5322 209 11129
N101	IR-RECEIVER	TDA3047P	4822 209 72364

DIODES/UNIT 4

H103	PHOTO DIODE	BP104	5322 130 83618

CAPACITORS/UNIT 4

C101	CER CAP	100V	10%	100NF	5322 126 11584
C102,103	CER CAP 1	100V	2%	100PF	4822 122 31316
C104	ELCAP	35V	20%	47UF	4822 124 40846
C105	CER CAP	100V	10%	100NF	5322 126 11584
C106	MKT FILM CAP	100V	10%	47NF	4822 121 43526
C107-109	CER CAP 2	100V	-20+50%	10NF	4822 122 31414
C110	CER CAP	100V	-10+10%	22NF	5322 126 13132
C111	CER CAP 2	100V	10%	6.8NF	4822 126 12448
C112,114	ELCAP	16V	20%	100UF	4822 124 21912
C113	CER CAP 2	100V	10%	2.2NF	5322 122 32818
C115	CER CAP	100V	10%	100NF	5322 126 11584

RESISTORS/UNIT 4

R101	POTMETER		20%	10K	5322 100 20692
R102	NTC THERMISTOR	0.25W	5%	2K7	5322 116 30456

MISCELLANEOUS/UNIT 4

H101	BACKLIGHT D517 HIGH-BRIGHTNESS	5322 130 82157	
H102	LC DISPLAY	5322 130 91341	
G101	CER. RES. 455K CSB455E	5322 242 71606	
L101	MICRO CHOKE IMS5 10% 10MH	5322 158 14267	
S101-120	PUSHBUTTON	4822 276 11076	
S121	PUSHBUTTON (RESET)	5322 276 12919	★★
----	SOCKET FOR DISPLAY	5322 266 51039	

★ ONWARDS LO 648 885
★★ UNTIL LO 648 884

POS.No. DESCRIPTION ORDERING CODE

UNIT 5, DC UNIT, Fig. 31, 32, 33 PM 9565

INTEGRATED CIRCUITS/UNIT 5

POS.No.	DESCRIPTION	ORDERING CODE
D201	2X 4-IN AN MUX PC74HC4052T	5322 209 12278
N101	ANALOG SWITCH DG413DY	5322 209 33203
N102	CHOPSTAB OPAMP LTC1050CS8	5322 209 33206
N103	HI PERF OPAMP OP-27GS	5322 209 33202
N104,205	HI PERF OPAMP OP-27GS	5322 209 33202
N105	ANALOG SWITCH DG413DY	5322 209 33203
N201	DUAL JF OPAMP TL072ACD	4822 209 30833
N202	HI PERF OPAMP OP-27GS	5322 209 33202
N203	8-BIT CMOS DAC AD7524JR	5322 209 33207
N206,207	HI PERF OPAMP OP-27GS	5322 209 33202

TRANSISTORS/UNIT 5

POS.No.	DESCRIPTION	ORDERING CODE
V103,104	LF TRANSISTOR BC847B	4822 130 60511
V105	LF TRANSISTOR BC857B	5322 130 42012
V201	LF TRANSISTOR BC847B	4822 130 60511

DIODES/UNIT 5

POS.No.	DESCRIPTION	ORDERING CODE
V101,102	SIL DIODE BAS32L	4822 130 80446
V107,108	SIL DIODE BAS32L	4822 130 80446

CAPACITORS/UNIT 5

POS.No.	DESCRIPTION	ORDERING CODE
C101	CER CHIP CAP 63V 5% 3.3NF	5322 122 33897
C102-105	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C111,112	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C201-210	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C211,212	CER CHIP CAP 63V 5% 1NF	4822 122 31746
C222	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C224	CER CHIP CAP 63V 5% 3.3NF	5322 122 33897

RESISTORS/UNIT 5

POS.No.	DESCRIPTION	ORDERING CODE
R101,102	MTL FILM RST MMA0204 1% 3K83	5322 117 10901
R103,104	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R105	PREC RST MPR34 0.4W 0.1% 100E	5322 117 11126
R106	MTL FILM RST MMA0204 1% 3K83	5322 117 10901
R107,108	MTL FILM RST MMA0204 1% 51K1	5322 117 10914
R111	RST NETWORK 8X1K	5322 116 90875
R121	MTL FILM RST MRS16T 1% 464E	4822 050 14641

POS.No.	DESCRIPTION	ORDERING CODE
R201	MTL FILM RST MMA0204 1% 3K16	5322 117 10896
R202	MTL FILM RST MMA0204 1% 2K37	5322 117 10889
R203	MTL FILM RST MMA0204 1% 31K6	5322 116 83695
R204	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R205	MTL FILM RST MMA0204 1% 19K6	5322 117 11029
R206	MTL FILM RST MMA0204 1% 34K8	5322 117 10898
R207,208	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R209	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R210	MTL FILM RST MMA0204 1% 56E2	5322 117 11039
R211	MTL FILM RST MMA0204 1% 4M64	5322 117 11037
R212	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R213	MTL FILM RST MMA0204 1% 464K	5322 117 11036
R214	MTL FILM RST MMA0204 1% 21K5	5322 117 10933
R215-218	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R216	MTL FILM RST MMA0204 1% 5K11	5322 117 10913
R221	MTL FILM RST MMA0204 1% 6K19	5322 117 11041
R223	MTL FILM RST MMA0204 1% 10K	5322 116 81249
R224-226	MTL FILM RST MMA0204 1% 1M	5322 116 81259
R227,228	MTL FILM RST MMA0204 1% 5K11	5322 117 10913

MISCELLANEOUS/UNIT 5

K101,102	MINI RELAIS TQ2-5V	5322 280 80716
L101	BC-CHOKE 47UH 5% SIE	5322 157 71139
----	I.C. SOCKET PLCC 32-P	5322 255 41318

UNIT 6, HANDLER INTERFACE, Fig. 34, 35 PM 9566

INTEGRATED CIRCUITS/UNIT 6

D101,105	HEX INVERTER PC74HCU04T	5322 209 11517
D106,107	8-ST SH/ST REG PC74HC4094T	5322 209 12171
N101	POS VOLT REG LM78L05ACM	4822 209 30867
N105,106	7 X DARLINGT ULN2003AD	5322 209 33209
H102-105	OPTOCOUPLER CNX36	5322 130 90097

DIODES/UNIT 6

V101-106	SIL DIODE BAS32L	4822 130 80446

CAPACITORS/UNIT 6

C101	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C102	ELCAP 40V 20% 470UF	5322 124 21729
C103,104	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C105	ELCAP 10V -20+20% 10UF	5322 124 11217
C106	CER CHIP CAP 63V 10% 100NF	4822 122 33496
C107-109	CER CHIP CAP 63V 10% 10NF	4822 122 32442

POS.No.	DESCRIPTION	ORDERING CODE

RESISTORS/UNIT 6

R101,104	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R102,105	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R103,106	MTL FILM RST MMA0204 1% 215K	5322 117 11031
R107	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R108,110	MTL FILM RST MMA0204 1% 4K64	5322 116 83698
R109,111	MTL FILM RST MMA0204 1% 215K	5322 117 11031
R112,113	MTL FILM RST MMA0204 1% 1K	5322 116 81256
R114	MTL FILM RST MMA0204 1% 2K15	5322 116 83693
R115	MTL FILM RST MMA0204 1% 100K	5322 116 81258

UNIT 7, FLEXPRINT, Fig. 14 — 5322 214 91307

C101-103	SMD CERAMIC CAP 500V 220PF	5322 126 13067
C104	SMD CERAMIC CAP 500V 680PF	5322 126 13066
L101-104	SMD CERAMIC INDUC 470NH	5322 157 62404

UNIT 8, RS-232 INTERFACE, Fig. 36, 37 — PM 9549

INTEGRATED CIRCUITS/UNIT 8

D101	MICROPROCESSOR P80C652FBA	5322 209 33173
D102	2 X 4B-BIN.CNT PC74HC393T	5322 209 60427
D103,104	6 X INV SMTR PC74HC14T	5322 209 11548
D105,106	2 X RS-232 ICL232CPE	5322 209 61886
D107	8 X D-LATCH PC74HCT573T	5322 209 31276
D109	PROM (LOADED)	5322 209 52543
N101	POS VOLT REG LM7805CT	5322 209 86445
H101-107	OPTOCOUPLER CNX36	5322 130 90097

TRANSISTORS/UNIT 8

V102	FET BSR57	5322 130 60646

DIODES/UNIT 8

V101	BRIDGE RECT PC40	5322 130 83608
V103-108	SIL DIODE BAS32L	4822 130 80446

POS.No. DESCRIPTION ORDERING CODE

CAPACITORS/UNIT 8

C101	ELCAP	16V	20%	100UF	4822 124 21912
C102,103	CER CHIP CAP	63V	5%	27PF	4822 122 31825
C104	ELCAP	40V	20%	1000UF	5322 124 21551
C105,106	CER CHIP CAP	63V	10%	100NF	4822 122 33496
C107	ELCAP	16V	20%	100UF	4822 124 21912
C108-113	CER CHIP CAP	63V	10%	10NF	4822 122 32442
C115,116	ELCAP	63V	20%	22UF	5322 124 88229
C117,118	ELCAP	35V	20%	47UF	4822 124 40846
C119,120	ELCAP	63V	20%	22UF	5322 124 88229
C123,124	ELCAP	16V	20%	100UF	4822 124 21912
C125	CER CHIP CAP	63V	10%	100NF	4822 122 33496
C137	CER CHIP CAP	63V	10%	10NF	4822 122 32442

RESISTORS/UNIT 8

R102,103	MTL FILM RST	MMA0204	1%	10K	5322 116 81249
R104,105	MTL FILM RST	MMA0204	1%	100E	5322 116 81305
R109-111	MTL FILM RST	MMA0204	1%	464E	5322 116 83697
R112,114	MTL FILM RST	MMA0204	1%	4K64	5322 116 83698
R113,115	MTL FILM RST	MMA0204	1%	464K	5322 117 11036
R116,118	MTL FILM RST	MMA0204	1%	4K64	5322 116 83698
R117,119	MTL FILM RST	MMA0204	1%	464K	5322 117 11036
R121,123	MTL FILM RST	MMA0204	1%	464K	5322 117 11036
R122,124	MTL FILM RST	MMA0204	1%	4K64	5322 116 83698
R125	MTL FILM RST	MMA0204	1%	464K	5322 117 11036
R126-129	MTL FILM RST	MMA0204	1%	464E	5322 116 83697
R131	MTL FILM RST	MMA0204	1%	100K	5322 116 81258
R133	MTL FILM RST	MMA0204	1%	1M	5322 116 81259
R141	MTL FILM RST	MMA0204	1%	4K64	5322 116 83698
R142	MTL FILM RST	MMA0204	1%	19K6	5322 117 11029

MISCELLANEOUS/UNIT 8

G101	QUARTZ CRYSTAL 11.0592MHZ		5322 242 72245
----	I.C. SOCKET PLCC	32-P	5322 255 41318

POS.No.	DESCRIPTION				ORDERING CODE

UNIT 9, IEEE-488 INTERFACE, Fig. 38, 39

PM 9548

INTEGRATED CIRCUITS/UNIT 9

D301	OPTO DRIVER	OQ0300	5322 209 11126
D311	OPTO DRIVER	OQ0300	5322 209 11126
D313	MICROPROCESSOR	PCF84C41CP/066	5322 209 30099
D314	6 X INV	PC74HCT04P	4822 209 82341
D315	4 X 2 INP AND	PC74HCT08P	5322 209 11265
D316	8 X BUS TRANSC	SN75160BN	5322 209 73557
D317	8 X BUS TRANSC	SN75161BN	5322 209 73556
N318	POS VOLT REG	LM340T-5.0	4822 209 81741
H303-H308	OPTOCOUPLER	CNX36	5322 130 90097

TRANSISTORS/UNIT 9

V312	TRANS.	PH2369	4822 130 41594
V319	TRANS.	PH2369	4822 130 41594

DIODES/UNIT 9

V401,402	SCHOTTKY DIODE	BAT85	4822 130 31983
V403	BRIDGE RECT	PL40	5322 130 83608
V404,405	SCHOTTKY DIODE	BAT85	4822 130 31983

CAPACITORS/UNIT 9

C501	ELCAP	16V	20%	100UF	4822 124 21912
C502-503	CER CAP	100V	-20+50%	10NF	4822 122 31414
C505	CER CAP	100V	-20+50%	10NF	4822 122 31414
C511-513	CER CAP	100V	-20+50%	10NF	4822 122 31414
C514-515	CER CAP	100V	0.25PF	5.6PF	5322 122 32163
C516	ELCAP	10V	20%	47UF	5322 124 21391
C517-519	CER CAP	100V	-20+50%	10NF	4822 122 31414
C520	ELCAP	25V	20%	2200UF	4822 124 21382
C521,522	CER CAP	50V	10%	100NF	5322 126 11584
C523	ELCAP	10V	20%	47UF	5322 124 21391

MISCELLANEOUS/UNIT 9

G781	QUARTZ CRYSTAL 9.216MHZ		5322 242 72349
----	I.C.SOCKET DIL	28-P	5322 255 44047

UNIT 10, CONNECTOR UNIT, Fig. 15

5322 214 91369

CAPACITORS/UNIT 10

C201-204	CER CHIP CAP 63V	10%	100NF	4822 122 33496

CODING SYSTEM FOR STANDARD RESISTORS

All resistors not listed are type MRS 16T, 1 %, 0.4 W coding as follows:

$$4822\ 050\ 1\underbrace{xxx}_{\text{Value in }\Omega}\underbrace{x}_{\text{x Factor}}$$

8 ≙ x 0.01
9 ≙ x 0.1
1 ≙ x 1
2 ≙ x 10
3 ≙ x 100
4 ≙ x 1000
5 ≙ x 10000

e.g. 4822 050 11052 ≙ 1K05
4822 050 12059 ≙ 20.5 Ω
4822 050 17874 ≙ 787 kΩ

FIGURES

Fig. 1 Front View
Fig. 2 Rear View
Fig. 3 PM 9540/TWE, SMD Tweezers
Fig. 4 PM 9540/BAN, 4-wire Test Cable with Banana Plugs
Fig. 5 PM 9541A, 4-wire Test Cable
Fig. 6 Single and Double Test Posts
Fig. 7 PM 9542SMD, SMD Adapter
Fig. 8 PM 9542A, RCL Adapter
Fig. 9 PM 9559 Bin Programmer, Infrared Remote Control

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Fig. 11 Detailed Block Diagram

Fig. 12 Overall Circuit Diagram
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Fig. 14 Unit 7, Flex Print
Fig. 15 Unit 10, Connector Unit
Fig. 16 Unit 1, Power Supply

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Fig. 18 Unit 2, Central Processing Unit, CPU
Fig. 19 Unit 2, Signal Synthesizer
Fig. 20 Unit 2, Counter

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Fig. 21.2 Unit 3, Analog Unit; Component Layout, Part 2
Fig. 22 Unit 3, Source
Fig. 23 Unit 3, Selector
Fig. 24 Unit 3, AC/V Converter
Fig. 25 Unit 3, Amplifier
Fig. 26 Unit 3, Filter
Fig. 27 Unit 3, Multiplying DAC
Fig. 28 Unit 3, Dual Slope Integrator

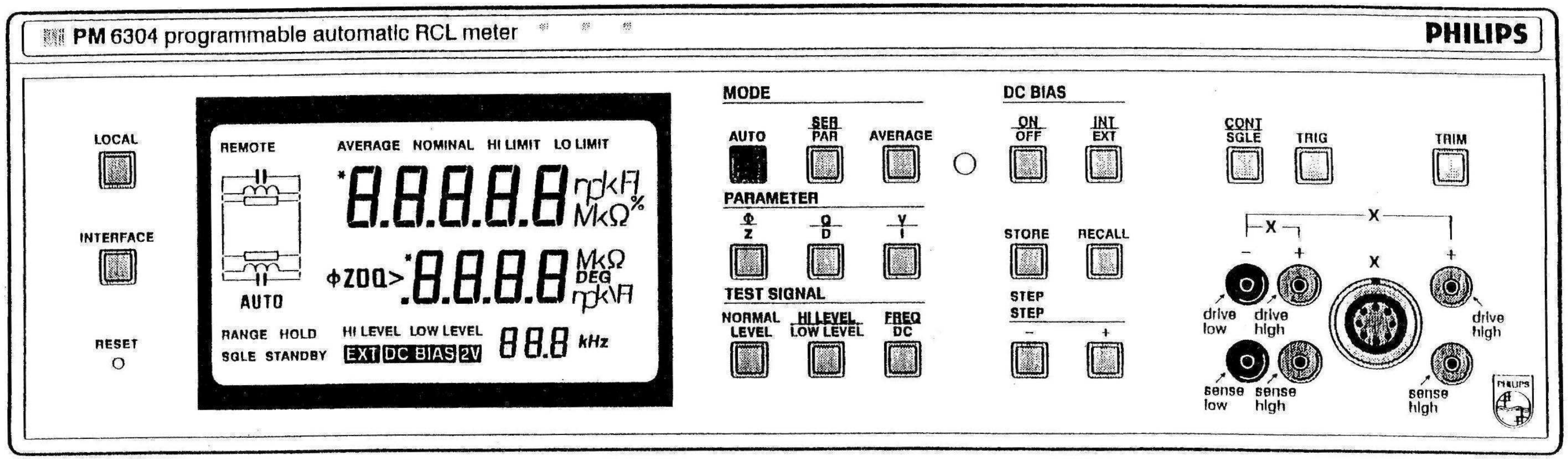
Fig. 29 Unit 4, Keyboard/Display; Component Layout
Fig. 30 Unit 4, Keyboard/Display

Fig. 31 Unit 5, DC Unit; Component Layout
Fig. 32 Unit 5, DC/V Converter
Fig. 33 Unit 5, DC/AC Converter

Fig. 34 Unit 6, Handler Interface; Component Layout
Fig. 35 Unit 6, Handler Interface

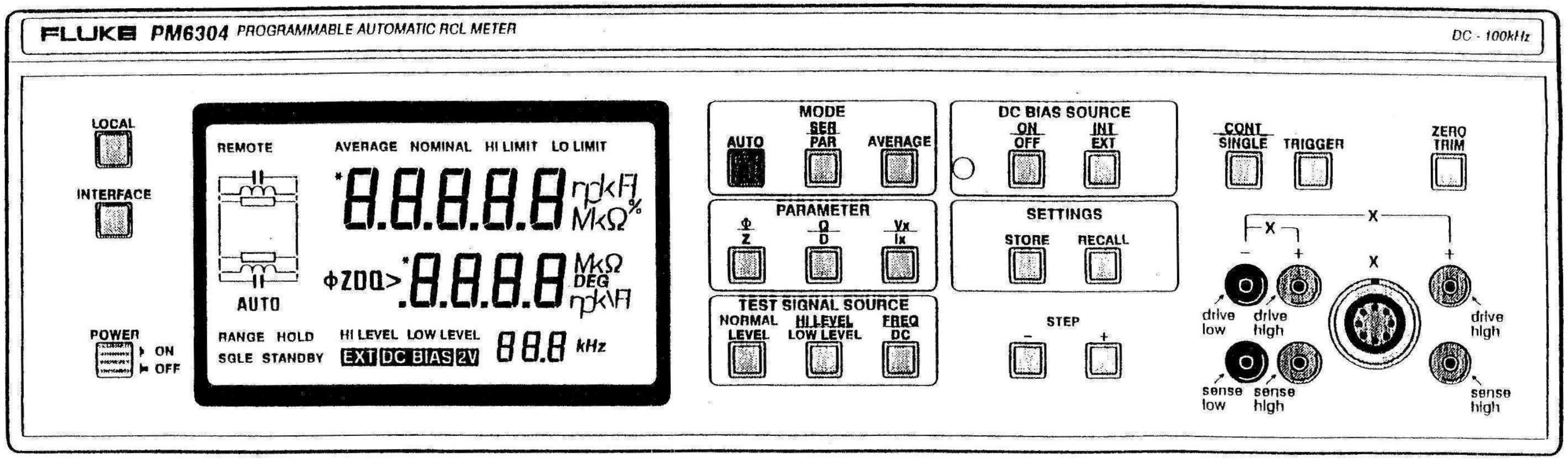
Fig. 36 Unit 8, RS-232 Interface; Component Layout
Fig. 37 Unit 8, RS-232 Interface

Fig. 38 Unit 9, IEEE-488 Interface; Component Layout
Fig. 39 Unit 9, IEEE-488 Interface

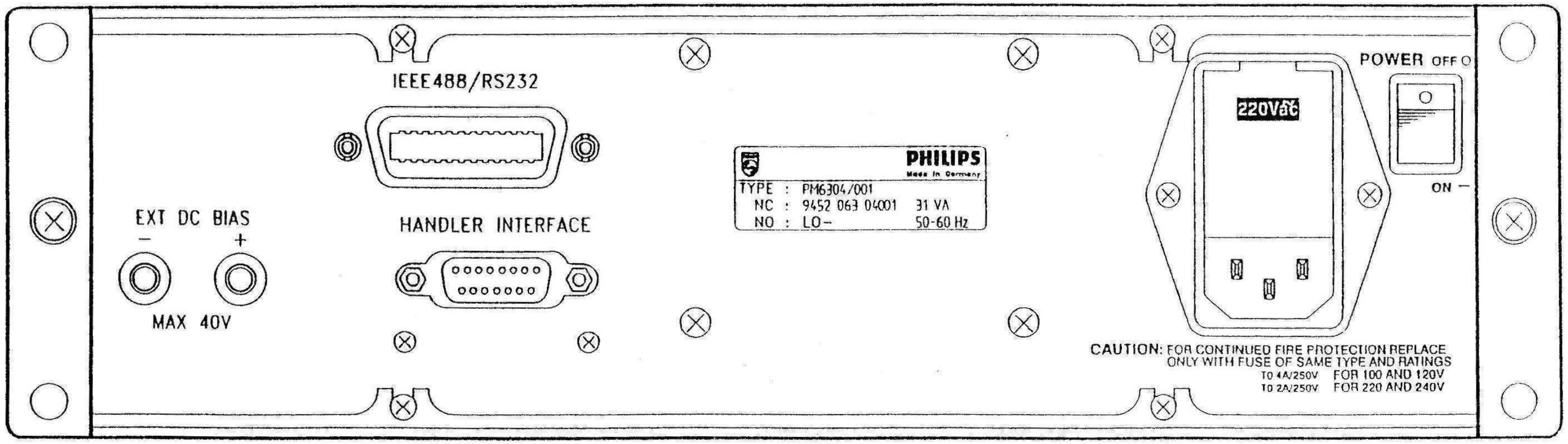


until serial number LO 648 884

Fig. 1
Front view

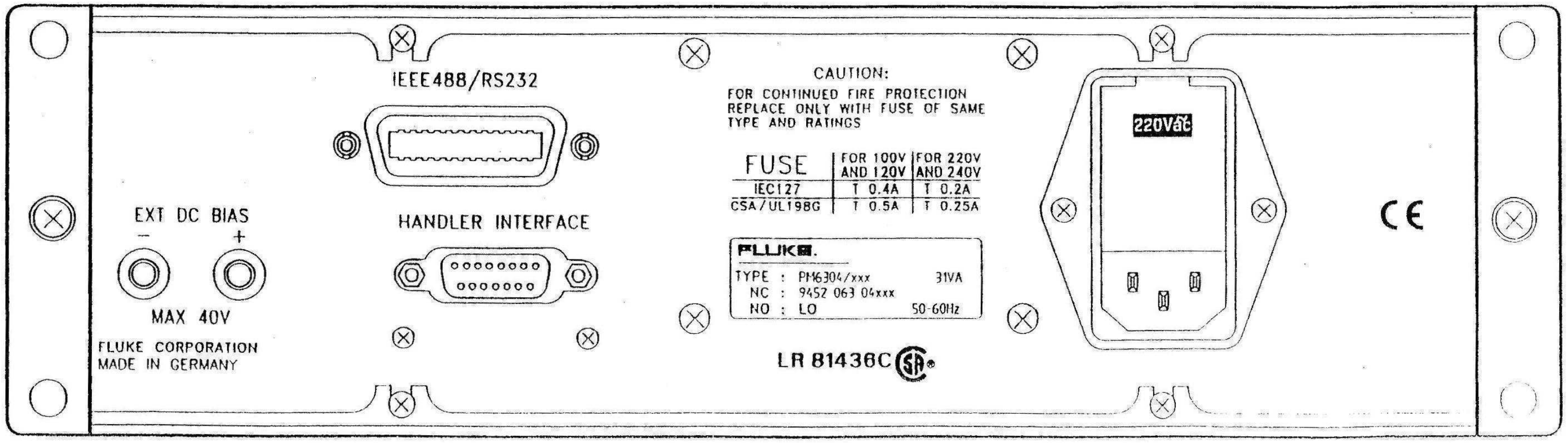


onwards serial number LO 648 885



until serial number LO 648 884

Fig. 2
Rear view



onwards serial number LO 648 885

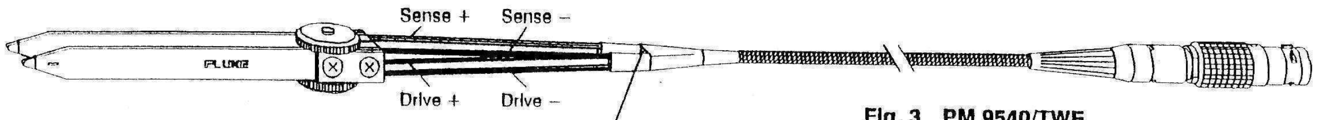


Fig. 3 PM 9540/TWE
SMD Tweezers

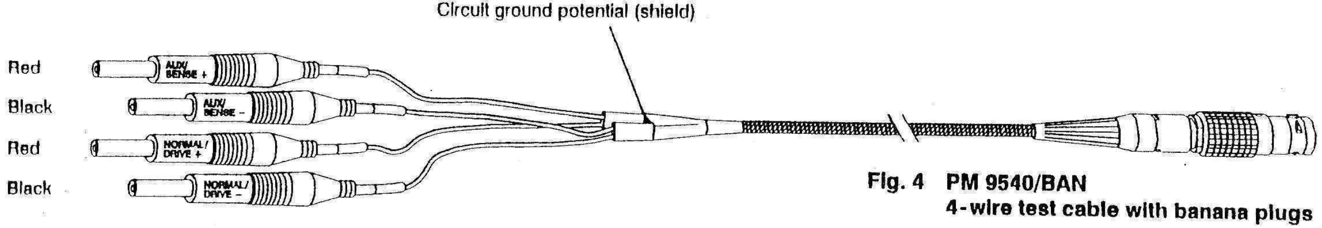
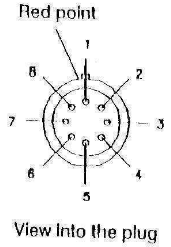
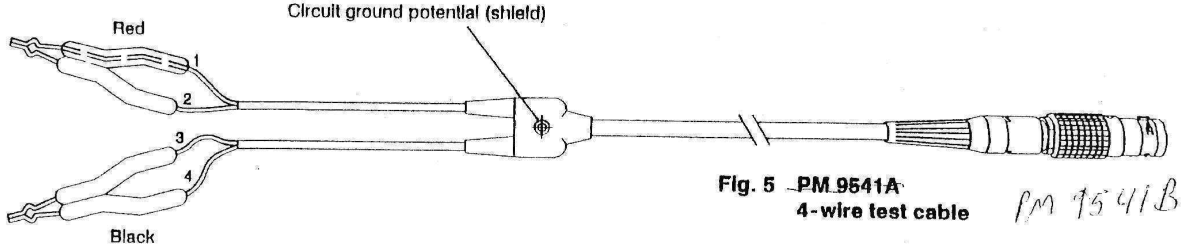


Fig. 4 PM 9540/BAN
4-wire test cable with banana plugs



Pin 1 = Shield of sense – /
circuit ground
Pin 2 = Sense –
Pin 3 = Shield of drive –
Pin 4 = Drive –
Pin 5 = Shield of Sense +
Pin 6 = Sense +
Pin 7 = Shield of Drive +
Pin 8 = Drive +



1 = Drive +
2 = Sense +
3 = Drive –
4 = Sense –

Fig. 5 ~~PM 9541A~~ PM 9541B
4-wire test cable

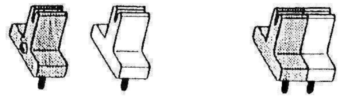


Fig. 6 Single and double test posts

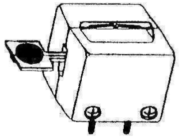


Fig. 7 PM 9542SMD
SMD Adapter

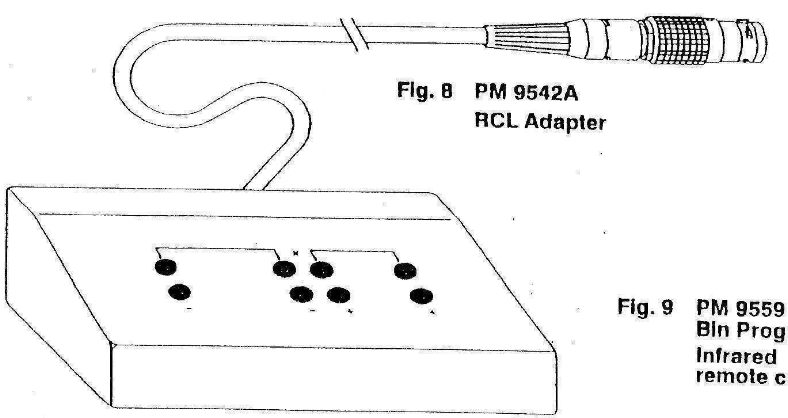


Fig. 8 PM 9542A
RCL Adapter

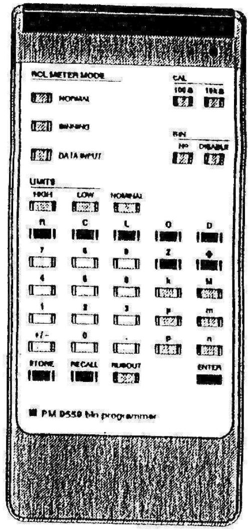


Fig. 9 PM 9559
Bin Programmer
Infrared
remote control

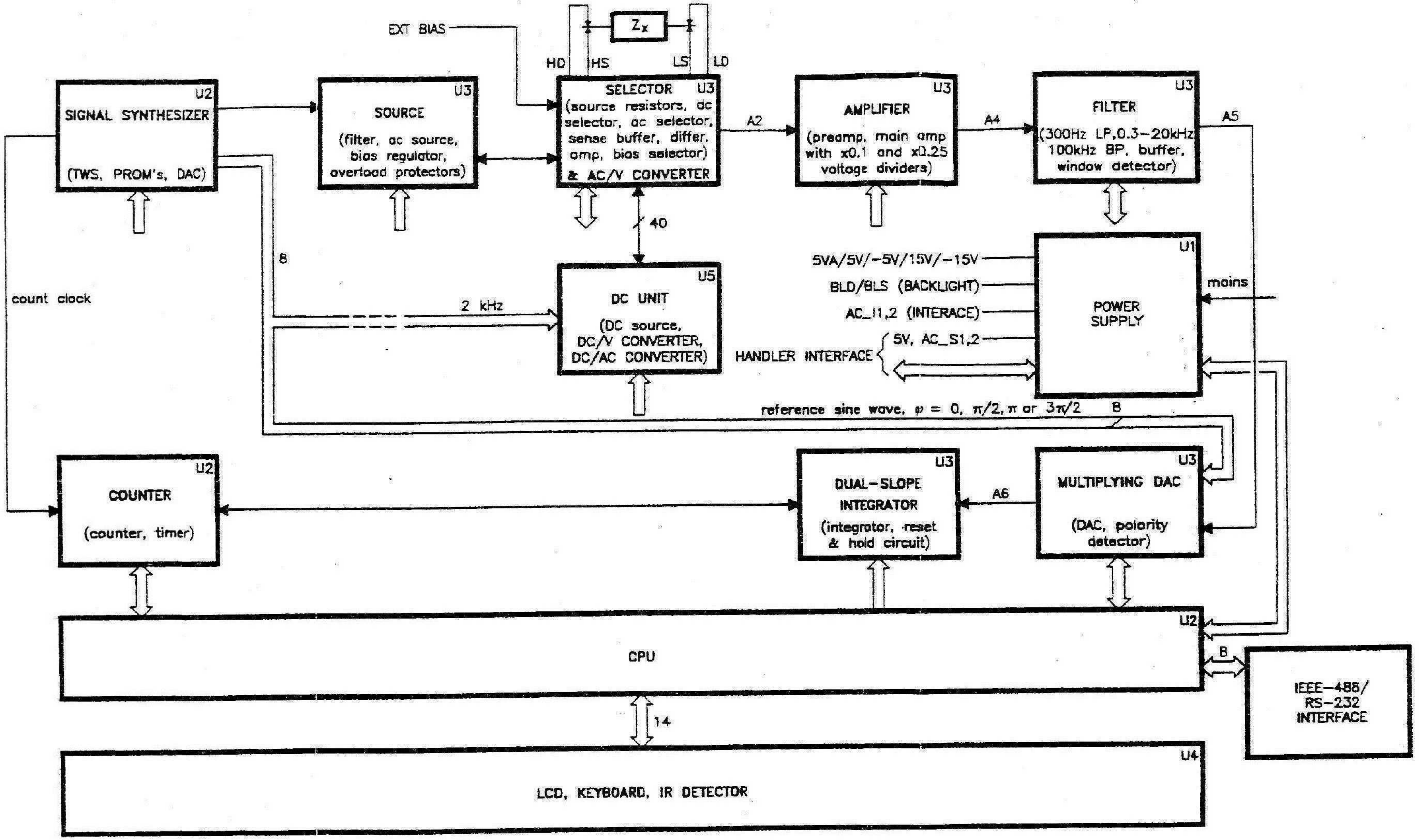


Fig. 10 **Basic Block Diagram**

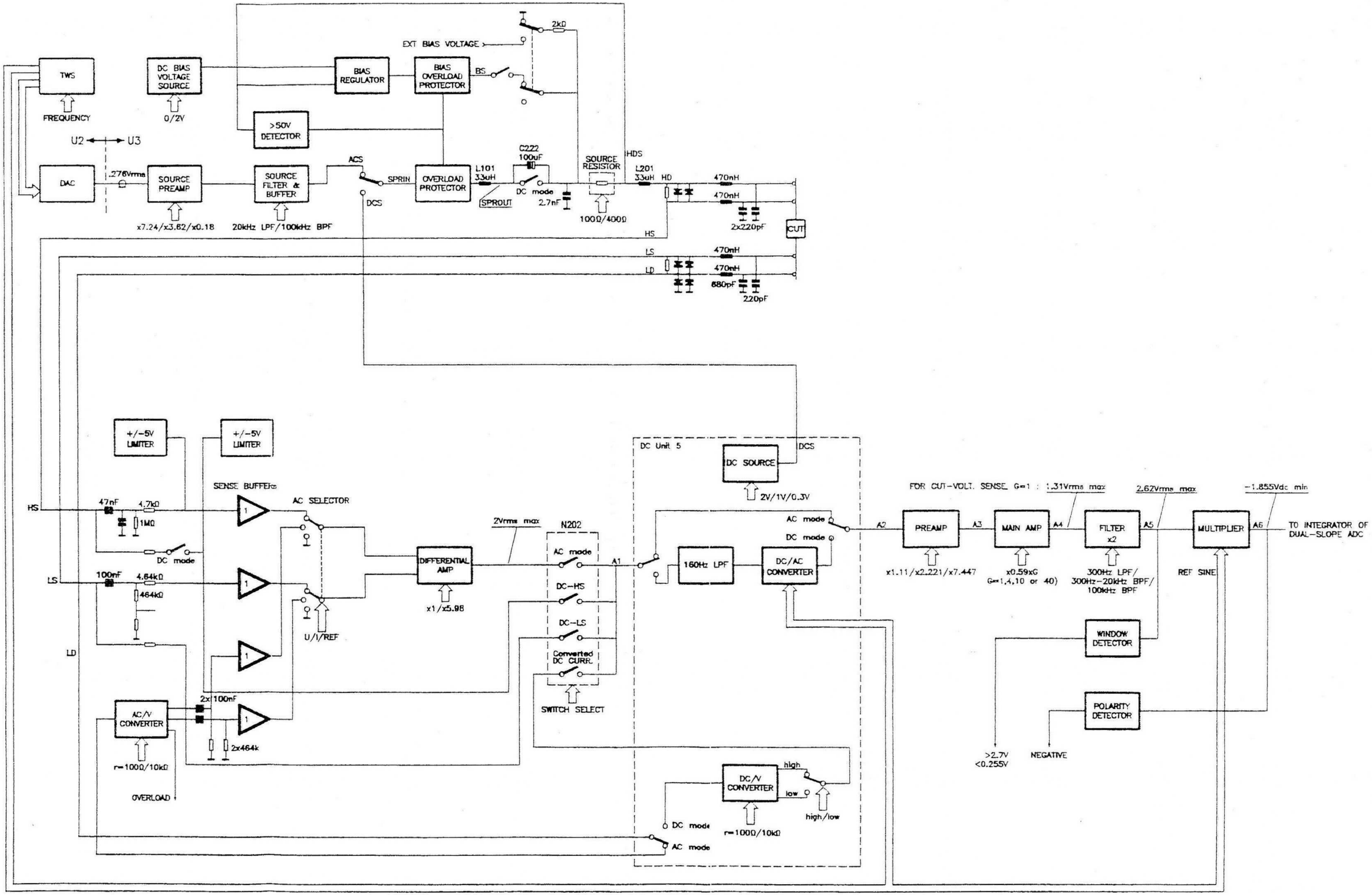
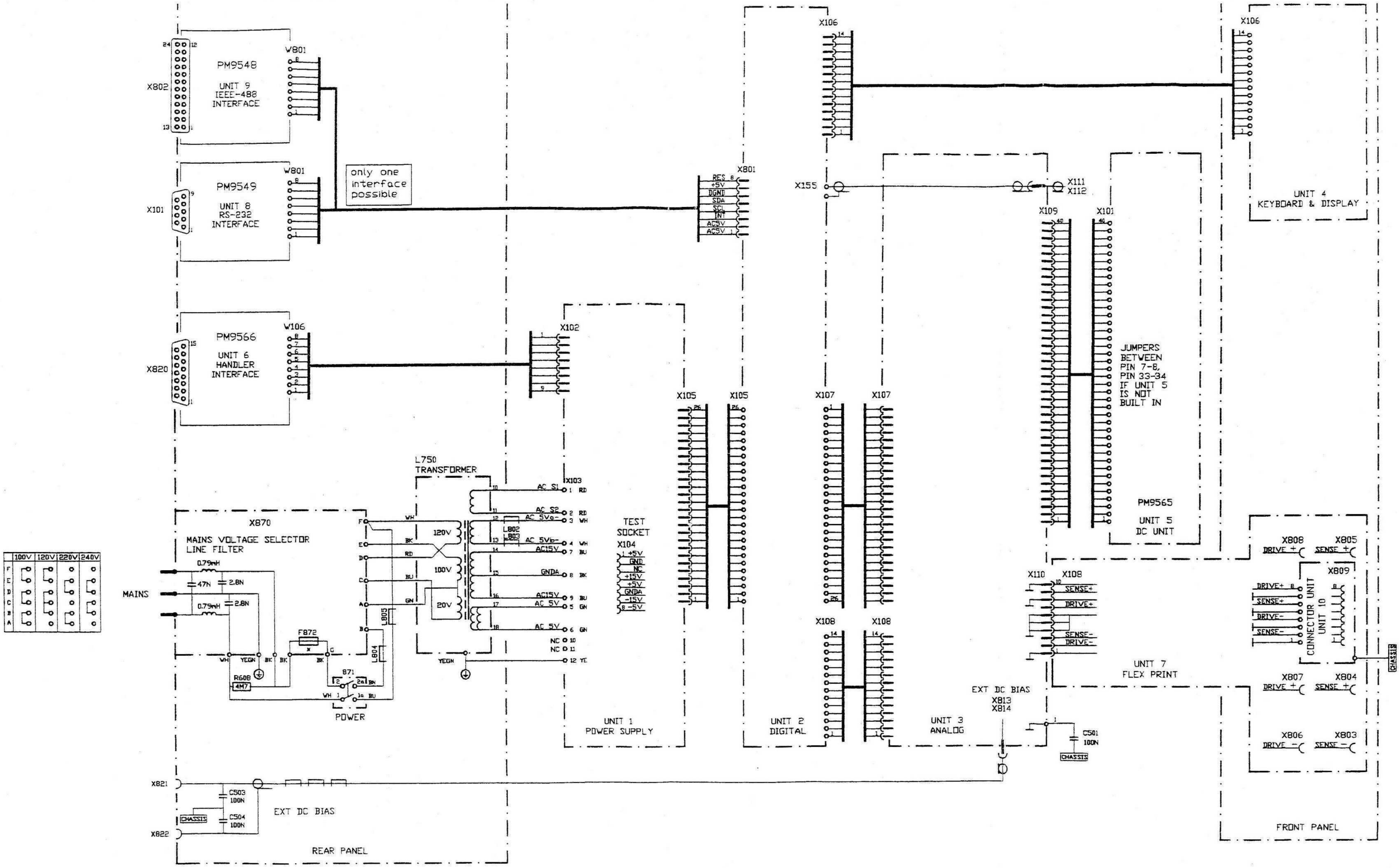


Fig. 11 **Detailed Block Diagram**



* 200mAT/250V FOR MAINS VOLTAGE 220 AND 240V
* 400mAT/250V FOR MAINS VOLTAGE 100 AND 120V

Fig. 12 Overall Circuit Diagram

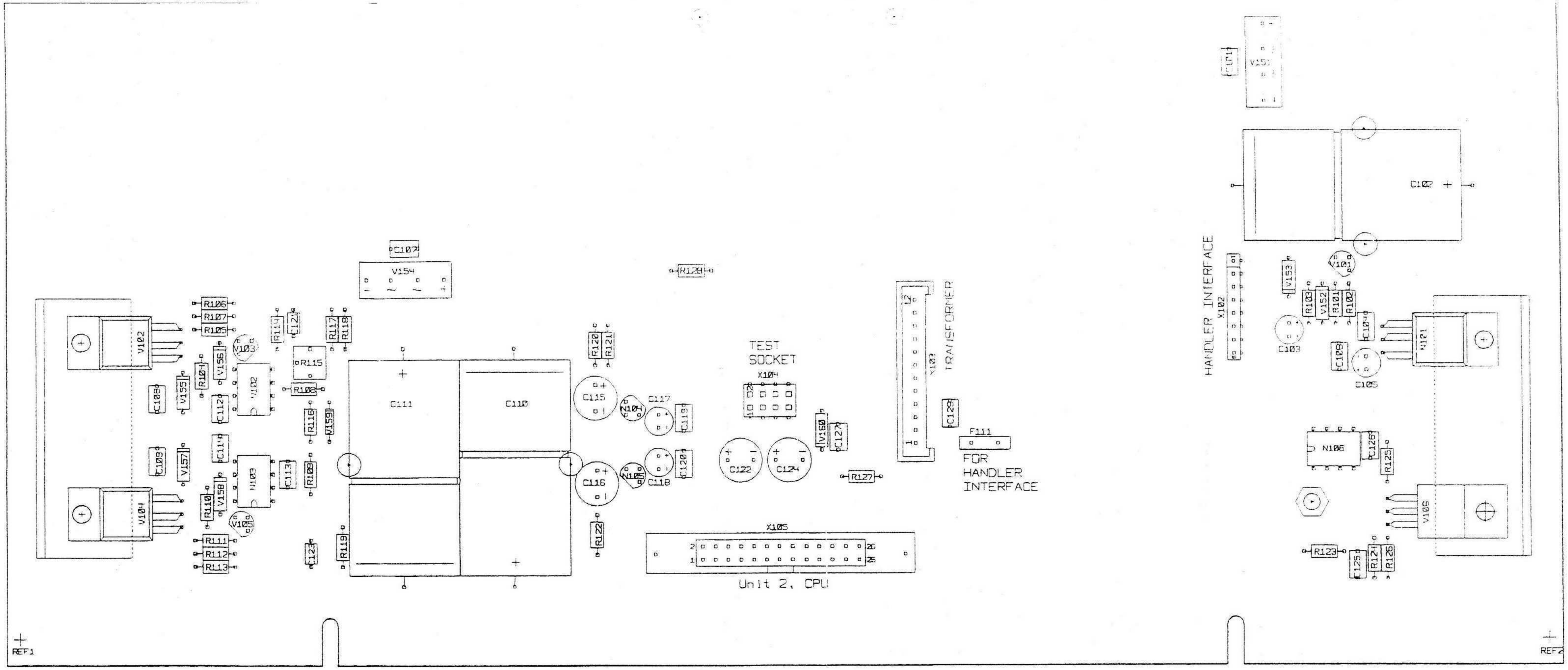


Fig. 13 Unit 1, Power Supply; Component Layout

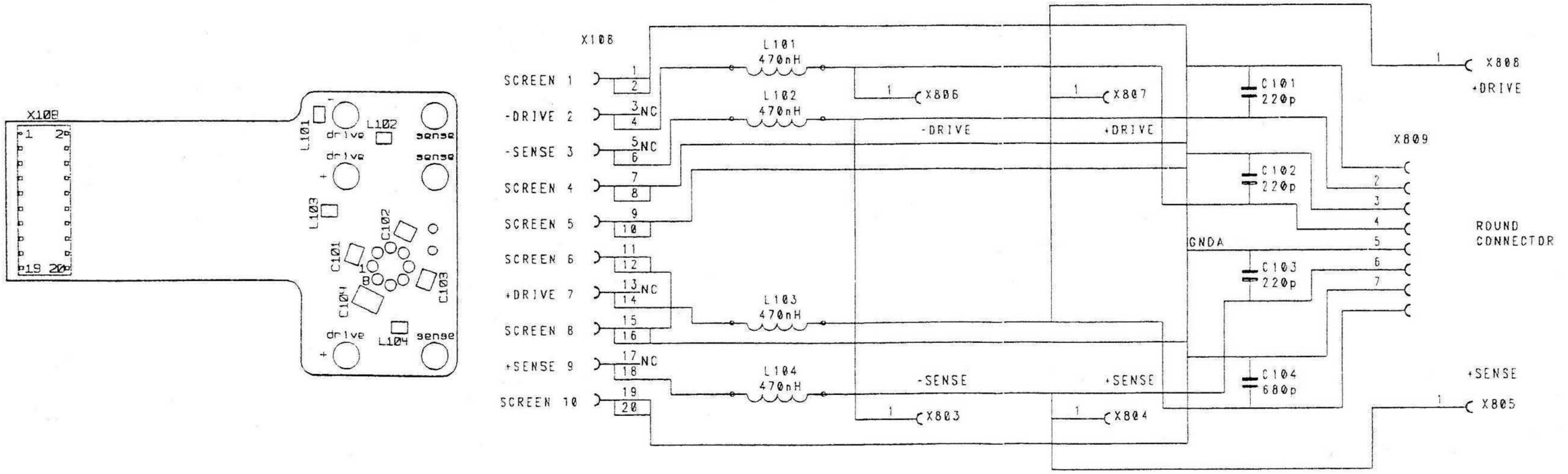


Fig. 14 Unit 7, Flex Print

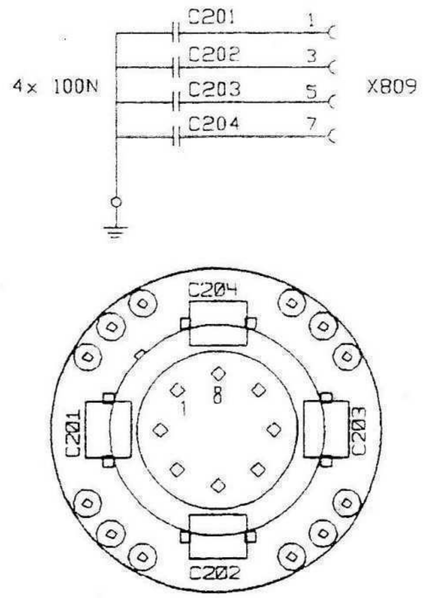


Fig. 15 Unit 10, Connector Unit

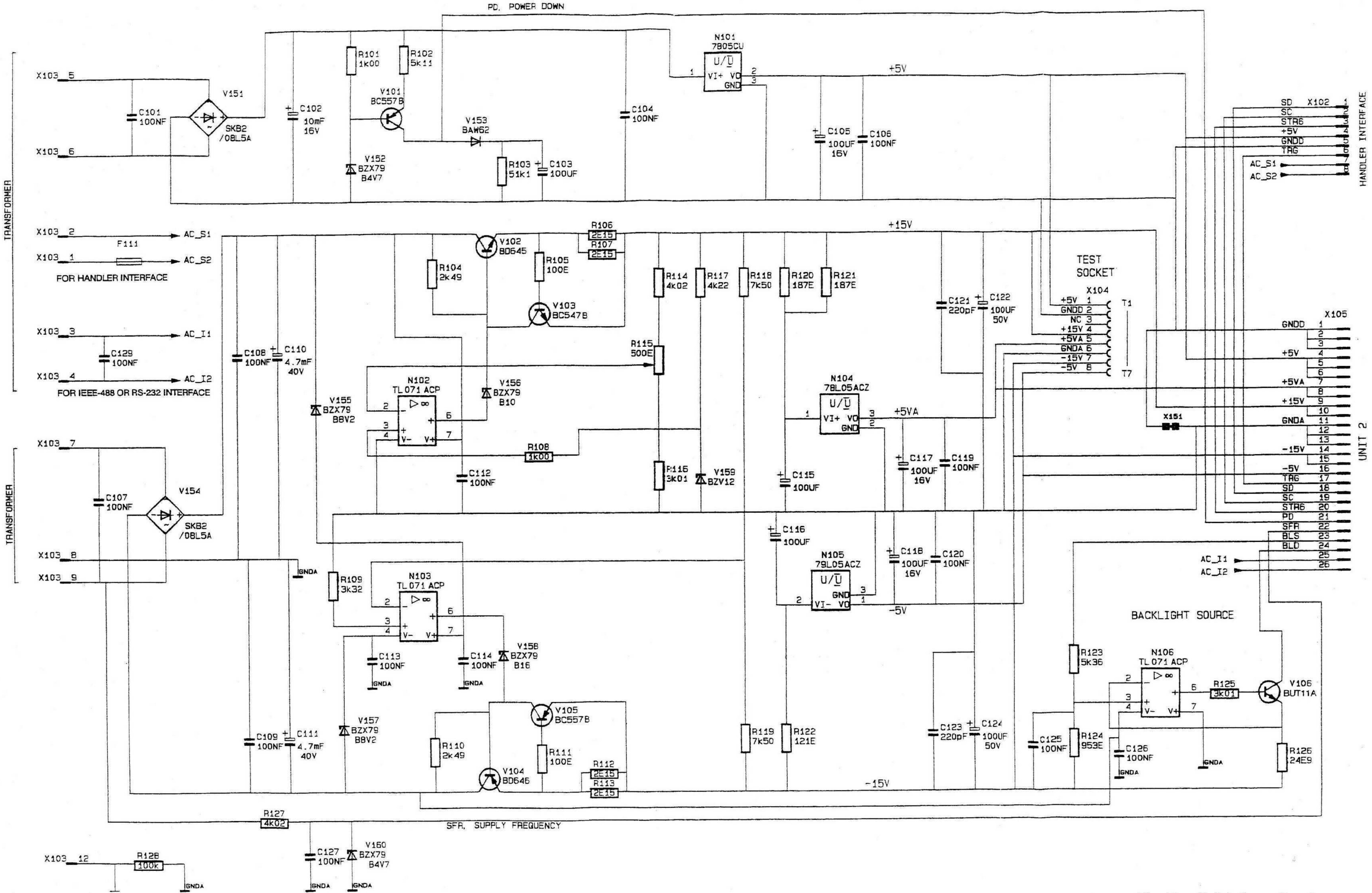
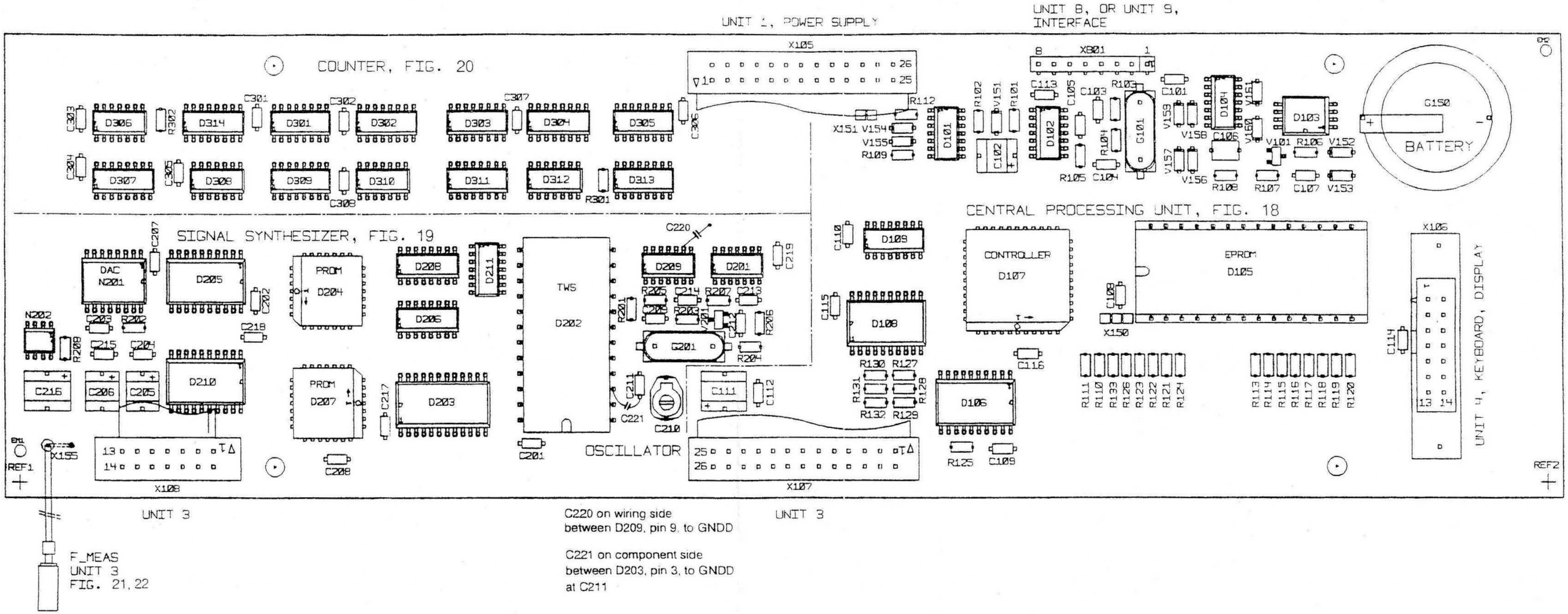


Fig. 16 Unit 1, Power Supply



C220 on wiring side
between D209, pin 9, to GNDD

C221 on component side
between D203, pin 3, to GNDD
at C211

Fig. 17 Unit 2, Digital Unit; Component Layout

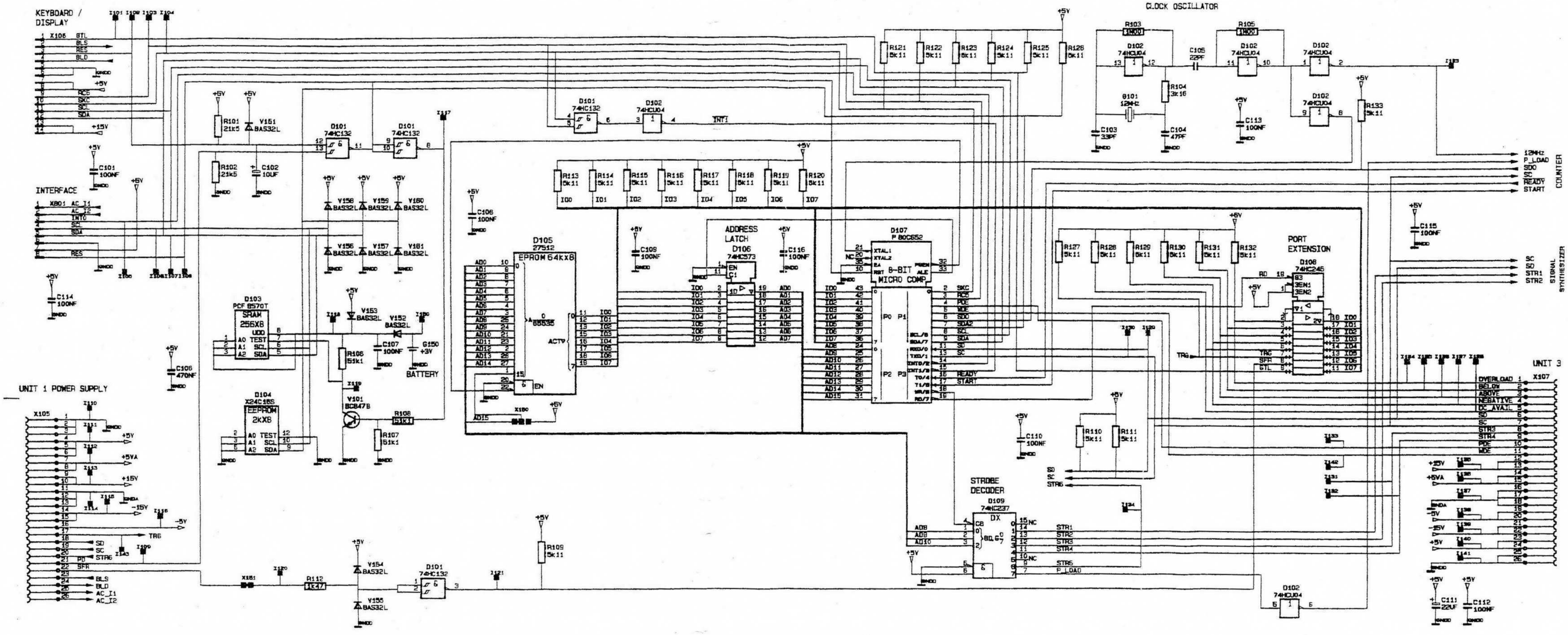


Fig. 18 Unit 2, Central Processing Unit, CPU

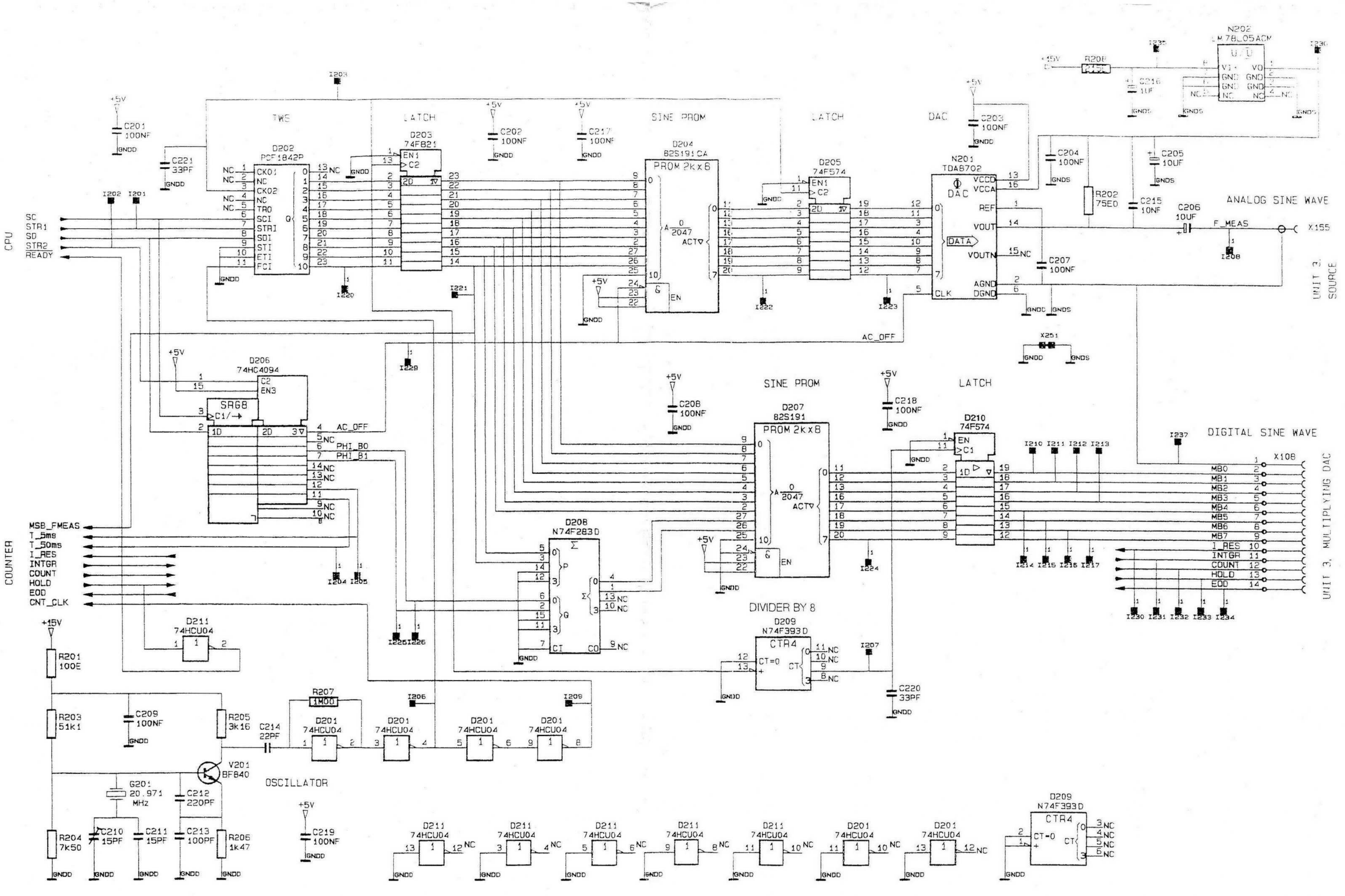


Fig. 19 Unit 2, Signal Synthesizer

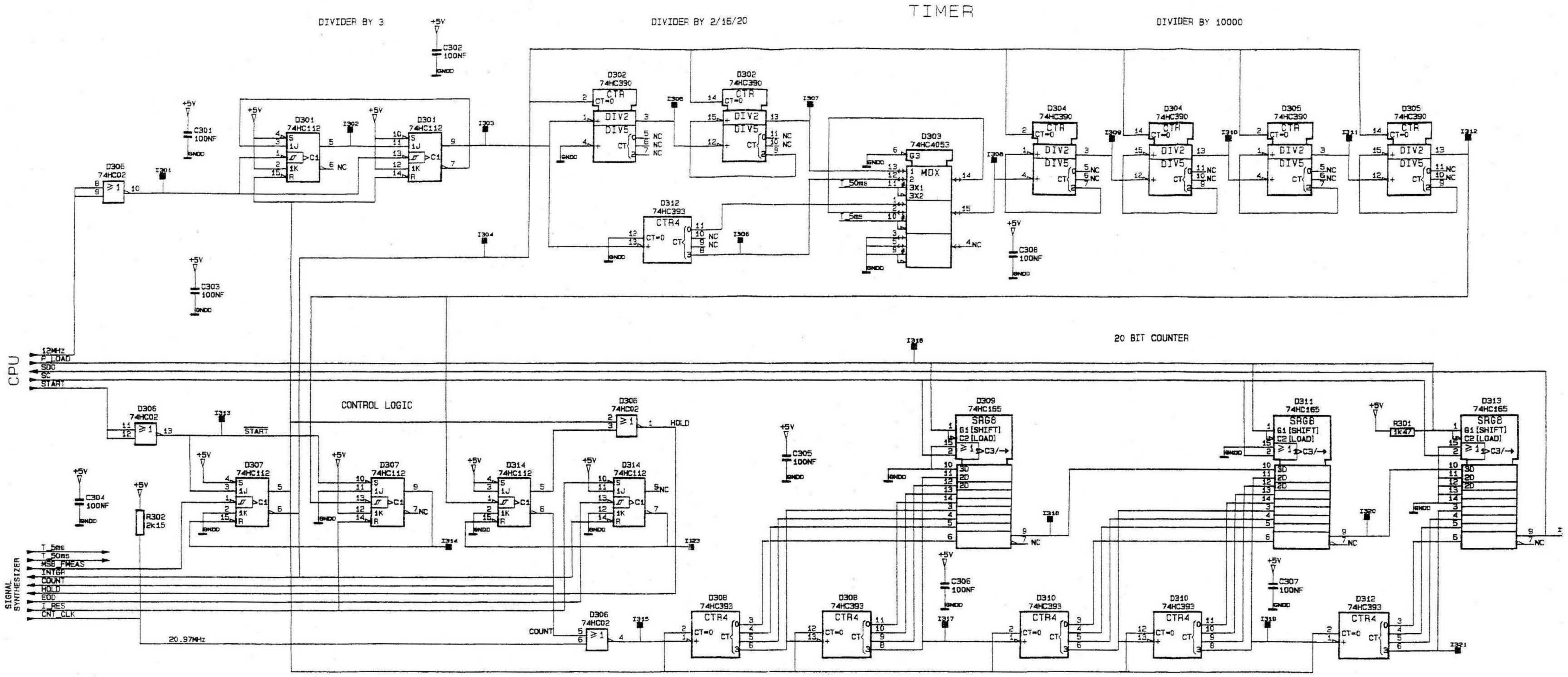


Fig. 20 Unit 2, Counter

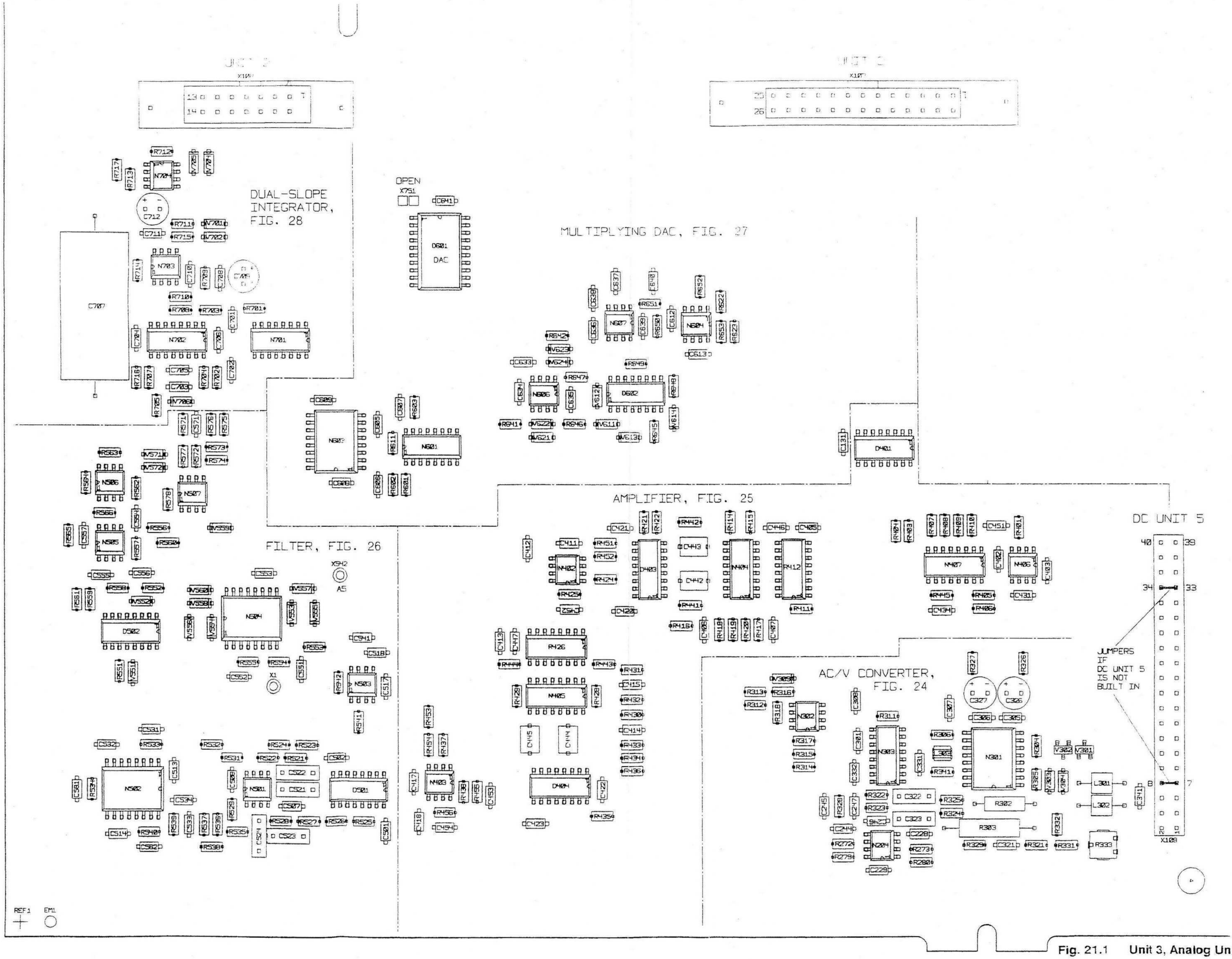


Fig. 21.1 Unit 3, Analog Unit; Component Layout, Part 1

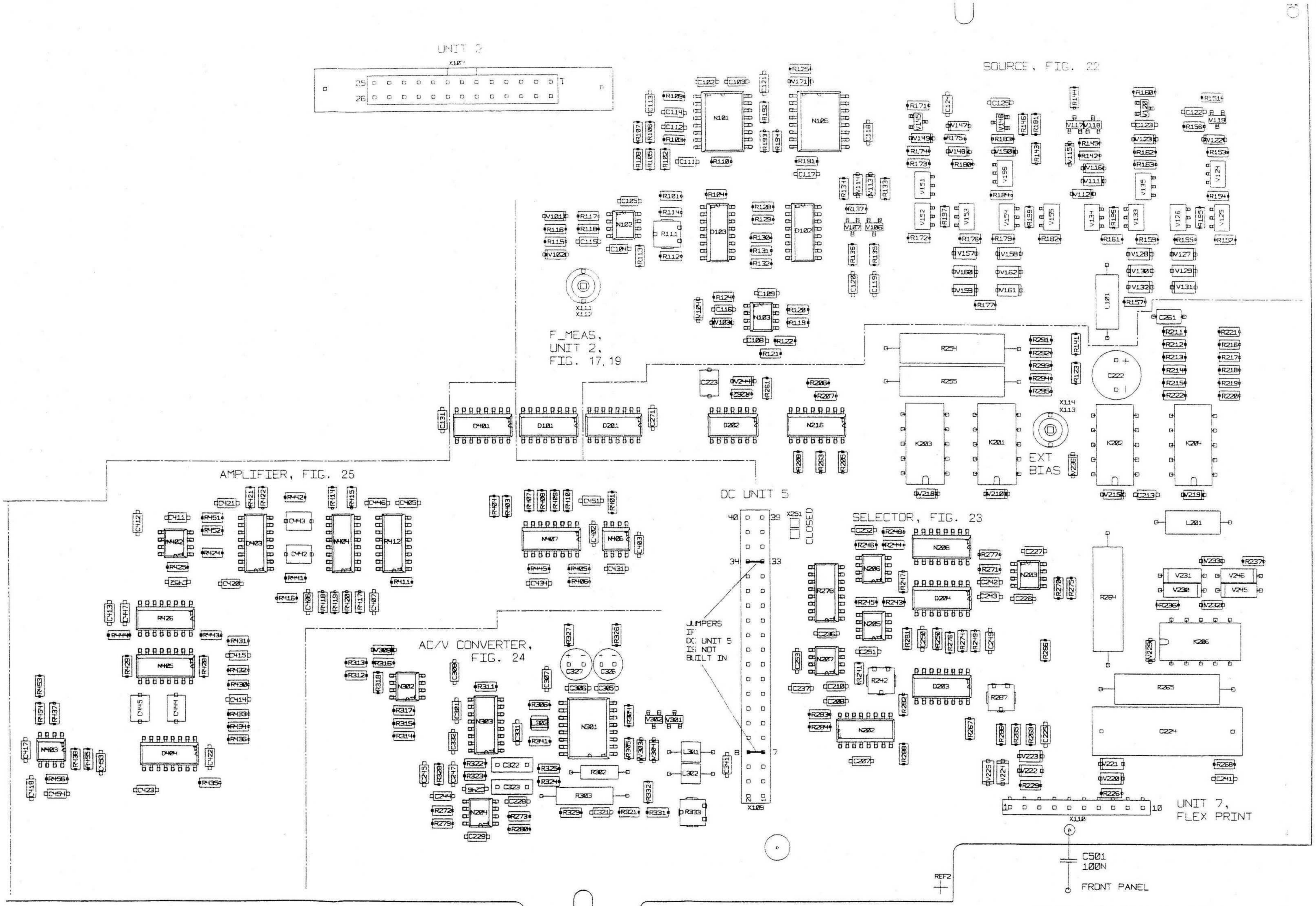


Fig. 21.2 Unit 3, Analog Unit; Component Layout, Part

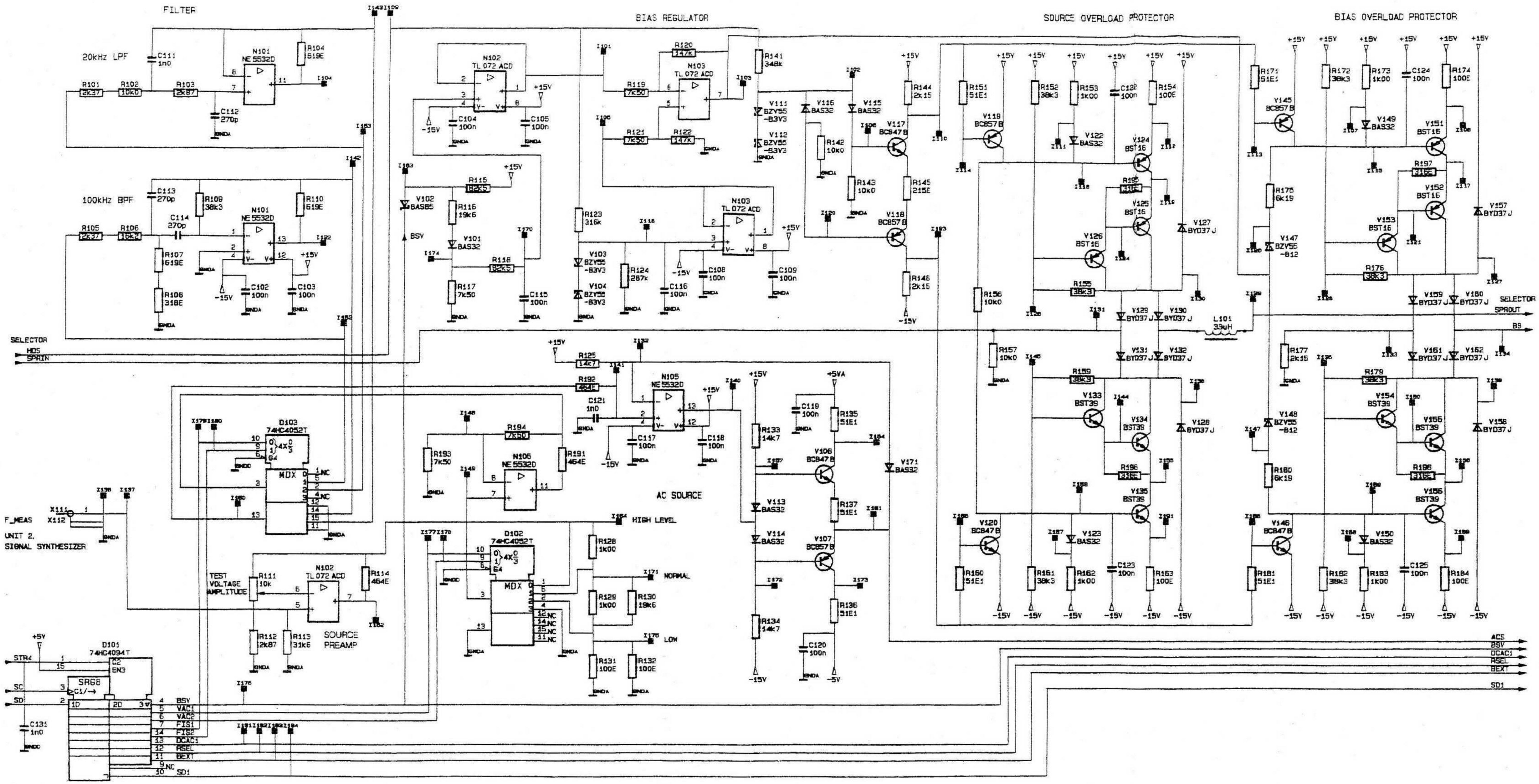


Fig. 22 Unit 3, Source

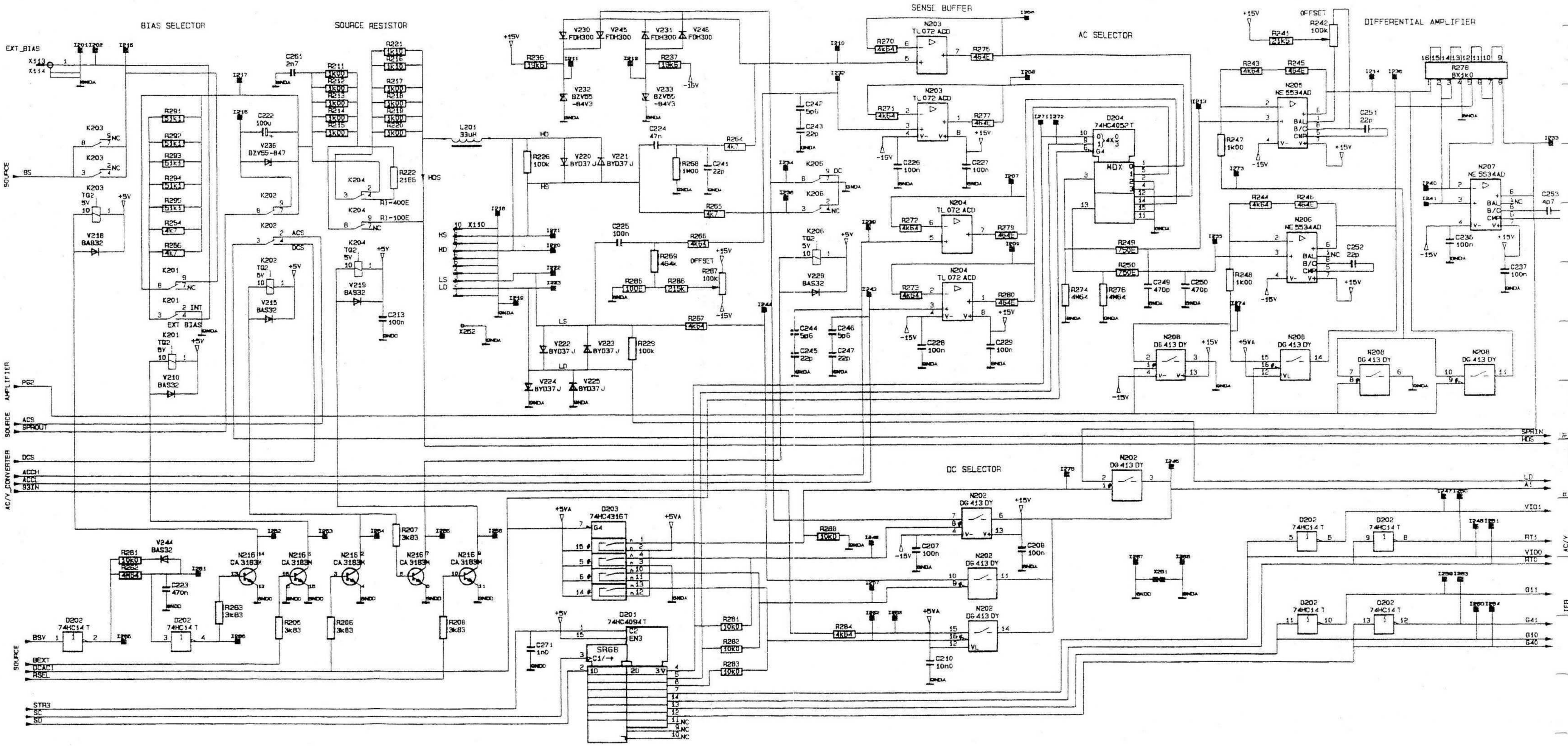


Fig. 23 Unit 3, Selector

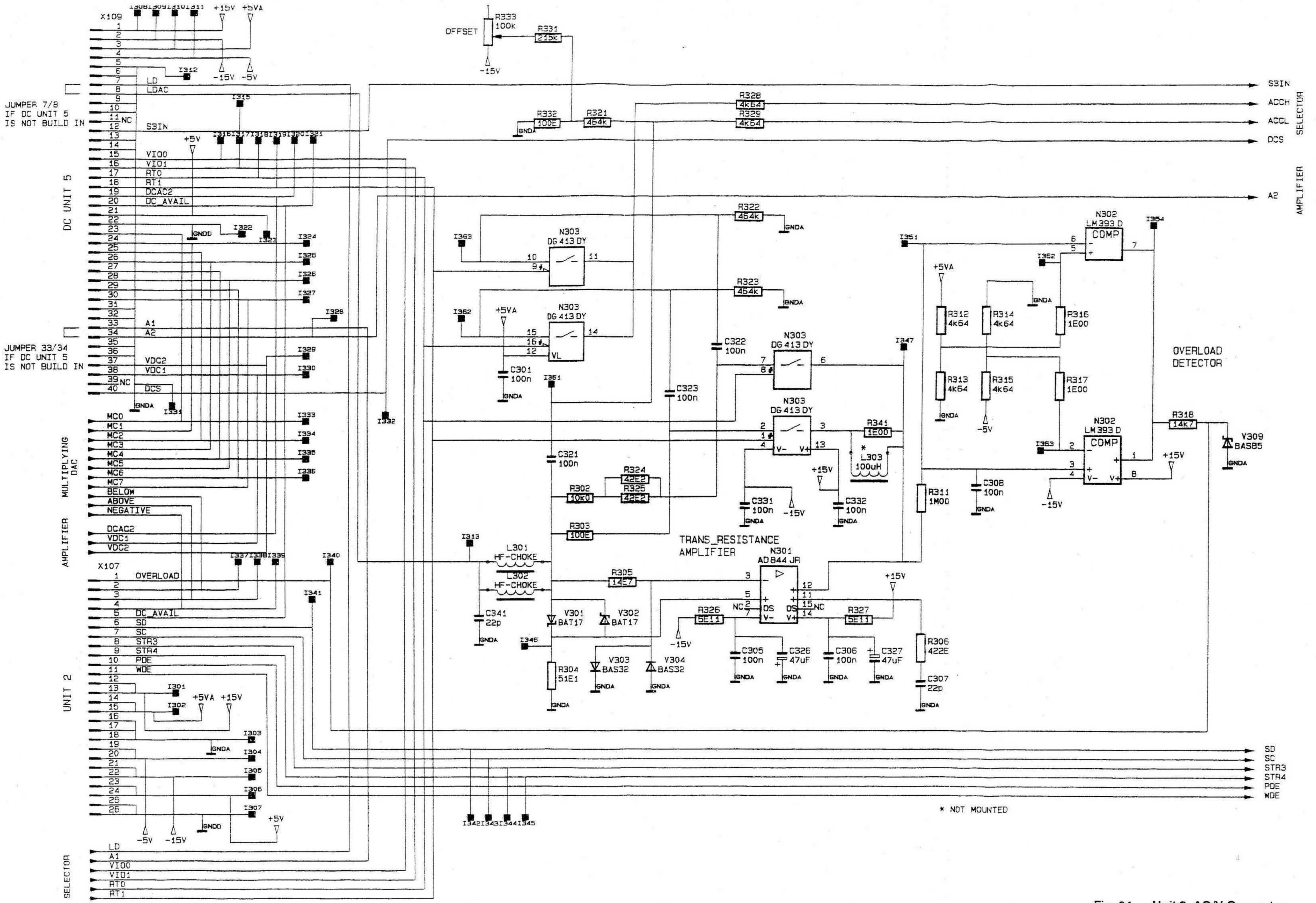


Fig. 24 Unit 3, AC/V Converter

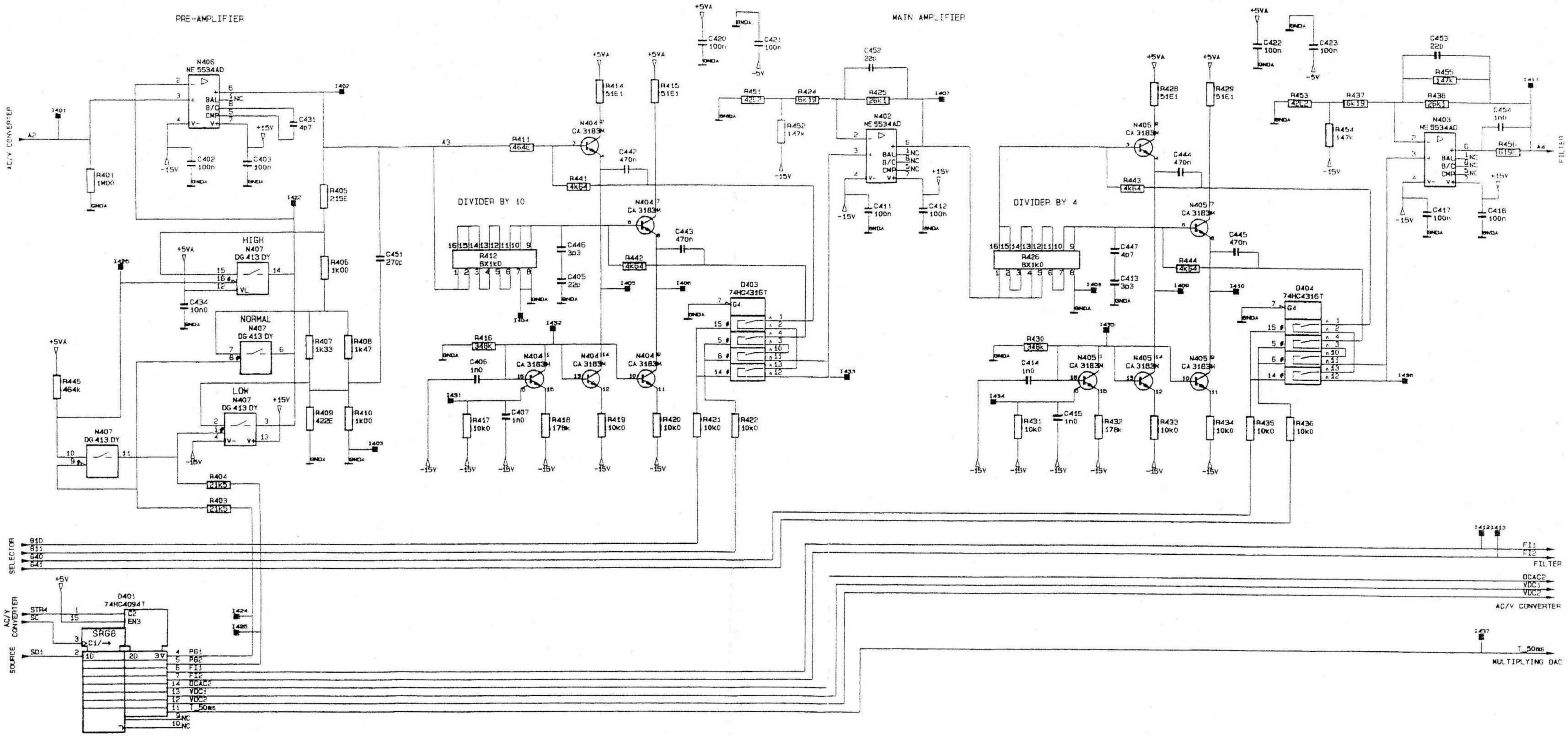


Fig. 25 Unit 3, Amplifier

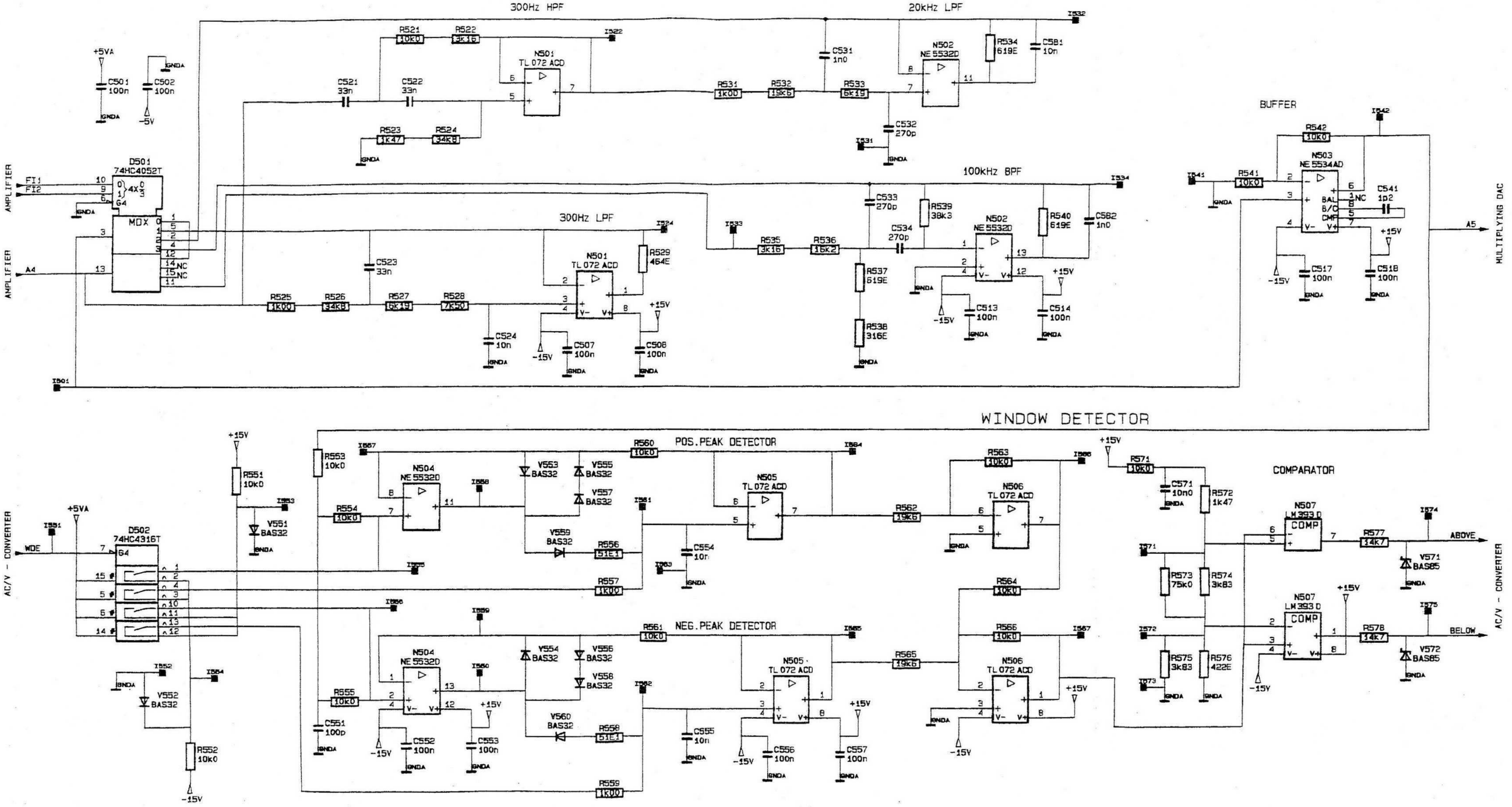


Fig. 26 Unit 3, Filter

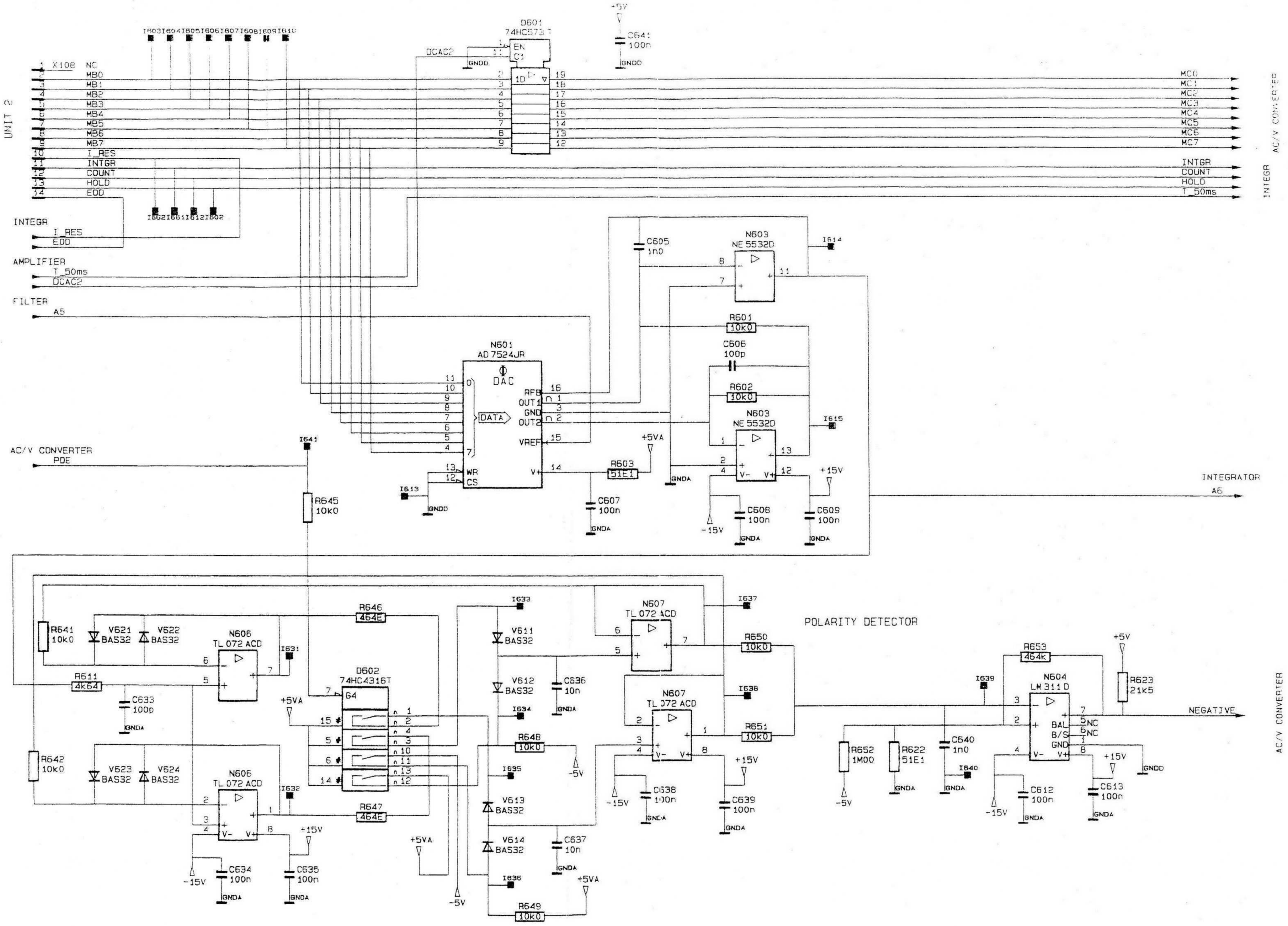


Fig. 27 Unit 3, Multiplying DAC

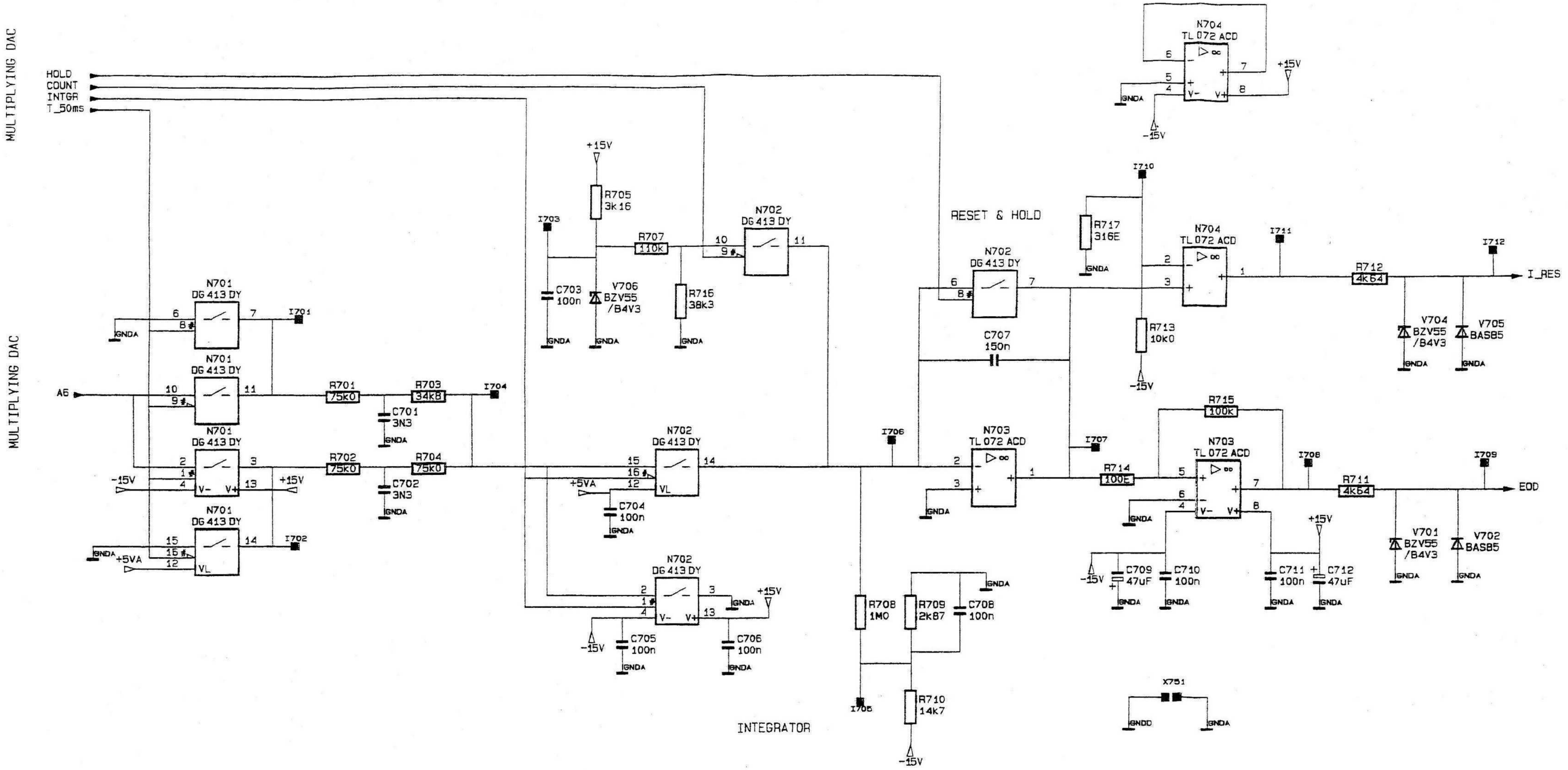


Fig. 28 Unit 3, Dual Slope Integrator

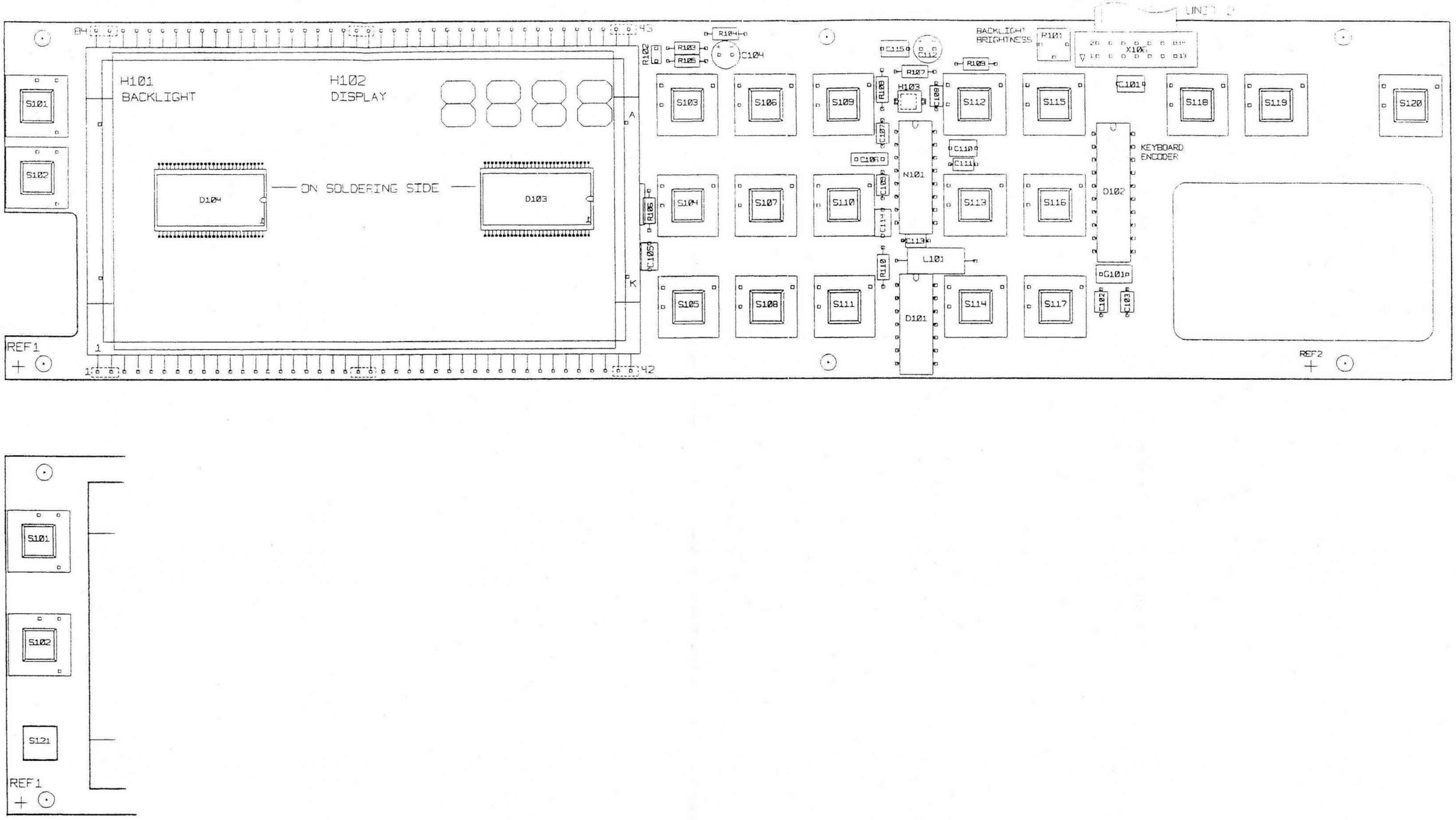


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Fig. 29 Unit 4, Keyboard/Display; Component Layout

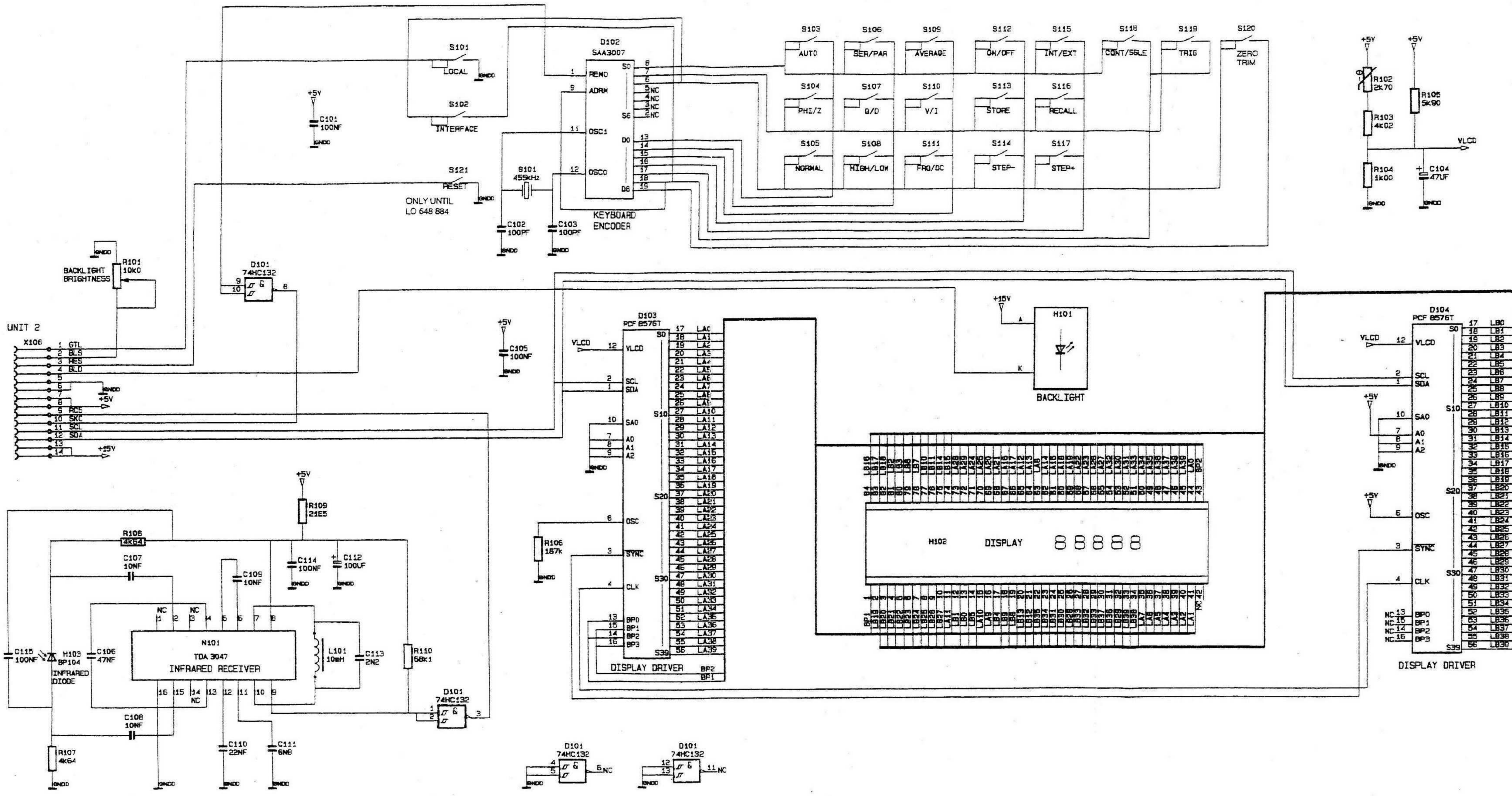

Fig. 30 Unit 4, Keyboard/Display

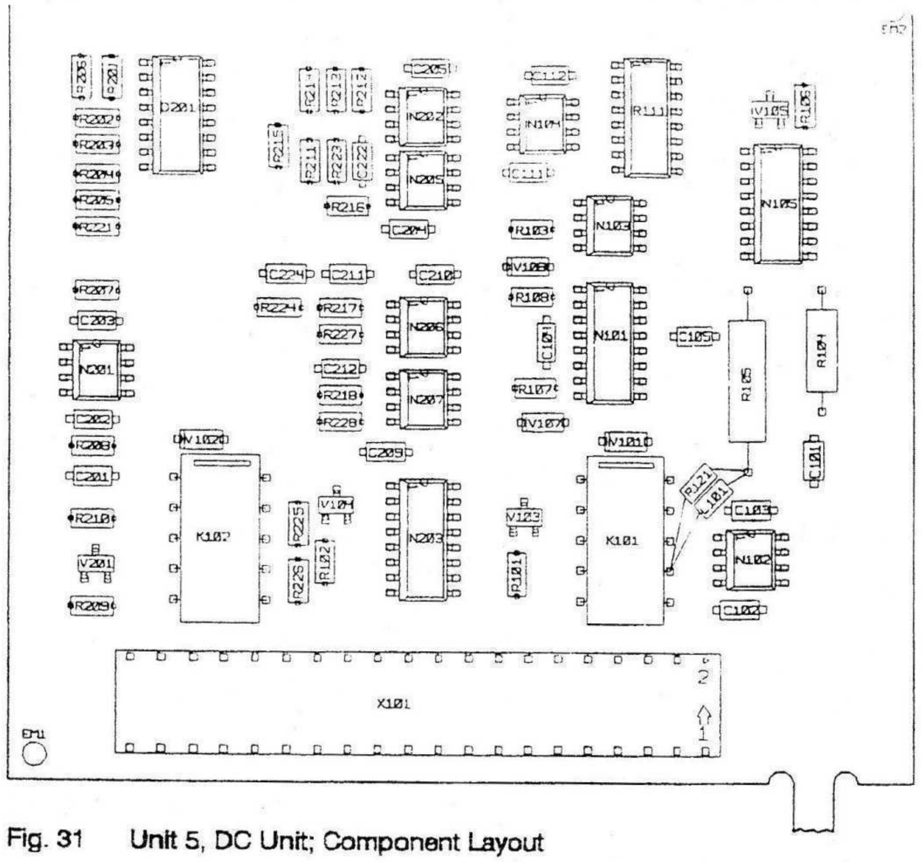

Fig. 31 Unit 5, DC Unit; Component Layout

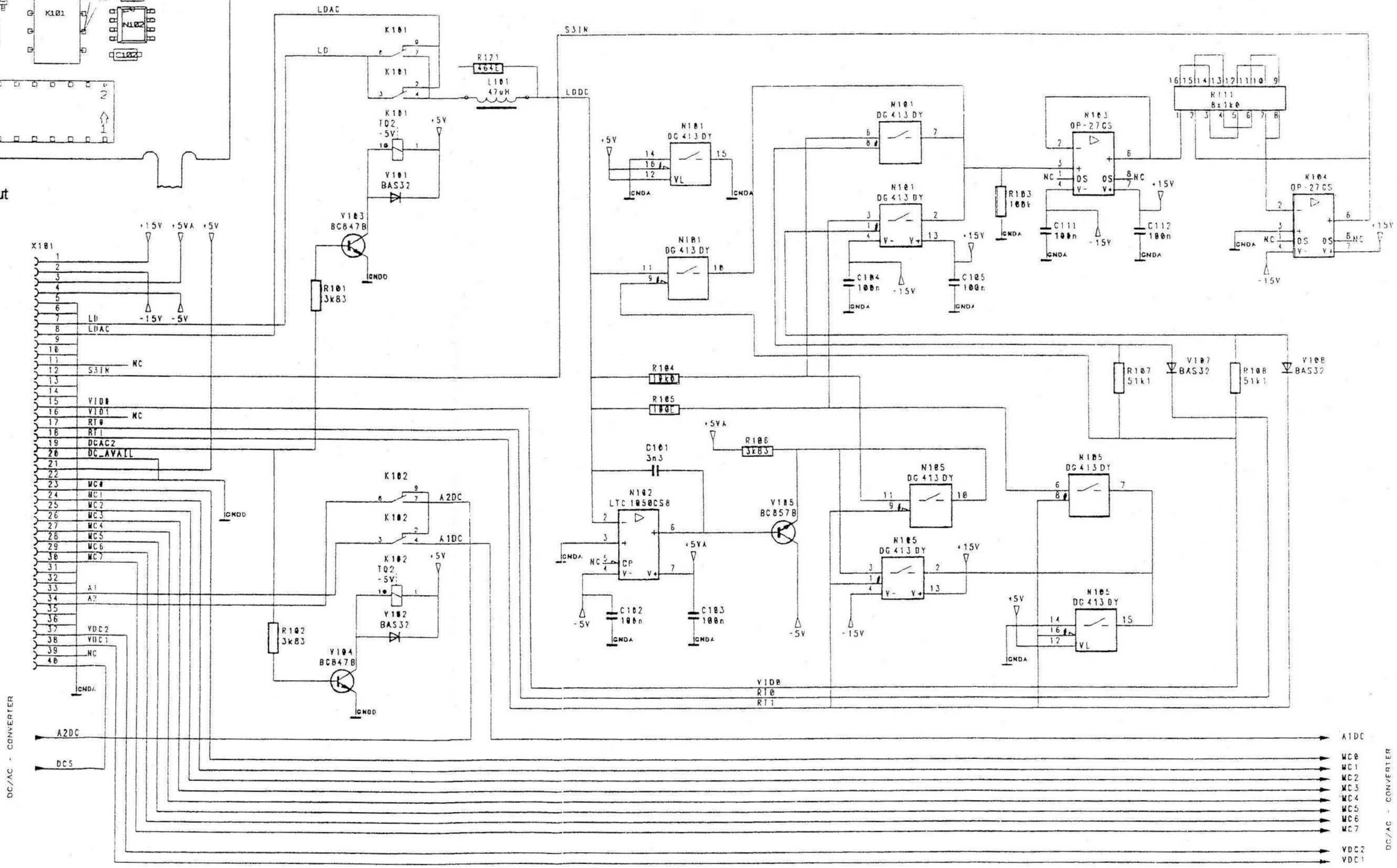

Fig. 32 Unit 5, DC/V Converter

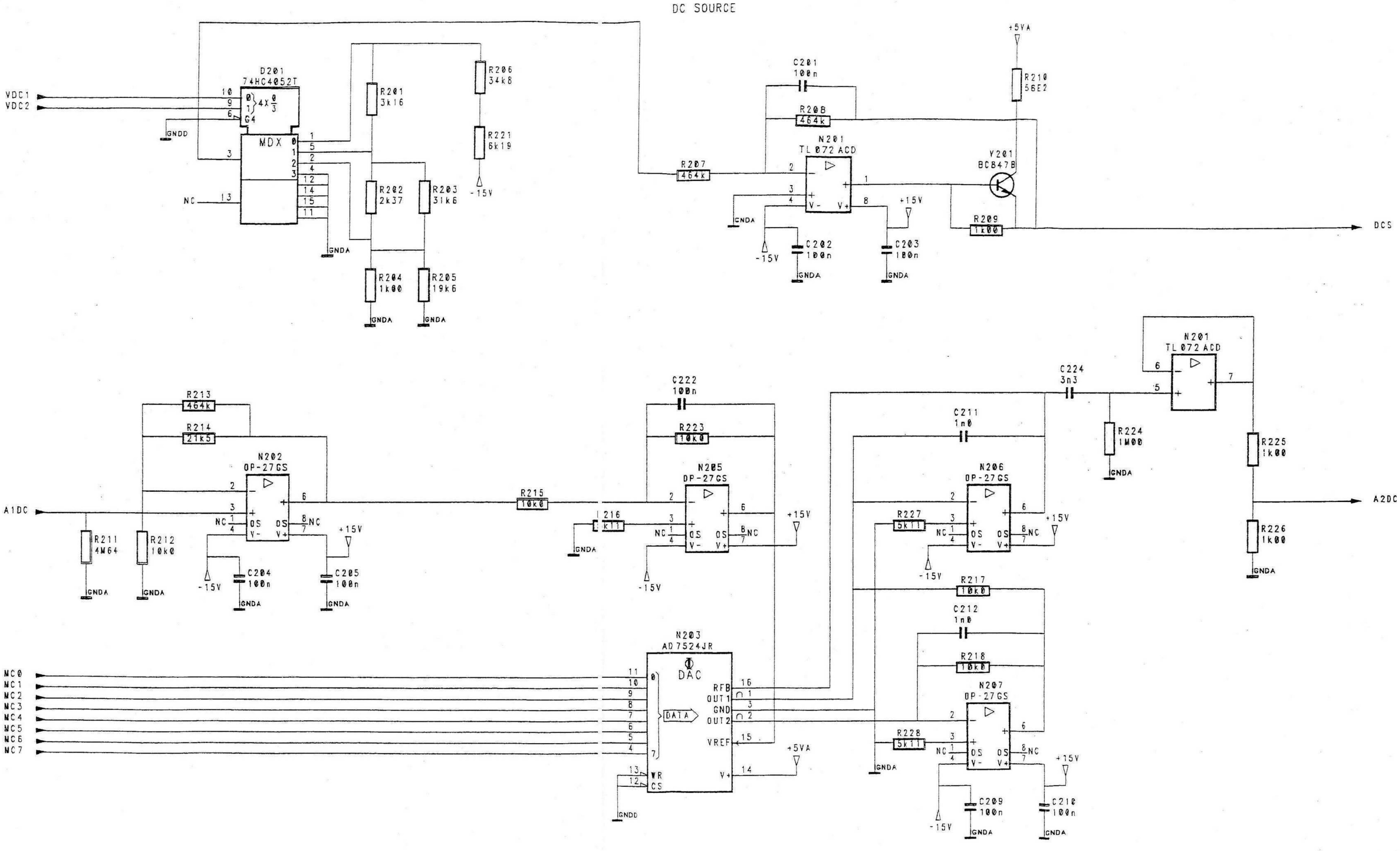

Fig. 33 Unit 5, DC/AC Converter

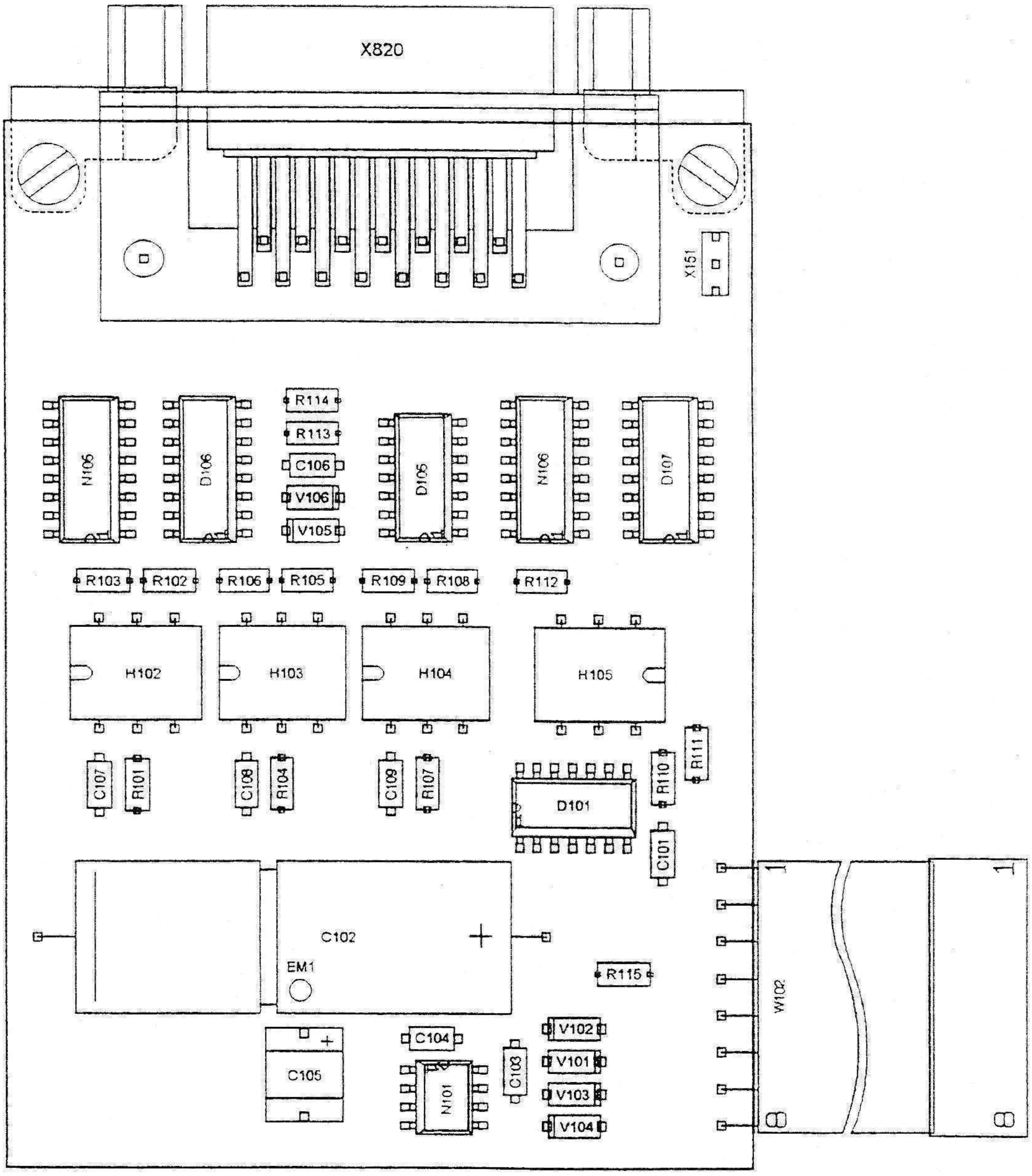

Fig. 34 Unit 6, Handler Interface; Component Layout

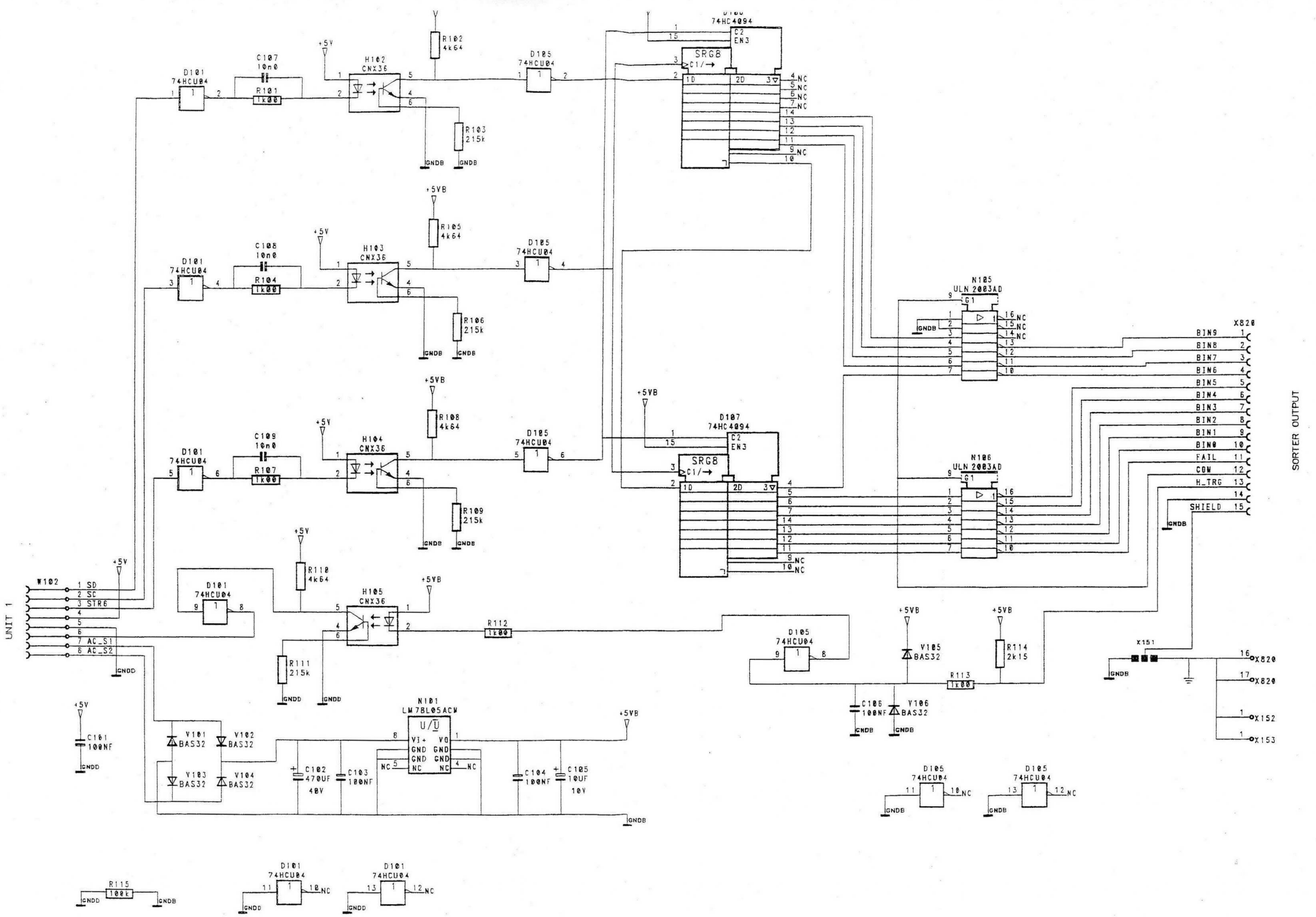

Fig. 35 Unit 6, Handler Interface

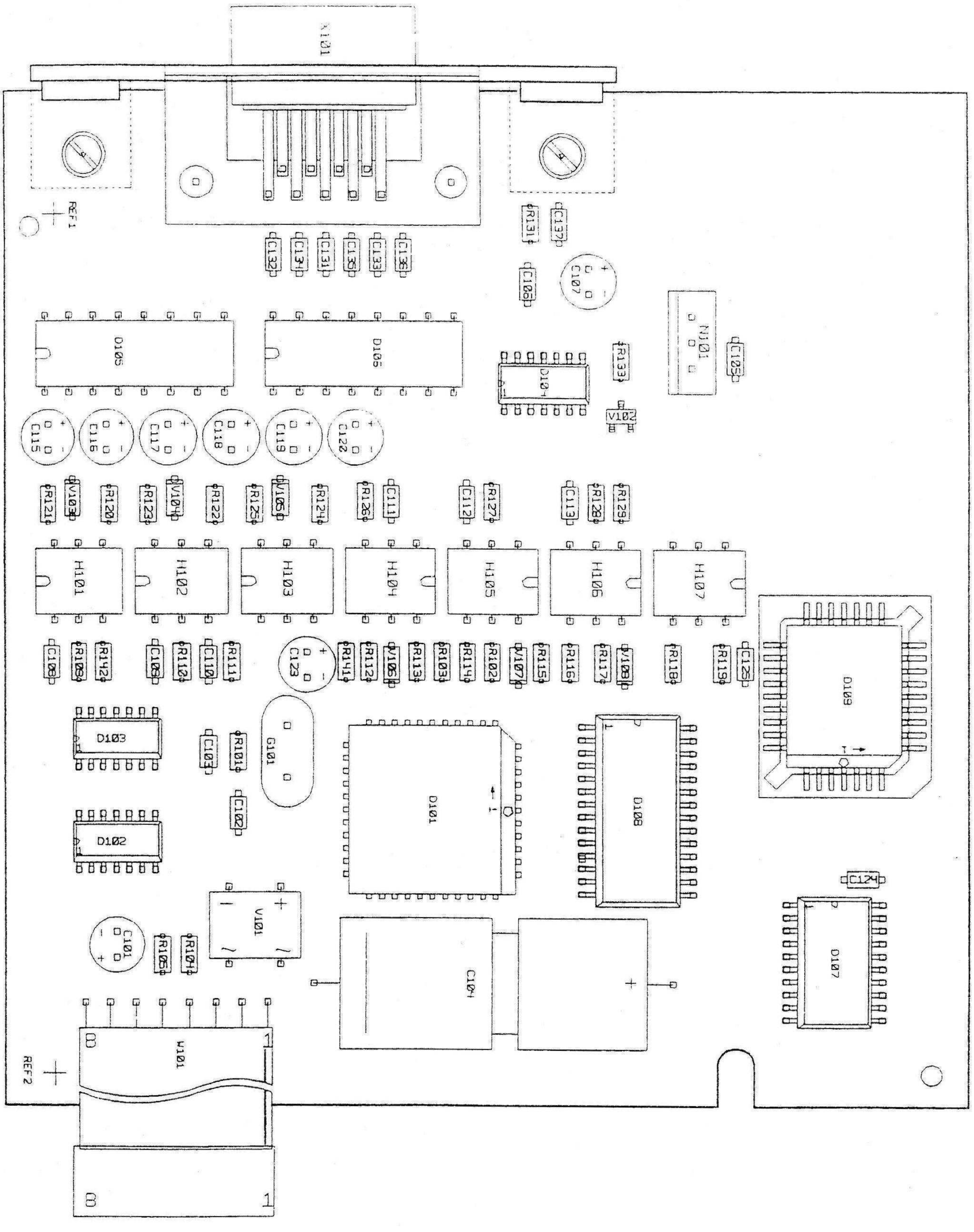

Fig. 36   Unit B, RS-232 Interface; Component Layout

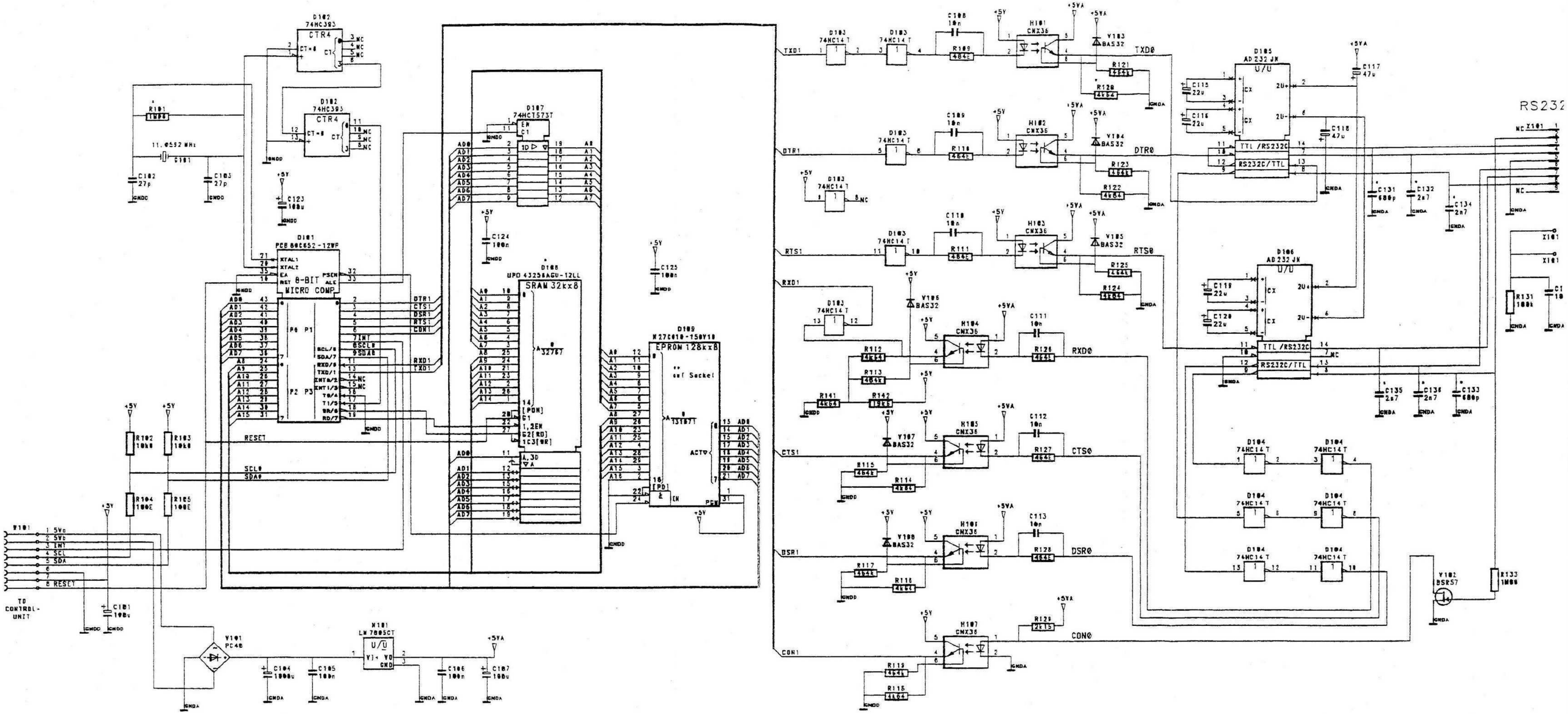

Fig. 37 Unit 8, RS-232 Interfac

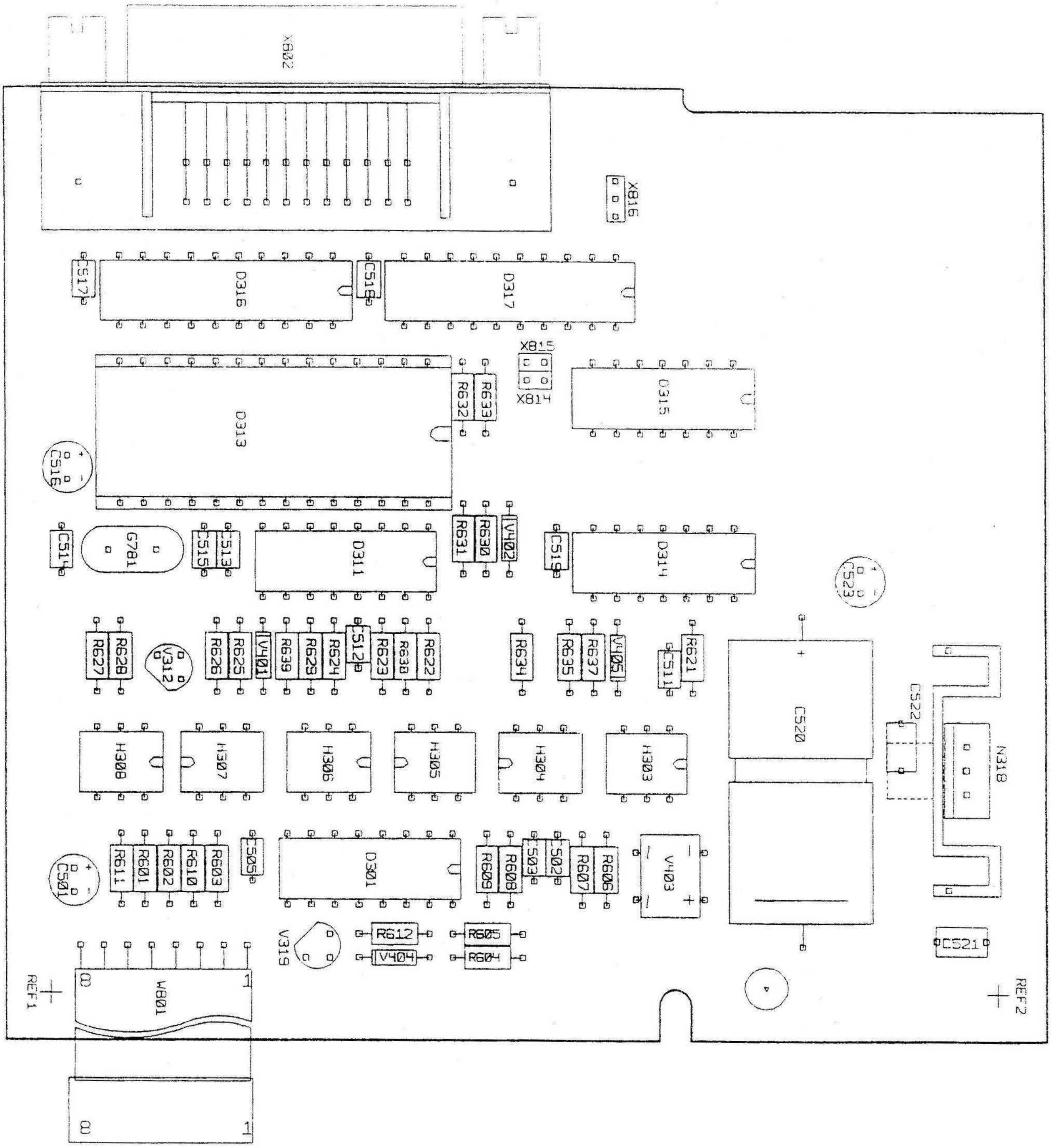

Fig. 38 Unit 9, IEEE-488 Interface; Component Layout

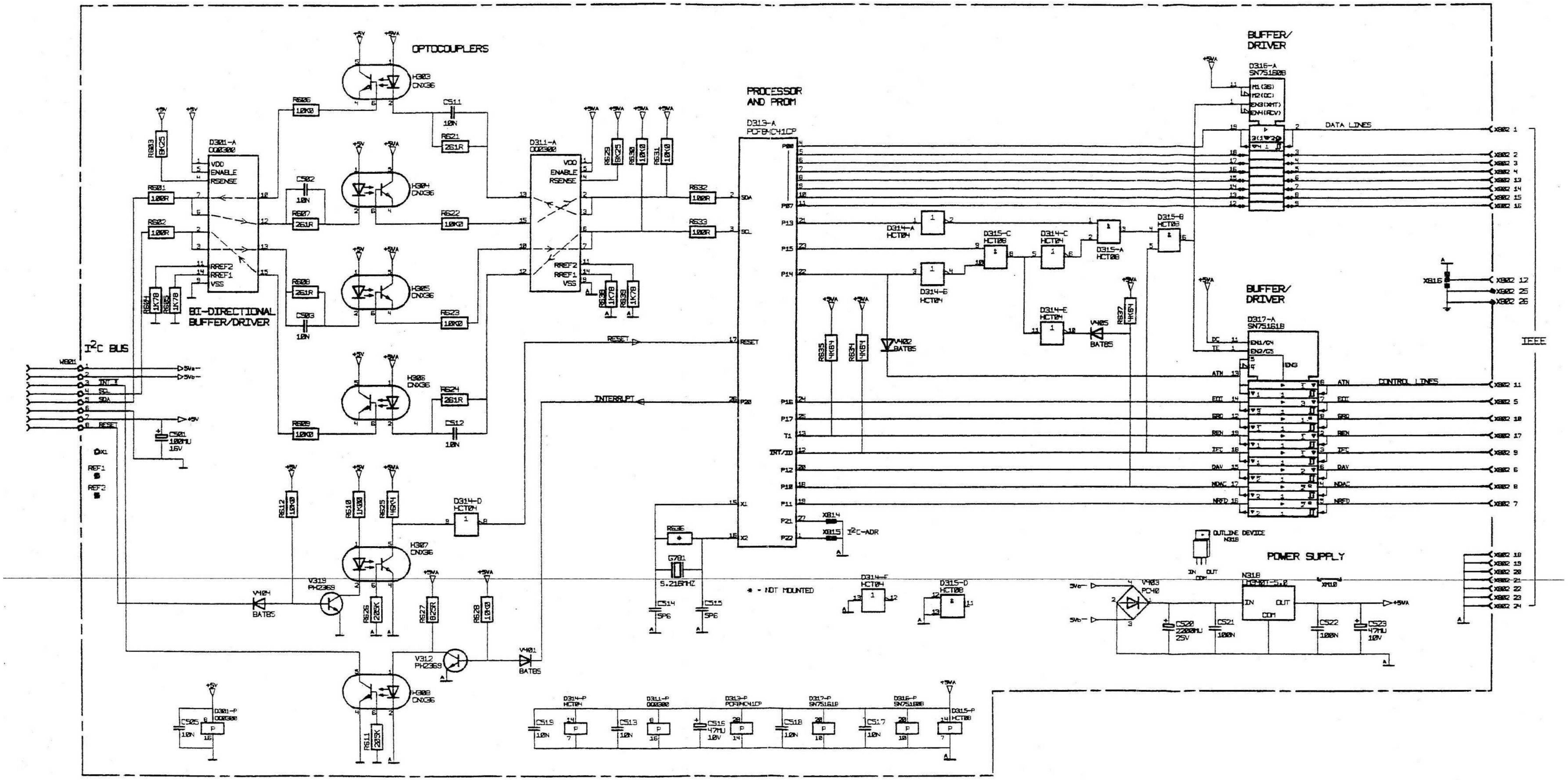

Fig. 39 Unit 9, IEEE-488 Interface