

PHILIPS





PHILIPS

Manual

L-C METER

PM 6305

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IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate at the back of the instrument.

GENERAL

I. INTRODUCTION

L-C meter PM 6305 serves for measuring inductances up to 1000 μH and capacitances up to 1000 pF. An incorporated measuring instrument enables direct reading of the measuring result. The meter immediately responds to slow reactance variations. For each measuring range a separate easy-to-read scale has been provided; the measuring ranges are divided according to a $1/3$ division. One side of the test object (the reactance) may remain connected to chassis potential.

On a separate output a guard voltage is available, by means of which the effects of parasitic capacitances - such as stray capacitances, shunt capacitances etc. - can be eliminated (in situ measurements).

As the measurements are carried out at a high frequency, the measuring process is restricted to those reactance (reactive impedances), as occur in practice in HF circuitry.

II. TECHNICAL DATA

Properties expressed in numerical values with statement of tolerances are guaranteed by the factory. Numerical values without tolerances are intended for information purposes only and indicate the properties of an average instrument. The numerical values apply to nominal mains voltages unless otherwise stated.

Warming-up time at constant ambient temperature: 30 minutes.

A. ELECTRICAL DATA

1. Measuring ranges

- | | |
|--|---|
| a. Inductance L | 0...1000 μ H in 6 ranges
0...3 μ H; 10; 30; 100; 300; 1000 |
| b. Capacitance C | 0...1000 pF in 6 ranges
0...3 pF; 10; 30; 100; 300; 1000 |
| c. Connection for test object | BNC-socket (proof against long-term short-circuits) |
| No-load voltage | 9 V p-p |
| Measuring frequency | 100 kHz - 80 kHz |
| d. Additional lead capacitance in the case of C measurements that can be compensated | 0 - 80 pF |

2. Measuring accuracy

- | | |
|--------------------------------------|---|
| a. Measuring error for L-measurement | $\leq \pm 3 \%$ of fsd $\pm 0.1 \mu$ H |
| typically | $\leq \pm 2 \%$ of fsd $\pm 0.1 \mu$ H
at all measuring ranges |
| b. Measuring error for C-measurement | $\leq \pm 3 \%$ of fsd ± 0.1 pF |
| typically | $\leq \pm 2 \%$ of fsd ± 0.1 pF
at all measuring ranges |

- c. Additional error due to temperature variations $0.15 \% / ^\circ\text{C}$
- d. Error due to mains voltage variations $\pm 0.1 \mu\text{H}$ or $\pm 0.1 \text{ pF}$ for nominal range (190 - 265 V), with respect to 220 V
- 3. Guard voltage for compensation of stray capacitances
Voltage and phase same as of test object
- Error in the case of
 - 100 pF load $< + 0.2 \text{ pF}$
 - 200 pF load $< + 0.4 \text{ pF}$

4. Ambient conditions

- a. Reference temperature $23 ^\circ\text{C}$
- b. Nominal temperature range $5...35 ^\circ\text{C}$
- c. Operating temperature limits $0...45 ^\circ\text{C}$
- d. Temperature limits for storage and transportation $-25...+70 ^\circ\text{C}$

5. Power supply

- a. Mains voltage 190-265 V/95-132 V, can be changed over
- b. Mains frequency 48-100 Hz
- c. Power consumption 2 VA

B. MECHANICAL DATA

Width	158 mm
Height	191 mm
Depth	415 mm
Weight	3.3 kg

III. ACCESSORIES

A. SUPPLIED

- 1 Mains lead, length 1.8 m
- 1 Manual

B. OPTIONAL

- PM 9051 (adapter from BNC to 4-mm socket terminals)

IV. DESCRIPTION OF THE BLOCK DIAGRAM (Fig. 1)

The measuring circuit comprises an L-C oscillator I. A second oscillator III supplies a fixed reference frequency of 100 kHz. The resonant frequency of variable oscillator I is changed by the reactance connected to CD1. The measuring value is derived from a different frequency formed in mixer stage V. Between the variable oscillator I and the fixed oscillator II emitter follower stages II and V have been included for impedance matching.

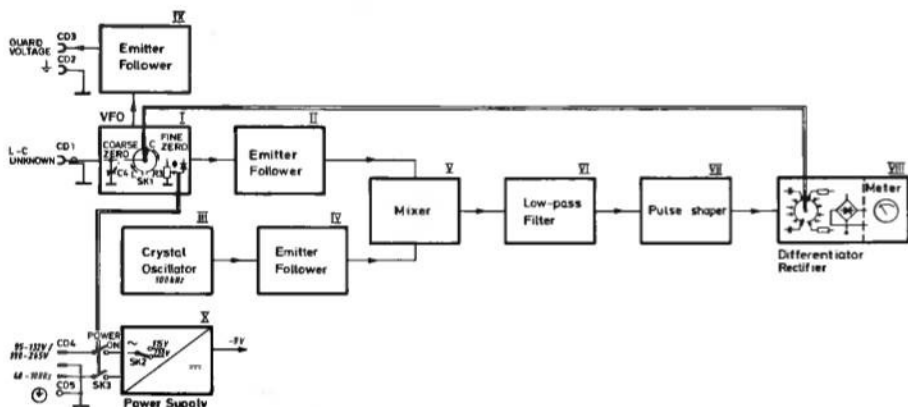


Fig. 1. Block diagram

PEM4018

The lower difference frequency passes low-pass filter VI and controls pulse-shaper VII, which supplies squarewave pulses to the differentiation, rectifying and indicating section VIII in the rhythm of the difference frequency. By means of switch SK1 the input is switched over to L or C operation and in the indicator section the measuring range is selected.

Direct reading of the measuring result is possible on the indicating instrument.

For special measurements a double emitter follower IX supplies a guard voltage to sockets CD2/CD3; amplitude and phase of this voltage are the same as at the test object

on socket CD1. In the case of C-measurements the non-used electrodes of a capacitive test object can be connected to socket CD3. As a result the capacitive effect on the electrodes used for the measurement is eliminated. The supply voltage is delivered by stabilised supply section K.

DIRECTIONS FOR USE

V. CONNECTION AND PUTTING INTO OPERATION

A. INSTALLATION

When installing the L-C meter no special measures are required. With the aid of the bracket at the bottom the instrument can be tilted backward.

B. CONNECTION TO THE MAINS

Upon delivery the instrument is suitable for connection to 230 V a.c. mains. However, if the instrument should be connected to 95-132 V mains, the mains voltage adapter should be set to 115 V:

- Slightly loosen the fixing screw below the mains voltage indication hole at the rear of the instrument
- Slide the loosened screw upwards in the slot, until the indication 115 V is visible through the opening
- Secure the screw

C. EARTHING

If the L-C meter is connected to a socket with rim earthing contacts by means of the mains lead, the outer jacket of the BNC socket (L-C UNKNOWN), the left-hand terminal \perp for the guard voltage and terminal screw \oplus at the rear of the instrument will have the same potential as the neutral conductor.

When the instrument is connected to a socket without rim earthing contacts, it should be earthed via screw terminal \oplus at the rear.

For measurements on capacitances or inductances which form

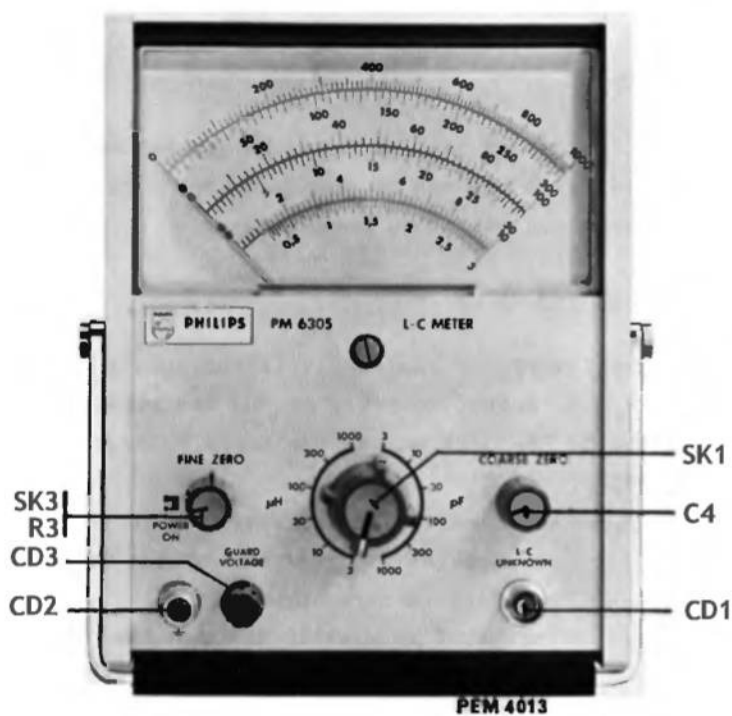


Fig. 2. Front View





part of an earthed circuit, the earthing of this circuit should be removed, in order to prevent earthing loops and, consequently, erroneous measuring results.

D. COUPLING THE PM 6305 WITH OTHER UNITS

L-C meter PM 6305 can be mechanically coupled to other units of the PHILIPS modular system in a very simple way.

For this reference is made to the manual of the instrument to which the PM 6305 is to be coupled and/or data sheet EM2-B35.

E. CONTROLS, SOCKETS AND TERMINALS (Fig. 2)

Control, socket or terminal	Description	Purpose
SK3	POWER ON	Mains switch with pilot lamp
CD1	L-C UNKNOWN	Connection of test object
CD2		Guard voltage output
CD3	GUARD VOLTAGE } 	
C4	COARSE ZERO	
		Coarse control for zero setting of the L-C meter. If required, the capacitance of the measuring lead (0...80 pF) can also be compensated by means of this control
R3	FINE ZERO	Fine control for zero setting of the L-C meter
SK1	$\mu\text{H} - \text{pF}$	Switch for selection of C/L measurements and measuring ranges
SK2 (Rear)	115V/230 V	Mains voltage adapter (slide switch)
CD4 (Rear)		Mains input socket
CD5 (Rear)		Terminal screw for earthing

VI. OPERATION

The following measurements can be carried out:

- Small capacitance values (fsd 3 pF)
- Electrode capacitance of electron valves, with and without compensation
- Capacitance of 3 and multi-core cables, the parasitic capacitance of other cores being eliminated
- Specific cable and wiring capacitances
- Capacitance values of piezo-electric and capacitor microphone inserts
- Input and output capacitances of electrical circuits
- Small inductance values (fsd 3 μ H)
- Cable and wiring inductances with short-circuited output
- Inductance values of dynamic microphones and magnetic dynamic pick up heads

1. Capacitance measurements

- Connect adapter PM 9051 to measuring socket "L-C UNKNOWN"
- Connect one side of the test object to the earthing terminal
- Set the range selector to position "300 pF"
- Set knob "FINE ZERO" to mid-position
- Set the meter to zero with "COARSE ZERO"
- Set the range selector to position "3 pF"
- Correct the zero setting with "FINE ZERO"
- Set the range selector to position "1000 pF"
- Connect the test object to the second terminal
- Turn the range selector from position "1000 pF" anti-clockwise until a clear reading is obtained
- Read the measuring result on the corresponding scale
(end-scale value and selected measuring range correspond)

2. Capacitance measurement with elimination of stray capacitances

- Connect adapter PM 9051 to socket "L-C UNKNOWN"
- Connect one side of the test object to the earthing terminal
- Set the range selector to position "300 pF"
- Set knob "FINE ZERO" to mid-position
- Set the meter to zero by means of "COARSE ZERO"
- Set the range selector to position "3 pF"
- Correct the zero setting with "FINE ZERO"
- Connect the terminal(s) of the element(s) whose capacitance is to be excluded from the measurement to socket "GUARD VOLTAGE"
- Correct the zero setting again
- Set the range selector to position "1000 pF"
- Connect the "hot" electrode to the input
- Turn the range selector from position "1000 pF" anti-clockwise until a clear reading is obtained
- Read the measuring result from the relevant scale (full-scale value and selected measuring range correspond)

In this mode it is possible to carry out accurate capacitance measurements for various capacitive arrangements with 3 or more connections, such as

- Electron valves
- Specific cable capacitances between two cores under elimination of the capacitive effect of other cores or screenings
- Capacitance of difference amplifier inputs (caution! The voltage applied to the test object is approximately 9 V_{p-p} at a frequency of 80...100 kHz)

3. Inductance measurements

- Connect adapter PM 9051 to socket "L-C UNKNOWN"
- Set the range selector to position "3 μ H"
- Short-circuit socket "L-C UNKNOWN" direct
- Adjust the zero setting with "FINE ZERO"

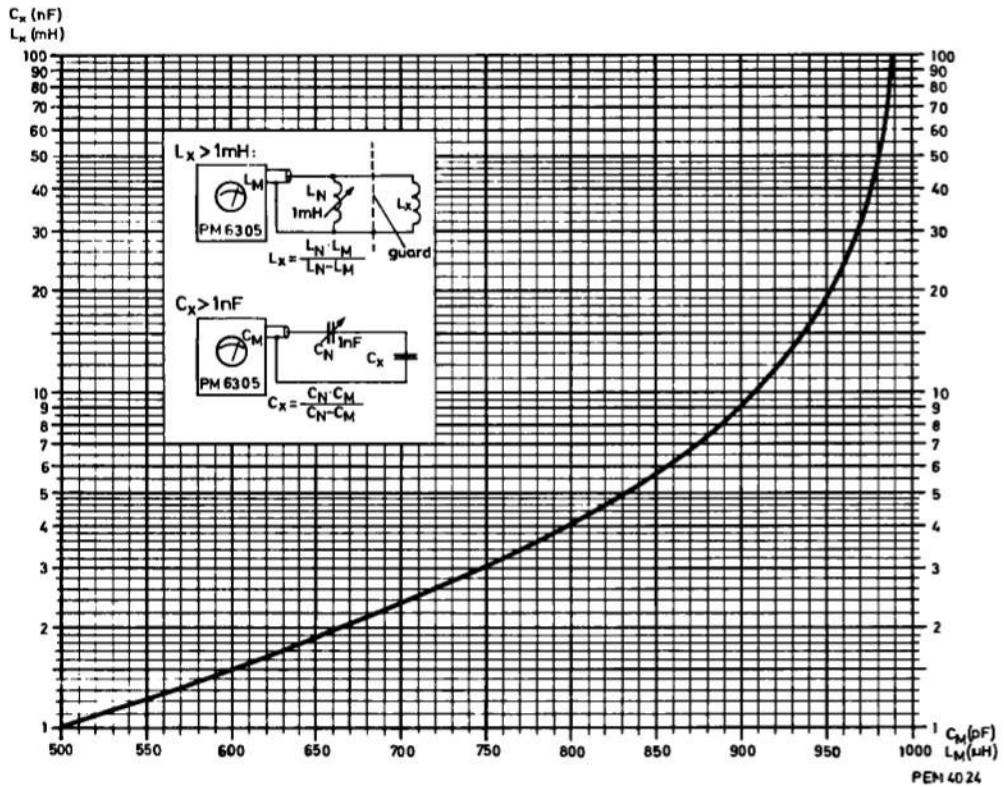


Fig. 3. Graph for extending the measuring range

- Set the range selector to position "1000 μ H"
- Remove the short-circuit
- Connect both sides of the test object to the input
- Turn the range selector from position "1000 μ H" anti-clockwise until a clear reading is obtained
- Read the measuring result from the corresponding scale (full-scale value and selected measuring range correspond)

4. Measuring reactance values which are higher than the highest measuring ranges

It is possible to measure capacitances or inductances >1000 pF or >1000 μ H by series or parallel connection with a known reactance. The maximum value of the known reactance should not exceed 1000 pF in the case of C-measurements and 1000 μ H in the case of L-measurements. For L-measurements it should moreover be observed that the parallel-connected inductances are not coupled to each other.

- In the case of C-measurements connect the known capacitance in series with the unknown capacitance. If one side of the unknown capacitance, which should be >1000 pF, is connected to chassis, the known capacitance should be included between the "hot" electrode of the unknown capacitance and terminal "L-C UNKNOWN".
- For the measurement proceed as described under VI-1
- For establishing the capacitance C_x the following calculation should be made:

$$C_x = \frac{C_M C_N}{C_N - C_M} \quad \begin{array}{l} C_M = \text{value measured} \\ C_N = \text{known series capacitance} \end{array}$$

If C_N is 1 nF, Fig. 3 can be employed for establishing the value of C_x

- In the case of L-measurements connect the known inductance in parallel with the unknown inductance; ensure that there is no coupling between the two inductances
- Further proceed as described under VI-3
- For establishing the inductance value L_x the following

calculation should be made:

$$L_x = \frac{L_M L_N}{L_N - L_M} \quad \begin{array}{l} L_M = \text{value measured} \\ L_N = \text{known parallel inductance} \end{array}$$

When L_N is 1 mH, Fig. 3 can be used for establishing the value of L_x

When measuring inductances in the order of magnitude of 20 mH and higher, resonance may occur due to self-capacitance.

5. In-circuit measurements of reactances wired in the circuits

- Remove adapter PM 9051
- Connect the measuring lead with adapter PM 9051 or without adapter (Fig. 4b and 4a resp.) to "L-C UNKNOWN" (the measuring lead is not included in delivery).
The cable of Fig. 4a is available at Central Service under code number 4822 321 20094
- Briefly connect the earthing connection of the measuring lead to the casing of the test object

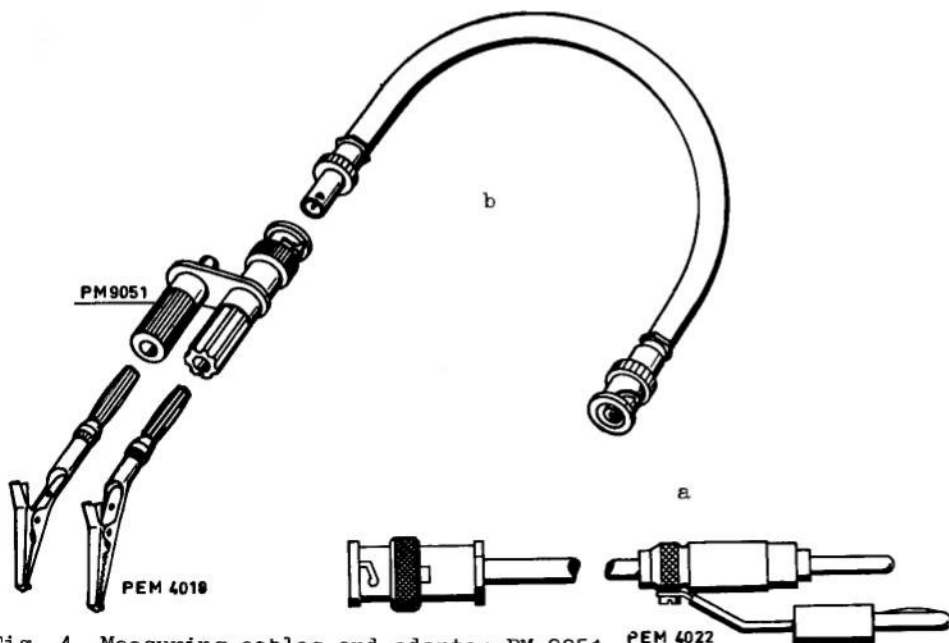


Fig. 4. Measuring cables and adapter PM 9051

- Unsolder the "hot" connection of the reactance; the other side need not be unsoldered
- Move the centre connection of the measuring lead towards the "hot" connection of the reactance
- Effect zero setting according to VI-1 or VI-3, not moving the measuring lead
- Connect the measuring lead to the "hot" connection of the test object
- Starting from position "1000 pF" or "1000 μ H" select the correct measuring range. Do not move the measuring lead
- Read the measuring result from the relevant scale
- Re-solder the "hot" connection of the reactance into circuit again

6. Measuring the input and output capacitance of electrical circuits

Caution!

The voltage applied to the test object is approx. 9 V_{p-p} at a frequency of 80...100 kHz; this may give rise to overloading, e.g. in the case of cathode follower measuring probes and amplifier inputs without attenuator.

a. Inputs

- Adjust the zero setting according to VI-1
 - Connect the input of the instrument under test to "L-C UNKNOWN"
 - Set the range selector to the appropriate measuring range, starting from position "1000 pF"
 - Read the measuring result on the appropriate scale
- It is, for example, possible to measure the input capacitance in the case of passive measuring probes and attenuators of the capacitive or ohmic type

b. Outputs

- Adjust the zero setting according to VI-1
- Connect the output of the instrument under test to

"L-C UNKNOWN"

- Set the range selector to the appropriate measuring range, starting from position "1000 pF"
- Read the measuring result on the relevant scale

When measuring output capacitances the risk of overloading is negligible. However, the value of the output impedance should be taken into account. Especially low ohmic outputs will strongly damp the output reactance, so that the measurement cannot be carried out when the amplifier circuits are in operation. Output capacitances of passive networks, whose reactive components are dominant at frequencies from 80...100 kHz, however, can be measured without any further measures.

SERVICE DATA

VII. CIRCUIT DESCRIPTION (Fig.18)

The instrument consists of the following units:

- A. Variable oscillator
- B. Emitter follower
- C. Crystal oscillator
- D. Emitter follower
- E. Mixer stage
- F. Low-pass filter
- G. Pulse shaper
- H. Differentiation, rectifying and indicating section
- J. Emitter follower
- K. Supply section

A. VARIABLE OSCILLATOR (Fig. 5)

The oscillator with TS5 is of the Colpitts type. The parallel resonant circuit is formed by the inductance S1 of coil L1 and the capacitance formed by series circuit C17, C18//C3, C4, C33. From the emitter output HF energy with the same phase is fed back via voltage divider C17/C18; as a result self-excitation occurs. The selected HF energy is applied to the base of the transistor via C16.

When the input terminals are open the resonant frequency of the a fore-mentioned resonant circuit is varied by means of capacitor C33 so that it corresponds to the frequency of the fixed oscillator.

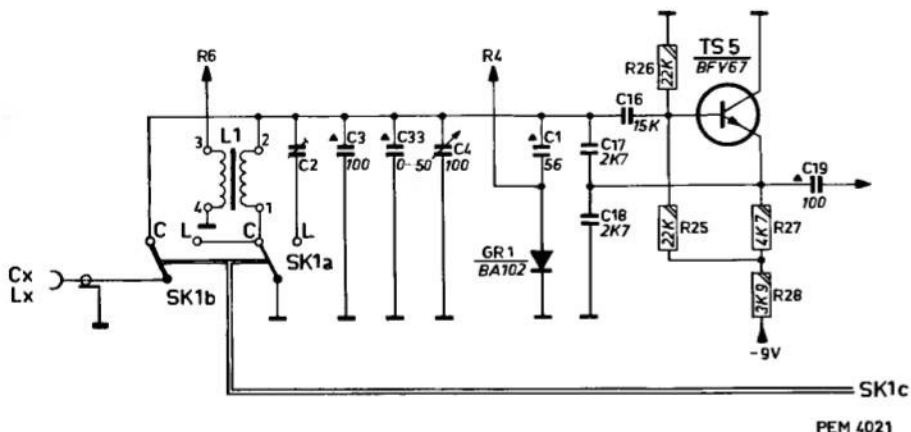


Fig. 5. Variable oscillator

Dependent on the switch position shown in Fig. 5, an externally connected capacitance C_x detunes the resonant circuit towards the lower frequencies.

Variable capacitor C_4 permits of eliminating the connecting lead capacitance (calibration, COARSE); this applies to C-measurements and to certain L-measurements.

Fine adjustment of the variable oscillator is effected by means of capacitance diode GR1 in conjunction with capacitor C_1 . For this purpose a voltage, adjustable with R_3 , is taken from temperature-compensated voltage divider $R_2/R_3/R_1$. This voltage is applied to the capacitance diode in the reverse direction. The resulting, slight capacitance variation influences the resonant frequency of the resonant circuit via C_1 .

By means of switch SK1 the resonant circuit of the variable oscillator is changed over from the C-mode to the L-mode. The unknown inductance L_x is connected in series with resonant-circuit inductance S1 of coil L1. Thus it is achieved that detuning in the case of L-operation takes place in the same direction as in the case of C-operation. C2, which is switched in during L-operation, serves for basic adjustment in the case of inductance measurements.

B. EMITTER FOLLOWER

The emitter follower with TS6 serves for impedance matching of the variable oscillator and mixer transistor TS7. The base voltage divider is relatively high ohmic so that it exerts minimum damping on the resonant circuit.

C. CRYSTAL OSCILLATOR

The fixed oscillator with TS10 is quartz-controlled, its resonant frequency is 100 kHz.

D. EMITTER FOLLOWER

Emitter follower TS9 is arranged in the same way as emitter follower TS6. This emitter follower ensures that the HF energy is taken from the base circuit of the crystal oscillator (100 kHz) with minimum feed-back and is applied to mixer transistor TS8 via a low impedance. Consequently the mixer stage is voltage controlled at both inputs (the control source resistance (R_i) is very small with respect to the load resistances).

E. MIXER STAGE

The mixer stage with TS7 and TS8 operates as a balanced modulator. This circuit ensures sufficient carrier suppression. The frequency of the variable oscillator f_2 is present at the base of TS7 and the frequency of the fixed oscillator f_1 at the base of TS8; at the output the two sideband

frequencies arise, viz. $f_1 + f_2$ and $f_1 - f_2$. The following π -filter C21/L2/C22 suppressed the upper sideband $f_1 + f_2$ (low-pass filter). The symmetry can be adjusted with R34.

F. LOW-PASS FILTER

This filter is a π -network; its characteristic impedance is approx. $2.5\text{ k}\Omega$. The cross-over frequency is approx. 70 kHz.

G. PULSE SHAPER

The stage with TS3 and TS4 serves as pulse shaper. The sine-wave frequency at the output of the low-pass filter is converted into squarewave pulses, whose repetition time corresponds to the period time of the sinewave voltages. On the load resistor of the Schmitt trigger R16 the control voltage arises for the following rectifier circuit.

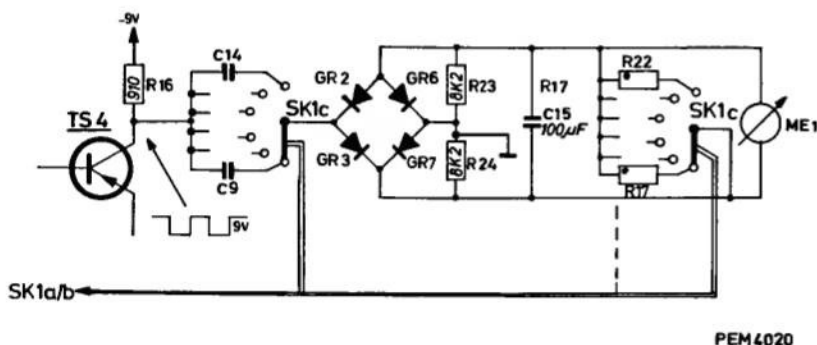


Fig. 6. Differentiation, rectifying and indicating section

H. DIFFERENTIATION, RECTIFYING AND INDICATING SECTION (Fig. 6)

The squarewave signal is applied to bridge rectifier GR2, GR3, GR6 and GR7 via capacitors C9...C14, which can be se-

lected by means of SK1. The direct voltage branch of the rectifier bridge contains balancing resistors R23 and R24 as well as switchable adjusting resistors R17...R22. The latter serve for calibrating the six measuring ranges. The rectifier section represents a switchable impedance, which effects differentiation in conjunction with the switched-in capacitor (C9...C14). In order to suppress pointer instabilities at low frequencies a capacitor C15 has been connected in parallel with the direct voltage branch of the bridge. Meter ME1 is included in the direct voltage branch of the bridge.

J. EMITTER FOLLOWER

For special measurements double emitter follower TS1 and TS2 is employed. By means of S2 the control voltage is taken inductively from L1 and applied to voltage divider R6/R55. The setting of the double emitter follower stage is adjusted by means of R6. The output voltage is available at sockets CD2 and CD3. The amplitude and phase of this voltage correspond to that of the voltage on the measuring object (guard voltage). This guard voltage is required if capacitive side effects, as caused by, for instance, the capacitance of the non-connected electrodes of a valve, should be eliminated. The capacitance of these electrodes has no effect, if they carry the same voltage as the electrodes employed for the measurement.

K. SUPPLY SECTION

The mains transformer is suitable for voltages of 115 V or 230 V on the primary side. The direct voltage is available on charging capacitor C30 of bridge rectifier GR4. A stabilising circuit, consisting of d.c. restorer GR5, amplifier transistor TS12 and regulator TS11, ensures that a constant supply voltage of 9 V is obtained. The positive pole of this voltage is connected to chassis.

VIII. GAINING ACCESS TO THE PARTS

A. REMOVING THE HOUSING

1. Removing the left-hand and right-hand side plates

- Loosen the screws of the handle
- Remove the handle
- Pull out the side plates in forward direction

2. Removing the top plate

- Turn the catch at the rear a quarter turn anti-clockwise
- Pull out the top plate in backward direction

3. Removing the bottom plate

- Remove the screws securing the bottom plate at the rear
- Pull out the bottom plate in backward direction
- When refitting the plate make sure that the recesses are positioned under the tilting assembly

4. Removing the tilting assembly

- Move the small outer slides A inwards (Fig. 7)
- Remove the tilting assembly



Fig. 7. Tilting assembly

B. REMOVING THE ROTARY KNOBS (Fig. 8)

- Carefully take out knob cap A
- Loosen nut B
- Pull the knob off the spindle, for releasing the clamping cone tap the spindle carefully in the axial direction while holding the knob

- When fitting knobs with marks, ensure that the mark is symmetrically positioned with respect to the control range of the potentiometer
- The switch knob (knob for SK1) should be mounted so that the mark points towards the range to which it was set before removal
- Fit the knob caps so that they are correctly positioned with respect to the marks on the knobs

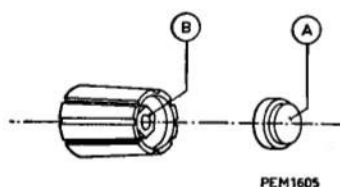


Fig. 8. Removing the knobs

C. REMOVING THE CONTROLS AND THE METER

Remove the cabinet (VIII A1-2-3)

1. Potentiometer R3

- Remove the rotary knob (VIII-B)
- Remove the M3 screws from the mounting support
- Take the potentiometer out in backward direction
- Remove the indication plate
- Fit the indication plate on the spindle of the new potentiometer in approximately the correct position and secure it hand-tight
- Mount the potentiometer
- Fit the rotary knob and position the indication plate

2. Variable capacitor C4

- Remove the knob (VIII-B)
- Remove the extension spindle
- Remove the variable capacitor

3. Switch SK1

- Remove the rotary knob (VIII-B)
- Detach the plug connections of unit E (Fig. 12)
- Unsolder the soldered connections of switch wafers SK1a and SK1b
- Loosen the central fixing nut
- Pull out the unit in backward direction

4. Measuring instrument

- Unsolder the connections
- Loosen the countersunk screws A (2 in each side frame) by means of which the moving coil meter is fitted on the mounting plate (Fig. 12)
- Remove the rotary knobs
- Loosen the other countersunk screws of the side frame, but do not remove them
- Slightly bend the side frames sideways
- Lift out the meter, together with the mounting plate, in forward direction

D. REMOVING THE PRINTED CIRCUIT BOARDS

1. Unit A

- Unplug the connectors
- Loosen the M3 screws of the spacer bolts
- Remove the unit in downward direction

2. Unit B

- Unplug the connectors
- Loosen the M3 screw of the spacer bolt on the side of the mounting plate
- Remove the unit to the right

3. Unit C

- Unsolder the connection
- Lift out the unit

IX. MAINTENANCE

A. SWITCHES

The switches used require no regular maintenance; occasionally rotate the switches a few times through all positions. If the switch mechanism cause excessive friction, the should be lubricated with graphite grease. The bearings should be lightly lubricated with thin liquid oil.

B. CABINET PARTS

When the cabinet plates have become dirty they can be cleaned with water and soap (for removing the plates, see VIII A).

Remark

In case of breakdowns it is always possible to apply to the PHILIPS Service Organisation for assistance.

Whenever the instrument is sent to a PHILIPS Service Centre, the following should be observed:

- Tie on a label bearing the full name and address of the sender
- Specify the fault(s) found
- Carefully pack the instrument in a sealed plastic bag and then in its original packing or, if this is no longer available, in a wooden case
- Send the instrument to the address provided by your local PHILIPS representative

X. SURVEY OF ADJUSTING ELEMENTS AND AUXILIARY EQUIPMENT

Adjustment	Adjusting Element	Fig.	Measuring Equipment	Chapter XI Point
Supply voltage	R51	11	Variable transformer Voltmeter PM 2411, (10 V range calibrated to 0.5 %)	B.1.
Hum voltage			Oscilloscope PM 3230	
Amplitude of the variable oscillator	R34	10	Oscilloscope PM 3230	B.2.
Amplitude and Phase at CD3	R6	12	Oscilloscope PM 3230	B.4.
Inductance of L1	L1	12	C-Standard 100 pF \pm 0.1 %	
			L-Standard 100 μ H \pm 0.2 % Q \geq 150	B.5.
Basic capacitance for L measurements	C2	12		B.6.
Complementary capacitance	C33	10		B.7.
Full scale deflection of the individual ranges	R17...R22	17	C-Standard (\pm 0.1 %) 3-10-30-100-300-1000 pF L-Standard 100 μ H \pm 0.2 % Q \geq 150	B.9.

XI. CHECKING AND ADJUSTING

The tolerances in the following description only apply to a completely readjusted instrument and may therefore deviate from the values mentioned in chapter II. All adjusting elements, their functions and their location are given in chapter X.

A. PREPARATION

1. Mechanical check:

- Check that the potentiometers and switches operate properly; check the correct position of the knob marks
- The rotary and switch knobs should not touch the text plate in any position. Switch SK1 has no stop
- The cabinet plates should be properly secured, they should not vibrate at light shocks

2. Checking and adjusting the mechanical zero of the meter

B. CHECKING AND ADJUSTING

1. Supply section (R51)

- Connect the instrument via a variable transformer
- Set the variable transformer to 220 V, check the output voltage with a multi-meter
- Measure the output voltage of the supply section at terminals 1 and 2 of UNIT C; nominal value 9 V d.c. ± 0.1 V
- When the tolerances are exceeded, replace R51 by a resistor of different value
- Set the variable transformer to 190 V; the 9 V direct voltage should not deviate more than 35 mV
- Set the variable transformer to 265 V; the 9 V direct voltage should not deviate more than 35 mV
- For checking the hum voltage connect an oscilloscope to terminals 1 and 2 of UNIT C: nominal value $\leq 600 \mu\text{Vp-p}$

2. Amplitude of the variable oscillator (R34)

- Connect an oscilloscope to terminal 16 of UNIT A
- Set SK1 at 100 pF
- Nominal value of the voltage: $1.5 V_{p-p}$. If required, adjust with R34

3. Control ranges C4 and R3

- Set the meter to zero with C4 (COARSE ZERO) and R3 (FINE ZERO); if required, change the value C33; target value 80 pF
- The control range of C4 should be greater than 80 pF
- Set SK1 to 3 pF
- Check the control range with R3; it must be possible to adjust the meter to full scale deflection
- Set SK1 to $3 \mu H$
- Short-circuit CD1 (L-C UNKNOWN) direct
- Set the meter to zero with C4 and R3
- Remove the short-circuit from input CD1

3. Output amplitude and phase at CD3 (R6)

- Set SK1 to 100 pF
- Measure the voltage at input CD1 with the oscilloscope, note the value measured
- Measure the voltage at output CD3 (GUARD VOLTAGE) with the oscilloscope; the voltage value should correspond to the value noted down. If this is not the case, the voltage at CD3 should be corrected with R6. Phase and amplitude should be equal as far as possible.

4. Inductance of L1

- Set SK1 to 3 pF
- Set the meter to zero with C4 and R3
- Set SK1 to 100 pF
- Connect C-standard of 100 pF to CD1
- Note the deflection of the measuring instrument (value A)
- Remove C-standard

- Set SK1 to $3\ \mu\text{H}$
- Short-circuit input CD1 direct
- Set the meter to zero with C4 and R3
- Remove the short-circuit from input CD1
- Connect L-standard, $100\ \mu\text{H}$, to CD1
- Read the deflection from the meter
- Adjust to value A with L1
- Set SK1 to $100\ \text{pF}$
- Remove L-standard
- Set the meter to zero with the aid of C4 and R3
- Connect C-standard, $100\ \text{pF}$, to CD1
- Note the deflection of the meter (value B)
- Set SK1 to $100\ \mu\text{H}$
- Short-circuit CD1 direct
- Set the meter to zero with C4 and R3
- Connect L-standard, $100\ \mu\text{H}$, to CD1
- Read the deflection of the meter
- Adjust the value B with L1
- Repeat the adjusting procedure for L1, until it is no longer necessary

6. Basic capacitance for L-measurements (C2)

- Set SK1 to $3\ \text{pF}$
- Set the meter to zero with C4 and R3
- Set SK1 to $3\ \mu\text{H}$
- Short-circuit input CD1 direct
- Set the meter to zero with C2
- Repeat this adjustment until correction of C2 is no longer required

7. Complementary capacitance (C33)

- Set SK1 to $3\ \text{pF}$
- Set R3 to mid-position
- Turn C4 until the stator and rotor plates cover each other; turn the rotor approx. 10° out on one side
- Select such a value for C33 (in parallel with C3) that

the deflection of the meter is zero

8. Compensation voltage at CD3

- Set SK1 to 3 pF
- Set R3 to mid-position
- Set the meter to zero with C4
- Adjust the meter to a deflection of 2 pF with R3
- Turn C4 slightly inward, the deflection of the meter should now increase
- Connect one side of a freely suspended 100-pF capacitor (mica) to CD3; the other connection should be held close to the central pin of CD1
- Press the free connection of the capacitor against the centre pin of CD1 by means of a plastic pin; the deflection of the meter should not vary more than ± 0.5 pF
- If the deflection is more 0.5 pF, readjust R6 with a plastic screwdriver

9. Full scale deflection of the individual ranges

- Set SK1 to the relevant range; start with the C-ranges
- For each measurement set the meter to zero; in the case of C-measurements the input should be open, for L-measurements it should be short-circuited direct
- Connect a standard component to input CD1 and change it each time
- Determine the difference between the deflection and f.s.d.
- When the tolerance specified is not obtained, adjust as accurately as possible by means of the resistors of the R17...R22. This resistor series consists of two parallel connected resistors, viz. one basic resistor of the order of magnitude of 3...6 k Ω and a shunt resistor for fine adjustment. The values of the shunt resistors vary from approx. 3 to 20 k Ω .

SK1 in position	Standard component on input CD1	Value	Permissible error at full scale deflection	Adjusting resistor
3 pF	C	3 pF $\pm 0.1 \%$	1 %	R17
10 pF	C	10 pF $\pm 0.1 \%$	1 %	R18
30 pF	C	30 pF $\pm 0.1 \%$	1 %	R19
100 pF	C	100 pF $\pm 0.1 \%$	1 %	R20
300 pF	C	300 pF $\pm 0.1 \%$	1 %	R21
1000 pF	C	1000 pF $\pm 0.1 \%$	1 %	R22
100 μ H	L *	100 μ H $\pm 0.2 \%$ $Q \geq 150$	1.5 %	

* Lowest possible loss

10. Final check of the control range R3

- Set SK1 to 3 pF
- Turn R3 fully anti-clockwise
- Set the meter to zero with C4
- It should be possible to obtain full-scale deflection with the aid of R3

XII. LIST OF PARTS

A. MECHANICAL

Fig.	Item	Qty	Ordering code	Description
10	1	4	4822 462 50101	Foot
10	2	4	4822 462 40157	Rubber foot
10	3	4	4822 502 10015	Threaded pin M3x8 (in foot)
9	4	2	4822 460 60014	Ornamental serround
13	5	2	4822 520 10182	Stop for bracket
13	6	2	4822 462 70366	Cam
13	7	1	4822 460 60017	Ornamental strip (length 0.42 m)
9	8	2	4822 404 50199	Handle bracket
9	9	1	4822 347 50026	Measuring instrument sensitivity: 100 A accuracy : 1 % Ri : 1300
9	10	1	4822 413 40112	Knob, dia 23 mm spindle 6 mm
9	11	1	4822 413 70037	Cap for knob dia 23 mm
9	12	2	4822 413 30082	Knob, dia 14.5 mm spindle 6 mm
9	13	2	4822 413 70038	Cap for knob, dia 14.5 mm
9	14	1	4822 267 10004	BNC connector (CD1)
9	15	1	4822 290 40011	Terminal 4 mm (CD3)
9	16	1	4822 290 40012	Earth terminal (CD2)
9	17	1	4822 455 90284	Text plate
10	18	1	4822 273 50084	Switch (SK1)
11	19	1	4822 277 20014	Slide switch (SK2)
10	20	1	4822 265 30058	Mains input plug (CD1)
11	21	1	4822 255 40017	Transistor holder
12	22	10	4822 255 40038	Transistor holder
12	23	1	4822 255 50003	Crystal holder
11	24	4	4822 693 40002	Distance piece
10	25	3	4822 325 60039	Grommet
-	-	-	4822 321 10071	Mains flex with plug and socket
-	-	1	4822 417 20017	Fixing screw for cover plate

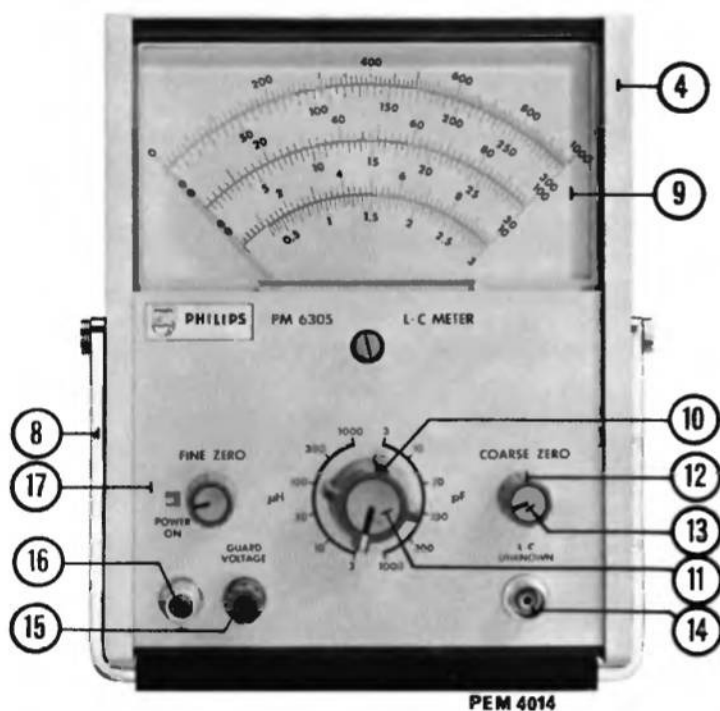


Fig. 9. Location of mechanical parts

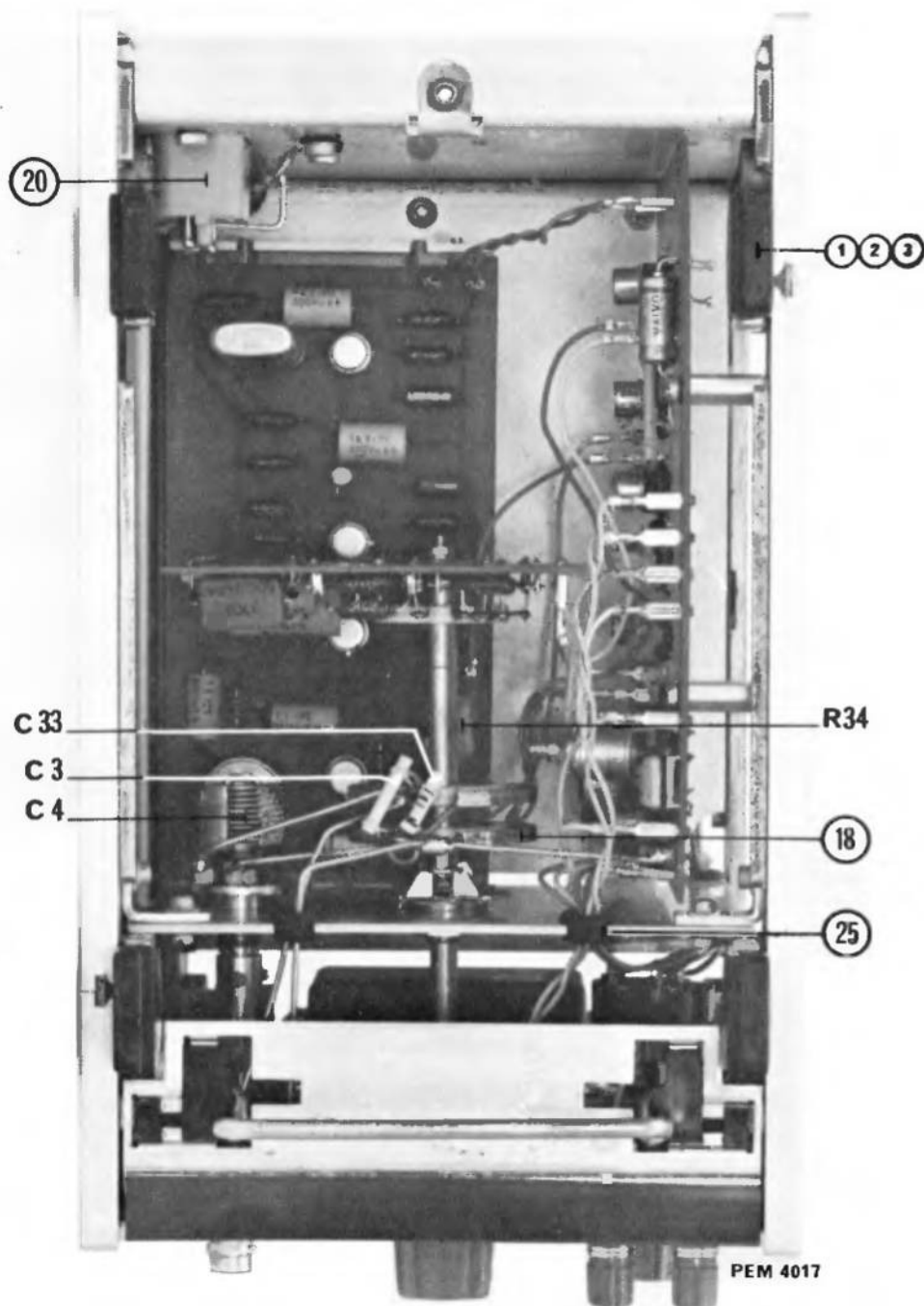


Fig. 10. Location of mechanical parts

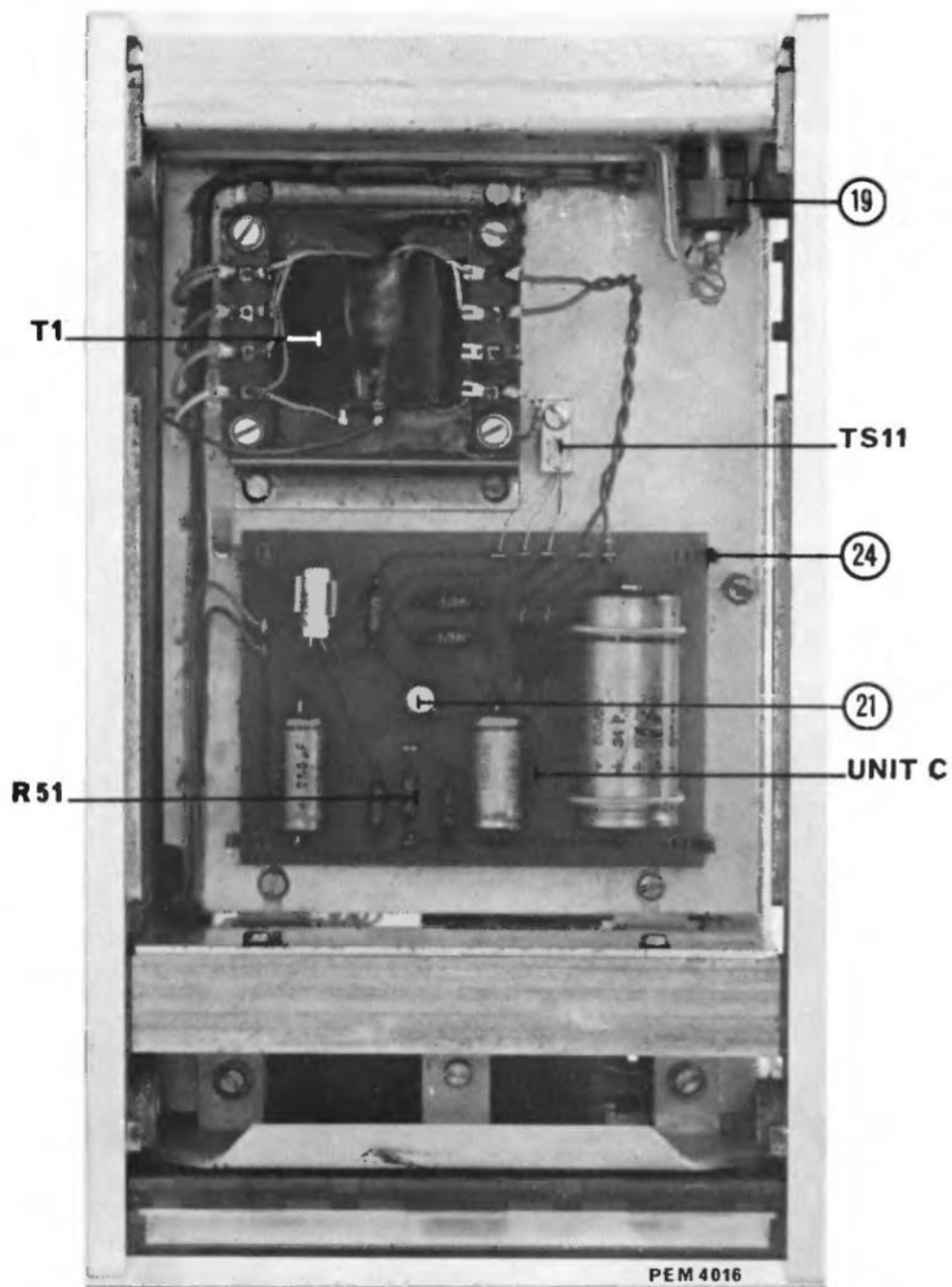


Fig. 11. Location of mechanical parts

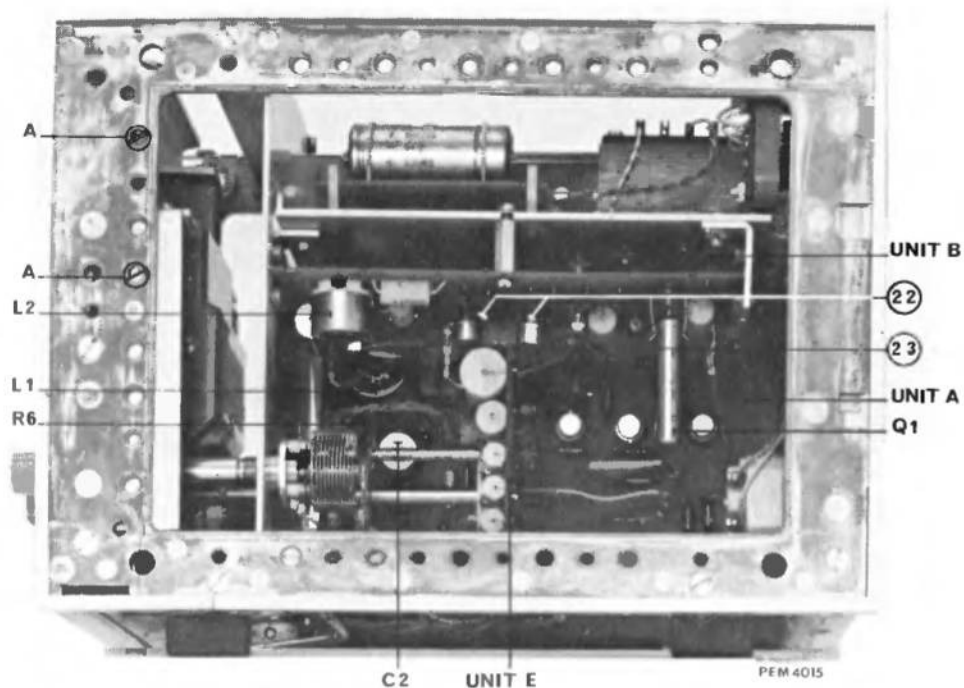


Fig. 12. Location of mechanical parts



Fig. 13. Location of parts of the tilting assembly

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS




















This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het prinsipschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs spécifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

	Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24	} 0,125 W	5%		Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	} 1	W ≤ 2,2 MΩ, 5% > 2,2 MΩ, 10%
	Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12			} 0,25 W ≤ 1 MΩ, 5% ≥ 1 MΩ, 10%			
	Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24	} 0,5 W ≤ 5 MΩ, 1% ≥ 5 MΩ ≤ 10 MΩ, 2% ≥ 10 MΩ, 5%			Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	} 0,4 – 1,8 W	0,5%
	Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12		} 0,5 W ≤ 1,5 MΩ, 5% ≥ 1,5 MΩ, 10%		Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada		
	Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	} 10 W		5%			
	Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular		500 V			Polyester capacitor Polyesterkondensator Polyesterkondensator Condensateur au polyester Condensador polyester	400 V
	Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular	700 V		Flat-foil polyester capacitor Miniatur-Polyesterkondensator (fach) Platte miniatur polyesterkondensator Condensateur au polyester, type plat Condensador polyester, tipo de placas planas	250 V		
	Ceramic capacitor, "pin-up" Keramikkondensator "Pin-up" (Perityp) Keramische kondensator "Pin-up" type Condensateur céramique, type perle Condensador cerámico, versión "colgable"	500 V		Paper capacitor Papierkondensator Papierkondensator Condensateur au papier Condensador de papel	1000 V		
	"Microplate" ceramic capacitor Miniatur-Scheibenkondensator "Microplate" keramische kondensator Condensateur céramique "microplaque" Condensador cerámico "microplaca"	30 V		Wire-wound trimmer Drahttrimmer Draadgewonden trimmer Trimmer à fil Trimmer bobinado			
	Mica capacitor Glimmerkondensator Micakondensator Condensateur au mica Condensador de mica	500 V		Tubular ceramic trimmer Rohrtrimmer Buisvormige keramische trimmer Trimmer céramique tubulaire Trimmer cerámico tubular			



For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.

Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.

Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.

Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.

Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

Capacitors

Nr.	Ordering code	Value	Tolerance (%)	Voltage (V)	Description
C2	4822 125 60029	16 pF			Air-trimmer
C4	4822 125 10032	100 pF			Variable capacitor
C9	4822 121 50174	100 nF	2	63	Polyester
C10	4822 121 50175	30 nF	2	63	Polyester
C11	4822 121 50239	10 nF	2	63	Polyester
C12	4822 121 50234	3 nF	2	125	Polyester
C13	4822 120 60109	1.2 nF	2	500	Mica
C14	4822 120 60097	430 pF	1	500	Mica
C15	4822 124 20078	100 μ F		15/18	Electrolytic
C16	4822 121 50154	15 nF	2	63	Polyester
C17	4822 121 50083	2.7 nF	1	125	Polyester
C18	4822 121 50083	2.7 nF	1	125	Polyester
C20	4822 120 60109	1.2 nF	5	500	Mica
C21	4822 121 50186	1 nF	2	125	Polyester
C22	4822 121 50186	1 nF	2	125	Polyester
C23	4822 124 20082	250 μ F		15	Electrolytic
C24	4822 120 60109	1.2 nF	5	500	Mica
C27	4822 121 50189	1.3 nF	2	125	Polyester
C28	4822 121 50104	910 pF	2	125	Polyester
C29	4822 124 20077	10 μ F		15/18	Electrolytic
C30	4822 124 20113	500 μ F		35/40	Electrolytic
C31	4822 124 20028	100 μ F		35/40	Electrolytic
C32	4822 124 20082	250 μ F		15	Electrolytic

Resistors

Nr.	Ordering code	Value	Tolerance (%)	Power (w)	Description
R2	4822 116 30012	4.7 k	10	0.6	NTC
R3	4822 101 50031	10 k			Carbon potentiometer with mains switch
R6	4822 101 10024	22 k			Carbon trimming potentiometer
R34	4822 101 10026	4.7 k	20	0.25	Carbon trimming potentiometer

Miscellaneous

Fig.	Nr.	Qty.	Ordering code	Description
12	L1	1	4822 158 30112	Coil
12	L2	1	4822 158 30111	Coil
12	Q1	1	4822 242 70119	Crystal
11	T1	1	4822 145 10068	Mains transformer
-	VL1	1	4822 252 20001	Thermal fuse
-	-	1	4822 216 90113	Print plate with components (UNIT A)
-	-	1	4822 216 90114	Print plate with components (UNIT B)
-	-	1	4822 216 90115	Print plate with components (UNIT C)
-	-	1	4822 216 90116	Print plate with components (UNIT E)

Transistors

Nr.	Type
TS1	ASY26
TS2	ASY26
TS3	ASY26
TS4	ASY26
TS5	BFY67
TS6	AF178
TS7	AF178
TS8	AF178
TS9	AF178
TS10	AC128

Nr.	Type
TS11	AC128K Siemens
TS12	AC126

Diodes

Nr.	Type
GR1	BA102
GR2	AAY21
GR3	AAY21
GR4	BY122
GR5	OAZ203 Zener diode
GR6	AAY21
GR7	AAY21

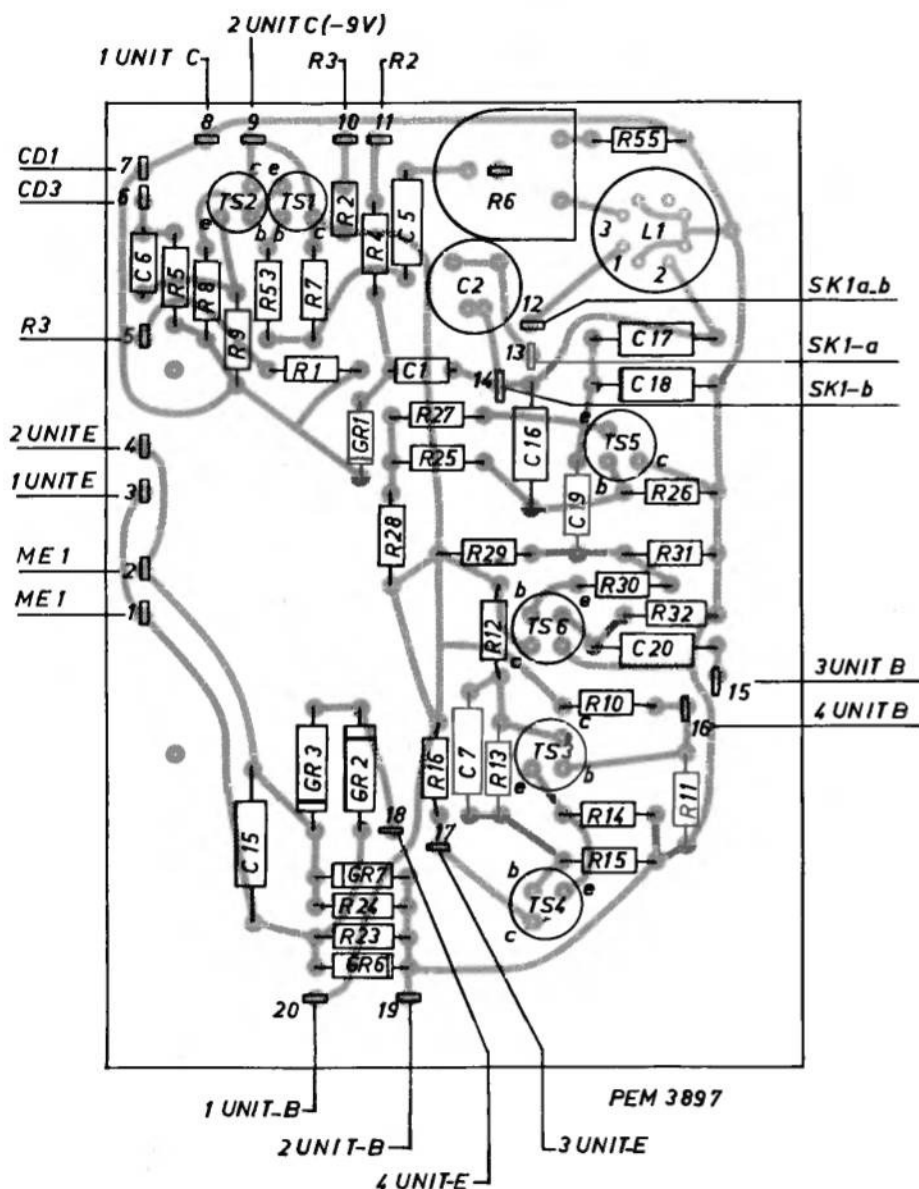
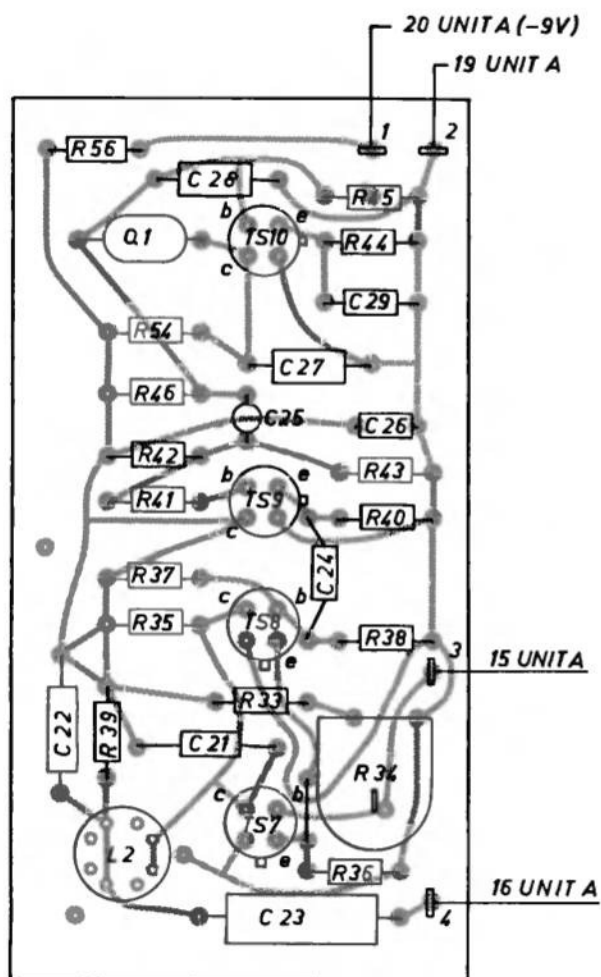
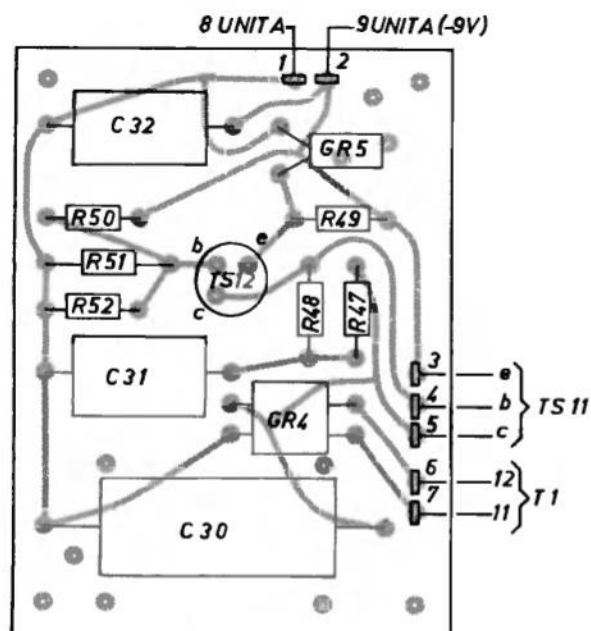


Fig. 14. Printed circuit Board A



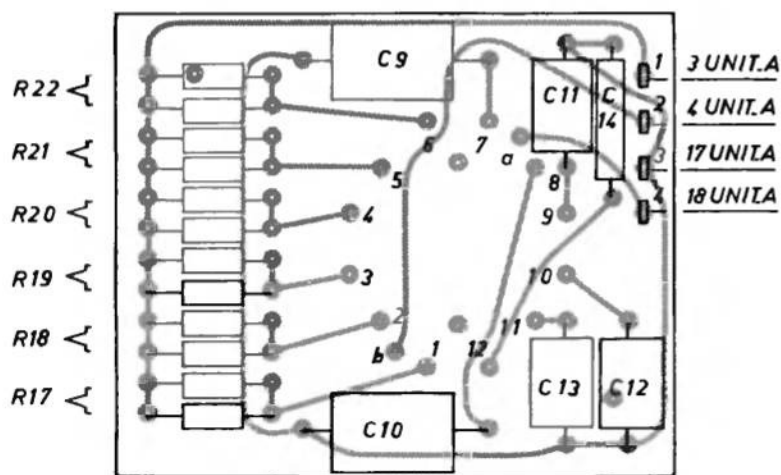
PEM 3896

Fig. 15. Printed circuit board B



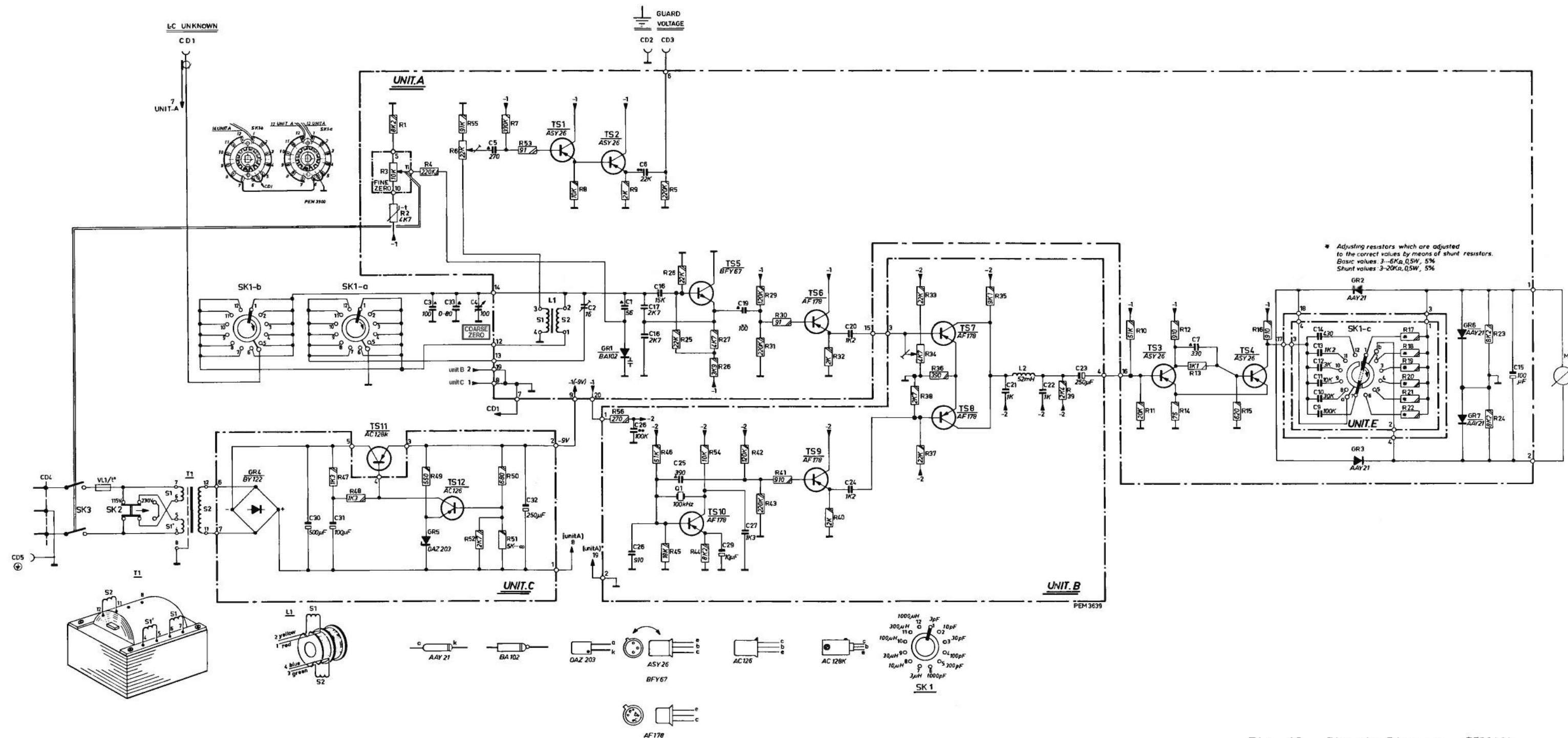
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Fig. 16. Printed circuit board C



PEM 3898

Fig. 17. Printed circuit board E



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