

PHILIPS



PM 3344 FOUR TRACE Y-AMPLIFIER 9444 033 44031

IMPORTANT

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

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GENERAL INFORMATION

Introduction

Four-trace h.f. unit PM 3344 is a plug-in unit for the Y-channel of basic oscilloscope PM 3330. This unit comprises four identical amplifiers and an

electronic switch, by means of which it is possible to display four signals.

The amplifier data apply to all channels.

Technical data

Properties expressed in numerical values with tolerances stated are guaranteed by the factory. Numerical values without tolerances stated represent the properties of an average unit and merely serve as a guide. The following

data apply in case of nominal mains voltage, unless otherwise stated. All data of this unit apply when the unit is used in combination with main frame PM 3330.

Channels	4 identical channels A...D.
Input circuit	identical for channels A...D.
input	AC/DC Push-button for checking zero level and channel identification.
input impedance	1 M Ω /18 pF
input socket	B.N.C.
maximum permissible input voltage in position AC	400 V.
Amplifiers	4 identical amplifiers for channels A...D.
deflection coefficient	adjustable to 10 calibrated values i.e. 10 mV/cm... 10 V/cm in 1, 2, 5 sequence. Tolerance: + or - 3%. Continuous (non-calibrated) adjustment between the steps is possible.
bandwidth	in position DC: 0 Hz...50 MHz in position AC: 1.6 Hz...50 MHz
rise time	7 ns. Unit only: 5ns.
magnification	up to 3 \times the useful screen height for frequencies up to 10 MHz. The peaks of a displayed picture, having maximum amplitude, can be displayed by means of the shift control.
polarity	reversible for each channel.
Mode of operation	Channels A, B, C and D, chopped at 2 MHz. Channels A, B, C and D alternately. Each channel can be switched off separately. Blanking during switching.

Triggering	from any of the four channels.
required trace height	3 mm for frequencies up to 10 MHz.
Phase difference between the channels	not visible.
Cross-talk	at 5 MHz: $\leq 1\%$.
Mechanical data	width 15 cm.
dimensions	depth 29 cm (controls and plug included) height 17.5 cm.
weight	3 kg.
Accessories	manual probe identification set trimming tool.
Optional	4 measuring probes PM 9331 A/10 4 measuring probes PM 9334 A/10

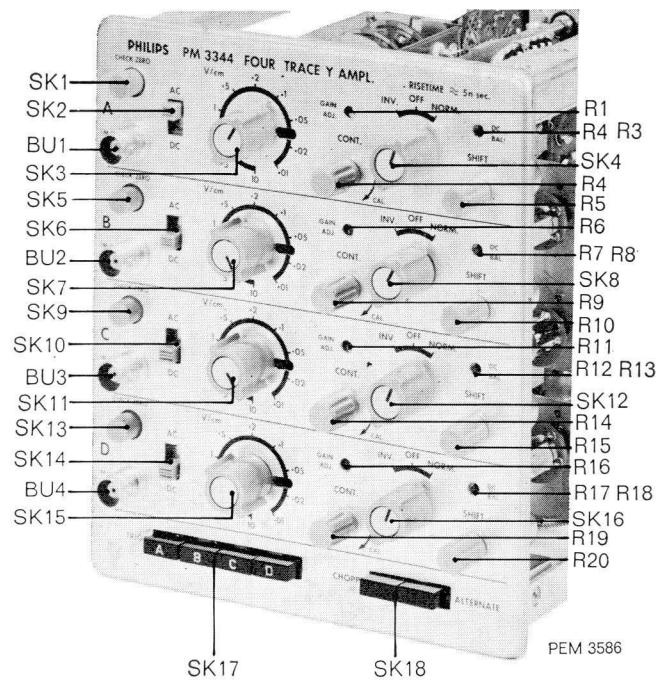


Fig. 1. Front-view with controls and sockets

DIRECTIONS FOR USE

Installation



The PM 3344 should be plugged into the left plug-in compartment (Y-UNIT) of basic oscilloscope PM 3330. Switching-on is effected with the mains switch of the basic oscilloscope.

Approximately two minutes after switching-on the unit

has reached its operating temperature and meets the technical data.

When the PM 3344 is used, the switch on the rear side of the basic oscilloscope should be set to position MULTI-TRACE CHOPPER.

Controls and their functions



Channels A, B, C and D are provided with the following controls and sockets.

CHECK ZERO
(SK1, SK5, SK9, SK13)

When this button is depressed, the connection between amplifier input and input socket is interrupted and the amplifier input is earthed.

AC – DC
(SK2, SK6, SK10, SK14)

This switch couples the input socket to the amplifier either direct or capacitively.

V/cm
(SK2, SK7, SK11, SK15)

By means of this control the deflection coefficients may be selected in steps.

INVERT-OFF-NORM
(SK4, SK8, SK12, SK16)

Position NORM A positive going input signal causes an upward deflection on the screen.

Position INVERT A positive going input signal causes a downward deflection on the screen.

Position OFF The channel is switched off.

A, B, C, D
(BU1, BU2, BU3, BU4)

Input socket

GAIN ADJ.
(R1, R6, R11, R16)

The deflection coefficient of each channel can be checked by applying the calibration voltage of the basic oscilloscope to the input socket.

If the deflection coefficient does not correspond to the indicated value, it can be corrected by adjusting screw-driver control GAIN ADJ. In this case continuous control CONT should be turned fully clockwise (CAL).

DC – BAL
(R2/R3, R7/R8, R12/R13, R17/R18)

The dc-balance of the amplifier can be adjusted with this control. For this, remove the input signal and adjust the time-base generator of the basic oscilloscope to its free-running position (TRIGG. MODE to position AUT, or STAB. fully clockwise).

Adjust the DC.BAL. so that the line on the screen does not move when the continuous attenuator CONT. is turned.

CONT
(R4, R9, R14, R19)

This control enables a continuous setting of the deflection coefficients (control range 1 : 3).

The deflection coefficients are calibrated when this control is turned fully clockwise (CAL).

SHIFT
(R5, R10, R15, R20)

TRIGG. A, B, C, D
(SK17)

CHOPPED-ALTERNATE
(SK18)

With this knob, the trace can be shifted in Y-direction.
The working-direction of this SHIFT-control depends on the position of the polarity switch.

With this push-button switch the triggersignal can be taken from channel A, B, C or D.

Moreover it is possible to suppress the display of the triggering signal by positioning the relevant INV-OFF-NORM selector to OFF.

This push-button switch allows two modes of operation, viz.

- CHOPPED.

The signals of each channel are displayed in the sequence A, B, C and D for 500 ns. Channels out of operation are skipped.

- ALTERNATE.

The signals of each channel are displayed successively in the sequence A, B, C and D while channels out of operation are skipped.

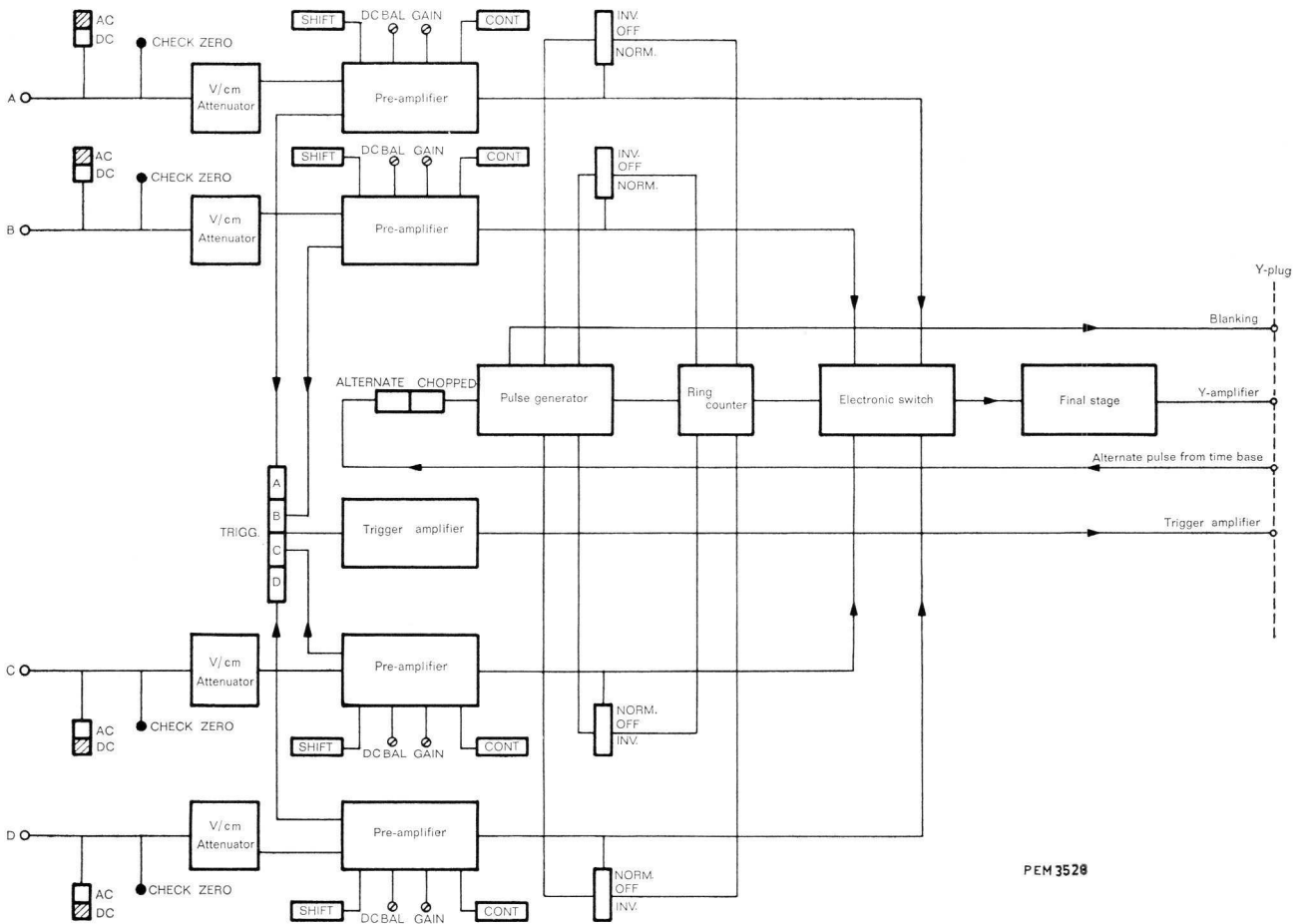


Fig. 2. Block-diagram

SERVICE NOTES

Circuit description



A. PREAMPLIFIER CHANNEL A (Fig. 18)

The incoming signal is fed to a ten step attenuator, direct or via a capacitor, depending on the position of switch AC – DC (SK2) which reduces the signal amplitude by a factor 1, 2, 5, 10 etc. up to 1000, as selected with switch V/cm (SK3).

Source follower TS101 provides an impedance transformation to drive the following transistor amplifier. A second source follower TS103 is symmetrically connected to TS101 to minimise drift.

Furthermore, a provision is made to balance the amplifier by varying the gate potential of TS103 with DC. BAL (R3 coarse and R2 fine).

The second stage is formed by emitter-followers TS102, TS106 and TS104, TS107. They offer a low impedance signal source for the next stage and for the trigger-amplifier which receives its signals via R120 and R130. As continuous attenuator CONT (R4) and gain adjustment GAIN ADJ (R1) are connected between the emitters of this stage, no shift will occur in case of correct dc balance, when continuous attenuator CONT (R4) is operated (the emitters have the same dc potential).

Moreover, the trigger voltage is balanced before it is applied to the trigger amplifier.

The FET amplifier is protected by diodes GR102-103.

The third stage and the first stage of the final amplifier form the series and the shunt feedback transistor circuit TS108 – TS501, in push-pull with an identical circuit TS109 – TS503.

The amplification factor of this circuit is mainly determined by the ratio of the values of R506 (or R517) and the resistance at the emitter of TS108 (or TS109) and resistor R508 (or R516).

By means of potentiometer SHIFT (R5) in the emitter circuit of TS108 – TS109 the currents in these transistors can be varied.

This variation results in a vertical shift of the display. Capacitors C111 and C112 and resistor R142 provide a square-wave response correction.

Resistor R134 – R146 and R124 – R129 provide a

constant dissipation of the relevant transistors so that no sag occurs in case of square waves of low frequency. Between the third stage and the final amplifier, switch NORMAL-OFF-INVERT (SK4) has been inserted. This is a 3-position rotary switch. In the first and the third position the leads of the pre-amplifier and the electronic switch are interchanged so that the signal is inverted 180°. In centre position of the switch the channel is disconnected from the output amplifier by means of the electronic switch.

When three channels are switched off, the pulse generator is stopped and no blanking pulses are fed to the cathode-ray tube.

The INV-OFF-NORMAL-switch (SK4) is followed by the electronic switch consisting of diodes GR104, GR106...GR109 and GR111 and the resistors R144, R147 and R148. A pulse from the ring counter is fed to junctions GR107 – GR109 and GR106 – GR108.

If the pulse from the ring counter is *negative* with respect to the input level of the output stage, diodes GR106...GR109 will be blocked, while GR104 and GR111 are conductive. This means that the relevant pre-amplifier is connected to the output stage.

If the pulse of the ring counter is *positive* with respect to the input level of the output stage, diodes GR106...GR109 will become conductive and GR104 and GR111 will be blocked. The output stage is now switched off from the relevant pre-amplifier.

The pre-amplifier is then supplied with current from the ring counter via conductive diodes GR106...GR109. As a blocked diode always possesses a certain capacitance there is some capacitive transmission of the signal. To minimize this effect the circuit is doubled. GR106 and GR108 short-circuit the signal, after which any remaining signal is further attenuated by resistors R147 and R148 and conductive diodes GR107 and GR109.

R144 serves to equalize the current through GR106 – GR108 and GR107 – GR109.

B. PREAMPLIFIER CHANNELS B, C AND D (Fig. 18)

These pre-amplifiers are identical to that of channel A. The components of channel B are numbered one hundred higher than those of channel A, those of C two hundred higher than those of channel A, and those of D three hundred.

The controls and sockets form an exception. For them see Fig. 1.

C. FINAL AMPLIFIER

This amplifier consists of two push-pull amplifier stages:

- TS501 and TS503, which are part of the series and shunt feedback circuit already discussed.

The input voltage required for the electronic switch is obtained by setting the emitters of this stage to a fixed voltage by means of Zener diode GR503.

- two output emitter followers TS502 and TS504 feeding the signal to the basic oscilloscope PM 3330.

D. TRIGGER AMPLIFIER (Fig. 19)

The triggersignal can be picked up from each channel. The choice is made by means of push-button switch TRIGG. A, B, C, D (SK17).

The triggersignal is fed to a transistorized trigger-amplifier consisting of:

- a push-pull series and shunt feedback circuit (TS601–TS602 and TS604 – TS606).

R607 and R608 compensate for thermal drift of TS601 – TS604, which improves the square-wave response.

- a push-pull emitter follower output stage (TS603 – TS607) through which the signal is fed to basic oscilloscope PM 3330.

The dc balance of the trigger amplifier is adjusted with R611.

E. PULSE GENERATOR

This generator comprises a blocking oscillator (Fig. 20). In position CHOPPED (SK18), switch SK18^b is opened.

The base potential of TS707, which is determined by voltage divider R756 – R757, is such that the blocking oscillator is free running.

The repetition rate of the oscillator signal is determined by the time constant of the RC-network in the emitter circuit of TS707 and amounts to 2 MHz.

When the base potential is equal to or positive with respect to the emitter potential, the oscillator stops. This happens in two cases:

- When three amplifiers are switched off.

By means of diode GR701 the base potential will be driven to a positive value with respect to the emitter and the blocking oscillator will be switched off, so that no further pulses come from the oscillator and no beam suppression takes place.

- In position ALTERNATE (SK18) switch SK18^b is closed.

Resistor R757 is short-circuited and the base potential will be equal to the emitter potential. At the same time the alternate pulse from the PM 3330 will be fed to the base of TS706 after differentiation by C714 – R752. The collector of this transistor is connected to winding S3 of the blocking transformer so that an incoming alternate pulse produces a negative pulse on the base of TS707. Consequently the blocking oscillator will operate once for each arriving alternate pulse.

Winding S3 also serves to supply the blanking pulse. Diode GR702, connected in parallel to S3, ensures that, when the blocking oscillator is switched off rapidly, the polarity of the voltage across the transformer does not change; this could cause undesirable restarting of the ring counter.

F. RING COUNTER (Fig. 20)

The ring counter consists of four emitter coupled transistors TS701...TS704, so connected that if one draws current, the other three are blocked. This has been achieved by coupling the collector of each transistor to the base of the other three, by means of voltage dividers.

The collectors of the transistors are also capacitively (C701...C704) coupled to the base of the next transistor via the INVERT-OFF-NORMAL switch (SK4. SK8, 12, 16).

At each incoming positive pulse from the blocking oscillator the current through the conductive transistor will fall off to zero for a moment, so that the collector becomes positive.

Via the above-mentioned capacitor this surge is fed to the base of the next transistor, which becomes conductive.

This process is started by each pulse from the blocking oscillator (in position CHOPPED every 500 ns and in position ALTERNATE at every fly-back of the time base).

The pulse generator is coupled to the ring counter by means of a diode so that only the peak of the pulse is fed to the ring counter.

The voltage wave forms at the collectors of the ring counter transistors are shown in Fig. 3.

The collectors of the ring counter are connected to the electronic switch.

As already mentioned in chapter V A, the relevant channels can be switched on or off with a negative and positive voltage respectively.

If a channel is not used (INV-OFF-NORMAL (SK4, 8, 12, 16 switch to position OFF), the transistor in the ring counter corresponding to this channel is cut off by connecting the base to the negative supply voltage via a resistor (R702 or R704 or R707 or R709).

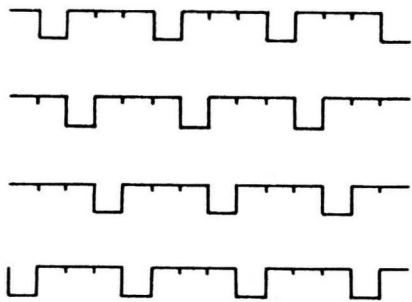


Fig. 3. Collector wave forms during the switching

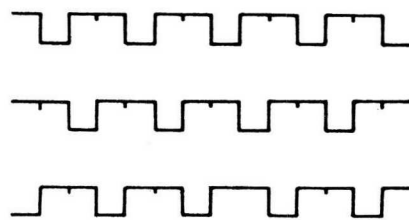


Fig. 4. Collector wave forms if one channel is switched off

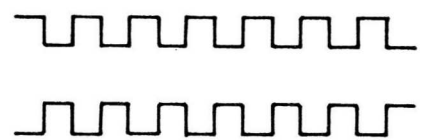


Fig. 5. Collector wave forms if two channels are switched off

Moreover, the capacitor connected between the preceding collector and the relevant base is switched over to the base of the next functioning transistor.

The collector wave forms are shown in Fig. 4.

The collector wave forms with two channels switched off are shown in Fig. 5.

The switching frequency in CHOPPED position is always 2 MHz, so that in this position a different channel is displayed every 500 ns.

PEM 3529

Checking and adjusting

VI

A. GENERAL

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

With the aid of these data, it is possible to carry out all the adjustments to four-trace unit PM 3344 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.

Note: Only the input FET's must be paired and the transistors TS108, 208, 308, 408, selected on equal h_{fe} . All other semiconductors can be ordinary production ones.

B. DC BALANCE

This adjustment should be carried out when the unit has obtained its operating temperature, i.e. 10 minutes after switching-on.

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

TRIGG. MODE (SK1) to AUT.

+/- (SK2) to +

TRIGG. SOURCE (SK3) to INT.

TIME/cm (SK4) to .5 msec.

X-DEFLECTION (SK7) to TIME BASE A.

1. Channel A (B, C, D)

R2 (R7, 12, 17) (Fig. 1)

R135 (R235, 335, 435) (Fig. 6)

– Set INV-OFF-NORM. SK4 (SK8, SK12, SK16) to NORM.

– Set potentiometers DC BAL, R2 (R7, R12, R17) and

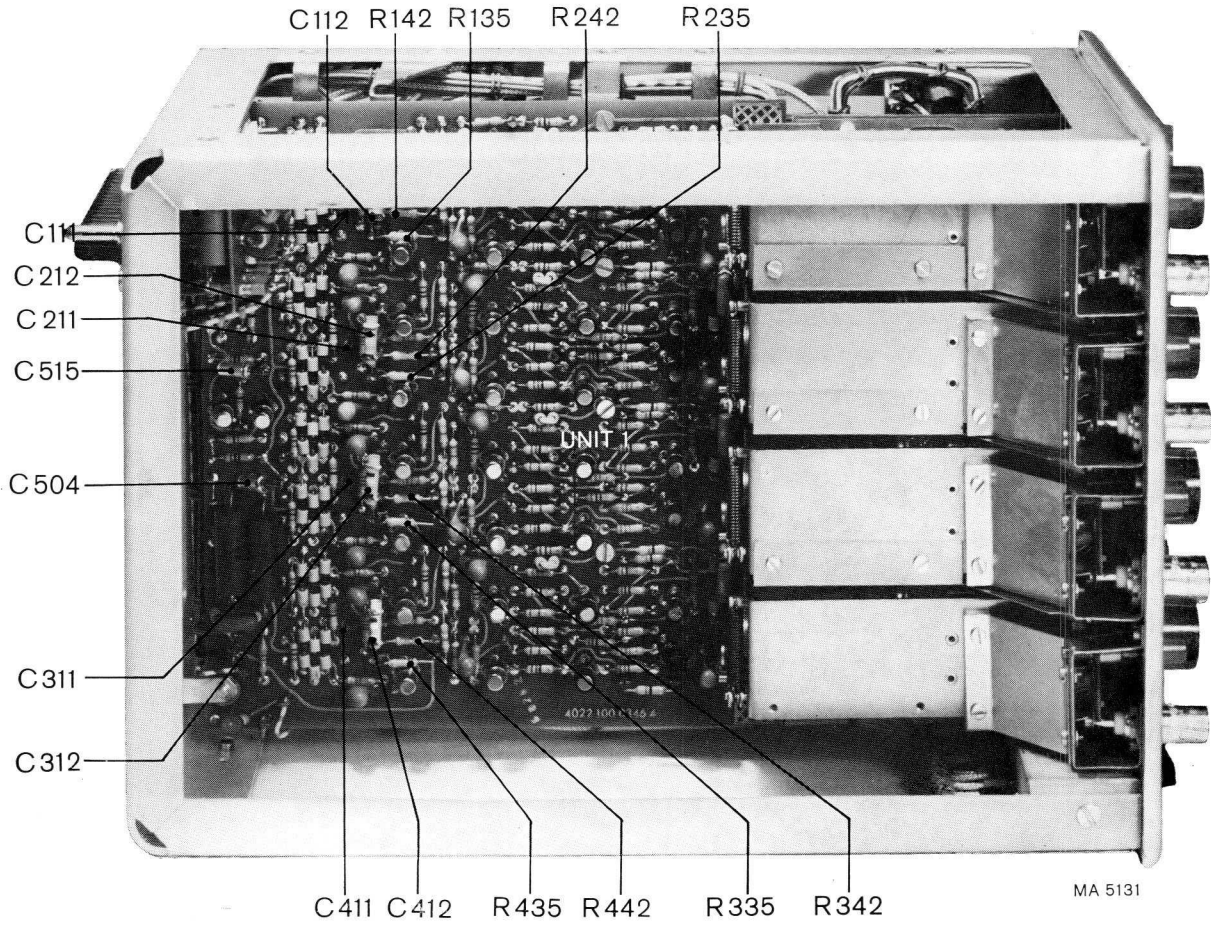


Fig. 6. Left-hand side with adjusting elements

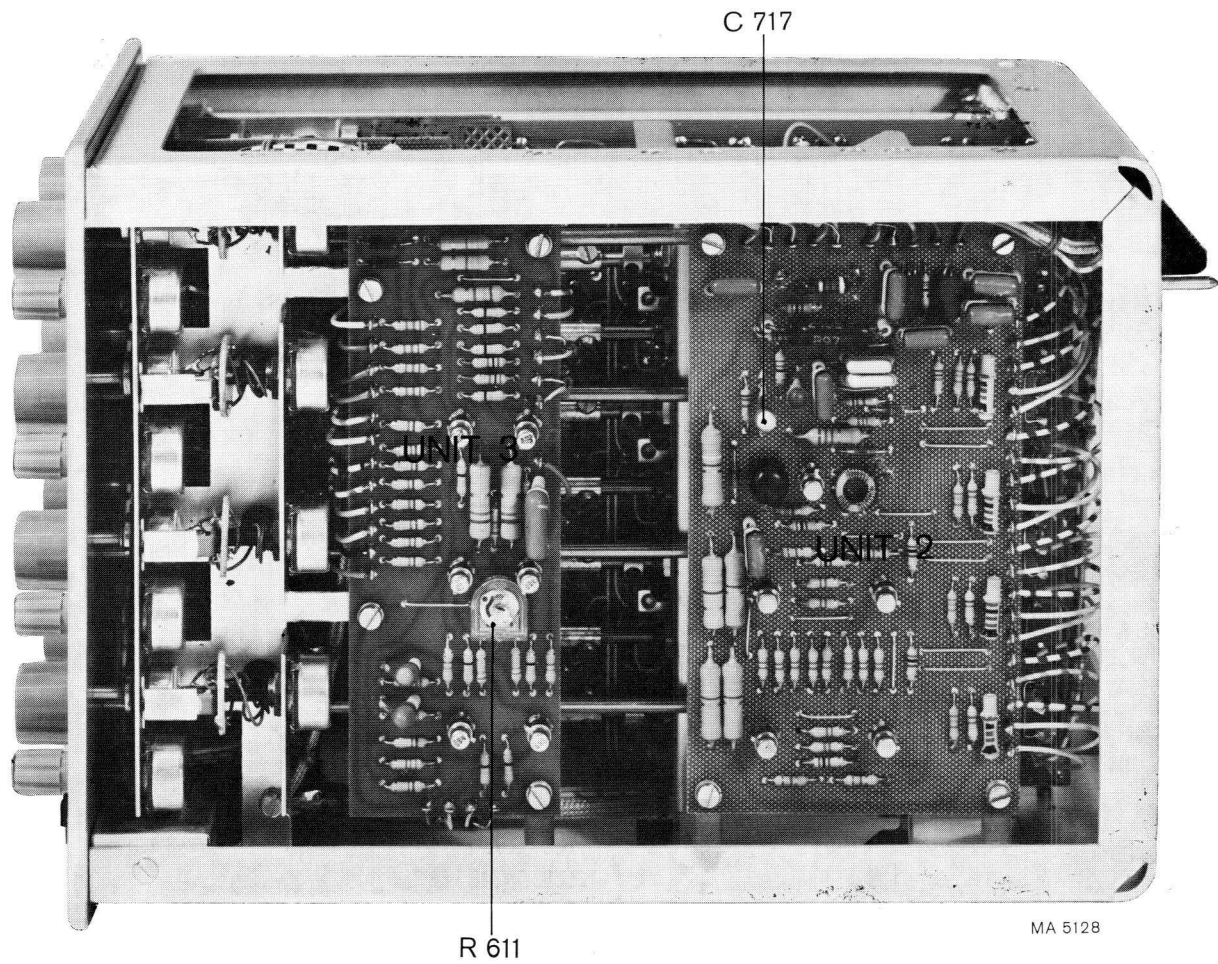


Fig. 7. Right-hand side with adjusting elements

SHIFT, R5 (R10, R15, R20) to their mid-positions.

- Adjust DC BAL, R2 (R7, R12, R17) so, that the time base line moves max. 0.5 mm when CONT, R4 (R9, R14, R19) is turned.

During this adjustment keep the time-base line on the screen with SHIFT, R5 (R10, R15, R20).

- If necessary select such a value for R135 (R235, R335, R435) that the time-base line does not move when CONT, R4 (R9, R14, R19) is turned.

2. Trigger amplifier

R611 (Fig. 7)

The adjusting element is accessible when the unit to be checked is connected to the basic oscilloscope via the extension plug.

- Short-circuit the input of the trigger amplifier by interconnecting the bases of TS601 and TS604.
- Depress TRIGG. A (SK 17).
- Measure the voltage on the output of the amplifier between the emitters of transistors TS 603 and TS 607.
- Adjust this voltage to minimum with potentiometer R611.
- Remove the interconnection.

C. LEVELS OF CHANNELS A, B, C AND D

- Adjust SHIFT, R5 (R10, R15, R20) so that the time-base line does not jump when switch INV-OFF-NORM SK4 (SK8, SK12, SK16) is switched from NORM to INV.
- In all cases, the vertical position of the time-base line should not deviate more than 1 cm from the centre of the screen.

D. SENSITIVITY OF CHANNEL A (B, C, D)

R1 (R6, 11, 16) (Fig. 1)

- Set V/cm, SK3, (SK7, SK11, SK15) to .01.
- Set CONT, R4 (R9, R14, R19) to CAL.
- Set TRIGG (SK17) to A (B, C, D).
- Set AC-DC, SK2 (SK6, SK10, SK14) to DC.
- Set INV.-OFF-NORM. SK4 (SK8, SK12, SK16) to NORM.
- Adjust the calibration voltage of the basic oscilloscope to 40 mV and apply this voltage to channel A (B, C, D).
- With SHIFT, R5 (R10, R15, R20) adjust the trace to the screen centre.
- With GAIN ADJ., R1 (R6, R11, R16) adjust the trace height to 4 cm.
- Turn CONT. R4 (R9, R14, R19) fully anti-clockwise. The trace height should be between 16 and 11.4 mm. (Control range 1 : 2.5 to 1 : 3.5).

E. AC/DC SWITCH: CHECK ZERO

- Set V/cm SK3 (SK7, SK11, SK15) to .01.
- Set CONT. R4 (R9, R14, R19) to CAL.
- Adjust the calibration voltage of the basic oscilloscope to 40 mV and apply this voltage to channel A (B, C, D).
- Set TRIGG (SK17) to A (B, C, D).
- Adjust SHIFT, R5 (R10, R15, R20) so, that the lower side of the trace coincides with the centre line of the screen.
- Set AC-DC SK2 (SK6, SK10, SK14) to AC.
- The dc component of the input signal should be blocked, as a result of which the trace is written approximately around the centre line of the screen. If CHECK ZERO, SK1 (SK5, SK9, SK13) is depressed, the trace should no longer be visible, only the time-base line should.

F. SQUARE-WAVE RESPONSE

C504, C515, C111 (C211, C311, C411) C112 (C212, C312, C412) R142 (R242, R342, R442) (Fig. 6)

To avoid extra capacitive load on the output of the amplifier, this adjustment should be carried out without using the extension plug.

To check the rise time and the overshoot, a square-wave voltage with a value of 40 mV_{p-p} and a rise time of < 2ns is required.

This voltage can be obtained with the aid of a pulser which is controlled with the calibration voltage of the basic oscilloscope; the output voltage of the pulser can be adjusted to the required value by means of an attenuator. If a Tektronix TU-5 Pulser (cat. nr. 015-0038-00) is used a 2700 Ω resistor (.1 Watt, 5%) must be added as shown in Fig. 8.

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

TIME/cm: .05 μsec.

MAGN. : × 5

- Set V/cm, SK3 (SK7, SK11, SK15) in position .01.
- Set CONT., R4 (R9, R14, R19) in position CAL.
- Set TRIGG, SK17 to position A (B, C, D).
- Connect the pulser to channel A (B, C, D) via a 1 : 5 attenuator (e.g. Tektronix cat. no. 011-0060-00) and a 50 Ω pad (e.g. XE 101 96, code number 4822 455 60006).
- Adjust the calibration voltage of the basic oscilloscope to 80 V and apply this voltage to the pulser.
- Adjust the pulser by turning its knob clockwise so, that the output voltage instantly obtains its correct value.
- Adjust C111 (C211, C311, C411) and select such a value for C112 and R142 (C212 and R242, C312 and R342, C412 and R442) and if necessary C504 – C515) that the rise time of the displayed step is less than 7 ns and that the overshoot does not exceed 1%.

- Set AC-DC, SK2 (SK6, SK10,) SK14) to DC.
- Apply a 40 mV_{p-p}-square-wave voltage with a frequency of .3 Hz and a rise time of approximately 25 ns to channel A (B, C, D).
- Check that no sag is visible.

G. FREQUENCY RESPONSE CURVE

After adjusting the square-wave response of the four channels, the -3 dB point of the amplifier should be at a frequency over 50 MHz. The frequency response curve can be measured with e.g. PHILIPS A.M./F.M.-generator GM 2621 and PHILIPS H.F.-millivoltmeter GM 6025. Check at the input of all channels that the voltages required for the measurement of the frequency response curve are equal.

- Set the knobs to the positions mentioned under F.
- Connect output socket HF II of the GM 2621 to the input of channel A (B, C, D) via a terminated 50 Ω cable. A 50 Ω terminating plug XE 101 96 can be used.
- Adjust the frequency to 4.5 MHz and adjust the generator voltage so that a deflection of 4 cm is obtained.
- Increase the frequency to 50 MHz. With the same value of the input voltage, the deflection should exceed 28 mm.

H. DEFLECTION AND SHIFT

Before carrying out this measurement, check that the dc-balance and the sensitivity of all channels have been correctly adjusted.

- Set V/cm, SK3 (SK7, SK11, SK15) to position .01.
- Set CONT. R4 (R9, R14, R19) to position CAL.
- Apply a triangle or sine wave voltage with a peak-to-peak value of 180 mV and a frequency of 1 kHz to channel A (B, C, D).
- The control range of SHIFT, R5 (R10, R15, R20) 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.
- Repeat this check at 10 MHz.
- Apply a signal with a frequency of 50 MHz and such an amplitude that a trace height of 2 cm is obtained.
- Double the input voltage; the trace height should then be 4 cm, + or - 2%.

J. INPUT ATTENUATORS

1. Square wave response

- Apply the calibration voltage of the basic oscilloscope to channel A, (B, C, D). Adjust the calibration voltage to 40 mV. After correct adjustment of the sensitivity, the trace height should amount to 40 mm.

- Check the trace height in all positions of V/cm, SK3 (SK7, SK11, SK15) according to the following table; the trace height should amount to 40 mm, + or - 2%.
- At the same time adjust the trimmers mentioned in the table so, that just no overshoot occurs.

Calibration voltage (SK3, 7, 11, 15)	V/cm	Channel A (B, C, D)
40 mV	.01	
80 mV	.02	C28
.2 mV	.05	C31
.4 mV	.1	C34
.8 mV	.2	C38
2 V	.5	C42
4 V	1	C44
8 V	2	C48
20 V	5	C51
40 V	10	C54

The trimmers are accessible through the hole next to knob V/cm. (right hand side trimmers).

2. Input capacitance

With the aid of an input RC standardiser, (e.g. Tektronix cat. no. 011.0073-00 BNC) the input capacitance can be adjusted to 18 pF in all positions of V/cm, SK3 (SK7, SK11, SK15).

- Apply the calibration voltage of the basic oscilloscope to channel A (B, C, D) via the input RC standardiser.
- Adjust the input capacitance of all channels by means of the trimmers mentioned in the table below so that the square-wave response is optimum.

Calibration voltage (SK3, 7, 11, 15)	V/cm	Channel A (B, C, D)
80 mV	.01	C27
.2 V	.02	C29
.4 V	.05	C32
.8 V	.1	C36
2 V	.2	C39
4 V	.5	C43
8 V	1	C46
20 V	2	C49
40 V	5	C52
80 V	10	C56

The trimmers are accessible through the hole next to knob V/cm (left hand side trimmers).

K. HUM

With this test the cabinet plates of the basic oscilloscope should be mounted.

- Set V/cm SK3 (SK7, SK11, SK15) to .01.
- Depress CHECK ZERO SK1 (SK5, SK9, SK13). The hum should not exceed 0.25 mm.

L. CROSS-TALK

- Set V/cm SK2 (SK7, SK11, SK15) to .01.
- Apply a sinusoidal voltage with a peak-to-peak value of 180 mV, frequency 10 MHz, to channel A.
- Check that the deflection of channels B, C and D does not exceed 2 mm.
- Repeat this check for the other channels.
- Set V/cm (SK3) to position 10 V/cm (SK7, SK11, SK15) remains in positions .01.
- Apply a sinusoidal voltage, having a peak-to-peak value of 100 V, frequency 1 MHz to channel A.
- Check that the deflection of channels B, C and D does not exceed 1 mm.
- Repeat this check for the other channels.

M. TRIGGERING

- Apply a signal, having a frequency of 20 kHz, to channel A (B, C, D).
- Check that with a signal height of 10 mm, applied to channel A (B, C, D) and TRIGG. (SK18) to position A (B, C, D) a triggered display can be obtained.
- Set switch INV.-OFF-NORM, SK4 (SK8, SK12, SK16) from position NORM to position INV. The polarity of the displayed signal should invert.

N. CHOPPED

1. Frequency

C717 (Fig. 7)

- Set switch CHOPPED-ALTERNATE (SK18) to position CHOPPED.
- Set TIME/cm (SK4) of the basic oscilloscope to position .2 μ sec.
- All time base lines should be periodically interrupted in the frequency of the switching voltage.

- Check the frequency by measuring the period time. For this, the basic oscilloscope should be externally triggered by the switching pulses. Apply this signal to EXT. (BU1) of the basic oscilloscope and set TRIGG. SOURCE (SK3) to EXT.
- The period time should be between 500 and 600 ns. If necessary, select an other value for C717.

2. Blanking

- Trigger the basic oscilloscope externally with the switching voltage as indicated in point N1.
- Without blanking (SK14 of the basic oscilloscope to EXT.) the edges of the switching pulses are visible. When SK14 is set to position MULTI-TRACE CHOPPER the edges should not be visible.

O. ALTERNATE

- Adjust the basic oscilloscope so as to obtain a free running time base.
- Set CHOPPED-ALTERNATE (SK18) to position ALTERNATE.
- Check that in all positions of TIME/cm (SK4) of the basic oscilloscope, four time-base lines are written in the sequence A, B, C, D.
- Insert a PM 3347 into compartment X-UNIT of the basic oscilloscope.
- Set X-DEFLECTION (SK7) of the basic oscilloscope to position X-UNIT.
- Set the X-deflection mode selector (SK7) of the PM 3347 to position "B intensified by A".
- Check that in all positions of TIME/cm (SK4) of the basic oscilloscope, four time-base lines are written in the sequence A, B, C, D.

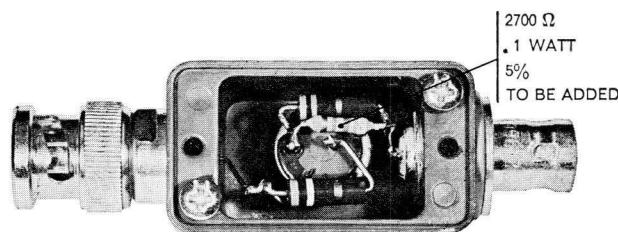
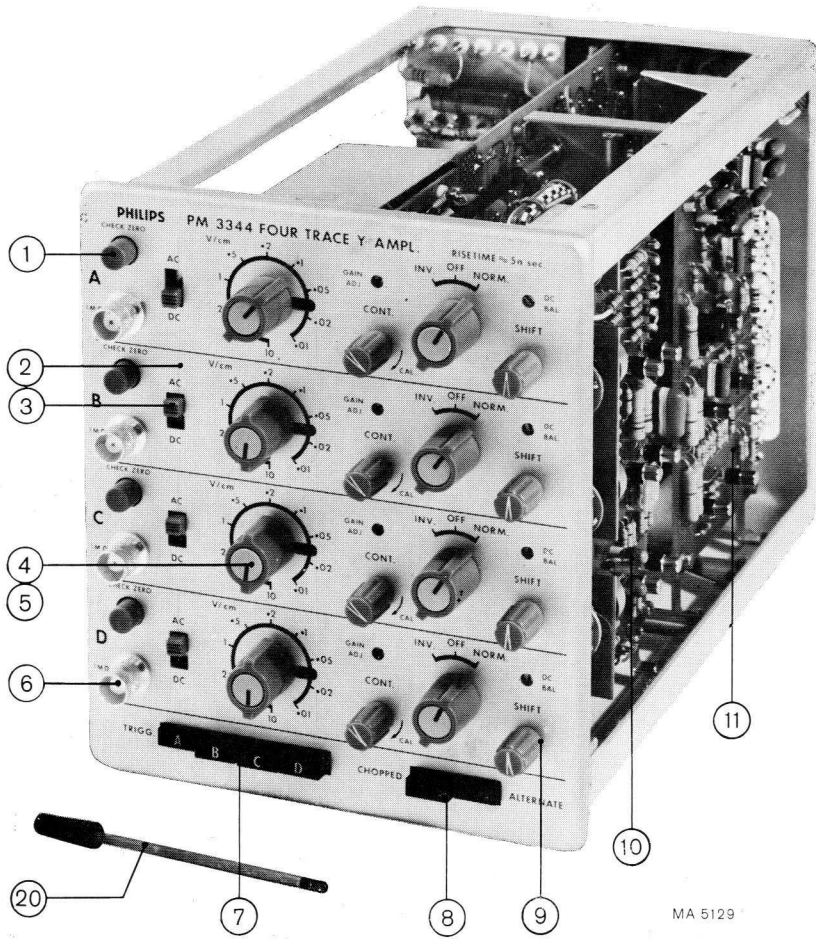
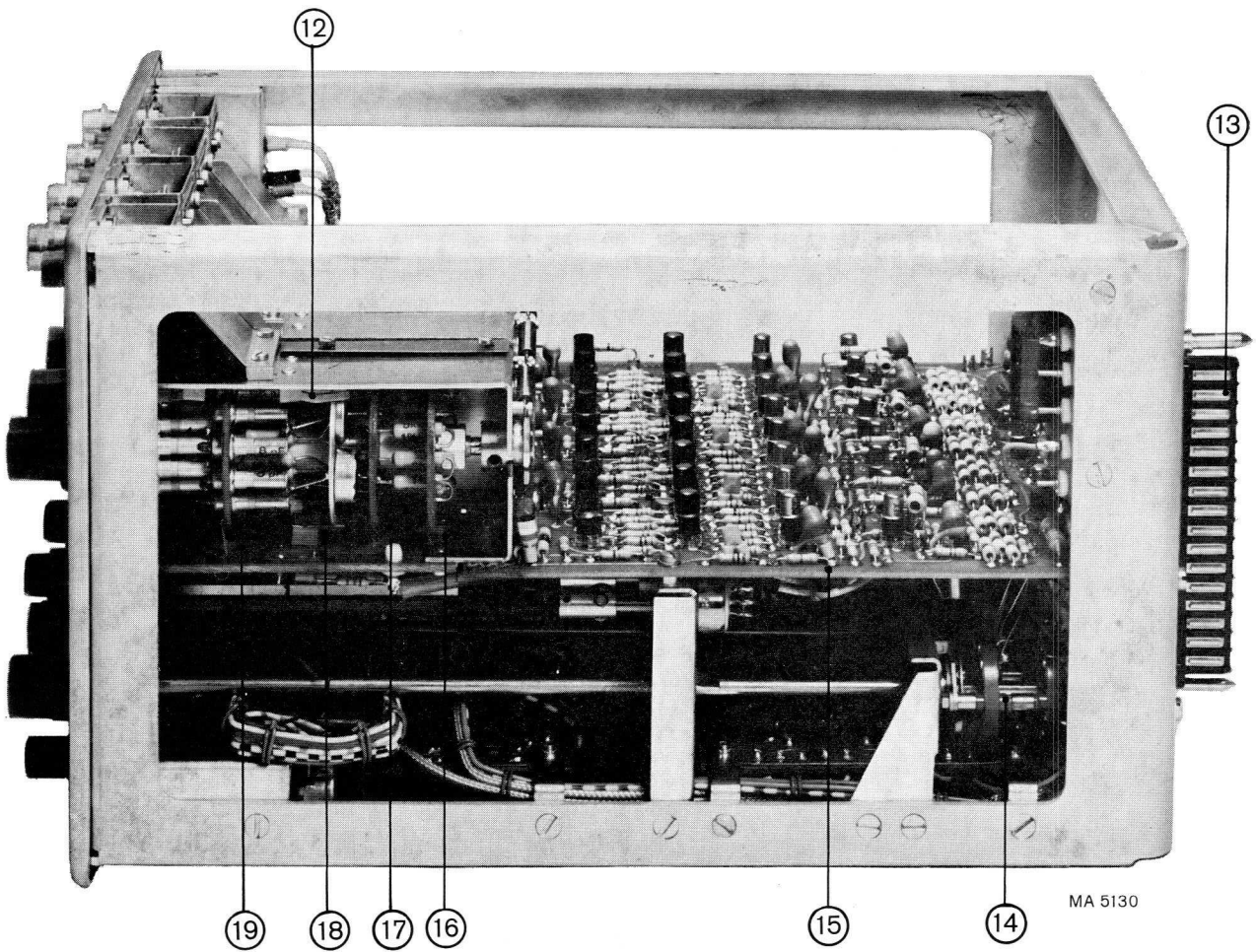


Fig. 8. Pulser TU5



MA 5129

Fig. 9. Front view with item numbers



MA 5130

Fig. 10. Top view with item numbers

List of parts**A. MECHANICAL**

<i>Item</i>	<i>Qty.</i>	<i>Fig.</i>	<i>Ordering code</i>	<i>Description</i>
1	4	9	4822 413 30164	Push-button
2	1	9	4822 454 40042	Text plate
3	4	9	4822 277 20054	Sliding switch (two positions)
4	8	9	4822 413 30084	Switch knob
5	8	9	4822 413 70038	Cap for knob
6	4	9	4822 267 10004	B.N.C.
7	1	9	4822 276 40121	Push-button switch (four buttons)
8	1	9	4822 276 20051	Push-button switch (two buttons)
9	8	9	4822 413 30156	Control knob
10	1	9	4822 214 10068	Ring counter (unit 3 complete)
11	1	9	4822 214 10043	Trigger amplifier (unit 2 complete)
12	8	10	4822 492 61135	Spring
13	1	10	4822 265 60002	Multi-pole connector
14	4	10	4822 273 70018	Switch
15	1	10	4822 214 10069	Y-Amplifier (unit 1 complete)
16	12	10	4822 492 61132	Contact spring
17	4	10	4822 492 61133	Earthing spring
18	4	10	4822 492 61134	Earthing spring
19	8	10	4822 492 61132	Contact spring
20	1	9	4822 395 50104	Trimming tool

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, 2% > 10 MΩ, 5%				Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	} 0,4 – 1,8 W
	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 (flach) Platte miniatuur polyesterkondensator Condensateur au polyester, type plat Condensador polyester, tipo de placas planas	} 250 V	
	Ceramic capacitor, "pin-up" Keramikkondensator "Pin-up" (Perltyp) 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 "microplaca" 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

No.	Ordering code	Value	Voltage	Tolerance	Description
C33	4822 122 70041	6.8 pF			Feed-through
C37	4822 122 70024	15 pF			Feed-through
C41	4822 123 10197	100 pF			Button
C47	4822 123 10198	680 pF			Button
C53	4822 123 10199	3 nF			Button
C102, C202, C302, C402	4822 121 40047	10 nF	250 V	10%	Flat-foil polyester
C103, C203, C303, C403	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C105, C205, C305, C405	4822 122 30043	10 nF	30 V	-20...+100%	Plate ceramic
C113, C213, C313, C413	4822 121 40047	10 nF	250 V	10%	Flat-foil polyester
C114, C214, C314, C414	4822 121 40047	10 nF	250 V	10%	Flat-foil polyester
C501	4822 121 40146	100 nF	400 V		Polyester
C502	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C503	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C506	4822 124 20198	20 μ F	100 V		Electrolytic
C507...C511	4822 122 70055	4.7 nF			Feed-through
C513	4822 122 70055	4.7 nF			Feed-through
C514, C516	4822 121 40146	100 nF	400 V		Polyester
C517	4822 121 40146	100 nF	400 V		Polyester
C706...C709	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C711	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C712	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester
C713	4822 121 40055	47 nF	250 V	10%	Flat-foil polyester
C716	4822 121 40055	47 nF	250 V	10%	Flat-foil polyester
C718	4822 121 40059	100 nF	250 V	10%	Flat-foil polyester

RESISTORS

No.	Ordering code	Value	Power	Tolerance	Description
R1, R4, R6, R9, R11, R14, R16, R19	4822 100 20016	100 Ω			Potentiometer, lin.
R2, R7, R12, R17	4822 100 20016	200 Ω			Potentiometer, lin.
R3, R8, R13, R18	4822 101 20237	2200 Ω			Potentiometer, lin.
R5, R10, R15, R20	4822 101 20238	10 k Ω			Potentiometer, lin.
R23	4822 111 20121	1 M Ω	0.1	1%	Carbon
R28	4822 111 20121	1 M Ω	0.1	1%	Carbon
R29	4822 111 20147	800 k Ω	0.1	1%	Carbon
R32	4822 116 50197	900 k Ω	0.1	1%	Carbon
R33	4822 111 20115	111 k Ω	0.125	1%	Carbon
R34	4822 111 20149	950 k Ω	0.1	1%	Carbon
R36	4822 111 20268	55.6 k Ω	0.125	1%	Carbon
R37	4822 111 20151	980 k Ω	0.1	1%	Carbon
R38	4822 116 50206	20.9 k Ω	0.125	1%	Metal film
R39	4822 111 20152	990 k Ω	0.1	1%	Carbon

No.	Ordering code	Value	Power	Tolerance	Description
R41	4822 116 50284	10.2 k Ω	0.125	1%	Metal film
R42	4822 111 20237	995 k Ω	0.1 W	1%	Carbon
R43	4822 111 20238	5.05 k Ω	0.125 W	1%	Carbon
R44	4822 111 20239	998 k Ω	0.1 W	1%	Carbon
R47	4822 111 20244	999 k Ω	0.1 W	1%	Carbon
R500, R520	4822 111 30273	10 k Ω	0.1 W	5%	Carbon
R525, R530	4822 111 30273	10 k Ω	0.1 W	5%	Carbon
R600	4822 111 30273	10 k Ω	0.1 W	5%	Carbon
R605	4822 111 30273	10 k Ω	0.1 W	5%	Carbon
R611	4822 100 10036	5 k Ω			Adjusting potentiometer

MISCELLANEOUS

No.	Ordering code	Description
T701	4822 158 10203	Transformer
L101, L201, L301, L401	4822 526 10024	Coil
L501,...L504, L507 508, 701, 702	4822 158 10038	Coil

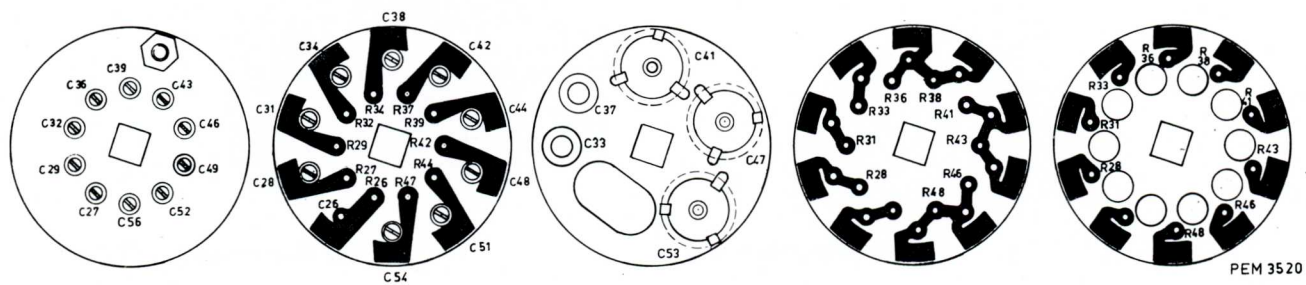
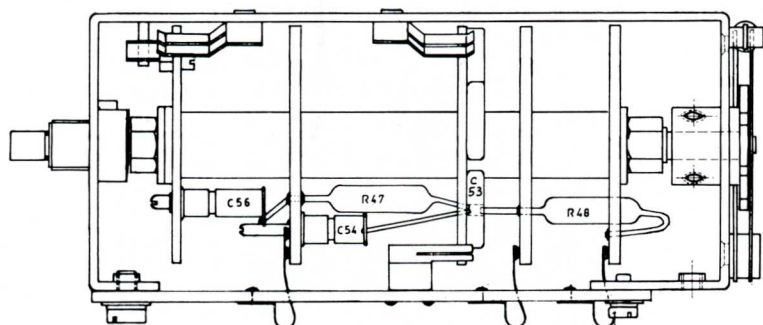
SEMICONDUCTORS

No.	Type	Ordering code	Description
GR102...GR111 GR202...GR211 GR302...GR311 GR402...GR411 GR701 GR703	BAX13	4822 130 40182	Silicon diode
GR702	AAZ13	4822 130 30231	Germanium diode
GR702	BAY38	4822 130 40256	Silicon diode
GR501, GR502	BZY58	4822 130 30324	Zener diode
GR503	BZY60	4822 130 30196	Zener diode
GR101, 201, 301, 401	BZY63	4822 130 30245	Zener diode
GR103, 203, 303, 403	OA202	4822 130 30239	Silicon diode
TS101, TS103 TS201, TS203 TS301, TS303 TS401, TS403	BFW11	4822 130 40408	Field effect transistor
TS102...TS109 TS202...TS209 TS302...TS309 TS402...TS409 TS501...TS504	BFY90	4822 130 40493	Transistor
TS601...TS607	BF115	4822 130 40308	Transistor
TS701...TS706	BC107	4822 130 40184	Transistor
TS707	2N3638	4822 130 40065	Transistor

Note TS101 and TS102
TS201 ,, TS203
TS301 ,, TS303
TS401, ,, TS403

Must be paired on equal V_{GS} within 200 mV at $I_D = 1.5$ mA and $V_{DS} = 9$ V.
Fets having a $V_{GS} > 3$ V must be rejected

TS108, 208, 308, 408 must have equal h_{fe} (within 10%) at $I_e = 4$ mA and $V_{CE} = 4.5$ V.



PEM 3520

Fig. 11. Attenuator switch

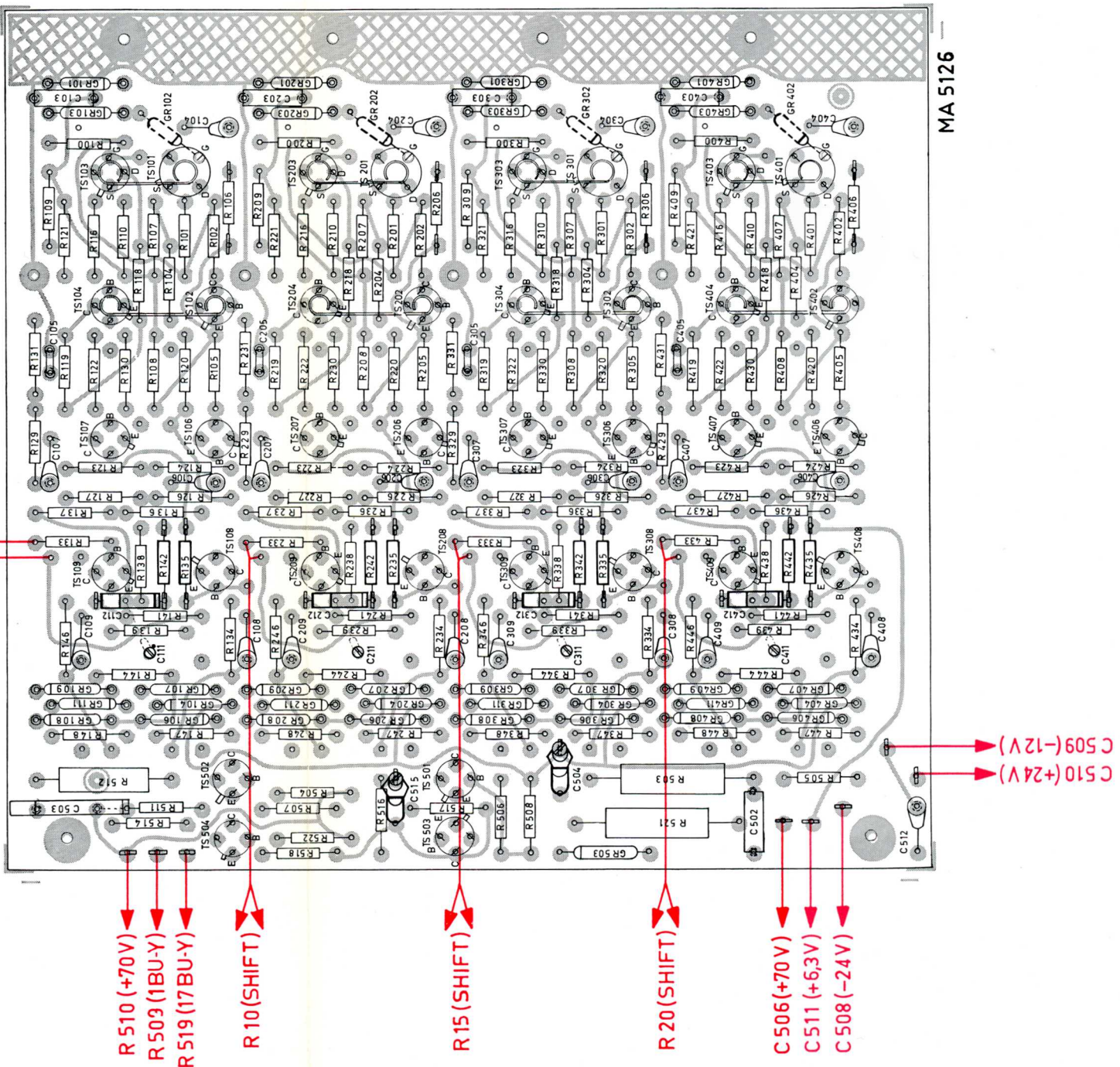


Fig. 12a. Y-Amplifier unit I

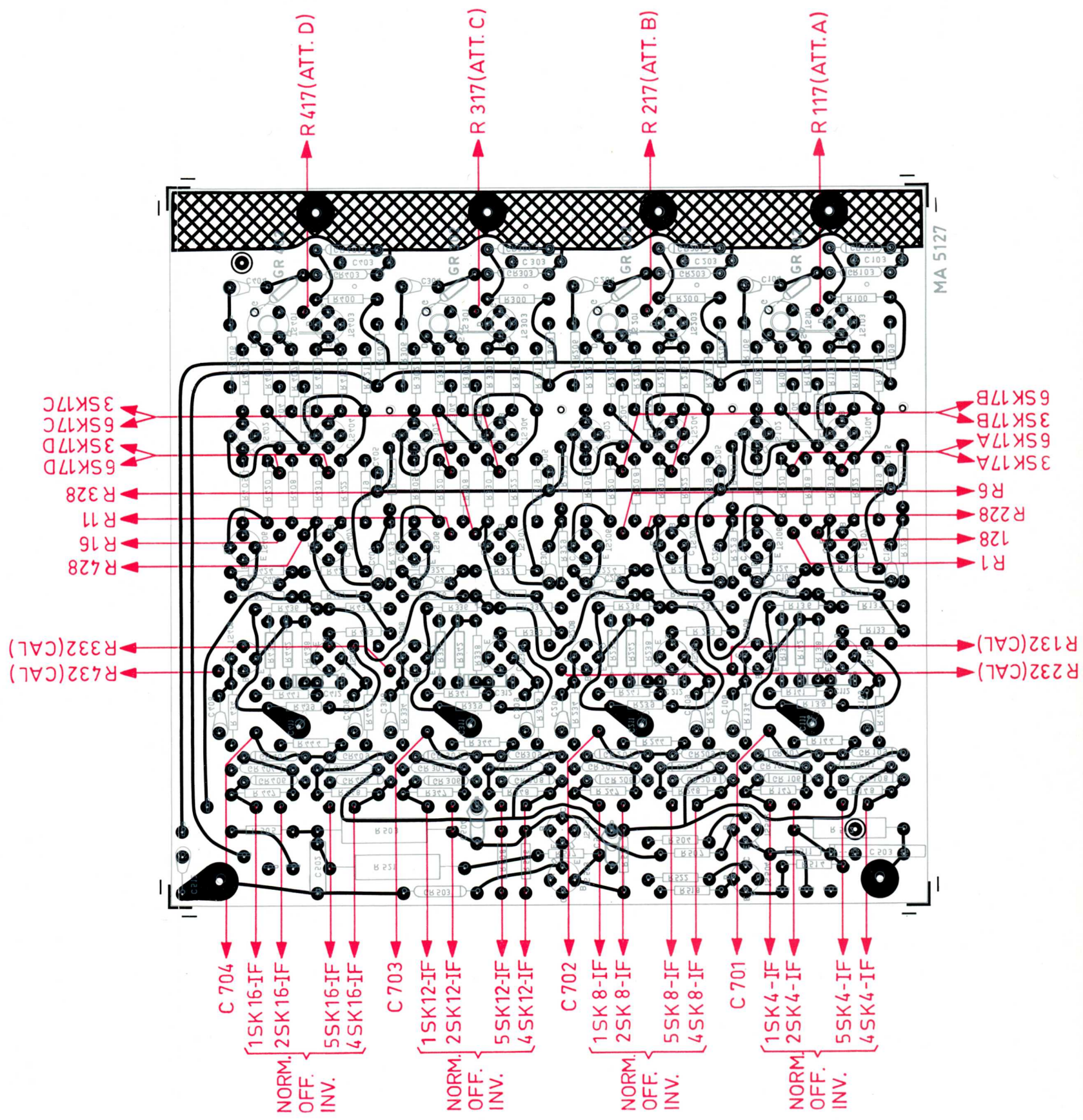


Fig. 12b. Y-Amplifier unit I

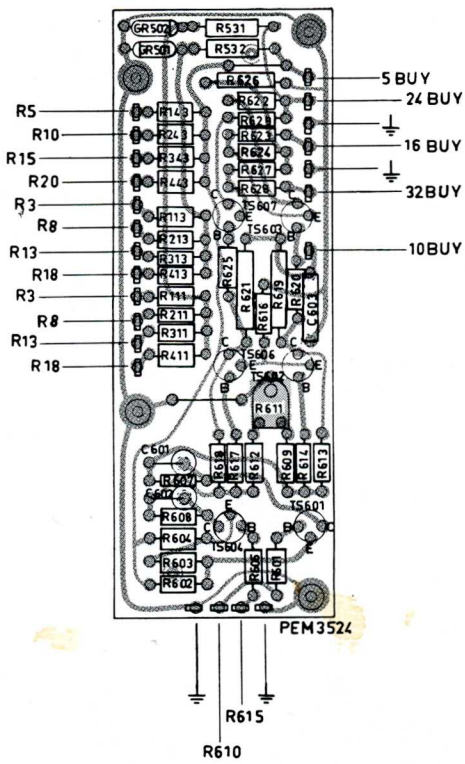


Fig. 13. Trigger amplifier, unit 2

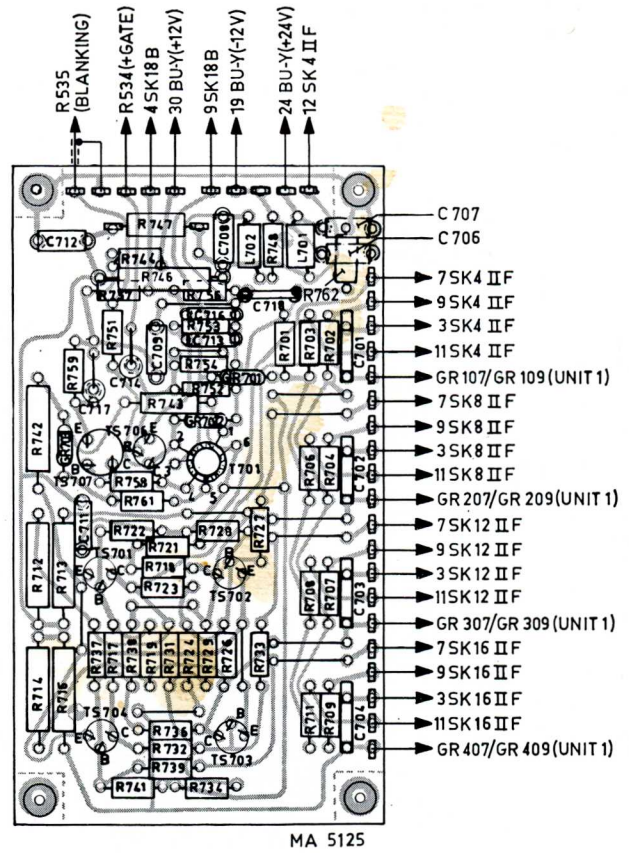


Fig. 14. Ring counter, unit 3

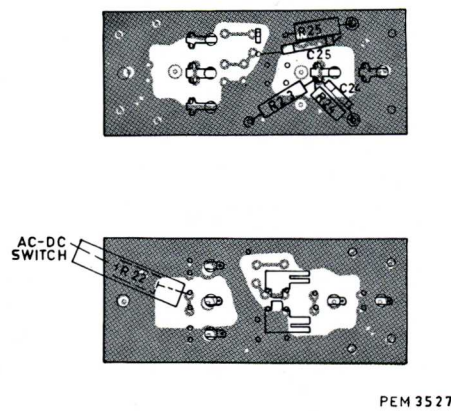


Fig. 15. Attenuator print, unit 7

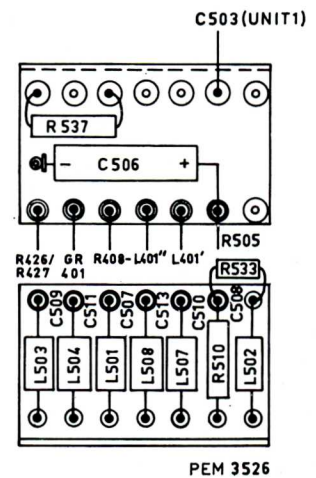
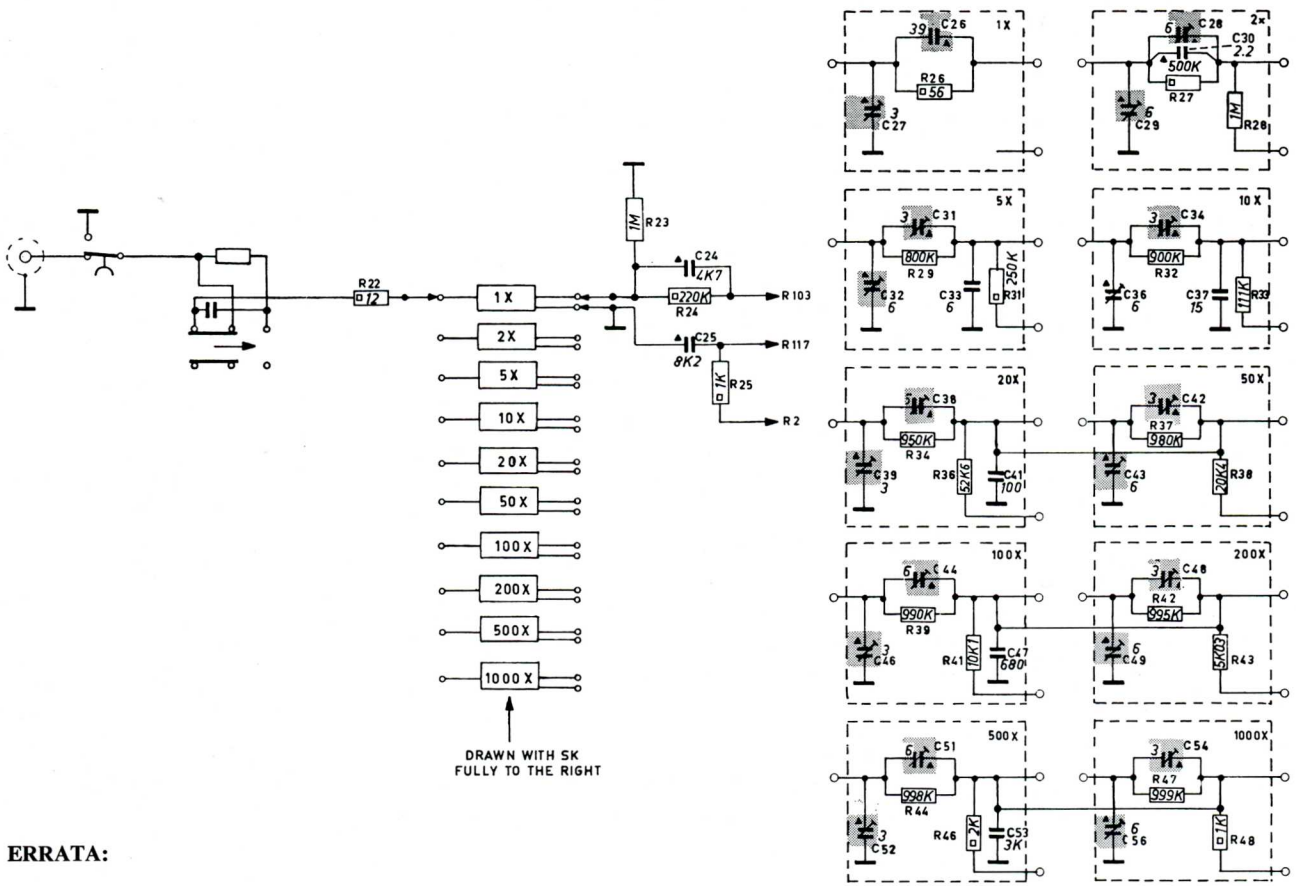


Fig. 16. Decouple unit



ERRATA:

- R36 → 55.6 kΩ
- R38 → 20.9 kΩ
- R41 → 10.2 kΩ
- R43 → 5.05 kΩ

PEM 3523

Fig. 17. Attenuator, circuit diagram

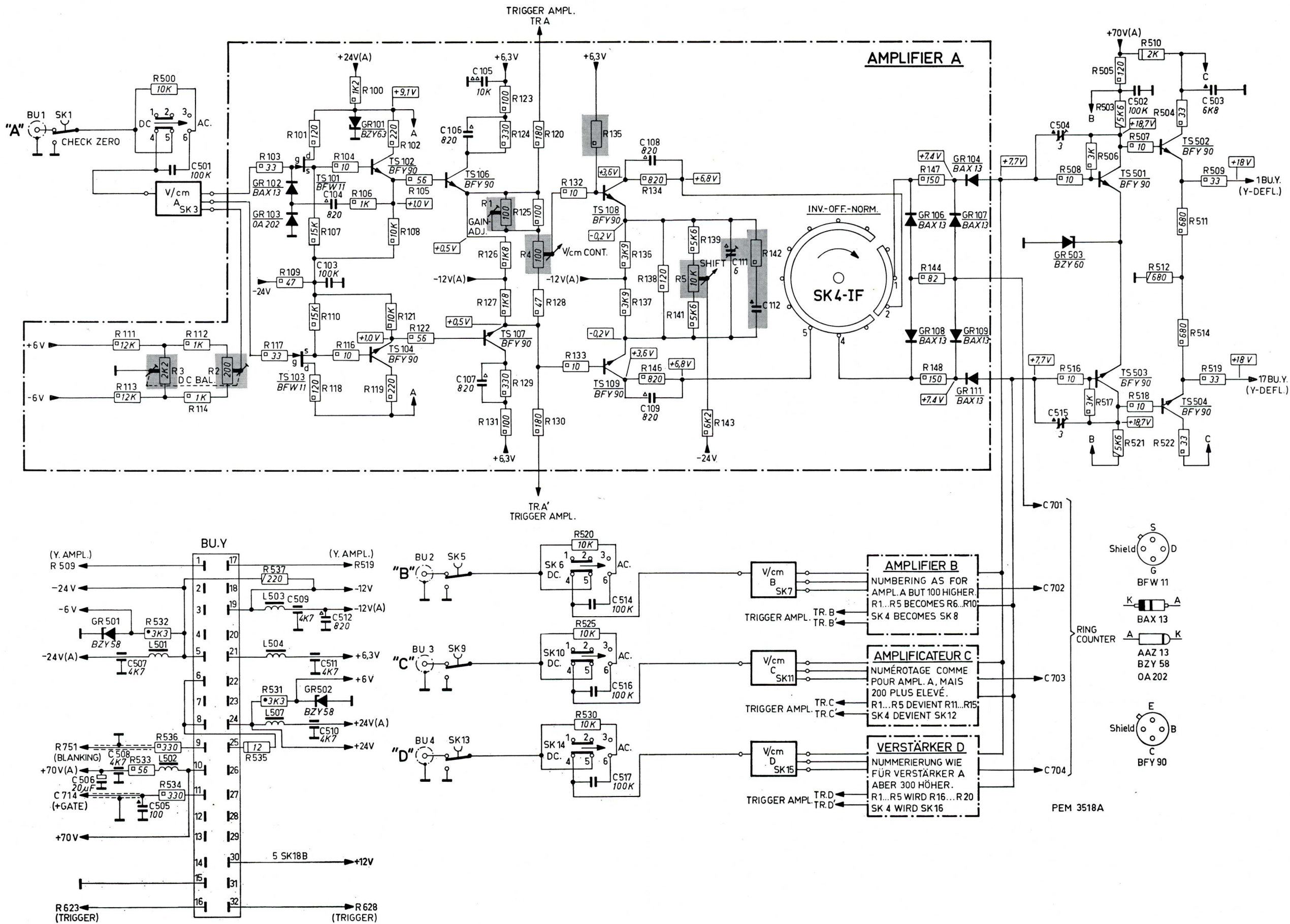


Fig. 18. Y-Amplifier, circuit diagram

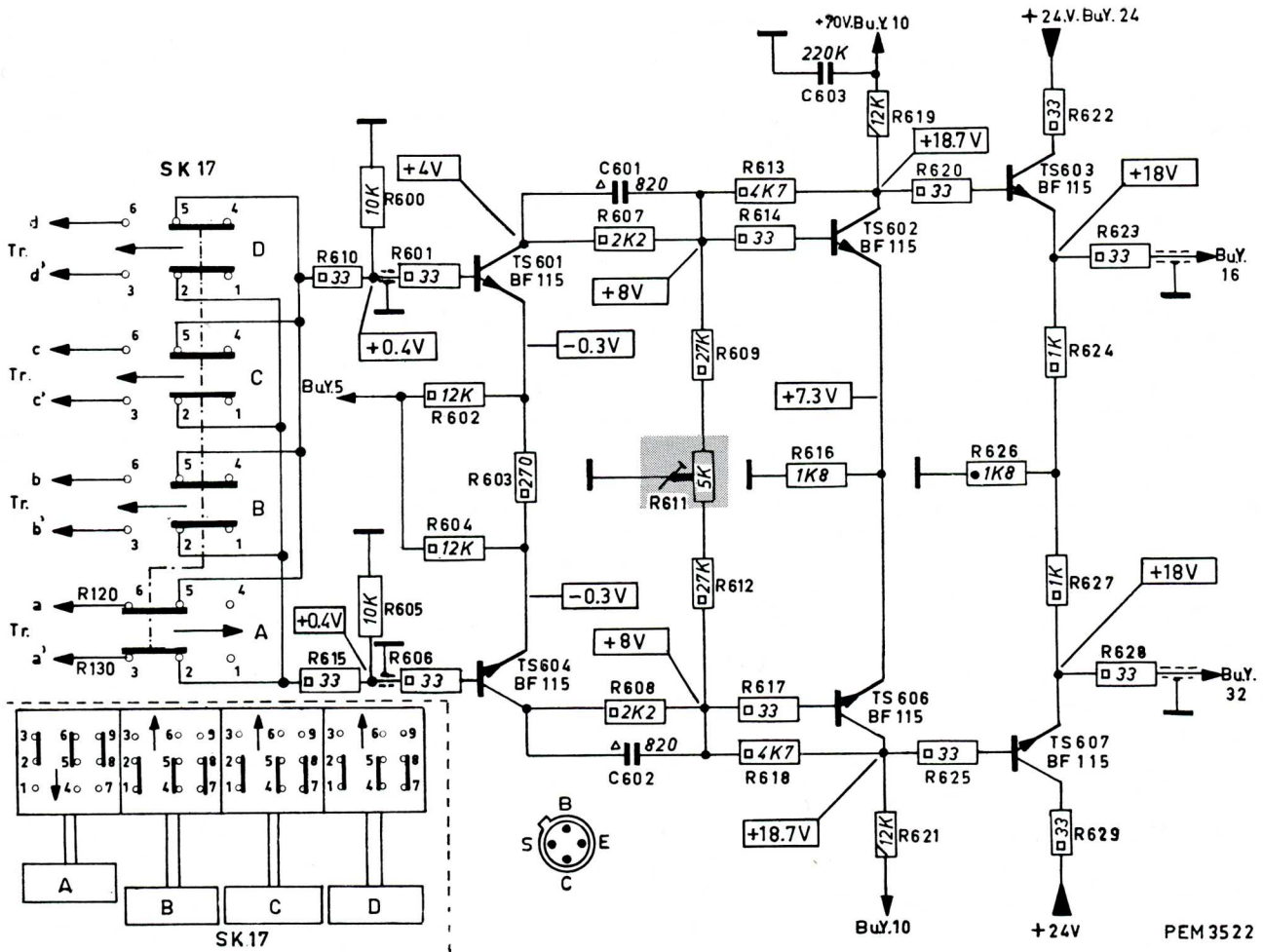
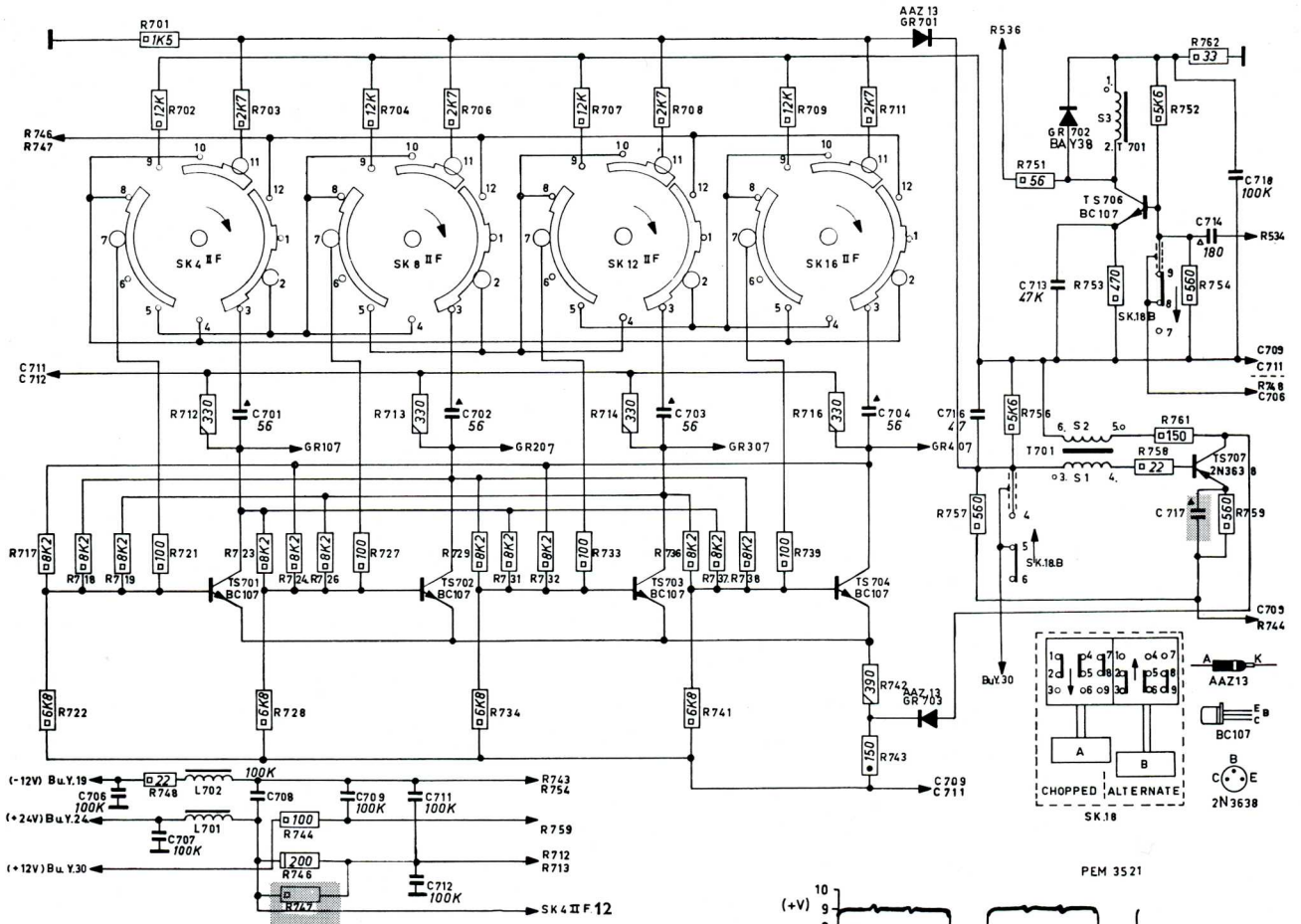


Fig. 19. Trigger amplifier, circuit diagram



ERRATA:

- R746 → 240Ω
- R761 → 100Ω

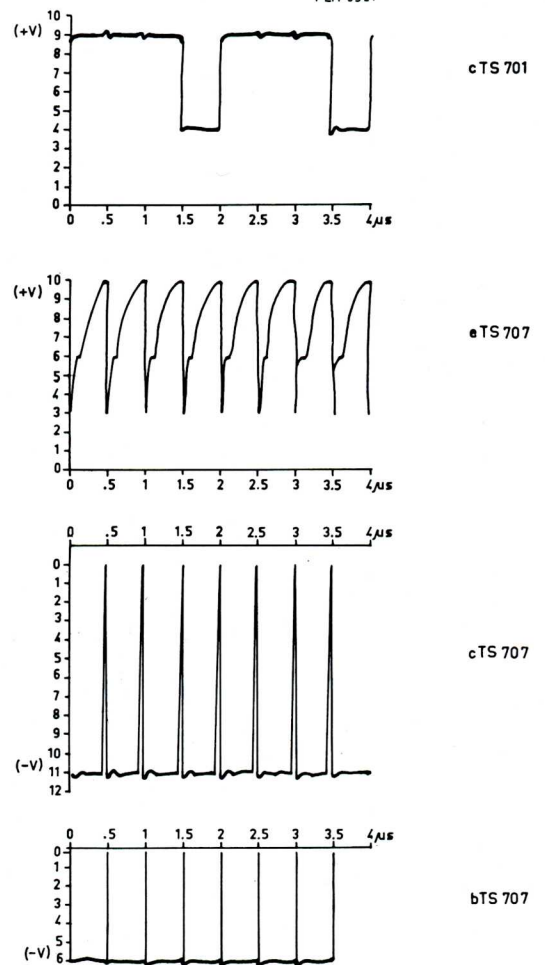


Fig. 20. Switching part, circuit diagram