PM 6303A
AUTOMATIC RCL METER

Service manual

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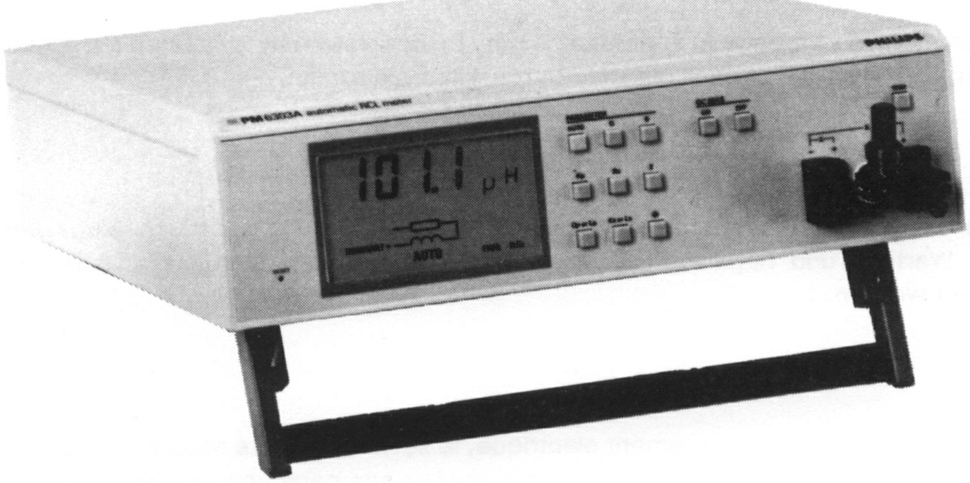

PHILIPS

PHILIPS

CONTENTS

1 SAFETY INSTRUCTIONS

WARNING:	These servicing 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 retain 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 in order 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 in order 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 made inoperative 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 gaines by hand, is likely to expose live parts and accessible terminals which can be dangerous to live.

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

Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated 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 renewed by components obtained through your local Philips organization (see also chapter 10).

After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in chapter 9, have to be performed.

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2 MAINS VOLTAGE SETTING AND FUSES

The safety instructions in previous chapters must be followed.

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.

> **WARNING:** If the mains plug 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 mains voltages:

Type	Code no.	Mains voltage	Delivered mains cable
PM 6303A	9452 063 03101	220 V	Europe, Schuko
PM 6303A	9452 063 03103	120 V	North America
PM 6303A	9452 063 03104	240 V	England (U.K.)
PM 6303A	9452 063 03105	220 V	Switzerland
PM 6303A	9452 063 03108	240 V	Australia

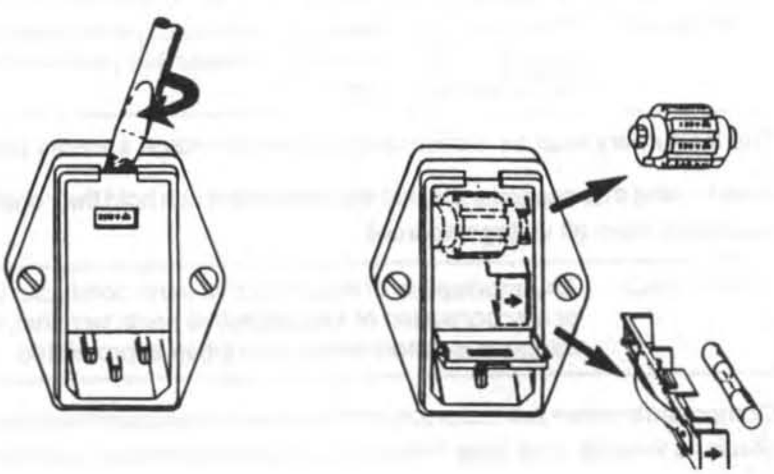
The set mains voltage and the corresponding fuse are indicated on the rear panel.

Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses and/or the short circuiting of fuse holders are prohibited. The fuse shall be renewed only by a qualified person who is aware of the hazard involved.

> **WARNING:** The instrument shall be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different mains voltage.

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

Select one of the voltage ranges, as appropriate, by turning the selector. If necessary, insert the advised fuse (T0.1A or T0.2A) into the fuse holder instead of the one built-in.



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3 OPERATING AND MEASUREMENT PRINCIPLE, BLOCK DIAGRAM, Figs. 1 to 5

3.1 DESCRIPTION OF THE BLOCK DIAGRAM, Fig. 3

The **16 MHz crystal clock** generates the basic frequency for all signals, so the count pulses for the analog to digital converter ADC.

The **frequency divider** generates the 8 MHz clock pulse for the microprocessor and the 1 kHz measurement frequency in 3 reference phases 0°, 90°, or 180° for the phase sensitive rectifier and the ADC.

The **band-pass filter 1** converts the TTL signal into a 1 kHz sinewave signal.

The **test voltage amplifier** amplifies the 1 kHz sinewave signal to a 2 V open-circuit voltage at the component connection. In the DC BIAS mode 2 V DC are added to the 1 kHz signal.

The isolating **buffer** senses the voltage at the component.

The **current to voltage converter** converts the current through the component into a proportional voltage. The conversion factor (gain) can be switched by a factor 10.

For voltage or current measurement the input of the subsequent **differential amplifier** is switched over by the **voltage/current (V/I) selector** controlled by the CPU.

In the **programmable amplifier** gain factors x 0.1, x 1, or x 10 are selected by the CPU depending on the impedance of the component. For reference measurement the input is short-circuited.

The **1 kHz band-pass filter 2** suppresses hum interference and reduces the harmonic contents on the 1 kHz measurement signal.

The **level detector** compares the output voltage of band-pass filter 2 with a preset reference value. If this value is exceeded, the CPU switches the programmable amplifier to a lower gain factor.

The **phase sensitive rectifier** generates DC voltages which are proportional to that component of the measurement voltage being in-phase with the reference voltage.

The **analog to digital converter ADC** converts the output signal of the rectifier into a binary number which can be processed by the CPU.

The **central processing unit CPU** with the microprocessor controls and monitores the measurement process according to the keyboard setting, computates and stores the measurement values and transfers the result to the display. It also comprises the **non-volatile memory** for the keyboard settings and the TRIM data.

On unit 2 you find the backlit **liquid crystal display LCD** with 2 backplanes controlled in duplex mode by the decoder/driver.

Overmore on unit 2 you find the **keyboard** with its assigned encoder.

The **power supply** generates the required stabilized dc voltages +15 V, –15 V, +5 V, and –5 V for the circuitries. It also comprises the power-down circuit for the non-volatile memory.

3.2 MEASUREMENT PRINCIPLE

The component measurement is based on the so-called current and voltage technique. The component voltage and after that 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 component is automatically displayed (AUTO) – resistance, capacitance or inductance – or the selected parameter is displayed.

Each measurement cycle lasts approx. 0.5 seconds. It comprises 5 single measurements, the results of which are stored and arithmetically evaluated. Finally they are transferred to the display, see fig.2. The 5 single measurements are as follows:

1. Reference measurement.
At the beginning of each measurement cycle a reference measurement is performed, with the output of the programmable amplifier grounded, caused by low signals PA1, PA2 at pins 1, 2 of the micro-processor D315. The programmable amplifier is set to gain x0.1. After a delay time of 50 ms for each of the single measurements, necessary for settling of the zero control and band-pass filter 2, a measurement without 1 kHz signal is performed, comprehending all failures within the signal path from multiplexer D103 to the A/D converter. The counter contents of the A/D conversion at the end of this measurement serves as reference for the subsequent 4 measurements.

2. 0° voltage measurement:
The voltage at the component is measured.
The switching phase of the phase sensitive rectifier is 0°.

For voltage sensing at the component the inputs of the differential amplifier are connected via the V/I selector, multiplexer D101, to the measurement input. This is achieved by low signal VIS from the microprocessor D315.3. The 0° switching phase is activated by low signal 'select Φ', D315.14. The gain of the programmable amplifier is set to x0.1. After 5 ms settling time for the 1 kHz signal the output of the level detector is sensed, OVR D315.12. If no overrange is detected, the gain is set to x1; the level detector is sensed again. If now overrange is detected, the gain is set back to x0.1 and an A/D conversion is started, D315.5. For low-ohmic components the maximum gain x10 is set and, if no overrange is detected, the measurement is performed.

3. 90° voltage measurement:
The voltage at the component is measured.
The switching phase of the phase sensitive rectifier is 90°.
The gain of the programmable amplifier is not altered with respect to the 0° voltage measurement. An A/D conversion is performed.

4. 0° current measurement:
The current through the component is measured.
The inputs of the differential amplifier are switched over to the ouput of the current to voltage converter.
The switching phase of the phase sensitive rectifier is 0°.

The gain of the programmable amplifier is set to x.1 and, as for voltage measurement, increased to x1 with regard to the level detector. Next, if necessary, the conversion coefficient of the I/V converter is increased from x1 to x10 (high at D315.4) and the gain of the prog. amplifier is increased to x10 and evt. set back to x1 after overrange detection. An A/D conversion is performed.

For low-ohmic components the sequence is slightly different:
If for voltage measurement the gain was set to x1 or x10, the impedance is in any case very low, resulting in maximum current to flow. The current measurement is performed at gain x0.1 without trial for gain changing.

5. 90° current measurement:
The current through the component is measured. The switching phase of the phase sensitive rectifier is 90°. The gain of the programmable amplifier is not altered. A final A/D conversion is performed.

At the end of the single measurements the 5 measured values are stored in the CPU. From this the microprocessor first calculates the equivalent series resistance Rs, the equivalent series reactance Xs and the quality factor Q = Xs/Rs of the component. In AUTO mode the microprocessor determines the dominant component, Rs resp. Rp, Cp or Ls, calculates its value, and displays it together with the equivalent-circuit symbol. If one of the other parameters is selected, this parameter is calculated and displayed. After that the next measurement cycle starts with the 5 single measurements.

For **fault finding** the 5 single measurements can statically be controlled, performed by the **test program,** chapter 6.

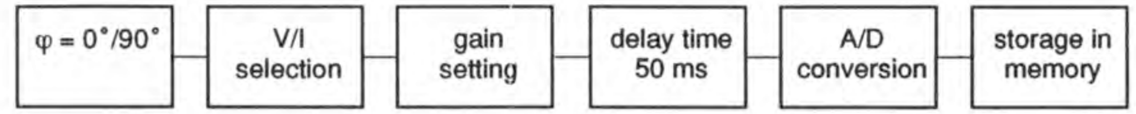


Fig. 1 One single measurement

Fig. 2 One measurement cycle (ca. 0.5 s)

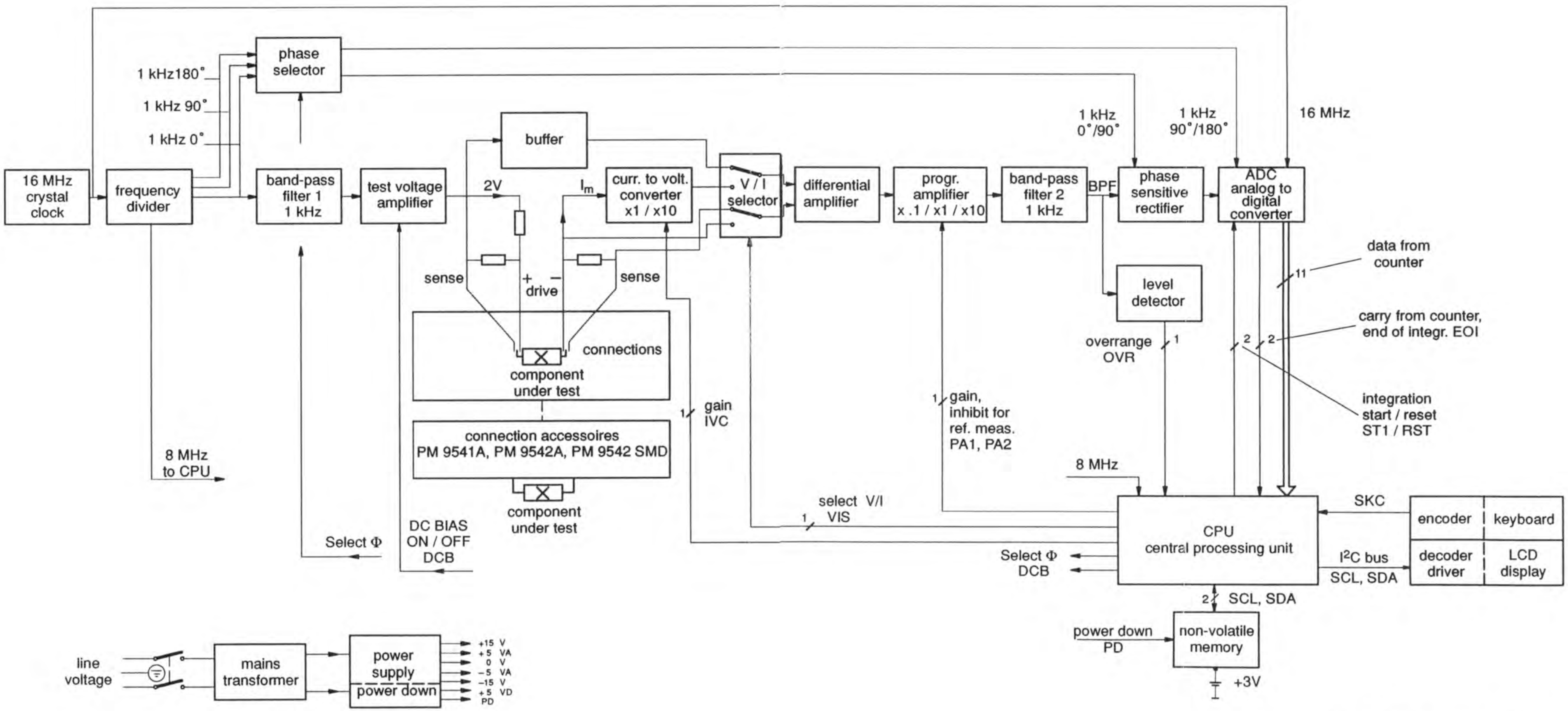


Fig. 3 Block diagram PM 6303A

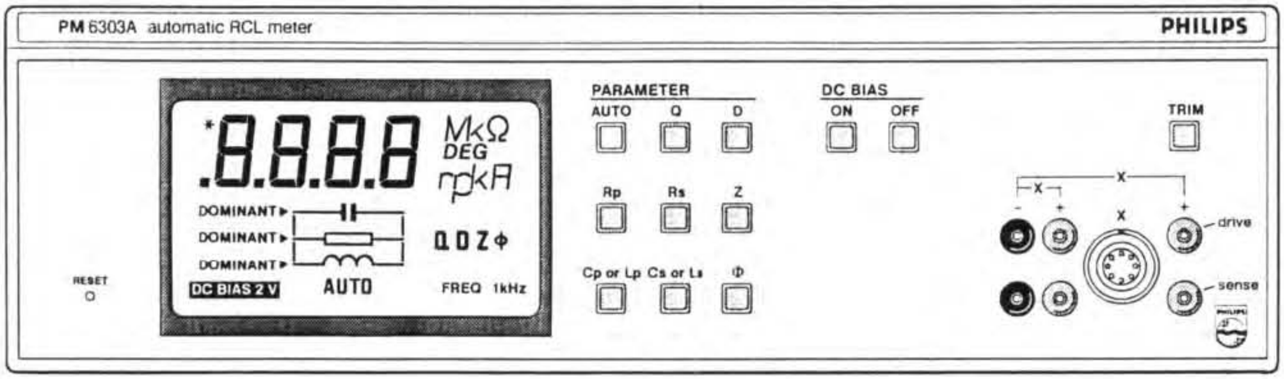


Fig. 4 Front view

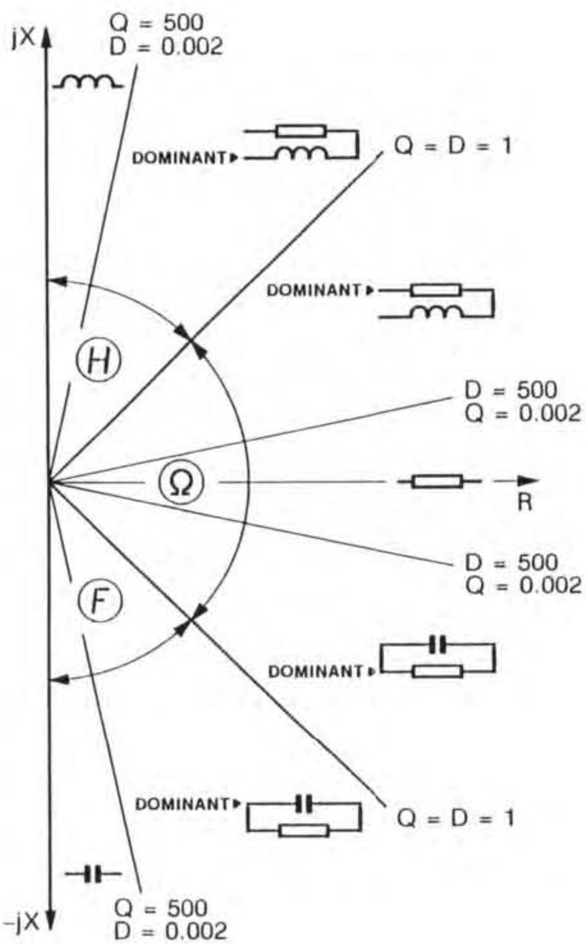
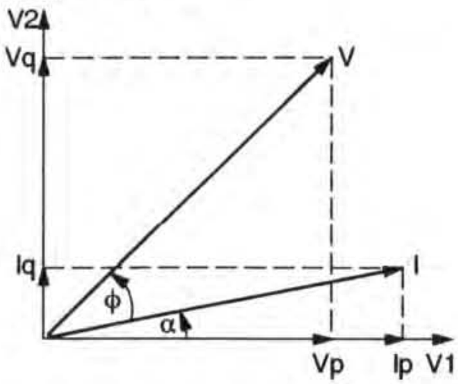


Fig. 5 Equivalent-circuit symbol and dominant parameter in the sectors of the phasor plane (AUTO mode)

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



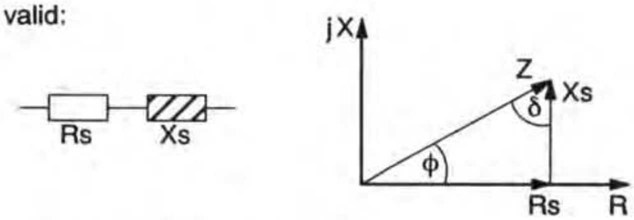
V: voltage
I: current
V1, V2: 0°-voltage, 90°-voltage

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.
From these components the series resistance and reactance are calculated.

$$Rs = \frac{Vp\,Ip + Vq\,Iq}{Ip^2 + Iq^2} \quad (1) \qquad Xs = \frac{Vq\,Ip - Vp\,Iq}{Ip^2 + Iq^2} \quad (2)$$

The following 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.

The formulas for the various parameters are:

$Q = \frac{|Xs|}{Rs}$ 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 $Y = 1/Z$

Example:

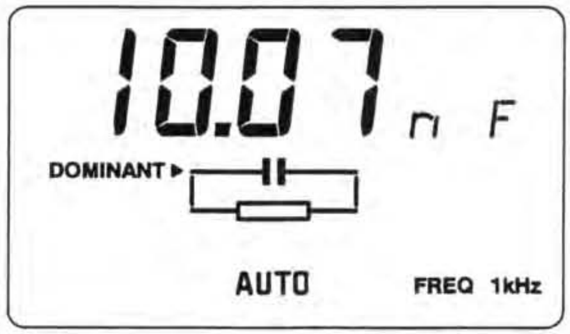
By means of the 5 measurements the instrument has calculated Rs and Xs in accordance with formulas 1 and 2, e.g.:

$$Rs = 3.037\ k\Omega$$
$$Xs = -15.197\ k\Omega$$

From this the instrument calculated:

$$Q = \frac{|Xs|}{Rs} = 5.004$$

The instrument displays the corresponding equivalent-circuit symbol with the dominant component, according to the criteria of the diagram on page 3 – 4; in this case, as Xs is negative and 1 < Q < 500:



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

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

$$Cp = \frac{1}{2\pi \cdot 1\ kHz\ (1 + 1/5.004^2) \cdot 15.197\ k\Omega} = 10.068\ nF$$

whereby the instrument calculates at a higher resolution. The maximum display is 4 digits ±1 digit tolerance.

The calculation of the further selectable parameters are performed as follows:

$$D = \frac{1}{Q} = \frac{1}{5.004} = 0.199$$

$$Rp = (1 + Q^2) \cdot Rs = (1 + 5.004^2) \cdot 3.037\ k\Omega = 79.08\ k\Omega$$

$Rs = 3.037\ k\Omega$ (calculated by the instrument acc. to formula 1)

$$Z = \sqrt{Rs^2 + Xs^2} = \sqrt{(3.037\ k\Omega)^2 + (15.197\ k\Omega)^2} = 15.497\ k\Omega$$

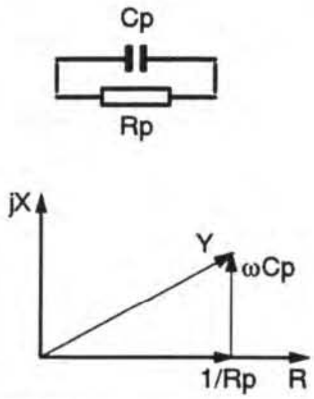
$$Cs = \frac{1}{\omega |Xs|} = \frac{1}{2\pi \cdot 1\ kHz \cdot 15.197\ k\Omega} = 10.472\ nF$$

Φ: The Instrument calculates

$$\tan\Phi = \frac{|Xs|}{Rs} = \frac{15.197\ k\Omega}{3.037\ k\Omega} = 5.004$$

and gets Φ from an internal table

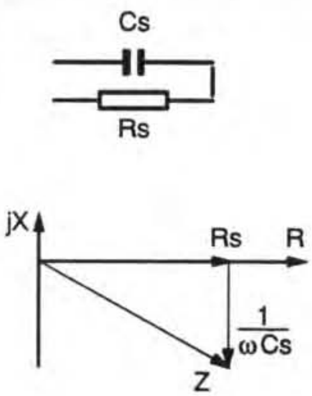
$\Phi = -78.7$ DEG



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

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

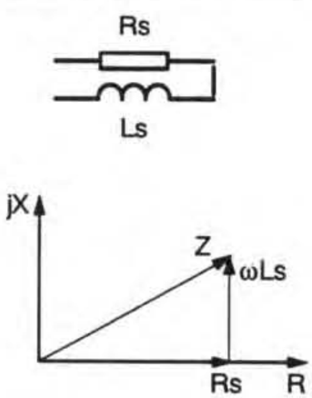
$$Cs = (1 + D^2) \times Cp \qquad Rs = \frac{D^2}{1 + D^2} \times Rp$$



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

$$D = \omega CsRs$$

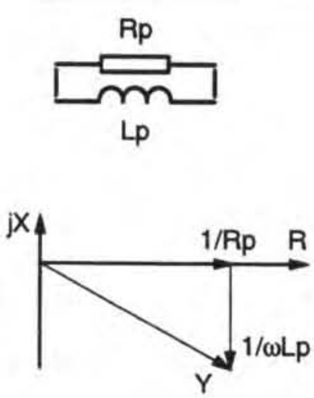
$$Cp = \frac{1}{1 + D^2} \times Cs \qquad Rp = \frac{1 + D^2}{D^2} \times Rs$$



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

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

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



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

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

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

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4 CIRCUIT DESCRIPTION, FAULT FINDING, Figs. 6 to 10

4.1 POWER SUPPLY, Fig. 52

Five voltages are generated by the power supply: +15 V and –15 V are stabilized by the voltage regulators N401, N402, adjusted by potmeters R402, R405. Z-diodes V403, V404 provide +5 V and –5 V for the CMOS switches (multiplexers) D101, D102, and D103, fig. 56. The +5 V supply for the digital circuitries is outputted by the voltage regulator N403.

When switching power off or when the power supply fails, the power-down-reset circuit resets the microprocessor D315 in fig. 58, thus preventing any further data exchange until the internal supply voltages are completely down. Furthermore the non-volatile memory, SRAM D314 in fig. 58, where the actual keyboard setting and the TRIM data are stored, is now backed-up by the battery G301.
When switching off, the PD signal gets low before the 5VD supply disappears; hence the reset input RST of the microprocessor D315 gets high. The same happens when pushing the concealed front panel RESET switch, figs. 59, 60. When switching on capacitor C309 in fig. 58 provides a low signal for resetting the microprocessor.

4.2 CRYSTAL CLOCK, FREQ. DIVIDER, PHASE SELECTOR; Fig. 58

The accuracy of the 16 MHz clock frequency is moderate, $\pm 5 \times 10^{-5}$. So fixed load capacitances are inserted; they nevertheless may be altered in test, if necessary. The output of the oscillator is decoupled by inverter D307. D307.6 feeds the 16 MHz count pulses for the counter in the analog to digital converter ADC.

The first divider stage of the 4-bit binary counter D306 generates the 8 MHz clock pulse for the microprocessor. Its last stage feeds 1 MHz to the frequency divider chain. D301 comprises two 4-bit BCD counters, the 5:1 division of which is used for dividing the frequency down to 40 kHz. Further division by 10 results in a 4 kHz signal at output D302.13, the bacis frequency for generation of the 1 kHz signals with different phase relations, see fig. 6. The trailing (high to low) edges trigger the JK-flipflops D303, D304. The 1 kHz 0° signal is fed to the band-pass filter 1 on fig. 56. At output 4 of the multiplexer D305 a 0° or 90° signal is available, selected ('select Φ') by the microprocessor. At output 7 a signal shifted by 90° with relation to pin 4 is available for synchronization of the analog to digital converter.

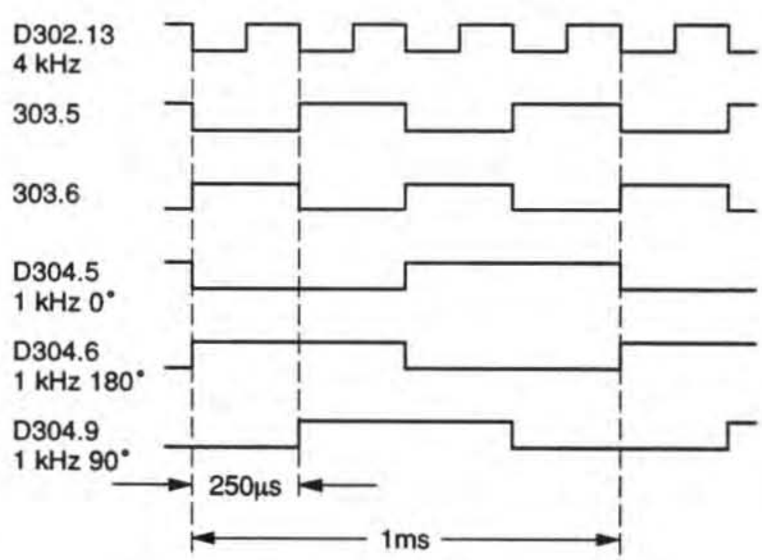


Fig. 6 Generation of the 1 kHz signals

4.3 COMPONENT CONNECTION, BUFFER, Fig. 56

For understanding the measurement of various types of components with respect to possible faults in the instrument and its accuracy, chapter 3.2 of this service manual is helpful, in shorter form also printed in the operating manual, chapter 3.6. In general influences by series or parallel impedances in the input/output connections of the component must be taken into account.
fig. 7 shows the circuitry for the four-wire connection of a pure ohmic component.
For two-wire measurement the component must be connected between + drive and – drive.
Depending on measuring either high-ohmic or low-ohmic components this figure can be simplified.
The contact resistance at the sockets may approx. be 50 mΩ.

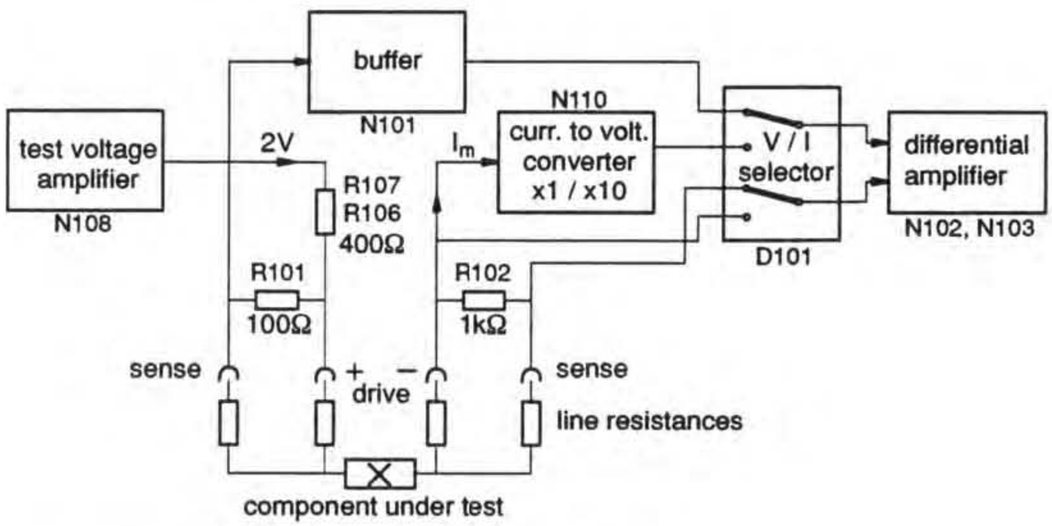


Fig. 7 Detailed circuitry for four-wire component connection

The 2 V measurement voltage is fed to the "+" socket, sensed at the appropriate socket. The current flows through the component to the "–" socket and the voltage at the low end is sensed. The "–" socket is no measurement earth contact of the circuitries; the circuit earth potential at the front plate is only available at pins 1, 3, 5, 7 of the round connector or at the 4 mm centre connection of the 4-wire test cable. These connections must not be used to connect a protective earth conductor.

The **buffer amplifier N101** serves for impedance conversion from high-ohmic sensing the measurement voltage to further signal processing. The signal is ac coupled (C101) in order to suppress the dc voltage in BIAS mode.

4.4 CURRENT TO VOLTAGE CONVERTER, Fig. 56

The **I/V converter N110** converts the component current into a proportional output voltage. Differential sensing the current at the feed-back resistor R104 or R105 allows measurement of low impedances down to 1 mΩ. Multiplexer D102 switches the conversion factor (gain) to x 1 or x 10 by selecting feed-back resistor R104 or R105. The tolerance of the resistors must be 0.05 %, as it directly influences the measurement accuracy of the instrument. By separate switching the current path and the voltage sensing at the resistors the on-resistances of the CMOS switches are eliminated. R108 and Z-diodes V119/V120 limit the amplitude at input 15 of the switch to ±4.5 V. Voltages above ±5.0 V would destroy the switch!

4.5 PROGRAMMABLE AMPLIFIER, BAND-PASS FILTER 2, Fig. 56

In the inverting amplifier N104 feed-back resistors are switched: Multiplexer D103 selects R114, R115, or R116 for gain setting x 0.1, x 1, or x 10 depending on the impedance of the component. The absolute gain accuracy of the amplifier is of no importance; only the accuracy of the gain factors x 10 between the 3 gain settings are important; so the resistors mentioned have 0.05 % accuracy.

Capacitors C112/113/114 are paralleled to the resistors in order to achieve equal bandwidth and so equal phase errors for the 3 gain settings.
2-pole switching of the feed-back resistors eliminates the on-resistances of the CMOS switch. Via the lower contacts the high-ohmic input of IC N105 senses the voltage at the resistors.

Signals PA1 and PA2, binary coded from the CPU, select the gain at inputs 10 and 9 of D103. For the reference measurement within the measurement cycle, the input of the band-pass filter N105 is set to ground, code 00, pins 12 and 13 of D103 connected. Codes 01 to 11 correspond to gains x 0.1 to x 10.

The **BAND-PASS FILTER 2** suppresses hum interference coupled into the component and reduces the harmonic contents of the 1 kHz signal. The gain at 1 kHz is 0.98.

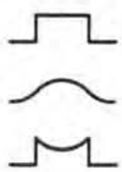
4.6 LEVEL DETECTOR, Fig. 57

The Level detector comprises comparator N206 and the retriggerable monostable multivibrator, flipflop D202. If the positive peak value of the measurement signal exceeds the reference value 2.8 V, set by R251, R252, the comparator generates 1 kHz pulses, which trigger the flipflop. R254 and C212 determine the duration of the output pulse to 2 ms; hence the output 12 is low, as long as the comparator detects overrange. The microprocessor detects the overrange signal OVR and switches the programmable amplifier to a lower gain, PA1, PA2.

4.7 PHASE SENSITIVE RECTIFIER, Fig. 57

The circuit resolves the component voltages into vectors along the two reference phases and converts them to d.c. voltages. It is essentially an on/off switch for the component voltage Vm.

Without Vm, i.e. during reference measurement, rectangular 1 kHz pulses of about 4.4 V (zero-peak) are available at the buffer output N202.6. The pulse amplitude and rise and fall times are stable for at least one measurement cycle, achieved by differential switch V201/202 and reference diode V212. The phase of the switching pulses in relation to the measurement voltage is selectable to 0° and 90°. The measurement voltage Vm at the input of the rectifier is superimposed on the pulses only during the half cycle:



N202.6 without Vm

Vm only, e.g. in-phase

N202.6 with Vm

The maximum portion of Vm is ±30 % with respect to the d.c. pulse amplitude, achieved by Vm = ca. 2 V eff being in-phase or anti-phase related to the switching signal.

4.8 ANALOG TO DIGITAL CONVERTER, ADC, Fig. 57

The output signal of the phase sensitive rectifier is converted into digital data by a dual-slope analog to digital coverter. The ADC comprises integrator N203, zero control N204, comparator N205, ADC control D204, D205 and a 19-bit counter. The latter is composed by the 11-bit counter D310 in fig. 58 and an 8-bit counter within the microprocessor D315. Oscilloscope drawings in fig. 8 show one complete measurement cycle. fig. 9 enlightens one conversion period within one of the single measurement cycles.

High signal ST1 of the microprocessor D315.5 prepares the conversion at t1. The time t2 – t1 may vary from 0 to 1 ms (1 pulse duration). The start pulse duration is 1.5 ms. The trailing edge of the 1 kHz signal at D205.1 sets the output 5 to high to start the integration at t2. ST2 switches the zero control off and connects the output of the phase sensitive rectifier via CMOS switch D201 to the input of the integrator. This is done during the zero period of the measurement pulses. For this the 1 kHz 90° signal is taken.

The integrator reference current, defined by R221, R222, is equal for integration (t2 to t4) and de-integration (discharge slope t4 to t5). The difference between input current, defined by measurement voltage pulses and resistor R220, and the integrator reference current effects the output voltage of the integrator to go in negative direction. At t2 flipflop D203 and counter D204 are activated. The flipflop divides the 1 kHz frequency by 2, feeding the down counter which was preset to 10. At t3, counter stage 7, high signal MR, D204.6, resets the 11-bit counter to zero. Low signal D204.7 resets flipflop D203 of the comparator enabled again at t4. At t4 the counter stage is zero. At the trailing edge of the 1 kHz signal the output D204.13 generates a short low pulse resetting D205 and so terminating the integration and starting the de-integration. The integration period T1 = 20 ms comprises 20 pulses; so zero- and time-symmetrical 50 Hz noise and its odd harmonics have no influence on the measurement result.

When D205 is reset at t4, all 3 enable inputs at NAND gate D309, fig. 58, are high; so the 16 MHz count pulses can pass to the 11-bit counter D310. The carry of the counter toggles the 8-bit counter within the mocroprocessor, input 15.

At t5 the output voltage of the integrator crosses the zero level causing the comparator an the flipflop D203.9 to turn over to low. This signal EOI, 'end of integration', disables gate D309 to stop the 16 MHz count pulses. The counter state at t5 is proportional to the integrator output voltage at t4 and consequently to the measurement value. For reference measurement the integrator output is ca. 5 V at t4 resulting in T2 = ca. 15 ms, corresponding to 240.000 count pulses. The maximun counter state is ca. 475.000 = T2 = 29.7 ms, the minimum is ca. 5000 = T2 = 0.3 ms. So for the measurement range ca. ± 235.000 count pulses are available.

As the tilt of the de-integration is independent of the measurement value, the delay time between zero crossing and comparator turn-over and so the counter state for every single measurement is equal; hence the difference of the counter states is not affected.

The output D203.9 of the comparator is sensed by the CPU. Low signal EOI at t5 causes the CPU to store the 19-bit counter contents into the memory. The CPU sends a reset pulse RST at t6 preparing the circuitry for the next single measurement cycle: the zero control is activated decreasing the integrator output voltage to zero. In the rest position the zero control has to compensate the integrator reference current.

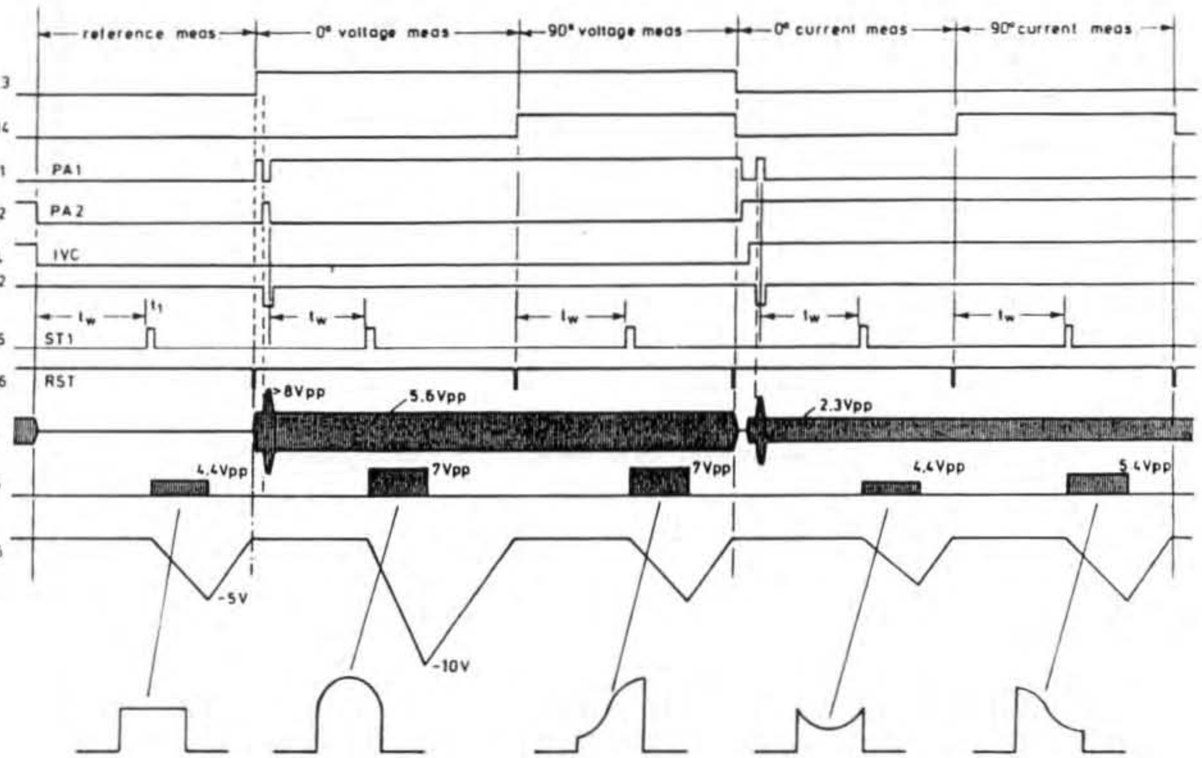


Fig. 8 One complete measurement cycle (for a 100 kΩ resistor)

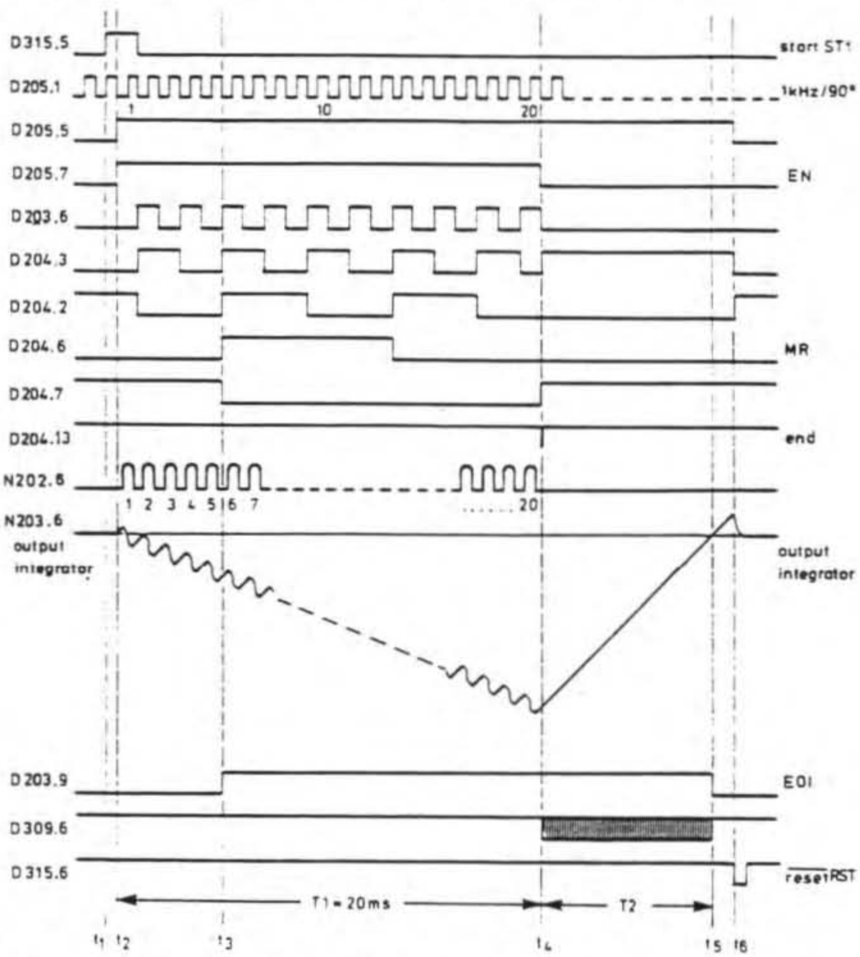


Fig. 9 One conversion period of the ADC

4.9 CENTRAL PROCESSING UNIT, CPU, Fig. 58

The CPU contains an 8–bit microprocessor PCB 80C652, D315, Program Memory (PROM) D316, address latch D313 and the battery buffered RAM D314 for storage of instrument settings and TRIM data. The processor is clocked by 8 MHz derived by divider D306 from the 16 MHz crystal clock.

The multiplexed address/data bus (IO0 ... IO7) of the processor supplies the address inputs (0 ... 7) of the PROM via address latch. The address inputs 8 ... 14 are directly supplied from the processor ports AD8 ... AD15. Data transfer from PROM to processor takes place via PROM data outputs 0 ... 7 and processor inputs AD8 ... AD14, controlled by $\overline{\text{PSEN}}$ (Program Store ENable).

Processor reset before power off is done via line (SUP) PD from the power supply manual reset via line RES from the keyboard.

The communication between memory for the instrument settings and processor is done by an I^2C–bus with data line SDA and clock line SCL. These lines also serve for data transfer to the display, unit 2.

When power is switched off RAM D314 is supplied at U_{DD} with a 3 V battery voltage in order to avoid loss of stored data. Additional pin 7 (TEST) is provided with this voltage; by this the RAM is set in a mode which reduces power consumption.

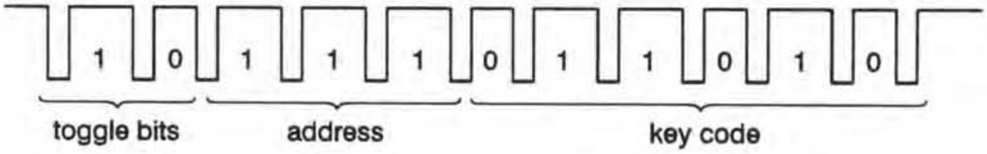
The solder bridge E next to the processor serves to activate the test program, but it is preferred to activate it by front panel operation, see chapter 6.

4.10 KEYBOARD / DISPLAY, UNIT 2, Fig. 60

The unit consists of the Liquid Crystal Display (LCD) H102 with separate backlight H101, the decoder/ driver D103 for the LCD, and the switches with the keyboard encoder D102.
The data for the display are directly sent from the processor via I^2C-bus (SCL, SDA) to the decoder/ driver D103. This component is a Surface Mounted Device (SMD). If replacement is necessary and no suitable equipment for soldering is available, a complete mounted pcb without LCD and backlight can be ordered, see spare parts chapt. 10.
The function of the decoder/driver together with the correct function of the display can be checked by the test program, step 2.
The display has 67 segments, lit by two backplanes. The backplanes are controlled by D103, pins 1+ 84 (backplane 1) and pins 42 + 43 (backplane 2).
For allocation of display segments to display pins, see fig. 10, next page.

The backlight H101 consists of serial and parallel connected LEDs, supplied by 22 V. The brightness can be adjusted with potmeter R101; the brightness is normally set to 60 ... 94 Lux.
When the display has been replaced, check brightness resp. adjust it before the unit is built in again.

The keyboard encoder D102 controls a 6 x 3 keyboard matrix (drive lines D0 ... D5 and sense lines S0 ... 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.

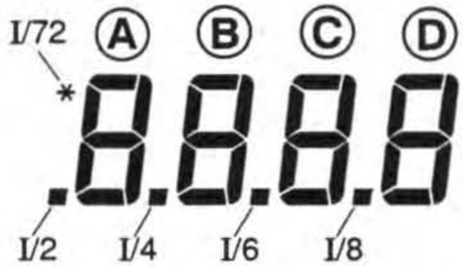


Each time a key is pressed such a bit sequence must be measurable at line SKC (pin 10 of connector A101 or pin 8 of D101. The toggle bits of this sequence change each time when a key is pressed, so the processor can distinguish whether a key is pressed several times or once for a longer time.

The line RES (reset) of the switch S121 is directly routed to the processor.

Allocation of display segments to display pins

The digit I or II in front of the slash represents the assigned backplane (I = pins 1 and 84, II = pins 42 and 43). The digit behind the slash is the pin number of the display.



Segment / Digit							
A	II/75	I/75	I/3	II/2	II/3	II/76	I/76
B	II/70	I/70	I/5	II/4	II/5	II/71	I/71
C	II/65	I/65	I/7	II/6	II/7	II/66	I/66
D	II/60	I/60	I/14	II/8	II/14	II/61	I/61

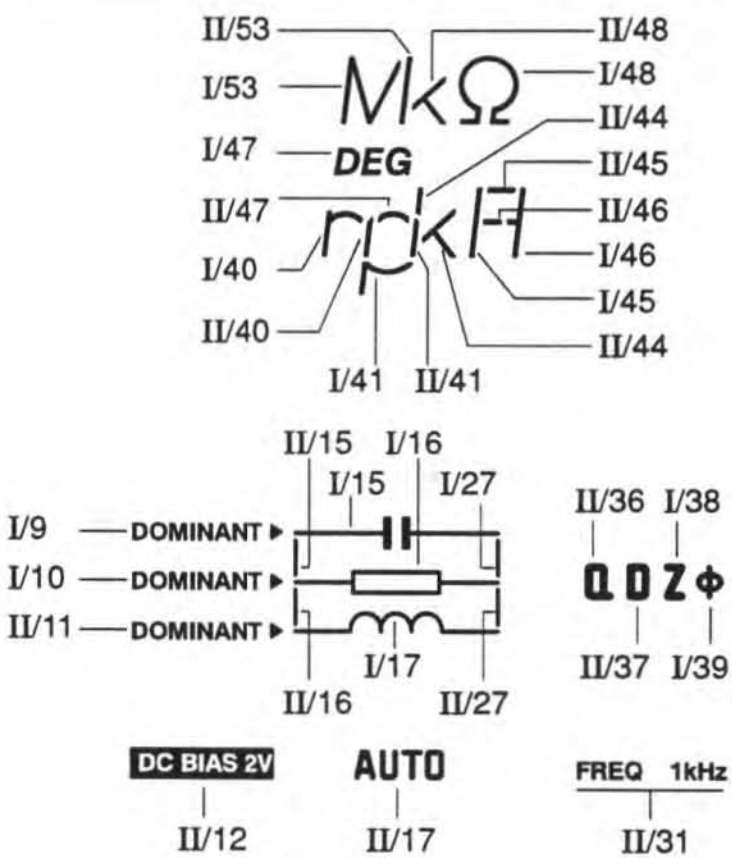


Fig. 10 Allocation of display segments to display pins

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5 PERFORMANCE TEST

5.1 INTRODUCTION

These chapters describe the performance test for the key parameters of the RCL meter PM 6303A using the instrument specifications (chapter 4, operating manual) as the performance standard. These performance tests may be used as an acceptance test upon receipt of the instrument, as an indication that repair and/or adjustment is required or as a performance verification after repair or adjustment of the instrument.
The PM 6303A must be warmed up with all covers in place for at least 5 minutes before starting the tests, the reference conditions must be met, chap. 4.3, 4.4, operating manual.

5.2 RECOMMENDED TEST EQUIPMENT

Voltmeter, ac and dc e.g. 8920A (Fluke), PM 2535
Counter e.g. PM 6665
For voltmeter and counter no critical specification is required.

2 **single test posts,** red and black, code no. 5322 264 30184, delivered with every PM 6303A.

Set of **precision metal film resistors and capacitor**, code no. 5312 395 38004. This set can be ordered via Supply Centre Hamburg.

Type	Supplier	Value	Tolerance	Temp. coeff.
9960	Megatron	1 Ω	0.05 %	(5 ppm)
		(2 resistors soldered in parallel for 0.5 Ω)		
MPR24	Philips	34.8 Ω	0.02 %	25 ppm
MPR24	Philips	3.48 kΩ	0.02 %	25 ppm
MPR24	Philips	34.8 kΩ	0.02 %	25 ppm
RD70	Megatron	348 kΩ	0.025 %	25 ppm
RD 70	Megatron	1 MΩ	0.025 %	25 ppm
		(3 resistors soldered in series for 3 MΩ)		
CS006	Electronic	100 MΩ	1 %	100 ppm
53.20	Möricke	10 nF	see label on capacitor	40 ppm

If you use own test components, the values of which are exactly known, the test result must be calculated accordingly (instrument tolerance is ±0.25 %, resp. ±6 % for 100 MΩ).

5.3 SELFTEST ROUTINE

When switched on, the instrument first carries out a selftest, whereby PROM, processor RAM, external RAM and backup memory are checked. After this the software version is indicated in the upper display line for a short moment, all segments of the display field are shown for ca. 2 seconds, and the instrument is set to that operating mode to which it was set before power off.

A possible fault is indicated as follows: e.g. Err2

The digits mean:

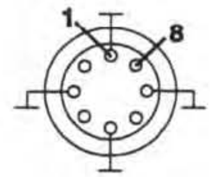
1	PROM checksum error
2	error in processor RAM
3	external RAM defective
4	error in backup memory

5.4 PERFORMANCE VERIFICATION

Measurement voltage

No component connected to PM 6303A.
Test equipment: voltmeter

Set PM 6303A to AUTO and to DC BIAS OFF.
Contact voltmeter with tips between pin 8 and 1 of the round connector;
pin 8: +, also red frontplate sockets +
pin 1: circuit earth potential, also pins 3, 5, 7
Test result: 1.8 ... 2.2 V, rms



Set PM 6303A to DC BIAS ON
Test result: 1.8 ... 2.2 V, dc

Measurement frequency

Test equipment: counter

Push DC BIAS OFF.
Set counter to 1 s gate time.
Contact counter with tips between pin 8 and 1 of the round connector.
Test result: 999.75 ... 1000.25 Hz

Open circuit trimming

Insert the two single test posts into the two left positions.
Push Cp. Push TRIM.
Test result:
The display shows **BUSY** **PASS** and finally **0.0 pF**

Push Rp.
Test result:
The display shows overrange - - - - (flashing)

Short circuit trimming

Short circuit the test posts by a clean wire, min. diameter 1 mm.
Push Rs. Push TRIM.
Test result:
The display shows **BUSY** **PASS** and finally **0.000 Ω**

Resistor measurement

Insert the two single test posts into the outer positions of PM 6303A.
Set PM 6303A to AUTO.

For test 1 two resistors of 1 Ω are soldered in parallel.
For test 6 three resistors of 1 MΩ are soldered in series.

test	component value	component tolerance	test result
1	0.50 Ω	±0.05 %	0.449 ... 0.501 Ω
2	34.8 Ω	±0.02 %	34.72 ... 34.88 Ω
3	3.48 kΩ	±0.02 %	3.472 ... 3.488 kΩ
4	34.8 kΩ	±0.02 %	34.72 ... 34.88 kΩ
5	348 kΩ	±0.025 %	347.2 ... 348.8 kΩ
6	3.00 MΩ	±0.025 %	2.993 ... 3.007 MΩ
7	100 MΩ	±1 %	94 ... 106 MΩ

Capacitance/Inductance measurement

After check of the measurement accuracy by precision resistors it is only necessary to test the capacitance/inductance measurement by only one capacitor measurement or by one dissipation factor measurement with one of the resistors used above:

test	component value	component tolerance	test result
8a	10 nF	see label on component	value on label ±0.25 %
or			
8b	3.48 kΩ	(0.02 %) tolerance is for this test not important	– – – – flashing display indicates overrange, i.e. dissipation factor >500

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6 TEST PROGRAM, Figs. 11, 12

The test program contains 6 sub-programs:

1. display test
2. keyboard test
3. storage register test
4. test of the single measurement steps
5. test of a measurement cycle
6. test of measurement range settings

Push key AUTO or the concealed key RESET, while switching the instrument on. After power-on routine the letters 'TEST' appear in the display, after that the menu of sub-programs 1 to 6.
Press any key briefly to select and carry out the test required. Push a key again for about 3 seconds to return to the subprogram menu. To leave the test program, either push RESET or switch off the instrument.
It is also possible to activate the test program by closing solder joint E on unit 1, fig. 55.

Program 1: Display Test (Pro1)

This test checks the liquid crystal display H102 and the respective decoder/driver D103 on the keyboard/display unit (U2).
When the text 'Pro1' appears in the sub-program menu, push a key for a short moment. All segments of the display are switched on one after the other.
This procedure may be interrupted resp. continued if a key is pressed shortly. The instrument waits with the total display lit up until you push any key to take it back to the sub-menu or until you leave the test program.

Program 2: Keyboard Test (Pro2)

This test checks the function of each key (S103 to S120) as well as those of the keyboard encoder D102 on unit 2.
Push any key when the text 'Pro2' appears in the sub-menu, the display shows 'bCod'. If you push any key in random the current number of this key appears in the display together with a control number, e.g. 2–3 when key Q is pushed.
This control number is generated by the keyboard encoder and can be changed to 0, 1, 2, or 3 by pushing this key again. The keys are numbered row by row from left to right. Thus, for example, the key TRIM has the number 6, key Z has number 9. To return to the sub-program menu, push any key.

Program 3: Memory Register Test (Pro3)

This test checks the memory for the storage of instrument settings and trim data (TRIM). The content of this memory is not written over or deleted during the test and can be used as normal when the test has been completed.
The test runs automatically. The display shows 'rEG' and at the end of the test 'PASS'; if it finds an error, it will read 'Error'.
Push any key to return to the sub-program menu.
To leave the test program, either press RESET or switch off the instrument.

Program 4: Test of the single measurement steps (Pro4)

In the normal operating mode it's not easy to measure and control a complete measuring cycle resp. the different measuring ranges of the instrument; details are shown in fig. 11

By the test mode **Program 4** the five single measurement steps can be performed step-by-step:

- ME1: reference measurement
- ME2: voltage measurement, phase 0°
- ME3: voltage measurement, phase 90°
- ME4: current measurement, phase 0°
- ME5: current measurement, phase 90°

In the next steps the selected voltage gain (Gu) and current gain (Gi) are indicated. The range selection is done automatically and depends on the value of the component under test (CUT) applied to the measuring input, see column 5 of table fig. 11.

For the steps ME1 – ME5 the display represents the 16 MSB of the counter state in hexadecimal notation. The test result is not influenced by the short– resp. open–circuit trimming and should be stable in the first 3 digits.

Note: Please well distinguish **b** = B, **6** = 6

You can leave Program 4 by pressing any key for about 3 seconds to return to the sub–program.

Procedure:

Select this test by pressing any key for a short time when 'Pro4' is shown on the display. Now the display shows 'MEAS' for a short time followed by the indication 'ME1'. If a key is pressed again the value of the reference measurement is indicated in hex. notation. The value must be within 6F00...8B00.

If you want to get the voltage measurement mode 'ME2' (Zv-0°) you have to press a key and once again to get the result. The further measurements ME2 – ME5 are performed in the same way, step-by-step. When you have passed 'ME5', the display shows the selected measuring range. For a component under test, e.g. 402 Ω (normal tolerance 1 %), the display shows 'Gu 1' and 'Gi 1', representing a gain setting of –20 dB for the voltage and current measurement, see table fig. 11.
After indication of 'Gi' test 4 is finished.

By this test you have the possibility to check and follow the analog input path including the integrator. A detailed procedure for fault finding in the analog input path is shown in a fault finding tree (see fig. 12), applying a 402 Ω resistor (CUT = Ri). In this case the indicated value for voltage and current measurement must be nearly equal.

Program 5: Test of a complete measurement cycle (Pro5)

After indication of 'MEAS' the normal measurement cycle is performed. So it is not necessary to leave the test menu, if you want to have the normal measuring mode of the instrument. The measuring result is not indicated on the display.

Measuring range	Function	Progr. amplifier	I/V converter	Z range	Port D315 PA1 p.1	PA2 p.2	VIS p.3	IVC p.4	Φ p.14
any	inhibit			–	L	L	L	X	L
Gu 3	V, 0°	x10	–	<4Ω	H	H	H	L	L
	V,90°	x10	–		H	H	H	L	H
Gi 1	I, 0°	x.1	x1		H	L	L	L	L
	I, 90°	x.1	x1		H	L	L	L	H
Gu 2	V, 0°	x1	–	4Ω...40Ω	L	H	H	L	L
	V,90°	x1	–		L	H	H	L	H
Gi 1	I, 0°	x.1	x1		H	L	L	L	L
	I, 90°	x.1	x1		H	L	L	L	H
Gu 1	V, 0°	x.1	–	40Ω...4kΩ	H	L	H	L	L
	V,90°	x.1	–		H	L	H	L	H
Gi 1	I, 0°	x.1	x1		H	L	L	L	L
	I, 90°	x.1	x1		H	L	L	L	H
Gu 1	V, 0°	x.1	–	4k...40kΩ	H	L	H	L	L
	V,90°	x.1	–		H	L	H	L	H
Gi 2	I, 0°	x1	x1		L	H	L	L	L
	I, 90°	x1	x1		L	H	L	L	H
Gu 1	V, 0°	x.1	–	40k...400kΩ	H	L	H	L	L
	V,90°	x.1	–		H	L	H	L	H
Gi 3	I, 0°	x1	x10		L	H	L	H	L
	I, 90°	x1	x10		L	H	L	H	H
Gu 1	V, 0°	x.1	–	>400kΩ	H	L	H	L	L
	V,90°	x.1	–		H	L	H	L	H
Gi 4	I, 0°	x10	x10		H	H	L	H	L
	I, 90°	x10	x10		H	H	L	H	H

Fig. 11 Complete measuring ranges and measuring cycle, logic table port 1 of microprocessor D315

Program 6: Test of measurement range (Pro6)

In this test mode the reference (inhibit) measurement and the different gain settings of the voltage and current measurement can be checked.
The gain settings are archieved by the programmable amplifier D103, N104 and I/V converter D102, N110. The reference measurement is indicated by 'Gu 0', the different voltage ranges by 'Gu 1' to 'Gu 3' and the current ranges by 'Gi 1' to 'Gi 4'.

Indication	Voltage range	Indication	Current range
Gu 0	inhibit	Gi 1	–20 dB
Gu 1	–20 dB	Gi 2	0 dB
Gu 2	0 dB	Gi 3	+20 dB
Gu 3	+20 dB	Gi 4	+40 dB

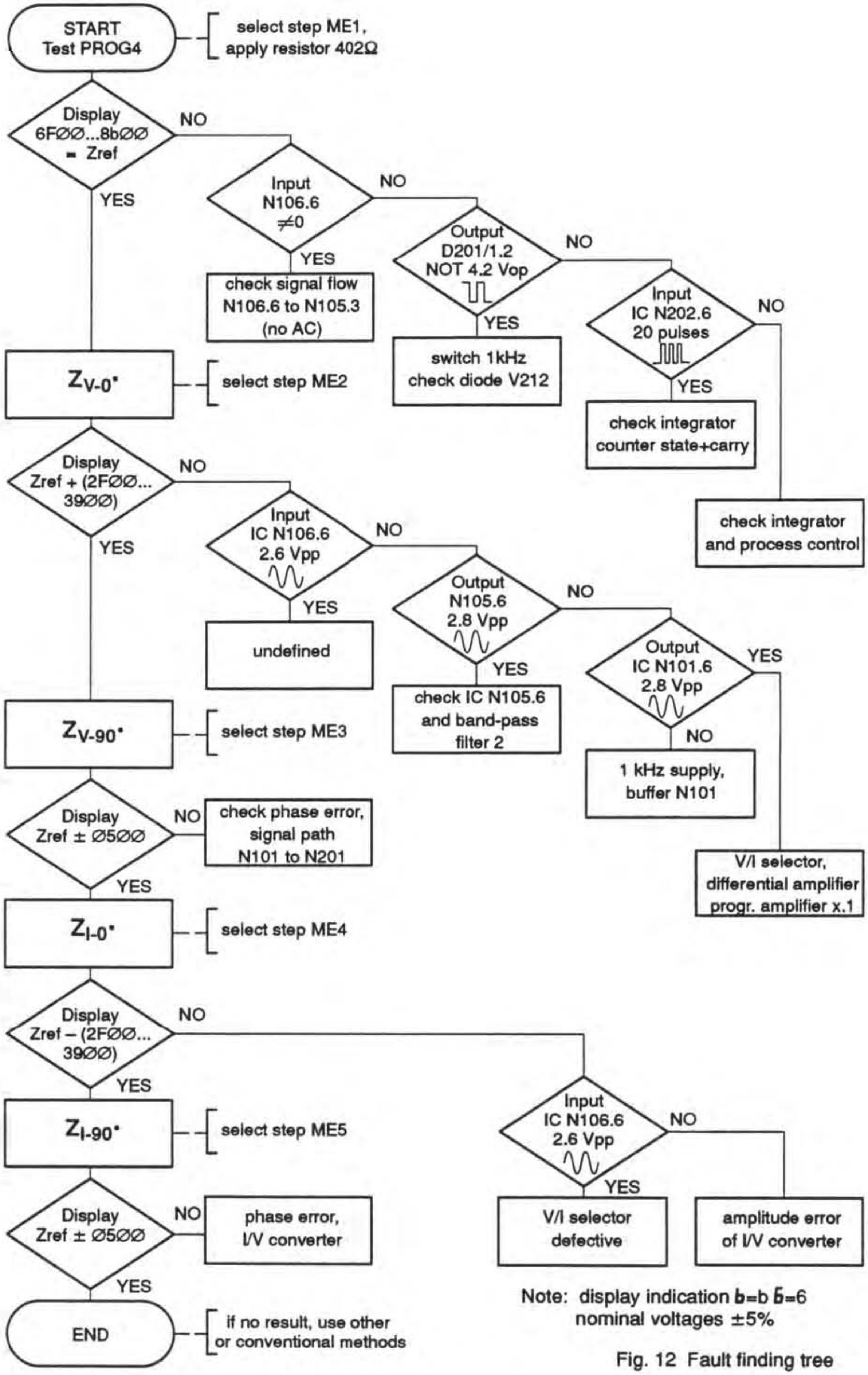
Procedure:

Select this test by pressing any key for a short time, when 'Pro6' is shown on the display. Now the display shows 'MEAS' for a short time followed by 'Gu 0'. Now you have the possibility, e.g. to check a stable and repeated signal at the output of the phase sensitive rectifier by an oscilloscope.
For checking the voltage ranges the measuring input should be short-circuited in a first step, in a second step apply resistors shown in the following table.
For the current ranges the measuring input should be open, in the second step resistors with the listed value should be applied. Deformation resp. over-driven signals point to faults in the analog path.
Furthermore the control signals of the microprocessor PA1, PA2, VIS and IVC can be checked. The control signal 'select Φ' can be checked by program 4.

Having passed the 40 dB current range 'Gi 4', this test is finished and returns to the sub-programs.

Indication/range	Gain setting voltage	Meas. input	Signal at D201 pin1	Input/CUT	Signal at D201 pin 1**	control signals D315 PA1 p.1	PA2 p.2	VIS p.3	IVC p.4	Φ p.14
Gu 0	inhibit		4.2V*	–		L	L	L	X	L
Gu 1		short circuit	4.2V*	open circuit	2.6±0.1V	H	L	H	L	L
Gu 2	0 dB			40.2 Ω		L	H	H	L	L
Gu 3	20 dB			3.9 Ω		H	H	H	L	L
	current gain									
Gi 1	–20 dB	open circuit	4.2V*	short circuit	2.6±0.1V	H	L	L	L	L
Gi 2	0 dB			4.02 kΩ		L	H	L	L	L
Gi 3	20 dB		*approx. value	40.2 kΩ		L	H	L	H	L
Gi 4	40 dB			402 kΩ		H	H	L	H	L

** connect oscilloscope; use probe 10:1, input impedance 1 MΩ



Note: display indication b=b 6=6
nominal voltages ±5%

Fig. 12 Fault finding tree

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7 DISASSEMBLING THE INSTRUMENT

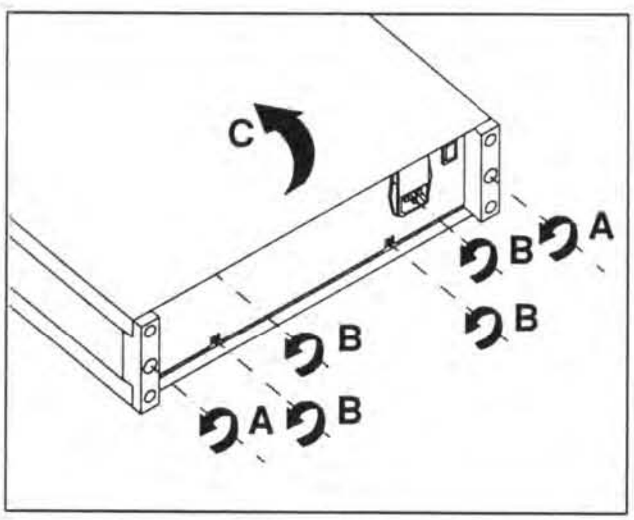
7.1 GENERAL INFORMATION

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.

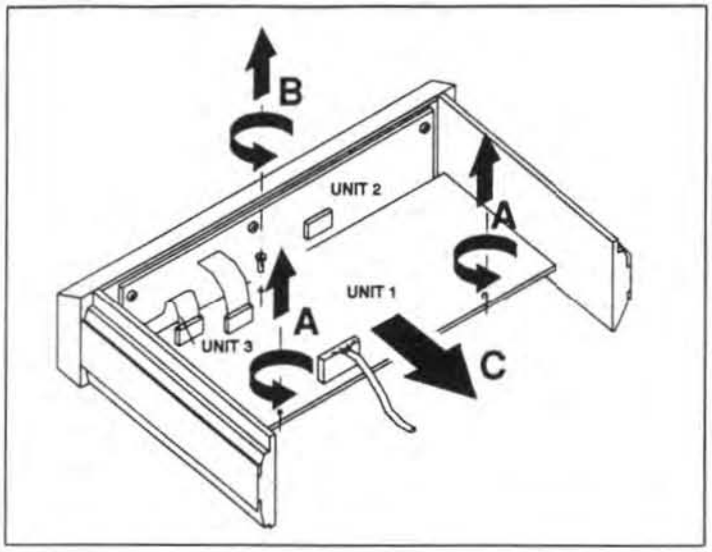
7.2 REMOVING THE COVERS

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.



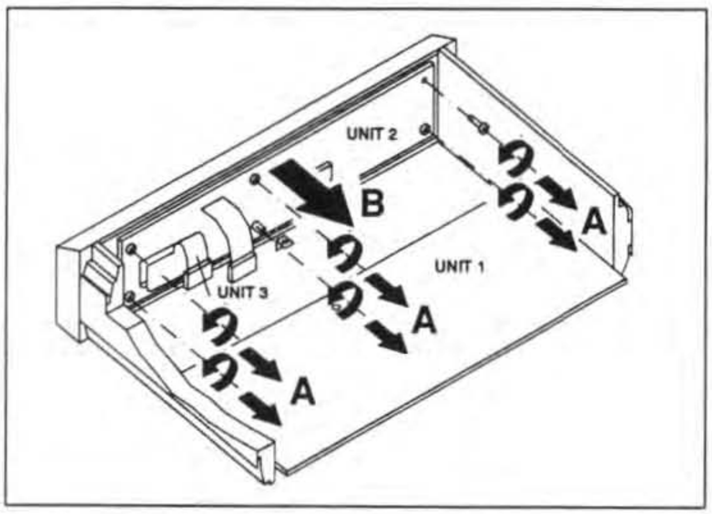
- Unscrew the two rear bumpers A.
- Loosen the four rear screws B.
- Remove top cover C and bottom cover.

7.3 UNIT 1



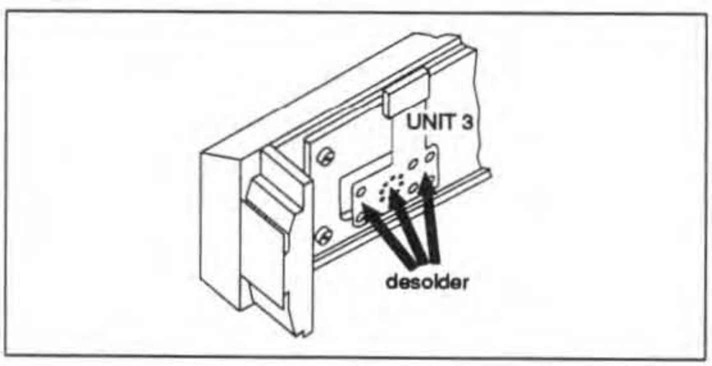
- Unplug plugs from unit 1.
- Unscrew the two distance nuts from the rear **A** and one screw from the central front **B** of unit 1.
- Move the unit with its holder slightly to the back **C**, shift the unit to the left and lift it off.

7.4 UNIT 2



- Move unit 1 to the back, see 7.3
- Unscrew six screws and the fixing angle **A**.
- Remove unit 2 **B**.
- Take note of the capacitor at the corner of the PCB

7.5 UNIT 3



- Move unit 1 to the back, see 7.3.
- Desolder solder tags of plugs.

7.6 TEXT PLATE

The text plate is an adhesive text foil which cannot be fitted again once you have removed it. Hook a small screwdriver behind the text foil and remove it carefully.

8 CHECKING AND ADJUSTING

8.1 GENERAL INFORMATION

This chapter provides the complete adjusting procedure for the instrument. As 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.

- Warming-up time under average conditions is 5 minutes
- Ambient temperature (23 ±1) °C
- Mains 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: The opening of covers or removal of parts, except those which can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement, maintenance or repair is done in the open instrument.
If afterwards any adjustment, maintenance or repair of the open instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may be charged even if the instrument has been separated from all voltage sources.

8.2 RECOMMENDED TEST EQUIPMENT

Voltmeter, ac and dc Fluke 8920A, PHILIPS PM 2535
Counter PHILIPS PM 6665
For the voltmeter and counter, no critical specification is required.

Two single test posts, red and black, code no. 5322 264 30184, are a standard accessory with every PM 6303A.

Set of **precision metal film resistors and capacitor**, code no. 5312 395 38004. This set can be ordered from PHILIPS, via Supply Centre Hamburg, or from Fluke.

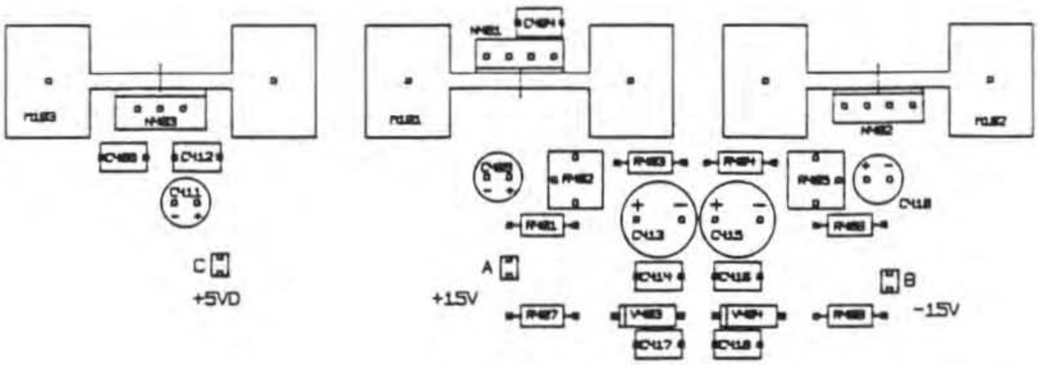
Type	Supplier	Value	Tolerance	Temp. coeff.
9960	Megatron	1 Ω	0.05 %	(5 ppm)
		(2 resistors soldered in parallel for 0.5 Ω)		
MPR24	Philips	34.8 Ω	0.02 %	25 ppm
MPR24	Philips	3.48 kΩ	0.02 %	25 ppm
MPR24	Philips	34.8 kΩ	0.02 %	25 ppm
RD70	Megatron	348 kΩ	0.025 %	25 ppm
RD 70	Megatron	1 MΩ	0.025 %	25 ppm
		(3 resistors soldered in series for 3 MΩ)		
CS006	Electronic	100 MΩ	1 %	100 ppm
53.20	Möricke	10 nF	see label on capacitor	40 ppm

If you use your own test components, the values of which are exactly known, the test result must be calculated accordingly (instrument tolerance is ±0.25 %, or ±6 % for 100 MΩ).

8.3 ADJUSTING PROCEDURE

8.3.1 Internal Supply Voltages

Remove top cover.
Connect voltmeter to ground and to the test points on unit 1.

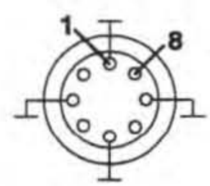


test	PM 6303A setting	adjusting element	test point	value to set	value min. to max.
A	AUTO	402	A	DC, +15 V	+14.98 to +15.02 V
B	AUTO	405	B	DC, –15 V	–14.98 to –15.02 V
C	AUTO	–	C	DC, +5 V	+4.75 to +5.25 V

8.3.2 Measurement Voltage

No component connected to PM 6303A.
Test equipment: voltmeter

Set the PM 6303A to AUTO and to DC BIAS OFF.
Contact voltmeter with tips between pin 8 and 1 of the round connector;
pin 8: +, also red frontpanel connectors +
pin 1: circuit ground potential, also pins 3, 5, 7
Test result: 1.8 to 2.2 V, rms



Set PM 6303A to DC BIAS ON
Test result: 1.8 to 2.2 V, dc

8.3.3 Measurement Frequency

Test equipment: counter

Press DC BIAS OFF.
Set counter to 1 s gate time.
Contact counter with tips between pin 8 and 1 of the round connector.
Test result: 999.75 to 1000.25 Hz

8.3.4 Open-Circuit Trimming

Insert the two single test posts into the two left positions.
Press Cp. Press TRIM.
Test result:
The display shows **BUSY PASS** and finally **0.0 pF**

Press Rp.
Test result:
The display shows overrange – – – – (flashing)

8.3.5 Short-Circuit Trimming

Short circuit the test posts by using a clean wire, with a minimum diameter of 1 mm.
Press Rs. Press TRIM.
Test result:
The display shows **BUSY PASS** and finally **0.000 Ω**

8.3.6 Resistor Measurement

Insert the two single test posts into the outer positions of PM 6303A.
Set the PM 6303A to AUTO.

For test 1 two resistors of 1 Ω are soldered in parallel.
For test 6 three resistors of 1 MΩ are soldered in series.

test	component value	component tolerance	test result
1	0.50 Ω	±0.05 %	0.449 to 0.501 Ω
2	34.8 Ω	±0.02 %	34.72 to 34.88 Ω
3	3.48 kΩ	±0.02 %	3.472 to 3.488 kΩ
4	34.8 kΩ	±0.02 %	34.72 to 34.88 kΩ
5	348 kΩ	±0.025 %	347.2 to 348.8 kΩ
6	3.00 MΩ	±0.025 %	2.993 to 3.007 MΩ
7	100 MΩ	±1 %	94 to 106 MΩ

8.3.7 Capacitance/Inductance Measurement

Due to the measurement principle it is only necessary to test the capacitance/inductance measurement by only one capacitor measurement.

test	component value	component tolerance	test result
8	10 nF	see label on capacitor	value on label ±0.25 %
Press DC BIAS ON.			
9	10 nF	see label	value on label ±0.25 %

8.3.8 Quality/Dissipation Factor, Phase angle

test	PM 6303A setting	component value	component tolerance	test results
10	Q	10 nF	not important	---- flashing display indicates overrange i.e., dissipation factor >500
11	D	10 nF	not important	0.000 ±1 digit
12	Φ	10 nF	not important	Φ = –89.8 to –90.0 DEG
13	D	10 nF parallel with 3.48 kΩ	see label 0.002%	D = 4.55 to 4.60 (for calculation of other values see section 3.2)

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

9.1 GENERAL DIRECTIVES

- Take care that creepage distance and clearances have not been reduced.
- Before soldering, wires should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

9.2 SAFETY COMPONENTS

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 10.3.

9.3 CHECKING THE PROTECTIVE EARTH 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 mains cable should be moved. Resistance variations indicate a defect.

9.4 CHECKING THE INSULATING RESISTANCE

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains 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).

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10 SPARE PARTS

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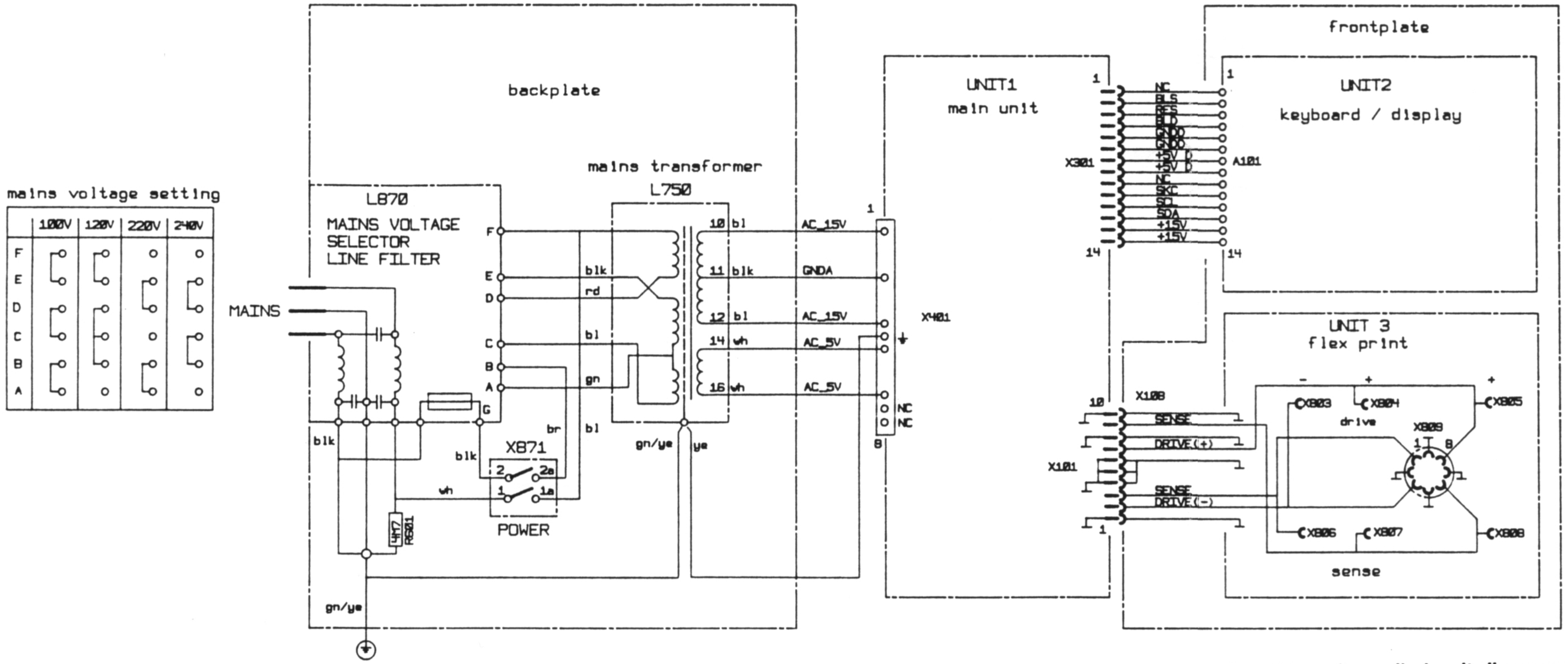

Fig. 51 Overall circuit diagram

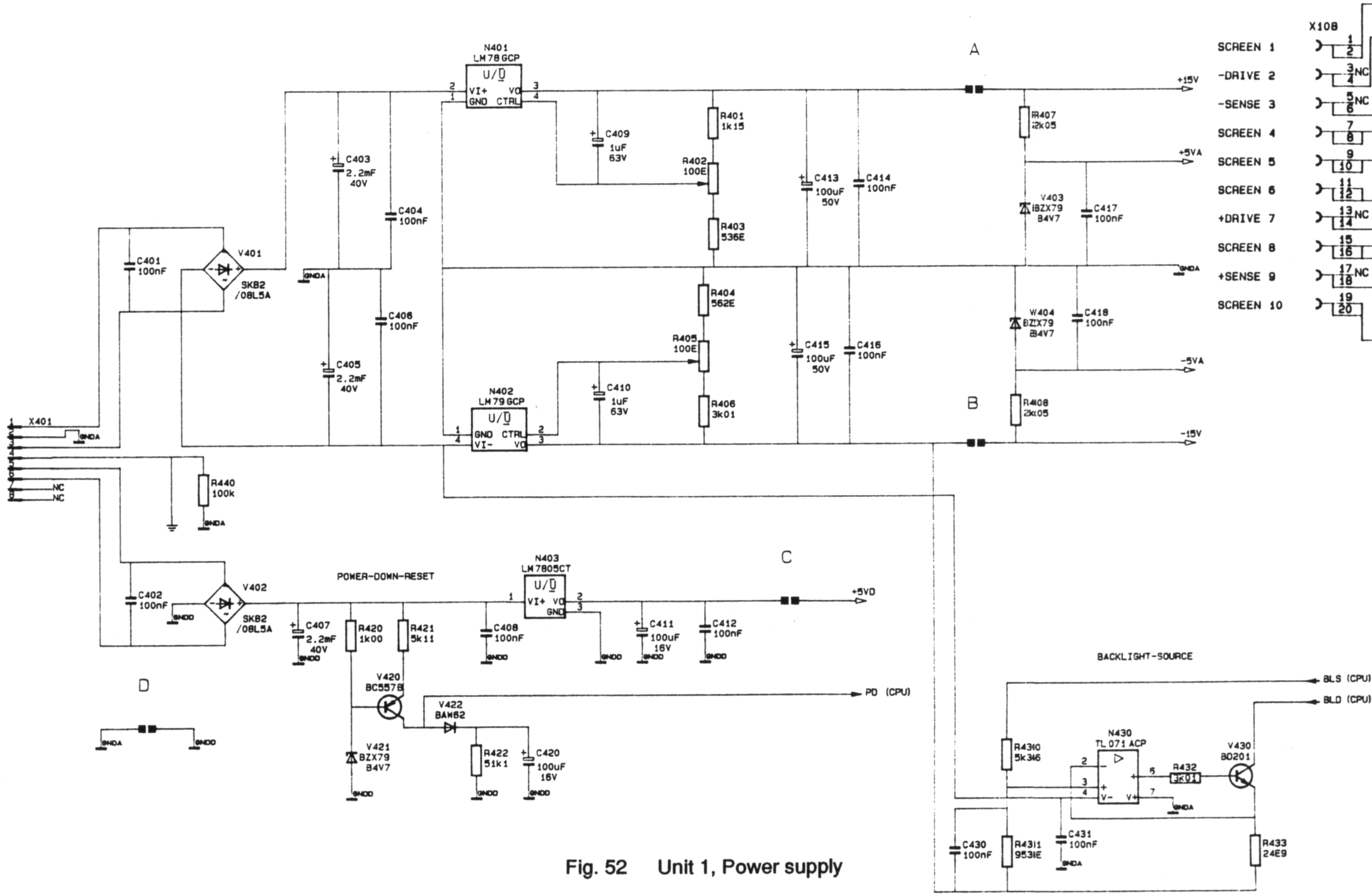

Fig. 52 Unit 1, Power supply

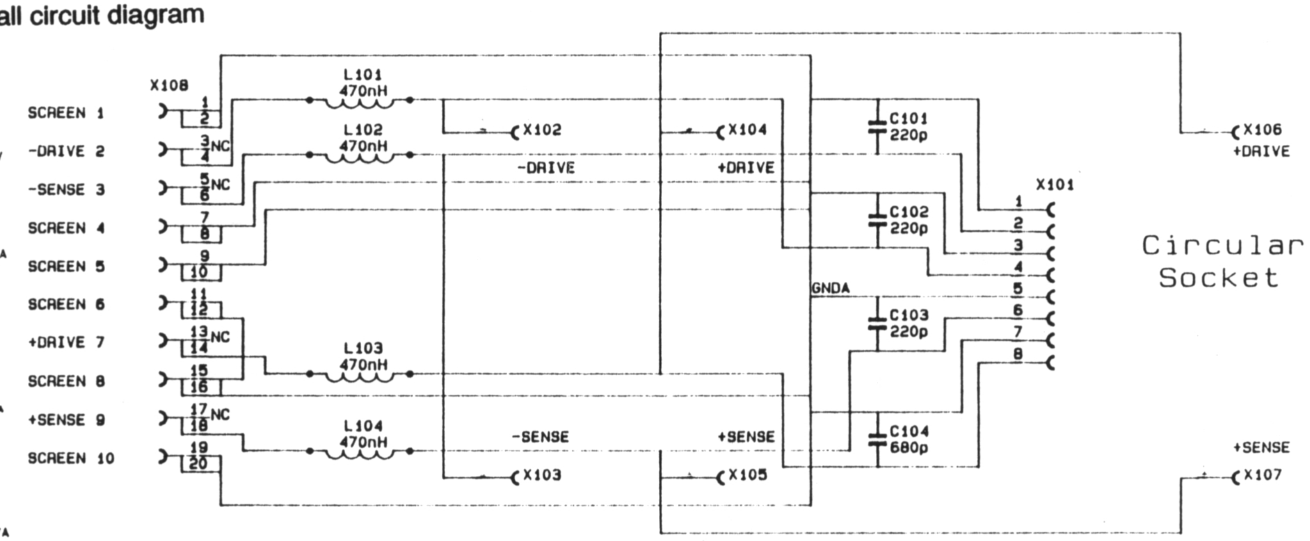

Fig. 53 Unit 3, Flex print

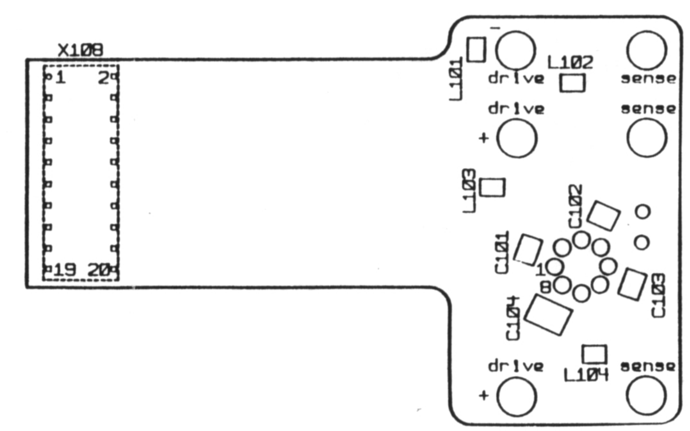

Fig. 54 Unit 3, Flex print; component lay–out

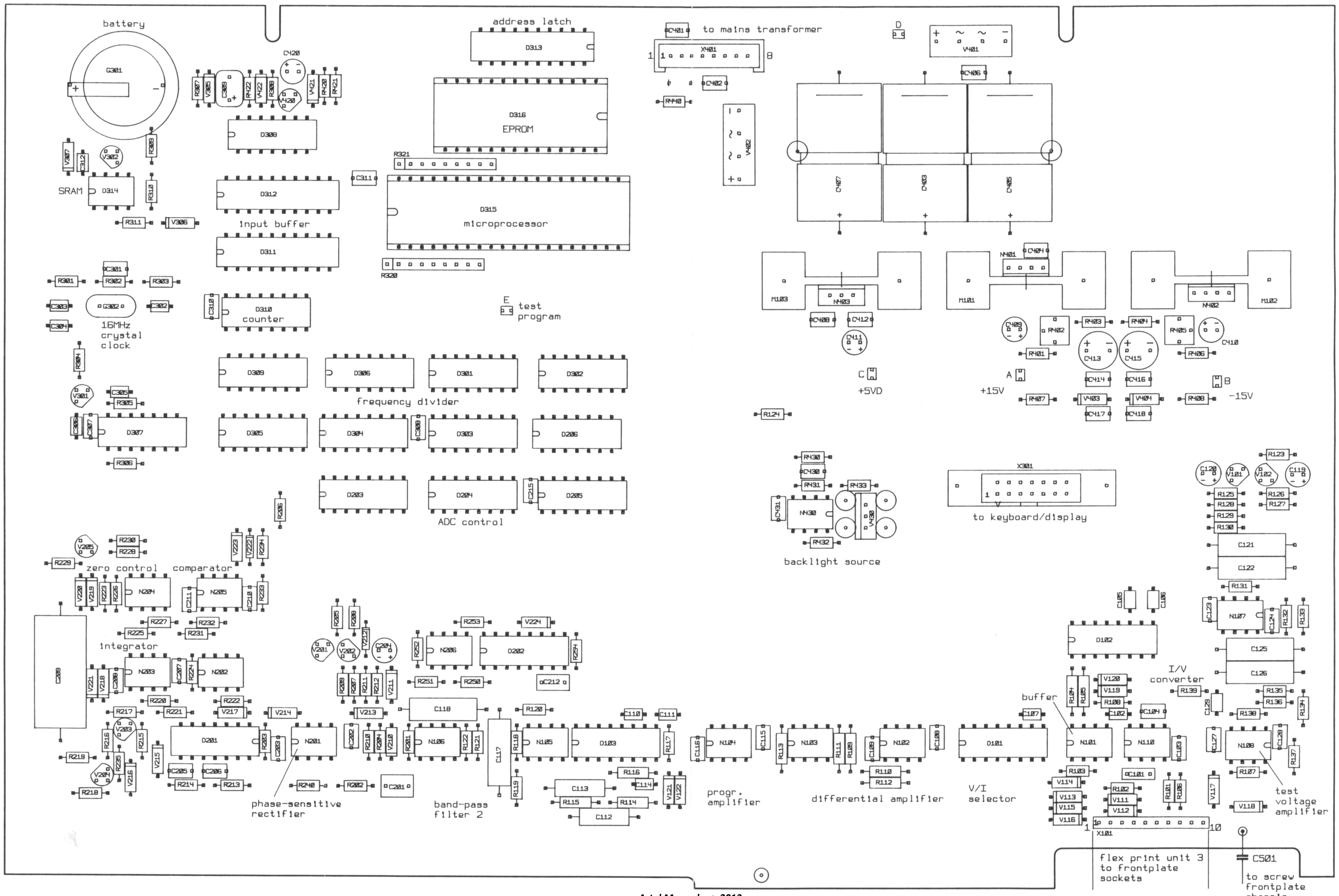

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Fig. 55 Unit 1, Component lay-out

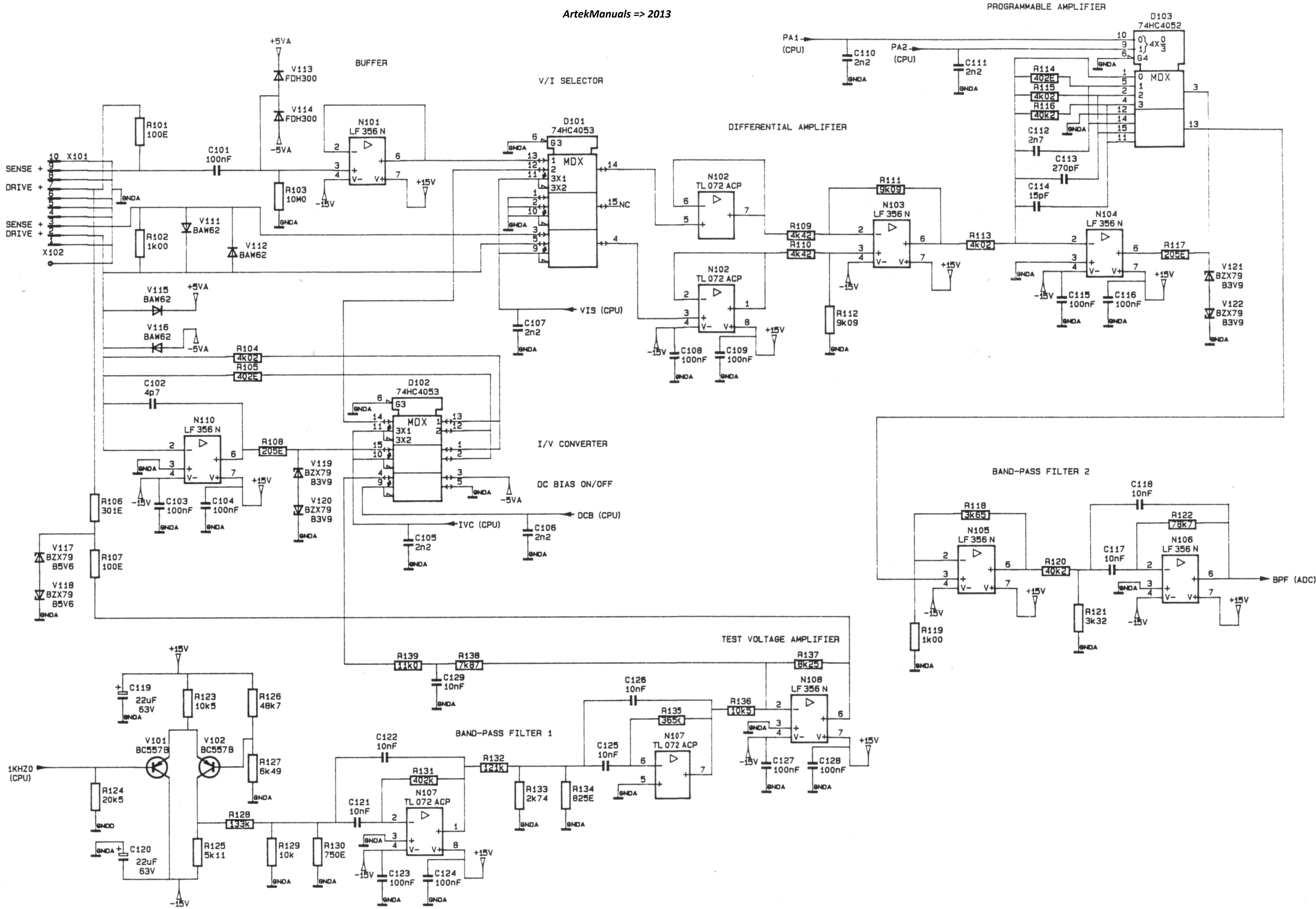

Fig. 56 Unit 1, Input circuit and amplifiers

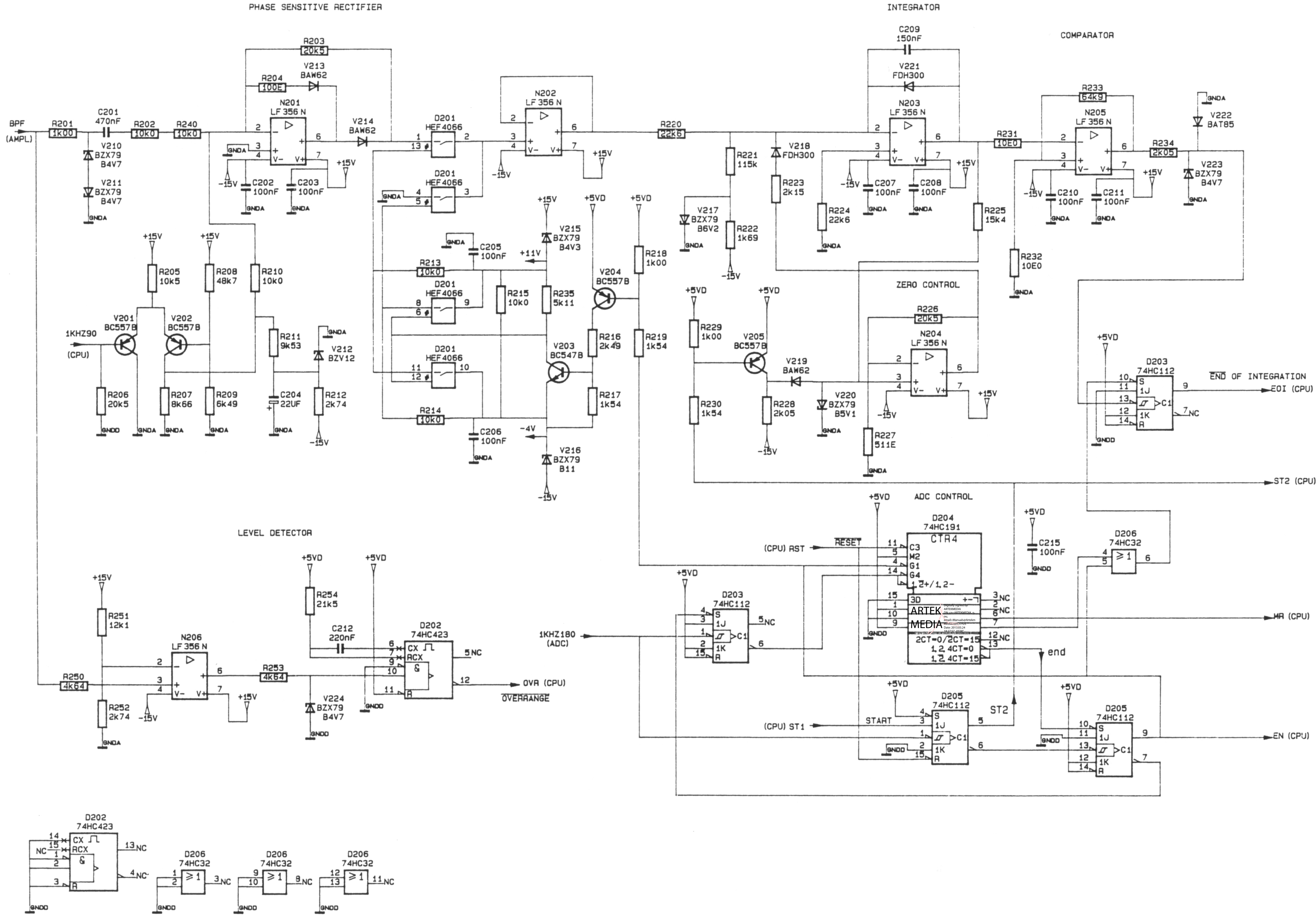

Fig. 57 Unit 1, Analog to digital converter

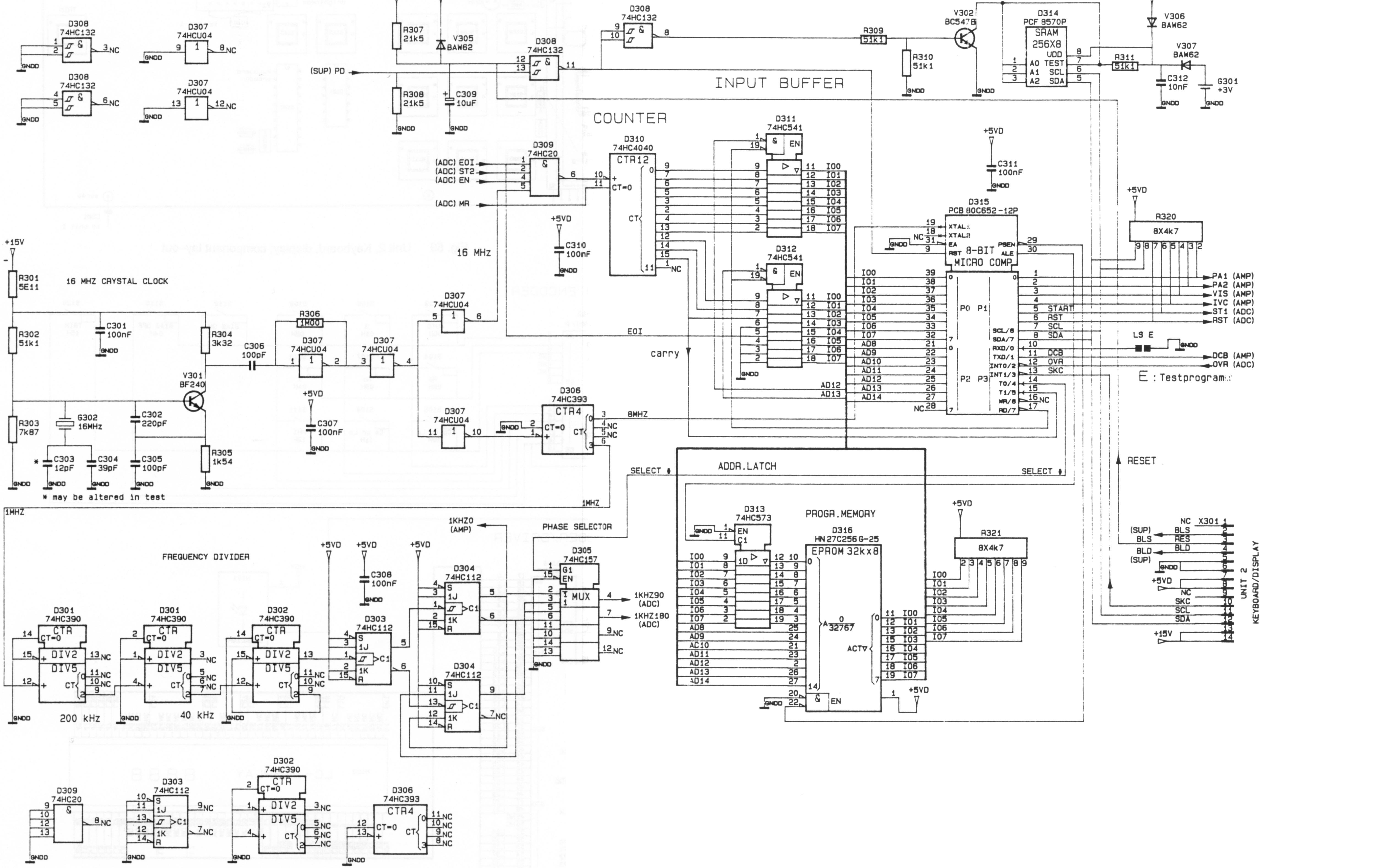

Fig. 58 Unit 1, Frequency generation, CPU, counter

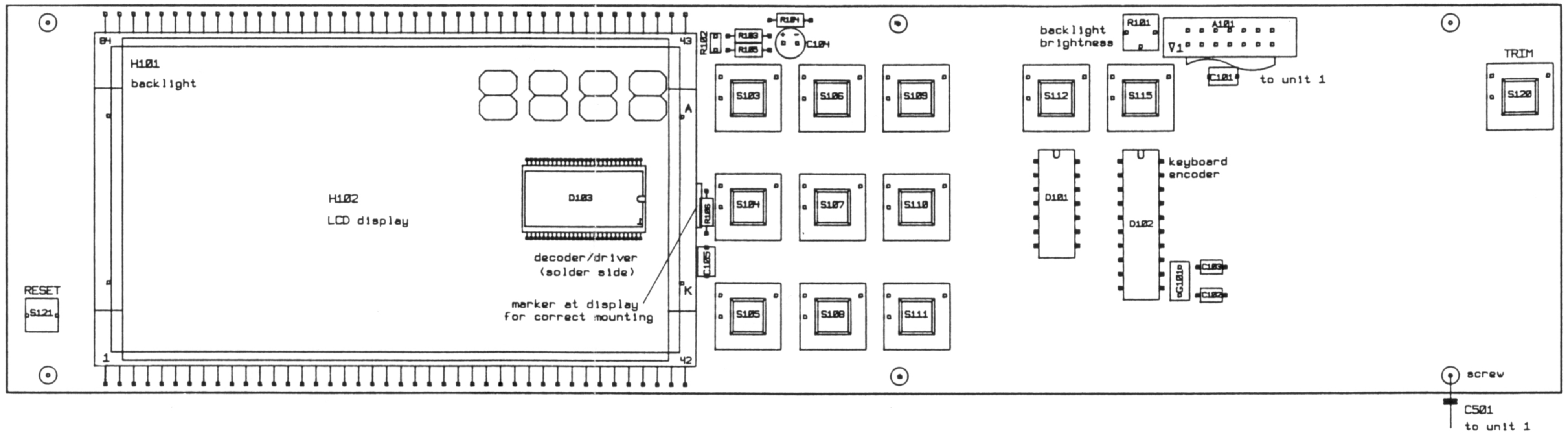

Fig. 59 Unit 2, Keyboard, display; component lay–out

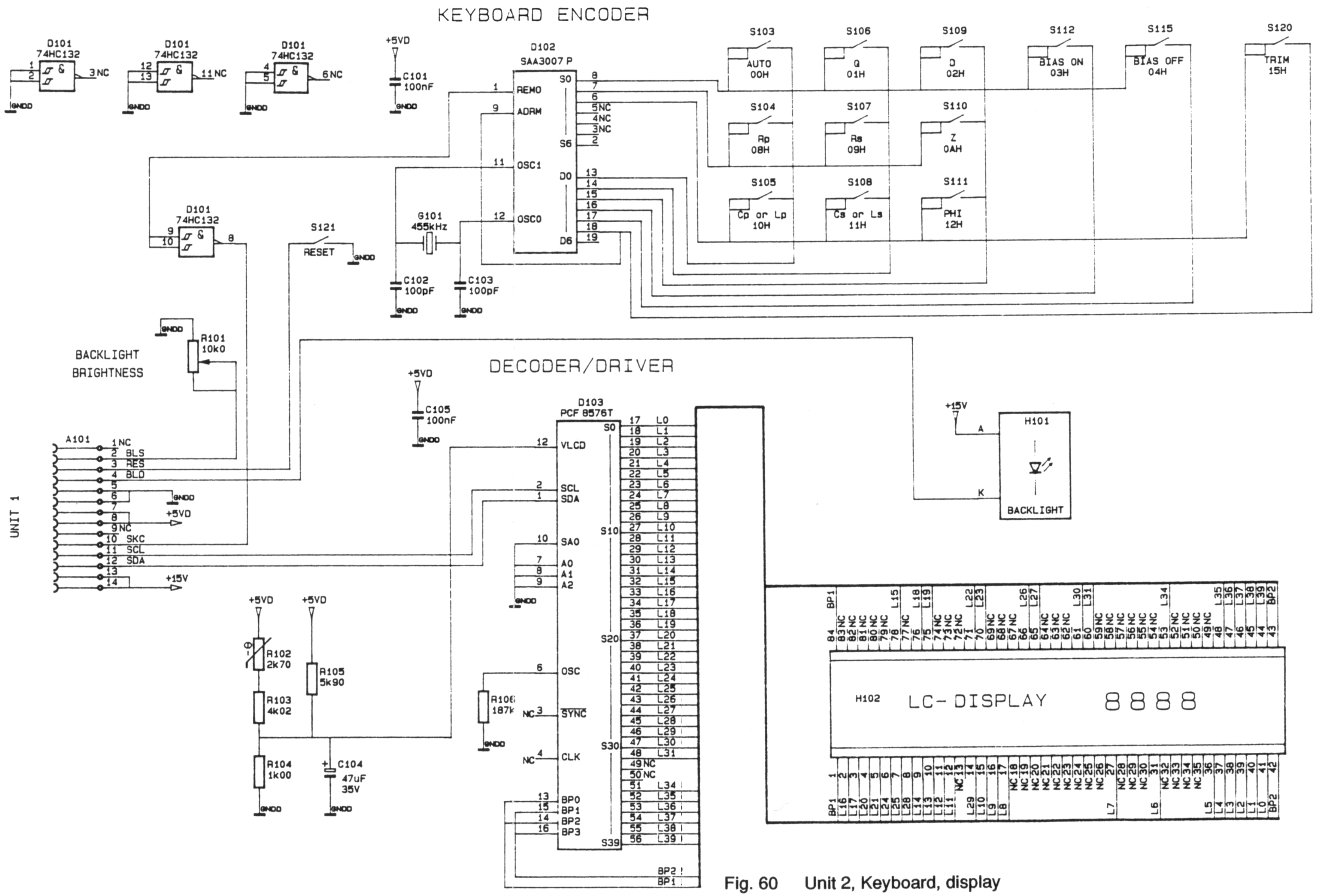

Fig. 60 Unit 2, Keyboard, display

PM 9541A

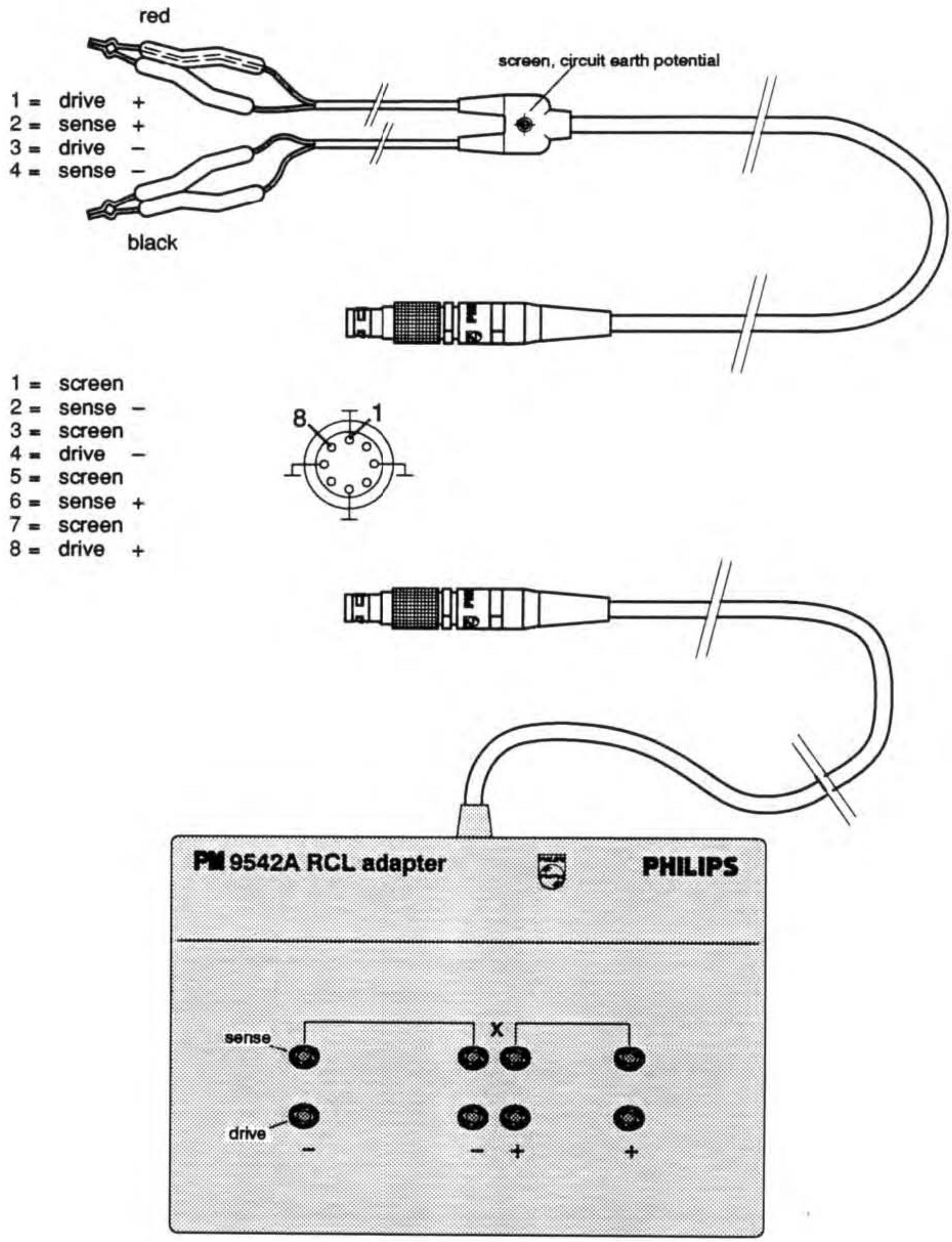

Fig. 61 Accessories PM 9541A, PM 9542A