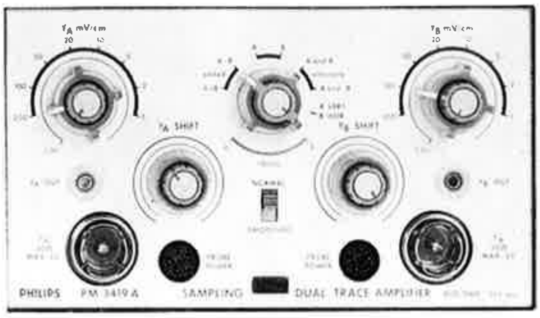


PHILIPS

Service manual

PM 3419A — Dual trace sampling amplifier

Contents

List of figures

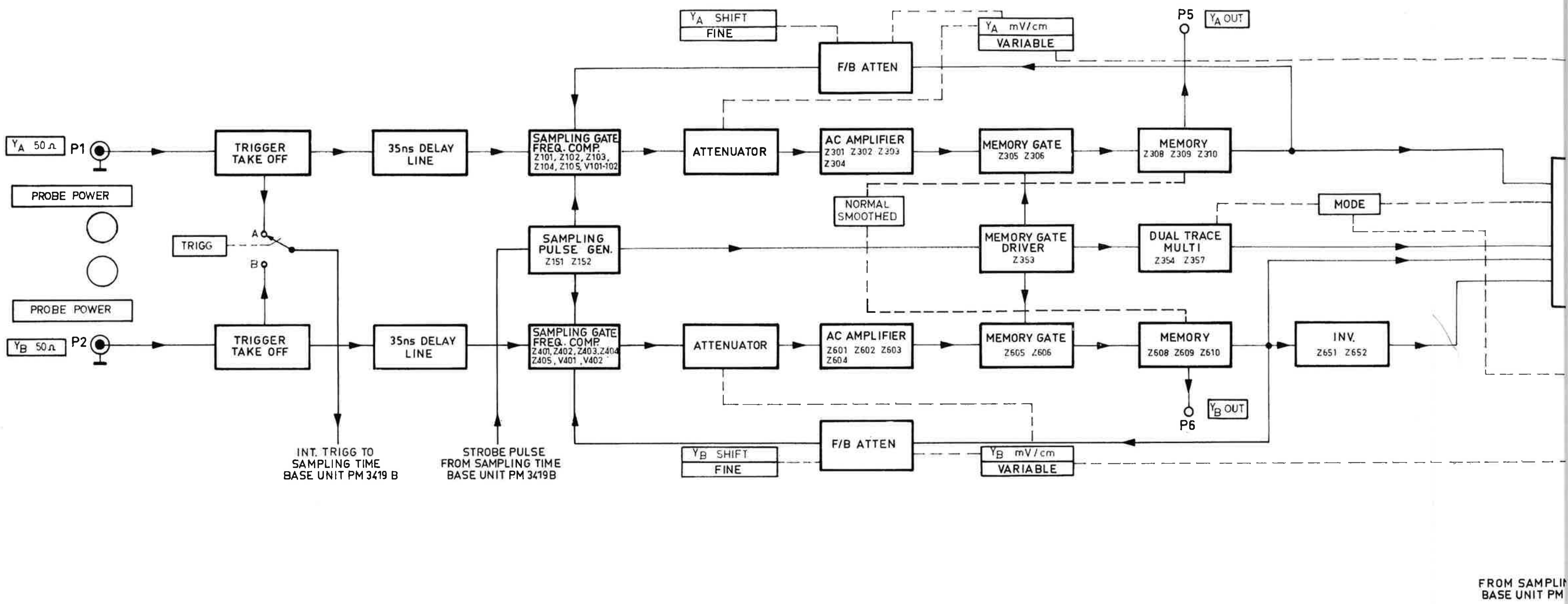
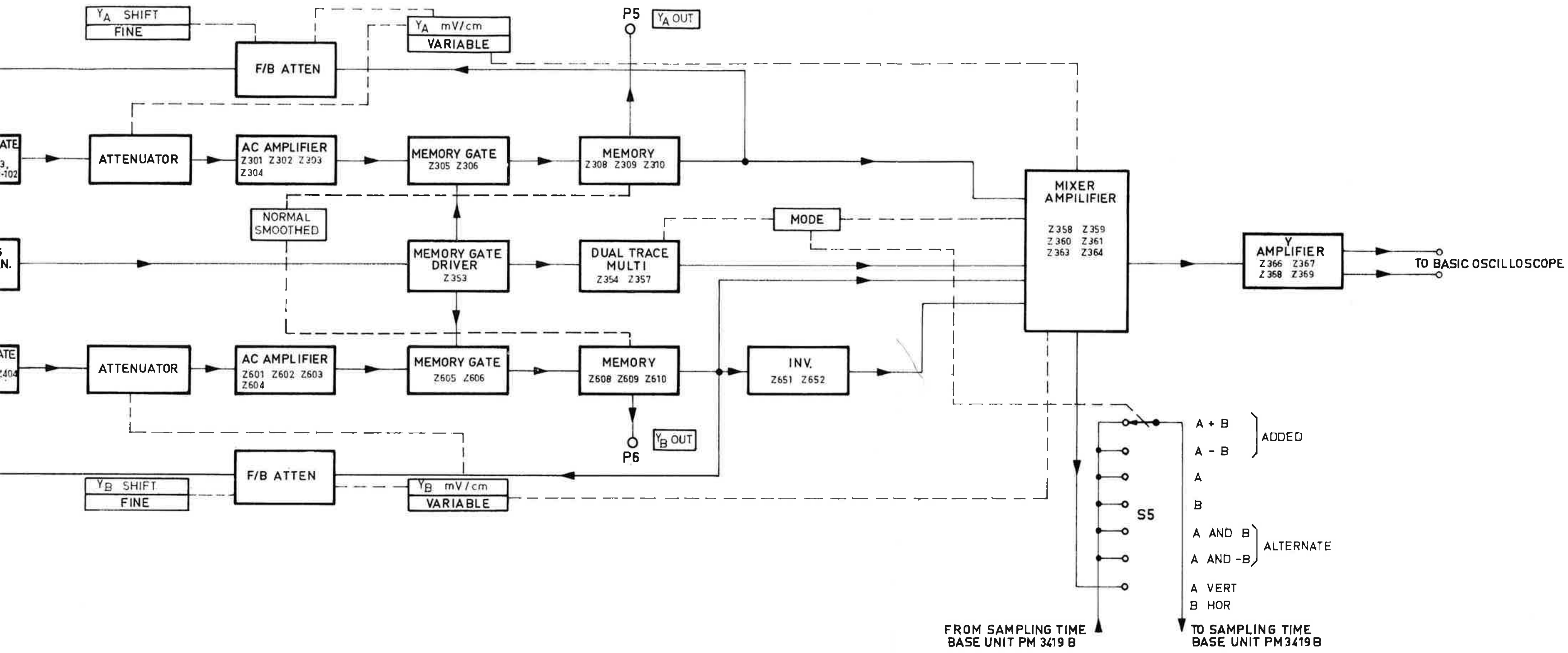


Fig. 1. Block diagram



YA SHIFT
FINE
F/B ATTEN
YA mV/cm
VARIABLE
P5
YA OUT
ATTENUATOR
AC AMPLIFIER
Z301 Z302 Z303
Z304
MEMORY GATE
Z305 Z306
MEMORY
Z308 Z309 Z310
NORMAL
SMOOTHED
MEMORY GATE
DRIVER
Z353
DUAL TRACE
MULTI
Z354 Z357
MODE
MIXER
AMPILIFIER
Z358 Z359
Z360 Z361
Z363 Z364
Y
AMPLIFIER
Z366 Z367
Z368 Z369
TO BASIC OSCILLOSCOPE
ATTENUATOR
AC AMPLIFIER
Z601 Z602 Z603
Z604
MEMORY GATE
Z605 Z606
MEMORY
Z608 Z609 Z610
INV.
Z651 Z652
YB OUT
P6
F/B ATTEN
YB SHIFT
FINE
YB mV/cm
VARIABLE
A + B
A - B
ADDED
A
B
S5
A AND B
A AND -B
ALTERNATE
A VERT
B HOR
FROM SAMPLING TIME
BASE UNIT PM 3419 B
TO SAMPLING TIME
BASE UNIT PM3419B

PEM 3653

Description of the block diagram I

The Dual Trace Sampling Amplifier consists of two similar channels, A and B, as well as certain circuits which are used by both channels. These common circuits are the sampling pulse generator, memory gate driver, dual trace multivibrator, mixer amplifier and the Y amplifier, As the channels are exactly similar, only one of them will be described.
The signal is applied to a 50 Ω connector P1 with a trigger take-off transformer fitted directly to it. A small part of the signal is taken out and fed to the X-deflection unit PM 3419B, where it starts the timing circuits. After a short interval the time base unit sends back a strobe pulse to the sampling pulse generator. After amplification and shaping, this pulse is used to open the sampling gate. The minimum time needed for the whole triggering process must be compensated for if the triggering part of the waveform is also to be observed. The compensation is done by the 35 ns delay line between the trigger take-off transformer and the sampling gate.
When the sampling gate is open, a capacitor is charged to a voltage, proportional to the difference between the signal level at the moment of sampling and the voltage established by the preceding sampling. The ratio between the voltage across the capacitor and the signal voltage is called sampling efficiency and is approx. 20%. After amplification, the voltage is fed to a memory via a memory gate, which is kept open for approx. 0.5 μs after each sampling. The memory stores the voltage until the next sampling. The output of the memory is fed back to the sampling capacitor at the input of the amplifier. The amplification is so chosen that the input capacitor is allowed to charge to the full signal voltage. This means that the feedback compensates for the inefficiency of the sampling gate. When the compensation is exactly right the loop gain is said to be 1.
The amount of feedback voltage can be changed by means of an attenuator, which therefore changes the sensitivity. In order to keep the loop gain constant this attenuator is coupled with a corresponding attenuator between the sampling gate and the memory.
The outputs of the memories of both channels are connected via the mode switch to the mixer amplifier. Depending on the position of the mode switch, a signal is applied to the mixer amplifier either from channel A or channel B – or some kind of combination. This function is controlled by a bi-stable multivibrator.
After the mixer amplifier the signal is further amplified in the Y amplifier and is then sent via a connector to the vertical deflection amplifier in the basic oscilloscope.
By means of the mode switch it is also possible to take out the Y_B signal, and use it for X deflection in the basic oscilloscope.

The fundamental principles of sampling have been fully described in books and periodicals. Some familiarity with this is assumed. The following references serve as a guide to basic reading.

1. Millman and Taub

Pulse, digital and switching waveforms
Chapter: Sampling Gates Page 664–66

2. Electronic Instrument Digest, Sept.-Oct. 1965.

Description of circuit

II

The description of the block diagram explains that the Dual Trace Sampling Amplifier is built up in two channels similar to each other from the input connector up to the memory circuits. Therefore this description will follow the signal in only one of these channels and further through the mixer amplifier and the Y amplifier.

Trigger take-off

The signal to be sampled is applied to the 50 Ω input connector P1 (and/or P2). The signal passes through the primary winding of the trigger take-off transformer T1. From the secondary winding a part of the signal is fed to the Sampling Time Base Unit, PM 3419 B, to trigger this unit.
Depending on the position of the switch S1, the trigger signals are supplied from either transformer T1 or T2 to the PM 3419 B Sampling Time Base Unit

Sampling pulse generator

From the Sampling Time Base Unit a trigger pulse is fed to the base of the avalanche transistor Z151 in PM 3419 A (see further the description of PM 3419 B). The triggeı pulse – strobe pulse – is further amplified and shaped by the transistor Z151 and a negative step appears at the collector. The avalanche voltage is adjusted by means of the potentiometer RV151 ("AVALANCHE VOLTS"). The negative going step is fed to the symmetrical transformer T151. A bias-current flows in the forward direction through the diode Z152. The current is adjustable by means of the potentiometer RV152 ("RISE TIME"). Therefore the negative step from the transistor Z151 has to overcome the bias-current and it is only after a certain time that a positive step with a rise time of 0.2 ns will occur at the cathode side of the diode Z152. The same step – but with opposite polarity – is at the same moment present at the solder-point of the secondary winding of the transformer T151 and the capacitor C157.
Both these pulses travel along a short-circuited transmission-line formed by a twisted pair. The pulses are cancelled out when they meet at the earthing point. Consequently the pulse width is determined by the length of the twisted pair. The lines between the transformers T151 and T101 (or T151 and T401) are also twisted pairs, and consequently the pulses appearing at the solder-points of C103 and T101 or C104 and T101 are similar to each other both in amplitude and pulse width, but of opposite polarity. It is essential that the pulses are as equal as possible in order to ensure correct functioning. The transmission-line transformer T101 is terminated by the resistors R108 and R109.

Sampling gate

The pulses now go through the capacitors C103 and C104. They cannot go through the filter consisting of the ferrite beads (inductances) L105, L106, L107, L108 and the capacitor C105.
From the capacitors C103 and C104, the pulses go to the sampling diodes Z101 and Z102. Z101 has a bias of about +2 V and Z102 of about —2 V.
Consequently the pulses emanating from C103 and C104 have to reach these values before current can flow through Z101 and Z102. The current through Z101 and Z102 also depends on the input signal from connector P1. From P1 the signal goes through the trigger take-off transformer T1, the delay line DL1 and passes via the network consisting of C101, R101, L101 and R102 to the terminating resistors R103 and R104. The delay line DL1 is inserted in order to delay the signal until the Sampling Time Base Unit has started. The network compensates for signal loss due to the delay line.

The signal appears at the point between the diodes Z101 and Z102. Current flows through the diodes during the sampling interval (about 0.35 ns) and, if the input signal differs from that at the previous sampling, the capacitors C103 and C104 will be charged. This charge is fed to the grid of the triode V101.
The biasing of the diodes Z101 and Z102 depends on the position of the potentiometer RV102 ("RISE TIME") because the resistors R116 and R119 are connected to the voltage divider consisting of the resistors R117, R118, RV102 and R115.
Another voltage divider is connected across R118 and RV102. By means of the potentiometer RV101 ("BRIDGE BALANCE") it is possible to adjust for differences between the two diodes Z101 and Z102.
A similar network is formed by capacitors CV101, C102 and CV102 to compensate for the capacitance of the diodes Z101 and Z102. A small part of the signal will pass through the capacitances of the sampling diodes and go directly to the grid of the triode V101. A similar part of the signal will, via the compensating network, pass to the grid of the triode V102. The tubes V101 and V102 and the transistors Z103, Z104 and Z105 form a differential amplifier.
From the memory circuit a feedback voltage is applied to diodes Z101 and Z102 via resistor R112 and the

bias network. Only if the input signal differs from this feedback voltage will there be an output signal from the differential amplifier.

AC amplifier

The output signal from the collector of the transistor Z105 in the differential amplifier is fed to the base of the transistor Z301 via an attenuator. Z301 is the input of the AC amplifier, which consists of two pairs of feedback transistors, Z301 and Z302 resp. Z303 and Z304. The amplification of the AC amplifier is adjusted by means of the potentiometer RV301 ("A LOOP GAIN").

Memory gate driver and memory gate

Transformer T351 and transistor Z353 form a blocking oscillator. From the collector of the transistor Z151 in the sampling pulse generator circuit a trigger pulse arrives at this blocking oscillator and starts it. From the winding a1/a2 gate pulses are fed to the memory gate circuit Z305 and Z306, which is kept open for approx. 0.5 μs after each sampling.

Memory

When the memory gate is open the signal from the AC amplifier can charge the memory capacitor C311. Z308 is a field effect transistor to provided a low leakage input. Together with Z309 and Z310, it forms an amplifier, and the memory capacitor is connected as a feedback element from output to input. The change in output voltage of the memory is therefore proportional to the signal from the AC amplifier. The smoothing, which can be introduced by switch S4, is produced by increasing the memory capacitor. By doing so the loop gain is decreased to approx. 1/3. The random noise is decreased in the same proportion. The consequence is, however, that the charge on the sampling capacitor (immediately after the sampling gate) does not fully compensate for by the inefficiency of the sampling gate. It takes a few more samples to build up the correct charge and this shows up in rounded waveforms, this rounding can be misinterpreted as a slow rise time. It is therefore important to have a high sampling density, when smoothing is used.

Y shift (DC-offset)

The output from the memory is fed back to the sampling diodes via the attenuator S2, resistor R112 and the diode biasing network. Via the potentiometers RV1 and RV2 ("Y_A SHIFT") a DC voltage is added to the feedback voltage. By means of these potentiometers the trace on the CRT can be moved vertically. That means, that it is possible to set the switch S2 ("mV/cm") in position e.g. 1 mV/cm and move the trace by means of RV1 or RV2, and study any part of a large input signal in greater detail.

B-channel inverter

As mentioned earlier, the A- and B-channels are similar to each other up to the memory circuit. However, to the B-channel is added an inverter, consisting of the transistors Z651 and Z652. The amplification in this inverter is —1. The balance of the inverter is adjusted by means of the potentiometer RV651 ("—B BAL").

Dual trace multivibrator and mixer amplifier. Display modes.

The "dual trace multivibrator" consists of a bistable multivibrator Z354 and Z357 and the mixer amplifier consists of Z361 and Z364. The currents through Z361 and Z364 are settled by the position of the bistable multivibrator which is directed by trigger pulses from the blocking oscillator Z353 and the position of the mode switch S5.

When Z354 is conducting its collector is at +15 volts. At the same time Z357 is non-conducting and its collector is at —5 volts. Via the diode Z358 the collector of the transistor Z361 is held at +15 volts while the diode Z359 is reverse biased. The emitter current of Z364 is thus fed to the Y amplifier. When the bistable multivibrator is set in the other position the emitter current of Z361 is fed to the Y amplifier.

When the switch S5 is in the position shown ("A+B added"), the signal path from the A-channel is from the memory capacitor C311 through the potentiometers RV5 ("Y_A VERNIER") and RV7 ("A CAL") and the resistor R5 to the emitter of Z364. The signal path from the B-channel is from the memory capacitor C611 through the potentiometers RV6 ("Y_B VERNIER") and RV8 ("B CAL") and the resistor R6 to the emitter of Z364.

The signals from the A- and B-channels are thus added on the emitter of Z364. In this position of S5 the base of Z354 is connected to earth, which means that the multivibrator is in such a position that the emitter current of Z364 is fed to the Y amplifier.

In the second position ("A—B added") of S5 the signal path from the A-channel is the same as earlier, but the signal from the B-channel is taken out after the inverter from the diode Z653 through RV6, RV8 and R6 to the emitter of Z364.

The multivibrator is in the same position as earlier. That means that the signal to the Y-amplifier is the signal from the A-channel minus the signal from the B-channel. In the third position ("A") of S5, only the signal from the A-channel is fed to the Y amplifier.

In the fourth position ("B") of S5 the multivibrator is switched to the other position and only the signal from the B-channel is fed to the Y-amplifier. In the fifth ("A and B alternate") and sixth positions ("A and —B alternate") of S5 the state of the multivibrator varies with the trigger pulses from the blocking oscillator.
Signals from either the A-channel or the B-channel are therefore alternately fed to the Y amplifier. In position five the signal from the B-channel is taken before and in position six after the inverter. Finally, in position seven ("A VERT. B HOR.") of S5 the signal from the A-channel is fed to the Y amplifier and the signal from the B-channel is fed to the Sampling Time Base Unit and further to the horizontal deflection amplifiei in the basic oscilloscope.
The balance of the A-channel is adjusted with RV353 ("A BAL") and the balance of the B-channel is adjusted with RV352 ("B BAL").

Y amplifier

The Y amplifier Z366, Z367, Z368 and Z369 is a differential amplifier. The amplification can be adjusted by means of the potentiometer RV354 ("Y GAIN"). From the emitters of Z367 and Z368 the output signals are fed to the vertical deflection amplifier in the basic oscilloscope.

Adjusting elements and their functions

III

Adjustment	*Adjusting elements*	*Instrument required*	*Specifications*	*Proposed model*	*Chapter IV section*
Avalanche volts	RV 151	Oscilloscope	DC to 10MHz bandpass. Sensitivity 2 mV/div. ×10 attenuator probe	PHILIPS PM 3230 PM 3220	B
Smoothing balance	RV 302, RV 602				G
Y amplifier balance	RV 353, RV 352 RV 651	DC-Voltmeter	Zero volt reading Sensitivity ≥ 100 kOhm/volt	PHILIPS PM 2340	F
Bridge balance	RV 101, RV 401				H
Rise time	RV 152 RV 102, RV 402	Pulse generator	Rise time ≤ 150 ps	Hewlett Packard 213 B	D
Memory gate width	RV 351	Square wave generator	Output: 500 mV into 50 Ohm with flat top, 50 kHz Rise time ≤ 50 ns	PHILIPS GM 2324	C
Loop gain	RV 301, RV 601				E
Low frequency compensation	CV 101, CV 401 CV 102, CV 402 R 106, R 406				J
Y-gain	RV 7, RV 8 RV 354	Sine wave generator	Output: 800 mV_{p-p} ± 1% into 50 Ohm, 1–10 MHz	PHILIPS GM 2621	K
Adjustments	—	Extension cable	—	See "Accessories"	—

Checking and adjusting IV

A. GENERAL

The adjusting elements and their functions are listed in chapter III.
The tolerances mentioned in the following text apply only to newly adjusted instruments. The values may differ from those given in the technical data, chapter II of the operating manual PM 3419A + PM 3419B.
In order to obtain a high degree of accuracy, it is best to make these adjustments with the aid of the APPROPRIATE PM 3410 basic equipment, which must be set correctly.
Do not preset internal controls unless the instrument has been repaired or is far out of adjustment.
The adjustments must be performed in the order given and after a warming-up period of at least half an hour for both the basic instrument and the plug-in unit.
The basic instrument must be switched off while the extension cable is being fitted to avoid damage to the transistors.

B. AVALANCHE VOLTS

1. Connect the PM 3419A to the basic instrument PM 3410 via the extension cable (instrument switched off).

   Set the controls of the units as follows:

PM 3419 A

Y_A mV/cm	100 (Vernier in pos. CAL)
Y_A SHIFT	middle position
Mode S5	A
TRIGG.	A
NORMAL/ SMOOTHED	NORMAL

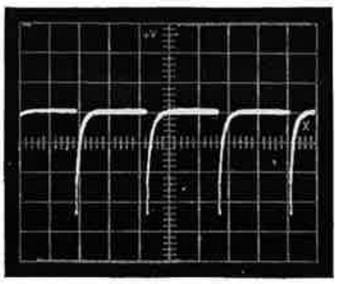


Fig. 2. Avalanche volts

PM 3419 B

TIME/cm	0.2 µs
TIME SCALE MAGN.	1 (Vernier in pos. CAL)
X SHIFT	NORMAL
SENSITIVITY	fully counter clockwise
X DEFL.	10 samples/cm
TRIGG.	INT.—
TRIGG./SYNC.	TRIGG.

2. Connect the test oscilloscope 10 × attenuator probe to the collector of transistor Z151 (print 3). Set the controls of the oscilloscope at 5 µs/div. and 2V/div. Trigger it internally.
3. Set TRIGG. on PM 3419 B to position FREE RUN and a display as in fig. 2 is shown.
4. Set TRIGG. on PM 3419 B in position INT.—and the display should disappear. If it does not, turn the AVALANCHE VOLTS, RV151, (print 3) about 5° anti-clockwise from the point where the waveform disappears.

C. MEMORY GATE WIDTH

1. Set the controls of the units as in B. 1, butwith TIME/cm in position 2 µs.
2. Connect the square wave generator output (50 kHz, 500 mV, less than 50 ns rise time) to input Y_A.
3. Adjust SENSITIVITY for internal triggering. Centre the step with X SHIFT.
4. Adjust MEMORY GATE WIDTH, RV351, (print 1) for maximum separation between the dots in the step.

D. RISE TIME

1. For this check the PM 3419A should be plugged into the basic instrument. The adjusting elements can be reached through the holes in the bottom plate.

   Set the controls of the units as follows:

PM 3419 A

Mode S5	B
TRIGG.	B
NORMAL/ SMOOTHED	NORMAL

PM 3419 B

TIME/cm	2 ns
TIME SCALE MAGN.	20 (Vernier in pos. CAL)
X DEFL.	100 samples/cm
TRIGG.	FREE RUN

If the pulse generator HP 213 B is used proceed as follows:

2. Connect the pulse generator output to input Y_B.
3. Connect TRIGG. OUT on PM 3419 B to the trigger input socket of the pulse generator. Centre the step with X SHIFT and Y_B SHIFT.
4. Set Y_B mV/cm and Vernier to obtain a step amplitude of 8 cm.
5. Adjust RISE TIME RV152 (print 3) for 0.33 ns rise time (10% to 90% points on step).
6. Repeat points D.1 to D.4 for channel A and adjust A RISE TIME RV102 (print 2) for 0.33 ns rise time.
7. If adjustment D.6 does not succeed, set RV102 (print 2) in the middle position and adjust RISE TIME RV152 (print 3) for 0.33 ns rise time.
8. Repeat points D.1 to D.4 for channel B and adjust B RISE TIME RV 402 (print 2) for 0.33 ns rise time.

E. LOOP GAIN

1. Set the controls of the units as follows:

PM 3419 A

Y_A mV/cm	100
Mode S5	A
TRIGG.	A
NORMAL/ SMOOTHED	NORMAL

PM 3419 B

TIME/cm	2 µs
TIME SCALE MAGN.	1 (Vernier in pos. CAL)
X DEFL.	10 samples/cm
TRIGG.	INT. +

2. Connect the square wave generator output (50 kHz, 500 mV, less than 50 ns rise time) to input Y_A.
3. Adjust SENSITIVITY for internal triggering. Centre the step with X SHIFT and Y_A SHIFT.

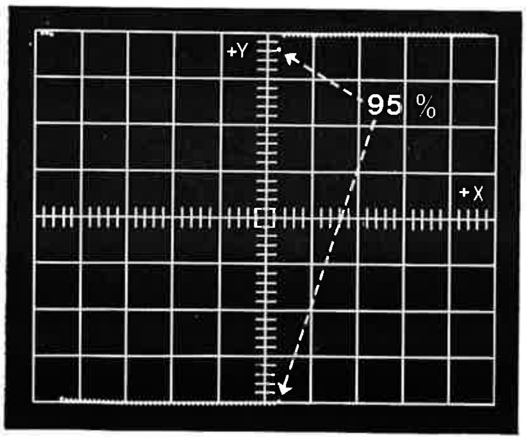


Fig. 3. Loop gain

4. Set Y_A mV/cm Vernier to obtain a step amplitude of 8 cm.
5. Adjust A LOOP GAIN RV301 (print 1) for about 95% (76 mm) separation between the dots in the step. See fig. 3.
6. Repeat points E.1 to E.4 for channel B and adjust B LOOP GAIN RV601 (print 1) for about 95% separation between the dots in the step.

F. Y AMPLIFIER BALANCE

1. Set the controls of the units as follows:

PM 3419 A

Y_A mV/cm, Y_B mV/cm	200
Mode S5	A

PM 3419 B

TIME/cm	2 µs
TRIGG.	FREE RUN
X DEFL.	100 samples/cm

2. Connect a DC voltmeter to Y_A OUT. Adjust Y_A SHIFT for 0.0 V reading on the DC voltmeter.
3. Adjust A BAL. RV353 (print 1) for trace on middle line of graticule.
4. Repeat points F.1 and F.2 for channel B. Adjust B BAL. RV352 (print 1) for trace on middle line of graticule.
5. Set Mode S5 in position A and —B alternate. Adjust —B BAL RV651 (print 1) for B trace on middle line of graticule.

G. SMOOTHING BALANCE

1. Set the controls of the units as follows:

PM 3419 A

Y_A mV/cm, Y_B mV/cm	5
Mode S5	A
Y_A SHIFT, Y_B SHIFT	middle position
NORMAL/ SMOOTHED	NORMAL

PM 3419 B

TIME/cm	0.2 µs
TIME SCALE MAGN.	1
X DEFL.	MANUAL
TRIGG.	FREE RUN

2. Connect the test oscilloscope ×10 attenuator probe to the collector of transistor Z302 (print 1). Set the controls of the test oscilloscope at 2 µs/div. and 2 mV/div. Trigger it externally from TRIGG. OUT on PM 3419 B.

3. Adjust A SMOOTHING BAL. RV302 (print 1) for minimum signal on the test oscilloscope. Centre the point on the sampling oscilloscope with Y_A SHIFT when adjusting RV302.
4. Set Mode S5 in position B. Connect the test oscillscope × 10 attenuator probe to the collector of transistor Z602 (print 1).
5. Adjust B SMOOTHING BAL. RV602 (print 1) for minimum signal on the test oscilloscope. Centre the trace on the sampling oscilloscope with Y_B SHIFT when adjusting RV602.

H. BRIDGE BALANCE

1. Put the metal covers on printplate 2 of PM 3419A before carrying out the following adjustments.
2. Set the controls of the units as in G.1, but X DEFL. in position 100 samples/cm.
3. Connect the DC voltmeter to wiper of Y_A SHIFT control. Adjust Y_A SHIFT to obtain a zero DC volt reading.
4. Connect the DC voltmeter to wiper of Y_A SHIFT Vernier control. Adjust Y_A SHIFT Vernier to obtain a zero DC volt reading.
5. Adjust A BRIDGE BAL. RV101 (print 2) for trace on middle line of graticule.
6. Set Mode S5 in position B. Repeat points H.2 and H.3 for channel B.
7. Adjust B BRIDGE BAL. RV401 (print 2) for trace on middle line of graticule.

J. LOW FREQUENCY COMPENSATION

1. Put the metal covers on printplate 2 of PM 3419 A before carrying out the following adjustments.
2. Set the controls of the units as follows:

PM 3419 A

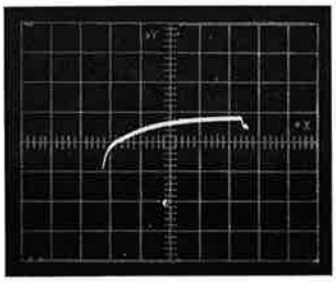
Y_A mV/cm	
Y_B mV/cm	5(Vernier in pos. CAL)
Mode S5	A
TRIGG.	A
NORMAL/ SMOOTHED	NORMAL

PM 3419 B

TIME/cm	2 μs
TIME SCALE	
MAGN.	1 (Vernier in pos. CAL.)
X DEFL.	100 samples/cm
TRIGG.	INT.—
TRIGG./SYNC.	TRIGG.

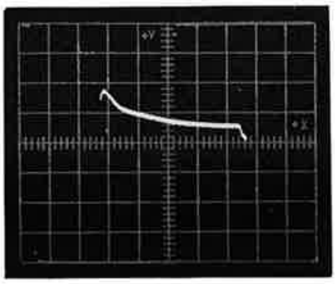
3. Connect the square wave generator output (50 kHz, 500 mV, less than 50 ns rise time, flat top) to input Y_A.
4. Adjust SENSITIVITY for internal triggering. Centre the top of the waveform with X SHIFT and Y_A SHIFT.
5. Adjust A FREQUENCY COMPENSATION CV101 and CV102 (print 2) simultaneously for a flat square wave with as little rounding at the corners as possible, as in fig. 4c.
6. If it is not possible to get a flat centre, change the resistor R106 (print 2) according to fig. 4 and repeat point J.5.
7. Repeat points J.2 to J.4 for channel B.
8. Adjust B FREQUENCY COMPENSATION CV401 and CV402 (print 2) simultaneously for a flat square wave with as little rounding at corners as possible, as in fig. 4c.
9. If it is not possible to get a flat centre, change the resistor R406 (print 2) according to fig. 4 and repeat point J.8.

Fig. 4. Low-frequency compensation



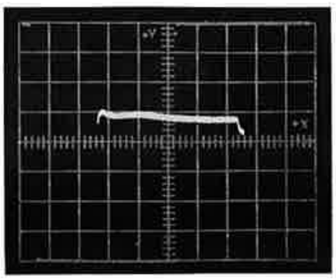
4a

Decrease the value of R106 (R406)



4b

Increase the value of R106 (R406)



4c

Correct adjusted

K. Y GAIN

1. Set the controls of the units as follows:

PM 3419 A

Y_A mV/cm	50 (Vernier in pos. CAL)
Y_B mV/cm	100 (Vernier in pos. CAL)
Mode S5	A VERT. B HOR.
TRIGG.	B
NORMAL/ SMOOTHED	NORMAL

PM 3419 B

TIME/cm	0.2 µs
TIME SCALE MAGN.	1 (Vernier in pos. CAL)
X DEFL.	100 samples/cm
TRIGG.	INT.—
TRIGG./SYNC.	TRIGG.

2. Connect the sine wave generator output (1 MHz, 800 $mV_{p-p} \pm 1\%$) to input Y_B and connect X OUT to input Y_A.
3. Adjust SENSITIVITY for internal triggering. Centre the display with Y_A SHIFT and Y_B SHIFT.
4. Adjust B CAL, RV8 (fig. 5), to obtain 8 cm $\pm$ 0.1 of horizontal deflection.
5. Set Mode S5 to B. Remove the cable between X OUT and input Y_A. Centre the display with Y_B SHIFT.
6. Adjust Y GAIN, RV354, (print 1) to obtain 8 cm $\pm$ 0.1 of vertical deflection.
7. Set the controls of PM 3419 A:

Y_A mV/cm	100 (Vernier in pos. CAL)
Mode S5	A
TRIGG.	A

8. Connect the sine wave generator output to input Y_A instead of to input Y_B.
9. Centre the display with Y_A SHIFT.
10. Adjust A CAL, RV7 (fig. 5), to obtain 8 cm $\pm$ 0.1 of vertical deflection.

Information for assistance in fault finding

V

To facilitate checking for correct operation and fault-finding, some oscillograms are given in figs. 9 and 12. These oscillograms were measured with a sampling oscilloscope at the points indicated on the circuit diagrams and printed wiring boards in Roman numerals.

Remark:

Whenever it is desired to send the plug-in units to a PHILIPS workshop the following points should be observed:

- give the symptomps of the fault as fully as possible
- tie on a label bearing the name and address of the sender.
- carefully pack the instrument in the original packing or, if the latter is not available, in a wooden box.
- send the instrument direct to the appropriate PHILIPS address provided by the local organization.
- if the required units must be set with a high degree of accuracy, the appropriate basic instrument must be sent with the units.

List of parts

VI

A. MECHANICAL

Item	Number	Code number	Description
1	1	4822 454 40034	Textplate
2	2	4822 159 00363	Knob (RV1, 3)
3	3	4822 159 00318	Knob (S2, 3, 5)
4	1	4822 159 00321	Knob (S1)
5	4	4822 159 00359	Knob (RV2, 4, 5, 6)
6	5	4822 159 00358	Knob cap
7	2	4822 273 80088	Switch (S1, 5)
8	2	4822 273 40186	Switch (S2, 3)
9	1	4822 159 00421	Switch (S4)
10	2	4822 267 10026	Connector (P1, 2) (General Radio: 874 – PRL8A)
11	2	979/4 × 270	Connector (P3, 4) (Preh: 8–6079)
12	2	4822 216 00496	Connector (P5, 6)
13	1	W4 125 73	Plug B (Amphenol 26–159–32)

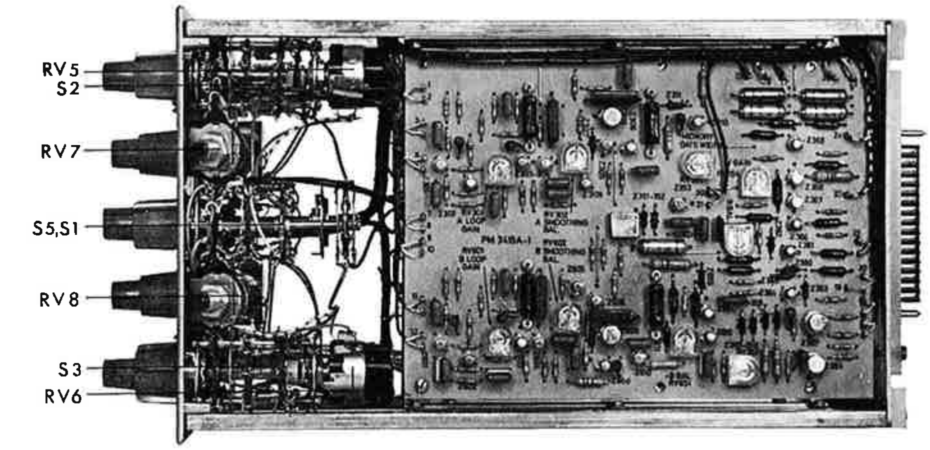


Fig. 5. Top view

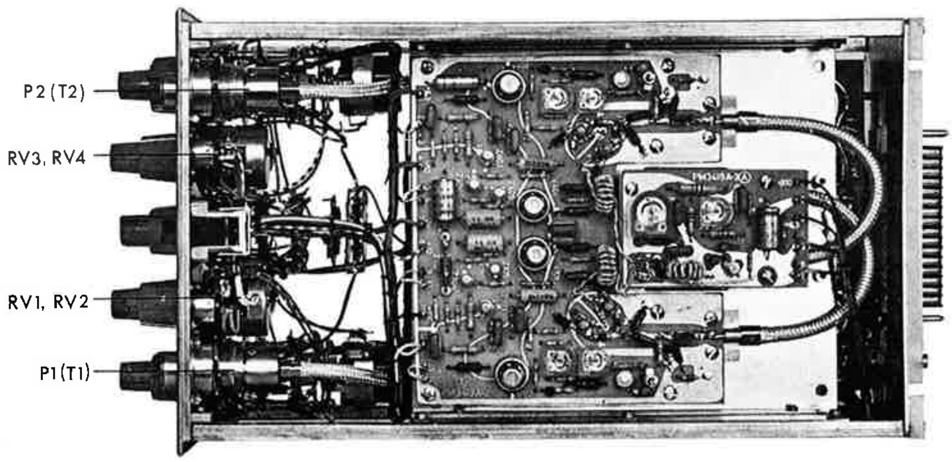


Fig. 6. Bottom view

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 principeschema 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 specifications 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.

Component	Specification
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	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 ≦ 10 MΩ, 2% > 10 MΩ, 5%
Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	0,5 W ≦ 1,5 MΩ, 5% > 1,5 MΩ, 10%
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	2 W 5%
Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	0,4 – 1,8 W 0,5%
Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	5,5 W ≦ 200 Ω, 10% > 200 Ω, 5%
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
Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular	700 V
Ceramic capacitor, "pin-up" Keramikkondensator "Pin-up" (Perltyp) Keramische kondensator "Pin-up" type Condensateur céramique, type perle Condensador cerámico, versión "colgable"	500 V
"Microplate" ceramic capacitor Miniatur-Scheibenkondensator "Microplate" keramische kondensator Condensateur céramique "microplate" Condensador cerámico "microplaca"	30 V
Mica capacitor Glimmerkondensator Micakondensator Condensateur au mica Condensador de mica	500 V
Polyester capacitor Polyesterkondensator Polyesterkondensator Condensateur au polyester Condensador polyester	400 V
Flat-foil polyester capacitor Miniatur-Polyesterkondensator (flach) Platte miniatuur polyesterkondensator Condensateur au polyester, type plat Condensador polyester, tipo de placas planas	250 V
Paper capacitor Papierkondensator Papierkondensator Condensateur au papier Condensador de papel	1000 V
Wire-wound trimmer Drahttrimmer Draadgewonden trimmer Trimmer à fil Trimmer bobinado	
Tubular ceramic trimmer Rohrtrimmer Buisvormige keramische trimmer Trimmer céramique tubulaire Trimmer cerámico tubular	

SERVICE

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.

RESISTORS

No.	*Code number*	*Value*	*%*	*Watt*	*Description*
R101	4822 071 00588	2.2 Ω	10	0.125	
R151	4822 071 00587	4.7 Ω	10	0.125	
R203	4822 071 00764	1 kΩ	1	0.05	
R213	B8 305 29D/30E	30 Ω	1	0.05	
R214	4822 116 50173	50 Ω	1	0.05	
R215	4822 071 00783	100 Ω	1	0.05	
R216	4822 071 00738	300 Ω	1	0.05	
R217	4822 071 00764	500 Ω	1	0.05	2 in parallel
R218	4822 071 00764	1 kΩ	1	0.05	
R219	4822 071 00791	2350 Ω	1	0.05	2 in parallel
R220	4822 071 00764	1 kΩ	1	0.05	
R221	4822 071 00764	500 Ω	1	0.05	2 in parallel
R222	4822 071 00738	300 Ω	1	0.05	
R223	4822 071 00783	100 Ω	1	0.05	
R224	4822 116 50173	50 Ω	1	0.05	
R225	4822 116 50173	50 Ω	1	0.05	
R401	4822 071 00588	2.2 Ω	10	0.125	
R503	4822 071 00764	1 kΩ	1	0.05	
R513	B8 305 29D/30E	30 Ω	1	0.05	
R514	4822 116 50173	50 Ω	1	0.05	
R515	4822 071 00783	100 Ω	1	0.05	
R516	4822 071 00738	300 Ω	1	0.05	
R517	4822 071 00764	500 Ω	1	0.05	2 in parallel
R518	4822 071 00764	1 kΩ	1	0.05	
R519	4822 071 00791	2350 Ω	1	0.05	2 in parallel
R520	4822 071 00764	1 kΩ	1	0.05	
R521	4822 071 00764	500 Ω	1	0.05	2 in parallel
R522	4822 071 00738	300 Ω	1	0.05	
R523	4822 071 00783	100 Ω	1	0.05	
R524	4822 116 50173	50 Ω	1	0.05	
R525	4822 116 50173	50 Ω	1	0.05	
R651	4822 071 00792	10 kΩ	0.5	0.1	
R654	4822 071 00792	10 kΩ	0.5	0.1	

POTENTIOMETERS

No.	*Code number*	*Value*	*%*	*Watt*	*Description*
RV1, 2	4822 102 10076	2×50 kΩ	20	0.25	Dual potentiometer
RV3, 4	4822 102 10076	2×50 kΩ	20	0.25	Dual potentiometer
RV5	E 199 AA/B13B3K5	3.5 kΩ	10	1	
RV6	E 199 AA/B13B3K5	3.5 kΩ	10	1	
RV7	4822 071 00949	1.5 kΩ	5	2	
RV8	4822 071 00949	1.5 kΩ	5	2	
RV101	4822 100 10035	10 kΩ	10	0.25	
RV102	4822 100 10052	100 kΩ	10	0.25	
RV151	4822 100 10035	10 kΩ	10	0.25	
RV152	4822 100 10054	50 Ω	10	0.5	
RV301	4822 140 00393	2 kΩ	10	0.25	
RV302	4822 100 10036	5 kΩ	10	0.25	
RV351	4822 100 10054	50 Ω	10	0.25	
RV352	4822 100 10051	20 kΩ	10	0.25	
RV353	4822 100 10051	20 kΩ	10	0.25	

No.	*Code number*	*Value*	*%*	*Watt*	*Description*
RV354	4822 100 10037	1 kΩ	10	0.25	
RV401	4822 100 10035	10 kΩ	10	0.25	
RV402	4822 100 10052	100 kΩ	10	0.25	
RV601	4822 140 00393	2 kΩ	10	0.25	
RV602	4822 100 10036	5 kΩ	10	0.25	
RV651	4822 100 10036	5 kΩ	10	0.25	

CAPACITORS

No.	*Code number*	*Value*	*%*	*Volt*	*Description*
C101	4822 122 50025	1200 pF	10	1000	
C105	4822 069 01093	10 nF	20	250	
C106	4822 069 01105	100 nF	20	250	
C108	4822 069 01105	100 nF	20	250	
C109	4822 069 01105	100 nF	20	250	
C111	4822 069 01105	100 nF	20	250	
C151	909/G6,4	6.4 µF	—10 +50	150	Electrolytic
C152	4822 069 01105	100 nF	20	250	
C153	4822 069 01105	100 nF	20	250	
C156	4822 069 01105	100 nF	20	250	
C158	909/G6,4	6.4 µF	—10 +50	150	Electrolytic
C159	909/U64	64 µF	—10 +50	10	Electrolytic
C301	4822 069 01105	100 nF	20	250	
C303	4822 069 01105	100 nF	20	250	
C304	4822 069 01105	100 nF	20	250	
C306	4822 069 01105	100 nF	20	250	
C307	4822 069 01105	100 nF	20	250	
C309	4822 069 01105	100 nF	20	250	
C312	4822 069 01105	100 nF	20	250	
C313	4822 069 01105	100 nF	20	250	
C351	4822 069 01105	100 nF	20	250	
C352	4822 069 00882	10 µF	—10 +50	25	Electrolytic
C353	4822 069 01105	100 nF	20	250	
C354	4822 069 01093	10 nF	20	250	
C357	4822 069 01105	100 nF	20	250	
C358	4822 069 00957	4 µF	—10 +50	64	Electrolytic
C359	909/Z10	10 µF	—10 +50	25	Electrolytic
C360	4822 069 00957	4 µF	—10 +50	64	Electrolytic
C361	909/Z10	10 µF	—10 +50	25	Electrolytic
C401	4822 122 50025	1200 pF	10	1000	
C405	4822 069 01093	10 nF	20	250	
C406	4822 069 01105	100 nF	20	250	
C408	4822 069 01105	100 nF	20	250	
C409	4822 069 01105	100 nF	20	250	
C411	4822 069 01105	100 nF	20	250	
C601	4822 069 01105	100 nF	20	250	
C603	4822 069 01105	100 nF	20	250	
C604	4822 069 01105	100 nF	20	250	
C606	4822 069 01105	100 nF	20	250	
C607	4822 069 01105	100 nF	20	250	

No.	Code number	Value	%	Volt	Description
C609	4822 069 01105	100 nF	20	250	
C612	4822 069 01105	100 nF	20	250	
C613	4822 069 01105	100 nF	20	250	

VARIABLE CAPACITORS

No.	Code number	Value	%	Volt	Description
CV102	4822 069 00871	4.5–20 pF		160	
CV402	4822 069 00871	4.5–20 pF		160	

COILS

No.	Code number	Value	%	Description
L1	4822 325 30005			Ferroxcube tube
L2	4822 325 30005			Ferroxcube tube
L101	4822 128 00274	2.2 µH	10	
L102	4822 526 10011			Ferroxcube tube
L103	4822 526 10011			Ferroxcube tube
L104	4822 526 10025			Ferroxcube tube
L105	4822 526 10025			Ferroxcube tube
L106	4822 526 10025			Ferroxcube tube
L107	4822 526 10025			Ferroxcube tube
L108	4822 526 10025			Feroxcube tube
L151	4822 526 10025			Ferroxcube tube
L152	4822 526 10025			Ferroxcube tube
L401	4822 128 00274	2.2 µH	10	
L402	4822 526 10011			Ferroxcube tube
L403	4822 526 10011			Ferroxcube tuve
L404	4822 526 10025			Ferroxcube tube
L405	4822 526 10025			Ferroxcube tube
L406	4822 526 10025			Ferroxcube tube
L407	4822 526 10025			Ferroxcube tube
L408	4822 526 10025			Ferroxcube tube

TRANSFORMERS

No.	Code number
T1	4822 158 10116
T2	4822 158 10116
T101	4822 158 10115
T151	4822 158 10123
T351	4822 142 60107
T401	4822 158 10115

MISCELLANEOUS

No.	Code number	Description
Print 1	4822 214 10047	Printed circuit board with components
Print 2	4822 214 10046	Printed circuit board with components
Print 3	4822 214 10048	Printed circuit board with components
DL1+DL2	4822 218 60071	Complete delay line unit with terminals

SEMI CONDUCTORS

No.	Type	Description
Z101 } Z102 }	4822 130 30108 (selected pair of diodes)	
Z103	BSY38	Transistor
Z104	BSY38	Transistor
Z105	BSY38	Transistor

No.	Type	Description
Z151	4822 130 40111	Transistor
Z152	4822 130 30109	Diode
Z153	SZ30C Mullard	Zener diode
Z301	BSY38	Transistor
Z302	BC109	Transistor

No.	Type	Description
Z303	BC109	Transistor
Z304	BSY38	Transistor
Z305	BSY38	Transistor
Z306	BSY38	Transistor
Z307	1N4009	Diode
Z308	2N4302 Amelco	Transistor
Z309	BC 109	Transistor
Z310	BSY38	Transistor
Z311	BZY88/C5V1	Zener Diode
Z351	1N 4009	Diode
Z352	1N 4009	Diode
Z353	2N 2369	Transistor
Z354	ASY26	Transistor
Z355	1N 4009	Diode
Z356	1N 4009	Diode
Z357	ASY26	Transistor
Z358	1N 4009	Diode
Z359	1N 4009	Diode
Z360	1N 4009	Diode
Z361	BC109	Transistor
Z362	BA114	Diode
Z363	1N 4009	Diode
Z364	BC109	Transistor
Z365	1N 4009	Diode
Z366	BC109	Transistor
Z367	BSY39	Transistor
Z368	BSY39	Transistor
Z369	BC109	Transistor
Z401 } Z402 }	4822 130 30108 (selected pair of diodes)	
Z403	BSY38	Transistor
Z404	BSY38	Transistor
Z405	BSY38	Transistor
Z601	BSY38	Transistor
Z602	BC109	Transistor
Z603	BC109	Transistor
Z604	BSY38	Transistor
Z605	BSY38	Transistor
Z606	BSY38	Transistor
Z607	1N 4009	Diode
Z608	2N 4302 Amelco	Transistor
Z609	BC109	Transistor
Z610	BSY38	Transistor
Z611	BZY88/C5V1	Zener Diode
Z651	BC109	Transistor
Z652	BC109	Transistor
Z653	BZY58	Zener Diode

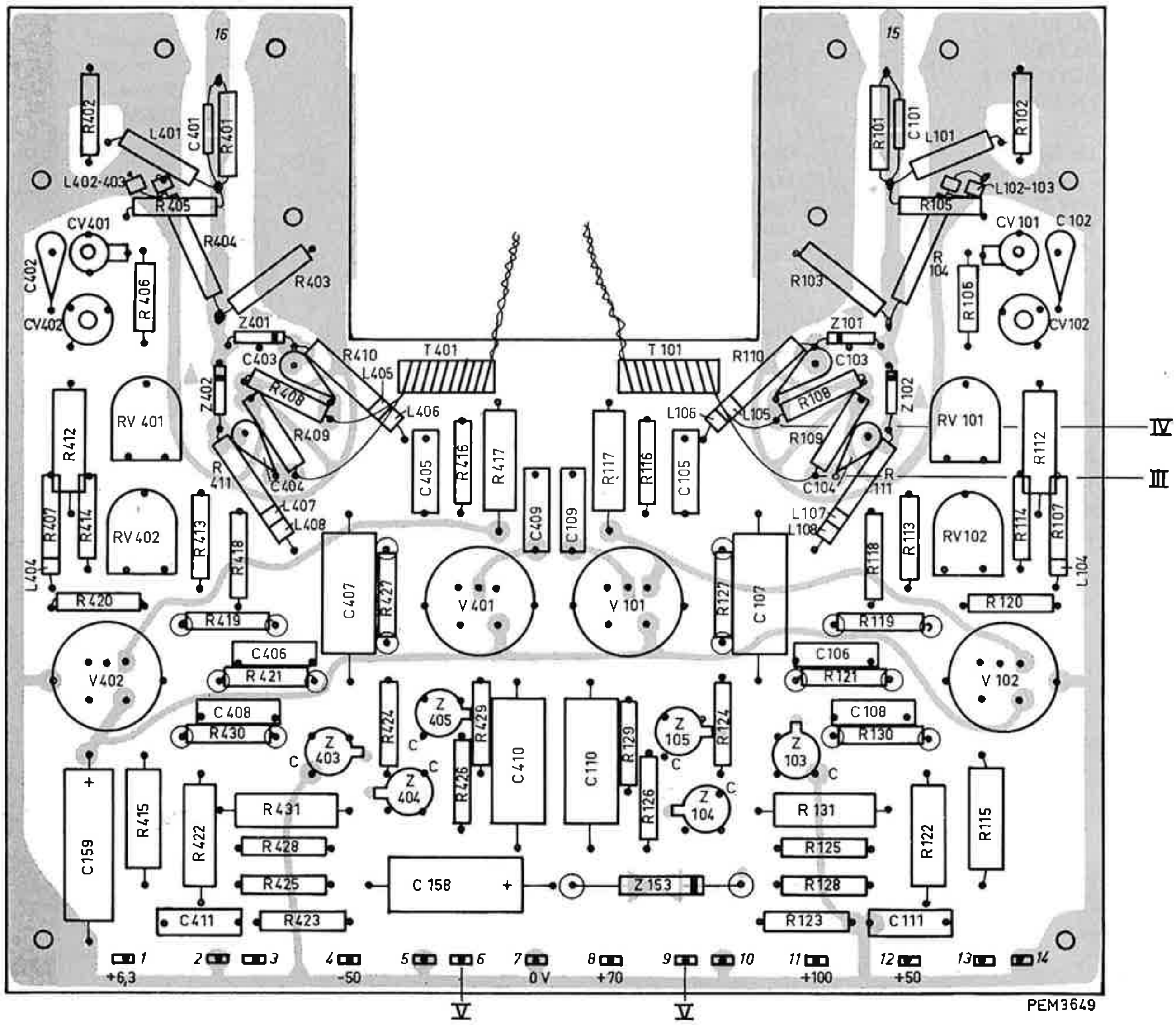


Fig. 7a. Printed circuit board 2, component side

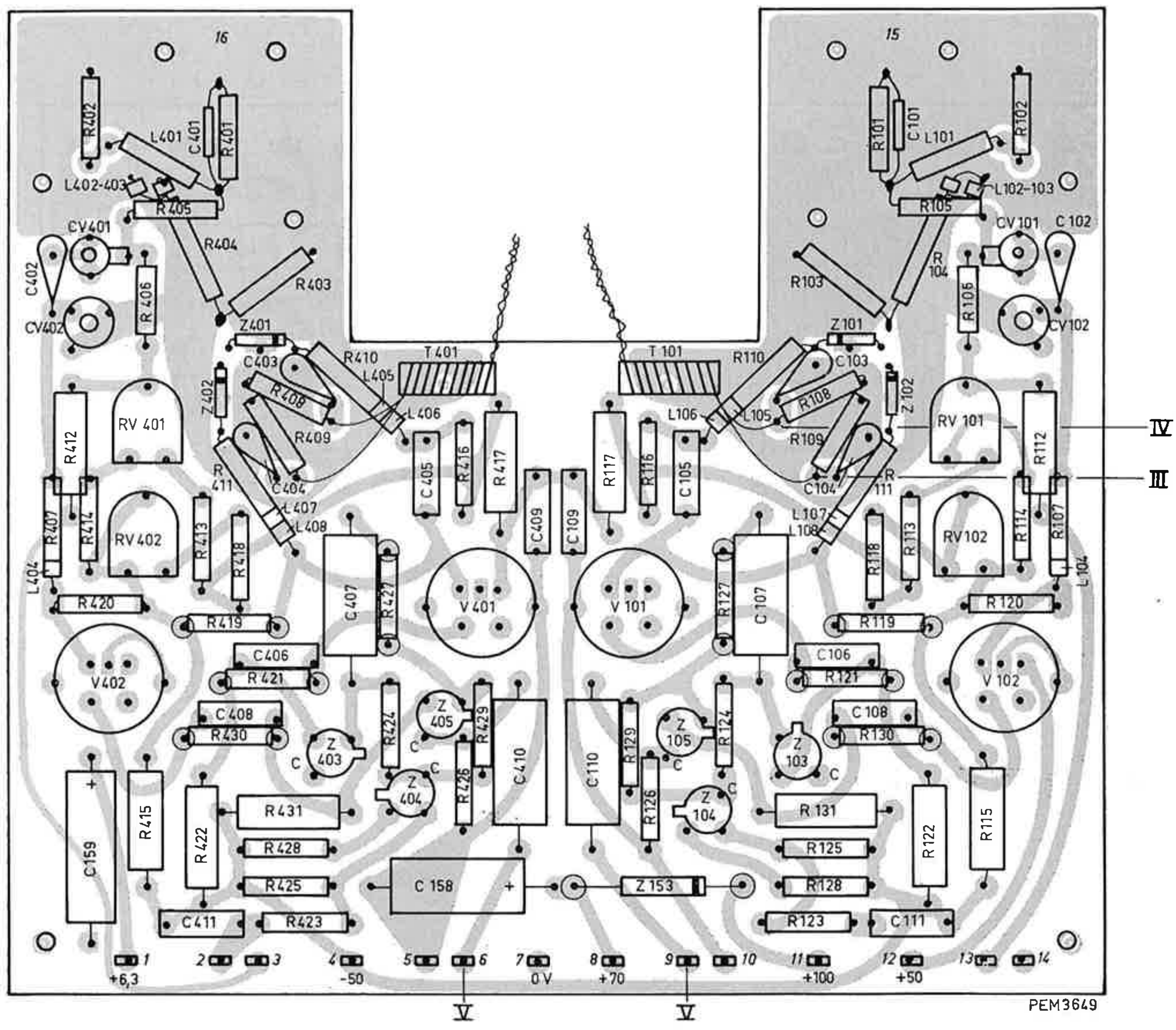


Fig. 7b. Printed circuit board 2, print side

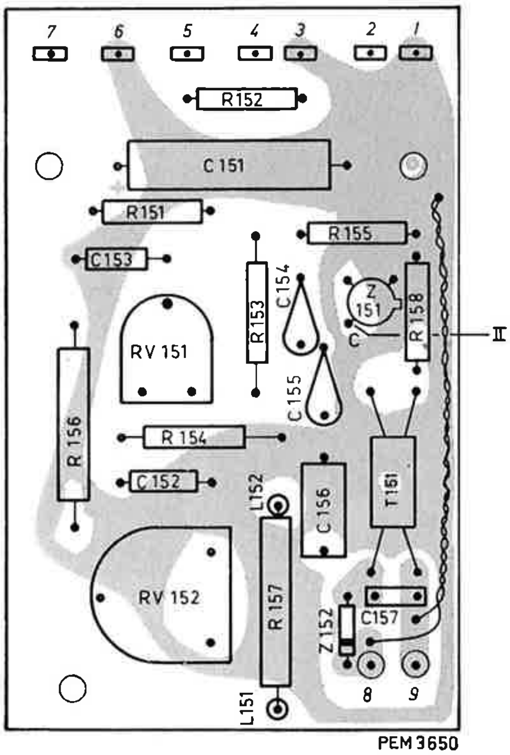


Fig. 8a. Printed circuit board 3, component side

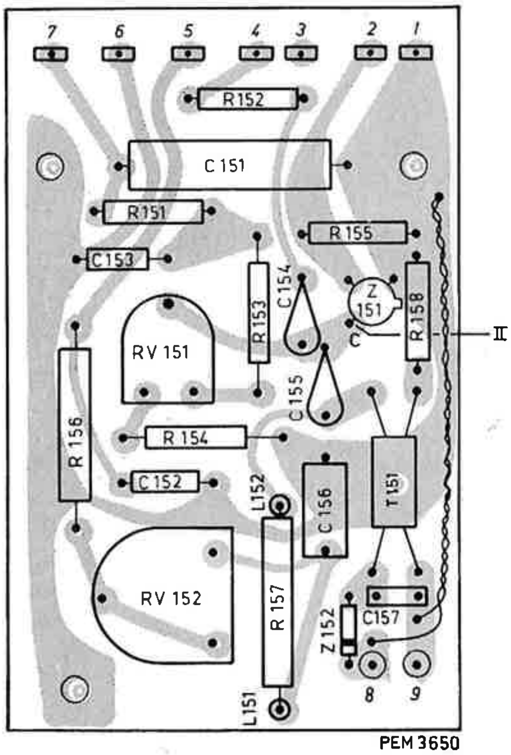


Fig. 8b. Printed circuit board 3, print side

10 V/cm

②

...ise time 1 ns

1 V/cm

④

...n A

...Oscillograms

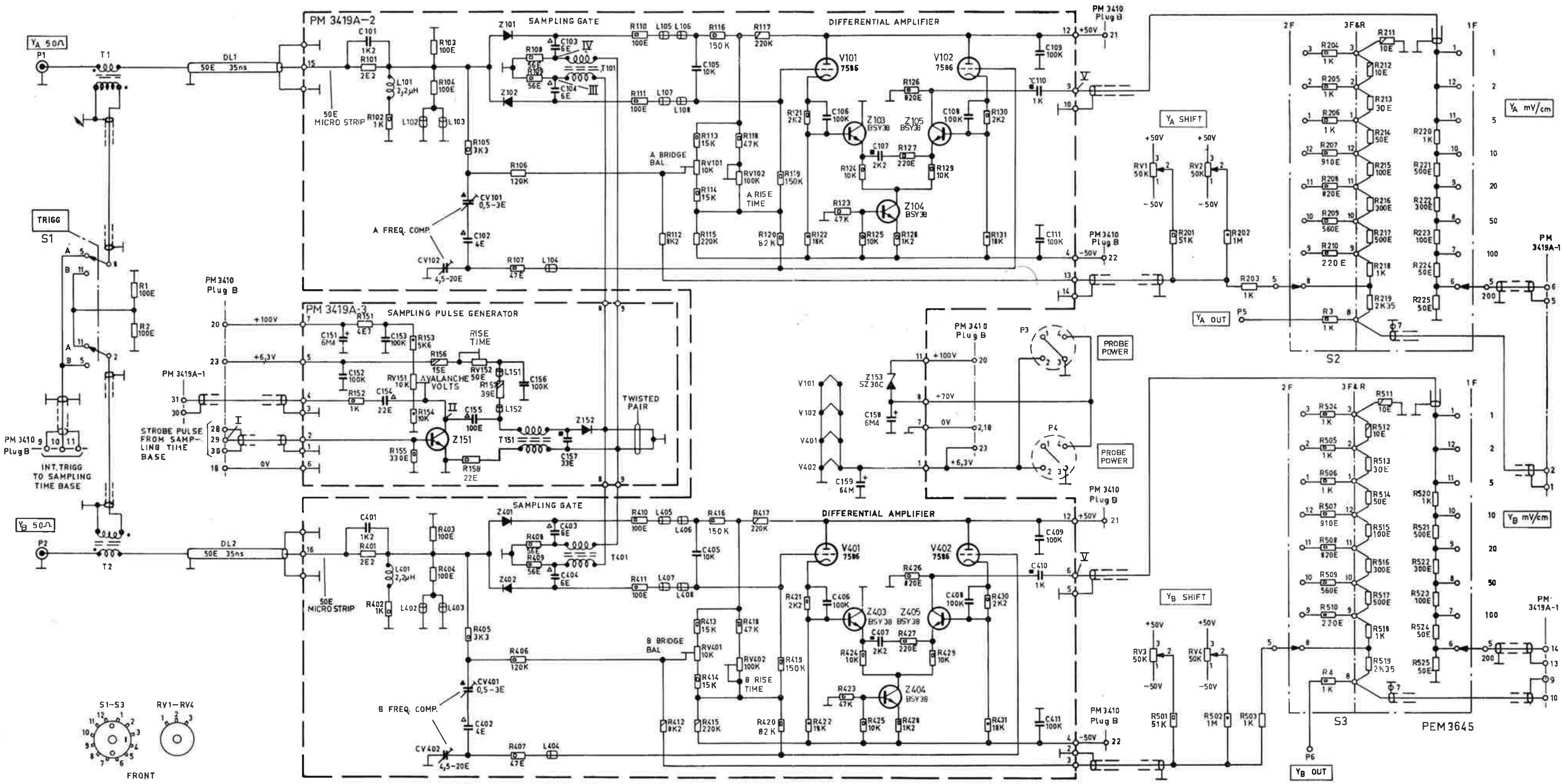


Fig. 10. Circuit diagram

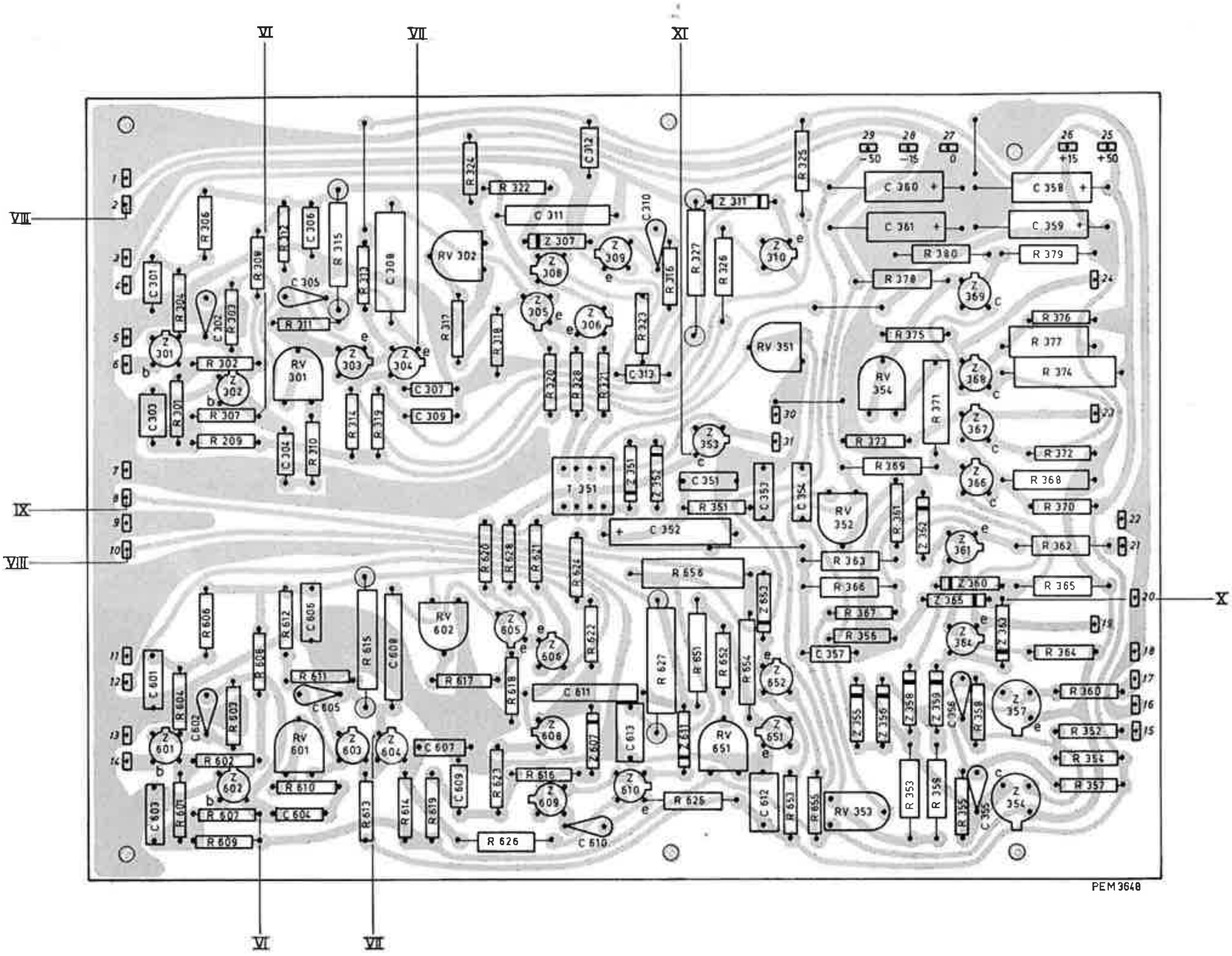
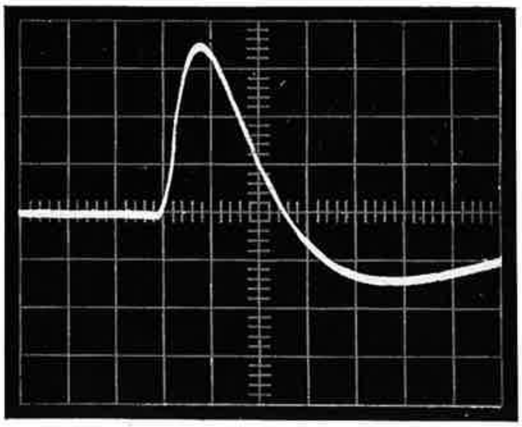


Fig. 11. Printed circuit board 1



400 ns/cm

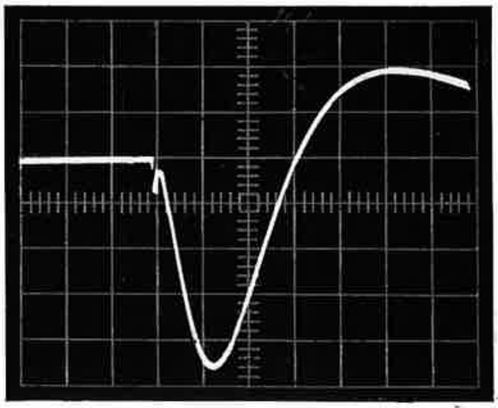
100 mV/cm

⑥

VI.

Z 602 c (Z 302 c)

Soldering points 9 and 10 (1 and 2) on print 1 short-circuited.
Y SHIFT max. clockwise.
(Opposite polarity of pulse when Y SHIFT max. anti-clockwise.)
S3 (S2) in position 200 mV/cm.
S1 in position B(A).



0.5 V/cm

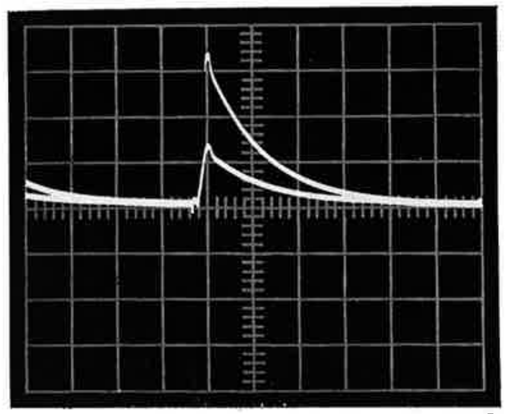
⑦

400 ns/cm

VII.

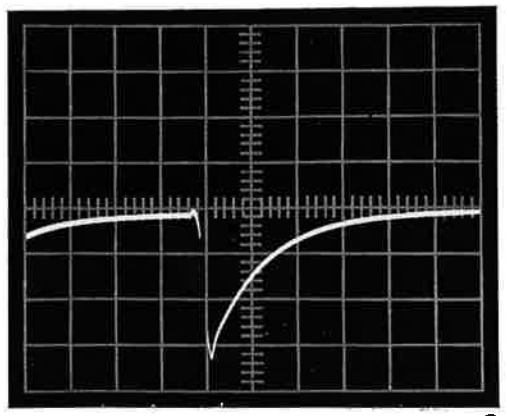
Z 604 e (Z 304 e)

Soldering points 9 and 10 (1 and 2) on print 1 short-circuited.
Y SHIFT max. clockwise.
S3 (S2) in position 200 mV/cm.



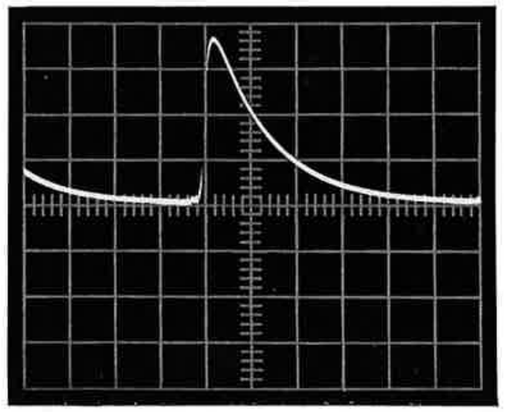
VIII.
C 611–Z 611
(C 311–Z311)

A resistor of 2200 Ω connected in parallel with C 611 (C 311).
Y SHIFT max. clockwise.
S1 in position B(A).
S4 in positions NORMAL and SMOOTHED



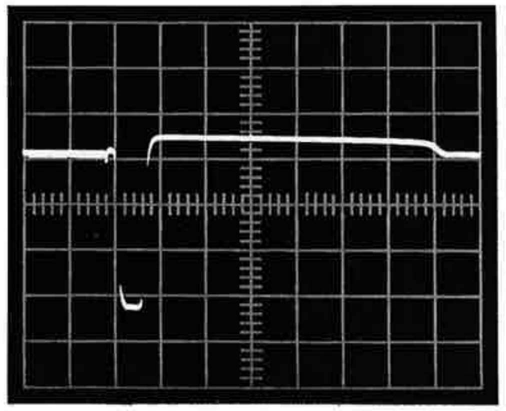
IX.
Printplate 1,
soldering point 8

A resistor of 2200 Ω connected in parallel with C 611.
Y SHIFT max. clockwise.
S1 in position B.
S4 in position NORMAL.



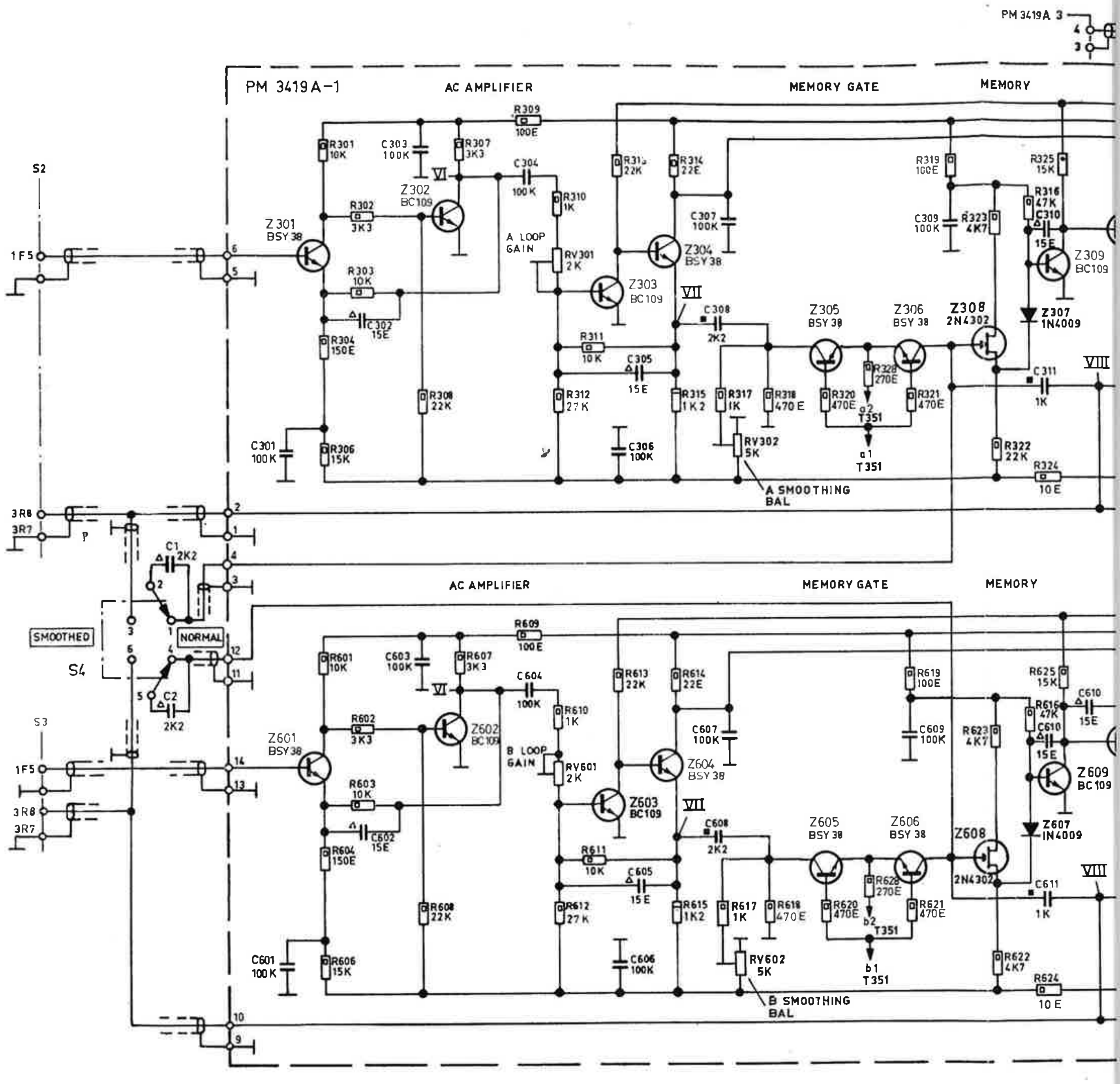
X.
Z 366 b

A resistor of 2200 Ω connected in parallel with C 611.
Y SHIFT max. clockwise.
S4 in position NORMAL.
S5 in position B.



XI.
Z 353 c

Fig. 12. Oscillograms VI . . . XI



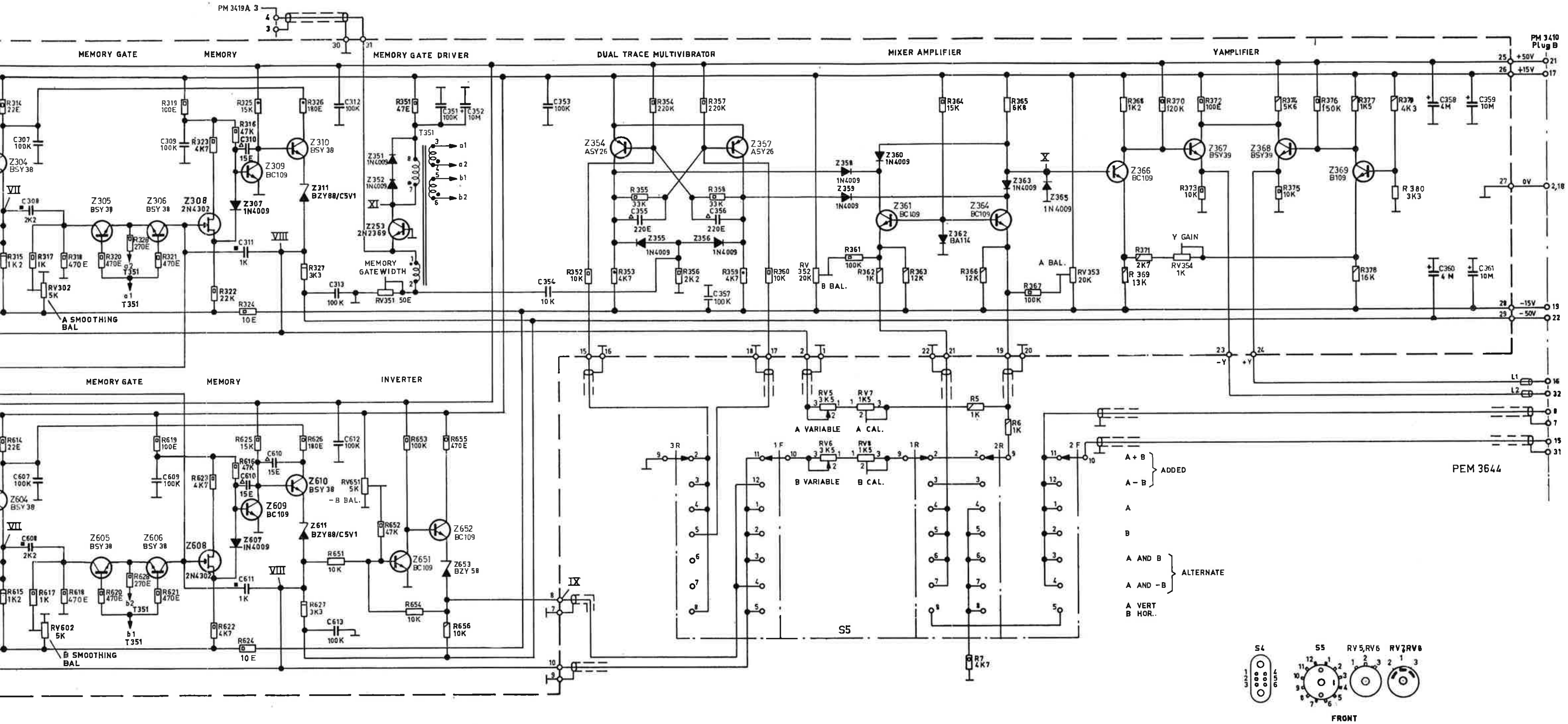


Fig. 13. Circuit diagram