

IMPORTANT

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

Contents

GENERAL INFORMATION

I. Characteristics	5
II. Description of the Block Diagram	6

DIRECTIONS FOR USE

III. Installation	7
IV. Functions of the Controls	7
A. Input	7
B. Deflection coefficient	8
C. Bandwidth	8
D. Shift	8
E. Gain Adjustment	8
V. Applications	9

SERVICE DATA

VI. Introduction	11
VII. Principles of the control loop	12

VIII. Circuit description	13
A. Input circuit	13
B. HF amplifier	13
C. DC amplifier	13
D. Interstage network	13
E. Chopper amplifier	15
F. Final amplifier	16

IX. Checking and Adjusting	17
A. Check of the chopper amplifier	17
B. Grid current compensation	18
C. Balance adjustment	19
D. Square-wave response	19
E. Deflection coefficient	20
F. Frequency response curve	20
G. Deflection and Shift	20
H. AC/DC switch; Check zero	20
I. Input attenuator	20

X. List of service parts	22
A. Mechanical parts	22
B. Electrical parts	23

List of Figures

1	Schematic diagram of the controls	7	14	Left-hand view	18
2	Input terminal and controls	7	15	Pulser	19
3	Y-deflection coefficient switch	8	16	Input RC standardiser	21
4	Bandwidth selector	8	17	Printed circuit U 7 (Supply filter)	27
5	Shift control	8	18	Printed circuit U 8 (Final stage)	27
6	Gain adjustment control	8	19	Printed circuit U 9 (Grid circuit)	27
7	Voltage measurement	9	20	Printed circuit U 10 (H.F. amplifier)	27
8	Limits of the Y deflection	9	21	Printed circuit U 11 (Amplifier)	29
9	Controlloop	12	22	Printed circuit U 12 (Chopper Amp.)	27
10	Bandwidth characteristics	14	23	Attenuator circuit	30
11	Operation of the cross-over filter	14	24	Chopper amplifier circuit	35
12	Operation of the demodulator	15	25	Final amplifier circuit	41
13	Right-hand view	17	26	HF and LF amplifier circuit	47

GENERAL INFORMATION

The PM 3332 is an H.F. amplifier, built into a plug-in unit for the vertical channel of basic oscilloscope PM 3330.

Owing to its high sensitivity and bandwidth, the unit covers a wide range of applications.

The amplifier is chopper-stabilised, with the result that d.c. drift is eliminated.

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 apparatus.

The numerical values hold good for nominal mains voltages unless otherwise stated.

Characteristics

Input circuit

input	asymmetrical
coupling	a.c. or d.c.
input socket	B.N.C.
input impedance	1 M Ω // 15 pF
maximum permissible d.c. voltage in position "AC"	400 V

Amplifier

zero level	by means of a push-button "CHECK ZERO", the zero level can be checked
deflection coefficient	adjustable to 12 calibrated values, i.e.: 500 μ V - 1 mV - 2 mV/cm etc. to 2 V/cm, tolerance $\pm 3\%$ continuous attenuation 1 : 3 is possible (non-calibrated)

Bandwidth

d.c.: 0...50 Mc/s ("FULL") or 0...100 kc/s
a.c.: 1.6 c/s...50 Mc/s ("FULL") or 1.6 c/s...100 kc/s

Noise in most sensitive position at bandwidth 0...50 Mc/s

open input	4 mm
short-circuited input	3 mm

at bandwidth 0...100 kc/s

open input	1.5 mm
short-circuited input	0.4 mm

Rise time: at maximum bandwidth

7 nsec.

Rise time of the unit itself

5 nsec.

Overshoot

< 2%

Pulse droop

< 3%

Magnification

Up to $10\times$ the useful screen height (symmetrically around the centre of the screen)

Of a picture that has been magnified to $3\times$ the usefull screen height (symmetrical around the centre of the screen), the peaks can be made visible by means of the shift control

Drift	500 μ V/week
Triggering of the time base required picture height:	3 mm for frequencies up to 10 Mc/s 10 mm for frequencies up to 30 Mc/s 1 cm in position "AUT." 1 cm video signal in positions "TV LINE" and "TV FRAME"
Mechanical data	width 15 cm depth 27.5 cm (including knobs and plug) height 17.5 cm weight 2 kg
Accessories	Manual
Optional accessories	measuring probe PM 9331 A/10 input impedance 10 M Ω // 8 pF attenuation 1 : 10, tolerance \pm 3% maximum permissible voltage 1000 V peak

Description of the block diagram

The input circuit includes an "AC-DC" switch, a step attenuator ("mV/cm - V/cm") and a push-button "CHECK ZERO".

The step attenuator is connected, via a cathode follower stage, to two parallel connected amplifiers, an a.c. coupled H.F. amplifier and a d.c. coupled L.F. amplifier. The output voltages are applied to an output amplifier via a cross over filter.

The input signal of the output amplifier is compared, via an attenuator, with the signal on the input of the cathode follower stage.

The difference voltage, due to drift in the d.c. coupled

L.F. amplifier, is converted into a square-wave voltage by a mechanical chopper.

This square-wave voltage is amplified in an a.c. coupled amplifier and after that detected. The output signal of the detector is applied to the d.c. coupled L.F. amplifier, with the result that drift in this amplifier is heavily fed back.

The output amplifier contains the continuous gain control, the "SHIFT" control and a screwdriver adjustment "GAIN ADJ.".

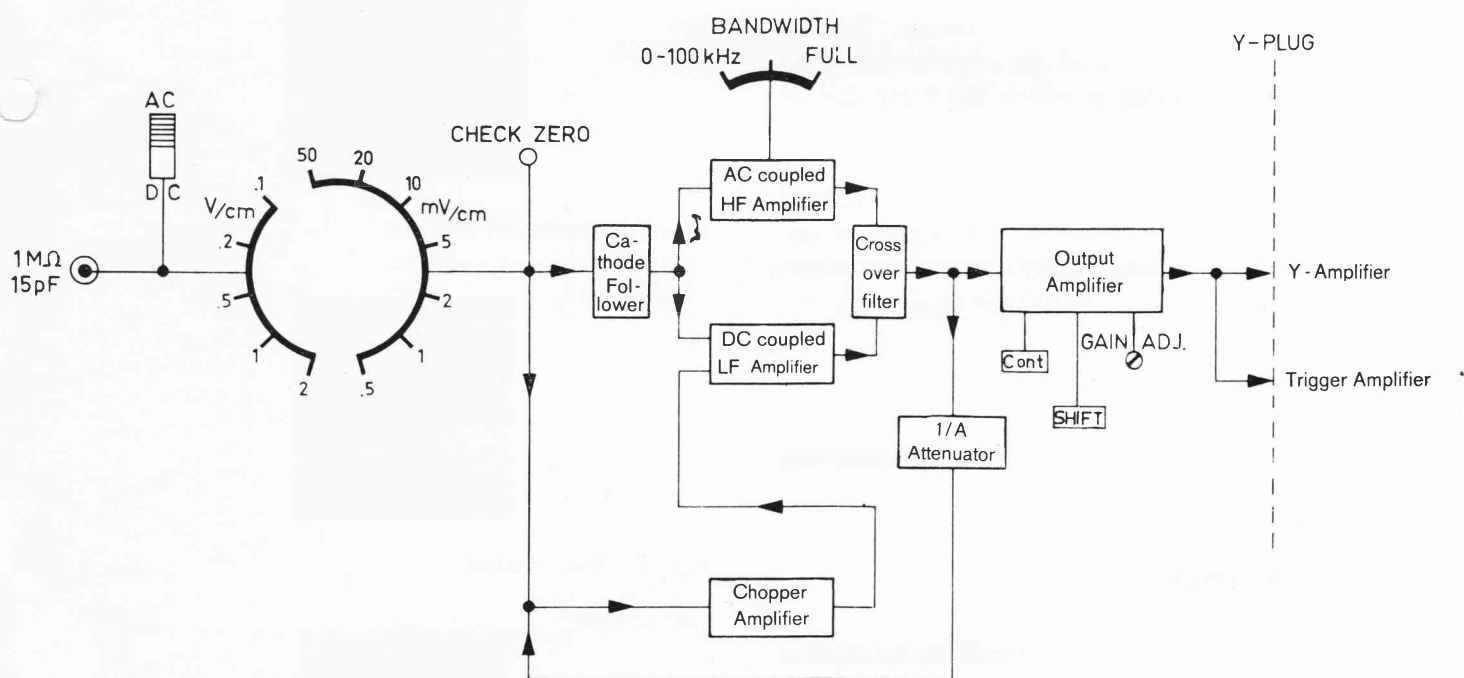
The output voltage of the output amplifier is applied to the vertical amplifier and the trigger preamplifier, via the Y-plug.

DIRECTIONS FOR USE

Installation

The PM 3332 should be slid into the left-hand compartment (Y-unit) of the basic oscilloscope PM 3330.

Switching on is effected via the mains switch of the basic oscilloscope.



PEM 2891

Fig. 1. Schematic diagram of the controls

Functions of the controls

IV

Fig. 1

A. INPUT

The input socket "1 MΩ// 15 pF" is connected to the step attenuator ("mV/cm" – "V/cm") via switch "AC-DC". In position "AC", the input is a.c. coupled to the attenuator; in position "DC" the coupling is direct. By depressing push-button "CHECK ZERO", the connection between the step attenuator and the amplifier is cut-off and the input of the amplifier is earthed. With this the zero level of the amplifier can be checked.

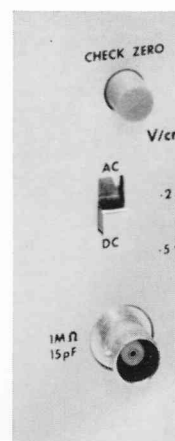


Fig. 2. Input terminal and controls

B. DEFLECTION COEFFICIENT

The deflection coefficients are adjusted by means of the attenuator ("mV/cm" – "V/cm"). These deflection coefficients are calibrated if the continuous gain control is turned fully clockwise (indicated with "CAL.").

C. "BANDWIDTH"

The maximum bandwidth is obtained by setting switch "BANDWIDTH" to position "FULL". In the most sensitive position of the attenuator, a noise band having a width of a few millimetres will appear on the screen.

In position "0...100 kc/s" of switch "BANDWIDTH", the bandwidth of the amplifier is limited to the indicated value at which the noise can be neglected.

Note: The noise is also reduced while maintaining the maximum bandwidth, by reducing the sensitivity of the amplifier by means of the attenuator.

D. "SHIFT"

The picture can be shifted in a vertical direction with the aid of knob "SHIFT".

E. "GAIN ADJ."

The deflection coefficients of the unit can be checked by applying the calibration voltage of the basic oscilloscope to the input of the unit. If the deflection coefficients do not correspond to the values indicated on the text plate, the coefficients can be corrected by means of setting "GAIN".

Note: With this adjustment, the continuous gain control should be turned fully clockwise, ("CAL").

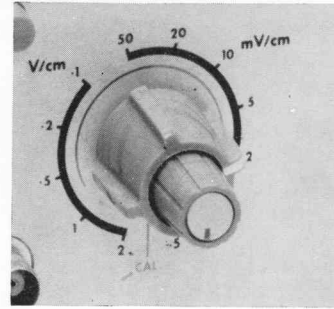


Fig. 3. Y-deflection coefficient switch

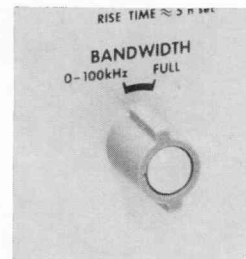


Fig. 4. Bandwidth selector

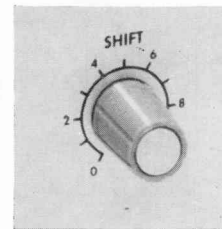


Fig. 5. Shift control

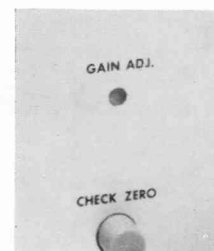


Fig. 6. Gain adjustment control

Applications



Voltage measurements

When measuring the voltage of a signal use is made of the calibrated deflection coefficients of the vertical deflection system. Using the control elements on the plug-in unit and the basic oscilloscope, adjust to a triggered trace.

In Fig. 7 the peak-to-peak value amounts to $3 \times 20 \text{ mV} = 60 \text{ mV}$.

Note: The tolerance of the deflection coefficient (3%) can be reduced by adjusting, in the position used, the deflection coefficient by means of setting "GAIN ADJ."

For this, the calibration voltage of the basic oscilloscope can be used.

Figure 8 indicates the maximum magnification (A) and the part of the magnified signal (B) that can be displayed on the screen (C) by means of the "SHIFT" control.

Note: When loading to more than $10\times$ the useful screen height, the amplifier will be overloaded. The picture then obtained is no longer proportional to the input voltage.

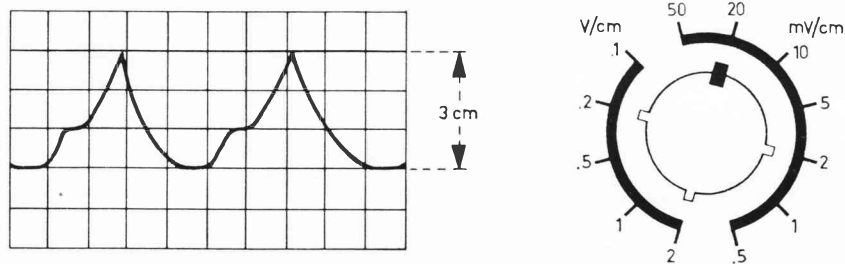


Fig. 7. Voltage measurement

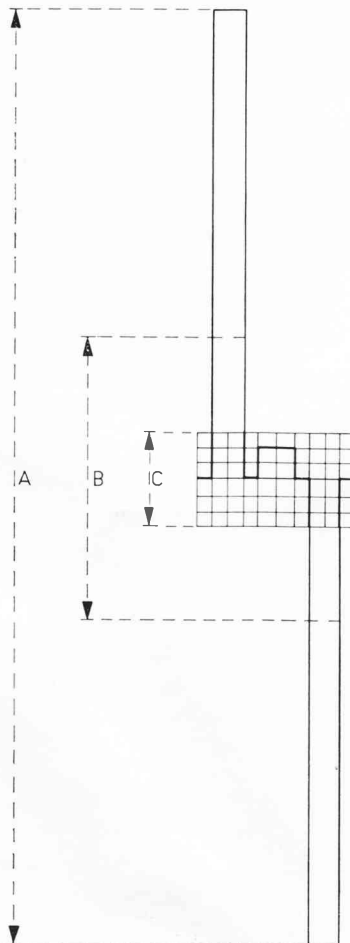


Fig. 8. Limits of the Y deflection

PEM 2892

SERVICE DATA

VI

Introduction

The pre-amplifier consists of an AC coupled HF-amplifier and a DC coupled LF-amplifier the outputs of which are combined by a cross-over filter. The latter forms a high-pass filter for the HF-amplifier and a low-pass filter for the DC-amplifier. The HF-amplifier has a bandwidth from 300 Hz to 100 MHz; the DC-amplifier has a bandwidth from DC to 4 MHz. The -3dB frequency of the cross-over filter lies at 100 kHz. In this way a split-band amplifier is obtained with a bandwidth from DC to 100 MHz.

The advantages of the split-band amplifier are:

a. lower noise

H.F. transistors suffer from a serious $1/f$ noise at frequencies lower than approx. 100 kHz. L.F. transistors cause a serious noise at higher frequencies. Moreover, they do not meet the rise-time requirements. In the split-band amplifier the best properties of the transistors are used, each in their own frequency range.

b. better DC biasing

In a split-band amplifier it is possible to adjust the transistors to their optimum collector-current i.e. for H.F. transistors to approx. 10 mA, for L.F. transistors to approx. 1 mA.

c. No necessity for constant dissipation networks

As the time-constant of the thermal processes in

the H.F. transistors amounts to several milliseconds and the H.F. amplifier is followed by a 100 kHz high-pass filter, there is no necessity to provide the H.F. amplifier with constant dissipation networks.

d. Better decoupling of the supply-voltages

As RC coupling is used, it is only necessary to have one common power supply. The supply per stage is sufficiently decoupled without impairing the L.F. square-wave response. To avoid undue interstage coupling the emitter resistors are connected to earth.

It is possible to switch off the AC amplifier with switch SK1 so that a DC amplifier remains with a bandwidth of 0...100 kHz, without HF noise.

At the 4 smallest deflection coefficients - 5 mV/cm to 0,5 mV/cm - the amplification factor of the split-band amplifier is increased by decreasing the negative feedback. A convenient deflection can be selected with switch SK4.

For the larger values, attenuator networks are inserted between the input terminal and the pre-amplifier. The DC-amplifier is provided with a control circuit (chopper amplifier) which counteracts DC drift.

The final amplifier, contrary to the pre-amplifier, is entirely push-pull connected. The output of the final amplifier is routed to both the Y-amplifier and the trigger amplifier of the basic oscilloscope.

Principles of the control-loop

VII

The input circuit of the DC amplifier consists of a differential amplifier. Input I receives signal V_i ; input II receives the control signal V_c . All drift-voltages are referred to input I where they are assumed to come from a voltage-source V_d (Fig. 9).

Output V_o of the DC-amplifier is attenuated by a factor A at the $1/A$ attenuator. At one side of voltage divider $R1 = R2 = 1.11$ Mohm, voltage V_i is fed in and at the other side voltage V_o/A ; therefore, the input of the chopper amplifier will be $\frac{1}{2}(V_i + V_o/A)$.

After amplification, control voltage V_c amounts to:

$$V_c = -\frac{1}{2} B (V_i + V_o/A).$$

At terminal I the input stage of the DC-amplifier receives a voltage equal to $V_i + V_d$ and at termi-

nal II voltage V_c . The difference is amplified ($-A$) times so output V_o amounts to:

$$V_o = -A (V_i + V_d) - [-\frac{1}{2} B (V_i + V_o/A)]$$

extracting V_o gives:

$$V_o = -A (V_i + \frac{V_d}{1 + \frac{1}{2}B})$$

As $B \approx 2000$, it is clear that drift V_d is reduced by a factor ≈ 1000 .

If SK3 is in position "AC", capacitor C102 is inserted in series with R1 so voltage divider R1—R2 is blocked for DC. Any leakage voltage of C26 is added to V_d but now the "new" drift voltage V_d' will

be reduced by a factor $\frac{1}{1 + B}$.

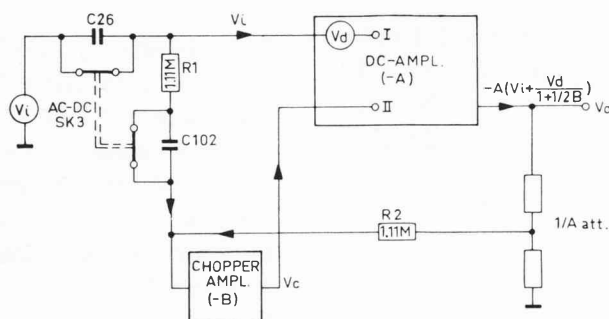


Fig. 9. Controlloop

Circuit description



A. INPUT CIRCUIT (Fig. 23)

When the AC—DC switch SK3 is in position “AC” it is possible to observe small AC signals superimposed on a maximal 400 V DC-voltage. At the same time relay RE101 is energised which switches capacitor C102 into comparison circuit R1—R2 (Fig. 9). In this way any DC component at the input circuit which may be due, among other things, to the leakage of C26, is compensated by the action of the chopper amplifier.

In the “AC” position of SK3, blocking capacitor C26 may be charged by a DC input voltage. On switching over to position “DC” the capacitor is discharged to prevent the charge of C26 from destroying any delicate test object when switching over again from DC to AC.

When the step attenuator is put at the 4 smallest deflection-coefficients (0,5, 1, 2, 5 mV/cm) the input signal is not attenuated. Trimmers C18-C21-C24-C29 allow the input capacitance to be adjusted to precisely 15 pF. For the larger deflection coefficients, attenuator networks are inserted between the input terminal and the cathode follower B101. With trimmers C33-C36-C39-C43-C47-C51-C54-C58, the input capacitance can be adjusted to 15 pF. Trimmers C32-C34-C38-C42-C46-C49-C53-C57 allow an adjustment for optimum square-wave response.

The 1.11 Mohm resistor consists of the resistors R103 (1 Mohm) and R102 (110 Kohm). This value is chosen to obtain a 1 Mohm input resistance because a grid-current compensating network with a 10 Mohm source resistor (R104) is connected at this point, and it is parallel to the 1.11 Mohm resistance. The grid-current compensating network consisting of resistors R106-R107-R110-R115 and potentiometer R108 delivers a positive or negative current, depending on the position of R108. This current is required for cathode follower stage B101, which supplies the input signal to the split-band amplifier via overload-protecting diodes GR104-GR106.

Push-button SK2 disconnects the input signal and earths the grid of the cathode-follower, to indicate the zero-level of the display.

Diodes GR101 and GR102 protect the chopper amplifier when the DC part of the split-band amplifier is overdriven.

B. HF-AMPLIFIER (Fig. 26)

The AC components of the input signal are fed into the HF amplifier via emitter-follower TS102. The three nearly identical stages consist of an ordinary emitter-amplifier and an emitter-follower.

Each stage provides an output which is in anti-phase with respect to its input. As a whole the HF-amplifier provides a 180 degrees phase-shift to match the output of the DC-amplifier.

In the positions “2 - 1 - .5 mV/cm” of SK4 the gain of the H.F. amplifier is increased by decreasing the current feedback respectively at the 3rd, 2nd and 1st stage. At these positions of SK4 the gain can be matched to that of the DC amplifier by selecting resistors as tabulated below.

Position of SK4	Resistor	
	Coarse	Fine
5 mV/cm	R138	R139
2 mV/cm	R173	R174
1 mV/cm	R158	R159
.5 mV/cm	R143	R144

If the measurements permit this, the HF-amplifier can be taken out of operation by throwing switch SK1 which cuts off only the power supply of the second stage.

C. DC-AMPLIFIER (Fig. 26)

The DC and LF-components of the input signal enter the DC coupled amplifier at the base of TS113, which is part of difference amplifier TS112 – TS114. The correction voltage delivered by the chopper-amplifier enters at the other emitter-follower (TS111). The difference of the two signals is fed, via emitter-follower TS116, to two more stages, which consist of an amplifier and an emitter-follower. At the last stage, zener-diode GR107 provides a low impedance step-down of the DC level.

When the most sensitive deflection coefficients are selected, SK4 reduces the emitter resistance of TS117 thus increasing stepwise the overall gain of the DC-amplifier from 10 x to 25 x, 50 x and 100 x. An exact match with the 1/A attenuator can be carried out by adjusting potentiometer R208.

D. INTERSTAGE NETWORK (Fig. 26)

The outputs of the HF-amplifier and the DC amplifier are combined in cross-over filter R216 – C157 and fed to emitter-follower TS401. The 1/A attenuator is connected to the emitter of TS401. It consists of precision resistors R406 – R408 – R409 – R411 and R412. Its output is fed to the chopper amplifier via the 1.11 Mohm resistors R300 – R301. The

continuous gain control R2 is also connected to the emitter of TS401.

The output impedance of the two amplifiers is very small compared with the impedance of R216 - C157. This means that, seen from the HF amplifier C157 + R216 act as a high-pass filter with a cross-over frequency of 100 kHz, thus suppressing low frequency noise components and other spurious low frequency signals, generated in the HF amplifier (Fig. 10). Seen from the LF amplifier, however, R216 + C157 act as a low-pass filter with a cross-over frequency of 100 kHz, suppressing high frequency noise components and other high frequency signals generated in the LF amplifier.

An input signal V_i applied to the split-band amplifier (see Fig. 11) causes an output signal $\alpha_1 V_i$ at "a" and an output signal $\alpha_2 V_i$ at "b" (α_1 and α_2 denoting the gain of respectively the HF amplifier and the LF amplifier).

At frequencies where $\alpha_1 \approx \alpha_2 \approx \alpha$ (α denoting the desired overall gain) the output at "a" equals the output at "b", thus no current will flow through the interstage network. Then the output at "C" equals αV_i .

At low frequencies, α_1 is smaller than α_2 and α_2 equals α . Now the output at "a" is smaller than the output at "b" so a current will flow through R216 and C157, which causes R216 - C157 to act as a low-pass filter to the output at "b". As $\alpha_2 V_i = \alpha V_i$ the output at "C" equals the output at "b".

At high frequencies, α_2 is smaller than α_1 and α_1 equals α .

Now the output at "b" is smaller than the output at "a", so a current will flow through R216 and C157, which causes R216 - C157 to act as a high-pass filter to the output at "a". As $\alpha_1 V_i = \alpha V_i$ the output at "c" equals the output at "a".

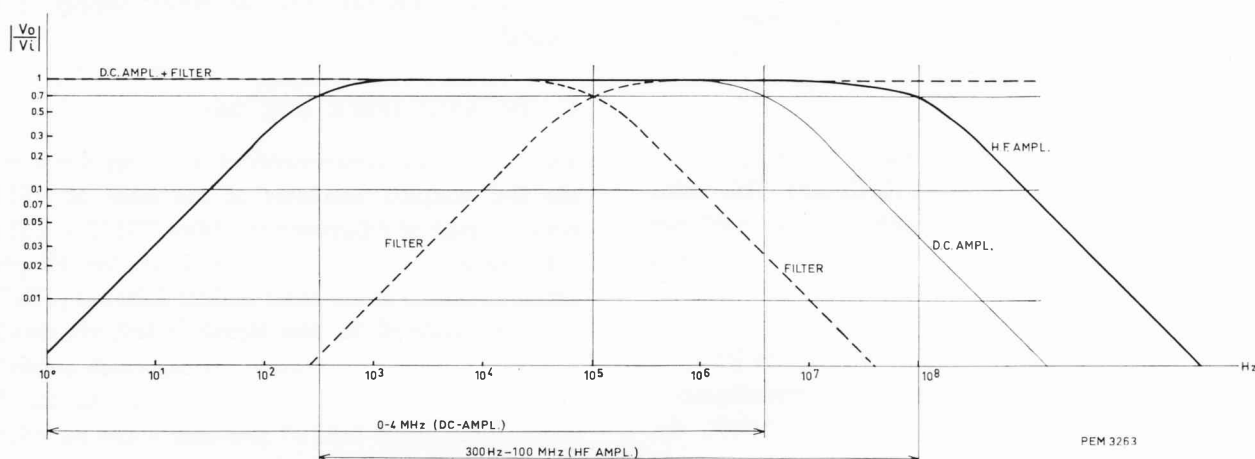


Fig. 10. Bandwidth characteristics

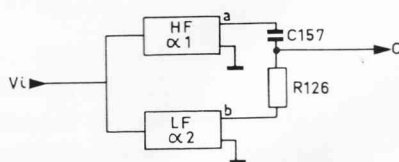


Fig. 11. Operation of the cross-over filter

E. CHOPPER AMPLIFIER (Fig. 24)

The chopper amplifier consists of:

1. the 400 Hz oscillator
2. the chopper
3. the amplifier
4. the demodulator.

The oscillator is an inductively fed-back push-pull oscillator which is tuned to 400 Hz by fixed capacitor C313 and the adjustable inductance of transformer L302. Its output drives the chopper directly, and the demodulator via a phase-shifting network. A DC voltage caused by the drift is applied to terminal 1 of the chopper. The latter switches the input of the amplifier alternately to this voltage and earth (at terminal 3) so the input receives a square wave voltage. In order to avoid hum, the earthing of the chopper is carried out at a single point near input cathode-follower B101.

The square-wave input-signal is amplified about 120x in stage TS301 – TS302 – TS303, the AC-amplification being determined mainly by the relation $R311 : R309$. The DC-amplification is determined by the relation $R311 : (R309 + R308)$ which amounts to about 1 : 1.

The next stage consisting of TS304 – TS306 gives a further 20x amplification for AC, but a 2 : 1 reduction for DC; so DC-variations have hardly any influence on the stability of the control circuit.

Via emitter-follower TS306, the chopped signal is fed to the phase-sensitive detector which contains the symmetrical NPN transistors TS307 – TS308 – TS309 – TS311.

The driving voltage of the detector is generated at two separate windings of transformer L301 which receives its primary voltage from the chopper driving source.

By the action of the collector-to-base diode of the transistors a biasing voltage builds up across capacitors C308 and C309, the charge of which can leak away across resistors R322 and R323. During the crests of the sinusoidal driving voltage the charge is supplemented until the biasing voltage equals the driving voltage, so during those times a base-current exists, which makes the transistors conductive.

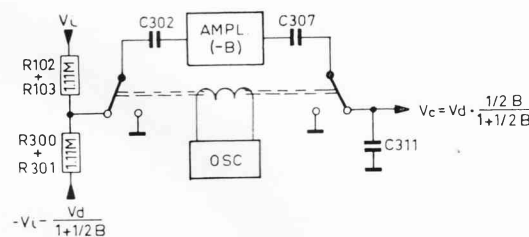
In this way, there is a change-over switch which operates synchronous with the chopper; network R332 – C317 provides the necessary phase-shift to be sure that the contact is made when the top of the square-wave is steady.

In the simplified diagram (Fig. 12) the demodulator is represented by a switch which connects capacitor C307 to capacitor C311 or earth. The switch makes a momentary contact under influence of the earlier mentioned biasing voltage.

From Fig. 12 it is clear that the polarity of the voltage over C311 will be inverse to that of the input voltage, due to the phase reversal of the amplifier. The amplitude virtually equals the peak to peak value of the amplifier output being insensitive to variations of the mean value, which could be caused by variations of the chopper duty cycle.

As the output may be either positive or negative, symmetrical transistors are used for the demodulator as they allow a bidirectional current flow as long as base-current is present. The AC earthing of the demodulator is carried out by capacitor C164. Potentiometer R187 allows the balance adjustment of the differential (first) stage of the DC amplifier. Once correctly adjusted, the balance will be maintained by the control-circuit.

The interconnection of the 1.11 Mohm resistors can be seen as a virtual earth and, as a consequence, the input resistance of the DC-amplifier will not change due to the action of the chopper amplifier.



PEM 3141

Fig. 12. Operation of the demodulator

F. FINAL AMPLIFIER (Fig. 25)

The input stage of the final amplifier consists of an asymmetrically driven long-tailed pair. The signal enters via emitter-follower TS402 at the base of TS404. The shift control enters via TS403 at the base of TS406.

At the emitter side of the long-tailed pair, screw-driver-set potentiometer R1 enables a vernier adjustment of the deflection coefficient. With trimmer C416 the rise-time can be adjusted to optimum. The output stage is provided with two complementary pairs of emitter-followers.

They allow for both fast rise and fall when displaying a squarewave, in spite of the capacitance load, present at the input of the Y-amplifier and the trigger-amplifier.

The signals enter via forward biased diodes whose standing current can be adjusted by R449 respectively R457. If, for instance, the voltage at the collector of TS404 rises, the current through GR403

decreases and the current through GR404 increases. This gives rise to an increase of the base-current of the NPN transistor TS407 which will become more conductive; so the output will become more positive. The increase of the current through GR404 causes a decrease of the base-current of PNP transistor TS408, which will become less conductive, offering a higher impedance to the NPN emitter-follower. As a whole, the capacitance present at the output of the final amplifier will be charged rapidly from a low ohmic current source.

At the time that the voltage at the collector of TS404 rises, the voltage at the collector of TS406 falls. The current through GR406 will decrease, thus opening PNP transistors TS409.

The output capacitance will be discharged rapidly through this low ohmic path.

The output voltage of the final amplifier is offered directly to the Y-amplifier of the basic oscilloscope via terminals 1BU-Y and 17BU-Y. The trigger-amplifier receives the same voltages via R236 and R237 next to terminals 16BU-Y and 32BU-Y.

Checking and adjusting

GENERAL INFORMATION

The tolerances mentioned are factory tolerances; they apply when the apparatus is readjusted completely. They may differ from the data given in chapter I.

A summary of the adjusting elements, their nomenclature and location has been given in chapter IV.

With the aid of these data, it is possible to carry out all the adjustments of low drift unit PM 3332 and to check the proper working of the plug-in unit. For this the unit should be inserted into the Y-plug-in compartment of a correctly adjusted basic oscilloscope PM 3330.

Some of the adjusting elements are on the right-hand side of the unit and are not directly accessible. When these elements should be adjusted, the unit should be connected to the basic oscilloscope via the rigid extension plug (for the code number of this plug, see the list of accessories of PM 3330).

For a complete adjustment of the instrument the sequence as described in this chapter is to be preferred.

A. CHECK OF THE CHOPPER-AMPLIFIER

It is possible to remove the chopper-amplifier from its housing after removing lid "A" (Fig. 13) and a four pin plug, a three pin plug and a single pin plug. If measurements are carried out when the amplifier is out of its housing, it should be carefully screened to avoid hum.

- Connect the positive pole of a 24 V supply to earth and to the green wire on the 4 pin plug. The negative pole should be connected to the black wire on the 4 pin plug.
- Adjust the oscillator frequency to approx 400 Hz by screwing in or out the core of coil L302.
- Apply a 1 mV negative voltage (with the aid of a suitable voltage divider and the 12 V power supply or a separate dry cell) to pin "1" of the 3-pin plug. Connect pin "2" to the "common" of the voltage divider and earth pin "3" by connecting it to the green wire of the 4-pin plug.

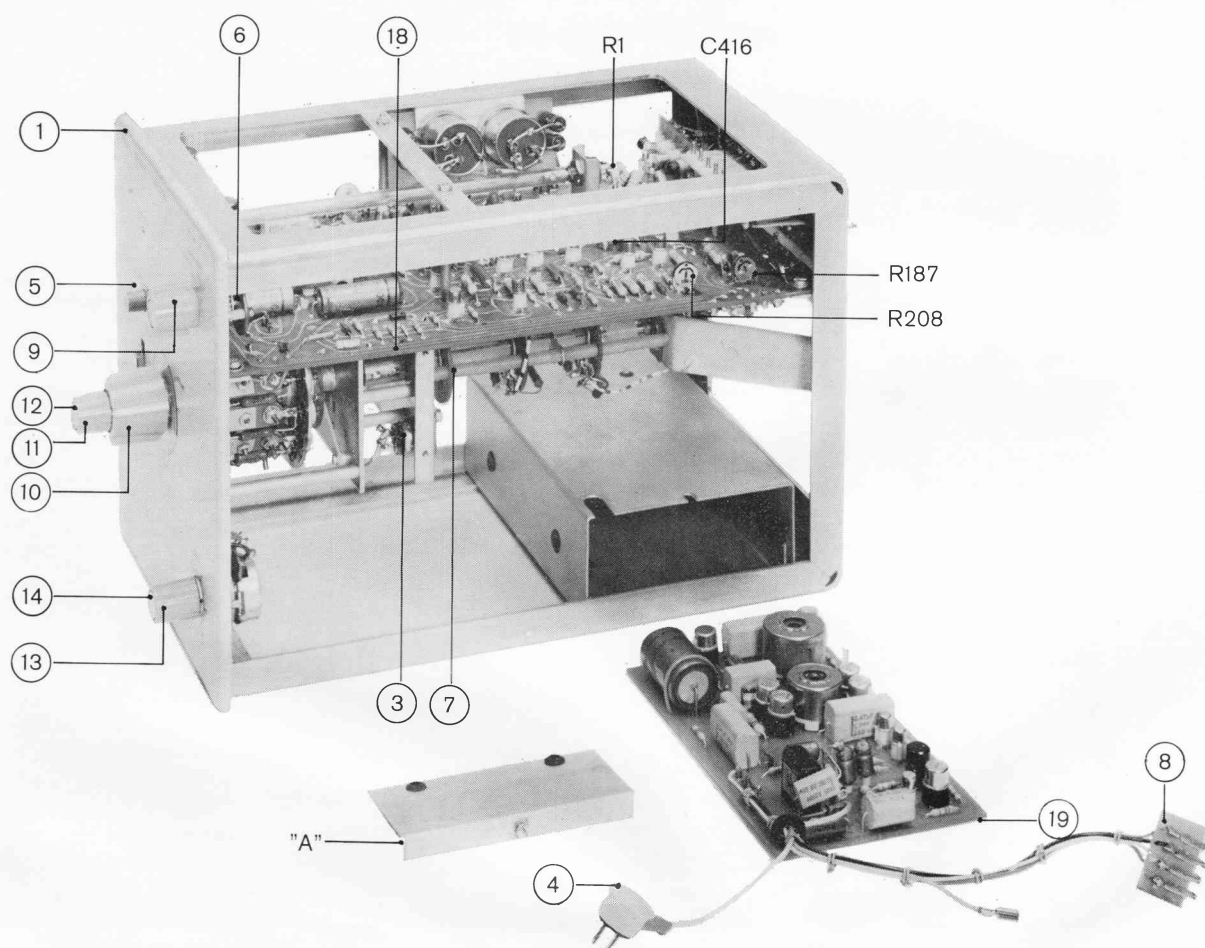


Fig. 13. Right-hand view

- Apply a load-resistance of 1 Mohm to the 2 remaining pins of the 4-pin plug. The voltage developed across this resistance should amount to a value between 2 and 2.5 V. The brown wire should be negative with respect to the orange one.
- Increase the input voltage to 3 mV. The output should be equal to 5 V or exceed that value.
- Change the polarity of the input voltage; the output voltage should be equal to or exceed 5 V, if possible, equal to the value, stated at the previous measurement.
- Remove the voltage from the 3-pin plug and interconnect pin "2" and pin "3". The output should be equal to or smaller than 20 mV.
- The noise across resistor R317 should be ≤ 10 mVrms.
- Remove the interconnection. Now the noise may not exceed 50 mVrms.

Note: If one of the last two requirements is not met, the input transistor TS301 (2N930) should be replaced.

B. GRID-CURRENT COMPENSATION R108 (Fig. 14)

- Set the knobs of the basic oscilloscope to the following positions:

"TRIGG. MODE"	: "AUT"
"TRIGG. SOURCE"	: "INT"
"TIME/cm"	: "5 msec./cm"
"X-DEFLECTION"	: "TIME BASE A"

- At the unit, set "V/cm" (SK4) to "0.5 mV/cm" and (R2) to "CAL."
- Adjust "SHIFT" (R3) so that the trace is in the middle of the screen. Short circuit the input connector.
- Adjust "Ig. COMP" (R108) so that the trace does not jump when button "CHECK ZERO" (SK2) is depressed.

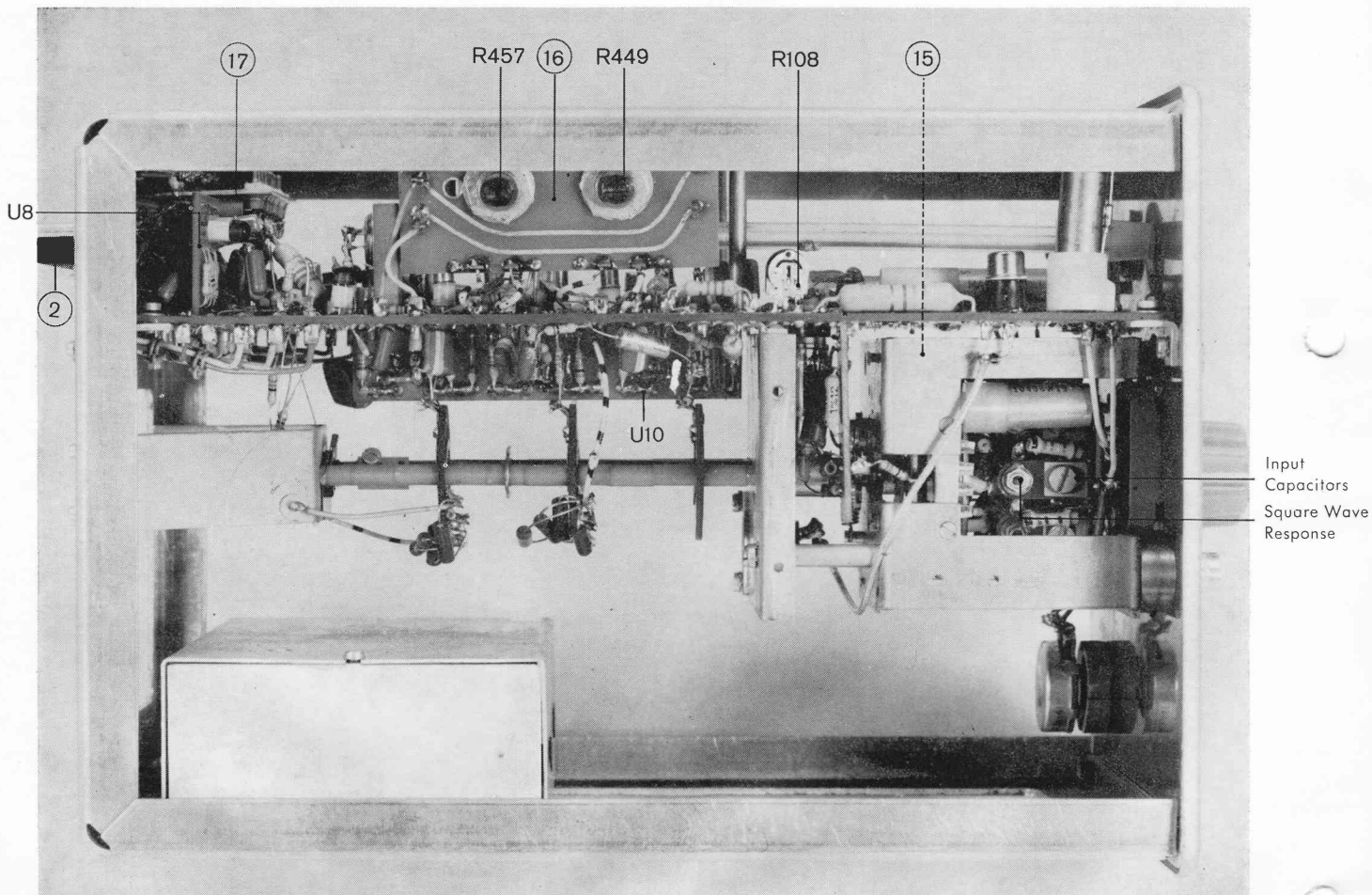


Fig. 14. Left-hand view

C. BALANCE ADJUSTMENT

R187 (Fig. 13)

Before carrying out this measurement connect unit PM 3332 to the basic oscilloscope with the extension cable (see list of accessories of PM 3330).

- Set "V/cm" (SK4) to "0,5 mV/cm". Keeping "CHECK ZERO" (SK3) depressed, turn "V/cm" (R2) quickly to and fro. If the trace is moving vertically, adjust R187 until the trace is stationary.

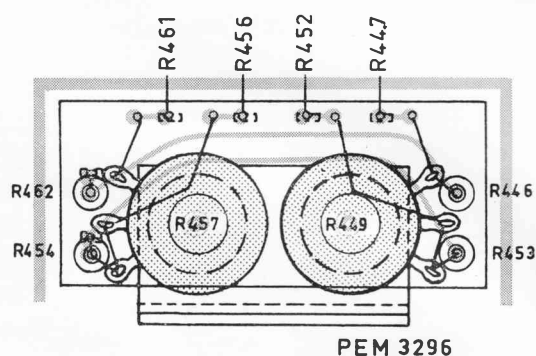
D. SQUARE WAVE RESPONSE

R208 (Fig. 13). C416 (Fig. 13)

R138-R139-R143-R144
R158-R159-R173-R174 } (Fig. 21)

Apply the rigid extension plug and set "V/cm" (SK4) to "5 mV/cm". Turn potentiometers "GAIN ADJ" (R1) and "V/cm" (R2) fully anticlockwise; set "AC-DC" (SK3) to "DC".

- Apply a square wave with a 10 Hz repetition frequency and such an amplitude as to obtain a 4 cm trace height.
- Adjust R208 to that the square wave has a flat top.
- Increase the frequency to 100 kHz with an amplitude of 20 mV_{p-p}. To obtain an optimum square-wave response the gain of the H.F. amplifier should be made equal to that of the DC amplifier. This can be obtained by changing the value of several emitter resistors according to the next table.



Item 16 of fig. 14

Position of SK3	Amplitude of the 100 kHz signal	Choice resistor coarse	Choice resistor fine
5 mV/cm	20 mV _{p-p}	R138	R139
2 mV/cm	8 mV _{p-p}	R174	R173
1 mV/cm	4 mV _{p-p}	R159	R158
0.5 mV/cm	2 mV _{p-p}	R144	R143

Note: With choice resistor "coarse" adjust the display so that some rounding off is present; with choice resistor "fine" adjust the display so that just no overshoot occurs.

- Remove the extension plug und apply a square wave with a 1.5 nsec. rise time.

This can be obtained by connecting a tunnel-diode pulse shaper to the calibration voltage. If a Tektronix TU-5 unit (cat. number 015-0038-00) is used, it should be adapted to the 80 V calibration voltage by connecting a 2700 ohm (0.1 Watt, 5%) resistor parallel to the 3300 ohm resistor of the unit (see Fig. 15).

Connect the pulser to the input terminal of the amplifier via a 5 : 1 and a 2½ : 1 attenuator (e.g. Tektronix 011-0060-00 resp. 011-0076-00) and a 50 ohm termination pad. (e.g. XE 101.96).

- Set the knobs of the basic oscilloscope to the following positions:

"TRIGG. MODE" : "H.F."
 "TRIGG. SOURCE" : "INT"
 "TIME/cm" : 0.05 μsec/cm
 "MAGN" : × 5

- Set the knob of the PM 3332 "V/cm" (SK4) to "5 mV/cm".
- With trimmer C416 adjust for a minimum rise time.

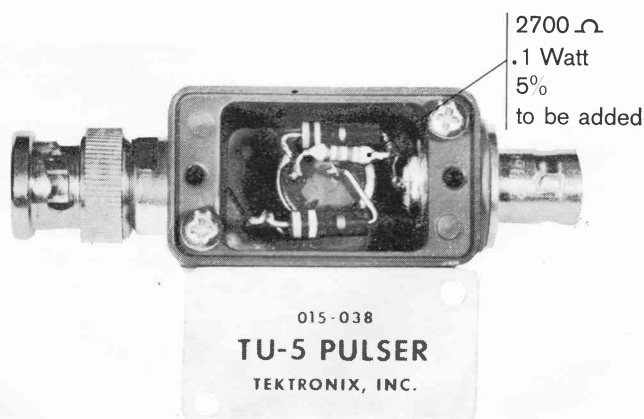


Fig. 15. Pulser

E. DEFLECTION COEFFICIENT

- Set “V/cm” (SK4) to “5 mV/cm” and “V/cm” (R2) to “CAL.”.
- Apply a 20 mV calibration voltage to the input of the plug-in unit.
- Adjust “GAIN ADJ.” (R1) so that the trace-height amounts to precisely 40 mm.
- It should be possible to reduce the trace height to less than 16 mm with “V/cm” (R2).

F. FREQUENCY RESPONSE CURVE

After adjusting the square wave response (point D) and the deflection coefficient (point E) the —3 dB point of the unit should lie at a frequency of more than 50 MHz.

The frequency response curve can be measured with e.g. the PHILIPS A.M./F.M.-generator GM 2621 and the PHILIPS H.F.-millivoltmeter GM 6025. The latter is to check that the input voltage remains constant at the various frequencies.

- Set “X-deflection” (SK7) on the basic oscilloscope to “50 Hz”.
- Set “V/cm” (SK4) on the unit to “5 mV/cm” and “V/cm” (R2) to “CAL.”.
- Connect the output connector HF II with a terminated 50-Ohm cable to a T-piece which takes in the HF probe of the millivoltmeter. Apply the T-piece to the input terminal of the plug-in unit.
- Switch the generator frequency to 10 MHz and adjust the voltage to a 40 mm trace height. Note the indication of the millivoltmeter.
- Increase the frequency to 50 MHz and adjust the amplitude to the same value as noted before.
- The trace height should exceed 28 mm.

G. DEFLECTION AND SHIFT

Before carrying out this measurement, check that the DC balance and the sensitivity have been correctly adjusted (see point C and E).

- Set the “AC/DC” switch (SK3) to “AC”, “V/cm” (SK4) to “5 mV/cm” and “V/cm” (R2) to “CAL.”.
- Set “TIME/cm” on the basic oscilloscope to “0.2 msec/cm”.
- Apply a triangular (or sinusoidal) signal with a frequency of 2 kHz and an amplitude of 90 mV_{p-p}.
- The control range of “SHIFT” (R3) should be so large, that the tops of the trace can be brought within the measuring graticule.
- With this triple overdriving, no distortion of the trace should occur.

H. AC/DC SWITCH; CHECK ZERO

- Set the below mentioned knobs to the following positions:
 - “AC/DC” (SK3) to “DC”
 - “V/cm” (SK4) to “5 mV/cm”
 - “V/cm” (R2) to “CAL.”.
 - Apply a 20 mV calibration voltage to the input of the plug-in unit.
 - Adjust “SHIFT” (R3) so that the lower side of the trace coincides with the centre line of the screen.
 - Set SK3 to “AC”.
- The DC components of the calibration voltage should be blocked, as a result of which the trace is written approximately symmetrically around the centre line of the screen.
- Slowly depress button “Check Zero” (SK2).
- First the signal should be visible in its differentiated form and next, it should disappear completely.

I. INPUT ATTENUATOR

1. Attenuation and square wave response

For the adjustment of the attenuator, in every position of “V/cm” (SK4), the corresponding trimmers are accessible via holes in the screening plate (see Fig. 14).

- Apply the calibration voltage of the basic oscilloscope to the input of the PM 3332.
- After correct adjustment of the deflection coefficient (see point E) the trace height should amount to precisely 40 mm.
- Check the trace height in all other positions of SK4 according to the table below; the trace height should amount to 40 mm, + or — 2%.
- At the same time, adjust the trimmers mentioned in the table for optimum square wave response.

Calibration voltage	V/cm (SK4)	Trimmer
2 mV	0.5 mV/cm	—
4	1	—
8	2	—
20	5	—
40	10	C31
80	20	C34
0.2 V	50	C38
0.4	0.1 V/cm	C42
0.8	0.2	C46
2	0.5	C49
4	1	C53
8	2	C57

2. Input capacitance

With the aid of an input RC standardiser (Fig. 16) (e.g. Tektronix cat. number 011-0073-00 BNC) the input capacitance can be adjusted to 15 pF in all positions of SK4.

- Apply the calibration voltage of the basic oscilloscope to the input of the unit via the input RC standardiser.
- Adjust the input capacitance by means of the trimmers mentioned in the tabel below so that the square wave response is optimum.

Calibration voltage	V/cm (SK4)	Trimmer
4 mV	0.5 mV/cm	C18
8	1	C21
20	2	C24
40	5	C29
80	10	C33
0.2 V	20	C36
0.4	50	C39
0.8	0.1 V/cm	C43
2	0.2	C47
4	0.5	C51
8	1	C54
20	2	C58

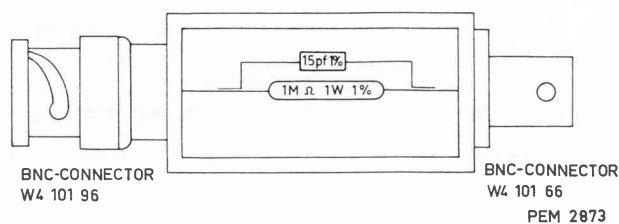


Fig. 16. Input RC standardiser

List of service parts



A. MECHANICAL PARTS

<i>Item</i>	<i>Fig.</i>	<i>Code number</i>	<i>Description</i>	<i>Qty.</i>	<i>S</i>
1	13	4822 454 40035	Textplate	1	**
2	14	W4 125 73	Connector	1	*
3	13	979/5 x 180	Socket	1	*
4	13	4822 211 00854	Plug	1	*
5	13	4822 159 00445	Push button	1	**
6	13	4822 273 30133	Switch SK1	1	*
7	13	4822 273 70013	Switch SK4	1	*
8	13	4822 265 40037	Plug (panel)	1	*
9	13	4822 159 00321	Knob	1	**
10	13	4822 159 00318	Knob	1	**
11	13	4822 159 00359	Knob	1	**
12	13	4822 159 00358	Cap	1	**
13	13	4822 159 00315	Knob	1	**
14	13	4822 159 00314	Cap	2	**
15	14	4822 105 30039	Unit 4 (Attenuator)	1	*
16	14	4822 214 10032	Unit 6 (Output adjustment)	1	*
17	14	4822 214 10033	Unit 7 (Supply filter)	1	*
18	13	4822 214 10034	Unit 11 (Amplifier)	1	*
19	13	4822 214 10035	Unit 12 (Chopper amplifier)	1	*

PURPOSE OF THE COLUMN "S"

— Components not marked

They should be present at the Service Department in the country concerned or at the customer who is using the apparatus.

They include:

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

- a. the number of equipment present in the country concerned;
- b. the necessity of having the apparatus working continuously or not;
- c. the time of delivery of the components with respect to the import restrictions in the country concerned and the duration of the transport.

— Components marked with one star

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:

— Components marked with two stars









These components have a long or unlimited service-life and they are not essential for the correct working of the apparatus. Generally they are not stocked locally.









B. ELECTRICAL PARTS

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



The standard parts in the circuit diagrams are indicated with symbols from which the service code number can be derived.

The key to the code is given below:

	Carbon resistor	0.25	W	≤ 1 M Ω : 5% > 1 M Ω : 10%	902/K
	Carbon resistor	1	W	≤ 2.2 M Ω : 5% > 2.2 M Ω : 10%	900/P
	Carbon resistor	0.5	W	≤ 10 M Ω : 1% > 10 M Ω : 2%	901/
	Wire-wound resistor	0.4—1.8	W	0.5%	901/W
	Carbon resistor	0.5	W	≤ 1.5 M Ω : 5% > 1.5 M Ω : 10%	902/P
	Wire-wound resistor	5.5	W	≤ 270 Ω : 10% > 270 Ω : 5%	938/A
	Wire-wound resistor	10	W	5%	938/B
	Carbon resistor	0.125	W	5%	902/A

	Ceramic capacitor	500—700	V		904/
	Ceramic "Pin-up" capacitor	500	V		904/P
	Styroflex capacitor	500	V	1%	905/D
	Polyester capacitor	400	V	10%	906/
	Paper capacitor	1000	V	10%	906/V
	Wire-wound trimmer				907/
	Ceramic trimmer ($\leq 22E$) Air trimmer ($\geq 30E$)				908/
	Air trimmer (for printed-wiring boards)				908/P

Example:

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

The correct values of the choice-resistors and capacitors are determined during factory adjustment. All resistors are vaporised carbon resistors, unless otherwise specified.

RESISTORS

<i>Number</i>	<i>Code number</i>	<i>Value</i>		<i>Watts</i>	<i>%</i>	<i>Description</i>
R1	4822 100 20011	500	ohm			Potentiometer
R2	4822 100 20013	100	ohm			Potentiometer
R3	916/GE10K	10	kohm			Potentiometer
R26	B8 305 80B/10K	10	kohm	0.1	1	Carbon
R29	B8 305 23D/500K	500	kohm	0.1	1	Carbon
R31	B8 305 23D/1M	1	Mohm	0.1	1	Carbon
R32	B8 305 23D/750K	750	kohm	0.1	1	Carbon
R33	B8 305 26D/333K	333	kohm	0.1	1	Carbon
R34	B8 305 23D/900K	900	kohm	0.1	1	Carbon
R36	B8 305 23D/111K	111	kohm	0.1	1	Carbon
R37	B8 305 23D/950K	950	kohm	0.1	1	Carbon
R38	B8 305 23D/52K6	52.6	kohm	0.1	1	Carbon
R39	4822 111 20253	975	kohm	0.1	1	Carbon
R41	4822 111 20254	25.6	kohm	0.1	1	Carbon
R42	B8 305 23D/990K	990	kohm	0.1	1	Carbon
R43	B8 305 23D/10K1	10.1	kohm	0.1	1	Carbon
R44	4822 111 20237	995	kohm	0.1	1	Carbon
R46	4822 111 20238	5.03	kohm	0.1	1	Carbon
R47	4822 111 20239	998	kohm	0.1	1	Carbon
R48	4822 111 20255	2.50	kohm	0.1	1	Carbon
R102	4822 116 50198	110	kohm	0.125	1	Carbon
R103	4822 071 00779	1	Mohm	0.25	1	Metal film
R104	901/10M	10	Mohm	0.1	1	Carbon
R108	4822 100 10035	10	kohm			Potentiometer
R126	4822 111 50241	15	kohm	1		Carbon
R134	901/330E	330	ohm	0.05	5	Carbon
R137	901/82E	82	ohm	0.05	5	Carbon
R152	901/330E	330	ohm	0.05	5	Carbon
R154	B8 305 39D/150E	150	ohm	0.05	5	Carbon
R157	B8 305 39D/99E	99	ohm	0.05	5	Carbon
R167	901/330E	330	ohm	0.05	5	Carbon
R169	B8 305 39D/150E	150	ohm	0.05	5	Carbon
R182	902/K2M2	2.2	Mohm	0.1	5	Carbon
R187	4822 100 10057	100	ohm			Potentiometer
R191	901/680E	680	ohm	0.05	5	Carbon
R199	4822 071 00753	6.8	kohm	0.125	1	Metal film
R201	4822 116 50225	590	ohm	0.125	1	Metal film
R202	4822 116 50226	780	ohm	0.125	1	Metal film
R203	4822 116 50227	2.28	kohm	0.125	1	Metal film
R205	4822 071 00837 (2 par)	28	kohm	0.125	1	Metal film
R208	4822 100 10035	10	kohm			Potentiometer
R300	4822 071 00779	1	Mohm	0.25	1	Metal film
R301	4822 116 50198	110	kohm	0.125	1	Carbon
R406	4822 116 50228	98.9	kohm	0.125	1	Metal film
R408	4822 071 00764	1	kohm	0.125	1	Metal film
R409	4822 116 50229	1.02	kohm	0.125	1	Metal film
R411	4822 116 50231	2.12	kohm	0.125	1	Metal film
R412	4822 116 50232	6.96	kohm	0.125	1	Metal film
R417	B8 305 39D/99E	99	ohm	0.05	5	Carbon
R446	938/A15K	15	kohm	5.5	10	Wire wound
R447	4822 071 00971	33	kohm	0.25	5	Carbon
R457	4822 071 01055	22	kohm			Potentiometer
R461	4822 071 00971	33	kohm	0.25	5	Carbon
R462	938/A15K	15	kohm	5.5	10	Wire wound
R142	B8 305 39D/99E	99	ohm	0.05	5	Carbon

CAPACITORS

<i>Number</i>	<i>Code number</i>	<i>Value</i>	<i>Volts</i>	<i>Description</i>
C18, 21, 24	4822 125 60045	68 pF		Trimmer (cer)
C29, 32, 33	4822 125 60045	68 pF		Trimmer (cer)
C34, 36, 38	4822 125 60045	68 pF		Trimmer (cer)
C39, 42, 43	4822 125 60045	68 pF		Trimmer (cer)
C46, 47, 49	4822 125 60045	68 pF		Trimmer (cer)
C51, 53, 54	4822 125 60045	68 pF		Trimmer (cer)
C57, 58, 61	4822 125 60045	68 pF		Trimmer (cer)
C62	4822 125 60045	68 pF		Trimmer (cer)
C26	4822 121 20085	0.1 μ F	300	Paper
C37	905/D9E1	9.1 pF	500	Ceramic
C41	4822 123 10165	27 pF	300	Button
C44	4822 123 10166	56 pF	300	Button
C48	4822 123 10167	150 pF	300	Button
C52	4822 123 10168	300 pF	300	Button
C56	4822 123 10169	600 pF	300	Button
C59	4822 123 10171	1500 pF	300	Button
C63	4822 123 10172	2400 pF	300	Button
C101	909/W250	250 μ F	10	Electrolytic
C102	4822 121 40095	0.12 μ F	250	Polyester
C104	4822 609 01127	20 μ F	100	Electrolytic
C107, 109, 111	4822 069 01103	0.068 μ F	250	Plate
C114, 118, 121	4822 069 01103	0.068 μ F	250	Plate
C128, 133, 138	4822 069 01103	0.068 μ F	250	Plate
C144, 149, 156	4822 069 01103	0.068 μ F	250	Plate
C112, 113, 123	4822 124 20191	10 μ F	200	Electrolytic
C116, 126, 131	4822 069 01034	4.7 μ F	35	Tantalum
C136, 142, 147	4822 069 01034	4.7 μ F	35	Tantalum
C153	4822 069 01034	4.7 μ F	35	Tantalum
C117, 122, 127	4822 069 00562	4700 pF	350	Feed through
C132, 137, 143	4822 069 00562	4700 pF	350	Feed through
C148, 154, 166	4822 069 00562	4700 pF	350	Feed through
C167, 168, 169	4822 069 00562	4700 pF	350	Feed through
C171, 172, 173	4822 069 00562	4700 pF	350	Feed through
C174	4822 069 00562	4700 pF	350	Feed through
C134, 146	4822 121 40099	0.33 μ F	60	
C157	905/D1K6	1600 pF	500	Mica
C161	C 420 ZZ/04	25 μ F	4	Tantalum
C162	909/W2.5	2.5 μ F	16	Tantalum
C164	4822 069 00884	100 μ F	4	Electrolytic
C302	4822 121 50219	0.01 μ F	125	Polyester
C303, 304, 306	909/C12.5	12.5 μ F	25	Electrolytic
C316	909/C12.5	12.5 μ F	25	Electrolytic
C305	4822 121 40088	0.01 μ F	250	Polyester
C307, 311	4822 069 00682	0.47 μ F	250	Polyester
C308, 309	4822 069 01105	0.1 μ F	250	Plate
C313	4822 121 40098	0.39 μ F	250	Polyester
C314	4822 069 01065	0.039 μ F	250	Polyester
C316	909/C12.5	12.5 μ F	25	Electrolytic
C317	4822 069 01123	0.22 μ F	250	Polyester
C318	909/X250	250 μ F	40	Electrolytic
C401, 403, 407	4822 069 00562	4700 pF	350	Feed through
C409, 412, 418	4822 069 00562	4700 pF	350	Feed through
C421, 424	4822 069 00562	4700 pF	350	Feed through
C402, 404, 406	4822 069 01103	0.068 μ F	250	Plate

<i>Number</i>	<i>Code number</i>	<i>Value</i>	<i>Volts</i>	<i>Discription</i>
C410, 413, 419	4822 069 01103	0.068 μ F	250	Plate
C422, 423	4822 069 01103	0.068 μ F	250	Plate
C414, 417	4822 069 00945	1000 pF	30	Plate (cer)
C416	4822 069 01139	20 pF		Trimmer

COILS, RELAYS, BEADS

<i>Number</i>	<i>Code number</i>	<i>Qty.</i>	<i>Discription</i>
L101	4822 158 10131	1	Coil
L102, 103, 104	4822 207 00365	9	Bead
L106, 107, 108			
L109, 111, 112			
L301	4822 158 40033	1	Demodulator coil
L302	4822 158 30102	1	Oscillator coil
RE101	SZC7123	1	Relay
RE301	4822 280 10025	1	Relay

SEMI-CONDUCTORS**Diodes**

GR101	OA200
GR102	OA200
GR103	BAY33
GR104	BAY38
GR106	BAY38
GR403	BAY38
GR404	AAZ13
GR406	AAZ13
GR407	BAY38

Zener diodes

GR107	BZY60
GR109	BZY60
GR111	BZY62
GR112	BZY63
GR113	BZY60
GR114	BZY63
GR301	BZY63
GR302	BZY63

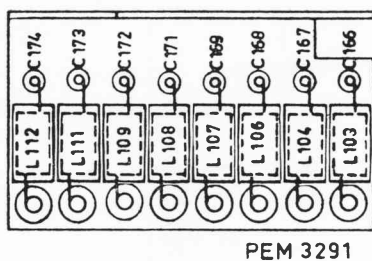
Transistors

TS101	BF109	TS119	BC107	TS403	BC107
TS102	2N3563	TS121	BC107	TS404	2N3563
TS103	2N3563	TS301	2N930	TS406	2N3563
TS104	2N3563	TS302	BCY32	TS407	2N3563
TS106	2N3563	TS303	BCY32	TS408	ASZ21
TS107	2N3563	TS304	BC107	TS409	ASZ21
TS108	2N3563	TS306	BC107	TS411	2N3563
TS109	2N3563	TS307	ASY75		
TS111	2N930	TS308	ASY75		
TS112	2N930	TS309	ASY75		
TS113	2N930	TS311	ASY75		
TS114	2N930	TS312	BCY39		
TS116	BC107	TS313	BCY39		
TS117	BC107	TS401	BF173		
TS118	BC107	TS402	2N3563		

VALVE

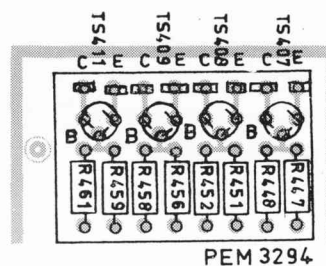
B 101 EC 1000

The semi-conductors and the valves are furnished by Com. Dept. ELCOMA.



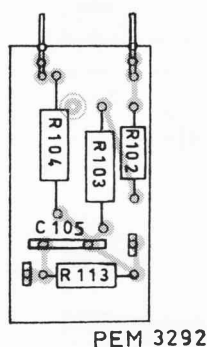
PEM 3291

Fig. 17. Printed circuit U 7 (Supply filter)



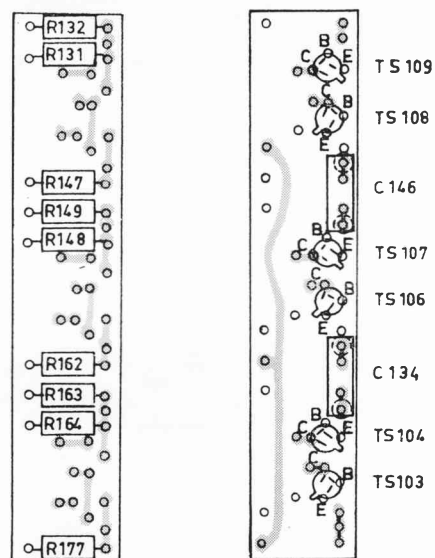
PEM 3294

Fig. 18. Printed circuit U 8 (Final stage)



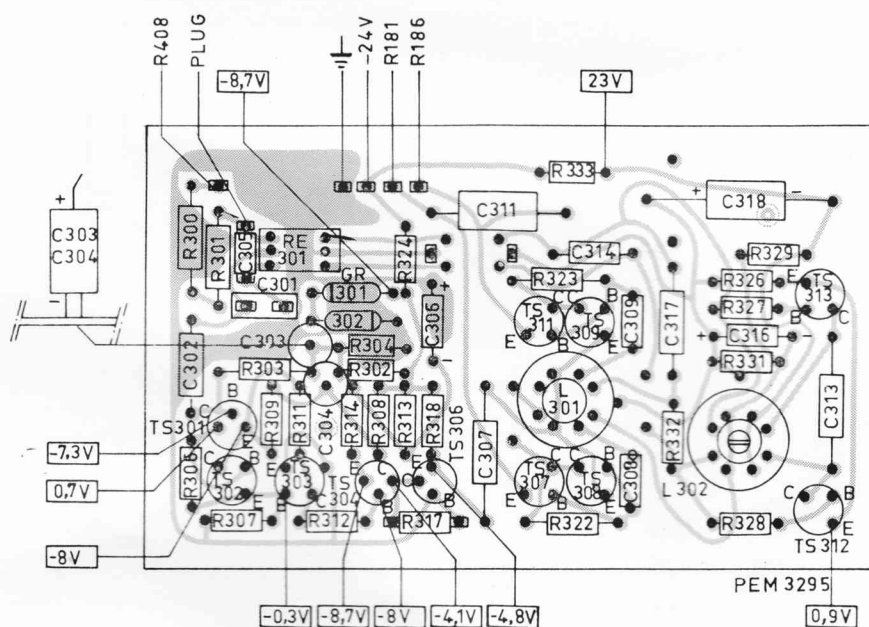
PEM 3292

Fig. 19. Printed circuit U 9 (Grid circuit)



PEM 3293

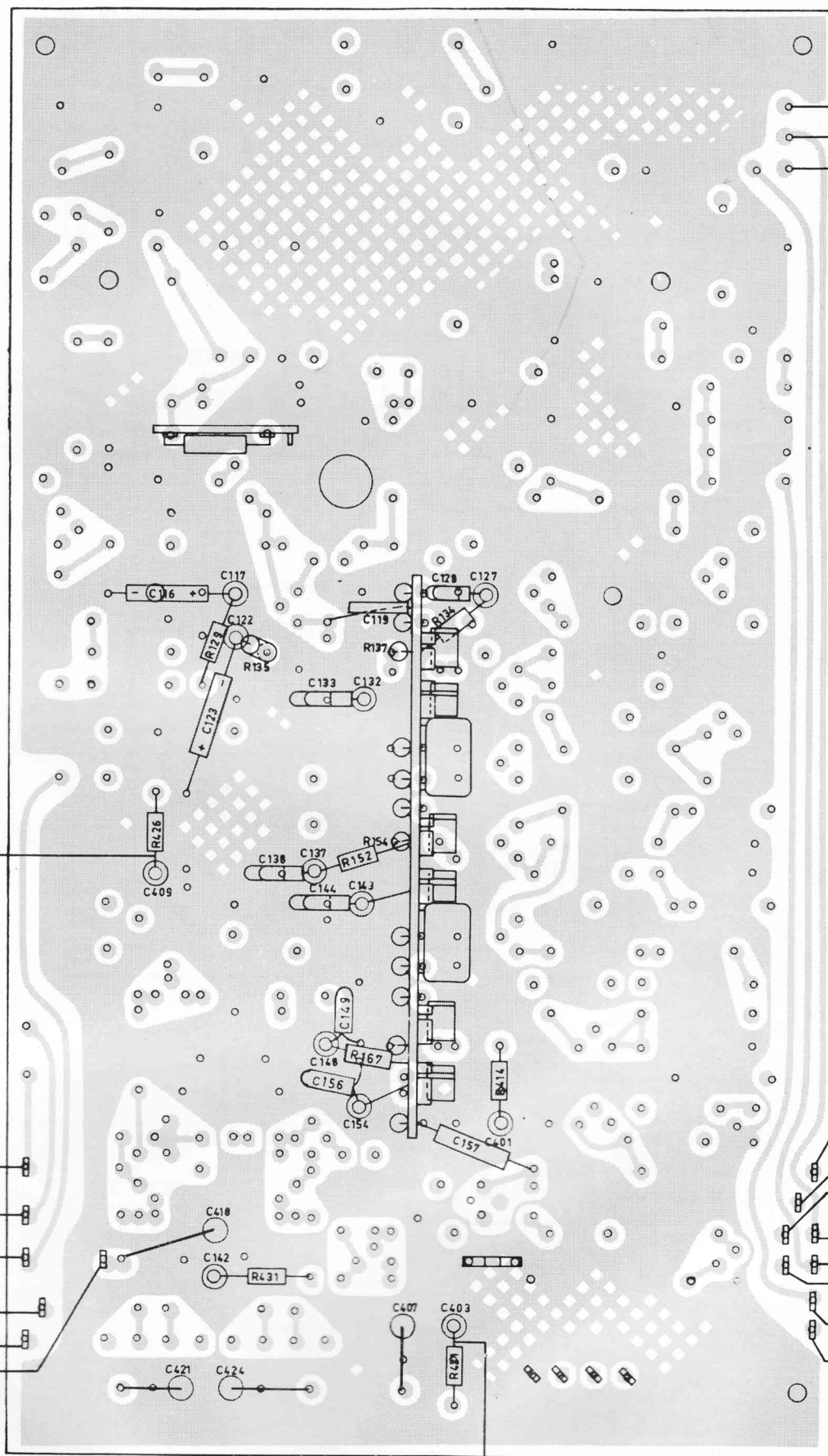
Fig. 20. Printed circuit U 10 (H.F. amplifier)



PEM 3295

Fig. 22. Printed circuit U 12 (Chopper Amplifier)

- 150V(brown)
 + 200V(grey)
 shift (yellow)
 + 24V(green)
 + 130V(purple)
 - 24V(green-white)



R2
 shift

-150V(brown)
 +6V(blue)
 -12V(green)
 shift (yellow)
 +24V(green)
 -24V(green-white)
 choppe
 +12V(green)

+10V

t

brown)
black)
grey-
white)

green)
green-
white)
output
grey)

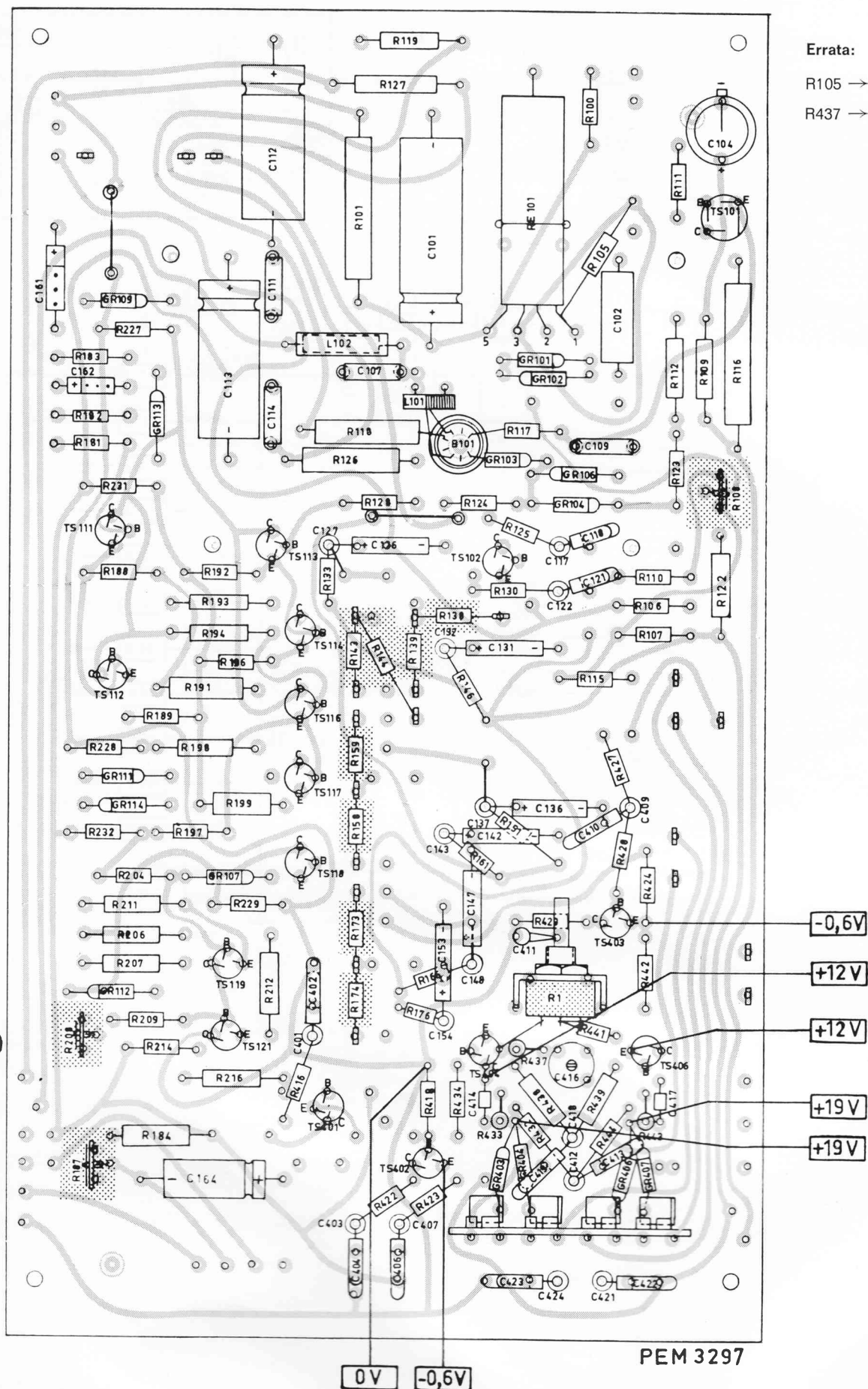


Fig. 21. Printed circuit U 11 (Amplifier)

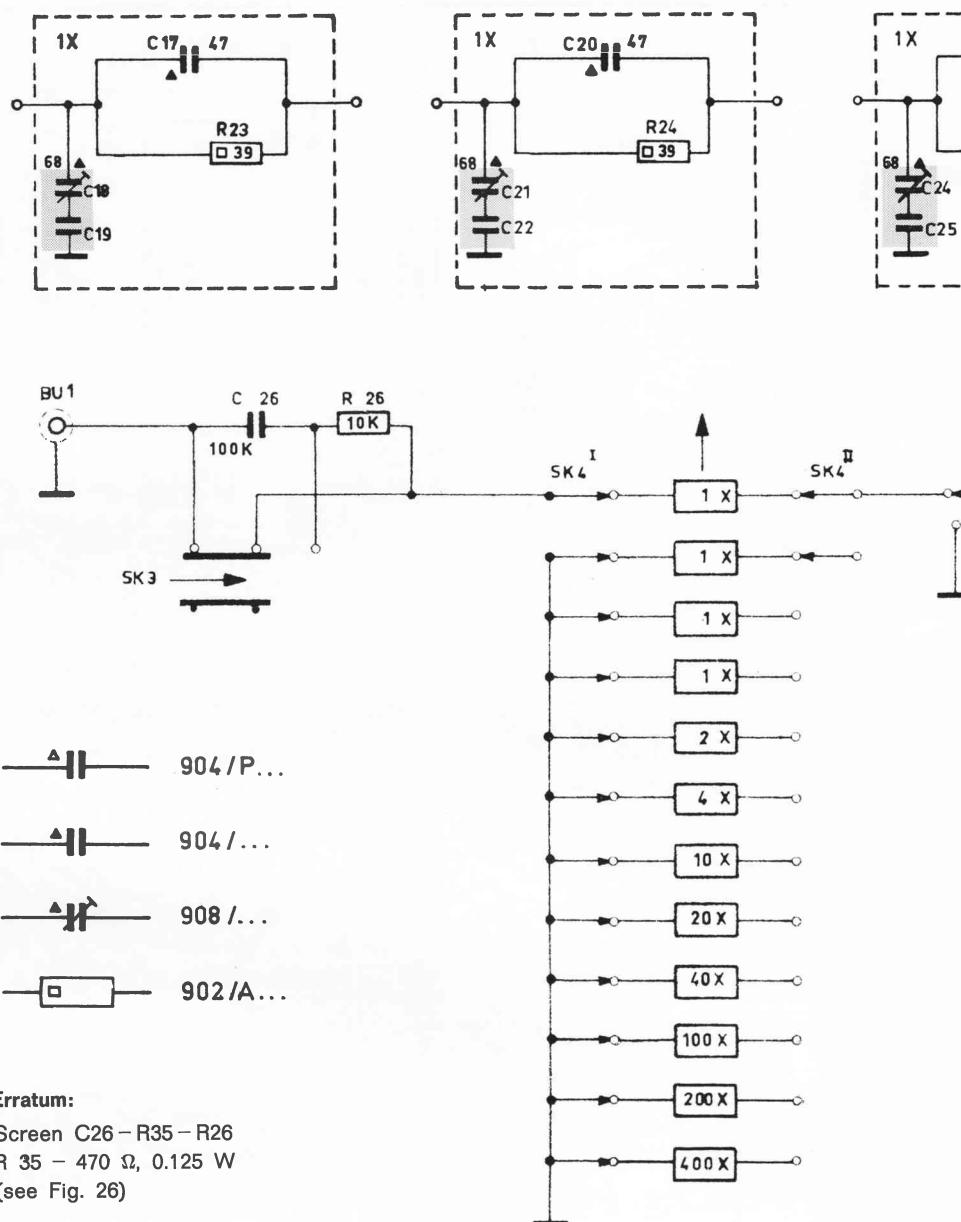
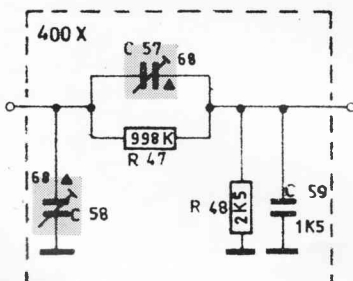
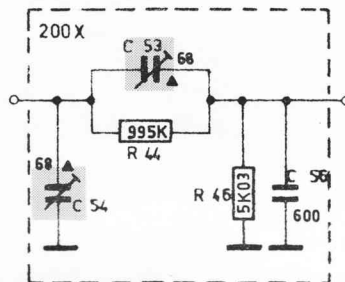
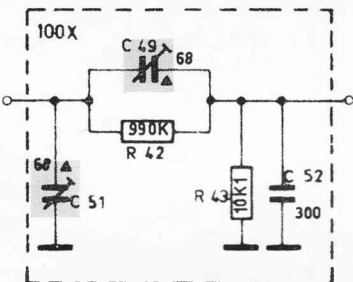
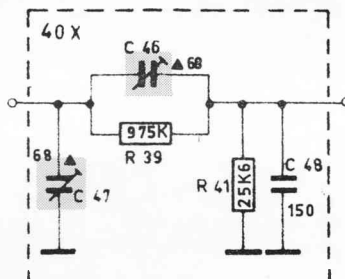
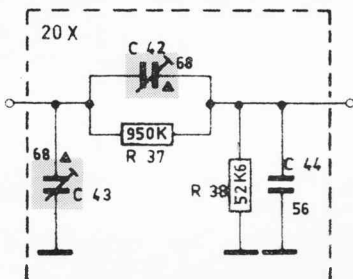
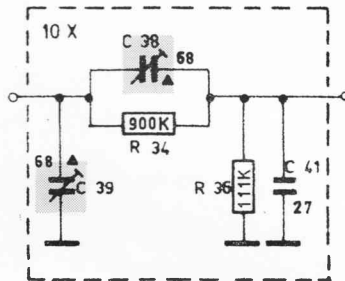
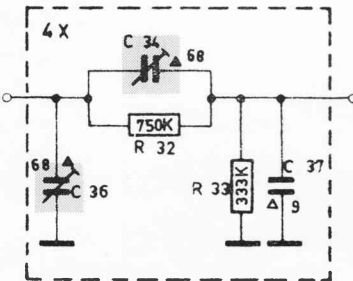
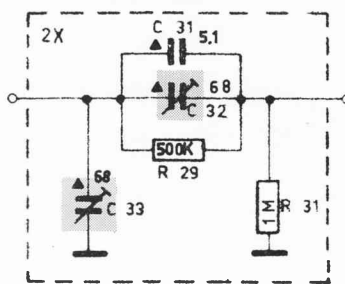
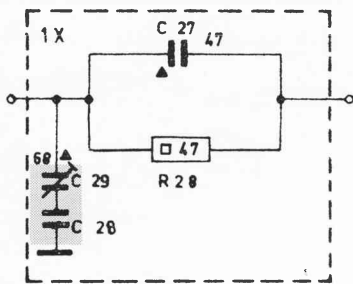
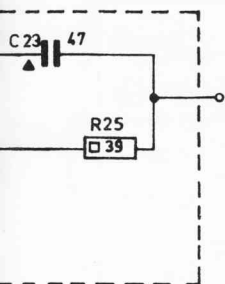
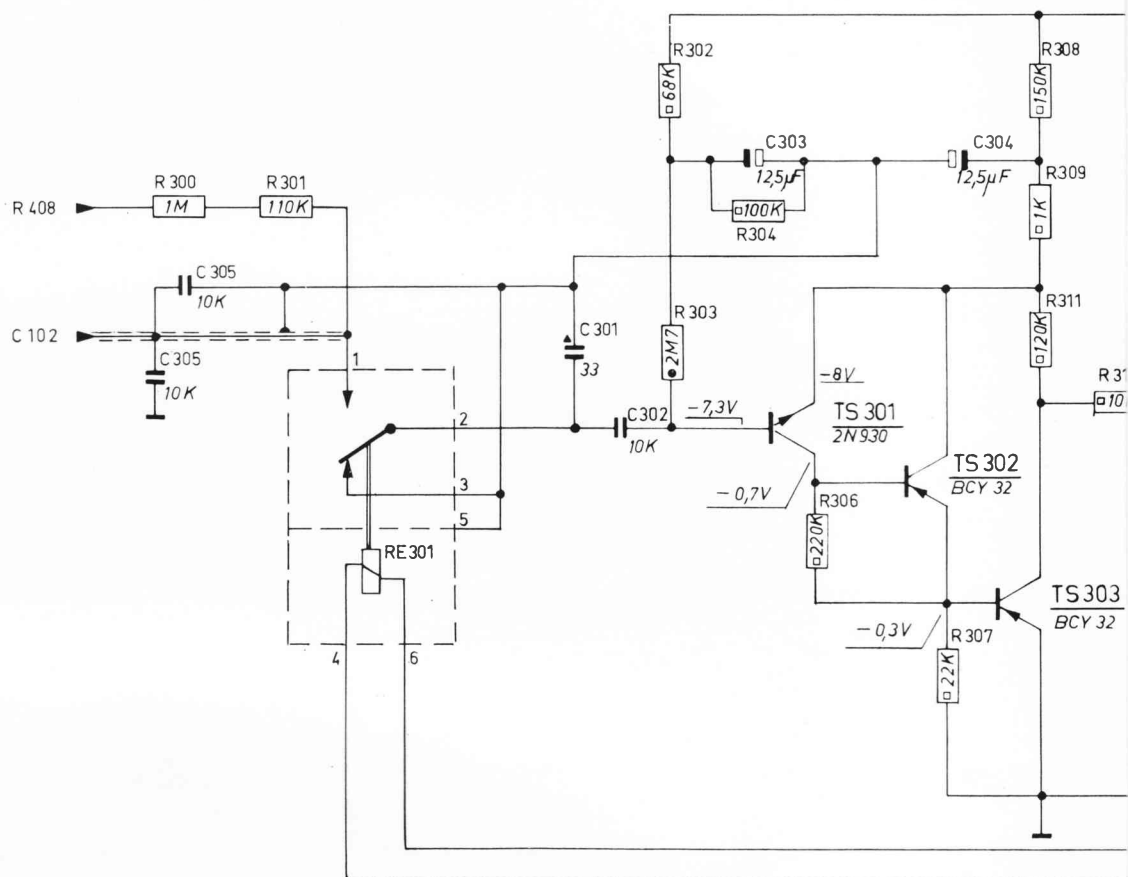


Fig. 23. Attenuator circuit



PEM 3194



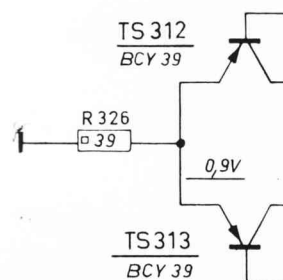
○ 6	1 ○
○ 5	○ 2 ○
○ 4	3 ○

RE 301

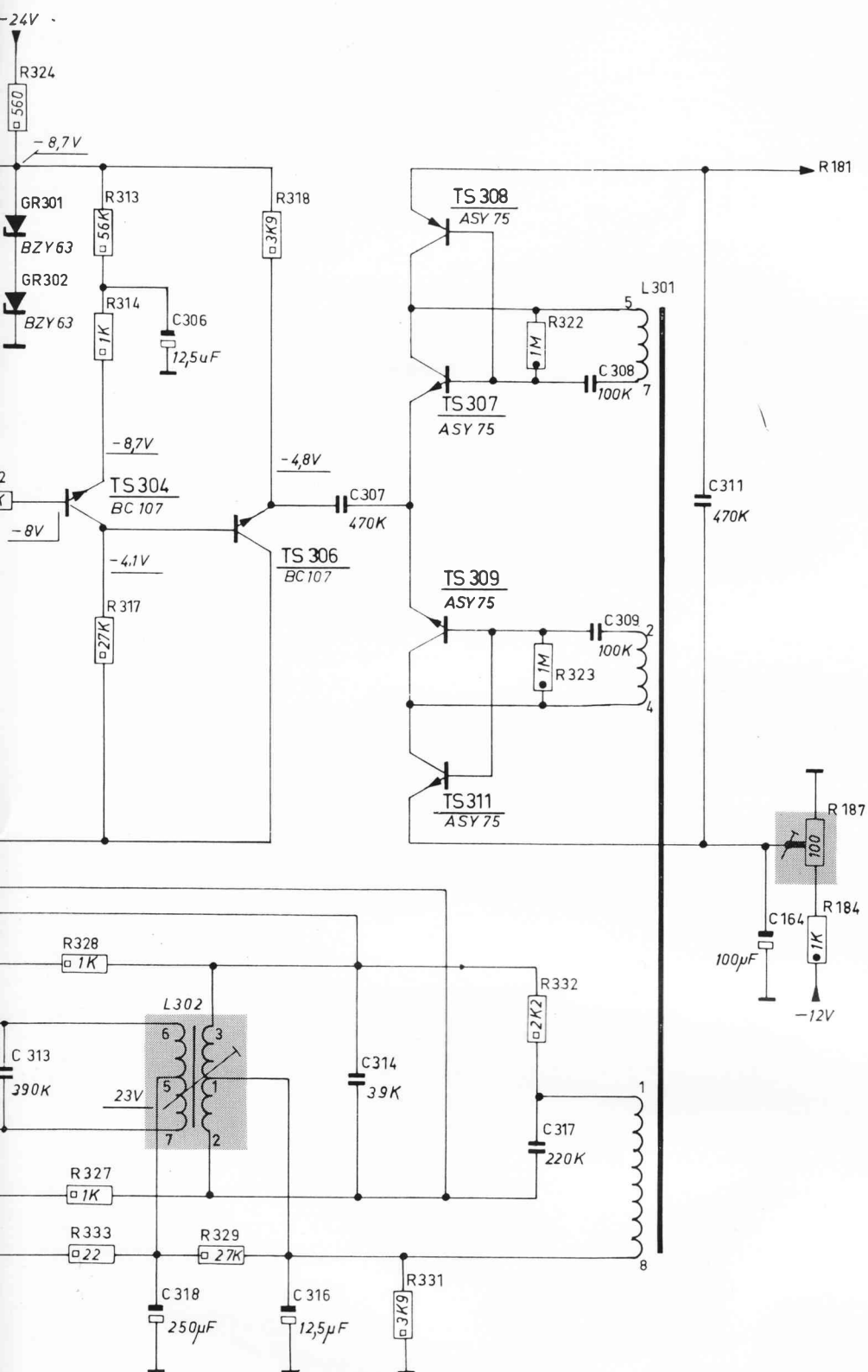
—||— 904 / ...

—□— 902 / A...

—●— 902 / K...

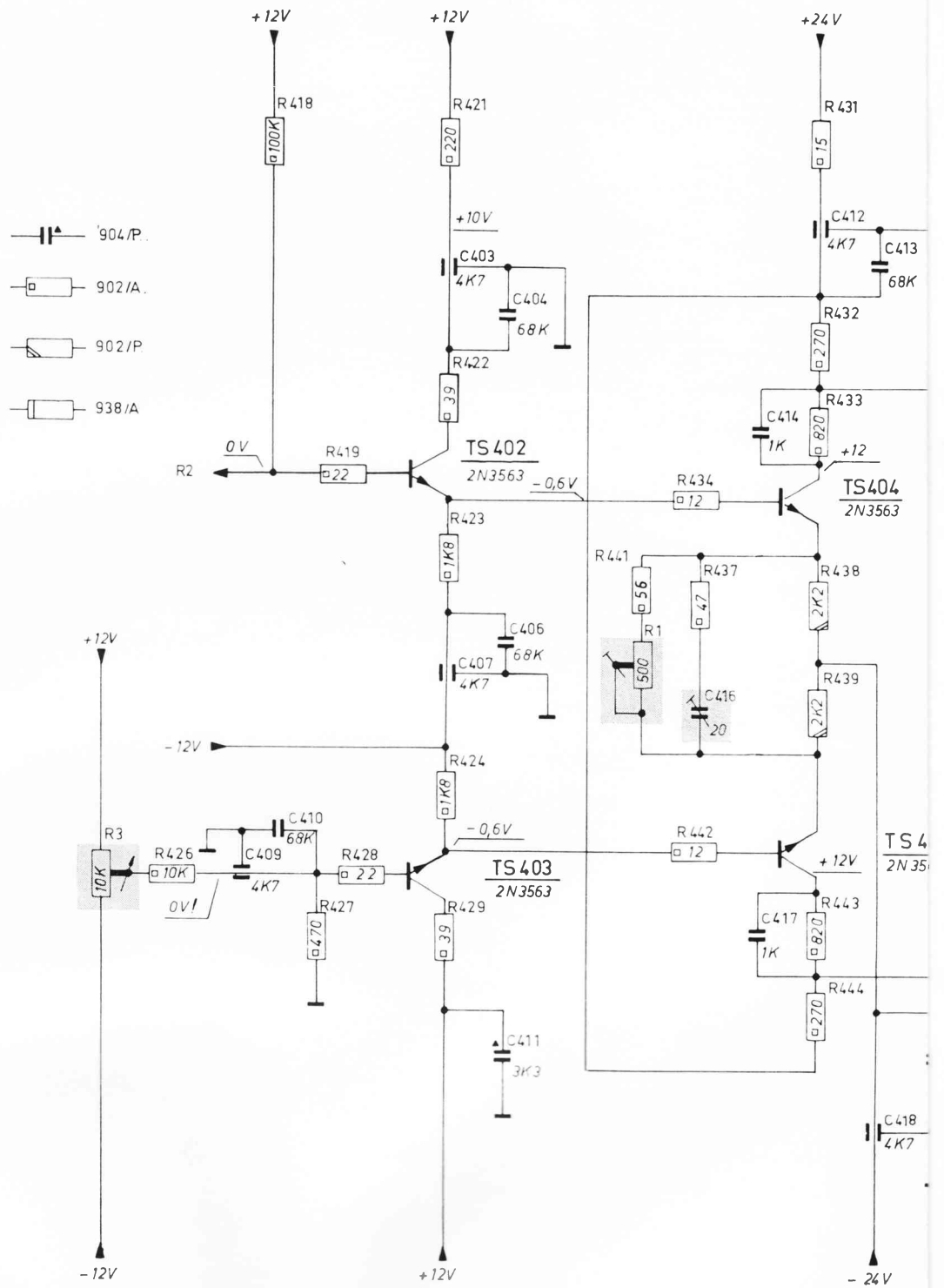


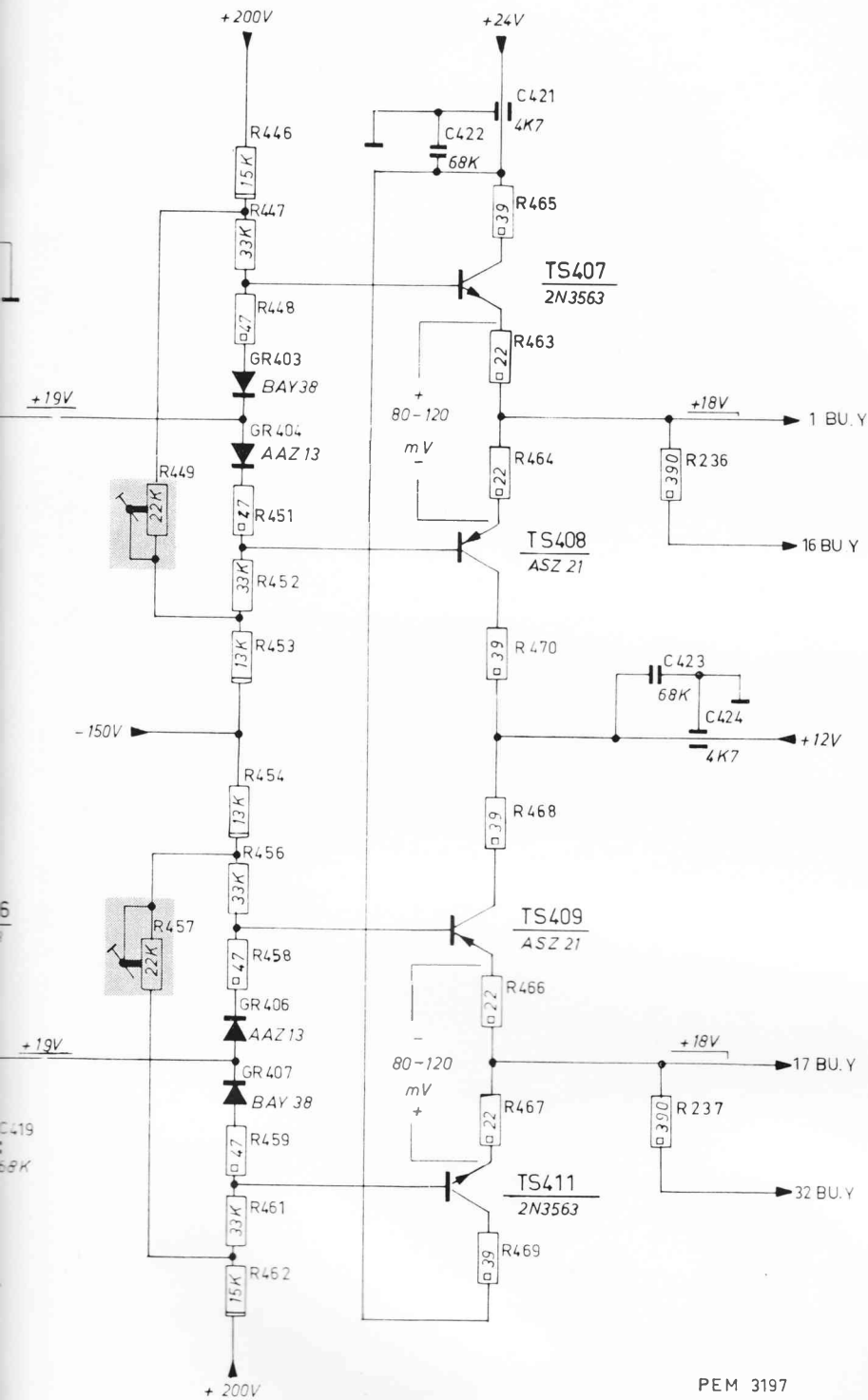
—24V



PEM 3198

Fig. 24. Chopper amplifier circuit



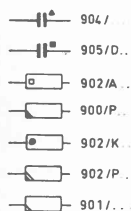


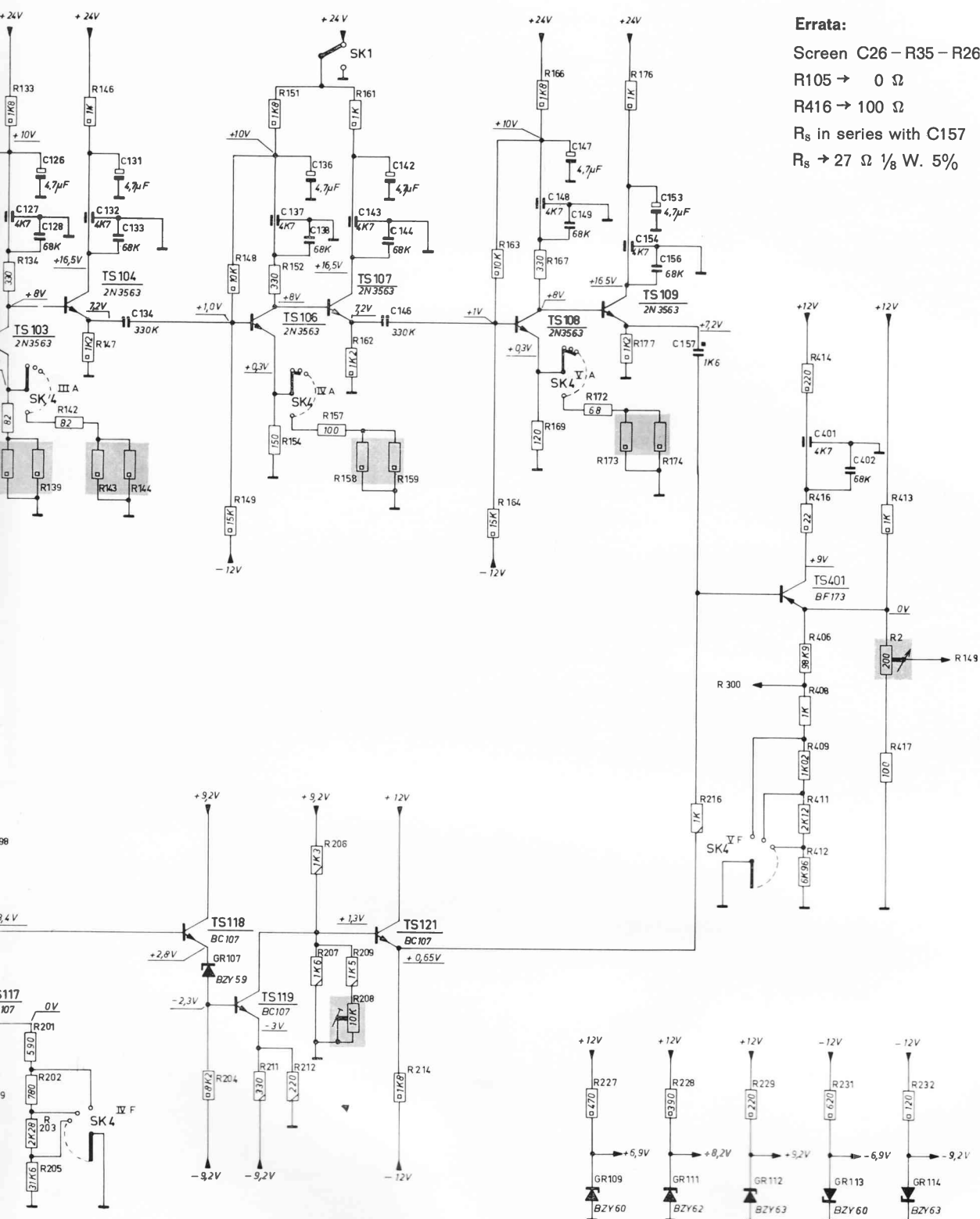
Errata:

R419	→	100 Ω
R434	→	100 Ω
R437	→	0 Ω
R442	→	100 Ω
R448	→	56 Ω
R451	→	56 Ω
R458	→	56 Ω
R459	→	56 Ω
TS403	→	BC107

PEM 3197

Fig. 25. Final amplifier circuit





PEM 3199

Fig. 26. HF and LF amplifier circuit



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PM 3332/01
9444 033 32011

Cd 542

**Information
PIT-EMA**

As of serial number D651 some modifications have been introduced, amongst others, to improve the squarewave reproduction and to prevent oscillations. However, these modifications do not affect the adjusting procedure and the technical data. Up-to-date circuit diagrams are attached. The principal changes are:

Attenuator circuit (Fig. 23)

Between input socket BU1 and blocking capacitor C26: resistor R27 (12 Ω , 1/8 W, 5 %).

The screening of C26 is connected to junction C26-R26 via resistor R35 (470 Ω , 1/8 W, 5 %).

Chopper amplifier circuit (Fig. 24)

Transistor TS313 and resistor R326 are bridged by a ceramic capacitor C312 (1000 pF, 500 V).

On account of this and in view of a more favourable arrangement of parts, printed circuit board U12 (Fig. 22) is changed. The anode voltage of GR301 amounts to -18.7 V instead of -8.7 V.

Final amplifier circuit (Fig. 25)

To improve the HF squarewave reproduction, a series RC circuit consisting of R445 (approx. 22 k Ω , 1/8 W, 5 %) and C415 (ceramic, approx. 33 pF, 500 V) is connected between junctions R432-R433 and R443-R444.

The following parts have been added to improve the control range of R1, C416 and R3:

control range R1: resistor R425 (100 Ω , 1/8 W, 5%) between junctions R441-R437 and R1-C416,

control range C416: ceramic capacitor C420 (39 pF, 500 V) in parallel with C416.

Note: R437 is maintained.

control range R3: resistor R430 (33 k Ω , 1/8 W, 5 %) between -12 V and junction R427-R428.

The value of the voltage between the emitters of TS407 and TS408 and between the emitters of TS409 and TS411 is approx. 80 mV instead of 80...120 mV.

Moreover, some resistor values have been changed.

HF and LF amplifier circuit (Fig. 26)

To improve the HF squarewave reproduction, a series RC circuit consisting of R140 (approx. 1 k Ω , 1/8 W, 5 %) and C129 (560 pF, 500 V) has been added in parallel with R139 in the HF amplifier.

To improve the LF squarewave reproduction, three series RC circuits have been added to the LF amplifier, viz.

1. R190 (100 Ω , 1/8 W, 5 %) and C163 (feed-through capacitor, 68 pF, 350 V) between junctions R191-R196 and earth,
2. R210 (12 k Ω , 1/8 W, 5 %) and C160 (plate capacitor, 68,000 pF, 250 V) in parallel with R211,
3. R213 (approx. 22 k Ω , 1/8 W, 5 %) and C165 (feed-through capacitor, 1500 pF, 350 V) between junction R211-emitter TS119 and earth.

To prevent oscillations, a resistor (R407, $56\ \Omega$, $1/8\ \text{W}$, 5 %) is included in the base circuit of TS401.

In the cross-over filter, resistor R215 (approx. $12\ \Omega$, $1/8\ \text{W}$, 5 %) is connected between C157 and junction R407-R216.

Diode GR108 (OA202) is connected between the master contact of SK1 and earth (its anode at the earth side). Resistor R238 ($6,800\ \Omega$, $1\ \text{W}$, 5 %) is connected between coils L106 and L111 at the supply side of printed circuit board U7.

Some resistor values have also been changed.

The following voltages are now different:

collector of TS117 becomes +4.1 V instead of +3.4 V,

emitter of TS118 becomes +3.5 V instead of +2.8 V,

base of TS119 becomes -2.4 V instead of -2.3 V,

anode of B101 becomes +74 V instead of +7.5 V,

supply for R413 becomes -12 V instead of +12 V.

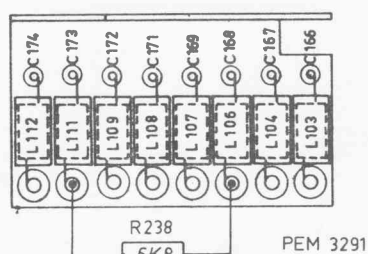


Fig. 17. Printed circuit U 7 (Supply filter)

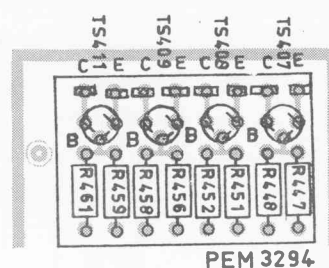


Fig. 18. Printed circuit U 8 (Final stage)

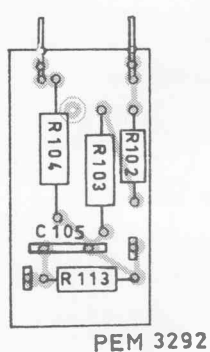


Fig. 19. Printed circuit U 9 (Grid circuit)

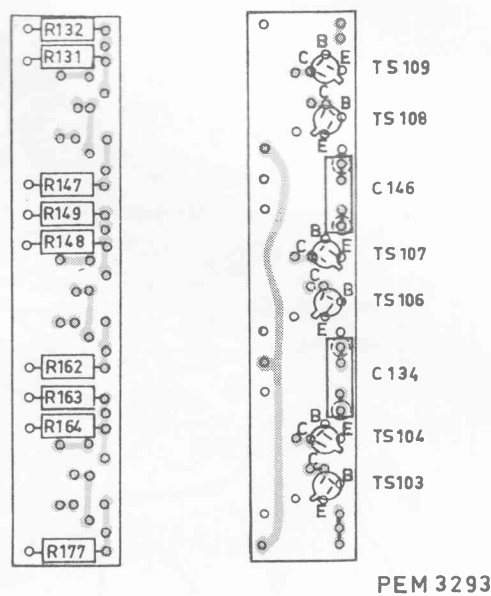


Fig. 20. Printed circuit U 10 (H.F. amplifier)

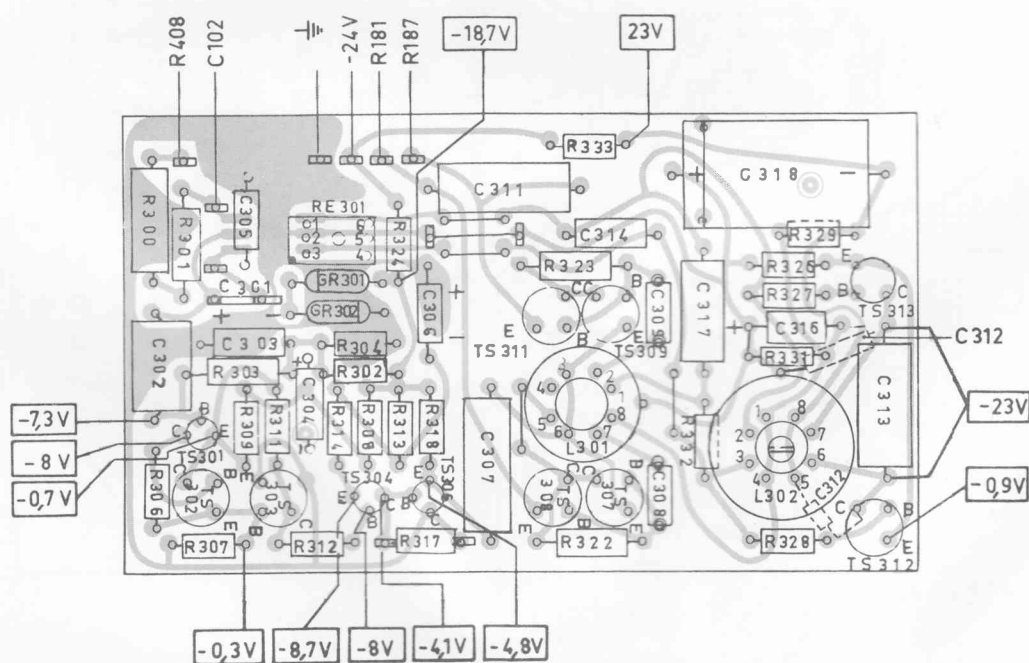
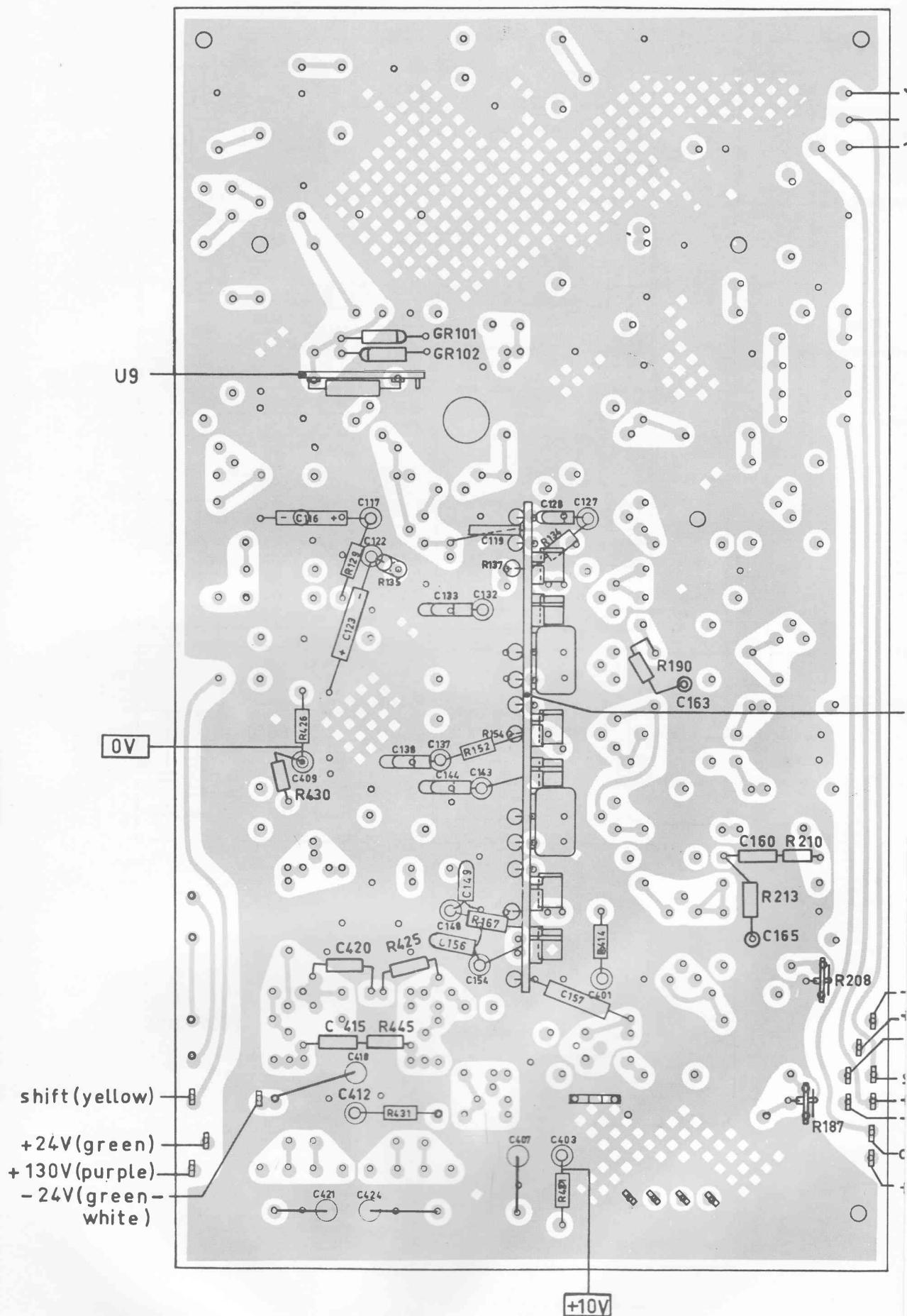


Fig. 22. Printed circuit U 12 (Chopper Amplifier)

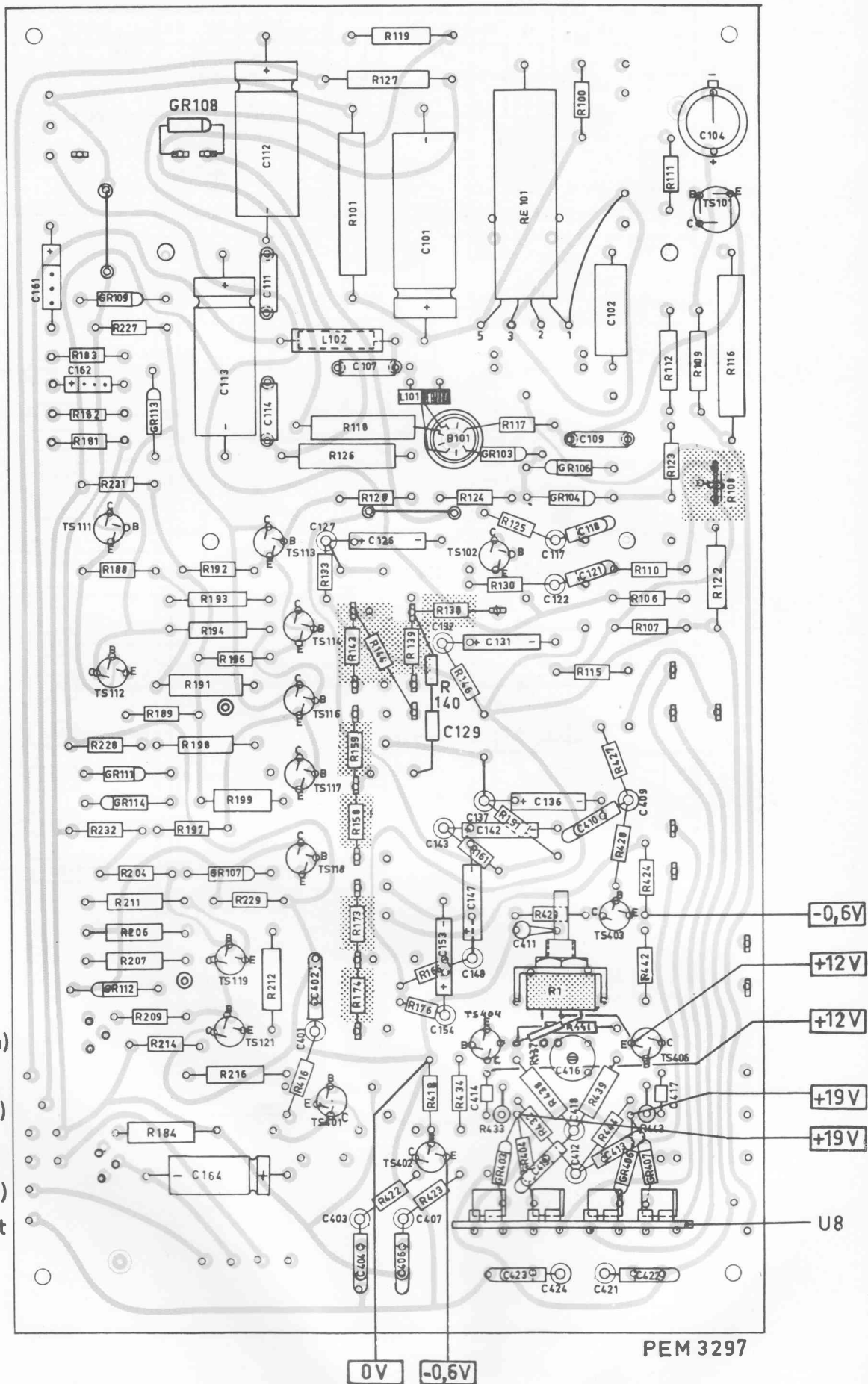
PEM 3295A



R2
GAIN

U10

150V(brown)
+6V(black)
-12V(grey-
white)
shift
-24V(green)
-24V(green-
white)
chopper
output
-12V(grey)



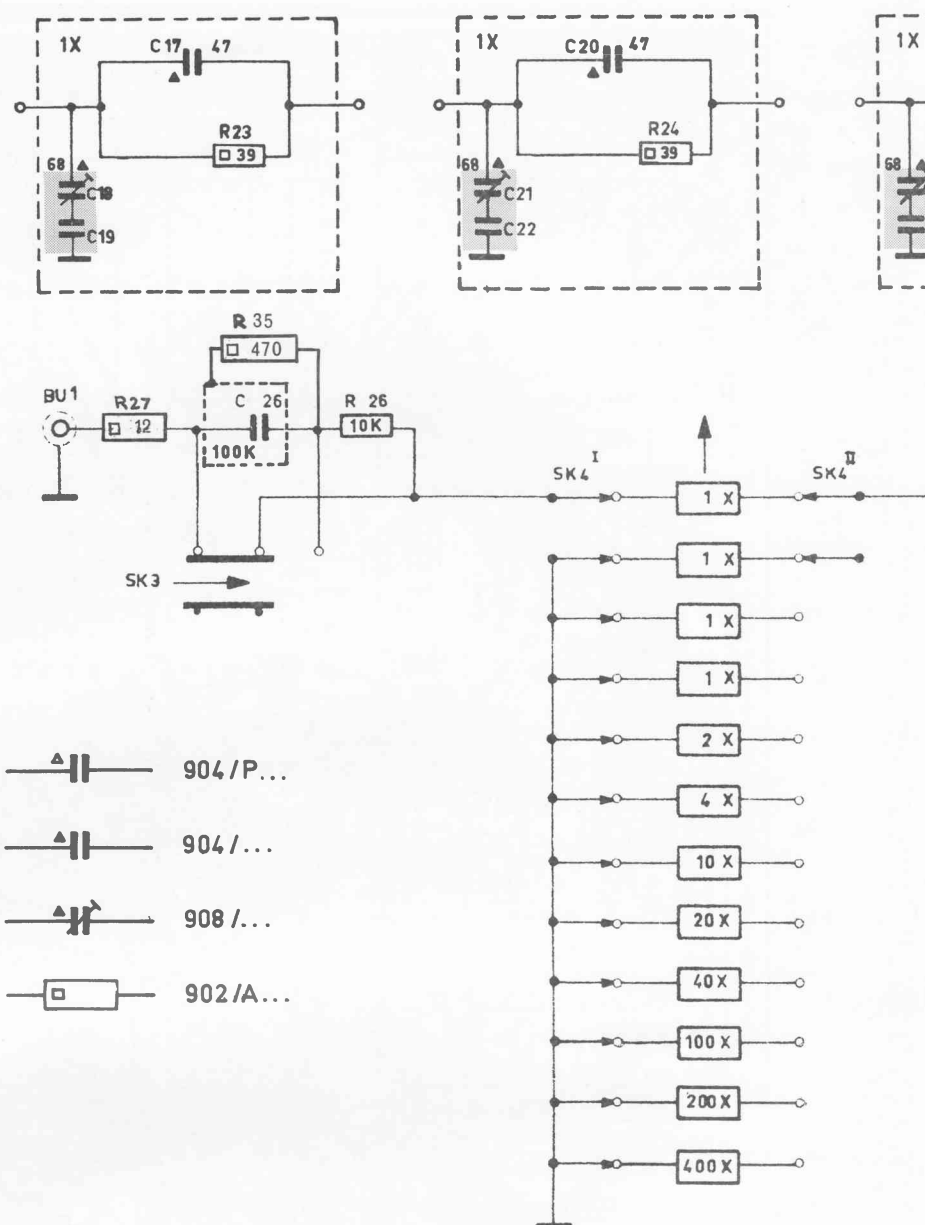
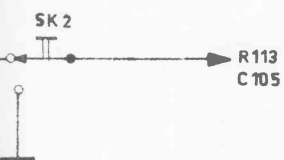
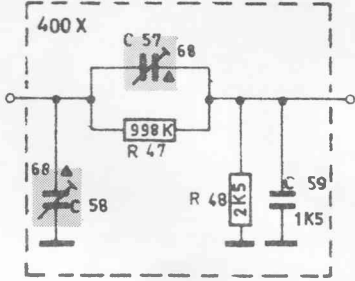
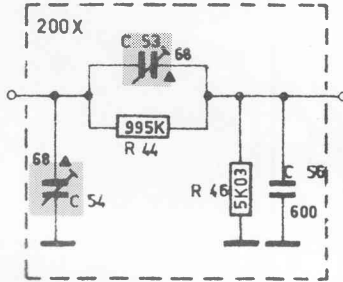
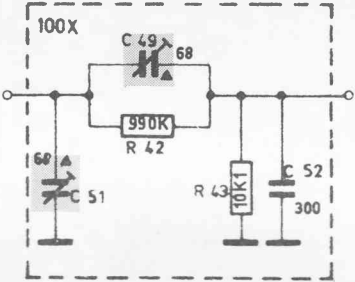
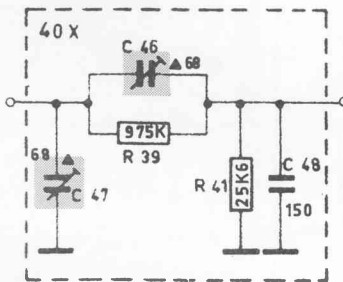
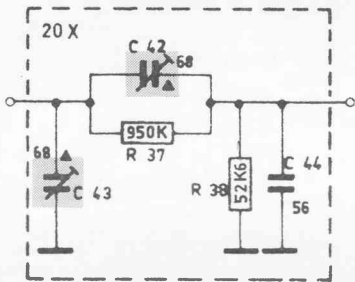
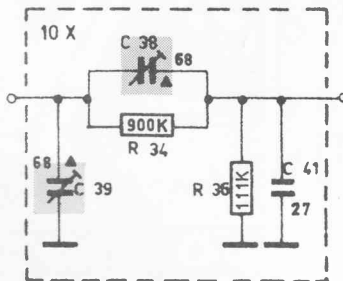
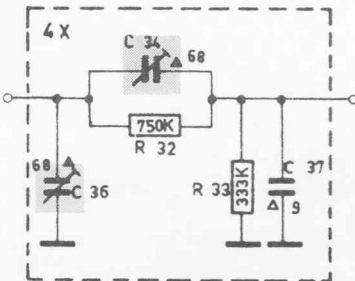
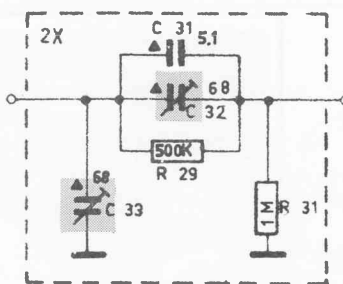
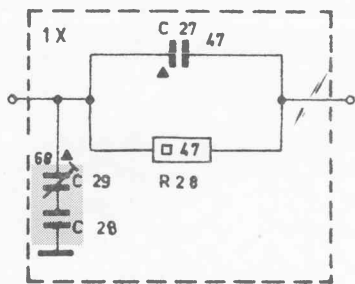
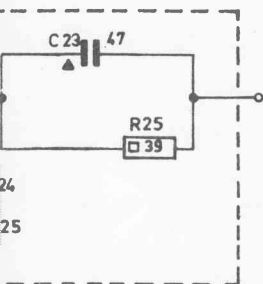
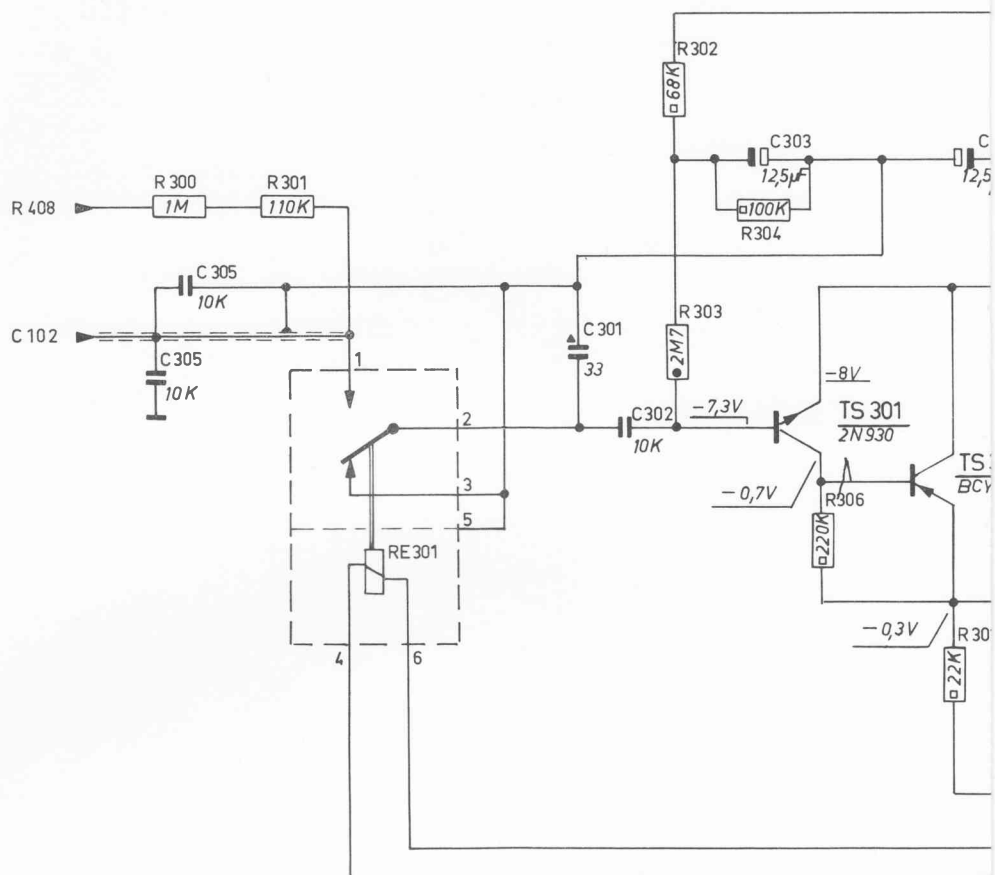


Fig. 23. Attenuator circuit

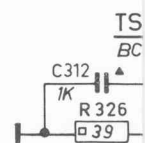
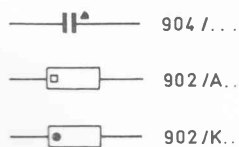


PEM 3194



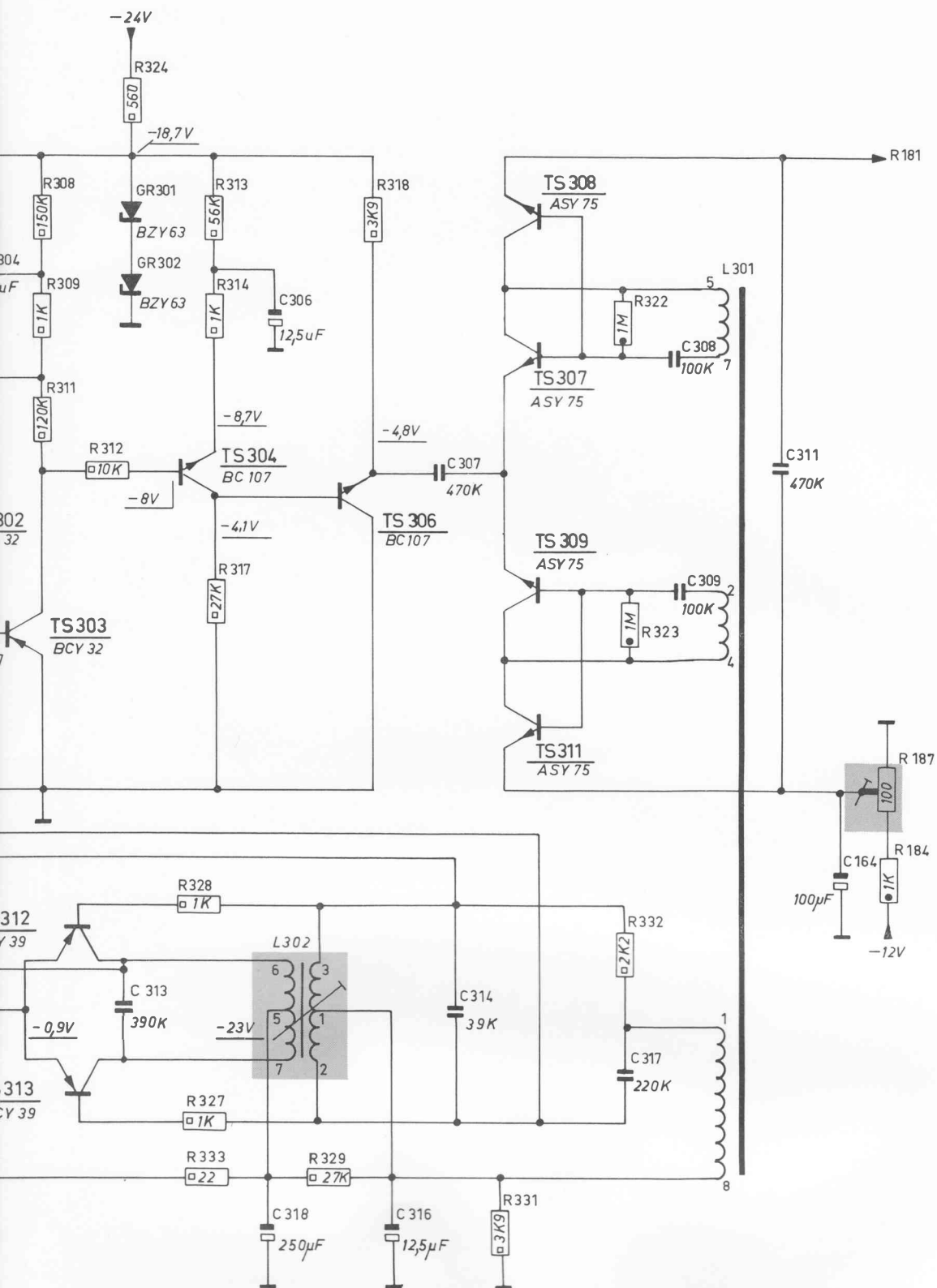
○6	1○
○5	○2○
○4	3○

RE 301







TS
BCV

-24V



PEM 3198A

Fig. 24. Chopper amplifier circuit

-  904/P..
-  902/A..
-  902/P..
-  938/A..

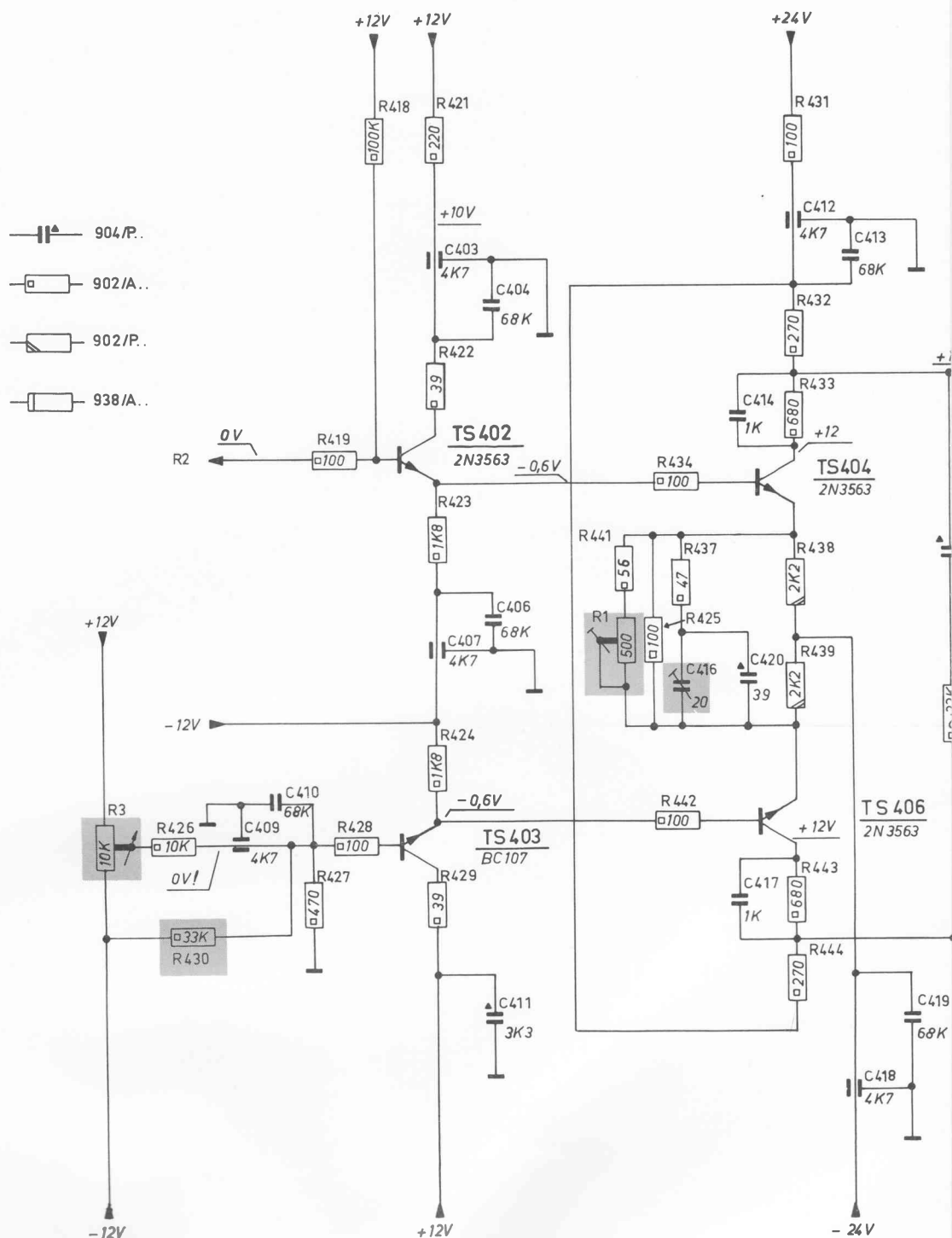
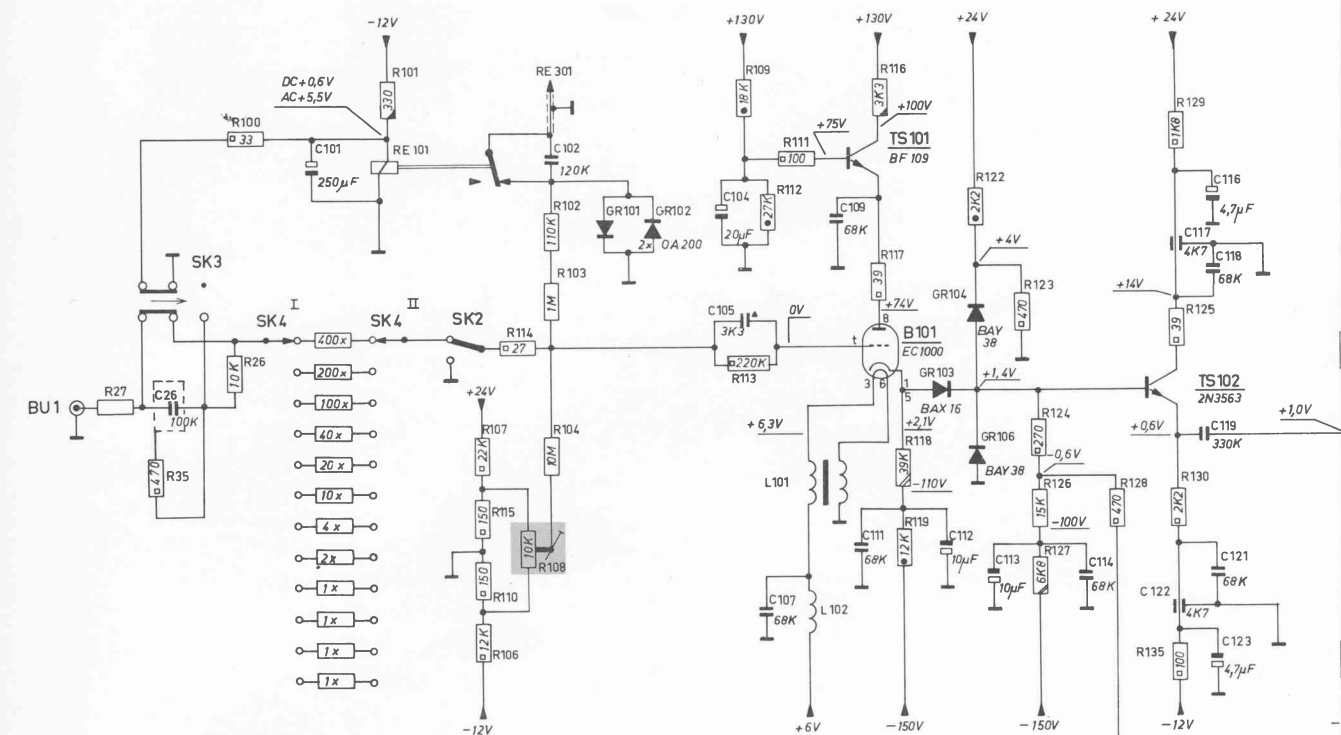


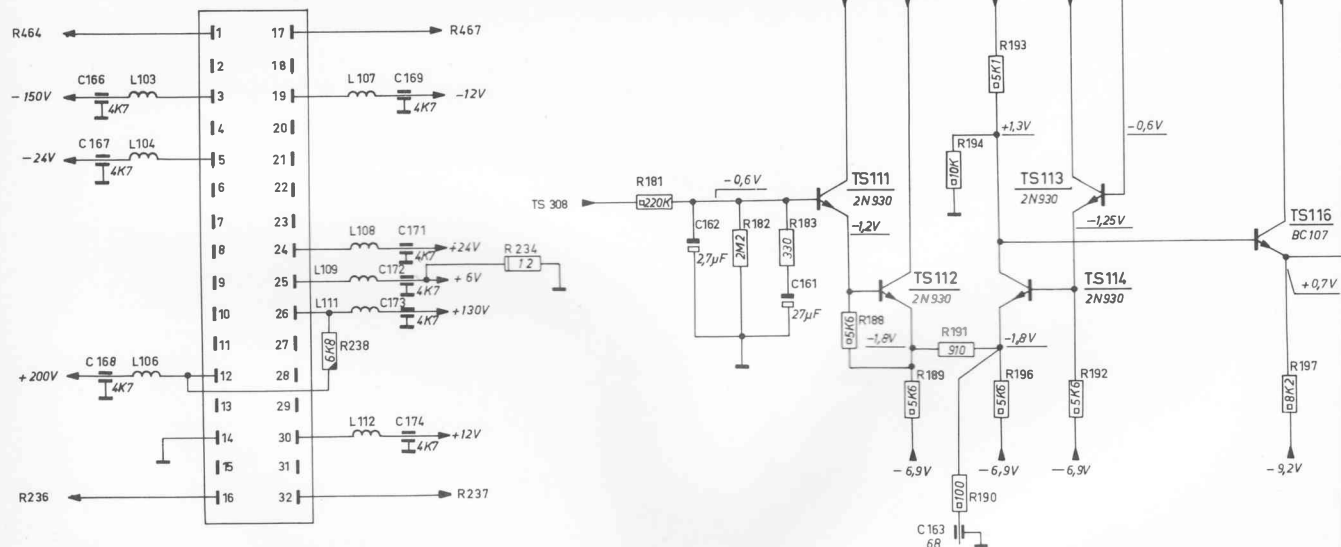


Fig. 25. Final amplifier circuit



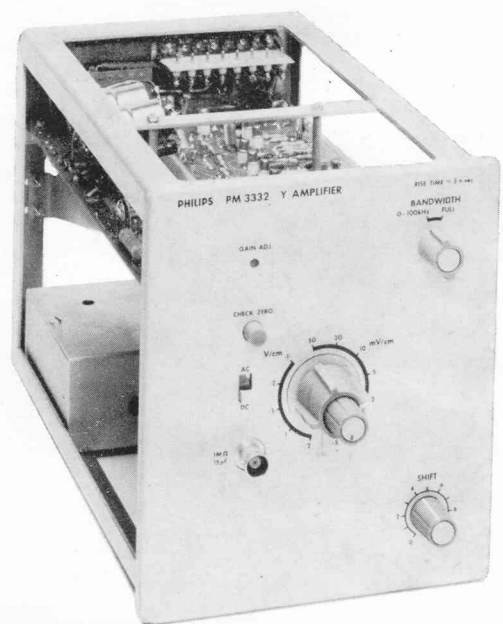
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- 905/D..
- 902/A..
- 900/P..
- 902/K..
- 902/P..
- 901/...

BU. Y





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