PHILIPS

L.F. GENERATOR
PM 5101

66 404 15.1-10 1/265/01

PEM 1563
E 1319

PHILIPS

Manual

L.F. GENERATOR
PM 5101

66 404 15.1-10 1/265/01

IMPORTANT

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

Contents

List of figures

GENERAL

Introduction

I

The PM 5101 is a portable LF generator, which in the frequency range 10 c/s to 100 kc/s supplies a sinusoidal voltage of 0 to 2 V_{rms} and a negative going square wave voltage of 0 to 4 V_{p-p}.
The apparatus is fully transistorised and is supplied by built-in batteries.

Technical data

II

Properties expressed as figures with tolerances stated, are guaranteed by the factory. The other figures represent values of an average apparatus and are stated merely to serve as a guide only.

1. Frequency ranges	10 c/s – 100 c/s 100 c/s – 1 kc/s 1 kc/s – 10 kc/s 10 kc/s – 100 kc/s
Frequency inaccuracy	± 5 % ± 1 c/s at 20 °C and a 16-V supply voltage.
Frequency drift	0.1 % in the 10 c/s to 1 kc/s range. 0.15 % in the 1 kc/s to 100 kc/s range. (measured during 7 hours, at which the supply voltage decreased from 17 to 16 V and the temperature rose from 19 to 28 °C)

2. Sinusoidal output voltage

Distortion	$< 1\,\%$ over a supply voltage of 14 to 18 V.
Amplitude	0 to 2 V_{rms} (unloaded)
Amplitude change due to a change in the frequency at a constant battery voltage	$\pm 2\,\%$
Amplitude change due to a change in the battery voltage (14 to 18 V) at a constant frequency	$\pm 2\,\%$
Output impedance	0 to 250 Ω (dependent on the position of the amplitude control).

3. Square wave output voltage

Amplitude	0 to 4 $V_{p\text{-}p}$ when unloaded (superimposed on an 0 to 2 V d.c. voltage). Continuously adjustable.
Amplitude change due to a change in the frequency at a constant battery voltage	$\pm 0.5\,\%$
Amplitude change due to a change in the battery voltage (14-18 V) at a constant frequency	$\pm 10\,\%$

Output impedance	0-350 Ω (dependent on the position of the amplitude control).
Rise-time at	100 c/s: $\leq$ 100 μsec. 1 kc/s: $\leq$ 10 μsec. 10 kc/s: $\leq$ 1.5 μsec. 100 kc/s: $\leq$ 0.8 μsec.
Sag (see Fig. 4)	1 % at 50 c/s
Mark/space ratio (see Fig. 4)	1 : 1 $\pm$ 5 % (for battery voltages of 14 to 18 V)
4. Temperature range	17 to 40 °C
5. Supply	two 9-V batteries in series
7. Weight	Width: 25 cm (9¾ inches) Depth: 14 cm (5½ inches) Height: 13 cm (5 inches)
6. Dimensions	1.5 kg (3.75 lbs.) without batteries 2.6 kg (5.75 lbs.) with batteries

DIRECTIONS FOR USE

III

A. SWITCHING ON (see Fig. 1)

Set switch "ON/OFF" (SK1) to position "ON". After approximately 30 secs. the apparatus is ready for use.

B. ADJUSTING THE FREQUENCY

The frequency ranges can be selected with knob "FREQ. Hz" (SK2). Continuous control of the frequency within each range can be effected with the aid of the frequency selector (R1).

C. ADJUSTING THE OUTPUT VOLTAGE

1. Sinusoidal voltage

Set switch "~/ ⊓ " (SK3) to position "~". The output voltage at sockets BU1-BU2 can be adjusted with knob "AMPLITUDE" (R2) between approximately 3 mV_{rms} and 2 V_{rms} (unloaded).

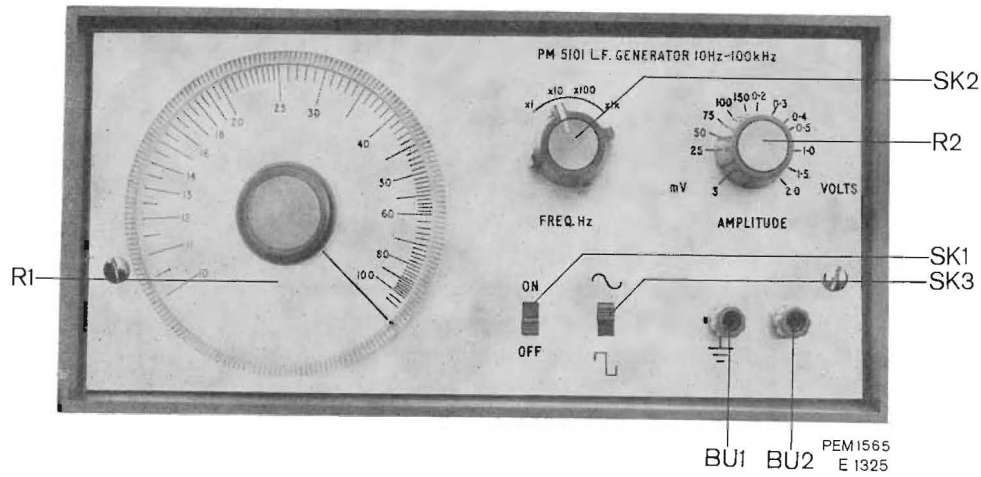


Fig. 1. Front view with indication of the controls

2. Square wave voltage

Set switch "∿/ ⊓ " (SK3) to position " ⊓ ". The output voltage at sockets BU1-BU2 can be adjusted with knob "AMPLITUDE" (R2) between approximately 6 mV_{p-p} and 4 V_{p-p} (unloaded). The output voltage consists of a square wave voltage which is superimposed on a negative d.c. voltage, equal to half the amplitude of the square wave voltage.
To obtain a square wave voltage which is symmetrical with respect to the zero line, a circuit should be used for changing the d.c. voltage level (in this case, a capacitor). The value of this capacitor depends entirely on the input impedance of the circuit to be fed and on the frequency. For this reason no capacitor has been fitted in the apparatus.

Note:

When using the sinusoidal or the square wave voltage, it is recommended that the output voltage of the generator is measured with a voltmeter with a high input impedance for obtaining accurate measurements. By doing so, the exact value of the voltage which is applied to the circuit connected will be known.

SERVICE NOTES

Technical description (see Fig. 2 and Fig. 8)

IV

A. INTRODUCTION

The generator is a Wien bridge oscillator using variable resistance for tuning.
The output voltage may be sinusoidal or square, according to the position of switch "∿/ ⊓ " (SK3). The frequency range is 10 c/s to 100 kc/s, subdivided into four decades which can be selected by the range selector (SK2).
The amplitude of the output voltage is continuously variable up to 2 V_{rms} for sinusoidal voltages or −4 $V_{p\text{-}p}$ for square-wave voltages.

B. THE OSCILLATOR

In the block diagram (Fig. 2) the oscillator section is indicated by the letter A. The oscillator is a Wien bridge, the frequency of oscillation of which is given by the formula:

$$f_o = \frac{1}{2\pi RC}$$

From this formula it is clear that the frequency is varied by changing the values of R or C. The four frequency decades are obtained by switching on and off capacitors in pairs, in the reactive bridge branches, while the continuous adjustment in each decade is made possible by the two gang potentiometer R1. R18 is a trimming potentiometer, with which the frequency calibration can be adjusted. Trimmercapacitors are used for an accurate adjustment in the highest frequency range, when the phaseshift of the oscillator amplifier tends to increase.
Trimmer C2 is used for adjusting at 100 kc/s, while C22 is used at 10 kc/s in the ×1 K range.

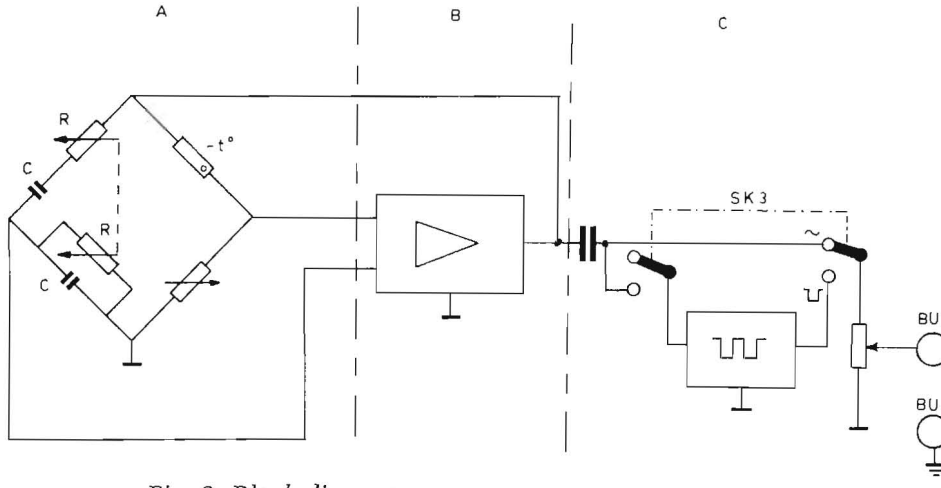


Fig. 2. Block diagram

C. THE AMPLIFIER

The Wien bridge is coupled to an amplitude-stabilised amplifier. In the block diagram (Fig. 2) this amplifier is indicated by the letter B, and consists of a differential amplifier which is coupled to a common emitter circuit. This circuit in turn is coupled to a White emitter follower.

The differential amplifier TS1 has a high effective input impedance and its shunting effect upon the bridge is very small.

Feedback is used in the common emitter circuit TS2, to reduce the Miller effect at high frequencies. The White emitter follower has a low output impedance, which is necessary for supplying the Wien bridge and the output potentiometer.

The collector of TS1 is connected to a resistor (R4), selected on test by which the d.c. voltage conditions can be slightly varied, in order to compensate for transistor spreads, if these cause excessive distortion.

In the amplifier, both positive feedback and negative feedback are applied.

The negative feedback prevails at all frequencies, except at the oscillation frequency f_o. At the oscillation frequency, the positive feedback is maximum and the phase-shift angle equals zero. The output voltage is kept constant with the aid of thermistor R16, which is connected in one of the bridge arms. This thermistor regulates

the negative feed-back in such a way that if the output voltage increases the negative feed-back also increases, so that the output voltage remains constant. The level of the oscillator voltage can be adjusted with R26. Thermistor R9 stabilises the bias conditions in TS2 up to a temperature of approximately 40 °C.

D. THE OUTPUT VOLTAGE

The output circuit is indicated in the block diagram (Fig. 2) by the letter C. The output voltage can optionally be either sinusoidal or square.

The sinusoidal voltage can be taken from the Wien bridge while the square wave voltage is discharged from the sinusoidal voltage by limiter circuit TS6/TS7. These transistors are alternately cut off and saturated. The output voltage of stage TS7 can be kept more constant with the aid of Zener diode GRZ1. The square wave voltage consists of negative-going pulses. But the d.c. voltage level can be changed by a circuit for adjusting the d.c. voltage level (see Chapter III, C2).

The mark/space ratio can be adjusted with trimming potentiometer R20 (Fig. 4).

The output potentiometer (R2) enables continuous amplitude variation of both the sinusoidal and the square wave voltage.

E. SUPPLY

The apparatus is supplied by two 9-V batteries connected in series.

Gaining access to parts

V

A. THE BATTERIES

- Remove the two screws at the rear. The rear panel then can be removed.
- Remove the connection wires from the battery.
- Remove the battery clamp.
- Remove the batteries.
- Fit the new batteries in the apparatus.
- Refit the battery clamp.
- Connect the series-connection wire to the new batteries.
- Connect the two remaining connection wires to the new batteries. (The batteries are provided with two different terminals for the positive and negative poles, so that it is impossible to interchange the connections.)
- Refit the rear panel.

B. THE PRINTED WIRING PANEL

Remove the rear panel (see V-A).
The cabinet then can be removed. The printed wiring panel (with all components) is then visible.
It is provided with figures 1 . . . 8, corresponding to figures 1 . . . 8 in the circuit diagram. These figures indicate the connection points between the parts mounted on the chassis and the printed wiring panel.

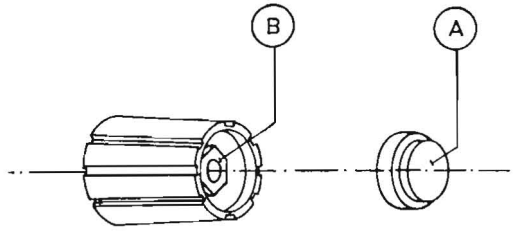


Fig. 3. Removing the knobs

C. REMOVING THE KNOBS (see Fig. 3)

- Remove cap A.
- Unscrew nut B and tap it slightly, while holding the knob.
- The knob then can be taken from the shaft.

Recommended batteries VI

The batteries used are in accordance with the IEC standard, No. 86-6F100.

Type	*Make*	*Country of origin*
439	Pertrix	England
P.P.9	Berec	England
276	Eveready	U.S.A.
495	EMCE	Germany

Maintenance VII

A. THE CABINET

If the cabinet becomes soiled it can, after removal (chapter V-B) be cleaned with soap and water, or with a light scouring agent.

B. THE SEGMENT SWITCHES

When the segment switches no longer function properly due to dirty contacts, they can be treated with switch oil (for code number see chapter XI-A). This oil has cleaning and lubricating properties.

Survey of adjusting and control elements

VIII

Adjustment	*Adjusting element*	*Fig.*	*Measuring device*	*Chapter IX*
Frequency response curve	R18 C22 C1	6	Oscilloscope + PM 5120 or PM 5121	B2
Distortion	R4	6	Distortion meter	C
Amplitude	R26	6	LF valve voltmeter Oscilloscope	D
Mark/space ratio of the square wave voltage (see Fig. 4)	R20	6	Oscilloscope	E

Checking and adjusting

IX

The tolerances stated below are factory tolerances which apply when the apparatus is re-adjusted. They may differ from the data given in Chapter II. All checks and adjustments should be carried out at a 16-V supply voltage, unless otherwise stated.

A. BATTERY CURRENT

Set SK1 to position "ON".
At an 18-V d.c. supply voltage the current consumption should be 25 mA ± 3 mA.

B. FREQUENCY RESPONSE CURVE

1. Mechanical check

- Adjust the hair-line of the dial to 15.
- Set SK3 to position "~" and SK2 to position "×100".
- Connect a oscilloscope to BU1-BU2.
- Check that the frequency amounts to 1500 c/s ± 10 c/s.

- If adjustment is necessary, the cap of the dial should be removed and the dial nut unscrewed.
- Set R18 to the middle position and turn the shaft of potentiometer R1 until the frequency lies within the required tolerance.
- Next, tighten the nut of the dial without turning either the potentiometer or the dial shaft.

2. Electrical check

- Adjust the hair-line to 100.
- Set SK3 to position "∼" and SK2 to position "×100".
- Check that the frequency amounts to 10 kc/s ± 2 % (heterodyne method). If required, adjust with R18.
- Adjust the hair-line to 10.
- Check that the frequency amounts to 1 kc/s ± 2 %.
- If required, readjust R18 until the deviation of both frequencies is less than 2 %.
- Adjust SK2 to position "×1 k".
- Set the hair-line to 10.
- Check that the frequency amounts to 10 kc/s ± 2 %. If necessary, adjust with C22.
- Adjust the hair-line to 100.
- Check that the frequency amounts to 100 kc/s ± 2 %. If necessary, adjust with C1.
- Check the frequency inaccuracy in each frequency range at points 10, 25, 40, 70 and 100 of the frequency scale. Tolerance: ± 3 %, ± 7 c/s.

C. DISTORTION

Set switch "∼/ ⊓ " (SK3) to position "∼". The distortion should be less than 0.7 % at 20 c/s and 100 kc/s, and smaller than 0.3 % at 1 kc/s (measured at a supply voltage of 14 V⎓). If required, select a different value for R4.

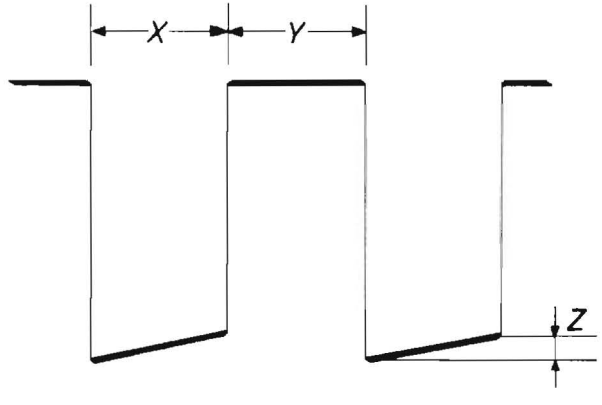
D. AMPLITUDE

- Set R2 to 2.0 V.
- Set SK3 to position "∼".
- Check that the output voltage at BU1-BU2 amounts to 2 V_{rms} at all frequencies.
- If necessary, adjust with R26.
- Set SK3 to position " ⊓ ".

- Check that the output voltage amounts to 4 $V_{p\text{-}p}$.
- Set SK3 to position "∼".
- Check that the output voltage at 1 kc/s corresponds to the values indicated at knob R2. Also check that the output voltages at frequencies 10 c/s, 30 c/s and 100 c/s (SK2 in position "×2") and 10 kc/s, 30 kc/s and 100 kc/s (SK2 in position "×100") do not differ more than 1 % from the values at 1 kc/s.

E. SQUARE WAVE VOLTAGE

- Set SK3 to position " ⊓ ".
- Adjust the frequency to 2 kc/s and check that the mark/space ratio amounts to 1 : 1 (see Fig. 4). If required, adjust with R20.
- Check that the output voltage amounts to 4 $V_{p\text{-}p}$ ± 5 %, when R2 is at 2 V.
- Check that the sag is less than 10 mV at 50 c/s and 4 $V_{p\text{-}p}$ output voltage.



x : y = mark/space ratio
z = sag

PEM 1515
E 1320

Fig. 4. Block voltage shape

Replacing parts

No special parts have been used in this apparatus.
After replacing parts, it may be necessary to readjust the relevant part of the circuit (see chapter IX, Checking and adjusting).
During replacement of parts, the apparatus should be switched off.
For gaining access to parts, see chapter V.

List of parts

XI

A. MECHANICAL PARTS

Fig.	*Item*	*Number*	*Code number*	*Description*	*"S"*	*Minimum basic stock for* 1	3	5	10 app.
5	1	1	4822 197 00059	Front plate	**	–	–	1	2
5	2	1	4822 197 00062	Text plate	*	–	–	1	2
5	3	1	4822 197 00063	Dial	*	–	1	2	3
5	4	2	M7 694 87	Terminal socket	*	–	–	1	1
5	5	1	4822 159 00318	Knob	**	–	–	1	2
5	6	1	4822 159 00363	Knob	**	–	–	1	2
5	7	2	4822 159 00364	Knob cap	**	–	1	1	3
5	8	2	M7 432 18	Switch	*	–	–	1	1
		1	4822 197 00061	Rear plate	**	–	–	1	2
			971/71	10 cc bottle of switch oil					

Purpose of column S

Components not marked

These should be present at the Service Department in the country concerned or at the customer's who is using the apparatus.
They include:

a. nearly all electrical components;
b. mechanical parts which are vulnerable, or which are subject to wear.

Components marked with one asterisk

These components generally have a long or unlimited service-life, but their presence is essential for the correct working of the apparatus. Stocking up of a few of these components depends on the following factors:

a. the number of equipment present in the country concerned;
b. the necessity of having the apparatus working continuously or not;

c. the delivery-time of the components with respect to the import restrictions in the country concerned and the duration of transport.

Components marked with two asterisks

These components have a long or unlimited service-life and they are not essential for the correct working of the apparatus.
Generally there is no local stock.

B. ELECTRICAL PARTS

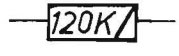
No standard parts are included in this parts list with the exception of choice resistor R4.

The standard parts in the circuit diagram (Fig. 8) are indicated with symbols from which the service codenumber can be derived.

The key to the code is given below:

Carbon resistor	0,25 W	≤ 1 MΩ: 5 % > 1 MΩ: 10 %	902/K...
Carbon resistor	0,5 W	≤10 MΩ: 1 % >10 MΩ: 2 %	901/...
Ceramic capacitor	500-700 V		904/...
Styroflex capacitor	500 V	1 %	905/D...
Air trimmer			908/...

Example:

	Code number	901/120K
	Code number	904/4E7

The correct value of the choice resistor R4 is determined during factory adjustment. All resistors are carbon film resistors, unless otherwise specified.

Resistors

Number	*Service code number*	*Value*	*Tolerance (%)*	*Watt*	*Description*
R1	4822 183 00044	50 kΩ			Double carbon potentiometer
R2	4822 071 00728	1 kΩ			Carbon potentiometer
R4	901/51K–150K	51 kΩ–150 kΩ	1	1/8	Choice resistor
R5	E 003 AB/D 3K3	3,3 kΩ	1	1/8	
R7	E 003 AB/D 8K2	8,2 kΩ	1	1/8	
R9	928/4K5	4,7 kΩ			Thermistor
R10	E 003 AB/D 1K	1 kΩ	1	1/8	
R12	E 003 AB/D 3K3	3,3 kΩ	1	1/8	
R16	4822 183 00045				Thermistor
R18	E 097 AD/5K	5 kΩ			Carbon potentiometer
R20	E 097 AD/2K	2 kΩ			Carbon potentiometer
R26	E 097 AD/1K	1 kΩ			Carbon potentiometer

Capacitors

Number	*Service code number*	*Value*	*Volt*	*Description*
C1	C 005 BC/25E	25 pF		Trimmer
C2	4822 069 00828	400 µF	16	Electrolytic
C4	4822 069 00828	400 µF	16	Electrolytic
C6	909/X16	16 µF	40	Electrolytic
C7	C 435 AL/F250	250 µF	25	Electrolytic
C8	C 435 AL/F250	250 µF	25	Electrolytic
C11	C 435 AL/F250	250 µF	25	Electrolytic
C12	4822 069 00826	0,15 µF	125	Electrolytic
C14	4822 069 00827	0,18 µF	125	Electrolytic
C16	4822 069 00825	33 000 pF		Polystyrene
C17	4822 069 00825	33 000 pF		Polystyrene
C19	4822 069 00826	0,15 µF	125	Polystyrene
C21	4822 069 00827	0,18 µF	125	Polystyrene
C24	C435 AL/F250	250 µF	125	Electrolytic

Chokes

L1	4822 153 00947	30 µH	Choke

Semi-conductors

TS1	OC 171	Transistor	
TS2	OC 171	Transistor	
TS4	GET 885	Transistor	
TS5	GET 885	Transistor	
TS6	OC 47	Transistor	These equivalent types
TS7	OC 47	Transistor	are furnished for
GRZ1	BZY 56	Zener diode	OC 43 resp. OAZ 240.

The semi-conductors can be ordered from the Commercial dept. "Electronica".

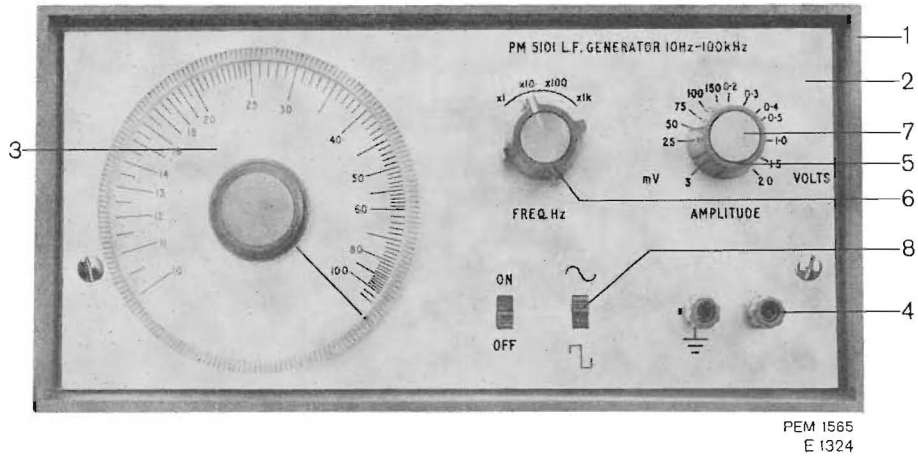


Fig. 5. Front view with indication of the mechanical parts

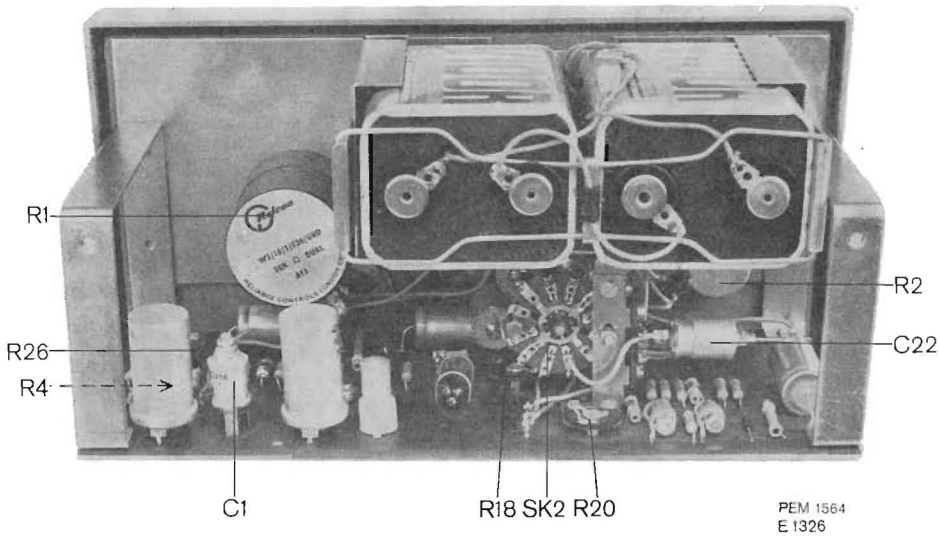


Fig. 6. Inside view

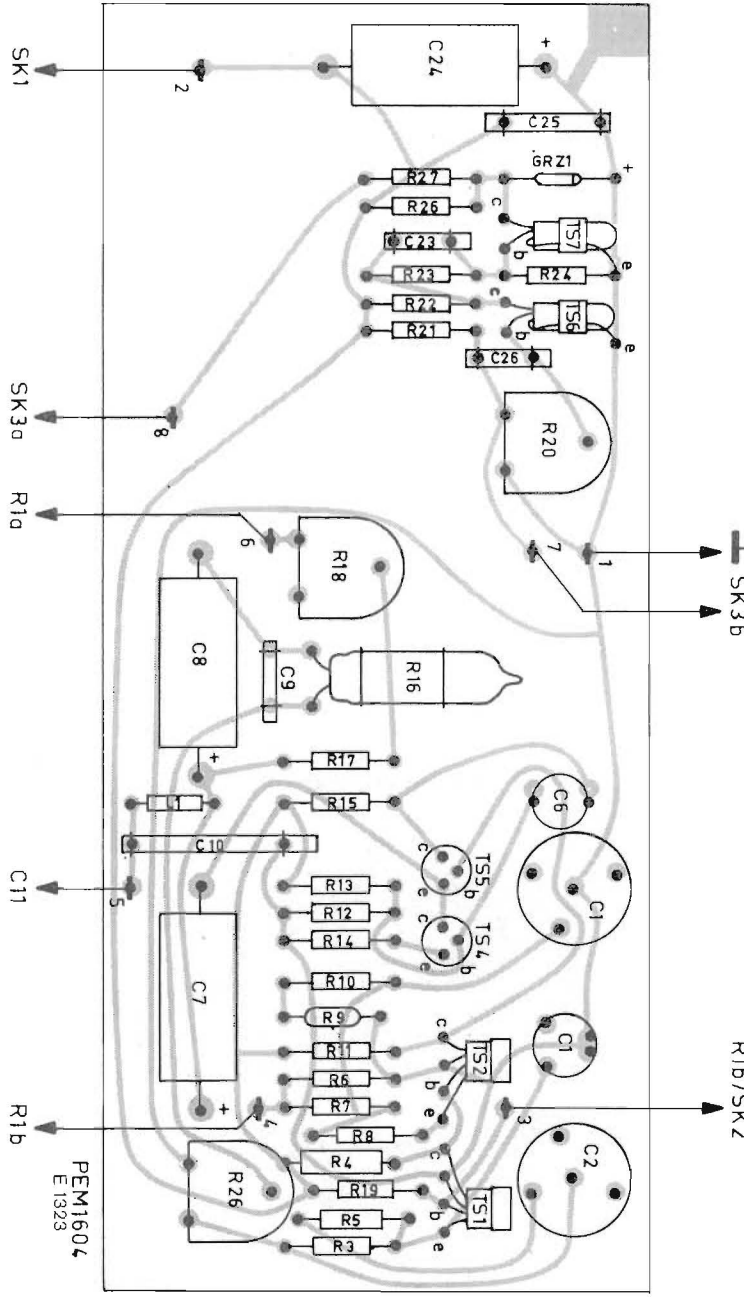

SK1
2
C24
C25
GRZ1
R27
R26
C23
R23
R22
R21
C26
TS7
TS6
R24
SK3a
8
R20
R1a
6
R18
7
1
SK3b
C8
C9
R16
R17
C1
R15
C10
C11
5
R13
R12
R14
R10
R9
R11
R6
R7
R8
R4
R19
R5
R3
C7
TS5
TS4
TS2
TS1
C6
C1
C1
C2
R1b/SK2
3
R1b
4
R26
PEM1604
E 1323

Fig. 7. Unit A

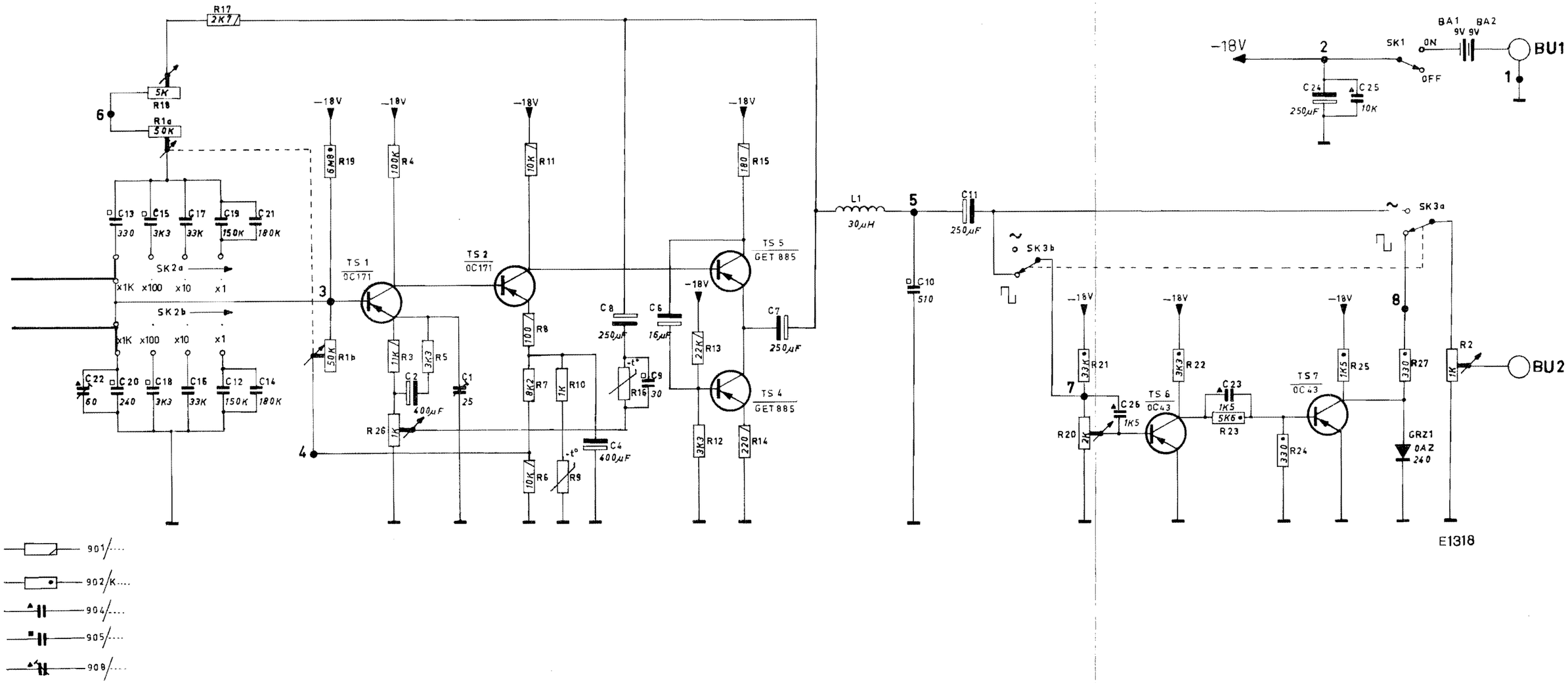


Fig. 8. Circuit diagram

Sales and service all over the world

Algérie:	S.A. Philips Nord-Africaine, Immeuble Maurétania, Carrefour de l'Agha, Alger
Argentina:	Philips Argentina S.A., Casilla Correo 3479, Buenos Aires
Australia:	Philips Electrical Ind. (Pty) Ltd., P.O.B. 2703, Sydney
België:	Philips S.A., Keizerinneboulevard 66, Brussel
Belgique:	Philips S.A., 66 Boulevard de l'Impératrice, Bruxelles
Bolivia:	Philips Sudamericana, Casilla 1609, La Paz
Brasil:	Messrs. Inbelsa, Caixa Postal 3159, São Paulo
Canada:	Philips Electronics Ind. Ltd., 116 Vanderhoof Avenue, Toronto 17, Ontario
Chile:	Philips Chilena S.A., Casilla 2687, Santiago de Chile
Colombia:	Philips Colombiana S.A., Communications Department, Apartado Nacional 1505, Bogotá
Costa Rica:	Philips de Costa Rica Ltda., Apartado Postal 4325, San José
Curaçao:	Philips Antillana N.V., Postbus 523, Willemstad
Danmark:	Philips A.S., Prags Boulevard 80, København
Deutschland:	Philips Industrie Elektronik G.m.b.H., Röntgenstrasse 22, Hamburg, Fuhlsbüttel
Ecuador:	Philips Ecuador S.A., Casilla 343, Quito
Egypte:	Philips Orient S.A., Adly Pacha Street 26, Cairo
Eire:	Philips Electrical (Ireland) Ltd., Newstead, Clonskeagh, Dublin 6
El Salvador:	Philips de El Salvador, Apartado Postal 865, San Salvador
España:	Philips Ibérica S.A.E., Paseo de las Delicias 65, Madrid
Ethiopia:	Philips Ethiopia Ltd., P.O.B. 659, Addis Abeba
France:	Philips Industrie, S.A., 105 Rue de Paris, Bobigny (Seine)
Great Britain:	M.E.L. Equipment Company Ltd., Instrument House, 207 King's Cross Road, London W.C. 1
Guatemala:	Philips de Guatemala S.A., Apartado Postal 238, Guatemala City
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New Zealand:	Electronic Development and Applications Co. Ltd., 18-20 Lorne St., Wellington
Nigeria:	Philips (Nigeria) Ltd., P.M. Bag 1136, Apapa, Lagos
Nippon:	Industrial Development and Consultant Co., Nikkatsu International Building, Room 420, Tokyo
Norge:	Norsk A.S. Philips, Postboks 5040, Oslo
Österreich:	Philips G.m.b.H., Abt. Industrie, Makartgasse 3, Wien
Pakistan:	Philips Electrical Co. of Pakistan Ltd., Bunder Road, P.O.B. 7101, Karachi
Paraguay:	Philips del Paraguay S.A., Casilla de Correo 605, Asunción
Perú:	Philips Peruana S.A., Apartado Postal 1841, Lima
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