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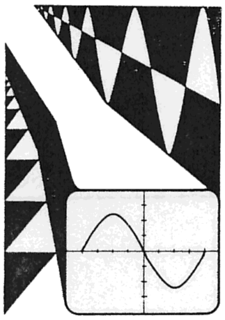

25 MHz Dual Channel Oscilloscope

PM 3214

(9444 032 14..1)

9499 440 18102

771201/03 e.v.

PHILIPS

SERVICE

Cryogenic Equipment / Electro Analytical Equipment / Electronic Weighing / Electron Optics / Industrial Data Processing systems / Numerical Control / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analysis

equipment for science and industry

781213 TEST AND MEASURING EQUIPMENT OSC 37

OSCILLOSCOPE PM 3214

Already published: OSC 1 - OSC 28

Subject: Alteration of the /04 version.

- During the production of the /04 version the following modifications are introduced:
  - Diodes V201, V202, V203 and V204 (4 x BY 127) are replaced by the diode type BY 227.
    Service ordering number: 5322 130 34633.
  - Integrated circuit D801 CA 3086 is replaced by the integrated circuit SL 3145C.
    Service ordering number: 5322 130 34764.
  - C503 and C603 of 33pF are introduced in parallel with R517 and R617 respectively. This is done for better bandwidth adjustment and better h.f. response in the 2-5-10 mV/div. positions of the attenuator switches.
    Service ordering number: 4822 122 31067.

9499 448 11111
PRINTED IN THE NETHERLANDS

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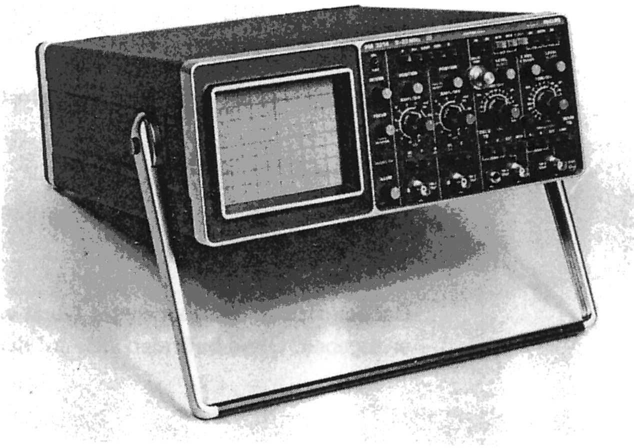

Instruction manual

Gerätehandbuch

Notice d'emploi et d'entretien

25 MHz Dual channel oscilloscope
25 MHz Zweikanal - Oszilloskop
Oscilloscope 25 MHz à double trace

PM 3214

(9444 032 14..1)

9499 440 18102

771201/03 e.v.

IMPORTANT

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

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos réclamations se rapportant à cet apparail, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Note: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

Bemerkung: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

Remarques: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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1. General information

1.1 INTRODUCTION

The 25 MHz dual-channel oscilloscope PM 3214 is a compact, portable instrument, ergonomically designed to facilitate its extensive measuring capabilities.

The instrument provides both a main and a delayed timebase with provision for alternate timebase displays, comprehensive triggering facilities including peak-to-peak Auto, DC coupling and automatic TV waveform display.

A large 8 x 10 cm screen with illuminated internal graticule lines makes for easier viewing, and a 10 kV accelerating potential gives a high intensity trace with a well-defined spot.

A double-insulated power supply allows the frame ground to be directly connected to floating ground circuits provided that this ground does not carry live potentials. By this means, interference by ground currents, as is frequently experienced with grounded oscilloscopes, is also substantially reduced.

The wide range of applications enabled by the above features is further extended by a versatile power supply that enables the instrument to be operated from different line voltages as well as from d.c. For field operation an optional battery version is also available.

Warning: The frame ground (and the ground lead of the probe) must not be connected to live potentials.

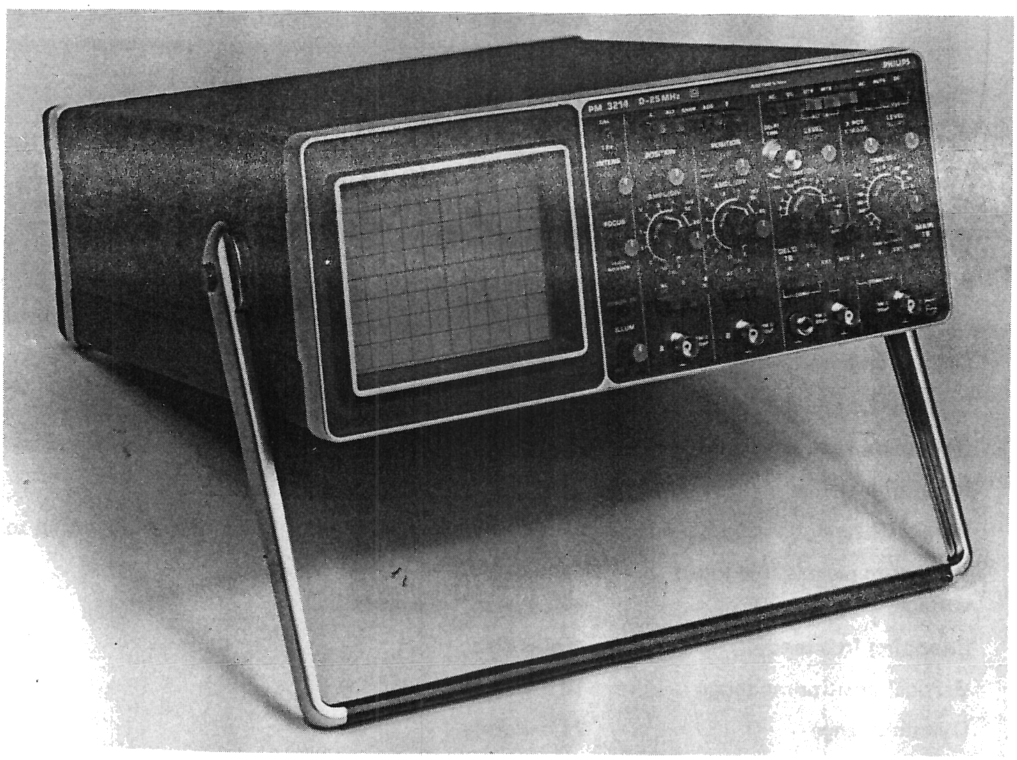


Fig. 1.1. 25 MHz dual-channel oscilloscope PM 3214

1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 for Class II instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition. Properties expressed in numerical values with stated tolerances are guaranteed for ambient temperatures of +5 ^{o}C ... +40 ^{o}C unless stated otherwise. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

	Designation	*Specification*	*Additional Information*
1.2.1	**C.R.T.**		
	Type	D14-125 GH/08	Rectangular tube face, mesh type, post accelerator, metal backed phosphor.
	Measuring area	8 x 10 divisions	1 div. equals 1 cm
	Screen type	P31 (GH)	P7 (GM) optional
	Total acceleration	10 kV	
	Graticule	Internal	Cont. variable illumination
	Engravings	Centimetre divisions with subdivisions of 2 mm along the central axes. Dotted lines indicate 10% and 90% of measuring lattice for measurement of rise time.	
1.2.2	**Vertical or Y-axis**		
	Display modes	Channel A only Channel B only A and B chopped A and B alternating A and B added	
	Channel B polarity	Normal or inverted	
	Response:		
	Frequency range	DC : 0 .... 25 MHz (-3 dB) AC : 2 Hz .... 25 MHz (-3 dB)	
	Rise time	≤ 14 ns	
	Pulse aberrations	≤ ± 3% (≤ 4% pp)	Measured at 6 div. amplitude and applied rise time of ≥ 1 ns.
	Deflection coefficients	2 mV/DIV .... 10 V/DIV	1-2-5 sequence
	Continuous control range	1 : ≥ 2,5	
	Deflection accuracy	± 3 %	
	Input impedance	1 MΩ/20 pF	
	Input RC time	0,1 s	Coupling switch to AC
	Maximum permissible input voltage	400 V, d.c. + a.c. peak	
	Chopping frequency	≈ 500 kHz	
	Vertical positioning range	16 divisions	
	Dynamic range	24 divisions	
	Visible signal delay	≥ 20 ns	
	C.M.R.R. in A-B mode	≥ 40 dB at 1 MHz	After adjustment at d.c. or low frequencies
	Cross talk between channels	-40 dB or better at 10 MHz	
	Instability of the spot position:		
	Temperature drift	≤ 0,3 div/hour	

1.2.3 Horizontal or X-axis

Horizontal deflection can be obtained from either the Main time base or the Delayed time base or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using A, B, the Ext input connector, or Line as a signal source for horizontal deflection.

Display modes	– Main time base – Main time base intensified by delayed time base – Main time base and delayed time base alternately displayed – Delayed time base – XY or XY/Y operation	X deflection by: – Channel A signal – Channel B signal – Signal applied to EXT connector of main time base – Line frequency

1.2.4 Main time base

Operation	Automatic	Possibility of automatic free-running in the absence of triggering signals
	Triggered	
Time coefficients	0,5 s/DIV ..... 0,2 μs/DIV	1-2-5 sequence
Continuous control range	1 : ≥ 2,5	
Coefficient error	± 3%	
Magnification	10x	
Magnifier error	± 2%	
Max. effective time coefficient	20 ns/DIV	

1.2.5 Delayed time base

Operation	Delayed time base either starts immediately after delay time or is triggerable after the delay time, by the selected delayed time base trigger source	
Time coefficients	1 mS/DIV – 0,2 μs/DIV	1-2-5 sequence
Continuous control range	1 : ≥ 2,5	
Coefficient error	± 3%	
Delay time	In steps variable with main time base. Continuously variable with 10-turn potentiometer between 0 x and 10 x the time coefficient of the main time base	
Incremental delay time accuracy	0,5%	
Delay time jitter	1 : ≥ 20.000	

	Designation	*Specification*	*Additional information*
1.2.6	**X Deflection**		
	Source	A, B, EXT. or LINE	As selected by trigger source switch, if push-button X DEFL. is depressed
	Deflection coefficients	A, or B: As selected by AMPL/DIV EXTERNAL: 0,5 V/division LINE: 8 divisions	
	Deflection accuracy	± 10% in A or B	
	Frequency range	DC: 0 .... 1 MHz (-3 dB) over 6 divisions	
	Phase shift	$\leqslant 3^\circ$ at 100 kHz	
	Dynamic range	24 divisions	For frequencies $\leqslant$ 100 kHz
1.2.7	**Triggering of the main time base**		
	Source	Ch. A, Ch. B, Composite, External and Line	
	Trigger mode	Automatic, normal AC normal DC, TV-line and TV frame	
	Trigger sensitivity	Internal: 0,5 div (DC .... 5 MHz) 1 div (DC .... 50 MHz) External: 250 mV (DC .... 5 MHz) 500 mV (DC .... 50 MHz)	
	Triggering frequency range	AUTO: 20 Hz..... $\geqslant$ 50 MHz AC: 5 Hz..... $\geqslant$ 50 MHz DC: 0 Hz..... $\geqslant$ 50 MHz	
	Level range	AUTO: Proportional to peak-to-peak value of trigger signal. AC, DC: 16 div. at Internal trigg., and 8 V at external trigg.	+ or −8 div and + or −4 V referenced to centre of scree..
	Triggering slope	Positive or negative going	
	Input impedance	1 MΩ//20 pF	
	Maximum permissible input voltage	400 V, d.c. + a.c. peak	
1.2.8	**Triggering of the delayed time base**		
	Source	chA, chB, Composite, External, MTB.	

Other trigger specifications are identical to "triggering of the main time base" with the exception of TV triggering.

1.2.9	**Calibration generator**		
	Output voltage	1,2 Vpp	Square wave
	Accuracy	± 1%	
	Frequency	≈ 2 kHz	

	Designation	Specification	Additional Information
1.2.10	**Power supply**		
	AC supply:	Double insulated	Safety class II, IEC 348
	Nominal voltage range (on line-mains voltage adaptor)	110, 127, 220 or 240 Vac ± 10%	
	Nominal frequency range	50 ..... 400 Hz ± 10%	
	Power consumption	30 W max.	At nominal mains voltage
	DC supply:		
	Voltage range	22-27 V dc 20-28 V	Floating input with relaxed specifications
	Current consumption	1,1 A max.	
	Capacity to earth	185 pF	Measured with rubber feet on grounded metal plate of 1 m^2
		27 pF	Measured 30 cm above grounded plate of 1 m^2

1.2.11 Environmetal characteristics

The environmental data are valid only if the instrument is checked in accordance with the offical checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

Ambient temperature:		
Rated range of use	+ 5 °C ..... + 40 °C	
Limit range of operation	– 10 °C ..... + 55 °C	
Storage and transport conditions	– 40 °C ..... + 70 °C	
Humidity	According to IEC 68 Db	
Bump	1000 bumps of 10 g, ½ sine, 6 ms duration in each of 3 directions	
Vibration	30 minutes in each of three directions, 10-150 Hz; 0.7 mm p-p and 5g max. acceleration	
Altitude:		
Limit range of operation	5000 m (475 mbar) (= 47,5 kPa)	in open air
Limit range of transport	15000 m (100 mbar) (= 10 kPa	in open air
Recovery time	30 minutes if instrument temperature is raised from – 10 °C to + 20 °C at 60% relative humidity	
Electromagnetic interference	The instrument meets the VDE, Störgrad K, requirements	

1.2.12 Mechanical data

Dimensions:		
Length	445 mm	Handle and controls excluded
Width	335 mm	Handle excluded
Height	137 mm	Feet excluded
Weight	8,4 kg (18,5 lb) approx.	

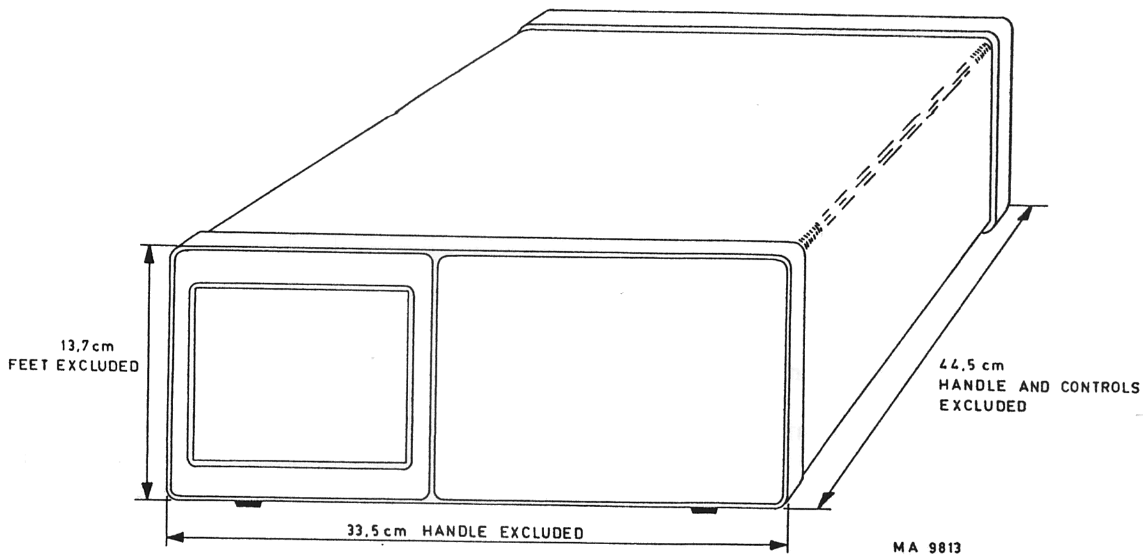


Fig. 1.2. Dimensions

1.3. ACCESSORIES

1.3.1. Supplied with the instrument

Front cover
1 BNC 4 mm adaptor
2 Probes PM 9336/00
Instruction manual

1.3.2. Optional

PM 8927	Passive probe set 10 : 1 (1.5 m) 75 MHz
PM 8927L	Passive probe set 10 : 1 (2.5 m) 75 MHz
PM 8935	Passive probe set 10 : 1 (1.5 m) 250 MHz
PM 8935L	Passive probe set 10 : 1 (2.5 m) 250 MHz
PM 9335	Passive probe set 1 : 1 (1.5 m) 10 MHz
PM 9335L	Passive probe set 1 : 1 (2.5 m) 10 MHz
PM 9336	Passive probe set 10 : 1 (1.5 m) 25 MHz
PM 9336L	Passive probe set 10 : 1 (2.5 m) 25 MHz
PM 9352	Micro miniature probe 150 MHz
PM 9353	Active FET probe 150 MHz
PM 9358/01	HV probe set 100 : 1 150 MHz
PM 9346	Power probe supply
PM 9355	Current probe
PM 8910	Polaroid anti-glare filter
PM 9380	Oscilloscope camera
PM 8971	Camera adaptor
M3 ... M5	Steinheil Oscilloscope camera range
PM 8963	19" Rack mount adaptor
PM 9366	Collapsible viewing hood
PM 8980	Closed long type viewing hood
PM 8901	Rechargeable battery pack 140 V d.c./24 V d.c.
PM 8991	Trolley
PM 8997	Accessory pouch
Trimming tool kit	

See also Chapter 3.5. "INFORMATION CONCERNING ACCESSORIES".

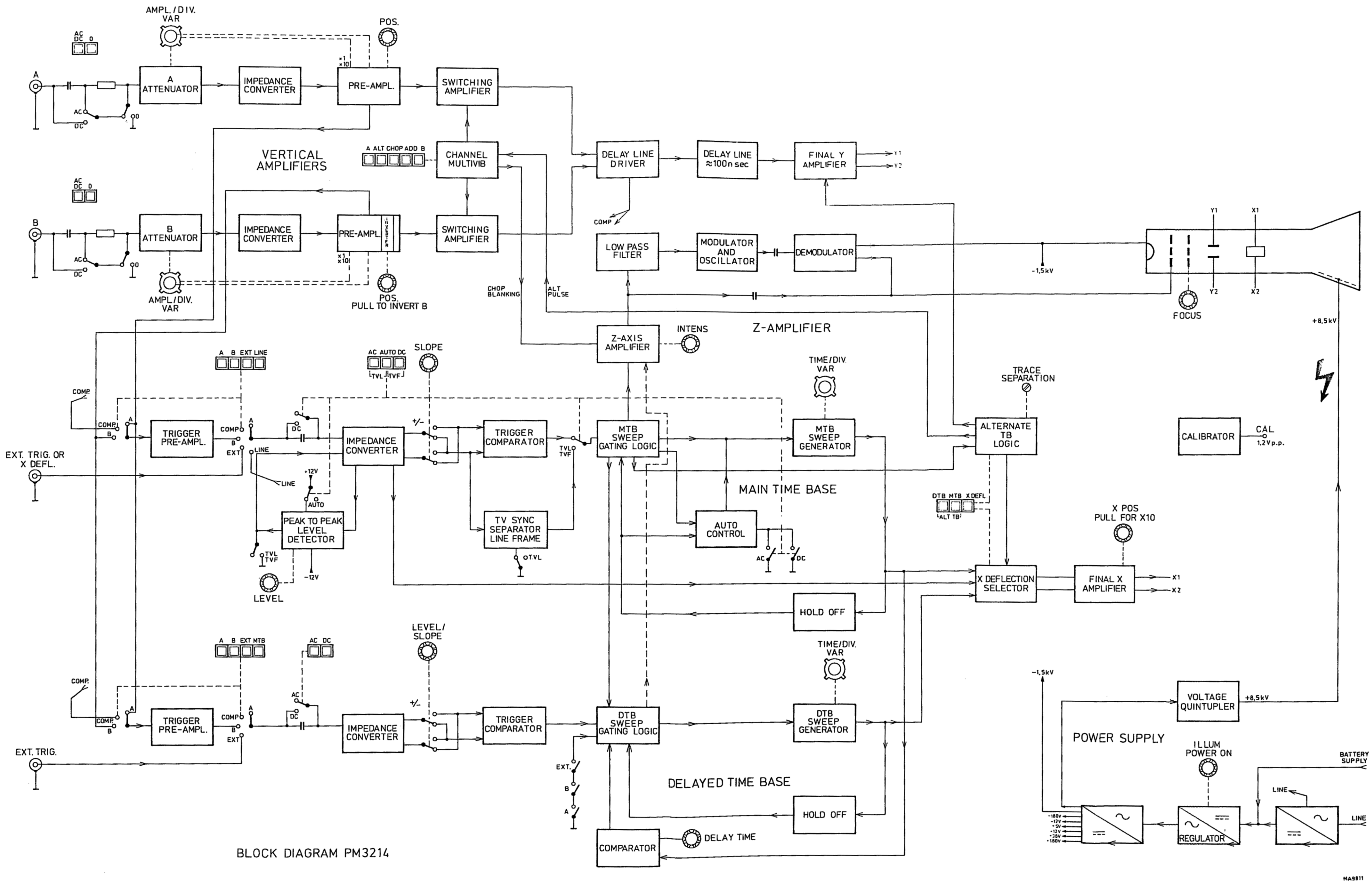


Fig. 1.3. Block diagram of the oscilloscope
Abb. 1.3. Blockschaltbild
Fig. 1.3. Schéma synoptique

1.4. BLOCK DIAGRAM DESCRIPTION (Fig. 1.3.)

1.4.1. Y Channel

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.

A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line. The channel multivibrator is operated by a pulse at the end of the sweep, and offers an uninterrupted display of the A and B waveforms in the ALT mode. In the ADD position, both switching amplifiers couple the signals through, thus adding channels A and B. By inverting the B channel amplifier (PULL TO INVERT B) the A – B mode is obtained.

The AMPL/DIV switches provide x 1 or x 10 gain control of the preamplifier, which offers in conjunction with the step attenuator a full range of deflection coefficients in a 1-2-5 sequence.

1.4.2. Main time base triggering

To initiate sweeps, trigger signals can be derived from the A and B vertical channel preamplifiers, from an external source, or internally from the mains supply (LINE triggering) as selected by the trigger source switch. Composite triggering (A and B depressed) is derived from the delay-line driver stage. The polarity of the trigger signal, negative or positive-going, on which the display will start is determined by changing the output polarity of the impedance converter.

With the AUTO switch depressed, the peak-to-peak level detector comes into operation. The peak-to-peak level of the signal then determines the range of the LEVEL control.

With AC or DC depressed, the range of the LEVEL control is fixed.

In the TVL and TVF modes the LEVEL control is inoperative and the TV sync separator is switched into circuit, thus initiating sweeps with line or frame pulses depending on the setting of the TVL and TVF switches.

1.4.3. Main time base circuit

For normal internal time base operation the horizontal amplifier is fed by sweeps from the time base circuit. With AUTO depressed, in the absence of trigger signals, the output of the sweep generator is fed back via the hold-off circuit and gate to its input. This causes sweeps to free-run and a resultant trace is displayed on the screen. As soon as the AUTO control circuit detects a trigger (i.e. a change in the output of the sweep-gating logic) the sweep is fed back to the sweep-gating logic. This causes the circuit to revert to the normal triggering mode in which sweeps are initiated only by trigger pulses at the input of the sweep-gating logic.

With AC or DC depressed, AUTO control is made inoperative. Sweeps are then only produced provided a trigger signal is present and the LEVEL control appropriately set.
The display can be magnified in the horizontal direction by increasing the gain of the final amplifier by a factor of x10 (also the X DEFL mode).

When the X DEFL pushbutton of the horizontal selection switch is depressed, the sweep generator output to the final amplifier is inhibited and the impedance converter is connected directly to the final amplifier. In this way, the signals normally selected for triggering, or an external source, can now be used for horizontal deflection.

1.4.4. Hold-off circuit

The hold-off stage, as its name implies, 'holds-off' triggers from the input of the time base circuit until the trace has completely returned and the time base circuits are completely reset.

1.4.5. Z Axis

The Z amplifier provides for the blanking of the trace during the fly-back and hold-off time. In addition, it blanks the sweep in the CHOP mode during the switching transients.
The l.f components of the blanking signal are modulated and demodulated before they are applied to the Wehnelt cylinder together with the a.c. coupled h.f. components.

1.4.6. Delayed time base triggering

To initiate sweeps, trigger signals can be derived from the A and B vertical channel preamplifiers, or from an external source as selected by the trigger source push button switch.

With both the A and B pushbuttons depressed simultaneously, composite triggering is derived from the delay-line driver stage of the Y amplifier channel. AC and DC coupling is provided to the impedance converter. The polarity of the trigger signal, negative or positive-going, on which the display will start, is determined by changing the output polarity of the impedance converter by the SLOPE switch.

With MTB selected, the delayed time base starts directly after the delay time. The DELAY TIME control in conjunction with the comparator determines the delay time for the delayed time base generator.

1.4.7. Delayed time base circuit

The delayed time base is operative unless its TIME/DIV switch is in the OFF position. It starts immediately after the delay time, or upon receipt of the first trigger pulse after the delay time.

The sawtooth signal derived from the main time base sweep generator is passed to a comparator where it is compared with an accurately adjustable d.c. voltage, controlled by the DELAY TIME control.

The comparator output is pulse-shaped and provides the required delay pulse for the sweep-gating logic of the delayed time base generator. A sawtooth voltage is then initiated.

The delayed sweep is reset by the hold-off circuit of the delayed time base (end of the sweep detection) or by the main time base.

It can be started again by the output signal of the comparator after the initiation of the next main time base sweep.

When pushbutton MTB of the horizontal deflection mode controls is selected, the part of the trace coinciding with the delayed sweep is intensified.

1.4.8. Alternate time base logic

In ALT TB mode an electronic switch enables main time base display and delayed time base display to be alternately traced on the screen.

The two displays can be separated by varying the voltage applied to the vertical amplifier, derived from the driving circuits of the electronic switch. This separation is symmetrically variable by means of the TRACE SEPARATION control on the front panel.

In the ALT TB mode the vertical channel multivibrator is controlled by a signal derived from the electronic switch.

In the vertical and horizontal ALT modes, successively are displayed on the screen, Channel A and main time base, Channel A and delayed time base, Channel B and main time base, Channel B and delayed time base.

1.4.9. Power supply

The mains (line) supply is transformed and rectified before being applied to a d.c. to a.c. converter.
When the instrument is operated from a battery supply, the battery output is connected directly to the d.c. to a.c. converter.

The output of the regulator is coupled to a transformer and rectifier which, after rectification, provides the −1.5 kV potential and the circuit supply voltages. The −1.5 kV is also multiplied to 8.5 kV to supply the required total accelerating voltage of ≈ 10 kV.

2. Directions for use

2.1 INSTALLATION

2.1.1 Safety regulations (in accordance with IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc. to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the instrument to the mains (line).

The instrument must be disconnected from all voltage sources and any high voltage points discharged before any maintenance or repair work is carried out. If adjustments or maintenance of the operating instrument with covers removed is inevitable, it must be carried out only by a skilled person who is aware of the hazards involved. In normal operation the double-insulated power supply obviates the need of a safety ground.

> Warning: **It must be borne in mind that in all measurements the frame ground of the oscilloscope is raised to the same potential as that of the measuring ground probe connection. Neither the probe's ground lead nor the frame ground shall be connected to live potentials.**

2.1.2 Local mains (line) connection and fuse protection

Before connecting the instrument to the mains (line) ensure that it is set to the local mains (line) voltage. On delivery the instrument is set to 220 V. If the instrument is to be used with 110 V, 127 V or 240 V supply, the appropriate voltage should be selected by turning the adaptor on the rear panel to indicate the voltage required (see Fig. 2.1).

The instrument is protected from overloads by a thermal fuse fitted between the mains (line) transformer windings. It can be replaced after having removed the instrument rear panel (see section 2.4.)

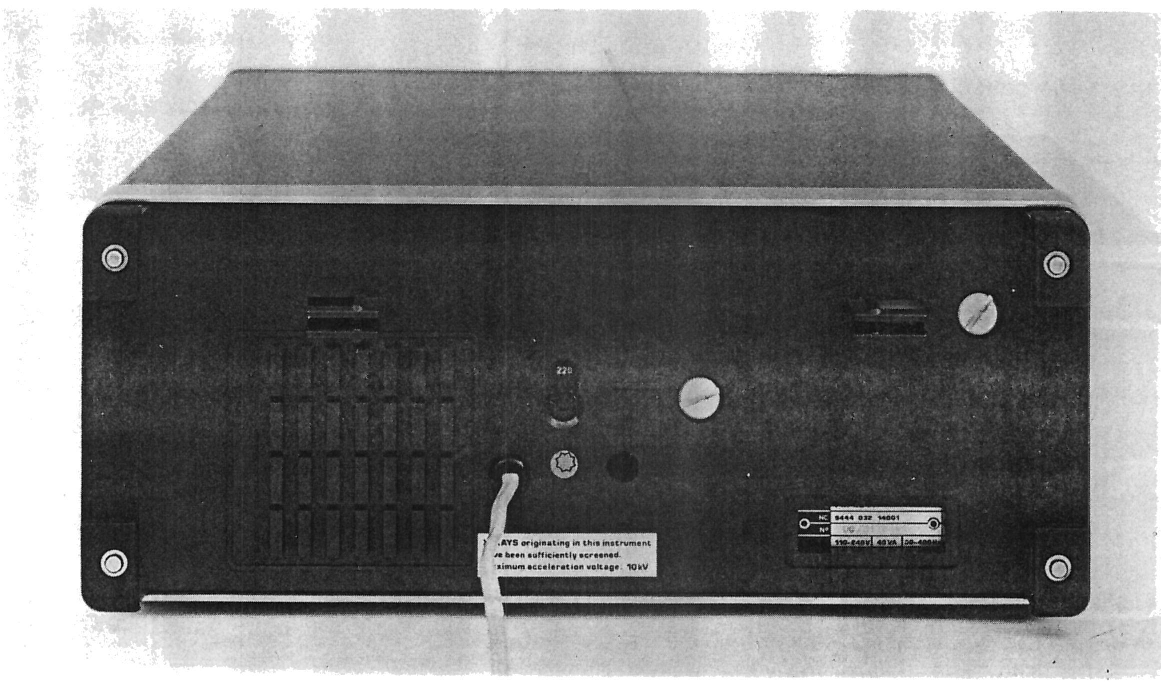


Fig. 2.1. Rear view of the oscilloscope showing the voltage adapter set to 220 V.

2.1.3 Connection to an external supply

An external supply or battery of 22 V to 27 V capable of delivering at least 1 A can be connected to the socket on the rear panel. (DC Power input cord set: 4822 321 20125).
The inner conductor must be connected to the negative pole and the outer conductor to the positive pole, as indicated on the rear panel.
The instrument is protected against overloads and reversed polarity by an internal fuse and diode. This fuse can be replaced after having removed the instrument rear panel (see section 2.4.).

2.1.4 Front cover and instrument position

The front cover can be simply removed by pulling it from the front.
The instrument may be used horizontally or in several sloping positions by using the carrying handle as a tilting bracket.
To unlock the handle, simultaneously push in both pivot centre knobs.

2.2 CONTROLS AND SOCKETS (Refer to Fig. 2.2)

2.2.1 Cathode-ray tube and POWER controls

ILLUM POWER ON	Continuously variable control of the graticule illumination; incorporates mains (line) switch. POWER ON pilot lamp indicates the ON state.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Allows beam to be focused for minimum spot size.
TRACE ROTATION	Screwdriver adjustment to align the trace with the horizontal graticule lines.

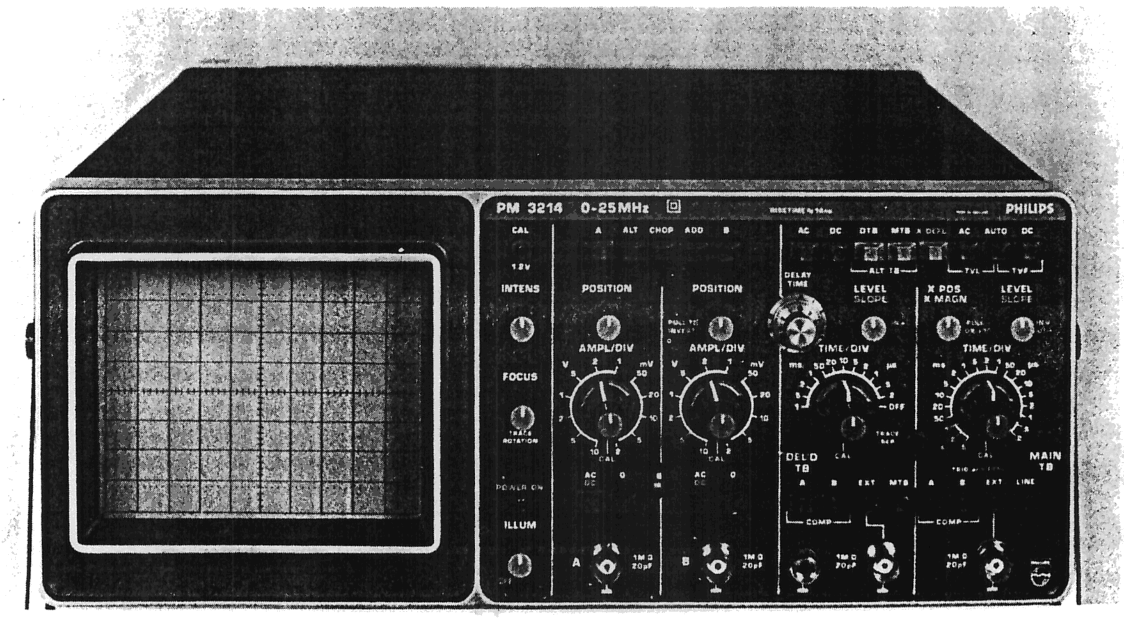


Fig. 2.2. Front view of the oscilloscope showing controls and sockets.

2.2.2 Vertical channels

Display mode switch	*Function*
A – ALT – CHOP – ADD – B	5-way pushbutton switch selecting the vertical display mode. With all buttons released, the ALT mode is in operation.
A	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT	The display is switched over from one vertical channel to the other at the end of every cycle of the timebase signal.
CHOP	The display is switched over from one vertical channel to the other at a fixed frequency. ($f \approx 500$ kHz)
ADD	Vertical deflection is achieved by the sum signal of channels A and B.
B	Vertical deflection is achieved by the signal connected to the input of channel B.
POSITION	Continuously variable controls giving vertical shift of the display.
PULL TO INVERT B	Push-pull switch combined with the channel B POSITION control. When pulled, channel B signal is inverted.
AMPL/DIV (outer-knob)	Step control of the vertical deflection coefficients, ranging from 2 mV/div up to 10 V/div in a 1-2-5 sequence.
AMPL/DIV (centre-knob)	Continuously variable control of the vertical deflection coefficients. Note that the deflection coefficient is calibrated only with the centre-knob switched to the CAL position (fully-clockwise).
Input coupling switch	Signal coupling; 2-way pushbutton switch
AC/DC – 0	
AC (depressed)	Coupling via a blocking capacitor
DC (released)	Direct coupling
0 (depressed)	Connection between input circuit and input socket is interrupted and the input circuit is grounded.
A (1MΩ//20pF)	BNC socket for channel A input
B (1MΩ//20pF)	BNC socket for channel B input

2.2.3 Horizontal channel

X deflection source switch	*Function*
DTB MTB – XDEFL └ALT TB┘	Horizontal-deflection controls; 3-way pushbutton switch
DTB	The horizontal deflection voltage is supplied by the delayed time-base generator.
MTB	The horizontal deflection voltage is supplied by the main timebase generator. A portion of the trace is intensified when the delayed timebase is running. The delayed timebase generator is switched off when the DELD TIME/DIV switch is in the OFF position. If no buttons are depressed the effect is the same as the MTB button depressed (only the MTB LEVEL control is not operating in this situation).
DTB MTB └ALT TB┘	When both the DTB and MTB pushbuttons are selected simultaneously, the horizontal deflection voltage is supplied by the main and delayed timebases alternately.
X DEFL	Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A signal, the channel B signal, or by a mains-frequency signal.

X POS/X MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch, PULL FOR x 10, which increases the horizontal deflection coefficient by a factor of 10. The magnifier is also operative if an external X deflection signal is used.
TRACE SEP	Continuously variable control of the vertical space between the two time-base displays in the ALT.TB mode.

2.2.4 Main time base generator

LEVEL SLOPE (IN +,OUT–)	Continuously variable control to select the level of the triggering signal at which the timebase generator starts. This control incorporates a push-pull switch, which enables choice of triggering on the positive or negative-going edge of the triggering signal. For TV triggering, select – for negative video signals and + for positive video signals.
Trigger mode switch	*Function*
AC – AUTO – DC └ TVL ┘└ TVF ┘	3-way pushbutton switch selecting the trigger mode. With all pushbuttons released AUTO sweep mode is in operation at a fixed range of the LEVEL control.
AUTO	A trace is displayed in the absence of trigger signals. The range of the LEVEL control is proportional to the peak-to-peak value of the triggering signal.
AC	Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is blocked.
DC	Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is passed.
AC AUTO └ TVL ┘	Line synchronisation is obtained.
AUTO DC └ TVF ┘	Frame synchronisation is obtained.
Trigger source switch	*Function*
A – B – EXT – LINE └ COMP ┘	4-way pushbutton switch selects the trigger source, (or the source of horizontal deflection if X deflection source switch is depressed for X DEFL). With all pushbuttons released, the effect is the same as the A button depressed.
A	Signal derived from channel A
B	Signal derived from channel B
A B └ COMP ┘	Composite signal, derived after the electronic switch. Triggering occurs on the displayed waveforms (not usable with X DEFL).
EXT	External signal derived via the adjacent 1 MΩ//20pF socket.
LINE (MAINS)	Signal derived from the line (mains) voltage. (Inoperable when instrument is battery-powered).
TIME/DIV (outer switch)	Selects the time coefficient from .2 μs/div to .5 s/div in a 1-2-5 sequence.
TIME/DIV (inner knob)	Continuously variable control of the time coefficients. Must be switched to CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.
1 MΩ – 20 pF	BNC socket for external triggering or horizontal deflection.

2.2.5 Delayed time base generator

LEVEL SLOPE (IN +, OUT –)	Continuously variable control to select over a fixed range the level of the triggering signal at which the time base generator starts. This control incorporates a push-pull switch, which enables choice of triggering on the positive or negative going edge of the triggering signal.
Trigger mode switch	*Function*
AC – DC	2-way pushbutton switch selecting the trigger mode
AC	Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is blocked.
DC	Normal triggering and fixed range of LEVEL control. The DC component of the trigger signal is passed.
DELAY TIME	Continuously variable vernier control of the delay time, together with the TIME/DIV controls of the main time base generator.
Trigger source switch	*Function*
A – B – EXT – MTB └COMP┘	4-way pushbutton switch selects the trigger source and starting point of delayed time base. No pushbutton depressed has the same effect as the MTB button depressed.
A	Internal triggering Signal derived from channel A.
B	Internal triggering Signal derived from channel B.
A B └COMP┘	Composite signal, derived after the electronic channel switch. Triggering occurs on the displayed waveform, after selected delay time.
EXT	Triggering on an external signal connected to the adjacent 1MΩ//20pF socket.
MTB	Internal triggering signal derived from the main time base to start the delayed time base immediately after the selected delay time.
TIME/DIV (outer switch)	Selects the time coefficient from .2 μs/div to 1 ms/div in a 1-2-5 sequence. Incorporates an OFF position by which the delayed time base generator is switched off.
TIME/DIV (inner knob)	Continuously variable control of the time coefficients. Must be in the CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.
1MΩ – 20 pF	BNC socket for external triggering signal.

2.2.6 Miscellaneous

CAL	Output socket supplying squarewave voltage ≈ 2 kHz at an amplitude of 1.2 V p-p ± 1%. To be used for probe compensation and/or checking vertical deflection accuracy.
DC POWER IN	Input socket at the rear of the instrument allows operation by an external d.c. supply. Rated supply voltage 22 V to 27 V, current capability > 1A.
LINE (MAINS) VOLTAGE ADAPTOR	Must be set according to section 2.1.2 before the instrument is connected to the local mains voltage.

2.3 OPERATING INSTRUCTIONS

2.3.1 Switching on the instrument

Before connecting the instrument to any supply, the instructions given in section 2.1 Installation, should be carefully carried out.

The oscilloscope will meet specifications (see section 1.2) normally after a warming-up period of approximately 15 minutes. However, if the instrument has been subjected to an extremely cold environment (e.g. left in a car overnight in freezing conditions) and is then brought in for use in a warm room, a warming-up period of sufficient length should be allowed (see 1.2.11).

2.3.2 Preliminary settings of the controls

This procedure is a general indication of whether the oscilloscope is functioning correctly and provides a suitable starting point before any measurements are made.

Refer to Fig. 2.2 for location of controls.

Set INTENS and FOCUS controls in mid position.

Depress AUTO and select an average time coefficient between 10 μs/div and 10 ms/div with the TIME/DIV switch. With all other pushbuttons normal (not depressed) channel A and channel B traces can be positioned on the screen with the relevant POSITION controls. Set the INTENS control for a display of medium brightness and adjust FOCUS control for well focused traces.

2.3.3 Input coupling (AC/DC, 0)

AC coupling (pushbutton depressed) is useful to block the d.c. component of a signal. Choice of AC limits the lower frequencies, causing low repetition rate sinewave signals to be attenuated and low repetition rate squarewaves to be distorted. The degree of attenuation is determined by the input RC time (0.1s). Input RC time is extended by 10 if 10:1 passive probes are employed.

When switching to AC coupling it will take approximately five input RC times before the trace is stabilised to the average value of the input signal.

AC position measurements cannot be made with respect to ground.

0 position disconnects input source and short-circuits input of amplifier to provide zero signal check.

DC coupling (pushbutton released) provides for full range frequency input, i.e. down to d.c.

2.3.4 Use of probes

1:1 passive probes should only be used for d.c. and low frequencies.
Capacitive loading attenuates high frequencies or increases the rise-time of measurement signals (dependent on source impedance).

10:1 passive probes have less capacitive loading; usually about 10pF to 20pF. FET probes are superior, especially when measurements are to be taken from high impedance test points or at the upper frequency limit of the oscilloscope bandwidth.

10:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies.
For correct adjustment, the CAL output connection can be used (see Fig. 2.3.)

2.3.5. Adjustment of attenuator probes

- Connect the compensation box to socket A and place the tip of the probe on socket CAL.
- Insert a small screwdriver through the hole in the compensation box and adjust the trimmer to obtain a correct display as shown in Fig. 2.3.

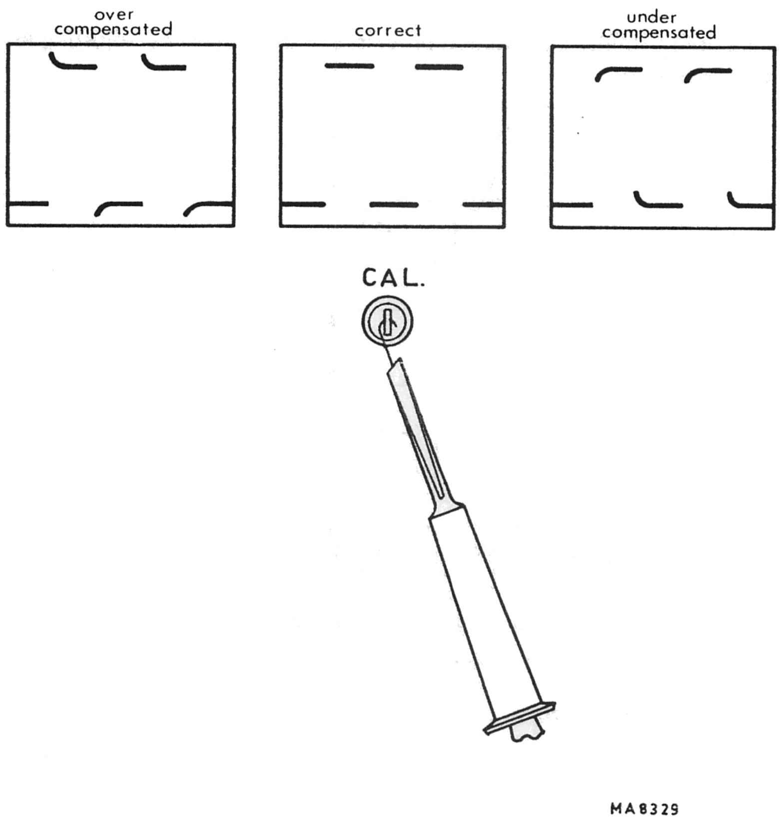


Fig. 2.3. Adjusting an attenuator probe

2.3.6. Selection of chopped or alternate modes

(A ALT CHOP ADD B)

In dual channel operations (CHOP or ALT depressed) the chopped mode (depress CHOP) must be selected for relatively slow sweep speeds (from .1 ms/div to .5 s/div) or at low repetition rates of sweeps occuring, even at high sweep rates. Selection of the ALTernate mode under these circumstances would make comparisons between waveforms difficult because traces would actually appear to be written one by one. However, when the display is fast enough to be interrupted by the chopping frequency the alternate mode must be selected (depress ALT), usually at sweep rates faster than .1 ms/div.

2.3.7. Differential mode

The A – B mode can be selected by depressing ADD and pulling the channel B POSITION control.

In measurements where signal lines carry substantial common mode signals (e.g. hum) the differential mode will cancel out these signals and leave the remainder of interest (A – B). The capability of the oscilloscope to suppress common mode signals is given by the CMR factor (see Fig. 2.4).

To obtain the degree of common mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the CAL output connector, and adjusting one of the continuous controls with the AMPL/DIV switch for minimum deflection on the screen.

When passive 10:1 probes are used a similar equalisation process is recommended by adjusting their compensating controls for minimum deflection.

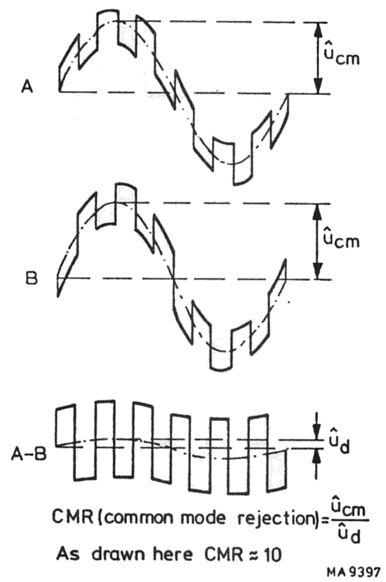


Fig. 2.4. Suppression of common mode signals

2.3.8. Selection of trigger mode

(AC AUTO DC)
└TVL┘└TVF┘

The AUTO mode is most useful because it provides trace(s) on the screen even in the absence of trigger signals. Furthermore, for a signal amplitude larger than 1 division, this mode provides stable triggering independently of the position of the LEVEL control; its range is automatically adjusted to the peak-to-peak value of the signal selected for triggering.

In this way the setting of the LEVEL control is facilitated at small amplitudes of the trigger signal.

The AUTO mode cannot be employed for signals with low repetition rates (10 Hz or lower) because the sweeps would be able to free run in between triggers. Therefore, for low repetition signals normal triggering must be used (AC or DC depressed).

In normal triggering, sweeps are only initiated with a trigger signal applied and the LEVEL control set appropriately.

With AC or DC depressed the range of the LEVEL control is fixed (+ or –8 divisions or more at the extremes of the LEVEL control with respect to mid screen).

The DC component in the trigger signal can be blocked by depressing AC. This is useful when triggering must take place on a.c. signals superimposed on a large d.c. level.

With AC coupling, the level at which the display starts will change with alterations in the average value of the trigger signal. The trigger level is thus no longer referenced to signal ground. This may cause instability with waveforms that vary in time interval from cycle to cycle. Normally it is preferable to use the DC position.

Slope selection is made with pushbutton +/–. In TV mode – must be selected for negative video signals and + for positive video signals. The LEVEL control is inoperable in the TV mode.

No buttons depressed offers an extra mode of use, a trace is on screen in the absence of a trigger signal, but the LEVEL range is fixed.

2.3.9. Trigger sources

The main time base trigger sources can be selected by the front-panel TRIG or X DEFL pushbuttons.

A B EXT LINE
└COMP┘

- *Internal triggering* will be most commonly used because it requires only one signal (the input signal) to obtain stable triggering.
- *External triggering.* When tracing many signals it is advantageous to use an external signal for triggering. There is no need to set and reset the trigger controls (LEVEL, SLOPE and SOURCE) on changing the input signal. Furthermore the two A and B inputs remain free for examining waveforms.
- *Selection of trigger source.* In comparing waveforms that are a multiple of each other's frequency, always select the signal, that has the lowest repetition rate as the trigger source. Not doing so may lead to double pictures (chopped mode) or untrue time-shifts (alternate mode).
- *Composite triggering.* With internal triggering signals are obtained from either the A channel, the B channel preamplifier stages or, when COMP is selected by depressing both A and B pushbuttons, from the delay line driver stage that follows the electronic channel switch.

Composite triggering offers three advantages:

1. In differential mode (A — B measurements) triggering is derived from the differential signal. Triggering is not disturbed by common mode signals.
2. For one channel operation it is not necessary to switch trigger sources from A to B or vice versa.
3. In the alternate mode, it is possible to compare signals that are not related in time.

Note: *When composite triggering is employed in dual channel operation (chopped or alternate), and there is only one signal applied (to A or B input), stable triggering cannot be obtained. This is only normal since the trigger source is also switched from A to B (see Fig. 2.5).*

- *Line (mains) triggering* is useful when the signal input is mains (line) frequency related.

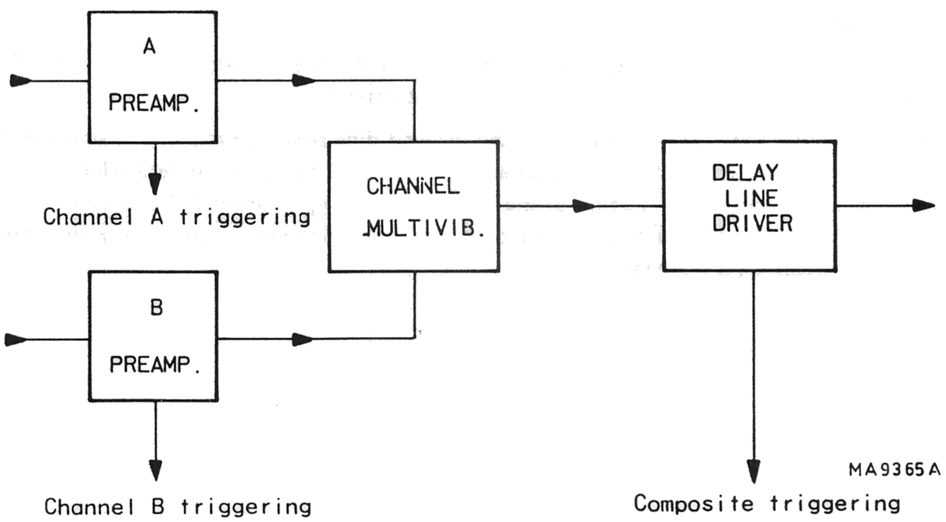


Fig. 2.5. Block diagram of composite trigger circuit

2.3.10. Time-base magnifier

The magnifier is operated by pulling the switch incorporated in the X position control.
When this switch is in the x10 position, the time-base sweep speed is increased 10 times. The sweep time is therefore determined by dividing the indicated TIME/DIV value by 10.

2.3.11. XY Measurements

XY measurements are made with the TIME/DIV switch at X DEFL, the source of horizontal deflection being selected by the EXT X DEFL or TRIG pushbutton switch (A, B, EXT or LINE).

XY measurements provide a useful means of making frequency or phase shift comparisons by displaying Lissajous patterns.

Measurements can be made up to 100 kHz with less than 3° phase error between oscilloscope channels.

The sensitivity for the different XY modes is shown in the following table:

X DEFL.	SENSITIVITY
A	AMPL/DIV A ± 10%
B	AMPL/DIV B ± 10%
EXT	0.5 V/div ± 10%
LINE	8 divisions at nominal line voltage

2.3.12. Using the Delayed time-base

The delayed time base can be used for the accurate study of complex signals. The delayed time base generator starts (TIME/DIV switch not at OFF) after the selected delay time and the delayed signal is intensified when the MTB pushbutton of the horizontal deflection controls has been selected.
The DELAY TIME potentiometer control enables the intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time base generator. When pushbutton DTB of the horizontal deflection controls is depressed, the intensified portion occupies the full width of the screen.

In the DTB position, the delay time (i.e. the interval between the starting points of the main time base and that of the delayed time base) is determined by the setting of the main time base TIME/DIV controls and the DELAY TIME control. The PM 3214 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time base and by the delayed time base.

By selecting ALT TB, detailed examination of a certain portion of the main time base display is enabled by expanding the time interval of interest, using the delayed time base.

Expansion is achieved by selecting a correspondingly faster sweep for the delayed time base TIME/DIV control and positioning the time interval by the DELAY TIME potentiometer.

The part of the signal under detailed observation by the delayed time base also remains as an intensified portion of the main time base display. This not only facilitates the location of the required detail during dialling, but also serves as a visual indication of the portion of the overall trace being examined. Selection of ALT TB thus enables immediate correlation of the detail with the overall signal, which may be extremely complex, without the need to switch between MTB and DTB.

2.4. PROCEDURES REQUIRED FOR THE REMOVAL OF FUSES, BEZEL AND CONTRAST PLATE

2.4.1. Removing the instrument covers

Always ensure that the mains supply is disconnected before removing any instrument cover plates.
The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.

To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:

- Hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 2.6.).
- Stand the instrument on its protective front cover on a flat surface.
- Slacken the two coin-slot screws located on the rear panel.
- Lift the rear panel and unplug the connector on the power supply board.
- Lift off the wrap-around cover.
- For access to the front-panel, stand the instrument horizontally and snap off the front cover.

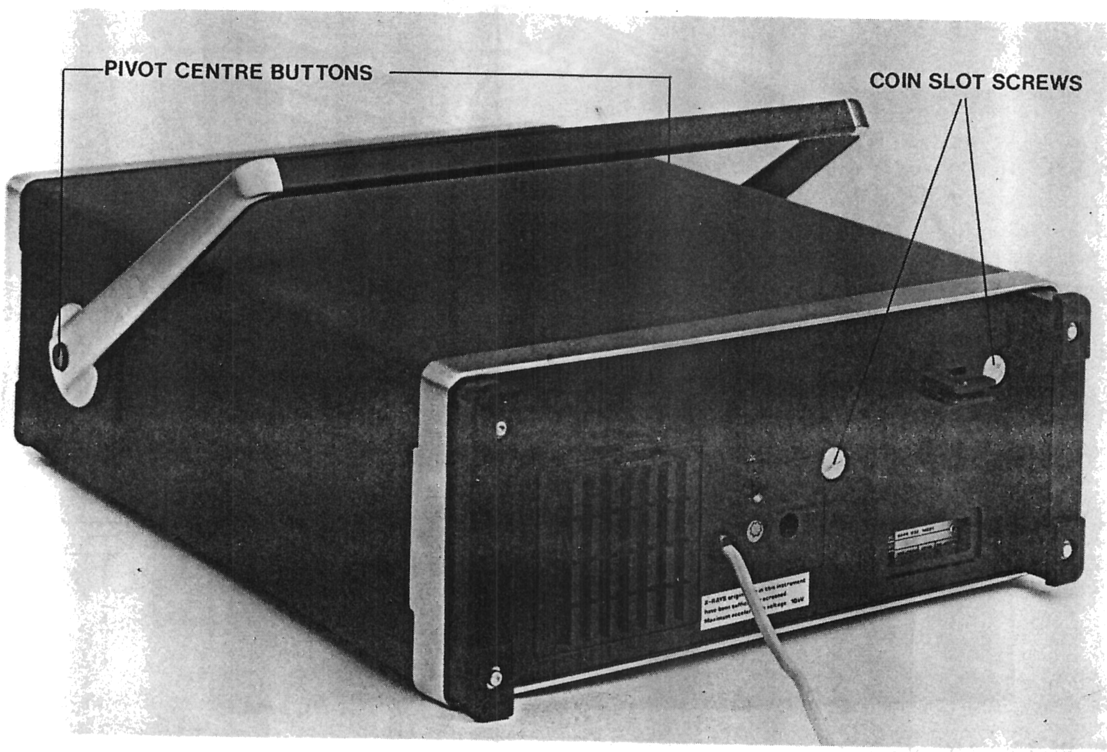


Fig. 2.6. Removing the instrument covers

2.4.2. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Take the lid off the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire form between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement.

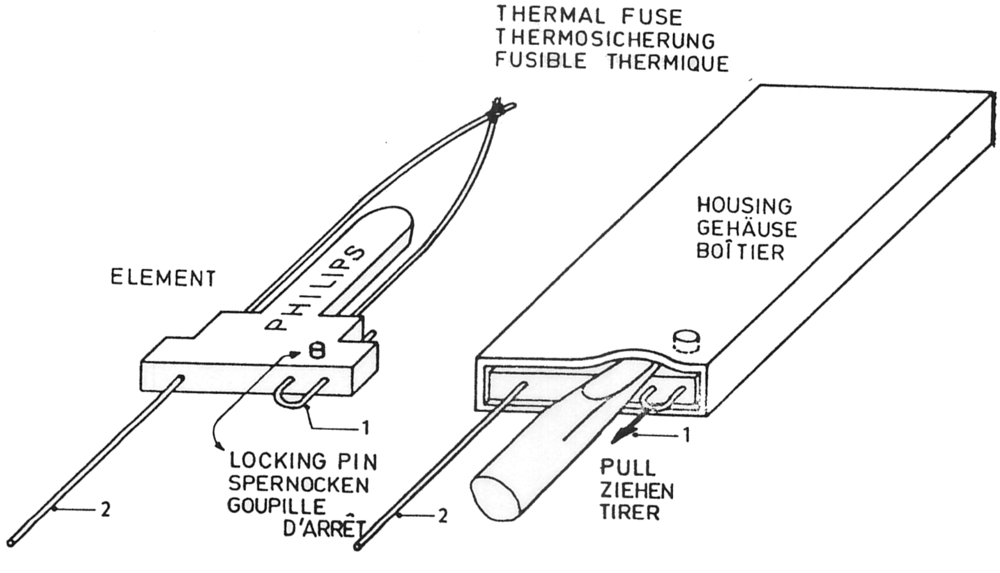


Fig. 2.7. Replacing the thermal fuse

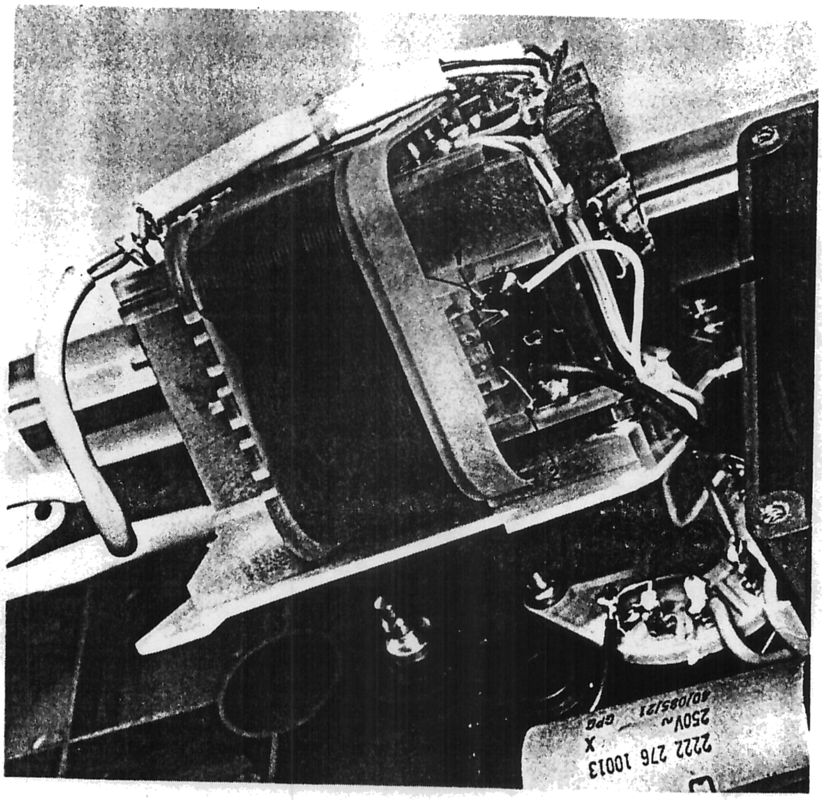


Fig. 2.8. Replacing the thermal fuse

2.4.3. Replacing the thermal fuse F101

- Remove the mains transformer (section 2.4.2.).
- Unsolder fuse terminals 1 and 2 (Fig. 2.7. and 2.8.).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

2.4.4. Replacing the fuse F201

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Fuse F201, which is located on the power supply printed circuit board, is now accessible for replacement.

2.4.5. Removing the bezel and the contrast plate

- Take hold of the bezel's bottom corners and gently pull it from the front panel (Fig. 2.9.).
- The contrast filter can be removed by pressing it gently out of the bezel.

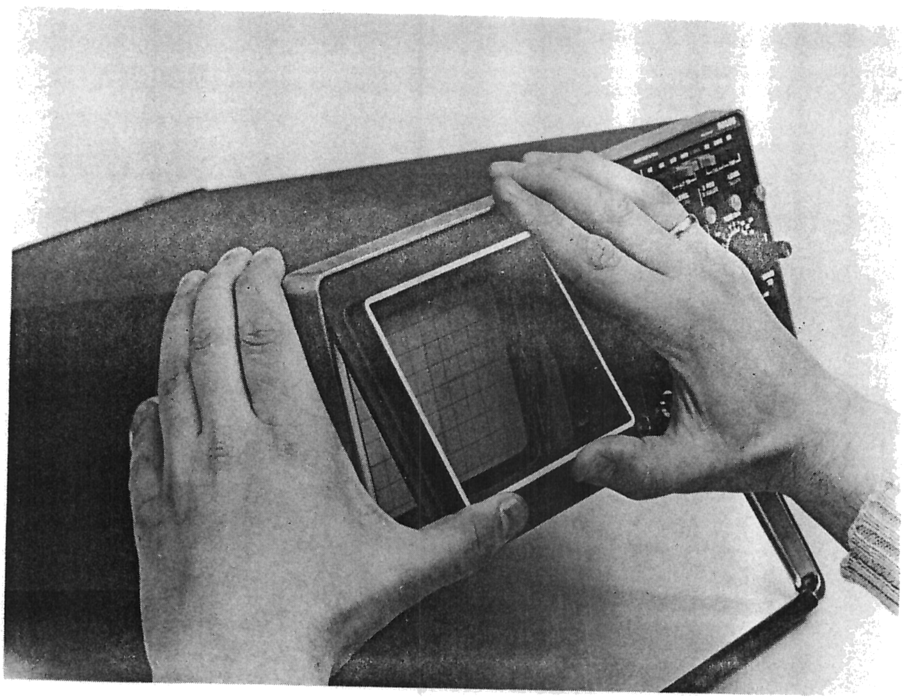


Fig. 2.9. Removing the bezel and the contrast plate

Bedienungsanleitung

1. Allgemeines

1.1 EINLEITUNG

Der 25 MHz Zweikanal-Oszillograf PM3214 ist ein leichtes Kompaktgerät. Er ist ergonomisch konstruiert und besitzt vielseitige Messmöglichkeiten. Der Oszillograf ist mit einer Hauptzeitablenkung und einer verzögerten Zeitablenkung ausgerüstet mit Möglichkeit für alternierende Darstellung der Zeitmassstäbe, sowie solche Möglichkeiten wie Spitzenwert-Autotriggerung, Wechselspannungs- und Gleichspannungs triggerung sowie TV-Triggerung.
Ein grosser 8 x 10 cm Bildschirm mit Innenraster und einer Beschleunigungsspannung von 10 kV ergeben eine sehr helle Schreibspur und wohl-definierter Leuchtfleck.
Ein doppelt isolierte Stromversorgung erlaubt direkten Anschluss der Geräte-Erde an erdfreie Schaltungen, vorausgesetzt diese Mess-Erde führt keine Berührungsgefährlichen Spannungen. Interferenzen durch Erdströme, wie sie häufig bei geerdeten Oszillografen vorkommen werden auch wesentlich reduziert.
Der Einsatz des Oszillografen im Freien wird durch wahlweisen Batteriebetrieb erleichtert.

Warnung:	**Die Geräte-Erde (und die Messkopf-Erdleitung) darf nicht mit berührungsgefährlichen Spannungen verbunden werden.**

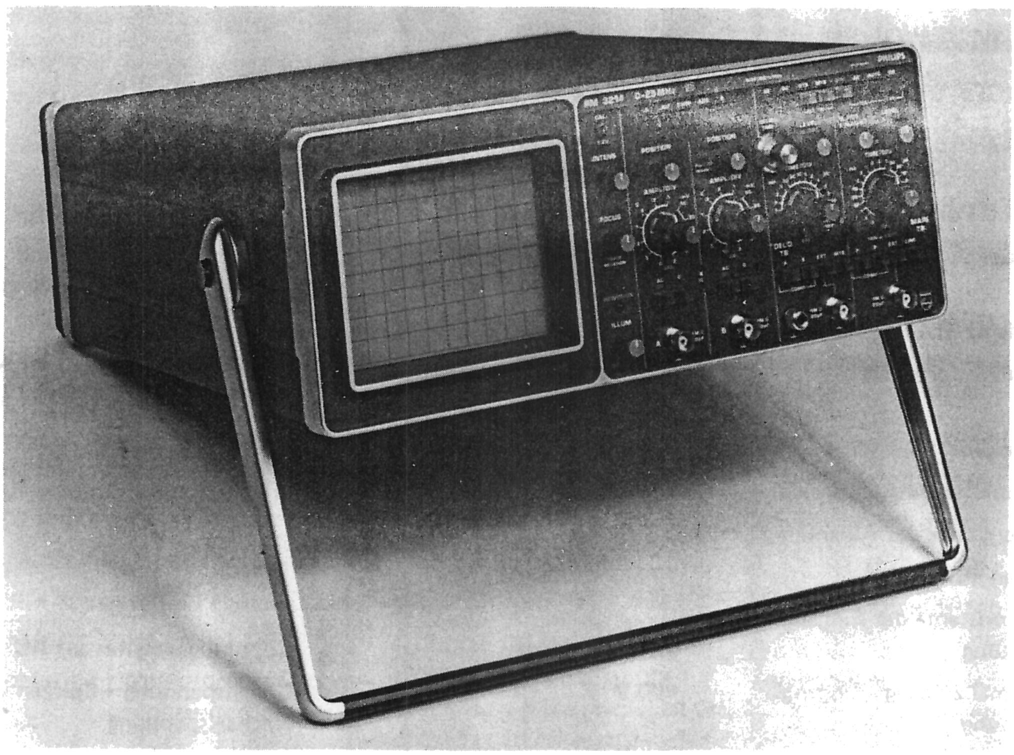


Abb. 1.1. 25 MHz Zweikanal-Oszillograf PM 3214

1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in der vorliegenden Anleitung enthalten sind.
Zahlenwerte mit Toleranzangaben werden bei Umgebungstemperaturen von +5 °C ... +40 °C garantiert, falls nicht anders angegeben. Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen nur zur Information.

	Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.1	**Elektronenstrahlröhre**		
	Typ	D14-125GH/08	Rechteckiger Schirm mit Netzelektrode und Nachbeschleunigung, metallhinterlegter Leuchtschirm
	Ausnutzbare Bildschirmfläche	8 x 10 Teile	1 Teil entspricht 1 cm
	Bildschirmtyp	P31 (GH)	P7 (GM) auf Wunsch lieferbar
	Gesammtbeschleunigungsspannung	10 kV	
	Raster	Innenraster	Stufenlos einstellbare Rasterbeleuchtung
	Einteilung	Zentimetereinteilung mit Untereinteilung von 2 mm an den mittleren Achsen. Gestrichelte Linien bei 10 % und 90 % des Messrasters, zur Messung von Anstiegszeiten	
1.2.2	**Vertikale oder Y-Achse**		
	Darstellungsarten	Kanal A allein Kanal B allein A und B zerhackt A und B alternierend A und B addiert	
	Kanal B Polarität	Normal oder invertiert	
	Frequenzbereich	0 ... 25 MHz (–3 dB) 2 Hz ... 25 MHz (–3 dB)	Gleichspannungskopplung Wechselspannungskopplung
	Anstiegszeit	⩽ 14 ns	
	Impulsverformungen	⩽ ± 3 % (⩽ 4 % Spitze-Spitze)	Gemessen bei 6 Teilen Bildhöhe mit einer Anstiegszeit von ⩾ 1 ns
	Ablenkkoeffizienten	2 mV/Teil ... 10 V/Teil	1-2-5-Folge
	Stufenloser Einstellbereich	1 : ⩾ 2,5	
	Fehlergrenze der Ablenkung	± 3 %	
	Eingangsimpedanz	10 Mohm//20 pF	
	Zeitkonstante der Eingangsschaltung	0,1 S	Kopplungsschalter auf AC
	Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Spitzenwert einer Wechselspannung
	Zerhackerfrequenz	≈ 500 kHz	
	Verschiebungsbereich	16 Teile	
	Dynamischer Bereich	24 Teile	
	Sichtbare Signalverzögerung	⩾ 20 ns	
	Gleichtaktunderdrückung in A-B Betrieb	⩾ 40 dB bei 1 MHz	Nach Einstellung bei Gleichspannung oder niedrigen Frequenzen

Übersprechen zwischen Kanälen	–40 dB oder besser bei 10 MHz	
Temperaturdrift	0,3 Teil/Stunde	

1.2.3 Horizontale oder X-Achse

Horizontalablenkung lässt sich entweder von der Hauptzeitbasis oder der verzögerten Zeitbasis oder von einer Verbindung der beiden erreichen, oder aber von der für X-Ablenkung gewählten Signalquelle. In einem solchen Fall erhält man X-Y Oszillogramme unter Verwendung von A, B, dem externen Eingangsanschluss, oder dem Netz als Signalquelle für Horizontalablenkung.

Darstellungsweisen	– Hauptzeitablenkung – Hauptzeitablenkung aufgehellt durch verzögerte Zeitablenkung – Hauptzeitablenkung und verzögerte Zeitablenkung alternierend dargestellt – Verzögerte Zeitablenkung – XY-Betrieb	X-Ablenkung durch: – Kanal A Signal – Kanal B Signal – Signal über EXT Anschluss der Hauptzeitablenkung – Signal mit Netzfrequenz

1.2.4 Hauptzeitablenkung

Betriebsart	Automatisch	Automatischer Freilauf bei Abwesenheit von Triggersignalen möglich
	Getriggert	
Zeitmassstäbe	0,5 S/Teil ... 0,2 μS/Teil	1-2-5-Folge
Stufenloser Einstellbereich	1 : ⩾ 2,5	
Fehlergrenze des Zeitmassstäbes	± 3 %	
Dehnung	10x	
Fehlergrenze der Dehnung	± 2 %	
Kürzester Zeitmassstab	20 nS/Teil	

1.2.5. Verzögerte Zeitablenkung

Betriebsart	Verzögerte Zeitablenkung startet entweder sofort nach Ablauf der Verzögerungszeit, oder ist nach Ablauf der Verzögerungszeit von der gewählten Triggerquelle der verzögerten Zeitablenkung triggerbar	
Zeitmassstäbe	1 mS/Teil ... 0,2 μS/Teil	1-2-5-Folge
Stufenloser Einstellbereich	1 : ⩾ 2,5	
Fehlergrenze des Zeitmassstäbes	± 3 %	
Verzögerungszeit	In Stufen regelbar mit Hauptzeitablenkungsschalter. Stufenlos regelbar zwischen 0x und 10x der Zeitmassstab der Hauptzeitablenkung mit Helipotentiometer	
Inkrementale Genauigkeit der Verzögerungszeit	0,5 %	
Verzögerungszeitjitter	1 : ⩾ 20 000	

1.2.6 X-Ablenkung

Quelle	A, B, EXT oder LINE (Netz)	Je nach Einstellung des Triggerquellenschalters, wenn die X DEFL Drucktaste eingedrückt ist
Ablenkkoeffizienten	A oder B: wie eingestellt mit AMPL/DIV Schalter EXTERNAL: 0,5 V/Teil LINE: 8 Teile	
Fehlergrenze der Ablenkung	± 10 % in A oder B	
Frequenzbereich	Gleichspannungsgekoppelt 0 ... 1 MHz	–3 dB Bandbreite über 6 Teile
Phasenverschiebung	$\leqslant 3^{\circ}$ bei 100 kHz	
Dynamischer Bereich	24 Teile	Für Frequenzen ⩽ 100 kHz

1.2.7 Triggerung der Hauptzeitablenkung

Quelle	Kanal A, Kanal B, zusammengesetzt, extern und Netz	
Triggerungsart	Automatisch, normal Wechselspannung, normal Gleichspannung, TV-Zeile und TV-Bild	
Triggerempfindlichkeit	Intern : 0,5 Teil (DC .... 5 MHz) 1 Teil (DC .... 50 MHz) Extern : 250 mV_{ss} (DC .... 5 MHz) 500 mV_{ss} (DC .... 50 MHz)	
Triggerfrequenzbereich	AUTO : 20 Hz .... ⩾ 50 MHz AC : 5 Hz .... ⩾ 50 MHz DC : 0 Hz .... ⩾ 50 MHz	
Pegelbereich	AUTO : Proportional dem Spitze-Spitzewert des Trigger-Signals AC, DC : 16 Teile bei interner Triggerung und 8 V bei externer Triggerung	
Triggerflanke	Positif oder negatif gehend	
Eingangsimpedanz	1 Mohm//20 pF	
Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Spitzenwert einer Wechselspannung

1.2.8 Triggerung der verzögerten Zeitablenkung

Quelle	Kanal A, Kanal B, zusammengesetzt, extern und MTB	

Die übrigen Eigenschaften sind die gleichen wie bei 'Triggerung der Hauptzeitablenkung', ausgenommen TV-Triggerung.

1.2.9 Kalibriergenerator

Ausgangsspannung	1,2 V_{SS}	Rechteckspannung
Fehlergrenze	± 1 %	
Frequenz	≈ 2 kHz	

1.2.10. Stromversorgung

Wechselspannungsversorgung	Doppelt isoliert	Schutzklasse II, IEC348
Nominaler Spannungsbereich (am Netzspannungsumschalter)	110, 127, 220 oder 240 V, Wechselspannung ± 10 %	
Nominaler Frequenzbereich	50 ... 400 Hz ± 10 %	
Leistungsaufnahme	30 W max.	Bei Netz-Nennspannung
Gleichspannungsversorgung		
Spannungsbereich	22 ... 27 V Gleichspannung	Erdfreier Eingang
	20 ... 28 V Gleichspannung	Bei gelockerten Spezifikationen
Kapazität gegen Erde	185 pF	Gemessen mit Gummifüssen auf einer geerdeten 1 m^2 grossen Metallplatte.
	27 pF	Gemessen 30 cm über eine geerdeten 1 m^2 grossen Metallplatte
Stromaufnahme	1,1 A max.	

1.2.11. Einflussgrössen

Die angegeben Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, NIEDERLANDE angefordert werden.

Umgebungstemperatur		
Nominaler Betriebsbereich	+5 °C ... +40 °C	
Zugelassener Betriebstemperatur-bereich	−10 °C ... +55 °C	
Lagerung und Transport	−40 °C ... +70 °C	
Feuchtigkeit	Entspricht den IEC 68 Db Bedingungen	
Stossfestigkeit	1000 Stösse je 10 g, 1/2 Sinus, Dauer 6 ms in jeder der 3 Richtungen	
Vibration	30 Minuten in jeder der 3 Richtungen, 10-150 Hz; 0,7 mm Spitze-Spitze und 5 g max. Beschleunigung	
Höhe:		
Betriebsgrenzbereich	5000 m (475 mbar) (= 47,5 K Pa)	in Umgebungsluft
Transportgrenzbereich	15000 m (100 mbar) (= 10 K Pa)	in Umgebungsluft
Erholungszeit	30 Minuten wenn die Temperatur des Gerätes von −10 °C auf +20 °C erhöht wird, bei 60 % relativer Luftfeuchtigkeit	
Störgrad	Das Gerät entspricht den Anforderungen gemäss VDE, Störgrad K.	

1.2.12. Mechanische Daten

Länge	445 mm	ohne Handgriff und Bedienungselemente
Breite	335 mm	ohne Handgriff
Höhe	137 mm	ohne Füsse
Gewicht	≈ 8,4 kg	

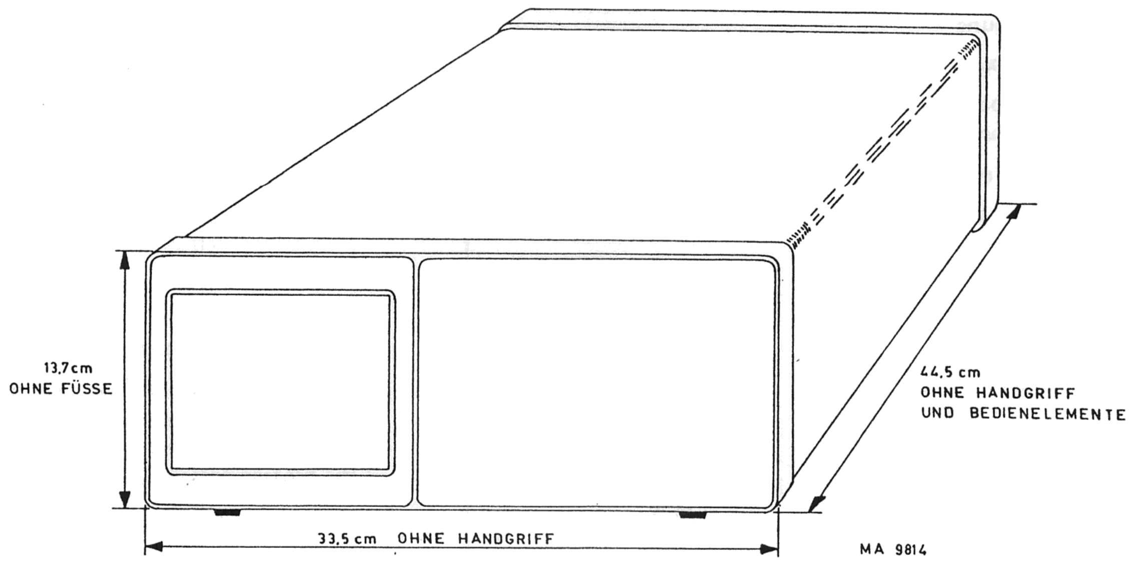


Abb. 1.2. Abmessungen

1.3. ZUBEHÖR

1.3.1. Standardzubehör (mitgeliefert)

Abdeckhaube
1 BNC 4 mm Adapter
2 Messköpfe PM 9336/00
Anleitung

1.3.2. Wahlzubehör

PM 8927	Passiver 10:1 Messkopf (1,5 m) 75 MHz
PM 8927L	Passiver 10:1 Messkopf (2,5 m) 75 MHz
PM 8935	Passiver 10:1 Messkopf (1,5 m) 250 MHz
PM 8935L	Passiver 10: 1 Messkopf (2,5 m) 250 MHz
PM 9335	Passiver 1:1 Mess kopf (1,5 m) 10 MHz
PM 9335L	Passiver 1:1 Messkopf (2,5 m) 10 MHz
PM 9336	Passiver 10: 1 Messkopf (1,5 m) 25 MHz
PM 9336L	Passiver 10: 1 Messkopf (2,5 m) 25 MHz
PM 9352	Miniatur Messkopf 150 MHz
PM 9353	Aktiver FET-Messkopf 150 MHz
PM 9358/01	HV Messkopfsatz 100: 1 150 MHz
PM 9346	Messkopfspeisung
PM 9355	Strommesskopf
PM 8910	Polaroidfilter
PM 9380	Oszillografenkamera
PM 8971	Kamera-Adapter
M3 ... M5	Steinheil Oszillografenkamera
PM 8963	19" Gestelleinbau
PM 9366	Faltbarer Lichtschutztubus
PM 8980	Geschlossenen langer Lichtschutztubus
PM 8901	Aufladbarer Batteriepack 140 V/24 V Gleichspannung
PM 8991	Rolltisch
PM 8997	Zubehörtasche

Trimmwerkzeug

Siehe auch Abschnitt 3.5. "INFORMATION CONCERNING ACCESSORIES"

1.4. BLOCKSCHALTBILDBESCHREIBUNG (Abb. 1.3.)

1.4.1. Y-Kanal

Die vertikalen Kanäle A und B für die Signale, die dargestellt werden sollen, sind identisch, jeder Kanal umfasst einen Eingangskopplungs-Schalter, einen Eingangs-Stufenabschwächer, einen Impedanzwandler und einen Vorverstärker mit Triggerentnahme-Stufe. Ein Kanal Multivibrator gesteuert von den Darstellungsart-Drucktasten, schaltet entweder Kanal A oder Kanal B über die Verzögerungsleitung an den Y-Endverstärker.
Der Kanal Multivibrator wird durch einen Impuls am Ende der Ablenkung betätigt und liefert in Betriebsart ALT eine ununterbrochene Darstellung der A und B Signalformen. In Stellung ADD werden die Signale von den beiden geschalteten Verstärkern durchgelassen und addieren somit die Kanäle A und B. Durch Invertierung des B-Kanal Verstärkers (PULL TO INVERT B) erhält man Betriebsart A-B.
Die Schalter AMPL/DIV ermöglichen Verstärkungseinstellung x1 oder x10 des Vorverstärkers der in Verbindung mit dem Stufenabschwächer einen Ablenkkoeffizienten-Bereich in 1-2-5 Folge zur Verfügung stellt.

1.4.2. Triggerung der Hauptzeitablenkung

Zur Einleitung von Zeitablenkungen lassen sich Triggersignale den A und B Kanal Vorverstärkern, einer externen Quelle, oder intern dem Netz (LINE-Triggerung) entnehmen, je nach Einstellung des Triggerquelle-Wahlschalters, Wenn die beiden Drucktasten A und B eingedrückt sind, bewirkt die Verzögerungsleitung-Treiberstufe zusammengesetzte Triggerung.
Die Polarität des Triggersignals, negativ oder positiv gerichtet, mit welchem die Darstellung startet, wird durch Änderung der Ausgangspolarität des Impedanzwandlers bestimmt.
Mit eingedrücktem Schalter AUTO wird der Spitze-Spitze Pegeldetektor wirksam. Der Spitze-Spitze Pegel des Signals bestimmt dann den Bereich des Stellers LEVEL.
Eindrücken von AC oder DC ergibt einen festen Bereich des Stellers LEVEL.
In Betriebsart TV ist Steller LEVEL nicht wirksam und die TV-Synchronisier Trennschaltung wird eingeschaltet und leitet auf diese Weise, je nach Einstellung der Schalter TVL und TVF mit Zeilen- oder Bildimpulsen Ablenkungen ein.

1.4.3. Hauptzeitablenkschaltung

Für normalen Zeitablenkbetrieb erhält der Horizontalverstärker Sägezahnspannungen von der Zeitablenkschaltung.
Wenn AUTO gedrückt ist und keine Triggersignale vorhanden sind wird der Ausgang des Ablenkgenerators über Sperrschaltung und Tor an seinen Eingang rückgekoppelt. Dies verursacht Freilauf der Zeitablenkung und eine resultierende Leuchtspur wird auf dem Schirm sichtbar. Sobald die Steuerschaltung AUTO einen Trigger ermittelt (das heisst eine Veränderung im Ausgang der Zeitablenk-Logik) dann wird die Ablenkung an die Zeitablenk-Logik rückgekoppelt. Dadurch kehrt die Schaltung zur normalen Triggerungsart zurück bei der Ablenkungen nur von Triggerimpulsen am Eingang der Zeitablenk-Logik ausgelöst werden.
Wenn AC oder DC eingedrückt ist, wird Betriebsart AUTO unwirksam.
Zeitablenkungen werden nur dann erzeugt, wenn ein Triggersignal vorhanden ist und Steller LEVEL entsprechend eingestellt ist.
Durch die Verstärkung des Endverstärkers zu vergrössern lässt sich die Darstellung in horizontaler Richtung um den Faktor 10 dehnen (auch Betriebsart X DEFL).
Wenn Drucktaste X DEFL des Horizontal-Wahlschalters eingedrückt ist wird der Ausgang des Ablenkgenerators zum Endverstärker gesperrt und der Impedanzwandler ist direkt mit dem Endverstärker verbunden.
Auf diese Weise können nur die normalerweise für Triggerung gewählten Signale oder eine externe Quelle für Horizontalablenkung verwendet werden.

1.4.4. Sperrschaltung

Die Sperrstufe (hold-off) hält die Trigger solange vom Eingang der Zeitablenkschaltung fern, bis die Leuchtspur gänzlich zurückgekehrt ist und die Zeitablenkschaltungen vollständig rückgestellt sind.

1.4.5. Z-Achse

Der Z-Verstärker dient zur Austastung des Bildes während des Rücklaufes und der Sperrzeit. Ausserdem wird während der Schaltspitzen in Betriebsart CHOP die Ablenkung ausgetastet.
Die Niederfrequenzkomponenten des Austastsignals werden moduliert und demoduliert bevor sie zusammen mit den wechselspannungsgekoppelten Hochfrequenzkomponenten dem Wehnelt Zylinder zugeführt werden.

1.4.6. Triggerung der verzögerten Zeitablenkung

Zur Einleitung von Zeitablenkungen lassen sich Triggersignale den Vorverstärkern der vertikalen A und B Kanäle oder einer externen Quelle entnehmen, je nach Einstellung der Triggerquellen Drucktaste.
Wenn die beiden Drucktasten A und B gleichzeitig eingedrückt sind, bewirkt die Verzögerungsleitung - Treiberstufe des Y-Kanal Verstärkers zusammengesetzte Triggerung. Wechselspannungs- und Gleichspannungskopplung wird dem Impedanzwandler zur Verfügung gestellt. Durch Änderung der Ausgangspolarität des Impedanzwandlers wird mit Hilfe des Schalters SLOPE die Polarität des Triggersignals, negativ oder positiv gerichtet, mit welchem die Darstellung startet, bestimmt.
In Stellung MTB startet die verzögerte Zeitablenkung sofort nach der Verzögerungszeit. Steller DELAY TIME in Verbindung mit dem Komparator bestimmt die Verzögerungszeit für die verzögerte Zeitablenkung.

1.4.7. Schaltung der verzögerten Zeitablenkung

Die verzögerte Zeitablenkung ist wirksam, ausser wenn ihr Schalter TIME/DIV in Stellung OFF steht. Sie startet sofort nach der Verzögerungszeit oder nach Erhalt des ersten Triggerimpulses nach Ablauf der Verzögerungszeit.
Das dem Hauptzeitablenkgenerator entnommene Sägezahnsignal wird einem Komparator zugeführt wo es mit einer genau eingestellten Wechselspannung welche mit Steller DELAY TIME regelbar ist verglichen wird.
Das Ausgangssignal des Komparators ist impulsförmig und liefert den erforderlichen Verzögerungsimpuls für die Zeitablenk-Logik des verzögerten Zeitablenkgenerators. Eine Sägezahnspannung wird dann eingeleitet.
Die verzögerte Ablenkung wird von der Sperrschaltung der verzögerten Zeitablenkung (Ende der Ablenkermittlung) oder von der Hauptzeitablenkung rückgestellt.
Sie kann vom Ausgangssignal des Komparators nach Einleitung der nächsten Hauptzeitablenkung von neuem gestartet werden.
Wenn Drucktaste MTB der Steller für die Horizontalablenkungsart gedrückt wird, dann wird jener Teil des Bildes, der mit der verzögerten Ablenkung zusammenfällt, aufgehellt.

1.4.8. Alternierende Zeitablenk-Logik

In Betriebsart ALT TB lässt sich mit Hilfe eines elektronischen Schalters die Darstellung der Hauptzeitablenkung und die Darstellung der verzögerten Zeitablenkung alternierend am Schirm aufzeichnen.
Durch Ändern der an den Vertikalverstärker gelegten Spannung, welche den Steuerschaltungen des elektronischen Schalters entnommen ist, können die beiden Darstellungen getrennt werden. Mit Hilfe des Stellers TRACE SEPARATION auf der Frontplatte ist diese Trennung symmetrisch einstellbar.
In Betriebsart ALT TB wird der Vertikalkanal-Multivibrator von einem dem elektronischen Schalter entnommenem Signal gesteuert.
In den vertikalen und horizontalen Betriebsarten ALT werden nacheinander Kanal A und Hauptzeitablenkung, Kanal A und verzögerte Zeitablenkung, Kanal B und Hauptzeitablenkung, Kanal B und verzögerte Zeitablenkung auf dem Bildschirm dargestellt.

1.4.9. Speisung

Die Netzspannung wird est gewandelt und gleichgerichtet und gelangt dann an einen Gleichspannungs-Wechselspannungswandler.
Wenn das Gerät mit Batteriespeisung betrieben wird, dann wird der Batterieausgang direkt an den Gleichspannungs/Wechselspannungswandler gelegt.
Der Ausgang des Wandlers ist gekoppelt an einen Transformator und Gleichrichter, der nach Gleichrichtung das −1,5 kV Hochspannungspotential liefert und die Speisespannungen der Schalter zur Verfügung stellt. Die −1,5 kV wird ausserdem auf 8,5 kV verstärkt um die erforderliche Gesamtbeschleunigungsspannung von 10 kV liefern zu können.

2. Gebrauchsanleitung

2.1 INBETRIEBNAHME

2.1.1 Sicherheitsvorschriften (den IEC 348 Bedingungen entsprechend)

Vor Anschluss des Geräts ist eine Sichtkontrolle des Geräts vorzunehmen, um festzustellen ob das Gerät möglicherweise während des Transports beschädigt wurde. Wenn irgend welche Defekte wahrgenommen werden darf das Gerät nicht and das Netz angeschlossen werden.
Vor Wartungs- oder Reparaturarbeiten ist das Gerät von allen Stromquellen zu trennen und müssen alle Hochspannung führenden Teile entladen sein. Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, sö darf das nur durch eine Fachkraft, die die damit verbundenen Gefahren kennt, geschehen. In Normalbetrieb erübrigt die doppelte Isolierung der Stromversorgung die Notwendigkeit einer Schutzerde.

WARNUNG:	**Es ist zu beachten dass bei allen Messungen die Gehäuseerde die gleiche Spannung wie die Messköpferde erreicht.** **Weder die Messköpferdleitung noch die Gehäuseerde dürfen mit berührungsgefährlichen Spannungen verbunden werden.**

2.1.2 Örtlicher Netzanschluss und Sicherung

Vor dem Anschliessen an das Netz ist zu prüfen, ob das Gerät für die örtliche Netzspannung eingestellt ist.
Das Gerät wird eingestellt auf 220 V geliefert. Falls das Gerät mit einem 110 V, 127 V oder 240 V Netz verwendet wird, ist die geeignete Netzspannung mit Hilfe des Spannungsumschalters an der Geräterückwand so einzustellen dass er die erforderliche Spannung anzeigt (siehe Abb. 2.1.).
Das Gerät is durch eine zwischen den Wicklungen des Netztransformators angebrachte Thermosicherung gegen Überlastungen geschützt.
Die Sicherung lässt sich nach Abnahme der Gehäuserückwand ersetzen (siehe Abschnitt 2.4.).

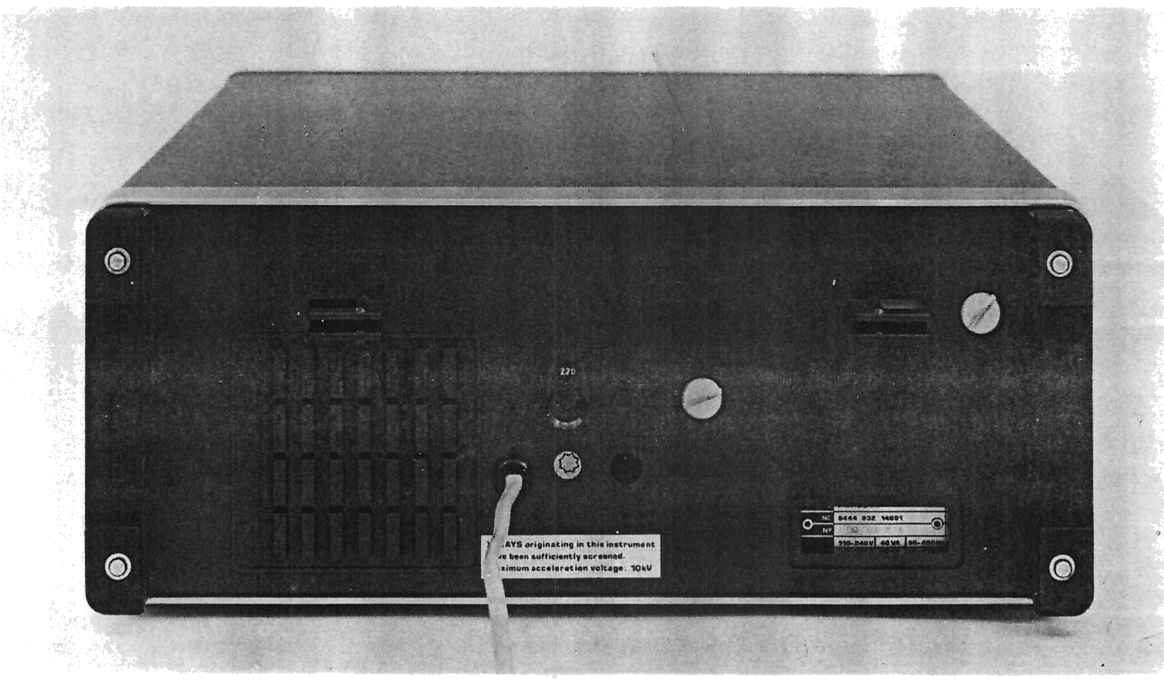


Abb. 2.1. Rückansicht des Oszillografen mit Spannungsumschalter in 220 V Stellung

2.1.3. Anschluss an eine externe Stromversorgung

Eine externe Stromversorgung oder eine 22 V bis 27 V Batterie die zumindest 1 A liefern kann lässt sich an die Buchse an der Geräterückwand anschliessen (Kabel und Stecker: 4822 321 20125).
Der Innenleiter muss an den Minuspol und der Aussenleiter an den Pluspol angeschlossen werden, wie an der Rückwand angegeben. Gegen Überlastungen und Polaritätswechsel ist das Gerät durch eine interne Sicherung und Diode geschützt. Die Sicherung lässt sich nach Abnahme der Gehäuserückwand ersetzen (siehe Abschnitt 2.4.).

2.1.4. Abdeckhaube und Betriebslage

Die Abdeckhaube lässt sich auf eine einfache Weise durch Ziehen von der Gerätefront abnehmen.
Das Gerät darf in waagrechter Lage oder mit Gebrauch des Tragsbügels als Kippbügel in verschiedenen Schrägstellungen aufgestellt werden. Um den Tragbügel zu entriegeln, gleichzeitig die beiden Lagerzapfenknöpfe eindrücken.

2.2. BEDIENUNGSELEMENTE UND BUCHSEN (Siehe Abb. 2.2)

2.2.1. Elektronenstrahlröhre und POWER–Einstellelemente

ILLUM	Stufenlose Einstellung der Rasterbeleuchtung; zugleich Netzschalter.
POWER ON	Signallampe zeigt Betriebszustand (ON) an.
INTENS	Stufenlose Einstellung der Bildhelligkeit.
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.
TRACE ROTATION	Schraubenziehereinstellung zur Ausrichtung der Schreibspur mit den horizontalen Rasterlinien.

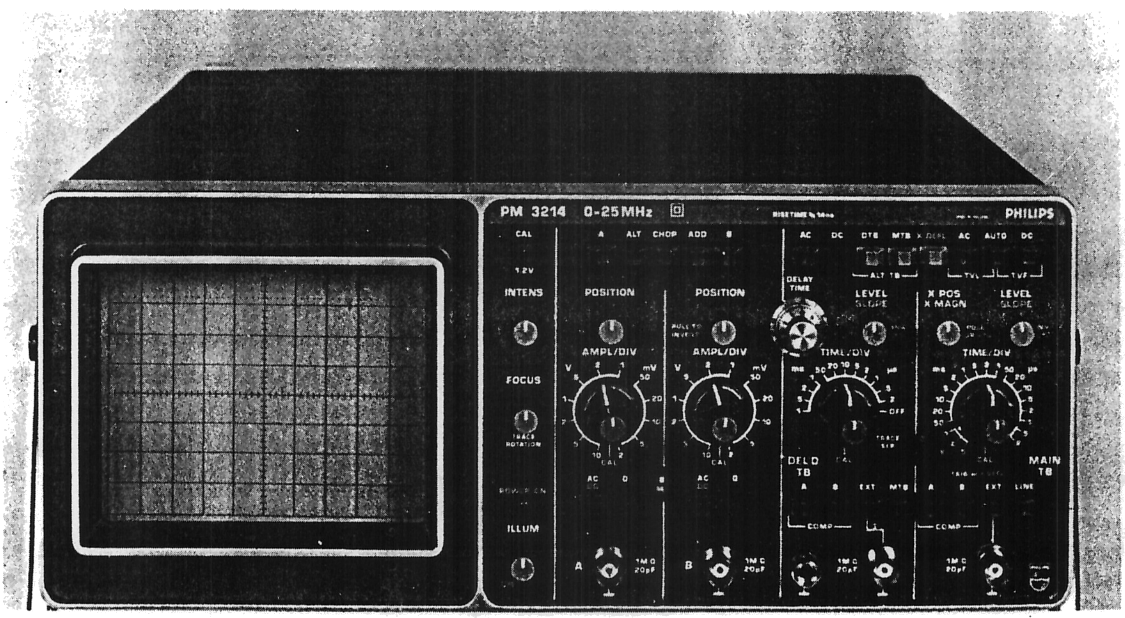


Abb. 2.2. Vorderansicht des Oszillografen mit Bedienungsorganen und Buchsen

2.2.2 Vertikale Kanäle

Darstellungsart-Schalter	*Funktion*
A – ALT – CHOP – ADD – B	Fünffacher Druckknopfschalter zur Einstellung der Darstellungsarten. Wird keine Drucktaste betätigt, dann ist Betriebsart ALT eingeschaltet.
A	Vertikalablenkung durch ein an Eingang von Kanal A gelegtes Signal.
ALT	Das Bild wird am Ende jedes Zyklus des Zeitablenksignals von einem Vertikalkanal auf den anderen umgeschaltet.
CHOP	Das Bild wird mit einer Festfrequenz von einem Vertikalkanal auf den anderen umgeschaltet ($f \approx 500$ kHz).
ADD	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
B	Vertikalablenkung durch ein an Eingang von Kanal B gelegtes Signal.
POSITION	Stufenlose Einstellung der vertikalen Verschiebung des Bildes.
PULL TO INVERT B	Zug-Druck Schalter kombiniert mit dem POSITION Schalter von Kanal B. Wenn gezogen wird die Kanal B Signalpolarität umgekehrt.
AMPL/DIV (Aussenknopf)	Stufenweise Einstellung der Vertikalablenkkoeffizienten, von 2 mV/div bis zu 10 V/div in 1 – 2 – 5 Folge.
AMPL/DIV (Mittelknopf)	Stufenlose Einstellung der Vertikalablenkkoeffizienten. Es ist zu beachten dass der Ablenkkoeffizient nur dann kalibriert ist wenn der Mittelknopf in Stellung CAL (ganz nach rechts) steht.
Eingangskopplungsschalter	Signalkopplung; Zweiweg Druckknopfschalter
AC (eingedrückt)	Kopplung über einen Sperrkondensator
DC (ausgelöst)	Direkte Kopplung
0 (eingedruckt)	Verbindung zwischen Eingangsschaltung und Eingangsbuchse unterbrochen und Eingangsschaltung geerdet.
A (1 Mohm//20 pF)	BNC-Buchse für Kanal A Eingang
B (1 Mohm//20 pF)	BNC-Buchse für Kanal B Eingang

2.2.3 Horizontaler Kanal

X-Ablenkungsquellenschalter	*Funktion*
DTB – MTB – X DEFL └ALT TB┘	Einstellung der Horizontalablenkung; 3-fache Drucktaste
DTB eingedrückt	Die Horizontalablenkspannung wird vom verzögerten Zeitablenkgenerator geliefert
MTB eingedrückt	Die Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert. Ein Teil der Darstellung wird aufgehellt wenn der verzögerte Zeitablenkgenerator läuft. In Stellung OFF des DTB TIME/DIV Schalters ist der verzögerte Zeitablenkgenerator ausgeschaltet. Ist keine Taste eingedrückt so gilt Einstellung MTB, aber das MTB LEVEL potentiometer wirkt nicht
DTB – MTB └ALT TB┘	Wenn die Tasten DTB und MTB zugleicherzeit eingedrückt werden wird die Horizontalablenkspannung alternierend vom verzögerten und Hauptzeitablenkgenerator geliefert
X DEFL eingedrückt	In diese Stellung wird die Horizontalablenkung vom Schalter A–B–EXT–LINE bestimmt
X POS X MAGN	Stufenlose Einstellung der horizontalen Lage des Bildes; einbezogen ein Zug-Druck für 10-fache Dehnung der Horizontalablenkung. Die Dehnung kann auch bei externen X-Ablenksignalen verwendet werden
TRACE SEP	Stufenlose Einstellung der vertikalen Distanz zwischen den beiden zeitablenkungsdarstellungen in Darstellungsart ALT. TB.

2.2.4 Hauptzeitablenkgenerator

LEVEL SLOPE (IN +, OUT –)	Stufenlose Einstellung des Triggerpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druckschalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales. In TV muss – für negative Videosignale eingestellt werden und + für positive Videosignale
Triggerungsartenschalter	*Funktion*
AC – AUTO – DC └TVL ┘└ TVF ┘	Fünffache Drucktaste zum Einstellen der Triggerungsarten. Wenn keine der Drucktasten betätigt ist, dann ist Betriebsart AUTO gewählt und der LEVEL Bereich auf einen festen Wert eingestellt
AUTO gedrückt	Ein Bild ist sichtbar auch wenn keine Triggersignale vorhanden sind. Der Bereich der LEVEL Einstellung ist proportional dem Spitze-Spitze Wert des Triggersignals
AC eingedrückt	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals ist gesperrt
DC gedrückt	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichstromkomponente des Triggersignals wird durchgelassen
AC AUTO eingedrückt └TVL ┘	Triggerung auf Zeilensynchronisationsimpulsen eines Fernsehsignals (AC und AUTO eingedrückt)
AUTO DC └TVF┘	Triggerung auf Bildsynchronisationsimpulsen eines Fernsehsignals (AUTO und DC eingedrückt)
Quellenschalter für Triggerung und X-Ablenkung	*Funktion*
A – B – EXT – LINE └COMP┘	Vierfache Drucktaste zur Wahl der Triggerquelle oder der Horizontalablenkungsquelle wenn Taste X DEFL gedrückt ist. Wenn keine dieser Tasten eingedrückt ist wird Quelle A gewählt
A gedrückt	Signal wird Kanal A entnommen
B gedrückt	Signal wird Kanal B entnommen
A B └COMP┘	Wenn die Tasten A und B zugleicherzeit eingedrückt werden, wird das Signal jenem Kanal entnommen, der mit dem elektronischen Schalter durchverbunden ist (nicht wirksam wenn Taste X DEFL eingedrückt ist)
EXT eingedrückt	Externes Signal wie an die angrenzende 1 Mohm//20 pF Buchse gelegt
LINE eingedrückt	Signal von der Netzspannung (Nicht Wirksam wenn das Gerät batteriebetrieben ist)
TIME/DIV (Aussenknopf)	Einstellung des Zeitmassstäbes von .2 μS bis .5 S/Teil in 1-2-5-Folge
TIME/DIV (Mittelknopf)	Stufenlose Einstellung des Zeitmassstabes. Muss in Stellung CAL stehen (d.h. völlig nach rechts) damit die Zeitachse gemäss der Anzeige des Schalters TIME/DIV kalibriert ist
1MΩ – 20 pF	BNC Buchse für externe Triggerung oder Horizontalablenkung.

2.2.5 Verzögerter Zeitablenkgenerator

LEVEL SLOPE (IN +, OUT –)	Stufenlose Einstellung über einen festen Bereich des Triggerpegels bei welchem der verzögerte Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druckschalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales.
Triggerungsartenschalter	*Funktion*
AC – DC	Zweifache Drucktaste zur Einstellen der Triggerungsarten.

AC gedrückt	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals ist gesperrt
DC gedrückt	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals wird durchgelassen
DELAY TIME	Stufenlose Einstellung der Verzögerungszeit; wirkt zusammen mit der TIME/DIV Einstellung des Hauptzeitablenkgenerators
Triggerquellenschalter	*Funktion*
A – B – EXT – MTB └COMP┘	Vierfache Drucktaste zur Wahl der Triggerquelle und des Anfangspunktes des verzögerten Zeitablenkgenerators. Wenn keine dieser Tasten eingedrückt ist wird Quelle MTB gewählt
A gedrückt	Triggersignal wird Kanal A entnommen
B gedrückt	Triggersignal wird Kanal B entnommen
A B └COMP┘	Wenn die Tasten A und B zugleicherzeit eingedrückt werden, wird das Signal jenem Kanal entnommen der mit dem elektronischen Schalter durchverbunden ist. Triggerung auf das dargestellte Signal nach Ablauf der gewählten Verzögerungszeit
EXT eingeldrückt	Triggerung auf externes Signal wie an die angrenzende 1 Mohm//20 pF Buchse gelegt
MTB eingedrückt	Triggersignal wird dem Hauptzeitablenkgenerator entnommen und startet den verzögerten Zeitablenkgenerator sofort nach Ablauf der gewählten Verzögerungszeit
TIME/DIV (Aussenknopf)	Einstellung des Zeitmassstabes von .2 μS/DIV bis 1 mS/DIV in 1-2-5 Folge
TIME/DIV (Mittelknopf)	Stufenlose Einstellung des Zeitmassstabes. Muss in Stellung CAL stehen (d.h. völlig nach rechts) damit die Zeitachse gemäss der Anzeige des Schalters TIME/DIV kalibriert ist
1MΩ – 20pF	BNC Buchse für externes Triggersignal

2.2.6 Verschiedenes

CAL	Ausgangsbuchse an der eine Rechteckspannung von 1,2 $V_{s\text{-}s}$ ± 1% zur Verfügung steht für Tastkopfkompensation und/oder Prüfung der Vertikalablenkgenauigkeit
DC POWER IN	Eingangsbüchse an der Rückseite des Geräts gestattet Betrieb mit einer externen Gleichspannung. Spannungsbereich 22 – 27 V, Stromabgabe > 1 A
Netzspannungswähler	Ist vor dem Anschluss an das örtliche Netz, den in Abschnitt 2.1.2 gegebenen Angaben entsprechend einzustellen.

2.3 BEDIENUNGSANLEITUNG

2.3.1 Einschalten des Geräts

Vor Anschluss des Geräts an eine Stromquelle sind die in Abschnitt "Inbetriebnahme" gegebenen Anleitungen genauestens auszuführen.
Das Gerät wird normalerweise nach einer Anwärmzeit von etwa 15 Minuten den Spezifikationen (siehe Abschnitt 1.2) entsprechen. Wenn das Gerät jedoch grosser Kälte ausgesetzt war (z.B. unter Frostbedingungen nachts im Auto gelassen) und danach in einen warmen Raum gebracht wird, ist eine Anwärmzeit von etwa einer halben Stunde einzuhalten (siehe Abschnitt 1.2.11).

2.3.2 Vorbereitende Einstellungen

Mit diesem Verfahren lässt sich feststellen ob der Oszillograf ordnungsgemäss funktioniert und es ergibt einen tauglichen Ausgangspunkt für den Beginn von Messungen.
Siehe Abb. 2.2. bezüglich der Lage der Bedienungselemente. Bringe die Einsteller INTENS und FOCUS in Mittelstellung. Taste AUTO drücken und mit Schalter TIME/DIV einen durchschnittlichen Zeitkoeffizienten zwischen 10 µs/div und 10 ms/div wählen. Mit allen übrigen Drucktasten in Normalstand (nicht gedrückt) lassen sich die Schreibstrahlspuren von Kanal A und Kanal B mit dem entsprechenden Einsteller POSITION auf dem Bildschirm darstellen.
Mit Bedienungselement INTENS eine mittlere Bildhelligkeit und mit FOCUS eine gute Strahlfokussierung einstellen.

2.3.3 Eingangskopplung (AC/DC, 0)

AC-Kopplung (Drucktaste eingedrückt) dient zum Sperren der Gleichspannungskomponente eines Signals.
Die AC Einstellung unterdrückt die Niederfrequenzen, wodurch sinusförmige Signale niedriger Folgefrequenz abgeschwächt werden und Rechtecksignale niedriger Folgefrequenz verformt werden. Der Abschwächungsgrad wird von der Eingangs RC-Zeit (0.1s) bestimmt.
Eingangs RC-Zeit wird 10-fach erweitert wenn 10 : 1 passive Messköpfe verwendet werden.
Wenn auf AC-Kopplung geschaltet wird dauert es etwa fünf Eingangs RC-Zeiten bevor der Strahl auf den Mittelwert des Eingangssignals stabilisiert ist.
AC-Stellung Messungen können nicht gegenüber Erde vorgenommen worden.
In **Stellung 0** wird das Eingangssignal unterbrochen und der Verstärkereingang kurzgeschlossen, dies zur Ermittlung des Nullpegels.
DC-Kopplung (Drucktaste normal) ermöglicht Frequenzeingang über den gesamten Bereich, dass heisst bis hinab auf Gleichspannung.

2.3.4 Anwendung von Messköpfen

1:1 passive Messköpfe sollten nur für Gleichspannung und Niederfrequenzen eingesetzt werden.
Kapazitive Belastung schwächt hohe Frequenzen ab oder erhöht die Anstiegszeit von Messignalen (abhängig von Quellimpedanz).
10:1 passive Messköpfe besitzen eine kleinere kapazitive Belastung; gewöhnlich etwa 10 pF bis 20 pF.
FET-Messköpfe sind besser, besonders wenn Messungen von Messpunkten mit hoher Impedanz vorgenommen oder an der oberen Frequenzgrenze der Bandbreite des Oszillografen ausgeführt werden sollen.
10:1 passive Messköpfe müssen vor Gebrauch ordnungsgemäss kompensiert werden. Ungenaue Kompensation hat Impulsverformung oder Amplitudenfehler bei hohen Frequenzen zur Folge.
Für genaue Einstellung kann der CAL-Ausgangsanschluss verwendet werden (siehe Abb. 2.3.).

2.3.5. Einstellen der Abschwächer-Messköpfe

- Die Kompensationsdose mit Buchse A verbinden und die Messkopfspitze an Buchse CAL legen.
- Einen kleinen Schraubenzieher durch das Loch in der Kompensationsdose einstecken und den Trimmer einstellen, um ein einwandfreies Bild zu erhalten (siehe Abb. 2.3.).

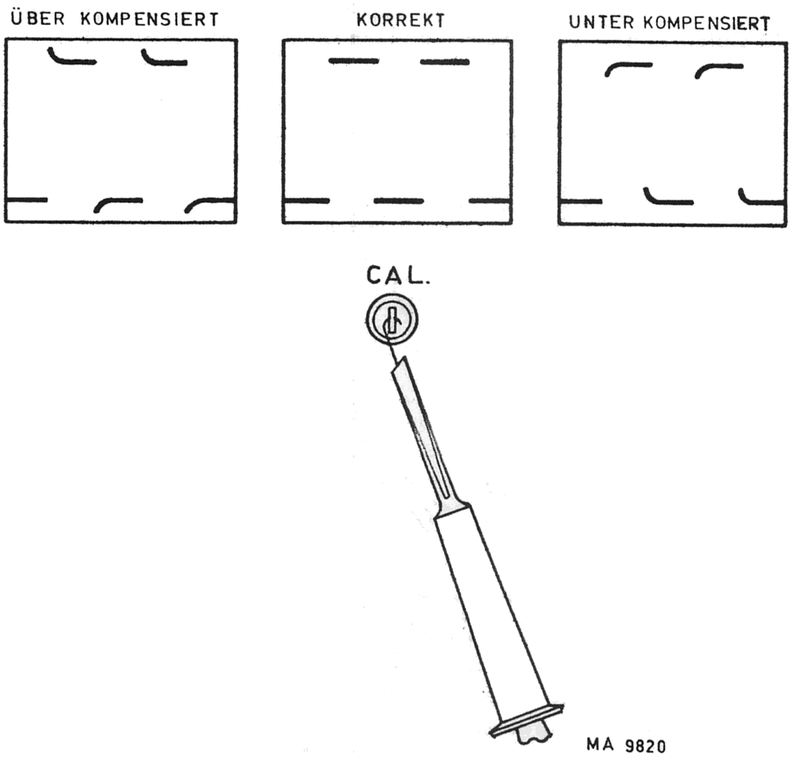


Abb. 2.3. Einstellen des Abschwächer-Messkopfs

2.3.6. Einstellen der gechoppten (CHOP) oder der alternierenden (ALT) Darstellungsart

Im Zweikanalbetrieb (CHOP oder ALT eingedrückt) muss für relative lange Ablenkzeiten (von .1 ms/div bis .5 s/div) oder bei vorkommender niedriger Ablenk-Folgefrequenz selbst bei kurzen Ablenkzeiten, die Darstellungsart CHOP verwendet werden (CHOP eingedrückt).
Stellung ALT würde unter diesen Umständen Vergleiche zwischen Signalformen erschweren da sonst die beiden Signale gesondert wahrgenommen würden.
Wenn die Darstellung jedoch schnell genug ist um von der Chopperfrequenz unterbrochen zu werden muss die alternierende Darstellungsart eingestellt werden (ALT eindrücken), gewöhnlich bei Ablenkzeiten schneller als .1 ms/div.

2.3.7. Differentielle Betriebsart

Betriebsart A – B lässt sich durch Drücken von ADD und Ziehen des Knopfes POSITION von Kanal B einstellen. Bei Messungen wobei Signalleitungen bedeutende Gleichtaktsignale führen (z.B. Brumm) hebt die differentielle Betriebsart diese Signale auf, und lässt den Rest, der von Bedeutung ist, übrig.
Die Fähigkeit des Oszillografen für Unterdrückung von Gleichtaktsignalen ist vom CMR-Faktor gegeben (siehe Abb. 2.4). Um den spezifizierten Grad der Gleichtaktunterdrückung zu erlangen müssen erst die Kanal A und B Verstärkungen ausgeglichen werden. Dies wird durch Anschluss beider Kanäle an den CAL-Ausgang und durch Einstellung eines der stufenlosen Einstellelemente mit dem Schalter AMPL/DIV auf Minimum-Ablenkung am Bildschirm erreicht.
Bei Verwendung von passiven 10:1 Messköpfen ist ein ähnliches Ausgleichsverfahren zu empfehlen und zwar durch ihre Kompensationseinstellung auf Minimum-Ablenkung zu bringen.

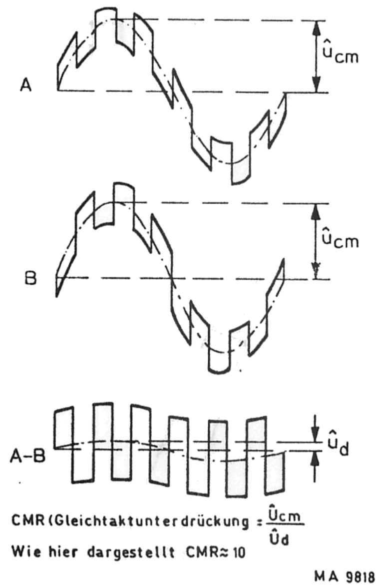


Abb. 2.4. Gleichtaktunterdrückung

2.3.8. Einstellen der Triggerart

(AUTO AC DC)
└ TVL┘└TVF┘

Betriebsart AUTO is äusserst nützlich, da dabei das Bild stets sichtbar ist, auch wenn keine Triggersignale vorhanden sind. Ausserdem bewirkt diese Betriebsart für eine Signalamplitude die grösser ist als ein Teil (div) eine stabile Triggerung unabhängig von der Stellung des Pegeleinstellers LEVEL; ihr Bereich wird automatisch auf den Spitze-Spitzewert des für Triggerung gewählten Signals eingestellt.
Auf diese Weise wird die LEVEL-Einstellung bei kleinen Amplituden des Triggersignals erleichtert.
Betriebsart AUTO lässt sich für Signale mit niedriger Folgefrequenz (10 Hz oder niedriger) nicht verwenden weil dies freilaufende Ablenkung zwischen Triggerimpulsen ermöglichen würde. Deshalb ist bei Signalen niedriger Folgefrequenz die normale Triggerung anzuwenden (AC oder DC gedrückt).
Bei normaler Triggerung wird die Zeitablenkung nur dann ausgelöst wenn ein Triggersignal angelegt wird und LEVEL entsprechend eingestellt ist.
Mit gedrückten AC oder DC ist der Bereich des Einstellers LEVEL festgesetst (+ oder – 8 Teile (div.) oder mehr in den äussersten Stellungen von LEVEL, bezogen auf die Bildschirmmitte).
Die Gleichspannungskomponente des Triggerssignals lässt sich durch Eindrücken von AC sperren.
Dies ist nützlich wenn bei einem Wechselspannungsignal das einem hohen Gleichspannungspegel überlagert ist getriggert werden soll. Bei AC-Kopplung verändert der Pegel bei welchem die Darstellung beginnt mit Anderungen im Mittelwert des Triggersignals. Dies kann bei Signalformen die im Zeitabstand von Zyklus zu Zyklus variieren Instabilität zur Folge haben. Normalerweise ist Anwendung der DC-Stellung vorzuziehen.
Flankenwahl ist mit Drucktaste +/– vorzunehmen. Bei Betriebsart TV ist für negative Videosignale "–" einzustellen und "+" für positive Videosignale. Einsteller LEVEL ist bei Betriebsart TV nicht wirksam. Eine zusätzliche Anwendungsweise wird geboten wenn keine Tasten eingedrückt sind, eine Zeitablenklinie ist am Bildschirm sichtbar während kein Triggersignal vorhanden ist, und der Pegelbereich des Einstellers LEVEL fest ist.

2.3.9. Triggerquelle

Die Triggerquelle der Hauptzeitablenkung wird mit den Frontplatte-Drucktasten eingestellt.

A B EXT LINE
└COMP┘

Die Triggerquelle wird mit den Frontplatte-Drucktasten TRIG OR X DEFL eingestellt.

- *Interne Triggerung* ist die im allgemeinen meist angewandte, da sie nur ein Signal erfordert (das Eingangssignal) um stabile Triggerung zu erlangen.
- *Externe Triggerung.* Falls mehrere Signale abgetastet werden, ist es günstig ein externes Signal zur Triggerung zu benutzen. Bei einer Änderung des Eingangssignals ist Einstellung und Neueinstellung der Trigger-Bedienungselemente (LEVEL, SLOPE und SOURCE) nicht nötig. Ausserdem bleiben die beiden Eingänge A und B für Untersuchungen der Signalformen verfügbar.
- *Wahl der Triggerquelle.* Bei Vergleichung von Signalformen die ein Vielfaches ihrer Frequenz sind, immer das Signal mit der niedrigsten Folgefrequenz als Triggersignal wählen. Wenn nicht, könnten Doppelbilder (gechopped) oder falsche Zeitverschiebungen (alternierend) entstehen.
- *Zusammengesetzte (composite) Triggerung.* Bei interner Triggerung werden Triggersignale von entweder dem A-Kanal, den B-Kanal Vorverstärkerstufen oder wenn in Stellung COMP durch Eindrücken der beider Tasten A und B, von der Verzögerungsleitungs-Treiberstufe die dem elektronischen Kanalschalter folgt, erhalten.

Zusammengesetzte Triggerung bietet drei Vorteile:

1. In der differentiellen Betriebsart (A-B Messungen) wird die Triggerung vom Differenzsignal ausgelöst. Die Triggerung wird nicht von Gleichtaktsignalen gestört.
2. Für Einkanal-Betrieb ist es nicht nötig Triggerquellen von A nach B oder umgekehrt zu schalten.
3. In alternierender Betriebsart lassen sich Signale vergleichen, die nicht in zeitlicher Beziehung stehen.

Bemerkung: Bei Anwendung zusammengesetzter Triggerung in Zweikanalbetrieb (gechopped oder alternierend) und wenn dabei nur ein Signal angelegt ist (an Eingang A oder B), ist stabile Triggerung nicht erlangbar. Das ist nicht ungewöhnlich, da die Triggerquelle auch von A nach B geschaltet wird (siehe Abb. 2.5.).

- *Netztriggerung* von der 50 Hz Netzspeisung ist nützlich wenn der Signaleingang Netzfrequenz bezogen ist.

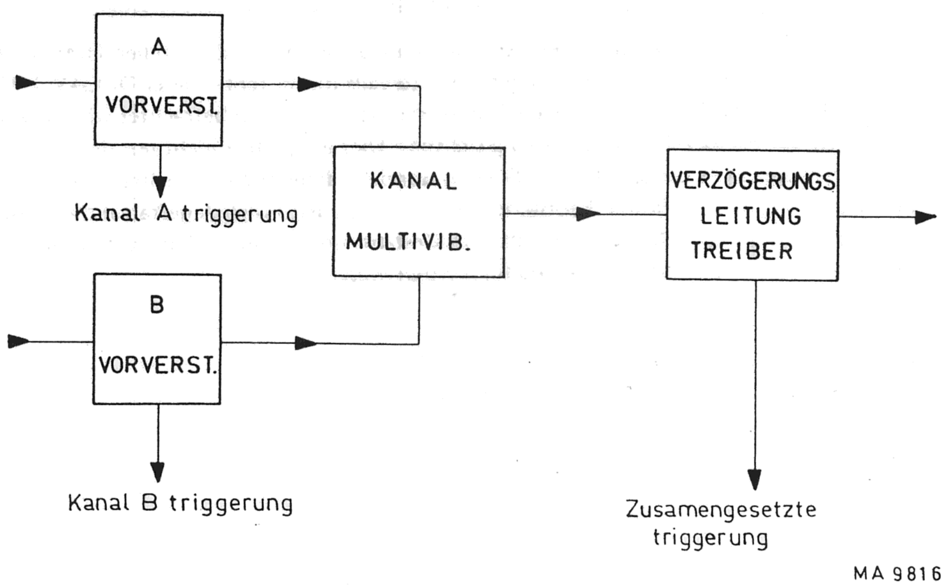


Abb. 2.5. Blockschaltbild der zusammengesetzte (composite) Triggerschaltung

2.3.10. Dehnung der Zeitablenkung

Die Dehnung wird durch des an Steller X POSITION gekoppelten Schalters X MAGN bewirkt. Mit diesem Schalter in Stellung x10 wird die Zeitablenkgeschwindigkeit 10 fach vergrössert. Die Ablenkzeit wird daher durch Teilung des angezeigten Wertes TIME/DIV durch 10 bestimmt.

2.3.11. XY Messungen

Für XY Messungen steht der Schalter TIME/DIV auf X DEFL, die Quelle der Horizontalablenkung wird mit Drucktaste EXT X DEFL oder TRIG (A, B, EXT oder LINE) eingestellt.
XY Messungen ergeben ein zweckmässiges Mittel für Frequenz- oder Phasenverschiebungsvergleiche durch Darstellung mit Lissajous Figuren. Messungen bis zu 100 kHZ sind möglich, wobei der Phasenfehler zwischen den Oszillografkanälen geringer als 3° ist.
Nachstehende Tabelle zeigt die Empfindlichkeit der verschiedenen XY-Betriebsarten.

X DEFL	EMPFINDLICHKEIT
A	AMPL/DIV A ± 10%
B	AMPL/DIV B ± 10%
EXT	0.5 V/DIV ± 10%
LINE	8 Teile (divisions) bei Netz-Nennspannung

2.3.12 Gebrauch der verzögerten Zeitablenkung

Die verzögerte Zeitablenkung kann zur genauen Beobachtung komplexer Signale verwendet werden. Wenn die Drucktaste MTB des X-Ablenkungsquellenschalters eingedrückt wird, wird die verzögerte Zeitablenkung (wenn der TIME/DIV Schalter nicht in Stellung OFF steht) sofort nach der gewählten Verzögerungszeit ausgelöst und das verzögerte Signal aufgehellt. Mit dem DELAY TIME Einsteller ist dieser aufgehellte Teil über die Zeitachse verschiebbar. Die Zeitdauer des aufgehellten Teils ist mit den Einstellern TIME/DIV des verzögerten Zeitablenkgenerators sowohl stufenweise wie stufenlos einstellbar. Mit Drucktaste DTB des X-Ablenkungs-quellenschalters wird der aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht. In Stellung DTB wird die verzögerungszeit (das heisst die Zeit zwischen dem Startpunkt der Hauptzeitablenkung und dem Startpunkt der verzögerten Zeitablenkung) bestimmt durch die Einstellungen der Hauptzeitablenkungsregler TIME/DIV und die des DELAY TIME Einstellers.

Der Oszillograf PM 3214 ist mit Darstellungsumschaltung ausgestattet. Dies bietet dem Gebraucher eine gleichzeitige Darstellung des Signals auf den beiden von der Hauptzeitablenkung und von der verzögerten Zeitablenkung gelieferten Zeitskalen.

Die Wahl von ALT TB gestattet ausführliche Betrachtung eines bestimmten Ausschnittes der Hauptzeitbasis-darstellung durch Dehnung des betreffenden Zeitintervalls mit Hilfe der verzögerten Zeitablenkung.

Die Zeitdehnung wird durch Wahl einer entsprechend schnelleren Ablenkung für den Steller TIME/DIV der verzögerten Zeitablenkung und durch Positionierung des Zeitintervalls mit Potentiometer DELAY TIME erlangt. Jenes Signalteil dass mit Hilfe der verzögerten Zeitablenkung ausführlich betrachtet wird, bleibt auch als aufgehellter Ausschnitt der Hauptzeitbasisdarstellung sichtbar. Dies erleichtert nicht nur die Standortermittlung der gewünschten Einzelheit beim Suchen, sondern dient auch als Sichtanzeige jenes Ausschnitts der Gesamtleuchtspur der für den Beobachter von Interesse ist. Folglich gestattet die Einstellung ALT TB sofortige Korrelation des Signalausschnitts mit dem Gesamtsignal, welches äusserst kompliziert sein kann, ohne dass dabei zwischen MTB und DTB geschaltet werden muss.

2.4. VERFAHREN ZUM ENTFERNEN VON SICHERUNGEN, BILDRÖHRENRAHMEN UND KONTRAST-PLATTE

2.4.1. Abnehmen der Abdeckhauben

Es ist immer darauf zu achten, dass vor Abnahme irgendwelcher Deckel oder Platten das Gerät vom Netz getrennt ist.
Das Gerät ist durch drei Abdeckhauben geschützt: eine Frontschutzhaube, ein Mantel mit Tragbügel und eine Abdeckplatte für die Rückwand.
Die Frontschutzhaube muss erst angebracht werden, dies erleichtert Abnahme des Mantels und der Rückwand-platte.
Das Abnehmen geschieht wie folgt:

- Den Tragbügel von der Frontplatte wegschwenken, zu diesem Zweck die beiden Drehzapfenknöpfe drücken (Abb. 2.6.).
- Das Gerät auf seiner Frontschutzhaube auf eine ebene Fläche stellen.
- Die beiden Schlitzschrauben auf der rückwärtigen Abdeckplatte lösen.
- Die rückwärtige Abdeckplatte abheben und den Stecker aus der Netzteil-Leiterplatte ziehen.
- Den Mantel abnehmen.
- Die Frontplatte wird zugänglich, wenn das Gerät horizontal aufgestellt wird und die Frontschutzhaube abgezogen wird.

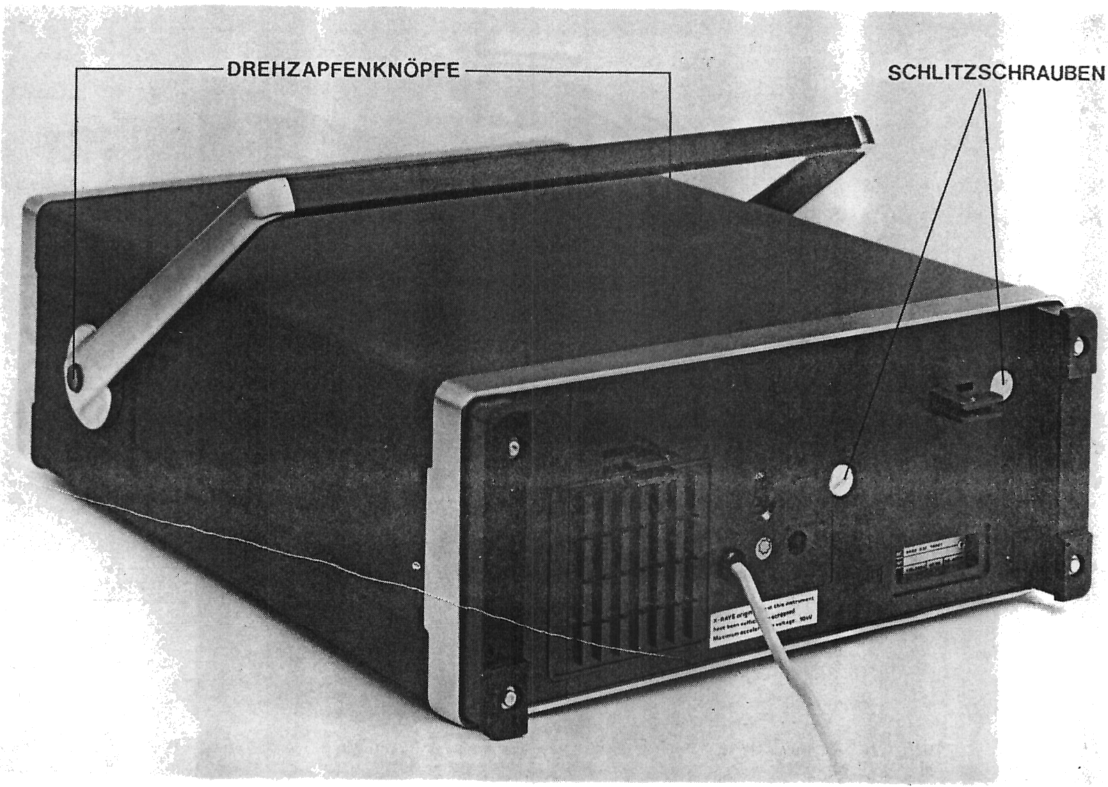


Abb. 2.6. Abnehmen der Gerätabdeckhauben und des Tragbügels

2.4.2. Ausbau des Netztransformators

- Gerätemantel und Rückwand abnehmen (Abschnitt 2.4.1.).
- Nach Lösen der 4 Kreuzschlitzschrauben den Deckel des Spannungsadapterfachs abnehmen.
- Die vier Kreuzschlitzschrauben mit denen der Deckel des Transformatorfachs befestigt ist lösen.
- Den Deckel mit dem daran befestigten Transformator abheben und gleichzeitig den Draht zwischen Transformator und Spannungsadapter aus dem Schlitz im Transformatorfach schieben.
- Transformator und Schmelzsicherung sind nun zugänglich und können ersetzt werden.

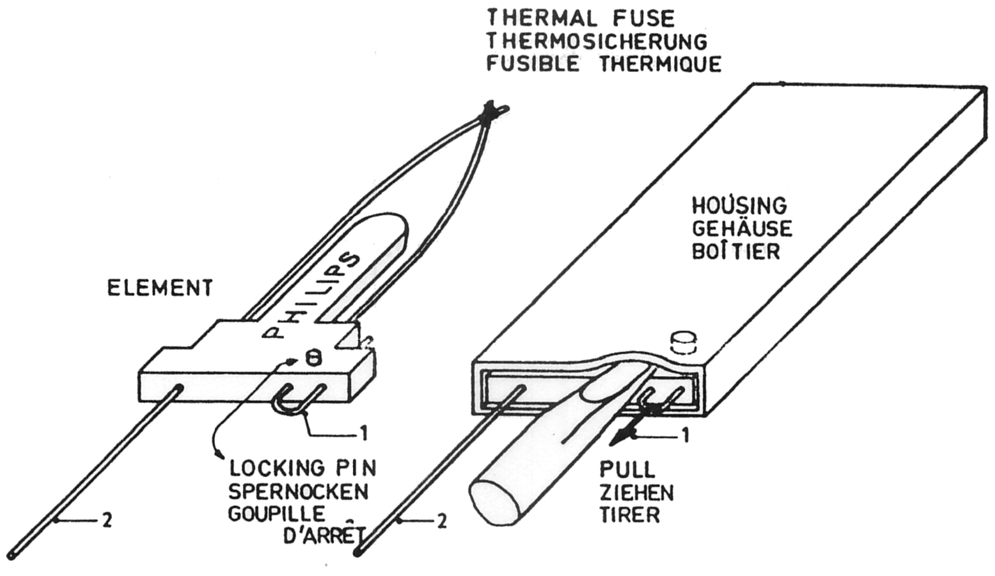


Abb. 2.7. Ersetzen der Schmelzsicherung

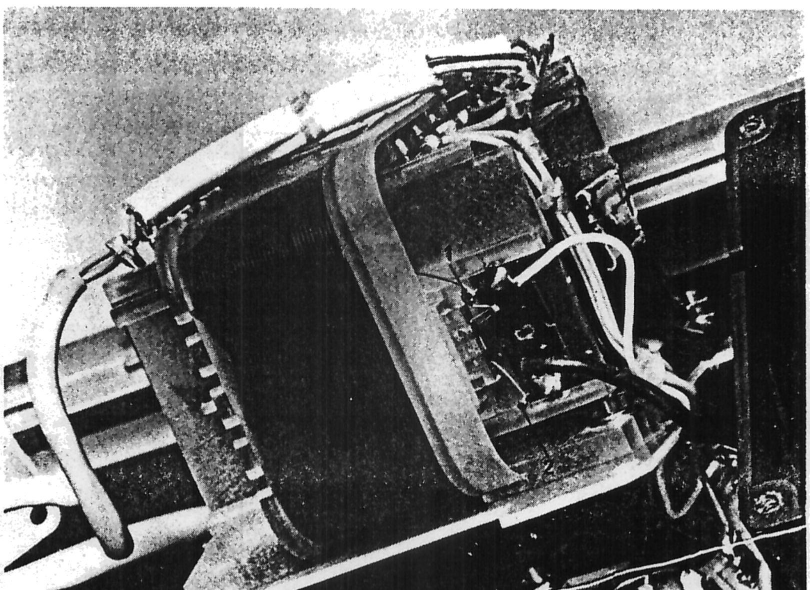


Abb. 2.8. Ersetzen der Schmelzsicherung

2.4.3. Ersetzen der Schmelzsicherung F101

- Netztransformator entfernen (Sbschnitt 2.4.2.).
- Sicherungsanschlussdrähte 1 und 2 ablöten (Abb. 2.7. und 2.8.).
- Es wird nur der Sicherungsdraht der alten Sicherung ersetzt und nicht die gesamte Sicherung; zu diesem Zweck das Gehäuse der Sicherung etwas nach aussen biegen, die Sperrnocken freilegen und den Draht herausziehen.
- Die neue Sicherung nehmen und den Sicherungsdraht auf die gleiche Weise wie oben beschrieben aus seinem Gehäuse ziehen.
- Den neuen Sicherungsdraht in das Gehäuse der alten Sicherung stecken bis die Sperrnocken im Loch einschnappen. Die Schleife im Sicherungsdraht muss nach Anschluss 1 gerichtet sein.
- Die Sicherungsdrähte an Anschlüsse 1 und 2 löten.

2.4.4. Ersetzen der Sicherung F201

- Gerätemantel und Rückwand abnehmen (Abschnitt 2.4.1.).
- Die sich auf der Netzteil-Leiterplatte befindliche Sicherung F201 ist nun zugänglich und kann ersetzt werden.

2.4.5. Abnehmen des Bildröhrenrahmens und der Kontrastplatte

- Den Bildröhrenrahmen an den unteren Ecken festhalten und vorsichtig von der Frontplatte ziehen. (Abb. 2.9.).
- Die Kontrastplatte kann nun behutsam aus dem Rahmen gedrückt werden.

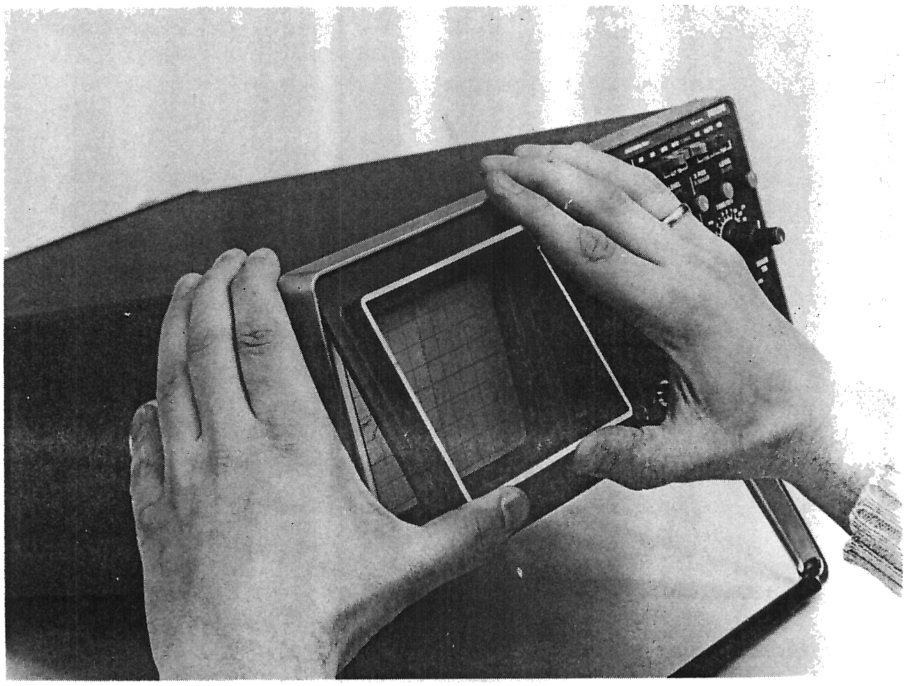


Abb. 2.9. Abnehmen des Bildröhrenrahmens und der Kontrastplatte

Notice d'emploi

1. Généralités

1.1 INTRODUCTION

L'oscilloscope 25 MHz à double trace PM 3214 est un instrument portatif compact et léger, de conception ergonomique et à possibilités de mesure étendues. L'appareil est pourvu d'une base de temps principale et d'une base de temps retardée; il permet l'affichage alterné de la base de temps ainsi que de nombreuses possibilités de déclenchement telles que crête-à-crête automatique, couplage continu et affichage automatique d'onde TV.

Un grand écran de 8 sur 10 cm avec lignes de graticule internes illuminées permet une représentation facile et un potentiel d'accélération 10 kV donne une trace de forte intensité et un point bien défini.

Une alimentation à double isolement permet de connecter le châssis directement à des circuits de terre flottants, à condition qu'ils ne présentent pas de tension dangereuse au toucher. De plus, il y a réduction substantielle du parasitage par les courants de terre, dont sont fréquemment affectés les oscilloscopes mis à terre. L'emploi de l'oscilloscope à pied d'oeuvre est facilité par la possibilités du fonctionnement sur batterie.

Attention:	**La masse du châssis (et le câble de masse de sonde) ne doivent pas être connectés à des circuits sous tension dangereuse au toucher.**

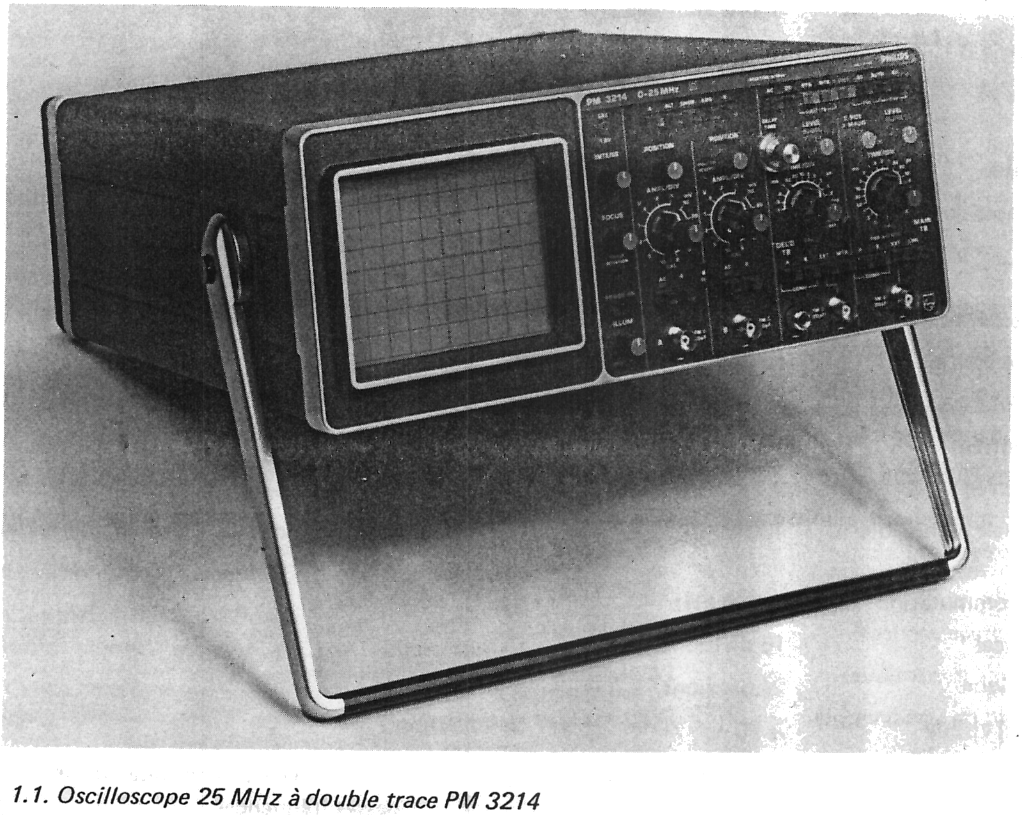


Fig. 1.1. Oscilloscope 25 MHz à double trace PM 3214

1.2 CARACTERISTIQUES

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe II. A sa livraison il répond aux règles de sécurité. La présente notice comporte les information et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

Sauf indications contraires, les proprietés exprimées en valeurs numériques tolérancées sont garanties pour des températures ambiantes comprises entre +5 °C et +40 °C. Les valeurs numériques non tolérancées sont des valeurs normales et représentent les caractéristiques d'un instrument moyen.

	Désignation	*Spécification*	*Renseignements supplémentaires*
1.2.1	**Tube cathodique**		
	Type	D14-125GH/08	Tube à face rectangulaire, type domed mesh, post-accélérateur, couche phosphore doublée de métal
	Aire de mesure	8 x 10 divisions	1 division égale 1 cm
	Type d'écran	P31 (GH)	P7 (GM) optional
	Tention totale d'accélération	10 kV	
	Graticule	Interne	Réglage continu de l'éclairement
	Gravures	Divisions centimétriques avec subdivisions de 2 mm sur les axes centraux, Les lignes interrompues indiquent les points 10 % et 90 % pour la mesure du temps de montée	
1.2.2	**Axe vertical ou Y**		
	Modes d'affichage	Voie A seulement Voie B seulement A et B commutées A et B alternées A et B ajoutées	
	Polarité de la voie B	Normale ou inversée	
	Bande passante	0 Hz ... 25 MHz (–3 dB) 2 Hz ... 25 MHz (–3 dB)	En couplage continu En couplage capacitif
	Temps de montée	⩽ 14 ns	
	Distortion d'impulsion	⩽ ± 3 % (⩽ 4 % c.c.)	Mesurée pour une amplitude de 6 divisions et un temps de montée ⩾ 1 ns
	Coefficients de déviation	2 mV/div ... 10 V/div	Progression 1-2-5
	Plage de réglage continu	1 : ⩾ 2,5	
	Précision de déviation	± 3 %	
	Impédance d'entrée	1 Mohm/20 pF	
	Temps RC d'entrée	0,1 s	Couplage capacitif
	Tension maximale admissible d'entrée	400 V	Tension continue + tension alternative crête
	Fréquence de commutation	≈ 500 kHz	
	Décadrage vertical	16 divisions	
	Gamme dynamique	24 divisions	
	Retard de signal visible	⩾ 20 ns	
	Facteur de réjection en mode commun	⩾ 40 dB à 1 MHz	Après réglage en continue ou sur basses fréquences
	Diaphonie entre voies	–40 dB ou mieux à 10 MHz	
	Dérive en température	⩽ 0,3 div/heure	

1.2.3 Axe X ou horizontal

La déflexion horizontale peut être obtenue par la base de temps principale, la base de temps retardée ou une combinaison des deux, ou encore par la source sélectionnée pour déflexion X. Dans ce cas on établit les oscillogrammes X-Y en utilisant la voie A, la voie B, le connecteur d'entrée externe ou le secteur pour source de signal pour déflexion horizontale.

Modes de représentation	– Base de temps principale – Base de temps principale intensifiée par base de temps retardée – Base de temps principale et base de temps retardée alternées – Base de temps retardée – Fonctionnement XY	Dévisation X par: – le signal voie A – le signal voie B – le signal appliqué au connecteur EXT de la base de temps principale – la fréquence secteur

1.2.4. Base de temps principale

Fonctionnements	Automatique	En automatique, la base de temps est en fonctionnement libre en l'absence de signaux de déclenchement.
	Déclenché	
Vitesses de balayage	0,5 s/div ... 0,2 µs/div	Progression 1-2-5
Gamme de réglage continu	1 : ⩾ 2,5	
Précision	± 3 %	
Agrandissement	x10	
Erreur d'agrandissement	± 2 %	
Vitesse de balayage efficace la plus rapide	20 ns/div	

1.2.5. Base de temps retardée

Fonctionnement	Déclenché par la base de temps principale immédiatement après le temps de retard choisi ou peut être déclenché après le temps de retard par la source de déclenchement choisie de la base de temps retardée	
Vitesses de balayage	1 ms/div ... 0,2 µs/div	Progression 1-2-5
Gamme de réglage continu	1 : ⩾ 2,5	
Précision	± 3 %	
Agrandissement	10x	
Erreur d'agrandissement	± 2 %	
Vitesse de balayage efficace la plus rapide	20 ns/div	
Temps de retard	Variable en échelons par commutateur TIME/DIV de la base de temps principale.	

	Continuellement variable entre 0x et 10x le coefficient de temps de la base de temps principale, par potentiomètre 10-tours	
Précision differentielle du temps de retard	0,5 %	
Instabilité du retard	1 : ⩾ 20 000	

1.2.6 Déviation X

Source	A, B, EXT ou LINE	En fonction de la position du commutateur de source, si le bouton X DEFL est enfoncé
Coefficients de déviation	A ou B : suivant la position de AMPL/DIV EXTERNE: 0,5 V/div LINE: 8 divisions	
Précision	± 10 % en A ou B	
Gamme de fréquence	0 Hz ... 1 MHz (–3 dB) pour 6 divisions	Couplage direct
Déphasage	⩽ 3° à 100 kHz	
Gamme dynamique	24 divisions	Pour fréquences ⩽ 100 kHz

1.2.7 Déclenchement de la base de temps principale

Source	Voie A, voie B, mixte, externe et fréquence secteur	
Mode de déclenchement	Automatique, normal alternatif, normal continu, TV ligne et TV trame	
Sensibilité de déclenchement	Interne: 0,5 div. (DC .... 5 MHz) 1 div. (DC .... 50 MHz) Externe: 250 mV (DC .... 5 MHz) 500 mV (DC .... 50 MHz)	
Gamme de fréquence de déclenchement	AUTO : 20 Hz ... ⩾ 50 MHz AC : 5 Hz ... ⩾ 50 MHz DC : 0 Hz ... ⩾ 50 MHz	
Gamme de niveau	AUTO : proportionelle à la valeur crête à crête du signal de déclenchement	
	AC : 16 div en déclenchement	+ ou – 8 div et
	DC : interne et 8 V en déclenchement externe	+ et –4 V par rapport au centre de l'écran
Pente	+ ou –	
Impédance d'entrée	1 Mohm//20 pF	
Tension maximale d'entrée	400 V	Tension continue + tension alternative crête

1.2.8 Déclenchement de la base de temps retardée

Source	Voie A, voie B, mixte, externe et MTB	

Les autres caractéristiques sont identiques à celles mentionnées au paragraphe 'Déclenchement de la base de temps principale' excepté le déclenchement TV.

1.2.9. Générateur d'étalonnage

Tension de sortie	1,2 V_{cc}	Onde carré
Précision	± 1 %	
Fréquence	≈ 2 kHz	

1.2.10. Alimentation

Alimentation alternative	A double isolement	Classe de sécurité II, IEC348
Tensions nominales (sur le carrousel)	110, 127, 220 ou 240 V alternative, ± 10 %	
Gamme de fréquence nominale	50 ... 400 Hz ± 10 %	
Consommation	30 W maximum	A la tension secteur nominale
Alimentation continue		
Gamme de tension	22 ... 27 V continu 20-28 V continu	Entrée flottante A des conditions moins strictes
Consommation	1,1 A maximum	
Capacité à la terre	185 pF	Mesurée avec pied caoutchouc sur plaque métallique de 1 m^2 mise à la terre
	27 pF	Mesurée 30 cm au-dessus de la plaque de 1 m^2 à la terre

1.2.11. Conditions ambiantes

Les données d'environnement ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation PHILIPS de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

Température ambiante:		
Gamme de référence d'utilisation	+5 °C ... +40 °C	
Gamme limite d'utilisation	−10 °C ... +55 °C	
Conditions de stockage et de transport	−40 °C ... +70 °C	
Humidité	Suivant IEC 68 Db	
Chocs	1000 chocs de 10 g, 1/2 sinus, d'une durée de 6 ms dans chacune des 3 directions	
Essais de vibration	30 minutes dans chacune des 3 directions, 10-150 Hz; amplitude 0,7 $mm_{c.c.}$ et 5 g accélération maxi	
Altitude maximum:		
Limite opérationelle	5000 m (475 m bars) (= 47,5 K Pa)	à l'air libre
Limite de transport	15000 m (100 m bars) (= 10 K Pa)	à l'air libre
Temps de rétablissement	30 minutes si la température de l'instrument passe de -10 °C à +20 °C sous humidité relative de 60 %	
Interférence électromagnétique	Conforme à VDE Störgrad K	

1.2.12. Caractéristiques mécaniques

Dimensions:		
Longueur	445 mm	Poignée et commandes non comprises
Largeur	335 mm	Poignée non comprise
Hauteur	137 mm	Pied non compris
Poids	8,4 kg	

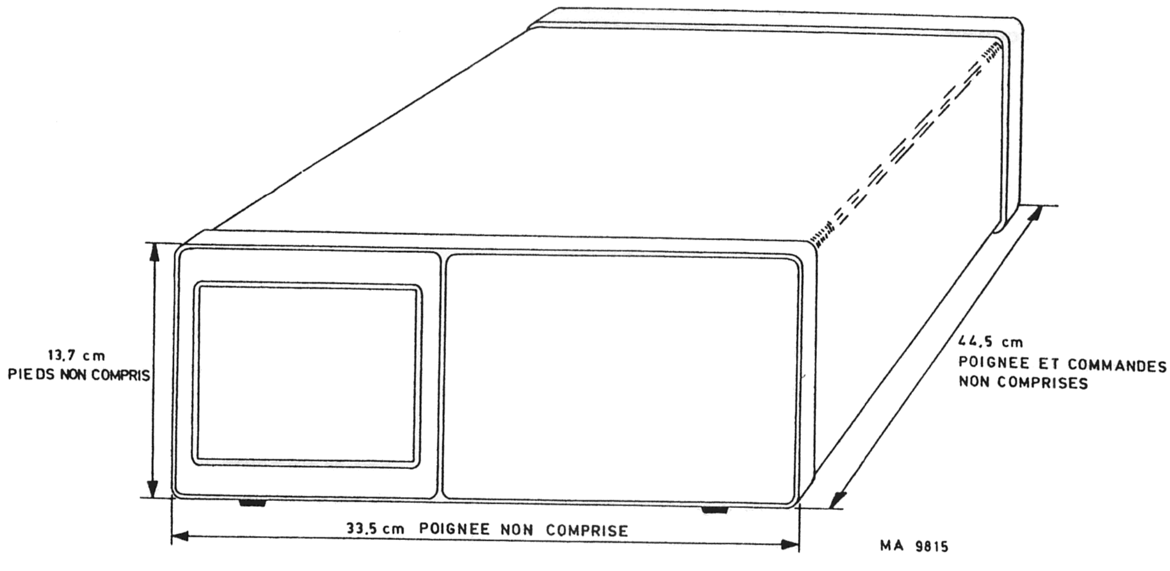


Fig. 1.2. Dimensions

1.3. ACCESSOIRES

1.3.1. Fournis avec l'instrument

Couvercle avant
1 Adaptateur BNC 4 mm
2 Sondes PM 9336/00
Notice d'emploi et d'entretien

1.3.2. En option

PM 8927	Sonde passive 10 : 1 (1,5 m) 75 MHz
PM 8927L	Sonde passive 10 : 1 (2,5 m) 75 MHz
PM 8935	Sonde passive 10 : 1 (1,5 m) 250 MHz
PM 8935L	Sonde passive 10 : 1 (2,5 m) 250 MHz
PM 9335	Sonde passive 1 : 1 (1,5 m) 10 MHz
PM 9335L	Sonde passive 1 : 1 (2,5 m) 10 MHz
PM 9336	Sonde passive 10 : 1 (1,5 m) 25 MHz
PM 9336L	Sonde passive 10 : 1 (2,5 m) 25 MHz
PM 9352	Sonde miniature 150 MHz
PM 9353	Sonde active à FET 150 MHz
PM 9358/01	Sonde HT 100 : 1 150 MHz
PM 9346	Alimentation de sonde
PM 9355	Sonde de courant
PM 8910	Filtre Polaroid
PM 9380	Caméra d'enregistrement
PM 8971	Adaptateur pour PM 9380
M3 ... M5	Caméras d'enregistrement Steinheil
PM 8963	Adaptateur pour montage en rack 19"
PM 9366	Visière repliable
PM 8980	Visière longue
PM 8901	Batteries rechargeables 140 V continues/24 V continue
PM 8991	Table roulante
PM 8997	Malette pour accessoires
Jeu d'outils d'ajustage	

Voir également chapitre 3.5. "INFORMATION CONCERNING ACCESSOIRES".

1.4. DESCRIPTION DU SCHEMA SYNOPTIQUE (voir figure 1.3.)

1.4.1. Voie Y

Les voies verticales A et B pour signaux à représenter sont identiques; elles comprennent chacune un commutateur de couplage d'entrée, un atténuateur d'entrée, un convertisseur d'impédance et un préamplificateur avec étage sélectif de déclenchement.
Un multivibrateur de voies, commandé par les boutons-poussoirs de mode de représentation, commute soit la voie A soit la voie B à l'amplificateur Y de sortie par l'intermédiaire de la ligne à retard.
Ce multivibrateur est piloté par une impulsion en fin de balayage et offre une représentation ininterrompue des formes d'onde A et B en mode ALT. En mode CHOP le multivibrateur fonctionne librement et fournit une représentation découpée des deux signaux. En position ADD, les deux amplificateurs de commutation connectent les deux signaux, ils additionnent les voies A et B. Lorsqu'on inverse l'amplificateur de voie B (PULL TO INVERT B), on obtient le mode A-B.
Les commutateurs AMPL/DIV donnent la commande de gain x1 ou x10 du préamplificateur, offrant avec l'atténuateur une gamme complète des coefficients de déviation dans une progression 1-2-5.

1.4.2. Déclenchement de la base de temps principale

Pour démarrer des balayages, des signaux de déclenchement peuvent être dérivés des préamplificateurs de voie verticale A et B, d'une source externe ou de façon interne de l'alimentation (déclenchement LINE) comme sélectionné à l'aide du commutateur de source de déclenchement.
Lorsque les boutons-poussoirs A et B sont enfoncés, le déclenchement composite est dérivé de l'étage de commande pour la ligne à retard.
La polarité du signal de déclenchement (négatif ou positif) auquel l'affichage est démarré, est déterminé en modifiant la polarité de sortie du convertisseur d'impédance.
Lorsque le commutateur AUTO est enfoncé, le détecteur de niveau crête-à-crête est mis en service. Le niveau crête-à-crête du signal détermine alors la gamme de commande LEVEL.
Lorsque AC ou DC est enfoncé, la gamme de la commande LEVEL est fixe.
En modes TVL et TVF, la commande LEVEL n'est pas en service et le séparateur de synchronisation TV est mis en circuit, ce qui démarre les balayages avec impulsions de ligne ou de trame en fonction de la position du commutateur TIME/DIV.

1.4.3. Circuit de base de temps principale

En fonctionnement normal interne, l'amplificateur horizontal reçoit des balayages du circuit de base de temps.
Lorsque AUTO est enfoncé et en l'absence de signaux de déclenchement, la sortie du générateur de balayage est retournée à son entrée par l'intermédiaire du circuit de blocage et de la porte. Les balayages sont alors libres et une trace résultante est représentée sur l'écran. Dès que le circuit de commande AUTO détecte un déclenchement (par ex. changement à la sortie du circuit logique de déverrouillage), le balayage est retourné au circuit logique de déverrouillage.
Le circuit repasse alors en mode de déclenchement normal, c à d que les balayages ne sont démarrés que par des impulsions de déclenchement à l'entrée du circuit logique de déverrouillage.
Lorsque AC ou DC est enfoncé, la commande AUTO est mise hors service.
Des balayages ne sont produits que si un signal de déclenchement est présent et que la commande LEVEL est adéquatement réglée.
L'affichage peut être agrandi en sens horizontal en accentuant le gain de l'amplificateur de sortie d'un facteur 10 (également en mode X DEFL).
Avec bouton X DEFL du sélecteur horizontal enfoncé, la sortie du générateur de balayage vers l'amplificateur de sortie est bloquée et le convertisseur d'impédance directement connecté à l'amplificateur de sortie. De cette façon, les signaux normalement sélectionnés pour le déclenchement ou une source externe peuvent servir à la déviation horizontale.

1.4.4. Circuit de blocage

L'étage de blocage bloque les déclenchements provenant de l'entrée du circuit de base de temps, jusqu'à ce que la trace soit entièrement retournée et que les circuits de base de temps soient remis à zéro.

1.4.5. Axe Z

L'amplificateur Z sert à supprimer la trace pendant le retour du spot et le temps de blocage. De plus, il supprime le balayage en mode CHOP pendant les phénomènes transitoires de commutation. Les composants basse fréquence du signal de suppression sont modulés et démodulés avant d'être appliqués au cylindre Wehnelt en même temps que les composants haute fréquence couplés en alternatif.

1.4.6. Déclenchement de la base de temps retardée

Pour démarrer les balayages, des signaux de déclenchement peuvent être dérivés des préamplificateurs de voies verticales A et B, ou de la source externe comme sélectionné par le sélecteur de source de déclenchement.
Avec les boutons-poussoirs A et B enfoncés simultanément, le déclenchement composite est dérivé de l'étage de commande de la ligne à retard (amplificateur Y).
Les couplages (continu et capacitif) sont fournis au convertisseur d'impédance. La polarité du signal de déclenchement (négatif ou positif) à laquelle l'affichage est démarré, est déterminée en modifiant la polarité de sortie du convertisseur d'impédance à l'aide du commutateur SLOPE.
Avec MTB la base de temps retardée démarre directement après le retard. La commande DELAY TIME avec le comparateur détermine le retard pour le générateur de base de temps retardée.

1.4.7. Circuit de base de temps retardée

La base de temps retardée est fonctionnelle pour peu que le commutateur TIME/DIV soit en position OFF.
Elle démarre immédiatement après le retard ou à la réception de la première impulsion suivant le retard.
Le signal en dents de scie dérivé du générateur pour balayage de la base de temps principale passe au comparateur, où il est comparé avec une tension continue précisément réglable par la commande DELAY TIME.
La sortie du comparateur est conformée en impulsions et produit l'impulsion de retard requise pour le circuit logique de déverrouillage du générateur de base de temps retardée. Une tension en dents de scie est alors démarrée.
Le balayage retardé est remis à zéro par le circuit de blocage de la base de temps retardée (fin de détection du balayage) ou par la base de temps principale.
Le balayage retardé peut à nouveau être démarré par le signal de sortie du comparateur après le démarrage du balayage suivant de la base de temps principale.
Lorsque le bouton-poussoir MTB du mode de déviation horizontale est sélectionné, la partie de la trace coïncidant au balayage retardé est intensifiée.

1.4.8. Logique de base de temps alternée

En mode ALT TB un commutateur électronique permet de tracer l'affichage de base de temps principale et retardée alternativement sur l'écran.
Les deux affichages peuvent être séparés en faisant varier la tension à l'amplificateur vertical dérivé des circuits de commande du commutateur électronique. Cette séparation est symétriquement variable par la commande TRACE SEPARATION sur le panneau avant.
En mode ALT TB, le multivibrateur de voie verticale est commandé par un signal dérivé du commutateur électronique.
En modes ALT vertical et horizontal sont successivement affichés: voie A et base de temps principale, voie A et base de temps retardée, voie B et base de temps principale, voie B et base de temps retardée.

1.4.9. Alimentation

L'alimentation secteur (réseau) est transformée et rectifiée avant d'être appliquée au convertisseur continu-alternatif.
Lorsque l'appareil est actionné par batteries, la sortie de batterie est directement connectée au convertisseur continu-alternatif.
La sortie du régulateur est couplée à un transformateur et à un rectificateur. Après la rectification, celui-ci fournit le potentiel de tension extrêmement élevé de −1,5 kV et les tensions d'alimentation du circuit.
Le −1,5 kV est multiplié à 8,5 kV afin de fournir la tension d'accélération totale requise de 10 kV environ.

2. Mode d'emploi

2.1. INSTALLATION

2.1.1 Règlements de sécurité (conformes à la IEC 348)

Avant de brancher l'instrument sur le secteur, examiner le coffret, les commandes, les connecteurs, etc. pour s'assurer qu'il n'y a pas eu de dommages en cours de transport. Si l'on constate des défauts, ne pas brancher l'instrument.

Il faut déconnecter l'instrument de toute source de tension et décharger les points sous haute tension avant d'effectuer aucun travail d'entretien ou de réparation. Si les réglages ou l'entretien ne peuvent se faire autrement que sur l'instrument en marche, couvercles déposés, le travail devra être confié à un spécialiste conscient des risques encourus. L'alimentation étant à double isolement, il n'est pas nécessaire de mettre l'appareil à la terre en fonctionnement normal.

Attention: **Il ne faut pas oublier qu'en cours de fonctionnement la masse du châssis de l'oscilloscope est portée au même potentiel que la connexion de terre de la sonde de mesure.**
Ni le câble de masse de la sonde, ni le châssis ne doivent être connectés à des sources de tension dangereuse au toucher.

2.1.2 Branchement sur le secteur et fusibles

Avant de brancher l'appareil sur le secteur, s'assurer qu'il est réglé sur la tension correcte. A sa livraison, l'instrument est réglé sur 220 V. S'il doit être utilisé sur du 110 V, 127 V ou 220 V, il faut l'adapter en modifiant la position du carrousel sur le panneau arrière (voir figure 2.1.).
L'instrument est protégé contre les surcharges par un fusible thermique monté entre les enroulements du transformateur secteur. Pour replacer le fusible, il faut déposer le panneau arrière de l'instrument (voir section 2.4.)

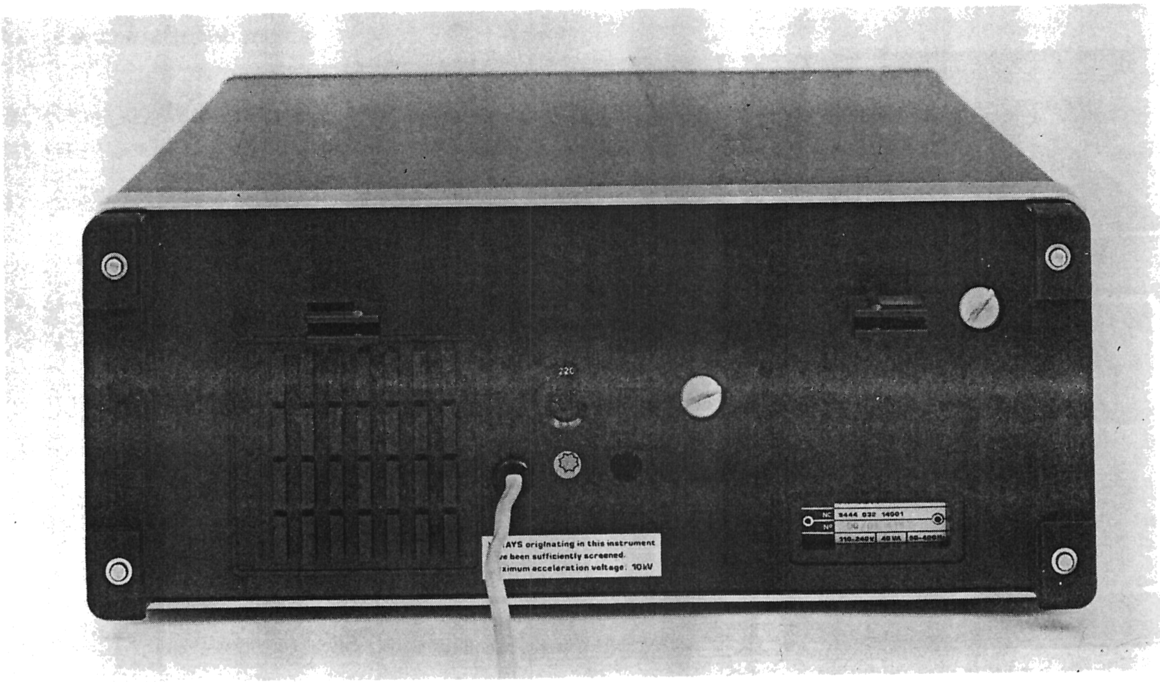


Fig. 2.1. Vue arrière de l'oscilloscope avec carrousel en position 220 V

2.1.3. Branchement sur une alimentation extérieure

On peut connecter une alimentation extérieure ou batterie de 22 à 27 V, capable de fournir au moins 1 A, sur la prise du panneau arrière (câble pourvu d'un fiche: 4822 321 20125).
Le conducteur intérieur doit être connecté au pôle négatif, le conducteur extérieur au pôle positif, comme indiqué sur le panneau arrière.
L'instrument est protégé contre les surcharges et contre le changement de polarité par une diode et un fusible internes. Pour remplacer le fusible, il faut déposer de panneau arrière de l'instrument (voir section 2.4.)

2.1.4. Couvercle avant et position de l'instrument

Pour enlever le couvercle avant, il suffit de le tirer vers soi. On peut employer l'instrument en position horizontale ou suivant plusieurs inclinaisons en se servant de la poignée de transport comme support.
Pour déverrouiller la poignée, enfoncer simultanément les deux boutons de pivotement centraux.

2.2. COMMANDES ET PRISES

Voir la figure 2.2.

2.2.1. Tube cathodique et commandes de puissance

ILLUM POWER ON	Bouton de réglage continu de l'éclairement du graticule; comprend l'interrupteur secteur. La veilleuse indique l'état en circuit.
INTENS	Réglage continu de la brillance de la trace.
FOCUS	Réglage continu de la focalisation du faisceau électronique.
TRACE ROTATION	Réglage par tournevis de l'alignement du tracé sur les lignes horizontales du graticule.

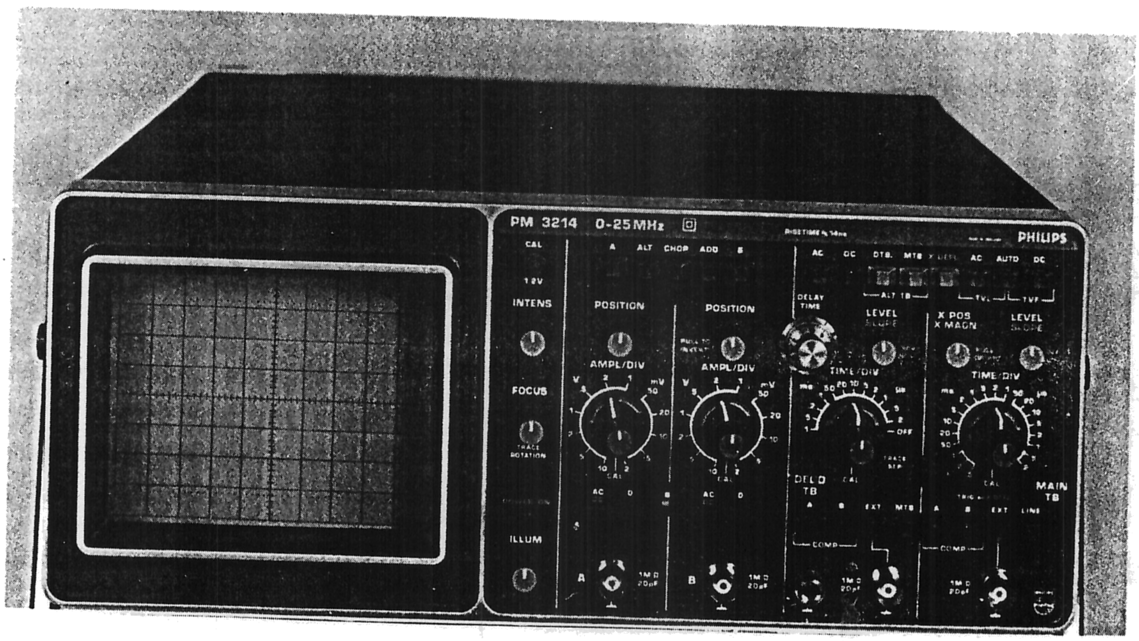


Fig. 2.2. Vue avant de l'oscilloscope montrant les commandes et douilles

2.2.2 Déviation verticale

Commutateur de mode d'affichage	*Fonction*
	5 boutons-poussoirs pour sélection du mode d'affichage verticale. Si aucun bouton n'est enfoncé, l'oscilloscope fonctionne en mode ALT.
A	La déviation verticale est commandée par le signal connecté à l'entrée de la voie A.
ALT	L'affichage passe d'une voie à l'autre à la fin de chaque cycle du signal de base de temps (f ≈ 500 kHz).
CHOP	L'affichage passe d'une voie à l'autre à une fréquence fixe.
ADD	La déviation verticale est la somme des signaux des voies A et B.
B	La déviation verticale est commandée par le signal connecté à l'entrée de la voie B.
POSITION	Commande de décalage vertical continu de la trace.
PULL TO INVERT B	Bouton tirette combiné à la commande POSITION de la voie B. S'il est tiré, il y a inversion du signal de la voie B.
AMPL/DIV (bouton extérieur)	Réglage échelonné des coefficients de déviation verticale, de 2 mV/div à 10 V/div dans la progression 1-2-5.
AMPL/DIV (bouton central)	Réglage continu des coefficients de déviation verticale. Le coefficient de déviation n'est étalonné que si le bouton central est en position CAL (position extrême droite).
Commutateur de couplage d'entrée	Couplage de signal; deux boutons-poussoirs.
AC (enfoncé)	Couplage via un condensateur d'arrêt.
DC (libéré)	Couplage direct.
O (enfoncé)	La connexion entre le circuit d'entrée et la prise d'entrée est coupée et le circuit d'entrée est mis à la terre.
A (1 MΩ//20 pF)	Prise BNC pour entrée de la voie A.
B (1 MΩ//20 pF)	Prise BNC pour entrée de la voie B.

2.2.3 Déviation horizontale

Commutateur de source	*Fonction*
DTB – MTB – X DEFL └ALT TB┘	Commandes de la déviation horizontale; par commutateur à trois boutons-poussoirs
DTB enfoncé	La déviation horizontale est fournie par le générateur de base de temps retardée.
MTB enfoncé	La tension de déviation horizontale est fournie par le générateur de base de temps principale. Une partie de la trace est intensifiée quand la base de temps retardée est en opération. Le générateur de base de temps retardée est hors circuit en position OFF du commutateur DTB TIME/DIV. Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton MTB est enfoncé (seulement commande MTB LEVEL est hors circuit).
DTB – MTB └ALT TB┘	Si les boutons DTB et MTB sont enfoncés à la fois, la déviation horizontale est fournie par les générateurs de base de temps principale et retardée, de façon alternée.
X DEFL enfoncé	La déviation horizontale est fournie par un signal d'origine extérieure appliqué à la prise d'entrée de l'amplificateur horizontal, par le signal de voie A, par le signal de voie B ou par un signal à la fréquence du secteur.

X POS X MAGN	Commande de réglage continu du décalage horizontal de la trace; comporte un bouton tirette qui multiplie par 10 la déviation horizontale. Le bouton X MAGN est opérant aussi quand un signal externe est utilisé pour la déviation horizontale.
TRACE SEP	Commande continuellement variable de la distance verticale entre les affichages de base de temps en mode ALT.TB.

2.2.4 Générateur de base de temps principale

LEVEL SLOPE (IN+, OUT –)	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auqúel le générateur de base de temps principale démarre. Cette commande comporte un bouton tirette qui permet de déclencher sur le front positif ou négatif du signal de déclenchement. En TV, il faut choisir – pour les signaux vidéo négatifs et + pour les signaux vidéo positifs.
Commutateur de mode de déclenchement	*Fonction*
AC AUTO DC └ TVL ┘└ TVF ┘	Choix du mode de déclenchement par trois boutons-poussoirs. Si aucun bouton-poussoir n'est enfoncé, il y a automatiquement sélection du mode automatique et la gamme de niveau est fixe.
AUTO enfoncé	Il y a affichage d'une trace en l'absence de signaux de déclenchement. La gamme de réglage du niveau est proportionnelle à la valeur crête à crête du signal de déclenchement.
AC enfoncé	Déclenchement normal et gamme fixe de réglage de niveau. Le composant continu du signal de déclenchement est bloqué.
DC enfoncé	Déclenchement normal et gamme fixe de réglage de niveau. Le composant continu du signal de déclenchement est transmis.
AC – AUTO └ TVL ┘	Il y a synchronisation ligne (AC et AUTO enfoncés à la fois).
AUTO – DC └ TVF ┘	Il y a synchronisation trame (AUTO et DC enfoncés à la fois)
Commutateur de source	*Fonction*
A – B – EXT – LINE └COMP┘	Quatre boutons-poussoirs permettent de choisir la source de déclenchement (ou la source de déviation horizontale si le bouton X DEFL est enfoncé). Si aucun des boutons-poussoirs n'est enfoncé, la source A est choisie.
A enfoncé	Signal fourni par la voie A.
B enfoncé	Signal fourni par la voie B.
COMP (A & B enfoncés à la fois)	Signal fourni après le commutateur électronique (inopérant avec X DEFL)
EXT enfoncé	Signal externe fourni à prise adjacente 1 Mohm//20 pF
LINE enfoncé	Signal fourni par la tension secteur (inopérant si l'instrument est alimenté par batterie).
TIME/DIV (bouton extérieur)	Choisit la vitesse de balayage entre 0,2 µs/div et 0,5 s/div dans une progression 1-2-5.
TIME/DIV (bouton central)	Réglage continu des vitesses de balayage. Doit être en position CAL (c'est à dire en position extrême droite) pour l'étalonnage de l'axe du temps suivant l'indication du commutateur TIME/DIV.
1 MΩ – 20 pF	Prise BNC pour déclenchement externe ou déviation horizontale.

2.2.5 Générateur de base de temps retardée

LEVEL SLOPE (IN +, OUT –)	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps retardée démarre; gamme fixe de réglage de niveau. Cette commande comporte un bouton tirette qui permet de déclencher sur le front positif ou négatif du signal de déclenchement.
Commutateur de mode de déclenchement	*Fonction*
AC – DC	Choix du mode de déclenchement par deux boutons-poussoirs.
AC enfoncé	Déclenchement normal et gamme fixe de réglage de niveau. Le composant continu du signal de déclenchement est transmis.
DC enfoncé	Déclenchement normal et gamme fixe de réglage de niveau. Le composant continu du signal de déclenchement est transmis.
DELAY TIME	Commande continuellement variable du temps de retard utilisée en association avec les commandes TIME/DIV du générateur de base de temps principale.
Commutateur de source	*Fonction*
A – B – EXT - MTB └COMP┘	Choix de la source de déclenchement et point de démarrage du générateur de base de temps retardée. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la bouton MTB était enfoncé.
A enfoncé	Signal de déclenchement interne fourni par la voie A.
B enfoncé	Signal de déclenchement interne fourni par la voie B.
COMP (A & B enfoncés à la fois)	Signal de déclenchement fourni après le commutateur électronique. Déclenchement par le signal affiché après le temps de retard sélectionné.
EXT enfoncé	Signal de déclenchement externe fourni à prise adjacente 1 Mohm//20 pF.
MTB enfoncé	Signal de déclenchement interne fourni par la base de temps principale pour démarrer la base de temps retardée immédiatement après le temps de retard sélectionné.
TIME/DIV (bouton extérieur)	Choisit la vitesse de balayage entre 2 μs/div et 1 ms/div dans une progression 1-2-5. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est mis hors circuit.
TIME/DIV (bouton central)	Réglage continu des vitesses de balayage. Doit être en position CAL (c'est à dire en position extrême droite) pour l'étalonnage de l'axe de temps suivant l'indication du commutateur TIME/DIV.
1 MΩ//20 pF	Prise BNC pour le signal de déclenchement externe.

2.2.6 Divers

CAL	Prise de sortie fournissant une onde carrée de $\approx$ 2 kHz et une amplitude de 1,2 V_{CC} $\pm$ 1 %. A utiliser pour compenser la sonde et/ou contrôler la précision de la déviation verticale.
DC POWER IN	Une prise d'entrée à l'arrière de l'instrument permet de le faire fonctionner sur une alimentation externe en courant continu. Tension d'alimentation 22 à 27 V; courant disponible $>$ 1 A.
Adaptateur de tension secteur	Le régler conformément à la section 2.1.2. avant de brancher l'instrument sur la tension secteur locale.

2.3. INSTRUCTIONS D'UTILISATION

2.3.1 Mise de l'instrument en circuit

Avant de connecter l'instrument à une source quelconque d'alimentation, il faut exécuter soigneusement les instructions de la section 2.1.
Normalement, l'oscilloscope fonctionne conformément à ses spécifications (voir section 1.2.) après une période d'échauffement d'environ 15 minutes. Toutefois, s'il à été exposé à une ambiance extrêmement froide, (par example laissé la nuit dans une voiture par temps de gel) et qu'on l'amène dans une pièce chauffée, il faut tenir compte d'une période d'échauffement suffisante (voir 1.2.11).

2.3.2 Réglage préliminaire des commandes

Les opérations décrites ci-après donnent une indication générale de la correction de fonctionnement de l'oscilloscope. Elles constituent un préalable utile à l'exécution des mesures.
Voir la figure 2.2 pour la position des commandes.
Mettre les commandes INTENS et FOCUS en position médiane. Enfoncer AUTO et choisir une vitesse de balayage moyenne comprise entre 10 μs/div et 10 ms/div à l'aide du commutateur TIME/DIV.
Les autres boutons-poussoirs étant en position normale (non enfoncés), on peut positionner la trace des voies A et B sur l'écran à l'aide des commandes appropriées. Donner aux traces une brillance moyenne à l'aide de la commande INTENS et régler leur netteté à l'aide de la commande FOCUS.

2.3.3 Couplage d'entrée (AC/DC, 0)

Le couplage AC ou capacitif (bouton enfoncé) permet de bloquer le composant continu d'un signal.
Le choix du couplage capacitif limite les fréquence inférieurs, provoquant ainsi l'atténuation des signaux sinusoïdaux à faible fréquence et la distortion des ondes carrées à faible fréquence. Le degré d'atténuation est déterminé par le temps d'entree RC (0.1 s). Le temps d'entrée RC est multiplié par 10 si l'on emploie des sondes passives 10:1.
Lorsqu'on passe au couplage capacitif, il faut attendre environ cinq fois le temps d'entrée RC avant que la trace se stabilise à la valeur moyenne du signal d'entrée. Les mesures de position AC ne peuvent être faites par rapport à la masse.

La position 0 déconnecté la source d'entrée et court-circuite l'entrée de l'amplificateur pour le contrôle du signal zéro.

Le couplage DC ou continu (bouton libéré) couvre toute la bande passante, c'est à dire jusqu'au courant continu.

2.3.4 Emploi des sondes

Les sondes passives 1 : 1 ne doivent être employées que pour le courant continu et les basses fréquences.
La charge capacitive atténue les hautes fréquences ou augmente le temps de montée des signaux de mesure (en fonction de l'impédance de source).
Les sondes passives 10:1 ont une charge capacitive moins grande, généralement environ 10 pF à 20 pF.
Les sondes FET sont supérieures, en particulier si les mesures doivent être prises en des points à impédance élevée ou à la limite supérieure de la bande de fréquence de l'oscilloscope.
Les sondes passives 10 : 1 doivent être compensées correctement avant emploi. Une compensation incorrecte provoque la distorsion des impulsions ou des erreurs d'amplitude aux fréquences élevées.
Pour un réglage correct, on peut utiliser la prise de sortie CAL (voir figure 2.3).

2.3.5. Réglage des sondes atténuatrices

- Connecter la boîte de compensation à la douille A et mettre la pointe de la sonde à la douille CAL.
- Introduire un petit tournevis par l'ouverture de la boîte de compensation et ajuster le trimmer afin d'obtenir un affichage correct comme illustré à la figure 2.3.

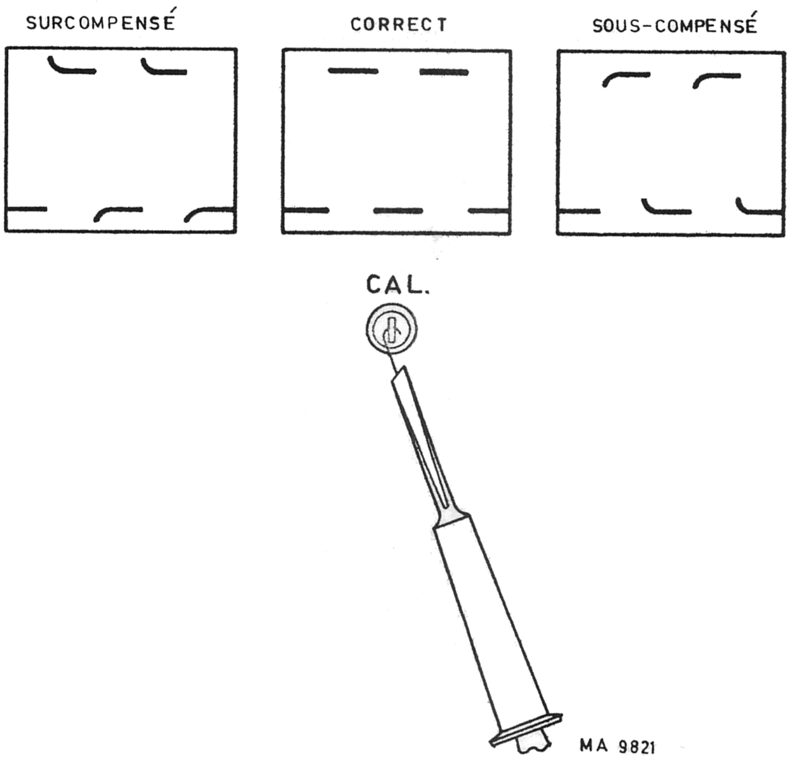


Fig. 2.3. Ajustage d'une sonde atténuatrice

2.3.6. Choix entre modes commuté et alterné

(A .. ALT .. CHOP .. ADD ... B)

En fonctionnement à double trace (CHOP ou ALT enfoncé), il faut choisir le mode commuté (CHOP enfoncé) pour des vitesses de balayage relativement faibles (de 0,1 ms/div à 0,5 s/div) ou pour des faibles fréquences de répétition du balayage, même s'il est rapide. Les choix du mode alterné (ALT) dans ces conditions rendrait difficile la comparaison des formes d'ondes, parce que les traces apparaîtraient en fait successivement. Toutefois, si l'affichage est assez rapide pour être interrompu par la fréquence de commutation, il faut choisir le mode alterné (enfoncer ALT), généralement pour des vitesses de balayage supérieures à 0,1 ms/div.

2.3.7. Mode différentiel

On peut choisir le mode A – B en enfonçant ADD et en tirant la commande POSITION de la voie B.
Dans les mesures au cours desquelles il y a réception de signaux de mode commun de valeur appréciable (par exemple ronflement), le mode différentiel annule ces signaux pour ne conserver que la valeur intéressante (A – B). L'amplitude de l'oscilloscope à supprimer les signaux de mode commun est donnée par le coefficient de réjection mode commun (CMR) (voir figure 2.4).
Pour obtenir le degré spécifié de réjection mode commun, il faut tout d'abord égaliser les gains respectifs des voies A et B. On peut obtenir ce résultat en connectant les deux voies au connecteur CAL et en ajustant l'un des commutateurs AMPL/DIV pour une déviation minimale sur l'écran.
Si l'on emploie des sondes passives 10 : 1, il est recommandé d'employer une méthode d'égalisation similaire consistant à régler leurs commandes de compensation pour une déviation minimale.

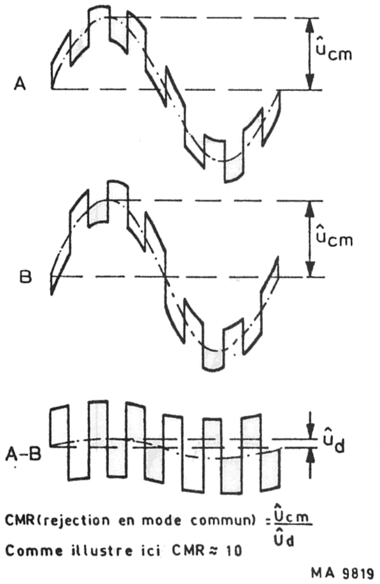


Fig. 2.4. Réjection en mode commun

2.3.8. Choix du mode de déclenchement

(AC AUTO DC)
└TVL ┘└ TVF┘

Le mode AUTO est des plus utiles parce qu'il fournit une trace ou plusieurs traces sur l'écran, même en l'absence de signaux de déclenchement. De plus, pour un signal d'amplitude supérieur à 1 division, ce mode fournit un déclenchement stable indépendamment du réglage de niveau (LEVEL); sa gamme est automatiquement réglée sur la valeur crête à crête du signal choisi pour le déclenchement.
Cela facilite le réglage du niveau (LEVEL) à faibles amplitudes du signal de déclenchement.
Le mode AUTO ne peut être employé pour les signaux à faible fréquence de répétition (10 Hz ou moins) parce qu'il y aurait alors balayage en relaxé entre les déclenchements. Il faut donc utiliser le déclenchement normal (AC ou DC enfoncé) pour les signaux à faible fréquence de répétition.
En déclenchement normal, il n'y a balayage que si un signal de déclenchement est fourni et que le réglage de niveau (LEVEL) est approprié.
AC ou DC étant enfoncé, la gamme du niveau est fixe (+ou – 8 divisions ou plus de part et d'autre du milieu de l'écran). On peut bloquer le composant continu du signal de déclenchement en enfonçant AC. C'est utile, si le déclenchement doit être provoqué par des signaux alternatifs superposés à un niveau continu important.
En couplage capacitif, le niveau auquel l'affichage commence varie avec les modifications de la valeur moyenne du signal de déclenchement). Le niveau de référence du signal n'est donc plus rapporté au niveau de référence du signal. Ceci peut être une source d'instabilité des formes d'ondes avec variation de leur durée d'un cycle à l'autre. Il est normalement préférable d'employer la position DC.

Le choix de la pente s'effectue à l'aide du bouton-poussoir +/–. Dans le mode TV il faut choisir – pour les signaux vidéo négatifs et + pour les signaux vidéo positifs. La commande LEVEL est inopérante dans le mode TV.

Le non enfoncement des boutons offre une possibilité supplémentaire: l'écran affiche une trace en l'absence d'un signal de déclenchement, mais la gamme de niveau est fixe.

2.3.9. Source de déclenchement

La source de déclenchement de la base de temps retardée se choisit à l'aide des boutons-poussoirs TRIG ou X DEFL en façade.

A B EXT LINE
└ COMP ┘

- *Le déclenchement interne* est le plus couramment employé parce qu'il ne demande qu'un signal (le signal d'entrée) pour obtenir un déclenchement stable.
- *Déclenchement externe.* Si l'on affichage de nombreux signaux, il est de se servir du signal externe pour le déclenchement. Il n'est pas nécessaire de régler à nouveau les commandes de déclenchement (LEVEL, SLOPE et SOURCE) à chaque changement de signal d'entrée. De plus, les deux entrées A et B restent libres pour l'examen des formes d'onde.
- *Choix de la source de déclenchement.* Pour comparer les formes d'ondes dont les fréquences sont des multiples les unes des autres, toujours choisir comme source de déclenchement le signal qui à la fréquence de répétition la plus faible.

  Sinon, on risque d'obtenir des images doubles (mode commuté) ou des décalages de temps incorrects (mode alterné).
- *Déclenchement mixte.* Dans le mode interne, les signaux de déclenchement sont fournis par les étages préamplificateurs de la voie A, ou de la voie B ou encore, si on choisit COMP en enfonçant à la fois les boutons A et B, par l'étage de commande de ligne à retard qui suit le commutateur électronique.

  Le déclenchement mixte offre trois avantages:
  1. Dans le mode différentiel (A-B) le déclenchement est assuré par le signal différentiel et n'est donc pas perturbé par les signaux de mode commun.
  2. Pour le fonctionnement monovoie, il n'est pas nécessaire de commuter les sources de déclenchement de A à B ou vice-versa.
  3. Dans le mode alterné, il est possible de comparer des signaux sans relation chronologique.

  Remarque: Si on emploie le déclenchement mixte en fonctionnement bivoie (commuté ou alterné) et qu'un seul signal est fourni (à l'entrée A ou B), on ne peut obtenir un déclenchement stable. C'est normal vu que la source de déclenchement est également commutée de A à B (voir figure 2.5).
- *Le déclenchement par la fréquence secteur* 50 Hz est utile si le signal est lié à la fréquence secteur.

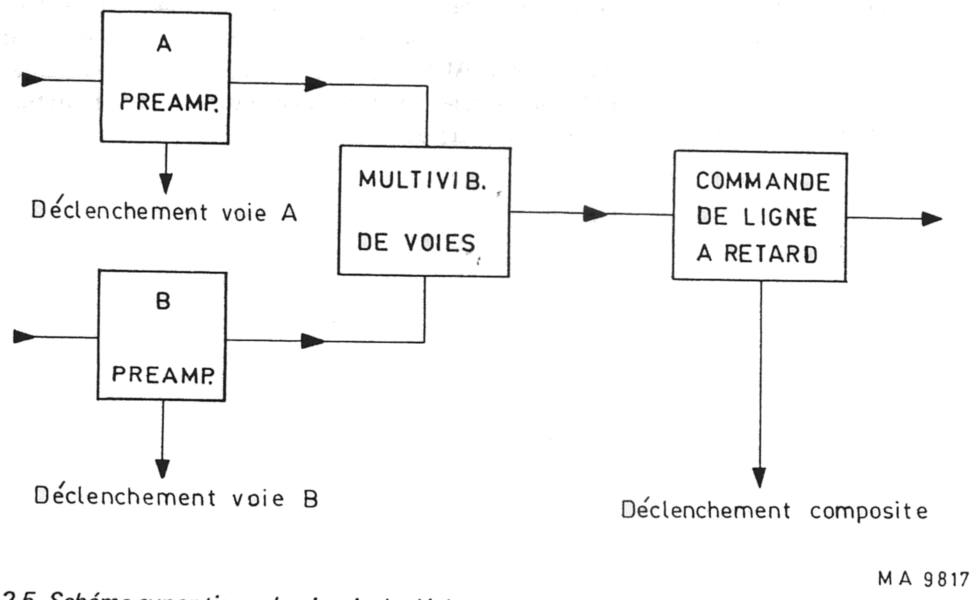


Fig. 2.5. Schéma synoptique du circuit de déclenchement mixte

2.3.10. Agrandisseur de base de temps

L'agrandisseur est actionné par traction du commutateur incorporé dans la commande de positionnement X. Lorsque ce commutateur est en position x10, le vitesse de balayage de base de temps est agrandie 10 fois. Aussi le temps de balayage est-il obtenu en divisant par 10 la valeur TIME/DIV indiquée.

2.3.11. Mesures XY

Les mesures XY s'effectuent avec le commutateur TIME/DIV en X DEFL, la source de déviation horizontale étant choisie à l'aide du EXT X DEFL ou du bouton-poussoir TRIG (A, B, EXT ou LINE).
Les mesures XY constituent un moyen utile de comparer des fréquences ou d'étudier des déphasages par l'affichage de figures de Lissajous.
Les mesures peuvent se fair jusqu'à 100 kHz avec une erreur de phase inférieure à 3° entre les voies de l'oscilloscope.

Le tableau suivant indique la sensibilité dans les différents modes XY:

X DEFL	SENSIBILITE
A	AMPL/DIV A ± 10 %
B	AMPL/DIV B ± 10 %
EXT	0,5 V/DIV ± 10 %
LINE	8 divisions à tension secteur nominale

2.3.12. Utilisation de la base de temps retardée

La base de temps retardée peut être utilisée pour l'étude précise de signaux complexes. Lorsque le bouton-poussoir MTB des commandes de déviation horizontale est actionné, la base de temps retardée est démarré après le temps de retard sélectionné (si le commutateur TIME/DIV n'est pas sur OFF) et une portion du signal affiché est intensifiée. La commande DELAY TIME permet de décaler cette partie intensifiée le long de l'axe des temps,
La durée de cette portion (c'est à dire sa longueur) peut être commandée par échelons et de façon continue à l'aide des commandes TIME/DIV du générateur de base de temps retardée. Lorsque le bouton-poussoir DTB des commandes de déviation horizontale est enfoncé, la portion intensifiée occupe la largeur totale de l'écran. En position DTB, le retard (c'est à dire l'intervalle entre les points de démarage des bases de temps principale et retardée) est déterminé par les réglages de commandes TIME/DIV de la base de temps principale et de la commande DELAY TIME.

Le PM 3214 est équipé d'une commutation de l'affichage. De la sorte, on peut obtenir une représentation simultanée du signal sur les deux échelles de temps à partir de chaque base de temps (principale et retardée). En mode ALT TB, une certaine portion de l'affichage de base de temps principale est examinée en détail; pour ce faire, l'intervalle de témps est accrû à l'aide de la base de temps retardée. A cet effet, on choisit un balayage plus rapide pour la commande TIME/DIV de la base de temps retardée et on détermine l'intervalle de temps avec le potentiomètre DELAY TIME.

La portion de signal détaillée à l'aide de la base de temps retardée reste une portion intensifiée de l'affichage de base de temps principale. On peut donc facilement localiser le détail requis et de plus obtenir une indication visuelle de la portion par rapport à la trace examinée. Le mode ALT TB permet donc de voir immédiatement la corrélation existant entre une portion détaillée et la trace totale – parfois très complexe – sans toutefois devoir passer de la base de temps principale à la base de temps retardée ou vice-versa.

2.4. PROCESSUS REQUIS A LA DEPOSE DE FUSIBLES, VISIERE ET PLAQUE DE CONTRASTE

2.4.1. Dépose des couvercles

Toujours s'assurer que l'appareil est débranché avant de déposer les couvercles et plaques de l'appareil.
L'appareil est protégé par trois couvercles: un couvercle de protection à l'avant, une enveloppe avec poignée et une plaque arrière.
Pour faciliter la dépose de l'enveloppe et la plaque arrière, s'assurer d'abord que le couvercle avant est bien en position.

Procéder comme suit:
- Pivoter la poignée du couvercle avant. Pour ce faire, enfoncer les deux boutons centraux (Fig. 2.6.).
- Placer l'appareil avec couvercle frontal sur une surface plane.
- Desserrer les vis de la plaque arrière.
- Soulever la plaque arrière et déficher le connecteur sur la platine d'alimentation.
- Soulever l'enveloppe.
- Pour accéder au panneau avant, mettre l'appareil en position horizontale et déboîter le couvercle frontal.

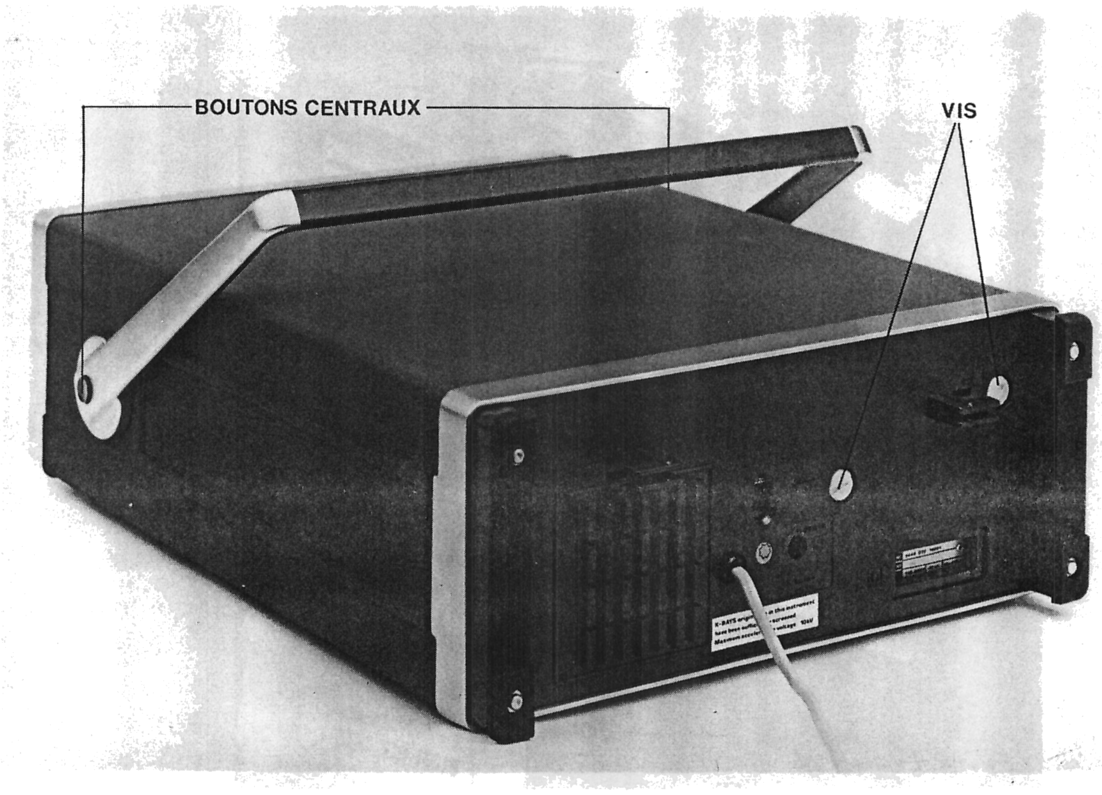


Fig. 2.6. Dépose des couvercles et de la poignée de l'appareil

2.4.2. Dépose du transformateur secteur

- Déposer l'enveloppe et le panneau arrière (section 2.4.1.).
- Enlever le couvercle du compartiment d'adaptateur de tension après dépose des 4 vis.
- Déposer les 4 vis du couvercle du compartiment de transformateur.
- Soulever le couvercle avec transformateur tout en faisant coulisser le fil entre le transformateur et l'adaptateur de tension de l'encoche pratiquée dans le compartiment de transformateur.
- Le transformateur et le fusible thermique sont alors accessibles.

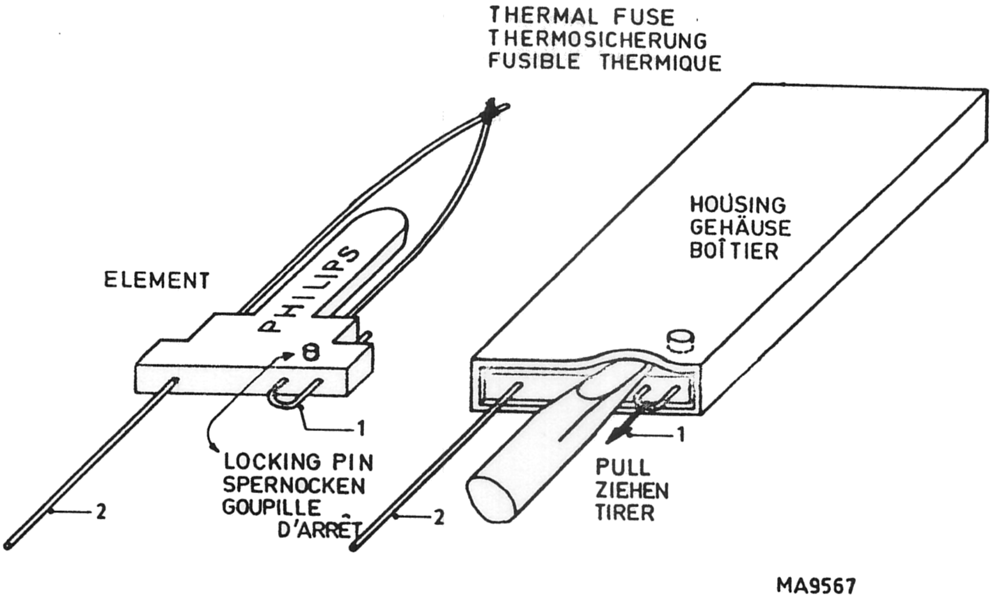


Fig. 2.7. Remplacement d'un fusible thermique

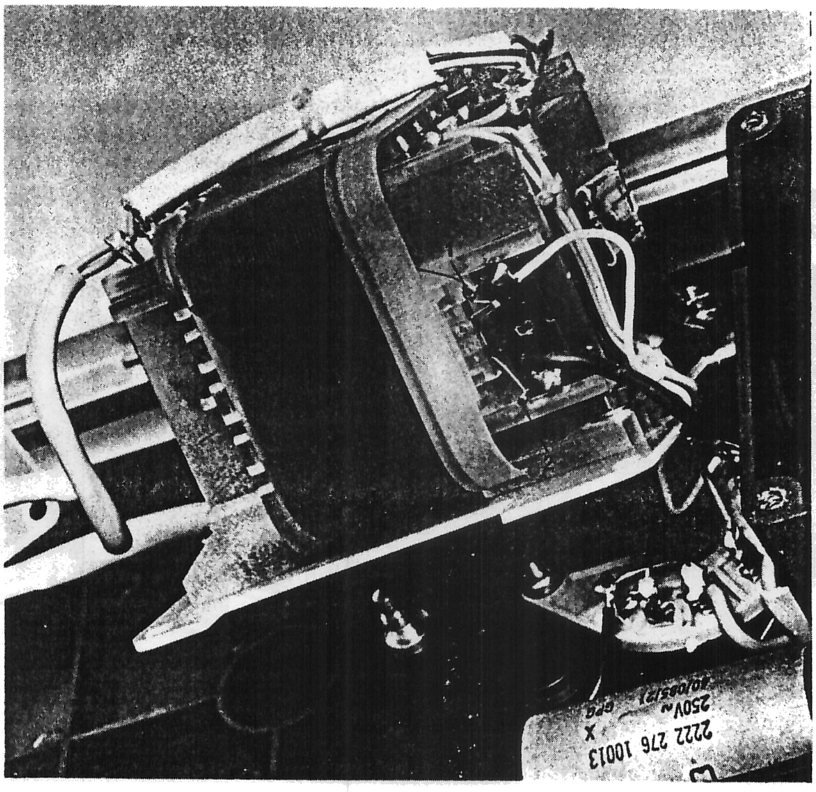


Fig. 2.8. Remplacement d'un fusible thermique

2.4.3. Remplacement d'un fusible thermique F101

- Déposer le transformateur secteur (section 2.4.2.).
- Dessouder les bornes de fusible 1 et 2 (Fig. 2.7. et 2.8.)
- Seul le fil de fusible est remplacé; à cet effet, plier légèrement vers l'extérieur, dégager le verrouillage et extraire le fil.
- Prendre un nouveau fusible et enlever le fil de fusible comme décrit précédemment.
- Enfoncer le nouveau fil dans l'ancien fusible jusqu'à ce que la goupille d'arrêts s'adapte dans le trou avec un déclic,la boucle du fil pointant vers la borne 1.
- Souder le fil de fusible aux bornes 1 et 2.

2.4.4. Remplacement du fusible F201

- Déposer l'enveloppe et le panneau arrière (section 2.4.1.).
- Fusible F201, lequel est situé sur le circuit imprimé de l'alimentation, est alors accessible en vue de son remplacement.

2.4.5. Dépose de la visière et de la plaque de contraste

- Prendre les coins inférieurs de la visière et la déposer du panneau avant par légère traction (Fig. 2.9.).
- Le filtre contraste est facilement démontable hors de la visière par légère pression.

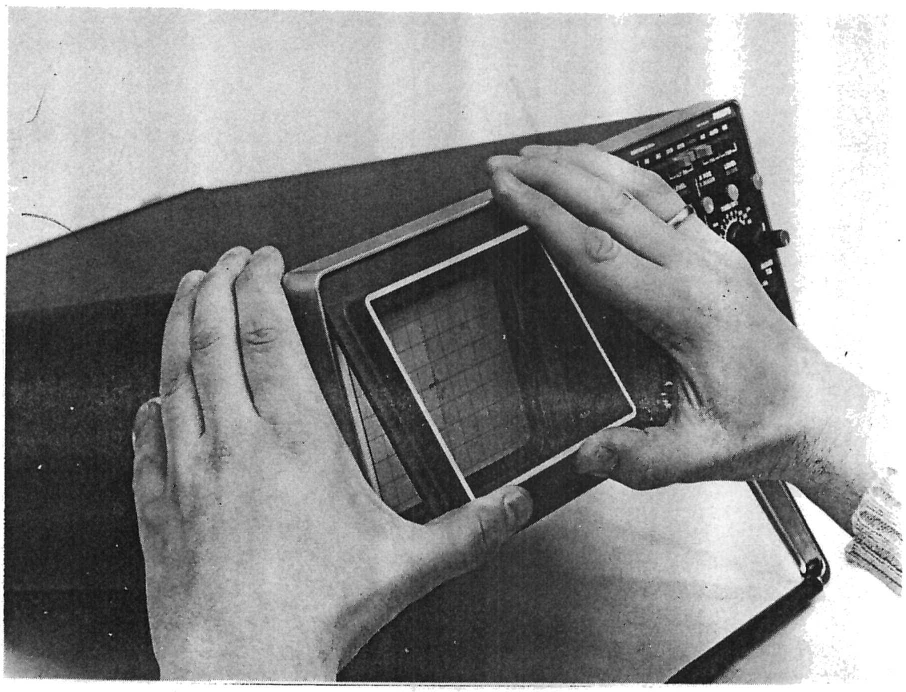


Fig. 2.9. Dépose de la visière et de la plaque de contraste.

Service manual

Contents

FIGURES

3.1. CIRCUIT DESCRIPTION

3.1.1. Vertical deflection system

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube.
The individual stages of the vertical deflection system are now described in some detail.
As the signal paths for channel A and channel B are basically identical, only the channel B signal path is described.

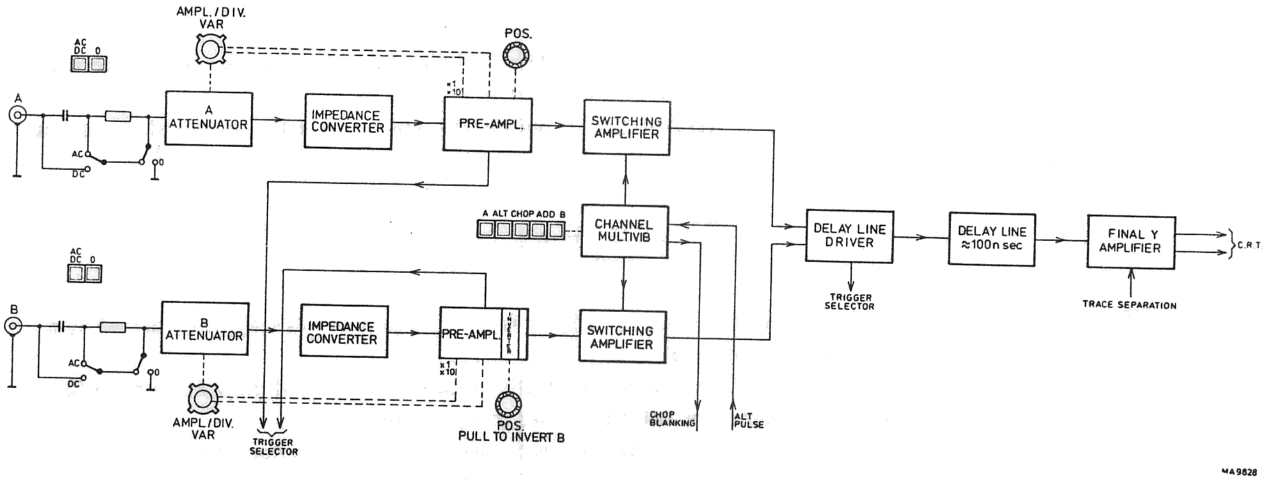


Fig. 3.1. Vertical deflection system

3.1.1.1. Input coupling

Input signals connected to the B input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected.
In the AC position of S19, there is a capacitor (C401) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier.
In position DC of switch S19, the input signal is coupled directly to the step attenuator.
At the same time, blocking capacitor C401 is discharged via R402, to prevent damage of the circuit under test by a possible high charge.
S20 (0) isolates the B input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

3.1.1.2. Input attenuator

The input attenuator is a frequency-compensated, high-impedance voltage divider with twelve positions. The overall attenuation of the stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the twelve positions of the frontpanel AMPL/DIV attenuator switch S11.

The first divider sections attenuate by a factor of 1.25, 3.125 and 6.25 and the second divider sections attenuate by a factor of 1x, 10x and 100x.
With the overall combinations of attenuation, nine Y deflection coefficients are realised from 20 mV/div. to 10 V/div. in a 1-2-5-sequence. Only for the most sensitive positions 2 mV/div., 5 mV/div. and 10 mV/div. of AMPL/DIV attenuator switch S11, the gain of the Y amplifier is increased by a factor of 10.
The input capacitance of the attenuator cannot be adjusted in the individual positions. Small differences of approx. 1 pF are allowed.
The voltage divider sections are made independent of the input frequency over the frequency range of the oscilloscope (i.e. 25 MHz) by means of trimmers C407, C413, C414, C416, C417, C418 and C419.

3.1.1.3. *Impedance converter*

The impedance converter is formed by V604 (two matched field-effect transistors). The two FET transistors are used in source follower configuration.
The signal level on the gate (and on the source) of the upper FET amounts to 1,6 mV/div. or 16 mV/div.
Diode V601 together with the output impedance of the attenuator and also the attenuator action protects the input source follower against excessive negative input signals. The d.c. balance of the circuit can be adjusted with R604, providing attenuator balance for the 10 mV/div. and 20 mV/div. positions.

3.1.1.4. *Preamplifier*

D601, V606 and V607 form a symmetrical cascode circuit. The Darlington pair input stages are fed from a constant-current source and direct coupling is employed throughout.
In the positions 20 mV/div. – 10 V/div. of the AMPL/DIV switch S11, contact K601 is open and the gain is determined by:

$$\frac{R632 + R633}{R612 + R613} = \text{approx. } 0,6x$$

If K601 is closed (in positions 2 mV/div., 5 mV/div. and 10 mV/div.) the gain of this stage is increased by a factor of 10. This is accurately adjusted with R619.
To prevent jumping of the trace when K601 is switched with the input short circuited, no voltage must be present across these contacts. R604 (attenuator balance) serves this purpose.
R10 in conjunction with R621, R622, R623 and R626 forms the vernier control. In the calibrated position (R10 is 1 kOhm) the transfer of this network is 0,9x. With R10 to its minimum position (0 Ohm) the transfer is 0,3x. Thus we have a control range of 3x.
V608, V609, V613, V614, V616 and V617 form a second symmetrical cascode circuit supplying an output CURRENT to the channel switch.
The transfer conductance of this stage is:

$$\frac{i\ out}{U\ in} = \frac{1}{R641\ //\ (R637+R638)\ //\ (R646+R647+R648)} = 10\ mA/V$$

The signal level at the input of this stage is approx. 7 mV/div. equivalent to approx. 70 µA/div. at the output.

Note: *The channel A gain can be equalised to the channel B gain with the aid of R543 (gain x1 in channel A amplifier).*

3.1.1.5. *Trigger pick-off*

The trigger signal is picked-off at the emitters of V608 and V609, a signal source with a low internal resistance, by the series feed-back stage V611 and V612.
From this stage the trigger signal currents are fed symmetrically to the main time base and delayed time base trigger selectors via 50 Ohm cables.

3.1.1.6. *Normal invert switch*

The B channel has a provision for inverting the polarity of the Y signal. Push-pull switch S5, PULL TO INVERT B, is mounted on the shaft of front-panel control B POSITION. In the invert position of the switch the normal signal paths are blocked because V613 and V614 are switched off.
Inversion is achieved by V616 and V617 providing alternative paths for the signal when their bases are switched less positive by S5. Possible unbalance between the two positions of the switch can be compensated by preset potentiometer R647 normal/invert balance.

3.1.1.7. *Position control*

Potentiometer R3 is the vertical POSITION control. Its balance is adjustable by means of R674 (shift balance).

3.1.1.8. *Channel multivibrator*

The channel multivibrator consists of two circuits which are inserted in the A and B channel signal paths. The A channel circuit consists of the transistors V524, V526 and the diodes V521, V522 and V523. The B channel circuit consists of the transistors V624 and V626 and the diodes V621, V622 and V623.
When the junction of the three diodes is positive in relation to mass, the diodes are non-conductive. The transistors, and thus, the signal path are conductive.
If the current drained from the junction exceeds 6 mA, the diodes are conductive and the transistors are turned off.
The circuits are driven from the flip-flop formed by the transistors V703 and V704.
With A (S1A) depressed: only channel A is displayed.
The base of V703 is connected to the –12 V supply voltage.
V703 is turned-off then, its collector voltage is high and channel A is switched on. At the same moment channel B is switched off.

With ALT (S1B) depressed: channels A and B are alternately displayed.
This push-button is a dummy and has no contacts, but it releases all the other push-buttons of the display-mode controls. In this mode there is a DC path via R704 between the two emitters, the circuit is bi-stable and one of the diodes is conductive.
V1668 is not conducting in ALT mode and negative going alternate pulses derived from the alternate time-base logic are fed to the circuit. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.
In ALT TB mode the circuit is switched at the end of every two sweeps.

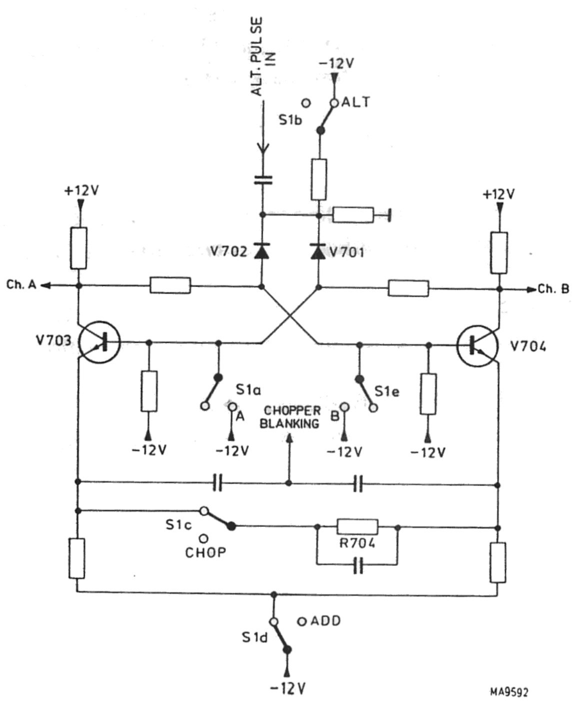


Fig. 3.2. Simplified diagram of the channel multivibrator

In the ALT mode −12 V is applied via S1A, S1C, S1D and S1E and R1687 to transistor V1511 in the beam blanking amplifier. This transistor is then blocked and the only control signals for the beam unblanking amplifier are the normal unblanking pulses coming from the time-base circuits.

With CHOP (S1C) depressed: channels A and B are chopped.
In this mode the circuit acts as a chopper generator. S1C is open then, the DC path between the emitters of V703 and V704 is interrupted and the circuit is a-stable. Both diodes V701 and V702 are then turned-off and the circuit starts oscillating, the oscillating frequency being approx. 500 kHz.
During the switching transients in the CHOP mode, the c.r.t. is blanked with the aid of differentiated chopper blanking pulses (at the junction of R703 and C704) which are fed to the Z-amplifier.

With ADD (S1D) depressed: channel A and B are added. Both transistors are turned-off, both collector voltages are high and both channels are switched on.

With B (S1E) depressed: only channel B is displayed.
The base of V704 is connected to the −12 V supply voltage. V704 is then turned-off, its collector voltage is high and channel B is switched on. At the same moment channel A is switched off.

3.1.1.9. Delay line driver

The symmetrical delay line is sandwiched between a series feed-back push-pull amplifier (called CHERRY) and a shunt feed-back push-pull amplifier (called HOOPER), consisting of integrated circuit D801.
Such an amplifier combination is called "CHERRY-HOOPER".
The series feed-back stage receives a signal of approx. 20 mV/div. which is obtained from a signal current of 0,065 mA/div. from the channel switch, multiplied by the value of the load resistance R803 + R804 = 308 Ohm.
The emitter impedance of the series feed-back stage consists besides RE = R819 + R821 of the parallel circuit of a number of RC networks. As the delay line is a source of distortion for higher frequencies, these networks are realizing the necessary delay line compensation.
At the input side, delay line D802 terminates in R828 and R829 (totally 200 Ohm).
The delay line itself is a symmetrically mount spiralized cable with a characteristic impedance of 200 Ohm and a delay of 110 nsec/m. At the output side, the cable terminates via R831 and R832 in the virtual earth points of the parallel feed-back stage (HOOPER). The input impedance on these virtual earth points is 14 Ohm. This value in series with the 86,6 Ohm of R831 and R832 forms the correct termination for the delay line. C814 and C816 are for HF correction.

3.1.1.10. Composite trigger pick-off

The composite trigger signal is picked-off at the emitters of the CHERRY stage (D801), a signal source with a low internal resistance, by the series feed-back stage V802 and V803. From this stage the composite trigger signal currents are fed symmetrically to the main time-base and delayed time-base trigger selectors via 50 Ohm cables.

3.1.1.11. Final Y amplifier

The output signals of the "HOOPER" stage are applied to the final Y amplifier stage consisting of the transistors V804, V806, V807 and V808, which are configurated as two series feed-back amplifiers in parallel fed by a constant current source.
The gain of the final amplifier can be set by means of potentiometer R848. The centre taps of the coils L801 and L802 are connected to the Y deflection plates of the c.r.t. The Y deflection plates form filters together with the coils L801 and L802.
These filters terminate in resistors R859, R861, R862 and R863.
The output signals from the TRACE SEPARATION circuit are applied via the resistors R864 and R866 of the Y final amplifier.

3.1.2. Main time-base triggering

The trigger source switches for triggering the main time-base generator, can select any of the following input sources:

- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal composite signal of channel A and channel B
- a signal derived from the mains supply
- an external source

All these sources can be used for both triggering and X deflection purposes. Source selection is done by means of a trigger selector switch S22 that feeds the trigger signals to the trigger amplifier.

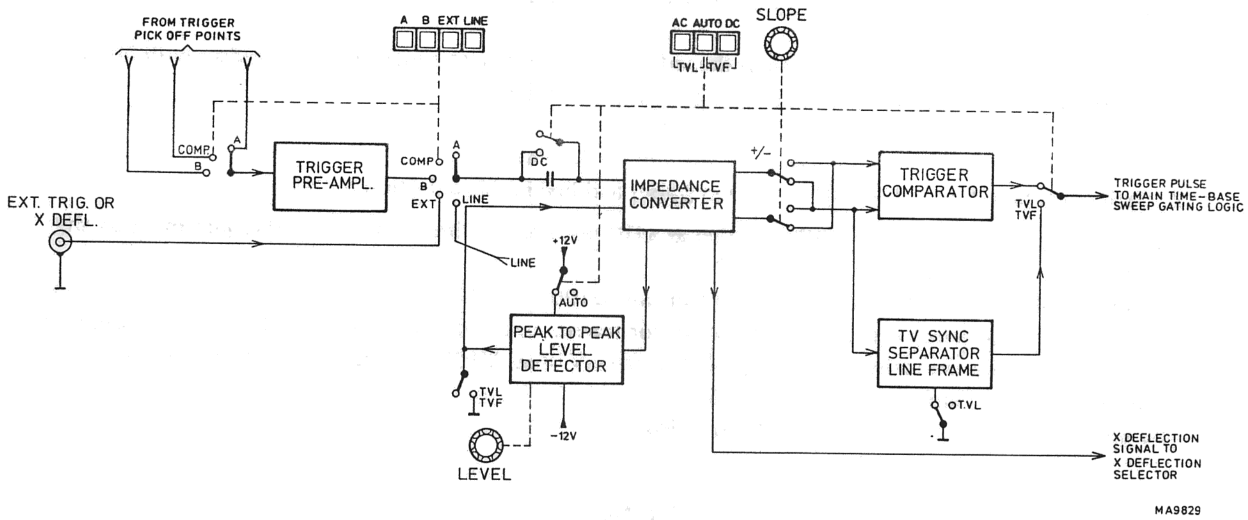


Fig. 3.3. Main time-base trigger circuit

3.1.2.1. Main time-base trigger source selection and preamplifier

The signal currents (60 μA/div.) of the three trigger pick-off stages are, after selection by S22C and S22D, amplified to a level of 100 mV/div. by a shunt feed-back stage + emitter follower stage consisting of V351 and V352. After this stage there is a selection between its output signal, a signal on the external socket and a signal with the line frequency by means of S22A and S22B. Signals that are not used are short-circuited to mass.
The externally applied signal is attenuated by a factor of five to achieve an input sensitivity of 500 mV/div.

3.1.2.2. Impedance converter and trigger comparator

The trigger signal of 100 mV/div. is fed via the AC-DC coupling circuit to a FET (V1006) in source follower configuration.
From here the signal is applied via an emitter follower and a common emitter amplifier D1001 (123/345) to the ± slope selection circuit. The selection switch S8 enables triggering on either the positive-going or the negative going edge of the triggering signal.
From the ± slope selector circuit, the signal is fed to the output shunt feed-back amplifier V1026 via the switches TVL mode (AC + AUTO) and TVF mode (AUTO + DC). The voltage gain is high (28x) but its dynamic range is small (2,8 Vp-p at the output). This is because of the tail current of the symmetrical common emitter stage is 2 mA. The current sweep at the output of this stage is consequently 2 mA at max. which is transformed into a 2,8 V max. voltage sweep at the output of the shunt feed-back amplifier V1026. This means that the trigger amplifier is completely driven at a trace height of 1 div. Which division on the screen this is, depends on the position of the LEVEL control R7.

With AC (S4A) or DC (S4C) depressed, the range of the LEVEL control is fixed. The DC voltage at the wiper of LEVEL control R7, which is fed to the FET (V1006) can vary between +2,8 V and −2,8 V. Diodes V1001 and V1002 are then turned-off, and the voltage on the gate of the FET is then adjustable between +0,86 V and −0,86 V. At a signal level on the gate of the other FET of 100 mV/div., there will be a control range of ± 8,6 divisions.

3.1.2.3. Peak to peak level detector

If the AUTO push-button S4B is depressed, the supply voltages for the level control circuit are interrupted. A trigger signal (300 mV/div.) which is derived from the emitter follower stage and amplified by V1007, gives after peak to peak detection a DC voltage across the level control. This DC voltage is approx. proportional to the amplitude of the trigger signal. This is the auto trigger level control. The peak to peak level of the signal then determines the range of the level control.

3.1.2.4. T.V. Synchronisation separator

If the TVL mode of the TVF mode is selected, the LEVEL control is switched off. The wiper of R7 is then connected to mass. A synchronisation separator for the television signals is then inserted into the trigger signal path.
A composite video signal contains, besides the video information, also synchronisation pulses with line and frame frequency which can be distinguished by their pulse width.
The TV synchronisation separator circuit is able to:
1. separate the synchronisation pulses from the video information.
2. distinguish between frame synchronisation pulses and line synchronisation pulses.

The first requirement is met by V1024, acting as a DC restorer and limiter, the second requirement by the integrating network R1044, C1009 and C1011.
The TV signal is picked-off from the emitter follower D1001 (678/91011) and fed to the ± slope selection circuit. The ± slope selector switch S8 can be set for the right polarity of the TV signal. The TV trigger signal is then amplified by the series feed-back push-pull stage V1008, V1009 and applied to synchronisation separator V1024 via emitter follower V1023.
The signal on the base of V1024 could be as follows:

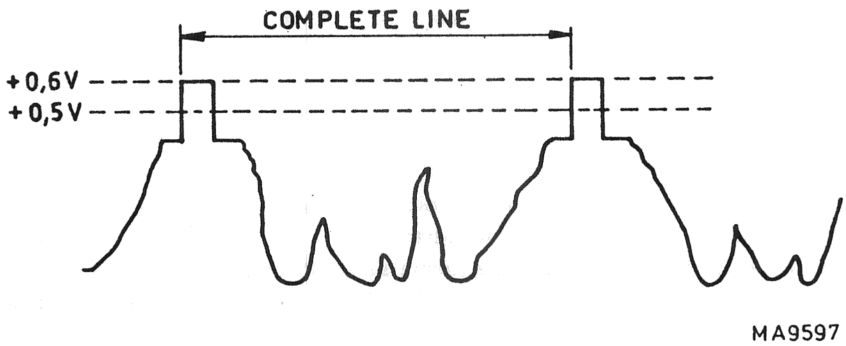


Fig. 3.4. Signal on the base of transistor V1024

The peaks of the synchronisation pulses are all at one level by the DC restorer action of C1007, R1042 and the base emitter diode of V1024, The base voltage will never exceed +0,6 V by a large amount, but the complete waveform will appear at the base. The signal level is at this point approx. 280 mV per screen division. Change in signal of approx. 100 mV is sufficient to turn off V1024. V1024 looks only to the peaks of the synchronisation pulses.
The rest of the TV signal has no influence. On the collector of V1024 we find only the synchronisation signal consisting of line synchronisation pulses and the wider frame synchronisation pulses.
In the TVL mode (push-buttons AC and AUTO depressed), this complete signal is transmitted to the time-base generator and we have line triggering.
In the TVF mode (push-buttons AUTO and DC depressed), C1009 and C1011 are connected to mass. The narrower line synchronisation pulses are then integrated out of the signal, but the wider frame synchronisation pulses remain and frame triggering is obtained. A second threshold is built-up by V1027.

V1028 reacts to the signal that still passes and consists of pure line or frame synchronisation pulses. After this the signal is fed to the time base generator via V1026.

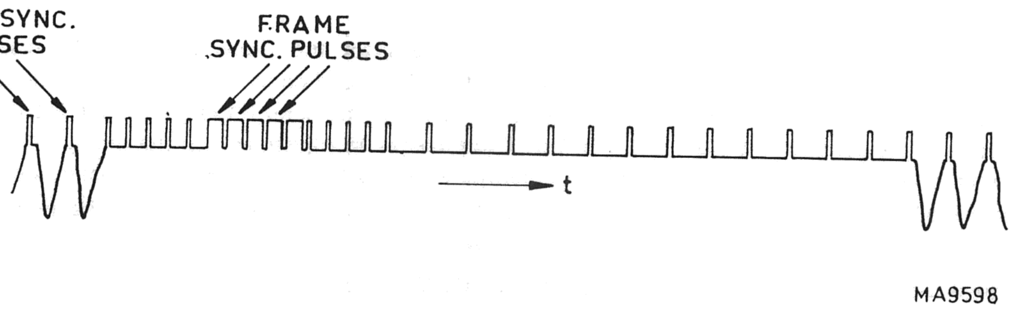


Fig. 3.5. A vertical interval with frame synchronisation pulse group.

3.1.3. Main time-base generator

The main time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit and an auto sweep circuit.

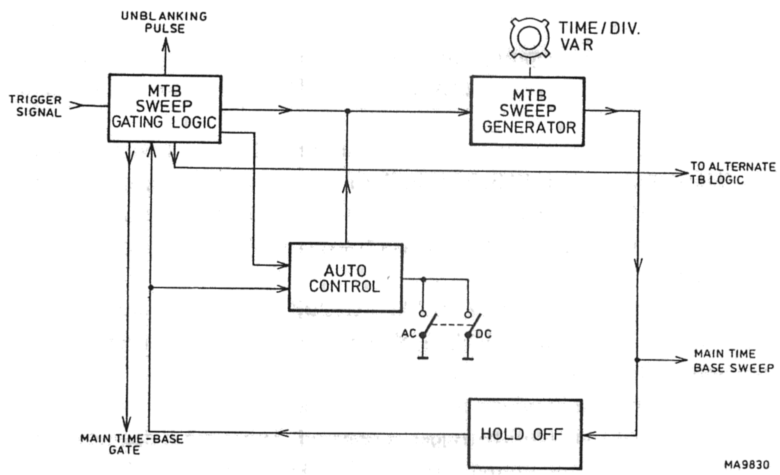


Fig. 3.6. Main time-base generator.

Before considering these stages in detail, the general principle is briefly described. Basically, the sweep gating logic, under the control of trigger signals from the trigger comparator and also feedback pulses from the hold-off circuit, supplies square-wave pulses to the switching transistor V1208 of the sawtooth generator.
The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed via the X deflection selector the the X final amplifier.

3.1.3.1. Main time-base sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors are C1203 and C1206. Capacitor C1203 is always in circuit, the other one is selected by the transistor V1212. This transistor operates as an electronic switch and is either fully cut-off or fully conducting. It is switched on by the application of a positive voltage to its base from the TIME/DIV switch S15.

According to the position of S15, this transistor V1212 switches in the capacitor C1206 in parallel with C1203. As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistor V1209. This current can be adjusted in steps by selecting the emitter resistance of V1209 by means of the TIME/DIV switch S15. Continuous control of the charging current can be effected by varying the base drive to V1209 with the continuous sweep control, TIME/DIV potentiometer R12. In the CAL position of this potentiometer, switch S16 closes and the charging current is solely determined by the calibrated emitter resistance.
To compensate for the temperature coefficient of the transistor, the base voltage of V1209 is supplied via transistor V1214. This also has the advantage of reducing the load on the TIME/DIV potentiometer R12. This transistor, in turn, has its base controlled by preset potentiometer R1216 when TIME/DIV switch S15 is in one of the positions 0,5 s/div ... 0,5 ms/div. This provides an adjustment for the timing circuit in the slower sweep speeds. In these positions the preset potentiometer R1216 provides an additional measure of control over the base voltage of V1209. In the positions of S15 when C1206 is not in circuit, the diode V1217 is blocked and the preset control R1216 is inoperative.

The discharge circuit for the capacitors C1203 and C1206 consists of resistor R1210 and transistor V1208. This switching transistor is driven by the sweep gating logic.
Transistor V1207, the other switching transistor, short-circuits the charging current to earth when the time-base capacitors are being discharged. This means that the voltage across C1203 and C1206 is independent of the charging current at the moment that the sweep starts. Both switching transistors are driven with the same control signal, supplied by the sweep gating multivibrator.
The resulting sawtooth voltage is taken from two transistors V1218 and V1221 in a Darlington configuration. C1208 improves the transfer of faster sawtooth signals at the expense of the input impedance which need not to be that high then. The sawtooth voltage amplitude is approx. 5 V. This sawtooth voltage is then fed via the X deflection selector to the X final amplifier.

3.1.3.2. Main time-base hold-off circuit

The hold-off circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington pair V1218 and V1221 is applied to the base of emitter follower V1219.
The switching transistor V1213 switches the hold-off capacitor C1207 in circuit, parallel to C1204 according to the position of the TIME/DIV switch S15, in a similar manner to that described for the time-base integrator timing capacitor. Capacitor C1204 is always in circuit irrespective of the TIME/DIV switch position.
Charging current for the hold-off capacitors follows via transistor V1219. When V1219 cuts off the discharge current flows through R1221.
The voltage across hold-off capacitor C1204 or C1204 + C1207 follows the sawtooth voltage fairly fast in positive going direction via emitter follower V1219. When a certain value is reached, integrated Schmitt-trigger D1201 reacts and the end of the sweep is initiated.
This is followed by a hold-off period in which the voltage across the hold-off capacitor decreases fairly slowly until the lower switching level of the Schmitt-trigger is reached. The system can now be triggered again. In the mean-time also the time-base integrator timing capacitor C1203 or C1203 + C1206 has reached its quiescent state. The output (point 3) of D1201 is low during the hold-off time, at any other moment this output is high.

3.1.3.3. Main time-base sweep gating logic

The main time-base sweep gating logic which consists of TTL logic circuits is controlled by the following signals:
- The trigger signals supplied by the trigger comparator.
- The voltage supplied by the hold-off circuit.
- The voltage supplied by the auto circuit.

The TTL circuit D1201 contains 2-input NAND-gates with Schmitt-trigger properties. D1202 is a retriggerable monostable multivibrator. D1203 contains two D-type flip-flops and D1204 contains normal 2-input NAND-gates.

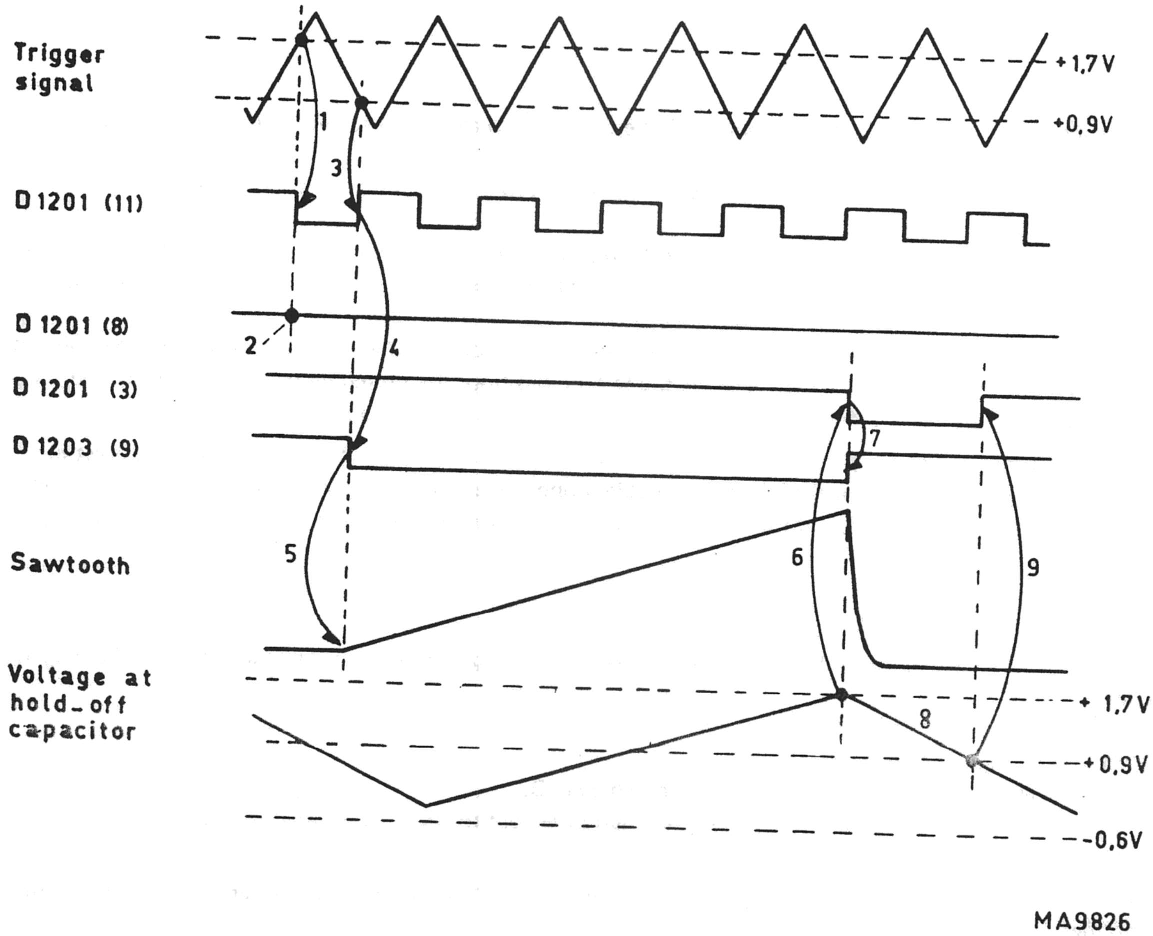


Fig. 3.7. The relation diagram of the main time-base sweep-gating logic in the AC or DC mode.

See for the following explanation time relation diagram Fig. 3.7.

1. The incoming trigger signal from the trigger comparator switches the Schmitt-trigger output (D1201, point 11) to zero after a positive going edge has exceeded the upper switching level (+ 1,7 V) of this Schmitt-trigger.
2. The Schmitt-trigger output (D1201, point 8) is set to the logic 1 state. Input 10 of this Schmitt-trigger is connected to mass via the switches S4B (AUTO) and S4A (AC) or S4C (DC).
3. If the negative going edge of the incoming trigger signal drops below the lower switching level (+0,9 V) of the Schmitt-trigger, the output (D1201, point 11) switches to logic 1 level again.
4. After this, the D-type flip-flop output (D1203, point 9) is set to the logic o-state by the trigger signal on its clock input.
5. The output signal of this flip-flop is applied to switching transistors V1207 and V1208 and causes the sweep to start.
6. The end of the sweep is reached when the signal across the hold-off capacitors C1204 and C1207 exceeds the upper switching level (+1,7 V) of the hold-off Schmitt-trigger. The output (D1201, point 3) of this Schmitt-trigger switches then to logic 0 level.
7. The D-type flip-flop is now reset. Switching transistors V1207 and V1208 start conducting and the time-base capacitors C1203 and C1206 will discharge.
8. The voltage across the hold-off capacitors C1204 and C1207 decreases slowly until the lower switching level (+0,9 V) of the Schmitt-trigger is reached.
9. This is the end of the hold-off period. The output (D1201, point 3) of the hold-off Schmitt-trigger rises to 1 again and the system can be triggered again.

3.1.3.4. Auto sweep circuit

In the absence of a trigger signal we would still like to see a display on the screen. The auto sweep circuit serves this purpose.
The oscilloscope can be set in AUTO mode by pushing the AUTO push-button of the MTB trigger mode selector switch.
In the absence of a trigger signal, the output of the retriggerable monostable multivibrator (D1202, point 6) remains at logical 1-level. The Schmitt-trigger output (D1201, point 8) remains at logical 0-level as input 10 is set to +5 V via R1201 (S4A, S4B and S4C are open).
In this situation the D-type flip-flop part between input 10 and output 9 will act as an inverter. The hold-off signal on point 3 of D1201 now can reach via the D-type flip-flop, the switching transistors V1207 and V1208. The loop is then closed and the time-base generator is in the free-running mode.

As soon as a trigger signal appears at the output of the trigger comparator, when the oscilloscope is set in AUTO mode, the output point 6 of the retriggerable monostable multivibrator will be set to logical 0-level. Input 13 of D-type flip-flop D1203 will be high then and the circuit works as in the normal trigger mode.

3.1.4. Delayed time-base triggering

The trigger source switches for triggering the delayed time-base generator, can select any of the following input sources:
- an internal signal from the vertical A channel.
- an internal signal from the vertical B channel.
- an internal composite signal of channel A and channel B.
- an internal triggering signal derived from the main time-base to start the delayed time-base immediately after the selected delay time.

Source selection is done by means of a trigger selector switch S21 that feeds the trigger signals to the trigger amplifier.

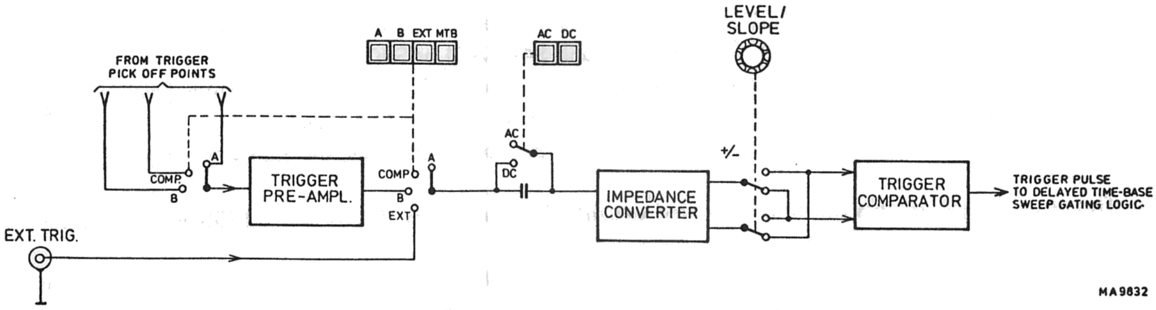


Fig. 3.8. Delayed time-base trigger circuit

3.1.4.1. Delayed time-base trigger source selection and preamplifier

The signal currents (60 μA/div.) of the three trigger pick-off stages are, after selection by S21C and S21D, amplified to a level of 150 mV/div. by a shunt feed-back stage + emitter follower stage consisting of V451, V452 and V453. After this stage there is a selection between its output signal and a signal on the external socket by means of S21B.
Signals that are not used are short-circuited to mass.
The externally applied signal is attenuated by a factor of five allowing standardisation of the input impedance of the EXT socket to 1 MOhm // 20 pF.

3.1.4.2. Impedance convertor and trigger comparator

The trigger signal of 150 mV/div. is fed via the AC-DC coupling circuit to a FET (V1102) in source follower configuration.
From here the signal is applied via an emitter follower and a common emitter amplifier D1101 (123/345) to the ± slope selection circuit.
The selection switch S6 enables triggering on either the positive-going or the negative-going edge of the triggering signal.
From the ± slope selector circuit, the signal is fed to the output shunt feed-back amplifier V1109.
The range of the LEVEL control is fixed. The DC voltage at the wiper of LEVEL control R5, which is fed to the FET (V1102) can vary between +12 V and −12 V. The voltage on the gate of the FET is then adjustable between +1,3 V and −1,3 V. At a signal level on the gate of the other FET of 150 mV/div. there will be a control range of ± 9 div.

3.1.5. Delayed time-base generator

The delayed time-base generator comprises a sweep gating logic, a sweep generator and an end of the sweep-detector.

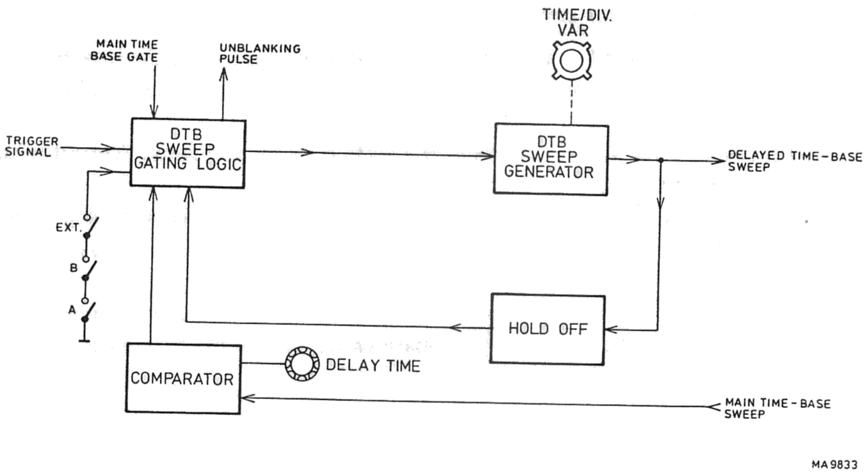


Fig. 3.9. Delayed time-base generator.

Before considering these stages in detail, the general principle is briefly described.
Basically, the sweep gating logic, under the control of trigger signals from the trigger comparator and also feed-back pulses from the hold-off circuit, supplies square-wave pulses to the switching transistor V1314 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed via the X-deflection selector to the X-final amplifier.

3.1.5.1. *Delayed time-base sweep generator*

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors are C1302 and C1303. Capacitor C1302 is always in circuit, the other one is selected by the transistor V1319. This transistor operates as an electronic switch and is either fully cut-off or fully-conducting. It is switched on by the application of a positive voltage to its base from the TIME/DIV switch S13. According to the position of S13, this transistor V1319 switches in the capacitor C1303 in parallel with C1302.
As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistor V1316. This current can be adjusted in steps by selecting the emitter resistance of V1316 by means of the TIME/DIV switch S13. Continuous control of the charging current can be effected by varying the base drive to V1316 with the continuous sweep control, TIME/DIV potentiometer R11.
In the CAL position of this potentiometer, switch S14 closes and the charging current is solely determined by the calibrated emitter resistance.
To compensate for the temperature coefficient of the transistor, the base voltage of V1316 is supplied via transistor V1318. This has also the advantage of reducing the load on the TIME/DIV potentiometer R11. This transistor, in turn, has its base controlled by preset potentiometer R1336 and by preset potentiometer R1344 only when TIME/DIV switch S13 is in one of the positions 20 μs/div. ... 1 ms/div. Potentiometer R1336 enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator. This provides a fine adjustment for the timing circuit in the slower sweep speeds.
In these positions the preset potentiometer R1344 provides an additional measure of control over the base voltage of V1316.
In the positions of S13 when C1303 is not in circuit, the diode V1326 is blocked and the preset control R1344 is inoperative.
The discharge circuit for the capacitors C1302 and C1303 consists of resistor R1328 and transistor V1314. This switching transistor is driven by the sweep gating logic.
The resulting sawtooth voltage is taken from two transistors V1321 and V1322 in a Darlington configuration. C1304 improves the transfer of faster sawtooth signals at the expense of the input impedance which need not to be that high then. The sawtooth voltage amplitude is approx. +5 V. This sawtooth voltage is then fed via the X-deflection selector to the X-final amplifier.

3.1.5.2. *Delayed time-base end of the sweep detector circuit*

This circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington V1321 and V1322 is applied to the base of emitterfollower V1324.
When the emitter of the emitterfollower V1324 has reached a certain value, integrated Schmitt-trigger D1301 reacts and the end of the sweep is initiated.
This is followed by a period in which the sawtooth voltage decreases until the lower switching level of the Schmitt-trigger is reached. The flip-flop formed by the two NAND-gates can now be reset by the signal from point 8 of NAND D1301 (8-9-10) i.e. at the end of the main time-base gate.
During one sweep of the main time-base only one sweep of the delayed time-base can be generated.
The DTB sweep is always reset at the end of the main time-base sweep via the main time-base gate signal.
The system can now be triggered again.

3.1.5.3. *Delay time function*

The function of the DELAY TIME potentiometer R4 is to provide an adjustable d.c. voltage for comparison with the sweep voltage of the main time-base generator. This comparison is then used to start the delayed time-base generator at a pre-determined time during the sweep of the main time-base.
The DELAY-TIME potentiometer R4 is a 10-turn front-panel control.

3.1.5.4. *Comparator circuit*

The comparator comprises the transistors V1302, V1303 and V1304. V1303 is a constant-current source for V1302 and V1304.
The d.c. voltage set by the DELAY TIME potentiometer R4 is fed to the base of the left hand transistor V1304 via the emitter followers V1307 and V1306. The sawtooth voltage of the main time-base generator is fed to the right-hand transistor V1302. As soon as the amplitude of the sawtooth exceeds the set d.c. voltage, the collector voltage of the right-hand transistor V1302 drops. This voltage drop is, fed via invertor V1301 to the delayed time-base sweep gating logic. The circuit is switched off in the OFF position of the DTB TIME/DIV switch S13 by interrupting the +12 V supply to R1305.

3.1.5.5. *Delayed time-base sweep gating logic*

The delayed time-base sweep gating logic which consists of TTL logic circuits is controlled by the following circuits:
The TTL circuit D1301 contains 2 - input NAND-gates with Schmitt-trigger properties. D1204 and D1302 contain normal 2-input NAND-gates and D1203 contains two D-type flip-flops.

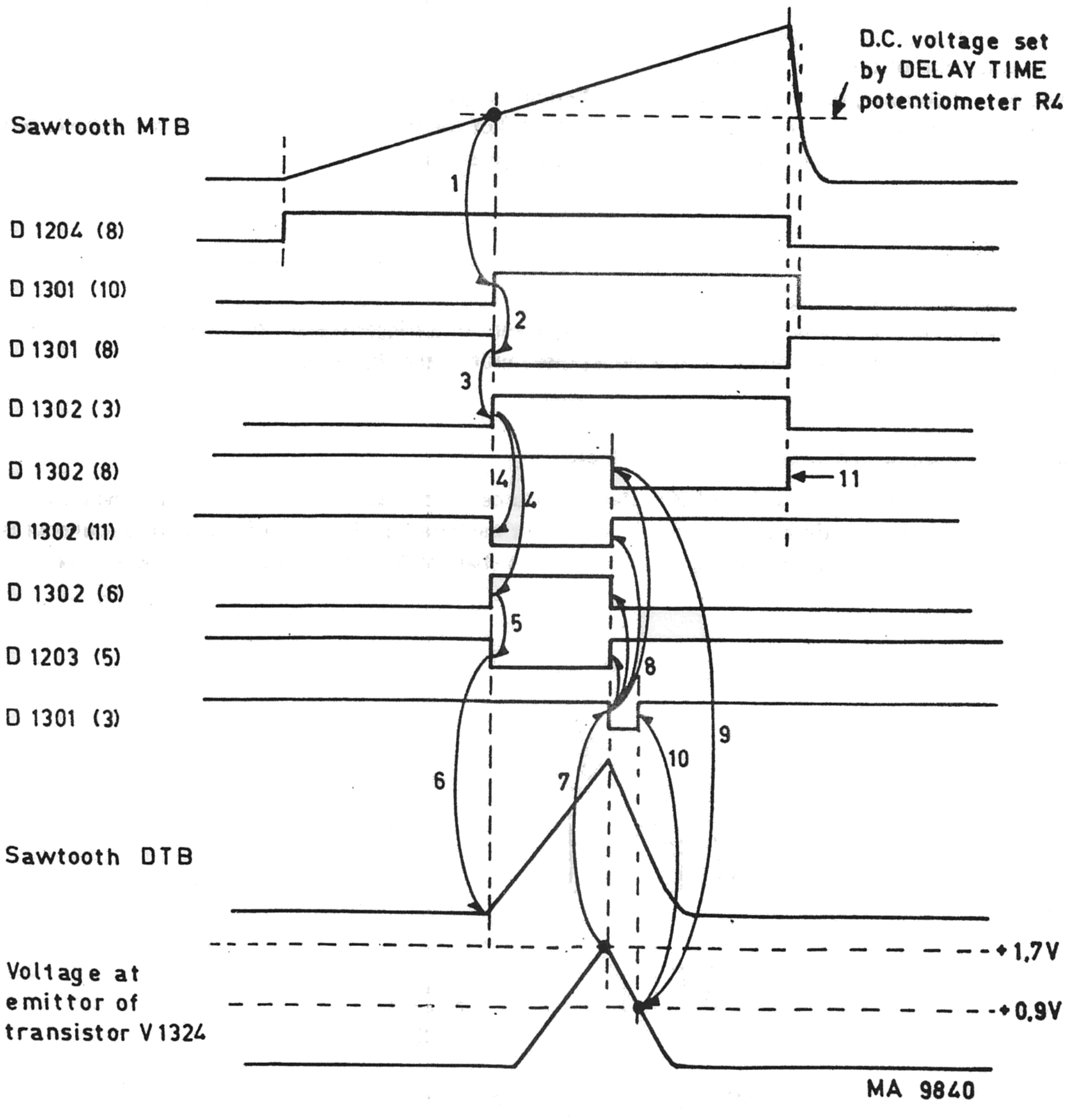


Fig. 3.10. Time relation diagram of the delayed time-base sweep gating logic in the MTB trigger mode.

See figure 3.10.

1. Comparing the main time-base sawtooth signal with the d.c. voltage set by the DELAY TIME potentiometer R4 results in a positive going signal at the input 10 of Schmitt-trigger D1301.
2. Only during a main time-base sweep, the main time-base gate at the input 9 of Schmitt-trigger D1301 will be at logical 1 level. The output (point 8) of this Schmitt-trigger will go to logical 0 level on the positive-going edge of the comparator output signal.
3. The output signal of the Schmitt-trigger is inverted in NAND-gate D1302 (output 3).

4. Assume that output 8 of the flip-flop formed by the two NAND-gates is at logical 1 level.
   Then the output 11 of D1302 will go to logical 0 level and the input 4 of D-type flip-flop D1203 to logical 1 level.
5. The switches S21B, S21C and S21D are closed in the MTB trigger mode and input 1 of D - type flip-flop D1203 is set to logical 0 level. In this situation the D - type flip-flop part between input 4 and output 5 will act as an inverter.
6. Output 5 of D1203 will go to zero level and this signal is applied to switching transistor V1314 and causes the sweep to start.
7. The end of the sweep is reached when the signal at the emitter of transistor V1324 exceeds the upper switching level (+1,7 V) of the hold-off Schmitt-trigger. The output (D1301, point 3) of this Schmitt-trigger switches then to logic 0 level.
8. The output of the flip-flop formed by the two NAND-gates is now set to 0 level.
9. The voltage at the emitter of transistor V1324 decreases slowly until the lower switching level (+0,9 V) of the Schmitt-trigger is reached.
10. This is the end of the hold-off period.
    The output (D1301, point 3) of the hold-off Schmitt-trigger rises to 1 again.
11. At the end of the main time-base sweep, the output 8 of the flip-flop formed by the two NAND-gates is switched to logical 1 level and the system can be triggered again.

A, B or EXT triggering

If one of the DTB trigger source selector switches A, B or EXT is selected, the level at input 1 of the D-type flip-flop D1203 will go to logical 1 level.
The D-type flip-flop can now only be set to zero by means of a trigger signal from the delayed time-base trigger comparator which is applied to the clockpulse input of the flip-flop.

3.1.6. X deflection selector and alternate time-base logic

Depending on the selected position of X deflection source selector switch S3, the circuit provides for Xdeflection by the main time-base signal, the delayed time-base signal, a signal from an external source or X deflection by one of the internal signals derived from channel A, channel B or the mains voltage.

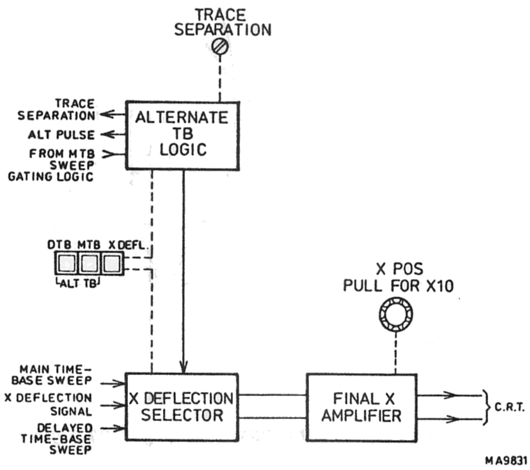


Fig. 3.11. X deflection selector and alternate time-base logic.

The source selector is described according to the selected mode.

MTB — In this position of the switch S3, the +12 V supply is routed via the contacts of S3A and via diode V1651 to the base of transistor V1658 which results in a collector voltage of –1,7 V. This voltage is routed to the junction of the two diodes V1401 and V1404, the diodes are blocked and there is no signal path for the delayed time-base output sawtooth signal to the X final amplifier.
At the same time the other transistor (V1659) of the alternate flip-flop is conducting and its collector voltage is about +10,5 V. This voltage is applied to the junction of the diodes V1403 and V1412, these diodes conduct and provide a path for the output sawtooth signal of the main time-base to the X final amplifier.
This means that only the main time-base sawtooth signal is fed to the X final amplifier and not the delayed time-base sawtooth signal and the X deflection signal.

DTB — In this position of the switch S3, the +12 V supply is routed via the contacts of S3A and S3B and via diode V1653 to the base of transistor V1659. This results in a voltage of –1,7 V at the collector of V1659 and a voltage of +10,5 V at the collector of V1658. The diodes V1403 and V1412 are blocked and there is no signal path for the main time-base output sawtooth signal to the X-final amplifier.
A signal path is now provided via the diodes V1401 and V1404 for the delayed time-base output sawtooth signal.
With DTB selected the main time-base signal and the X deflection signal are blocked.

X DEFL — In the position X DEFL of the switch S3 +12 V voltages are fed to the bases of the transistors V1658 and V1659. Both collector voltages are at a level of –3,9 V and the diodes V1401, V1404, V1403 and V1412 are blocked. The signal paths for the main time-base sawtooth signal as well as for the delayed time-base sawtooth signal are blocked.
At the same time the constant-current source V1011 in the main time-base trigger circuit is blocked and no trigger signals are fed to the sweep gating logic.
In the sweep gating logic there is a 0 V signal applied to the input 10 of D1204 and as result a 0 V is fed to the Z-amplifier. This means that the trace will be totally unblanked.
The Xdeflection signals are transmitted to the X final amplifier via transistor V1409 as described in the description of the X final amplifier.

ALT TB — With both push-buttons S3A and S3B depressed, the oscilloscope is set in the alternate time-base mode and the main and delayed time-bases are selected alternately.
In this mode there is no +12 V applied to the bases of the transistors V1658 and V1659, the alternate circuit is bi-stable and one of the diodes V1654 and V1656 is conductive. MTB-gate pulses derived from the main time-base generator are fed to the junction of the diodes V1654 and V1656 to switch the circuit at the end of each main time-base sweep and the main and delayed time-base are alternately selected.
The collector signal of transistor V1658 is fed to the junction of diodes V1401 and V1404 to block or open the DTB signal path and the collector signal of transistor V1659 is fed to the junction of diodes V1403 and V1412 to block or open the MTB signal path.
These collector signals are also applied to the trace separation circuit which allow an adjustable trace separation potential to be alternatively applied to the two paths of the vertical final amplifier depending on whether MTB or DTB is selected by the alternate flip-flop. Trace separation is adjustable by front-panel control R14. The trace separation potentials are routed from the collector of V1664 via R864 and from the collector of V1666 via R866 to the vertical final amplifier.

The generation of switching pulses for the channel multivibrator depends on the selection of ALT and ALT TB.

- With ALT TB not selected and ALT selected, negative going pulses derived from the main time-base gate are routed directly from R1653 to the channel multivibrator to switch the A and B channel alternately.
- With ALT TB selected and ALT mode not selected the signal path from R1653 to the channel multivibrator is blocked by a +12 V signal which is applied via switch S3B to R1671.

Transistor V1668 is conducting if ALT is not selected because a 0 V signal is fed to R1686 via R708 and the alternate signals from the switching of the alternate flip-flop are blocked.

- With ALT TB as well as ALT selected the signal path from R1653 to the channel multivibrator is blocked by a +12 V signal which is applied via switch S3B to R1671.
  Transistor V1668 is conducting now because a −12 V signal is fed to its base via S1A, S1C, S1D, S1E and R1686. Negative going alternate pulses derived from the alternate time-base logic are fed to the channel multivibrator. These pulses appear at the end of every two sweeps of the main time-base.

3.1.7. X final amplifier

Transistor V1414 is driven by the main time-base generator via diodes V1403 and V1412 when R1408 is kept at +12 V level, or by the delayed time-base generator via diodes V1401 and V1404 when V1406 is kept at +12 V level or the amplifier stage V1409 when R1409 is kept at +12 V level via the X deflection mode selector switch S3C (X DEFL).
Transistor V1409 receives its input signal from D1001 point 8 of the trigger amplifier. This signal is derived from one of the sources, channel A, channel B, line or an external source, depending on the setting of the X deflection selector switch S22.

The final X amplifier consists of two amplifier stages in parallel (one for each deflection plate).
Only one half is described.

The actual amplifier is the cascode circuit with transistors V1418 and V1419. The resistors R1429 and R1431 are feedback resistors. The bias current for the amplifier is supplied by transistor V1417. The average voltage on the deflection plate is kept at +26 V by means of zener diodes V1427 and V1428. Capacitor C1413 improves the h.f. response.
The final stage is supplied from the +180 V and −180 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.
The cascode amplifier stages are controlled via the transistors V1413 and V1414.

The bias of transistor V1413 can be varied with the X POSITION potentiometer R6, which consists of a tandem potentiometer with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time-base signals or one of the sources, channel A, channel B, line or an external signal. The deflection source is selected with the aid of X deflection mode selector switch S3 and the Xdeflection source selector switch S22.

The X amplifier offers the possibility of using either the nominal gain (x1 position of XMAGN switch S7), or the gain increased by a factor of 10 (x10 position of the XMAGN switch S7).
When the front-panel XMAGN switch is operated for x10 magnification, the emitter resistance R1416 + R1417 of transistors V1413 and V1414 is shunted by resistors R1418 + R1419 reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.
The x1 gai an be set by potentiometer R1417 and the x10 gain by potentiometer R1419. The x10 gain is also operati vhen XDEFL is selected.

Both outputs of the X final amplifier are connected to the X deflection plates of the C.R.T.

3.1.8. Cathode-ray tube circuit

The cathode-ray tube circuit comprises the C.R.T. itself and the brightness, focus, astigmatism, geometry and trace rotation controls and the beam blanking amplifier. A block diagram of the C.R.T. circuit is given in figure 3.12.

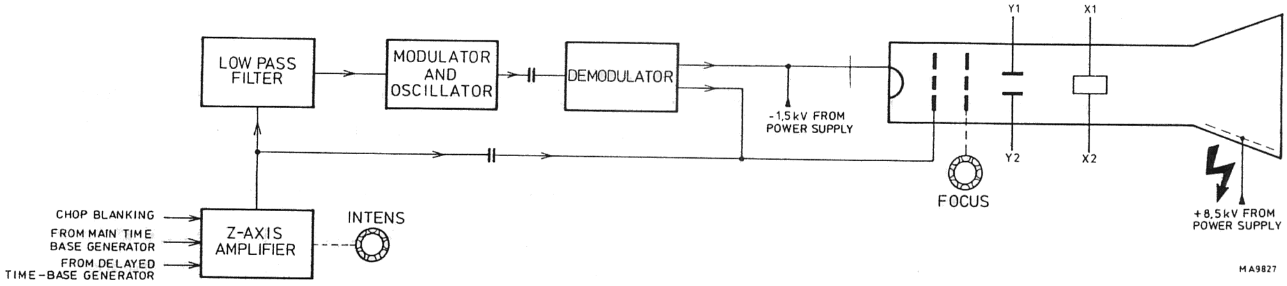


Fig. 3.12. Cathode-ray tube circuitry.

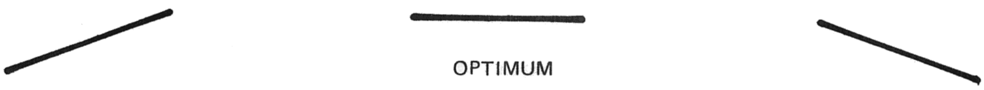
3.1.8.1. C.R.T. controls

By means of the INTENS potentiometer R1, the brightness of the display can be continuously controlled. The display can be focused by means of the FOCUS potentiometer R8. Both INTENS and FOCUS controls are front panel controls.

Furthermore the C.R.T. circuitry comprises preset potentiometers for trace rotation, astigmatism and geometry.

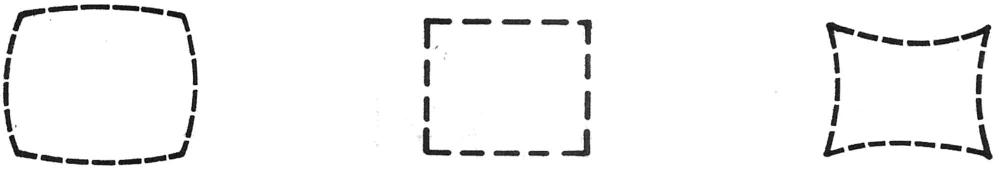
The FOCUS control R8 forms a part of a voltage divider network across the 1,5 kV output of the power supply. The slider of this potentiometer is connected direct to the focus, grid G3.

TRACE ROTATION is achieved by means of the trace rotation coil L1501. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of front panel potentiometer R13 (screwdriver operated). The slider of R13 is connected to the bases of the complementary transistors V1527 and V1528. The trace rotation coil L1501 is supplied by these transistors.



With the ASTIGMATISM control R1543, the form of the spot can be adjusted by influencing the voltage on the grids G2 and G4.

With the GEOMETRY control R1549 the barrel and pin-cushion distortion is corrected by influencing the voltage on the grid G7.



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3.1.8.2. Beam unblanking amplifier

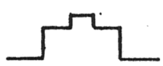
The beam unblanking amplifier receives three input signals.
Two signals originate in the main and delayed time-bases and are applied to the amplifier to unblank the trace during the sweeps. The third one is supplied by the channel multivibrator to blank the trace during switching from channel to channel in the chopped mode.
The INTENS potentiometer R1 determines the amount of input current fed to the amplifier.

In all the X deflection modes with the exception of XDEFL, input 10 of NAND-gate D1204 is kept at +5 V. The output point 8 of this NAND is now at logic 1-level when input 9 is low. In other words only during a sweep.
In the XDEFL position of the X deflection mode selector switch S3, input 10 of NAND D1204 is at a logic 0 level, and in that case the output point 8 of this NAND is steady at logic 1 level. This output signal (the MTB unblanking signal) is inverted by a NAND and fed via diode V1502 to diode V1512 of the beam unblanking amplifier.
The DTB unblanking signal is taken off from D-type flip-flop D1203 point 5 and fed via diode V1308 and V1503 to diode V1512 of the beam unblanking amplifier.
The chopped mode blanking signal from the channel multivibrator is fed to transistor V1511 via R1501. The inverted and amplified signal is applied to diode V1508.

MTB selected

- With the TIME/DIV switch S13 of the delayed time-base in the "OFF" position, only the MTB unblanking pulse is fed to the shunt feed-back amplifier and a bright main time-base trace is displayed on the screen.
- With the TIME/DIV switch S13 of the delayed time-base operative; i.e. not in the "OFF" position, R1508 is connected to the +12 V and a current flows through brilliance ratio potentiometer R1507. During the part of the sweep where only the main time-base is running, a part of the MTB current (controlled by R1507) flows into the Z-amplifier; i.e. the trace is less bright. During the delayed time-base gate there will flow more current into the Z-amplifier and the trace is then intensified as long as the delayed time-base is running. The ratio between the intensified and the non-intensified part is constant for high and low intensity.

High intensity



Low intensity

DTB selected

- If the delayed time-base is selected, the MTB unblanking pulse is suppressed and only the DTB unblanking pulse is fed to the shunt feed-back amplifier. The trace will be unblanked during the delayed time-base sweep.

All the signals are joined together at the base of transistor V1521 point A in figure 3.13. This is the virtual earth point of the shunt feed-back amplifier.

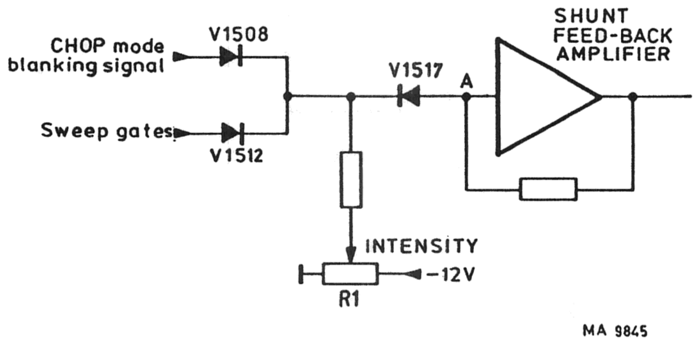


Fig. 3.13. Shunt feed-back amplifier.

Assume that V1508 and V1512 are turned-off by applying a logic zero to both inputs.
Then the output voltage of the amplifier can be varied with the aid of INTENS potentiometer R1. The light on the screen is variable then e.g. during a main and/or delayed sweep or in the X deflection mode. A logic 1 on either one or both inputs of the diodes V1508 and V1512 turns V1517 off. The C.R.T. is then blank e.g. between sweeps or during the sweep when there is channel switching in the chop mode.

The blanking signal is amplified in the stage with transistors V1518, V1519 and V1521. At the output of this amplifier the a.c. and d.c. components of the blanking signal are guided along different paths. The a.c. path runs straight to the Wehnelt cylinder of the C.R.T. via capacitor C1511.
A d.c. signal is fed to the emitter of transistor V1523 via a low-pass filter R1531/C1507/R1529. Transistor V1523 constitutes a multivibrator together with transistor V1522. The a.c. voltage on the collector of V1523 has a peak-to-peak value which depends on the voltage fed to the emitter of V1522 by the shunt feed-back amplifier.

The a.c. voltage supplied by multivibrator V1522/V1523 is applied to a peak detector. This peak detector rectifies this a.c. voltage.

The reason for the a.c. and d.c. paths is isolation of the cathode and Wehnelt cylinder, which are on a −1,5 kV potential, from the other circuits. The a.c. component of the blanking signal is transmitted straight away to the high-voltage part via blocking capacitor C1511, which is a high voltage capacitor. The d.c. signal, however, is converted into an a.c. voltage and then transmitted to the high-voltage part, via capacitor C1508, after which it is rectified by means of diode V1526. The dark level can be adjusted with the aid of potentiometer R1537 in the emitter circuit of transistor V1523 in the d.c. amplifier.

3.1.9. Power supply

The power supply comprises a mains transformer and rectifier, a DC to AC converter regulator and a transformer and output voltage rectifier.
The power supply also incorporates a circuit for the graticule illumination.

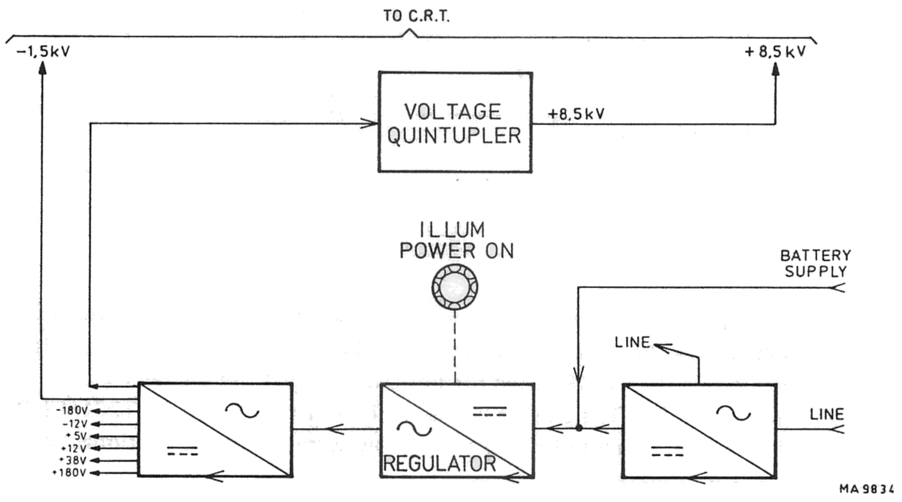


Fig. 3.14. Power supply.

The line part of the PM 3214 power supply is double insulated and meets IEC 348 SAFETY CLASS II recommendations for metal-encased electrical equipment. This eliminates the need for a 3-wire power cord with earth connection.
The converter together with the primary of the converter transformer is electrically floating in relation to mass. Therefore also the 24 V d.c. supply is floating.

3.1.9.1. *Mains transformer*

An incoming mains voltage is fed via the thermal fuse (F101) and the voltage selector S24 to the appropriate primary taps on the mains transformer T101. Transformer T101 has three primary windings which can be combined by means of voltage adapter S24. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

The voltage on the secundary windings of this transformer is full-wave rectified. The resulting negative d.c. voltage (approx. 24 V) across electrolytic capacitor C203, or alternatively a negative d.c. voltage on the rear panel DC POWER IN input socket X7, is applied to the voltage stabilizer and converter.

Part of the a.c. voltage on the secundary winding of the mains transformer is fed via C201, R368 and R367 to LINE trigger source selector switch S22A, to enable internal triggering on the line frequency.

3.1.9.2. *Converter and stabilized power supply*

The converter is a square-wave generator operating at a frequency of approx. 18 kHz and driven by the d.c. voltage across the electrolytic capacitor C203.
A basic diagram of the converter is shown in figure 3.15.

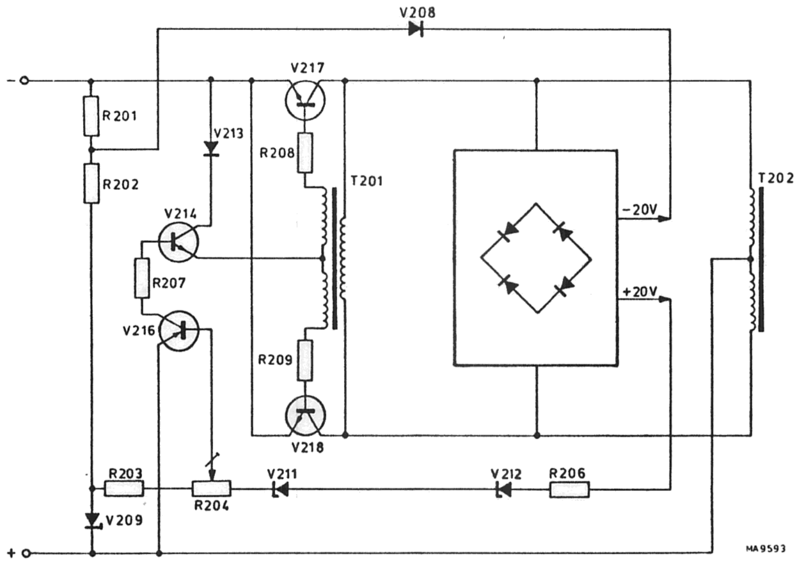


Fig. 3.15. Basic diagram of the converter.

In the converter, transistors V217 and V218 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of T201/T202. Assume that transistor V217 has a slightly higher current gain than V218. Then the positive voltage from the feed-back winding quickly drives transistor V217 into saturation. The current in the top half of the primary of T201/T202 increases linearly at a rate determined by the inductance of the primary. This current increase continues until the iron in transformer coil T201 is saturated.
Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feed-back winding. When its base drive ceases, the transistor is cut off. This reverses the polarity of the feed-back voltage and transistor V218 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction.
The subsequent absence of feed-back voltage initiates the switching back to V217 and the cycle starts again.

The regulation works as follows. When input voltage is applied to the converter, the negative voltage across Zener diode V209 turns transistor V216 fully on, as there is no positive voltage from temperature compensation stabistors V211 and V212. Then a bias current flows via transistor V216 through resistor R207, through the base-emitter junction of transistor V214 (operating as a diode since diode V213 interrupts the collector circuit) and from base to emitter of both transistors V217 and V218.
As there is then an a.c. voltage across the primary of T201/T202, diodes V222 and V223 produce a positive d.c. voltage of +20 V across capacitor C209. This voltage reduces the current through transistors V216 and V214 sufficiently to limit the drive to transistors V217 and V218 and produces the desired output level.

The setting of potentiometer R204 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via the temperature compensation stabistors V211 and V212 to transistor V216 so that the drive of transistors V217 and V218 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.
After rectifying and smoothing, the secundary voltages +5 V, +12 V, −12 V, +38 V, +180 V, −180 V, −1500 V and post acceleration voltage +8500 V are obtained. The voltage quintupler which supplies the +8500 V cannot be repaired and must be replaced when it breaks down.
T202 contains a separate secundary winding for the heater voltage for the C.R.T.
All supply voltages except the +8500 V and the −1500 V can be continuously short-circuited without damage to the components.
Resistor R207 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors V217 and V218 at a safe level. Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp B1, which indicates the ON state of the oscilloscope, failing to light up.
If supplied by an external d.c. voltage, the instrument is protected against overloads and wrong polarity by internal fuse F201 and diode V206.

3.1.9.3. Illumination circuit

The graticule of the C.R.T. can be illuminated by means of the bulbs E1. The intensity can be varied with the aid of ILLUM potentiometer R15 which controls the collector current (which is the current through the bulbs) of transistor V207. The illumination circuit is not short-circuit proof.

3.1.10. Calibration unit

The calibrator circuit consists of transistors V1601 and V1603, which are configurated as astable multivibrator such as used in the channel switch. Good shape of the wave-form is obtained by a constant current supplied by transistor V1602 which will flow in turns through the left hand or right hand transistor. The amplitude is 1,2 V or 6 div. in the 20 mV/div. attenuator positions. (The straight through position of the attenuator.)
Potentiometer R1607 allows accurate adjustment of the amplitude of the calibrator output voltage. This square-wave output voltage is taken off from the collector of transistor V1603 and fed to socket X1. This is the front panel CAL terminal.
The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

TEST EQUIPMENT AND TOOLS REQUIRED

For a complete checking and adjusting procedure, you will need the tools and test-equipment, listed in the following table.

TEST EQUIPMENT

Description of the instrument	*Specification of the test instrument*	*Suitable test instrument*	*Usage*
Digital multimeter	AC/DC instrument, accuracy within 0.1 %.	PHILIPS PM 2421 or equivalent	Power supply, C.R.T. circuit Trouble shooting
Time marker generator	Providing markers of 2 μs to 0.2 μs, accuracy within 0.5 %	–	Time-base timing checks
T.V. pattern generator or T.V. source	Providing frame and line synchronisation output amplitude at least 40 mV	PHILIPS PM 5504 or equivalent	Time-base T.V. triggering
Square-wave generator	Providing output voltages variable from 10 mV to 12 V, accuracy within 0.5 % Frequency range 2 kHz – 1 MHz. Rise time ⩽ 3 ns.	–	Attenuator response, vertical gain and response checks.
Sinewave generator	Providing output voltages variable from 10 mV to 10 V, frequency range 20 Hz ... 25 MHz	PHILIPS PM 5145 suitable for most purposes	Vertical amplifier bandwidth and triggering checks Trouble shooting
Monitor oscilloscope	0 – 25 MHz bandwidth	PHILIPS PM 3214 or equivalent	Trouble shooting
Ampere-meter	Moving-iron meter	–	Mains current consumption
Variable mains transformer	Well insulated for safe checking	PHILIPS 2422 529 00005	Power supply Trouble shooting
Probe 10x attenuation	Suitable for input capacities of 20 pF to 30 pF	PHILIPS PM 9336 or equivalent	Trouble shooting
Trimming tool kit	Low capacitance trimming tool	PHILIPS see Fig. 3.35.	Adjusting and maintenance

Fig. 3.16. Test equipment and tools required.

3.2. CHECKING AND ADJUSTING

3.2.1. General information

All adjusting elements have been listed in the headings of the various sections.
For required test equipment and tools see Fig. 3.16.

3.2.2. Power supply

3.2.2.1. Mains current

- Check that the mains voltage adapter (S24) has been set to the **local** mains voltage and connect the instrument to such a voltage.
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up.
- Check that the current consumption does not exceed 160 mA at 220 V local mains and 320 mA at 117 V local mains. (Measured with a moving iron meter.)

3.2.2.2. Supply voltages (R204)

- Check that the voltage across capacitor C224 is +12 V, + or −0,25 V; if necessary readjust potentiometer R204 (Fig. 3.17).
- Check the supply voltages in accordance with the following table:

Voltage across	*Required value*	*Max. allowable ripple*
C227 (Fig. 3.17)	+ 5 V, ± 0,2 V	⩽ 2 mVp-p
C224 (Fig. 3.17)	+ 12 V, ± 0,25 V	⩽ 4 mVp-p
C229 (Fig. 3.17)	− 12 V, ± 0,25 V	⩽ 4 mVp-p
C222 (Fig. 3.17)	+ 38 V, ± 2 V	⩽ 40 mVp-p
C231 (Fig. 3.17)	−180 V, ± 9 V	⩽ 1 Vp-p
C221 (Fig. 3.17)	+180 V, ± 9 V	⩽ 1 Vp-p
C211 (Fig. 3.17)	6,3 V, ± 0,6 V	

- Vary the a.c. voltage to which the instrument is connected with + or −10 % of the nominal voltage.
- Check that the supply voltages do not vary more than 2 ‰ and that the ripple voltages do not exceed the values mentioned in the table above.

3.2.3. Cathode-ray tube circuit

3.2.3.1. Brilliance (R1537)

- Depress push button A of the display mode switch S1.
- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button EXT of the MTB trigger source selector switch S22.
- Set A POSITION potentiometer R2 and X POSITION potentiometer R6 to their mid-positions.
- Set INTENS potentiometer R1 to 45° from its left hand stop.
- Adjust potentiometer R1537 (Fig. 3.19) in such a way that the spot is just not visible.

3.2.3.2. Brilliance ratio (R1507)

- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button MTB of the X deflection source selector switch S3.
- Set MTB TIME/DIV switch S15 to position 0,2 ms/div.
- Set DTB TIME/DIV switch S13 to position 0,1 ms/div.
- Set INTENS potentiometer R1 to 180° from its left hand stop.
- Set potentiometer R1507 (Fig. 3.19) to its right hand stop. Check that the MTB trace is just visible.

3.2.3.3. Trace rotation (R13)

- Depress push button AUTO of the MTB trigger mode switch S4.
- Set MTB TIME/DIV switch S15 to 0,1 ms/div.
- Set DTB TIME/DIV switch S13 to position "OFF".
- Depress push button MTB of the Xdeflection source selector switch S3.
- Depress push button A of the display mode switch S1.
- Depress push button A of the MTB trigger source selector switch S22.
- Centre the time-base line using A POSITION potentiometer R2.
- Depress the channel A input coupling switch S18 (0).
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust front panel TRACE ROTATION potentiometer R13.

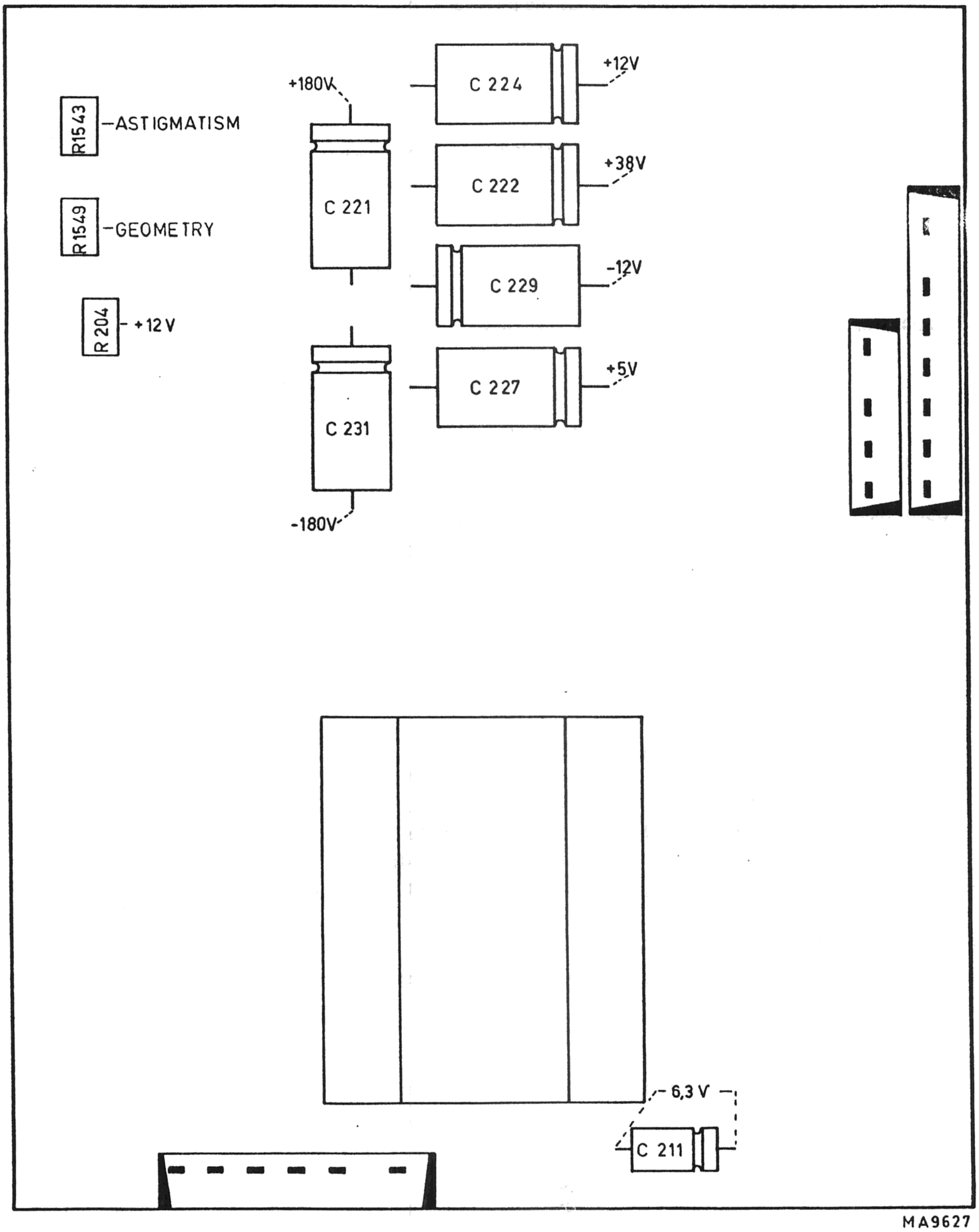


Fig. 3.17. Adjusting and checking the power supply

3.2.3.4. Focus and astigmatism (R1543)

- Depress push button A of the display mode switch S1.
- Depress push button A of the MTB trigger source selector switch S22.
- Depress the channel A input coupling switch S17 (AC).
- Release the channel A input coupling switch S18 (0).
- Set A AMPL/DIV switch S9 to 0,1 V/div. and A AMPL/DIV potentiometer R9 to CAL.
- Set TIME/DIV switch S15 to 50 µs/div. and TIME/DIV potentiometer R12 to CAL.
- Apply a sine-wave voltage to approx. 600 mVp-p, 10 kHz, to the A input socket X2.
- Set INTENS potentiometer R1 for normal brightness.

Use an insulated screw-driver.

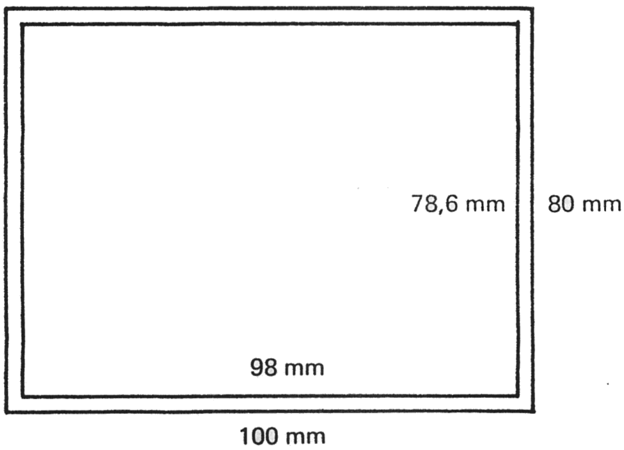
- Adjust FOCUS potentiometer R8 and astigmatism potentiometer R1543 for a sharp and well-defined trace over the whole screen area (Fig. 3.17).

3.2.3.5. Geometry (R1549)

- Set the controls as in the previous section.
- Set A AMPL/DIV switch S9 to 0,1 V/div. and A AMPL/DIV potentiometer R9 to CAL.
- Depress push button EXT of the MTB trigger source selector switch S22.
- Apply a sine-wave voltage of approx. 800 mVp-p, 100 kHz, to the A input socket X2.

Use an insulated screw-driver.

- Check that the displayed vertical lines are as straight as possible and check that the signal falls between 100x80 mm2 and 98x78,6 mm2.



If necessary readjust potentiometer R1549 (Fig. 3.17).

3.2.4. Y-amplifier balance

3.2.4.1. General information

The adjustments of the vertical amplifier channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

3.2.4.2. D.C. balance (R504, R604)

- Depress push button A (B) of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress the A (B) input coupling switch S18 (S20) (0).
- Set A (B) AMPL/DIV potentiometer R9 (R10) to CAL.
- Centre the trace using A (B) POSITION potentiometer R2 (R3).
- Check that the trace does not jump if AMPL/DIV switch S9 (S11) is switched from 10 mV/div. to 20 mV/div. If necessary, adjust potentiometer R504 (R604) for minimum jump (Fig. 3.19).
- Repeat the measurement for channel B.

3.2.4.3. Gain balance (R527, R627)

- Depress push button A (B) of the display mode switch S1.
- Depress the A (B) input coupling switch S18 (S20) (0).
- Check that the trace does not move when the AMPL/DIV potentiometer R9 (R10) is rotated. If necessary readjust R527 (R627) (Fig. 3.19).
- Repeat the measurement for channel B.

3.2.4.4. Normal/invert balance channel B (R647)

- Depress push button B of the display mode switch S1.
- Depress the channel B input coupling switch S20 (0).
- Check that the trace does not jump when PULL TO INVERT B switch S5 is switched between normal and invert.
  If necessary readjust R647 (Fig. 3.19).

3.2.4.5. Shift balance (R547, R674)

- Depress push button A (B) of the display mode switch S1.
- Depress push button A (B) of the MTB trigger source selector.switch S22.
- Depress the A (B) input coupling switch S17 (S19) (AC).
- Release the input coupling switch S18 (S20) (0).
- Set the A (B) AMPL/DIV switch S9 (S11) to 20 mV/div. and A (B) AMPL/DIV potentiometer R9 (R10) to CAL.
- Set the MTB TIME/DIV switch S15 to 50 μs/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Apply a sine-wave voltage of 480 mVp-p, 10 kHz to the A (B) input socket.
- Check if the extremes of the sine-wave can be displayed distortion free on the screen by rotating the A (B) POSITION potentiometer R2 (R3).
  If necessary readjust potentiometer R547 (R674). (Fig. 3.19)
- Repeat the measurement for channel B.

3.2.5. DTB and MTB trigger balance (R456, R351, R458, R356, R453 and R353)

- Depress push button ALT of the display mode switch S1.
- Depress push button AC of the DTB trigger mode switch S2.
- Depress both push buttons MTB and DTB of the X deflection source selector switch S3 (ALT TB).
- Depress push button AC of the MTB trigger mode switch S4.
- Release the A and B input coupling switches S17 and S19 (DC).
- Release the A and B input coupling switches S18 and S20 (0).
- Set A AMPL/DIV switch S9 and B AMPL/DIV switch S11 to position 0,1 V/div. and A and B AMPL/DIV potentiometers R9 and R10 to CAL.
- Set DTB TIME/DIV switch S13 to position 50 μs/div. and DTB TIME/DIV potentiometer R11 to CAL.
- Set MTB TIME/DIV switch S15 to position 0,2 ms/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Turn TRACE SEPARATION potentiometer R14 to its left hand stop.
- Depress push button A of the DTB trigger source selector switch S21.

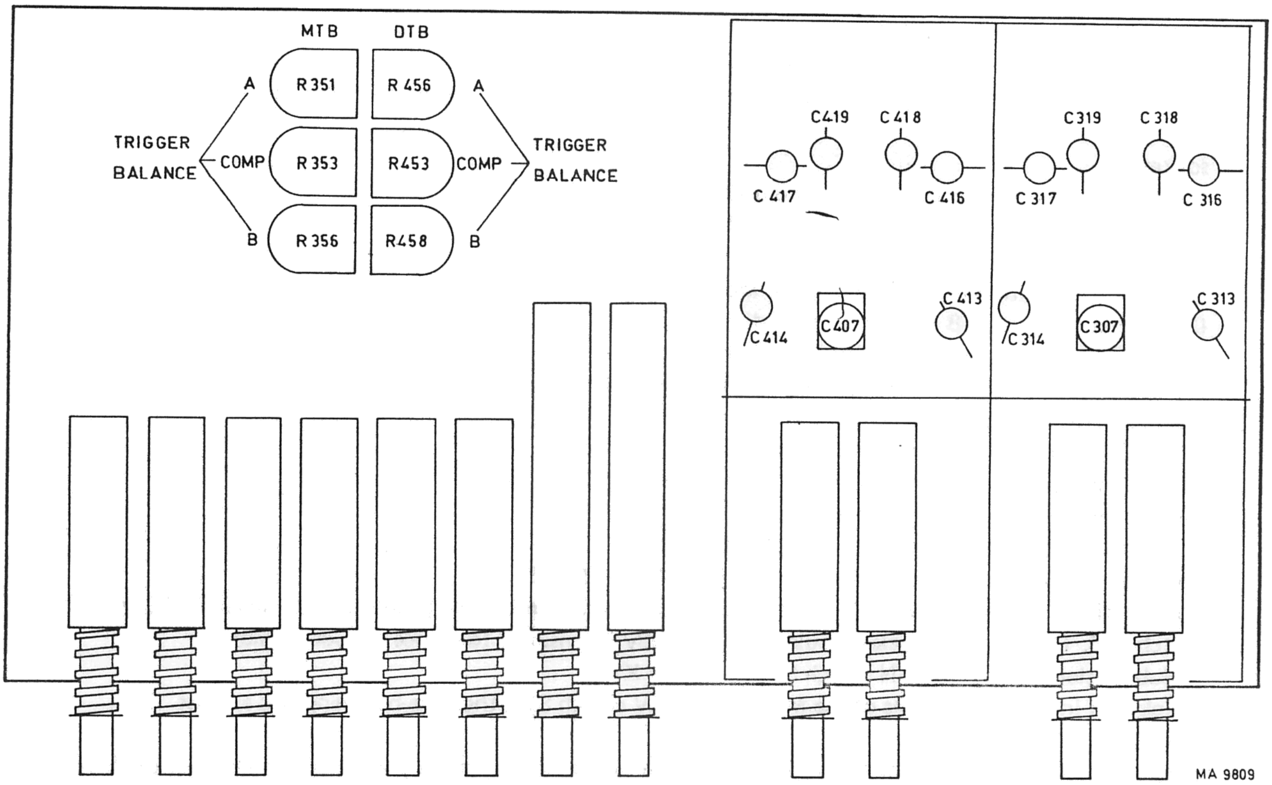


Fig. 3.18. Adjusting elements attenuator board

- Depress push button A of the MTB trigger source selector switch S22.
- Apply a sine-wave voltage of 480 mVp-p, 2 kHz to the A and B input sockets X2 and X3.
- Shift both traces to the central horizontal graticule line using A and B POSITION potentiometers R2 and R3.
- Set DTB LEVEL potentiometer R5 and MTB LEVEL potentiometer R7 in such a way that the DTB and the MTB start at a point on the central horizontal graticule line.
- Depress push button DC of the DTB trigger mode switch S2.
- Depress push button DC of the MTB trigger mode switch S4.
- Check that the starting point of the DTB and MTB is the same as adjusted above. If necessary readjust potentiometers R456 and R351 (Fig. 3.18).
- Depress push button B of the DTB trigger source selector switch S21.
- Depress push button B of the MTB trigger source selector switch S22.
- Check that the starting point of the DTB and the MTB is again the same as adjusted above. If necessary readjust potentiometers R458 and R356 (Fig. 3.18).
- Depress both push buttons A and B of the DTB trigger source selector switch S21 (COMP).
- Depress both push buttons A and B of the MTB trigger source selector switch S22 (COMP).
- Check that the starting point of the DTB and MTB is again the same as adjusted above. If necessary readjust potentiometers R453 and R353 (Fig. 3.18).

3.2.6. MTB Time coefficients(R1417, R1419, R1216)

- Depress push button A of the display mode switch S1.
- Depress push button DC of the DTB trigger mode switch S2.
- Depress push button MTB of the X deflection source selector switch S3.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Set X MAGN switch S7 to position X1.
- Depress MTB SLOPE switch S8 to the + position.
- Set A AMPL/DIV switch S9 to 20 mV/div.
- Release the channel A input coupling switch S18 (0).
- Release the channel A input coupling switch S17 (DC).

- Set DTB TIME/DIV switch S13 in position "OFF".
- Depress push button A of the MTB trigger source selector switch S22.
- Set MTB TIME/DIV switch S15 to 2 μs/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Apply a time-marker voltage with repetition time of 2 μs and an amplitude of 80 mVp-p to the A input socket X2.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1417 (Fig. 3.19).
- Pull X MAGN switch S7 to position X10.
- Change the repetition time of the applied input signal to 0,2 μs.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1419 (Fig. 3.19).
- Check that the trace can be shifted over 100 divisions with the aid of X POSITION potentiometer R6.
- Push X MAGN switch S7 to position X1.
- Set MTB TIME/DIV switch S15 to 2 ms/div.
- Change the repetition time of the applied input signal to 2 ms.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1216 (Fig. 3.19).
- Check all the other positions of the MTB TIME/DIV switch S15.
  The repetition time of the applied input signal should correspond to the position of the MTB TIME/DIV switch S15. The central 8 cycles should always occupy 8 divisions: tolerance ± 1 subdivision.
  (2 Subdivisions with X MAGN switch S7 to position X10).
- Check that in all the positions of the MTB TIME/DIV switch S15, the time-base length is at least 10 divisions.
- Check the control range of the MTB TIME/DIV potentiometer R12 in the position 0,1 ms/div. of the MTB TIME/DIV switch S15.
  This should be: 1 : ⩾ 2,5.

3.2.7. DTB time coefficients and DTB delay time multiplier

3.2.7.1. DTB time coefficients (R1336, R1344)

- Turn potentiometer DELAY TIME R4 to its left hand stop.
- Depress push button DTB of the X deflection source selector switch S3.
- Depress push button A of the DTB trigger source selector switch S21.
- Set DTB TIME/DIV switch S13 to position 2 μs/div. and DTB TIME/DIV potentiometer R11 to CAL.
- Set MTB TIME/DIV switch S15 to position 5 μs/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Apply a time marker voltage with a repetition time of 2 μs and an amplitude of 80 mVp-p to the A input socket X2.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1336 (Fig. 3.19).
- Set DTB TIME/DIV switch S13 to position 0,2 ms/div.
- Set MTB TIME/DIV switch S15 to position 0,5 ms/div.
- Change the repetition time of the applied input signal to 0,2 ms.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1344 (Fig. 3.19).
- Check all the other positions of the TIME/DIV switch S13.
  The repetition time of the applied input signal should correspond to the position of the TIME/DIV switch S13.
  The position of the MTB TIME/DIV switch S15 should be always one step lower.
  The central 8 cycles should always occupy 8 divisions: tolerance ± 1 subdivision.
- Check the control range of the TIME/DIV potentiometer R11 in the position 0,2 ms/div. of the TIME/DIV switch S13. This should be: 1 : ⩾ 2,5.

3.2.7.2. DTB delay time multiplier (R1318, R1319)

- Depress push button A of the display mode switch S1.
- Depress push button A of the MTB trigger source selector switch S22.
- Set A AMPL/DIV switch S9 to 20 mV/div.
- Depress push button MTB of the X deflection source selector switch S3.
- Depress push button MTB of the DTB trigger source selector switch S21.
- Set the MTB TIME/DIV switch S15 to 50 μs/div.
- Set the DTB TIME/DIV switch S13 to 0,2 μs/div.
- Apply a time-marker voltage with a repetition time of 50 μs and an amplitude of 80 mVp-p to A input socket X2.
- Adjust the MTB level potentiometer R7 for a stable, triggered display.
- Check that the intensity modulation of the delayed time-base is visible on the screen.
- Set X POSITION potentiometer R6 in such a way that the trace starts at the most left vertical graticule line.
- Turn potentiometer DELAY TIME R4 to position 1.
- Adjust R1319 (Fig. 3.19) in such a way that the starting point of the intensified portion falls together with the second vertical graticule line.
- Turn the potentiometer DELAY TIME R4 to position 9.
- Adjust R1318 (Fig. 3.19) in such a way that the starting point of the intensified portion falls together with the tenth vertical graticule line.
- If necessary repeat the above described procedure.

3.2.8. Vertical amplifiers

3.2.8.1. General information

The adjustments of the vertical amplifier channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

3.2.8.2. Deflection sensitivity (gain)

The adjustments of the vertical amplifier sensitivity must follow the specified sequence.
Channel B X1 Gain (R848)
Channel A X1 Gain (R543)
Channel B X10 Gain (R619)
Channel A X10 Gain (R519)

Deflection sensitivity X1 (R848, R543)

- Depress push button B (A) of the display mode switch S1.
- Depress push button MTB of the Xdeflection source selector switch S3.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button B (A) of the MTB trigger source selector switch S22.
- Set B (A) AMPL/DIV potentiometer R10 (R9) to CAL.
- Release B (A) input coupling switch S19 (S17) (DC).
- Release B (A) input coupling switch S20 (S18) (0).
- Set MTB TIME/DIV switch S15 to 0,2 ms/div.
- Set DTB TIME/DIV switch S13 to position "OFF".
- Set B (A) AMPL/DIV switch S11 (S9) to 20 mV/div.
- Apply a square-wave voltage of 120 mV, frequency approx. 2 kHz, to the B (A) input socket.
- Check that the signal occupies 6 divisions.
  If necessary readjust potentiometer R848 (R543) (Fig. 3.19).
- Repeat the measurement for channel A.

Deflection sensitivity X10 (R619, R519)

- Depress push button B (A) of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button B (A) of the MTB trigger source selector switch S22.
- Set B (A) AMPL/DIV potentiometer R10 (R9) to CAL.
- Release B (A) input coupling switch S19 (S17) (DC).

- Release B (A) input coupling switch S20 (S18) (0).
- Set MTB TIME/DIV switch S15 to 0,2 ms/div.
- Set B (A) AMPL/DIV switch S11 (S9) to 2 mV/div.
- Apply a square-wave voltage of 12 mVp-p, frequency approx. 2 kHz, to the B (A) input socket.
- Check that the signal occupies 6 divisions.
  If necessary readjust R619 (R519) (Fig. 3.19).
- Repeat the measurement for channel A.

3.2.8.3. Input attenuators

- Depress push button A (B) of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button A (B) of the MTB trigger source selector switch S22.
- Set MTB TIME/DIV switch S15 to 20 µs and the MTB TIME/DIV potentiometer R12 to CAL.
- Release A (B) input coupling switch S17 (S19) (DC).
- Release A (B) input coupling switch S18 (S20) (0).
- Set A (B) AMPL/DIV potentiometer R9 (R10) to CAL.
- Apply a Square-wave voltage with an amplitude as indicated in the following table, a repetition rate of approx. 10 kHz and a rise time $\leqslant$ 100 ns, to the A (B) input socket.
- Check that no overshoot is visible (max. pulse top errors 2 %), and check that the trace height is 6 divisions ± 3 % (1 subdivision).

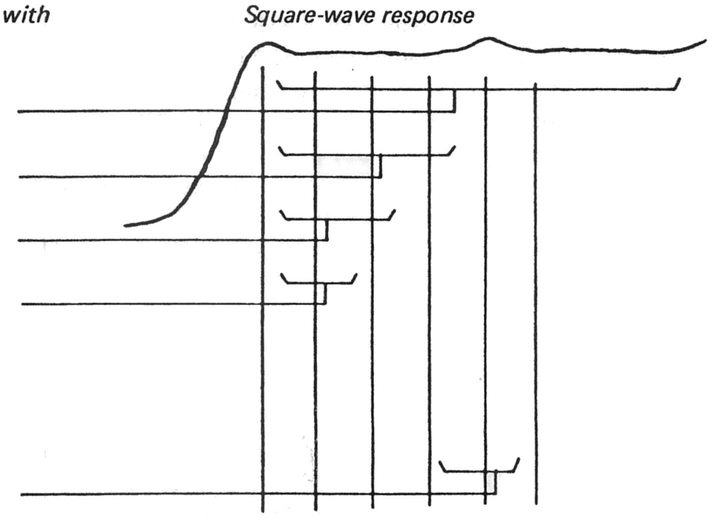
S9 (S11) ampl. to	*Input signal*	*Adjust with*
20 mV	120 mV	C307 (C407)
50 mV	.3 V	C313 (C413)
.1 V	.6 V	C314 (C414)
.2 V	1.2 V	C316+C318 (C416+C418)
2 V	12 V	C317+C319 (C417+C419)

- Repeat the measurement for channel B.

3.2.8.4. Square-wave response final amplifier

- Depress push button B of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button B of the MTB trigger source selector switch S22.
- Push NORMAL/INVERT switch S5 to position NORMAL.
- Set B AMPL/DIV switch S11 to 20 mV/div. and B AMPL/DIV potentiometer R10 to CAL.
- Apply a square-wave voltage of approx. 120 mVp-p, with a rise time $\leqslant$ 3 ns, to the B input socket. The pulse repetition should be in accordance with the table below.
- Check the square-wave response, pulse top errors may not exceed 1 subdivision.
- Check that the rise time does not exceed 14 ns.

Repetition rate	*Adjust with*	*Square-wave response*
10 kHz and 100 kHz	R813	
100 kHz	R812	
1 MHz	R814	
	*L801, *L802, C809, C811, R817	
	C818	



* L801 and L802 should be operated simultaneously and in the same direction and by the same amount.

– Check and readjust the square-wave response according to the table below.

Channel	*AMPL/DIV*	*Input signal*	*Trace height*	*Rep rate*	*TIME/DIV*	*Adj. with*	*Max. error*
B	2 mV/div.	12 mV	6 div.	1 MHz	.2 μs	C602	1 subdivision
A	20 mV/div.	120 mV	6 div.	1 MHz	.2 μs	C508	1 subdivision
A	2 mV/div.	12 mV	6 div.	1 MHz	.2 μs	C502	1 subdivision

3.2.8.5. Cross talk (R813)

– Depress push button CHOP of the display mode switch S1.
– Depress push button AUTO of the MTB trigger mode switch S4.
– Depress push button B of the MTB trigger source selector switch S22.
– Push NORMAL/INVERT switch S5 to position NORMAL.
– Set A and B AMPL/DIV switches S9 and S11 to 20 mV/div. and the A and B AMPL/DIV potentiometers R9 and R10 to CAL.
– Set the MTB TIME/DIV switch S15 to 0,5 ms/div. and the MTB TIME/DIV potentiometer R12 to CAL.
– Depress the A input coupling switch S18 (0).
– Apply a square-wave voltage of 120 mVp-p, rise time ⩽ 3 ns and a repetition rate of approx. 10 kHz to the B input socket.
– Adjust potentiometer R813 (Fig. 3.19). for minimum cross talk between both channels.

3.2.8.6. Bandwidth check of channel A (B)

– Depress push button A (B) of the display mode switch S1.
– Depress push button AUTO of the MTB trigger mode switch S4.
– Push NORMAL/INVERT switch S5 to position NORMAL.
– Depress push button A (B) of the MTB trigger source selector switch S22.
– Set MTB TIME/DIV switch S15 to 0,1 ms/div. and the MTB TIME/DIV potentiometer R12 to CAL.
– Set A (B) AMPL/DIV switch S9 (S11) to 2 mV/div. and AMPL/DIV potentiometer R9 (R10) to CAL.
– Release A (B) input coupling switch S17 (S19) (DC).
– Release A (B) input coupling switch S18 (S20) (0).
– Apply a sine-wave signal of 12 mVp-p, rise time ⩽ 3 ns and a repetition rate of approx. 100 kHz to the A (B) input socket.
– Increase the frequency of the input signal to 25 MHz, the amplitude of the signal must remain 12 mV.
– Check that the trace height is at least 4,2 divisions at input frequency of 25 MHz.

Repeat the measurement for channel B.

3.2.9. Triggering

3.2.9.1. Triggering sensitivity (R1016, R1107)

– Depress push button A of the display mode switch S1.
– Depress push button AC of the DTB trigger mode switch S2.
– Depress both push buttons DTB and MTB (ALT TB) of the Xdeflection source selector switch S3.
– Depress push button AUTO of the MTB trigger mode switch S4.
– Set A AMPL/DIV switch S9 to 20 mV/div. and A AMPL/DIV potentiometer R9 to CAL.
– Set DTB TIME/DIV switch S13 to 0,2 ms/div. and DTB TIME/DIV potentiometer R11 to CAL.
– Set MTB TIME/DIV switch S15 to 0,5 ms/div. and MTB TIME/DIV potentiometer R12 to CAL. Turn TRACE SEPARATION potentiometer R14 to its right hand stop.
– Depress push button A of the DTB trigger source selector switch S21.
– Depress push button A of the MTB trigger source selector switch S22.
– Apply a sine-wave signal of 14 mVp-p, frequency approx. 2 kHz, to the A input socket X2.
– Set DTB LEVEL potentiometer R5 to its midposition.
– Readjust potentiometer R1016 in such a way that the MTB trace is triggered and readjust R1107 in such a way that the DTB trace is triggered (Fig. 3.19).

3.2.9.2. Trigger level internal AC

- Depress push button AC of the MTB trigger mode switch S4.
- Depress DTB SLOPE switch S6 to the + position.
- Depress MTB SLOPE switch S8 to the + position.
- Apply a sine-wave signal of 120 mVp-p, frequency approx. 2 kHz, to the A input socket X2.
- Check that the traces start with a positive going edge.
- Pull DTB SLOPE switch S6 to the – position.
- Pull MTB SLOPE switch S8 to the – position.
- Check that the traces start with a negative going edge.
- Check if the starting points of the traces are shifted to the upperside of the screen when the DTB and MTB LEVEL potentiometers R5 and R7 are turned to their right hand stops.
- Both traces may not be triggered if the DTB and MTB LEVEL potentiometers R5 and R7 are in their right hand stops or in their left hand stops.
- Change the amplitude of the applied input signal to 480 mVp-p.
- Check that both traces are triggered if the DTB and MTB LEVEL potentiometers R5 and R7 are in the right hand stops or in the left hand stops.

3.2.9.3. Trigger level auto (MTB)

- Depress push button MTB of the X deflection source selector switch S3.
- Depress push button AUTO of the MTB trigger mode selector switch S4.
- Apply a sine-wave signal for a trace height equivalent of 6 divisions, frequency approx. 100 Hz to the A input socket X2.
- Check that the starting point of the sine-wave can be shifted across approx. 3 divisions with the aid of MTB LEVEL potentiometer R7.

3.2.9.4. Trigger level external (MTB)

- Depress push button AC of the MTB trigger mode switch S4.
- Depress push button EXT of the MTB trigger source selector switch S22.
- Apply a sine-wave signal of 8 Vp-p, frequency approx. 2 kHz to the A and EXT input sockets.
- Check that the starting point of the sine-wave can be shifted across the entire amplitude of the signal with the aid of the MTB level potentiometer R7.

3.2.9.5. Trigger sensitivities

- Depress push button A of the display mode switch S1.
- Depress push button DC of the DTB trigger mode switch S2.
- Depress both push buttons DTB and MTB (ALT TB) of the X deflection source selector switch S3.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Set DTB TIME/DIV switch S13 to 1 ms/div. and DTB TIME/DIV potentiometer R11 to CAL.
- Set MTB TIME/DIV switch S15 to 2 ms/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Set A and B AMPL/DIV switches S9 and S11 to 20 mV/div. and A and B AMPL/DIV potentiometers R9
- and R10 to CAL.
- Depress push button A of the DTB trigger source selector switch S21.
- Depress push button A of the MTB trigger source selector switch S22.
- Apply a sine-wave signal of 14 mVp-p, frequency approx. 2 kHz, to the A input socket X2.
- Check that there are now two triggered traces on the screen.
- Decrease the frequency of the input signal to approx. 100 Hz and check that there are now two triggered traces on the screen.
- Increase the frequency of the input signal to approx. 25 MHz and the amplitude to 20 mVp-p.
- Set the DTB and MTB TIME/DIV switches S13 and S15 to 0,2 μs/div.
- Check that there are two triggered traces on the screen.
- Depress push button AC of the DTB trigger mode switch S2.
- Depress push button AC of the MTB trigger mode switch S4.
- Set DTB TIME/DIV switch S13 to 1 ms/div. and DTB TIME/DIV potentiometer R11 to CAL.
- Set MTB TIME/DIV switch S15 to 50 ms/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Apply a sine-wave signal of 14 mVp-p, frequency approx. 20 Hz to the A input socket X2.
- Check that there are two triggered traces on the screen.
- Increase the frequency of the applied input signal to 25 MHz.

- Set the DTB and MTB TIME/DIV switches S13 and S15 to 0,2 μs/div.
- Check that the two traces on the screen are triggered.
- Depress push button DC of the DTB trigger mode switch S2.
- Depress push button DC of the MTB trigger mode switch S4.
- Check that the traces remain triggered.
  If necessary readjust the DTB and MTB LEVEL potentiometers R5 and R7.
- Depress push button B of the display mode switch S1.
- Depress push button B of the DTB trigger source selector switch S21.
- Depress push button B of the MTB trigger source selector switch S22.
- Apply a sinewave signal of 20 mVp-p, frequency of 25 MHz to the B input socket X3.
- Check that the traces remain triggered.
  If necessary readjust the DTB and MTB LEVEL potentiometers R5 and R7.
- Depress push button ALT of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Apply a sine-wave signal of 20 mVp-p, frequency approx. 25 MHz to both A and B input sockets X2 and X3.
- Set A POSITION potentiometer R2 and B POSITION potentiometer R3 so that both traces overlap each other.
- Set DTB TIME/DIV switch S13 to 0,2 ms/div. and DTB TIME/DIV potentiometer R11 to CAL.
- Set MTB TIME/DIV switch S15 to 0,2 ms/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Depress both Aand B push buttons (COMP) of the DTB trigger source selector switch S21.
- Depress both A and B push buttons (COMP) of the MTB trigger source selector switch S22.
- Apply two signals which are different in shape and frequency to the A and B input sockets X2 and X3.
- Check that there are now four triggered traces on the screen.

3.2.9.6. Triggering on the line frequency

- Depress push button A of the display mode switch S1.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Depress push button B of the MTB trigger source selector switch S22.
- Set MTB TIME/DIV switch S15 to 2 ms/div. and MTB TIME/DIV potentiometer R12 to CAL.
- Set A AMPL/DIV switch S9 to 20 mV/div. and A AMPL/DIV potentiometer R9 to CAL.
- Release A input coupling switch S17 (DC).
- Release A input coupling switch S18 (0).
- Apply a signal of approx. 10 mVp-p at the mains frequency to the A input socket.
- The trace is not triggered.
- Depress push button LINE of the MTB trigger source selector switch S22 and check that the trace is triggered.

3.2.9.7. T.V. Triggering

- Depress push button A of the display mode switch S1.
- Depress push button MTB of the X deflection source selector switch S3.
- Set MTB TIME/DIV switch S15 to 2 ms/div.
- Depress push buttons AUTO and DC (TVF) of the MTB trigger mode switch S4.
- Apply a T.V. signal with a synchronisation pulse of 14 mVp-p to the A input socket X2.
- Depress MTB SLOPE switch S8 to "+" for a T.V. signal with positive video.
- Check that the trace is triggered.
  If necessary readjust MTB LEVEL potentiometer R7.
- Release MTB SLOPE switch S8 to "–" for a T.V. signal with negative video.
- Check that there is a triggered trace.
- Depress push buttons AC and AUTO (TVL) of the MTB trigger mode switch S4.
- Set MTB TIME/DIV switch S15 to 10 μs/div.
- Check if the trace is triggered.
  If necessary use MTB LEVEL potentiometer R7.

3.2.9.8. Trace separation

- Depress push button A of the display mode switch S1.
- Depress both push buttons DTB and MTB (ALT TB) of the X deflection source selector switch S3.
- Depress push button AUTO of the MTB trigger mode switch S4.
- Set MTB TIME/DIV switch S15 to 50 μs/div.
- Set DTB TIME/DIV switch S13 to 50 μs/div.

- Turn TRACE SEPARATION potentiometer R14 to its left hand stop.
- Check that both traces overlap each other.
- Turn TRACE SEPARATION potentiometer R14 to its right hand stop.
- Check that the traces move > ± 2 div. from the centre of the screen.

3.2.10. X deflection

3.2.10.1. Sensitivity

- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button EXT of the MTB trigger source selector switch S22.
- Apply a sine-wave voltage of 4 Vp-p, frequency approx. 2 kHz, to the EXT input socket.
- Check that the trace length is 8 divisions ± 0,8 division.

3.2.10.2. Frequency response

- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button EXT of the trigger source selector switch S22.
- Apply a sine-wave voltage of 4 Vp-p (trace length 8 divisions), frequency approx. 10 kHz, to the EXT input socket.
- Increase the frequency to 1 MHz.
- Check that the trace length is at least 5,6 divisions.

3.2.10.3. X Deflection with a line signal

- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button LINE of the MTB trigger source selector switch S22.
- Check that the trace length is 8 divisions ± 1 division.

3.2.10.4. Horizontal sensitivity via input A

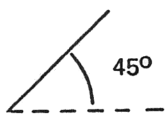
- Set A AMPL/DIV switch S9 to 20 mV/div. and A AMPL/DIV potentiometer R9 to CAL.
- Depress push button B of display mode switch S1.
- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button DC of the MTB trigger mode switch S4.
- Depress push button A of the MTB trigger source selector switch S22.
- Apply a sine-wave voltage of 120 mVp-p, frequency approx. 2 kHz, to the A input socket.
- Check that the trace length is 6 divisions ± 0,6 division.

3.2.10.5. Horizontal sensitivity via input B

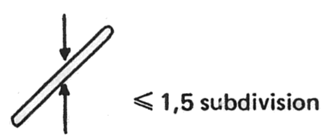
- Set B AMPL/DIV switch S11 to 20 mV/div. and B AMPL/DIV potentiometer R10 to CAL.
- Depress push button A of display mode switch S1.
- Depress push button XDEFL of the X deflection source selector switch S3.
- Depress push button DC of the MTB trigger mode switch S4.
- Depress push button B of the MTB trigger source selector switch S22.
- Apply a sine-wave voltage of 120 mVp-p, frequency approx. 2 kHz, to the B input socket.
- Check that the trace length is 6 divisions ± 0,6 division.

3.2.10.6. Phase difference between X and Y channels

- Input signal and control settings as in the previous section.
- Depress push button B of the display mode switch S1.
- Check that the line is displayed under an angle of 45°.



- Increase the frequency to 100 kHz.
- Check that the phase error does not exceed 3° (1,5 subdivision).



3.2.11. Calibration voltage (R1602)

- Check that the voltage on the CAL output socket is 1,2 V ± 1 %. If necessary readjust potentiometer R1602 (Fig. 3.19.).

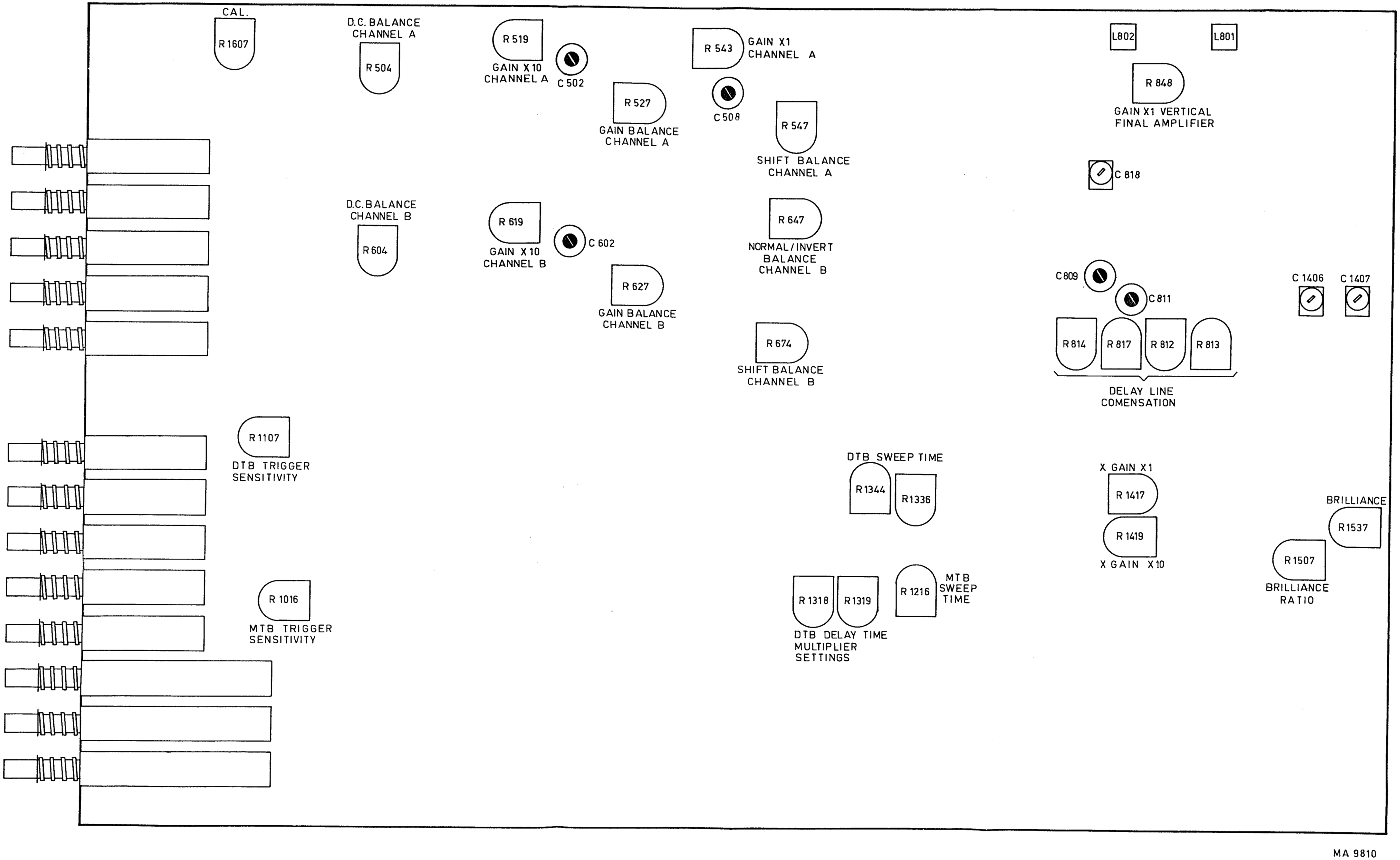


Fig. 3.19. Adjusting elements amplifier board.

3.3. INFORMATION FOR ASSISTENCE IN FAULT FINDING

3.3.1. Mains transformer data

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram (Fig. 3.44) in the form of a table.

3.3.2. Voltages and waveforms in the instrument

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generators are shown at the relevant points on the circuit diagrams (Fig. 3.44, Fig. 3.45 and Fig. 3.46). The oscilloscope under test must be set in the following way to measure the voltage wave forms as shown in Fig. 3.44 and Fig. 3.46.

- Display mode switch S1 to position "A".
- X deflection selector switch S3 to position "MTB".
- MTB trigger mode switch S4 to position "AUTO".
- A POSITION potentiometer R2 at mid-range.
- A AMPL/DIV switch S9 to 1 V/div. and potentiometer R9 to CAL.
- Input signal on A input socket X2: 2,5 kHz sine-wave voltage for 8 div. deflection.
- X POSITION potentiometer R6 at mid-range.
- X MAGN switch S7 to position "X1".
- MTB LEVEL potentiometer R7 at mid-range.
- DTB LEVEL potentiometer R5 at mid-range.
- MTB SLOPE switch S8 in position "+".
- DTB SLOPE switch S6 in position "+".
- MTB TRIGGER source selector switch S22 to position "A".
- DTB TRIGGER source selector switch S21 to position "A".
- MTB TIME/DIV switch S15 to 0,2 ms/div. and potentiometer R12 to CAL.
- DTB TIME/DIV switch S13 to OFF for measuring the diagrams 1-2-3-4-5-6-7-8-9-10-13-14-18a-18b-18d-19a en 19b.
- DTB TIME/DIV switch S13 to 50 μs/div. for measuring the diagrams 11-12-15-16-17-18c-18e and 19c.

3.3.3. Remark

In case of a defect it is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found, or the service required.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.4. DISMANTLING THE INSTRUMENT

3.4.1. General information

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.
During dismantling procedures, a careful note of all leads disconnected must be made so that they may be reconnected to their correct terminals during assembly.

Always ensure that the mains supply is disconnected before removing any instrument cover plates.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute of switching off the instrument.

3.4.2. Removing the instrument covers

The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.
To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:

- hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 3.20).
- stand the instrument on its protective front cover on a flat surface
- slacken the two coin-slot screws located on the rear panel
- lift the rear panel and unplug the connector on the power supply board
- lift off the wrap-around cover
- for access to the front-panel, stand the instrument horizontally and snap off the front cover.

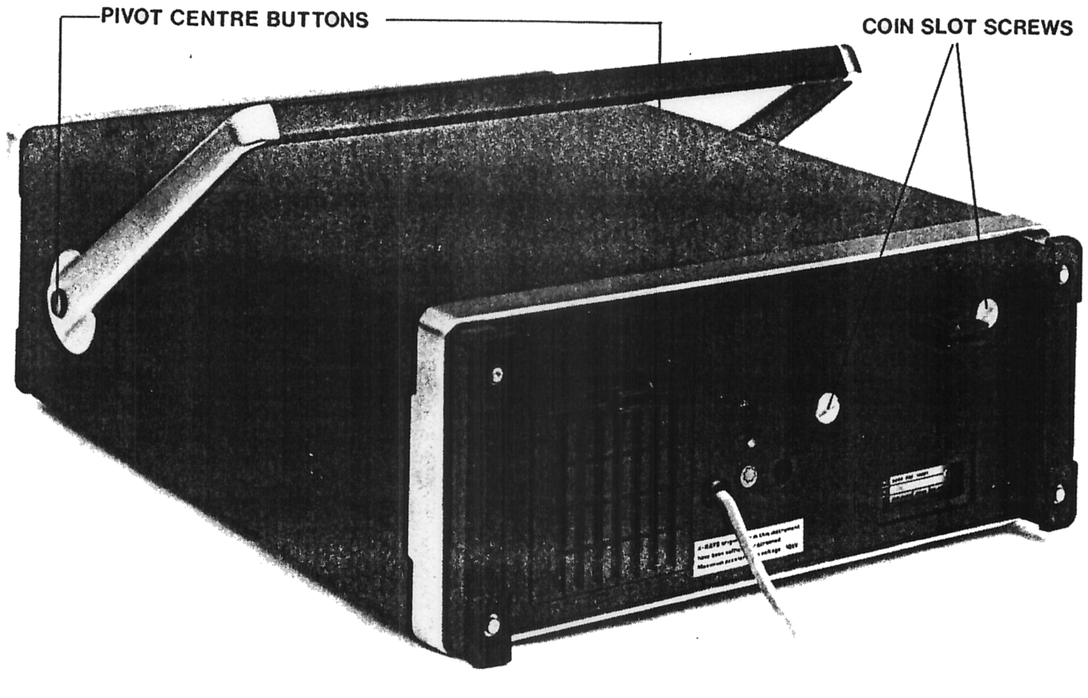


Fig. 3.20. Removing the instrument covers.

3.4.3. Removing the carrying handle

- Prise off the centre knobs from each pivot, using a screwdriver (Fig. 3.21) in one of the small slots at the sides of the knobs.
- Remove the cross-slotted screws that are now accessible.
- Bend both arms of the handle slightly outwards and take it off the cabinet.
- Grip and arms of the carrying handle must be ordered separately (see list of mechanical parts). A complete carrying handle can easily be constructed by pressing the arms into the grip.

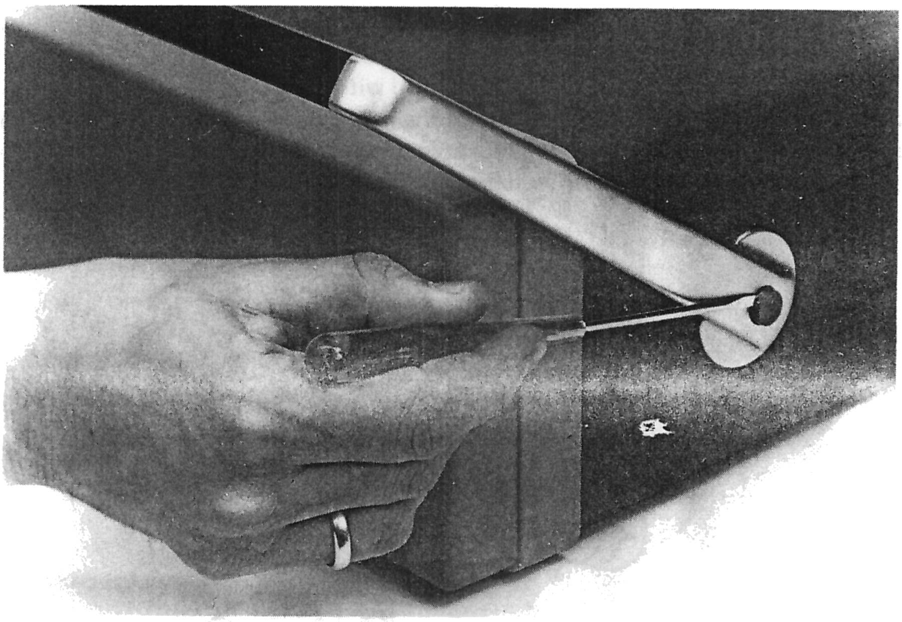


Fig. 3.21. Removing the carrying handle.

3.4.4. Removing the bezel and the contrast plate

- Take hold of the bezel's bottom corners and gently pull it from the front panel (Fig. 3.22).
- The contrast filter can be removed by pressing it gently out of the bezel.

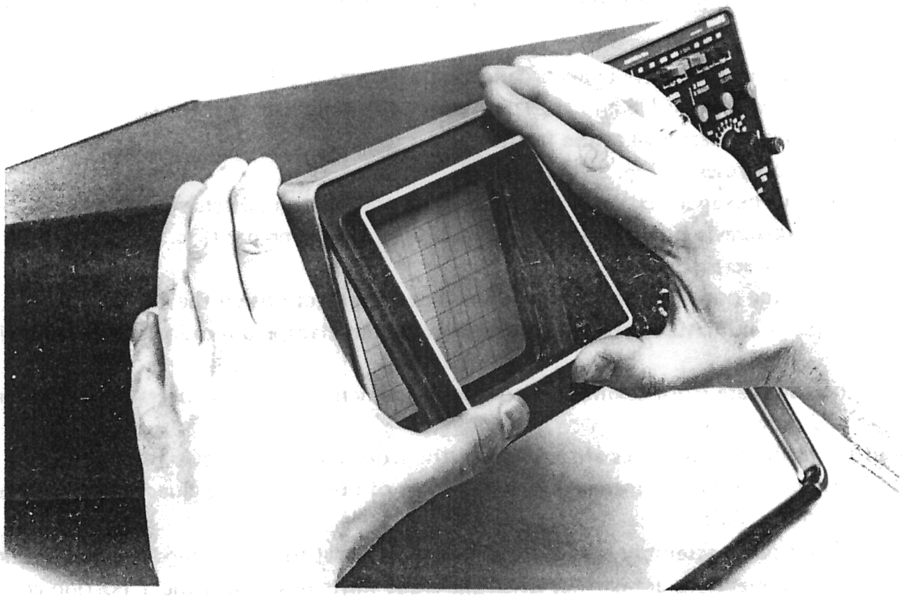


Fig. 3.22. Removing the bezel and the contrast plate.

3.4.5. Removing the knobs and the text plate

- The channel B POSITION, the X POSITION, the DTB LEVEL and the MTB LEVEL knobs can be removed after prising off the knob caps and unscrewing the slotted nuts that are then accessible.
- The remaining small knobs can be pulled off the shafts.
- The AMPL/DIV and TIME/DIV switch knobs can be removed after prising off the knob caps and unscrewing the hexagonal nuts that are then accessible.
- The delay-time multiplier knob (Fig. 3.23) can be removed in the following way:
  - Slacken screw A using a hexagonal key and pull the knob from the spindle.
  - Remove the nut B and withdraw the ring from the spindle.
- When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut B. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw A.
- When the knobs have been removed, the text plate can be taken off after removing the hexagonal nuts of the AMPL/DIV and the TIME/DIV switches.

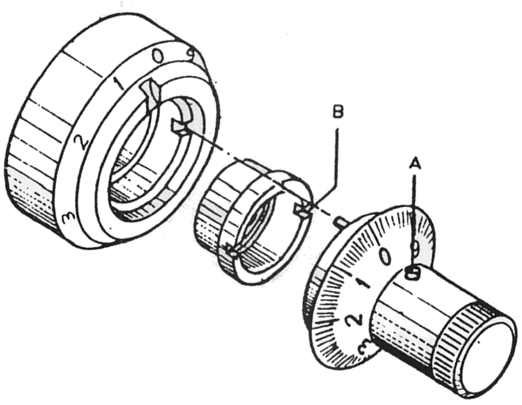


Fig. 3.23. Removing the delay-time multiplier knob

3.4.6. Removing the front assembly

In order to gain access to parts on the AMPL/DIV switches, to replace trimmer capacitors or other components on the attenuator board, it is best to remove the front panel assembly as a whole in accordance with the following procedure:

- Remove the instrument covers in accordance with section 3.4.2.
- Remove the INTENS, FOCUS and ILLUM knobs by pulling them off the shaft.
- Remove the earthing terminal at the front.
- Remove the two screws C (Fig. 3.24).
- Remove the four hexagon screws D that secure the pushbutton switches to the front panel (Fig. 3.25).
- Remove the two screws E that hold the attenuator to the frame bar (Fig. 3.26).
- Remove the three screws F (Fig. 3.27).
- Make a note of the positions of the miniature socket connections on the amplifier board.
- Remove all plugs, miniature sockets, coaxial sockets and clamping terminals from the unit and the amplifier board.
- Remove the complete front assembly from the instrument: screening covers can then be removed to gain access to and remove parts.
- Before the pushbutton switches are refitted to the front panel, it is advisable to stick the two parts of each clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate remplacement, refer to Fig. 3.28.
- When the front panel assembly is reinstalled, make sure not to interchange the connections of the Y position controls. The connections are correct when the trace shifts upwards if the Y postion control is rotated clockwise.

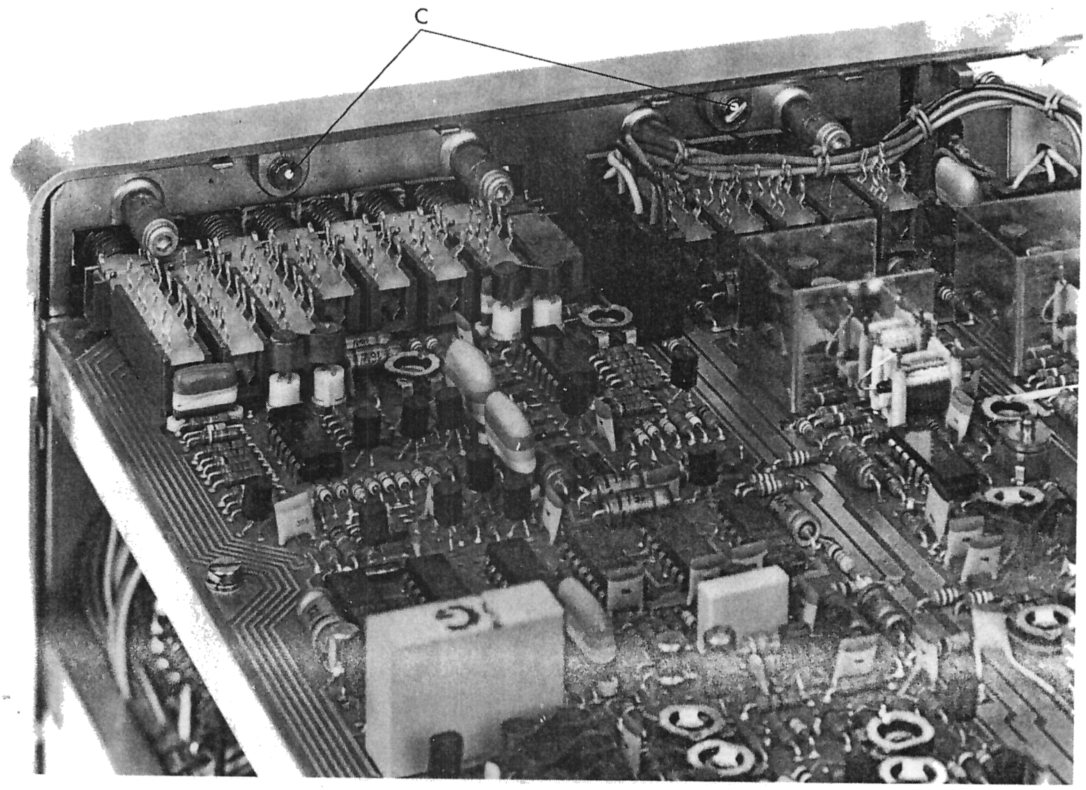


Fig. 3.24. Removing the front assembly (screws C).

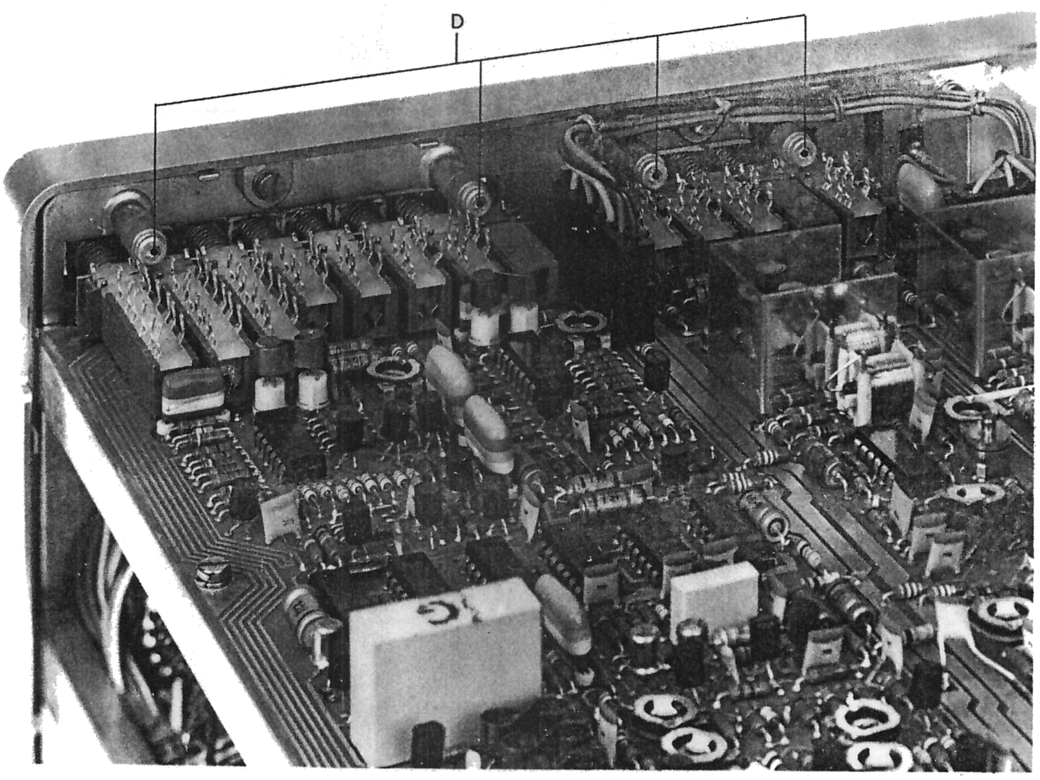


Fig. 3.25. Removing the pushbutton switches (screws D).

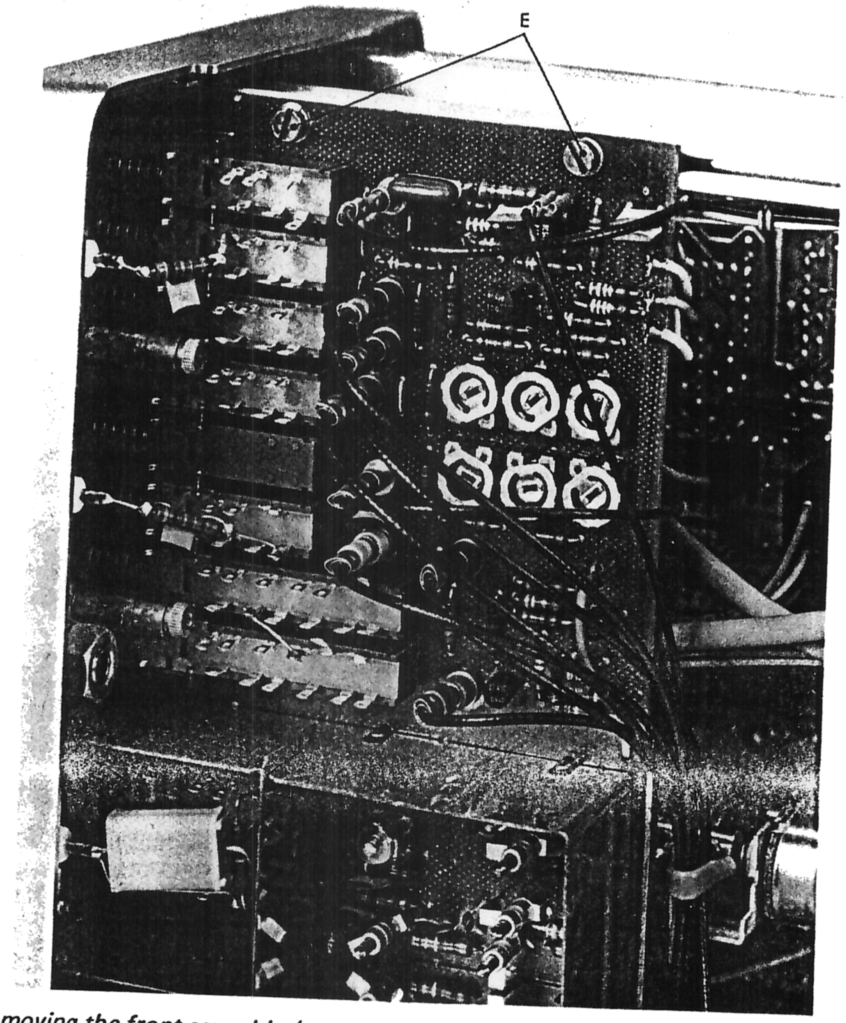


Fig. 3.26. Removing the front assembly (screws E).

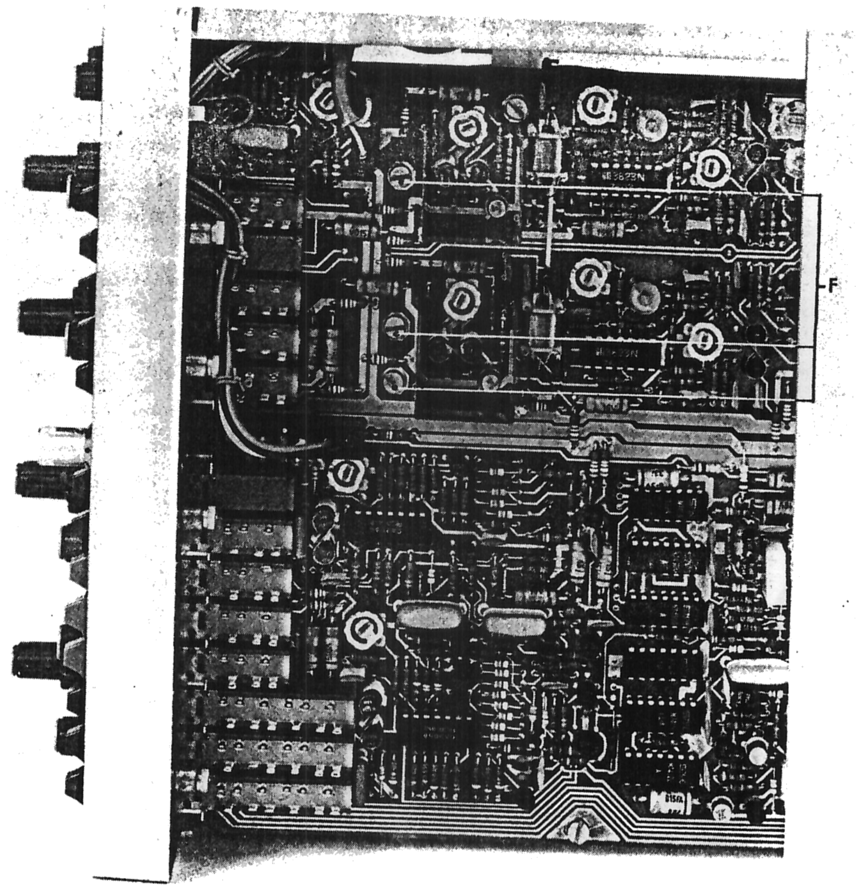


Fig. 3.27. Removing the front assembly (screws F).

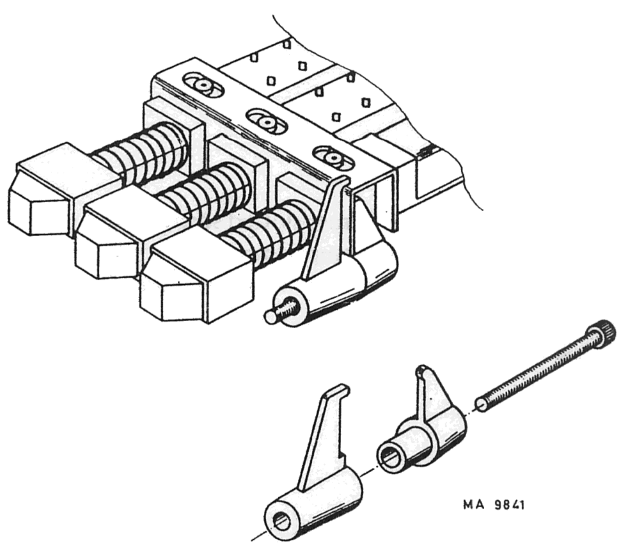


Fig. 3.28. Pushbutton set clamping device.

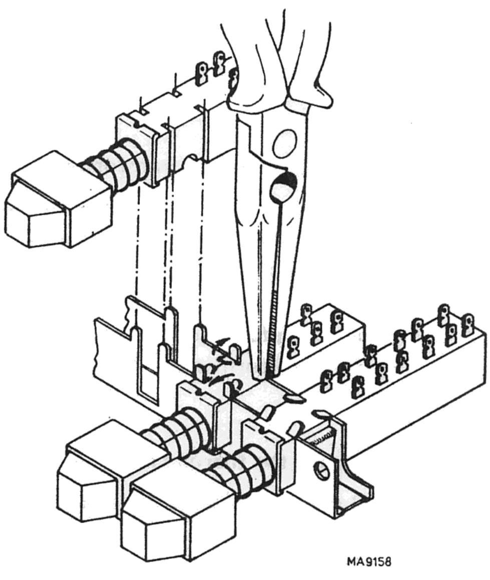


Fig. 3.29. Replacing a pushbutton switch

3.4.7. Replacing switches

3.4.7.1. General

- To replace the AMPL/DIV switches, first remove the front panel assembly (section 3.4.6.).
- To replace the TIME/DIV switch, first remove knobs and text plate (section 3.4.5.).
- If one of the push-button switches of the main and delayed trigger source selectors (A, B, EXT, MTB or A, B, EXT, LINE) or an input coupling switch (AC/DC 0) must be replaced, it is best to remove the front panel assembly first (section 3.4.6.). The defective switch is then replaced in accordance with the procedure described below.
- To replace one of the push-button switches of the vertical mode switch (A, ALT, CHOP, ADD, B) or the trigger and X deflection mode switches (AC, DC, DTB, MTB, X DEFL, AC, AUTO, DC) the amplifier board can be removed if so desired and the defective switch is then replaced as described below.

3.4.7.2. Replacing a switch of a pushbutton unit

- Straighten the 4 retaining lugs of the relevant switch as shown in Fig. 3.29.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron)
- Solder the new switch on to the printed-wiring board.
- Bend the four retaining lugs back to their original positions.

Note: The ALT switch and the AC and MTB switch on the delayed time base compartment are dummy switches which can be replaced by a not self-releasing type.

3.4.8. Replacing the cathode-ray tube

- Remove the instrument covers and rear frame (section 3.4.2.).
- Remove bezel and contrast plate (section 3.4.4.).
- Unplug the connectors on the c.r.t. neck.
- Ease the base socket off the c.r.t.
- Slacken the brace around the c.r.t. neck.
- Unplug the trace rotation coil connector on the amplifier board and pull cable and plug through the elongated hole in the centre frame.
- Withdraw the c.r.t. through the front panel until the e.h.t. connector at the side of the tube becomes accessible.
- Remove the e.h.t. connector.

- Take the c.r.t. out of the instrument via the front panel; mind the wire and plug of the trace rotation coil
- Install a c.r.t. in reverse order; position the c.r.t. screen flush with the contrast plate. The torque applied to the screw of the brace around the c.r.t. neck must be between 0,4 and 0,6 Nm.

3.4.9. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 3.4.2.).
- Take the lid off the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire from between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement.

3.4.10. Replacing the thermal fuse

- Remove the mains transformer (section 3.4.9.).
- Unsolder fuse terminals 1 and 2 (Fig. 3.30 and Fig. 3.31).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

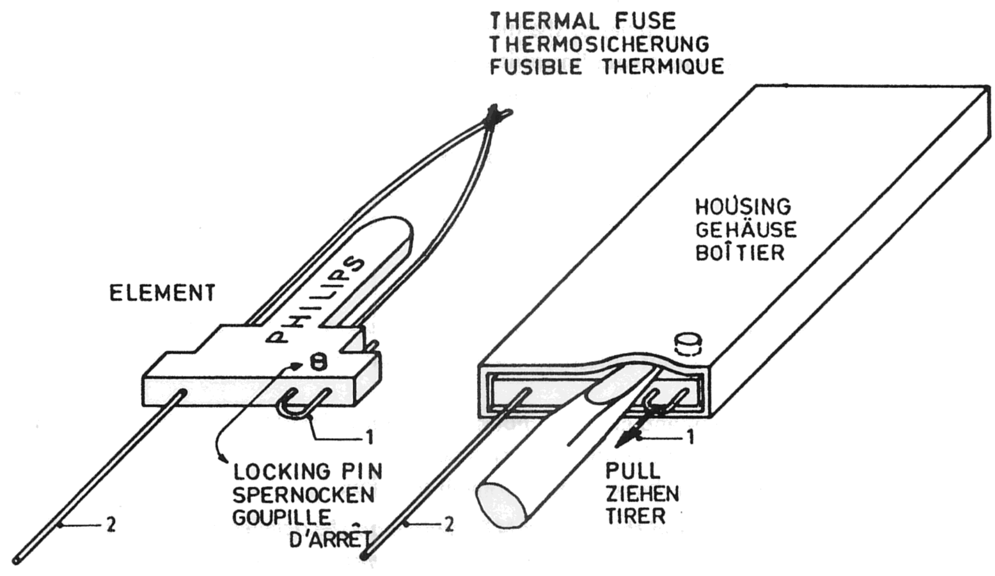


Fig. 3.30. Replacing the thermal fuse.

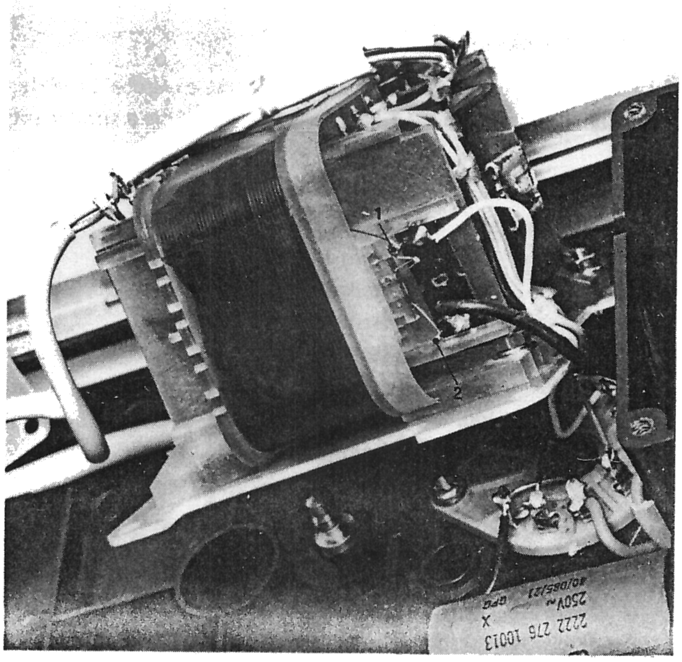


Fig. 3.31. Replacing the thermal fuse.

3.4.11. Replacing the delay line unit

- If there is a defect in the delay line, the complete delay line unit must be replaced.
- Replacement is self-evident, but take care not to interchange the connections at the same end of the delay line; interchange of the connections results in a downward movement of the trace when rotating the POSITION control clockwise.
- Before mounting it must be checked, that the new delay line is placed in its housing like shown in Fig. 3.32.

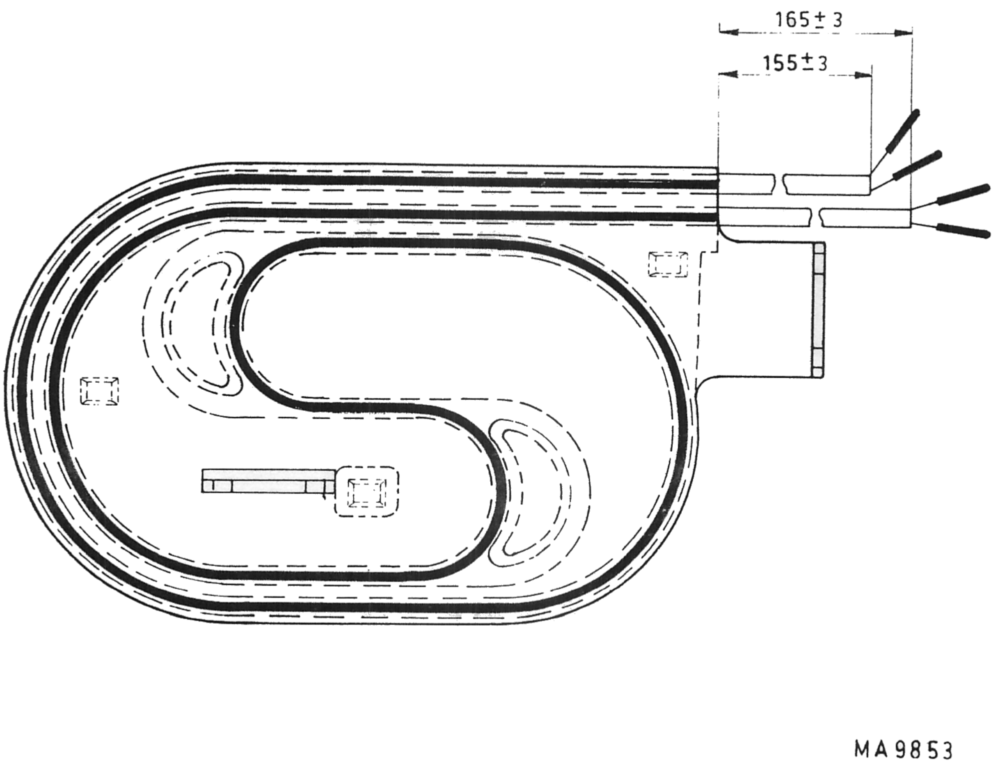


Fig. 3.32. Delay line.

3.5. INFORMATION CONCERNING ACCESSORIES

3.5.1. Attenuator probe sets PM 9336 and PM 9336L

The PM 9336 is a 10x attenuator probe, designed for oscilloscopes up to 25 MHz, having a BNC input jack and 10 to 35 pF input capacitance, paralleled by 1 MΩ. The PM 9336L is a similar probe with a cable length of 2.5 m.

The set consists of:

1 probe assembly	Fig. 3.33, item 1
5 soldering terminals	Fig. 3.33, item 2
1 test hook	Fig. 3.33, item 3
2 spare test hook sleeves	Fig. 3.33, item 4
1 protective cap	Fig. 3.33, item 5
1 probe holder	Fig. 3.33, item 6
2 probe tips	Fig. 3.33, item 7
1 earthing cord	Fig. 3.33, item 8
1 box	item 9

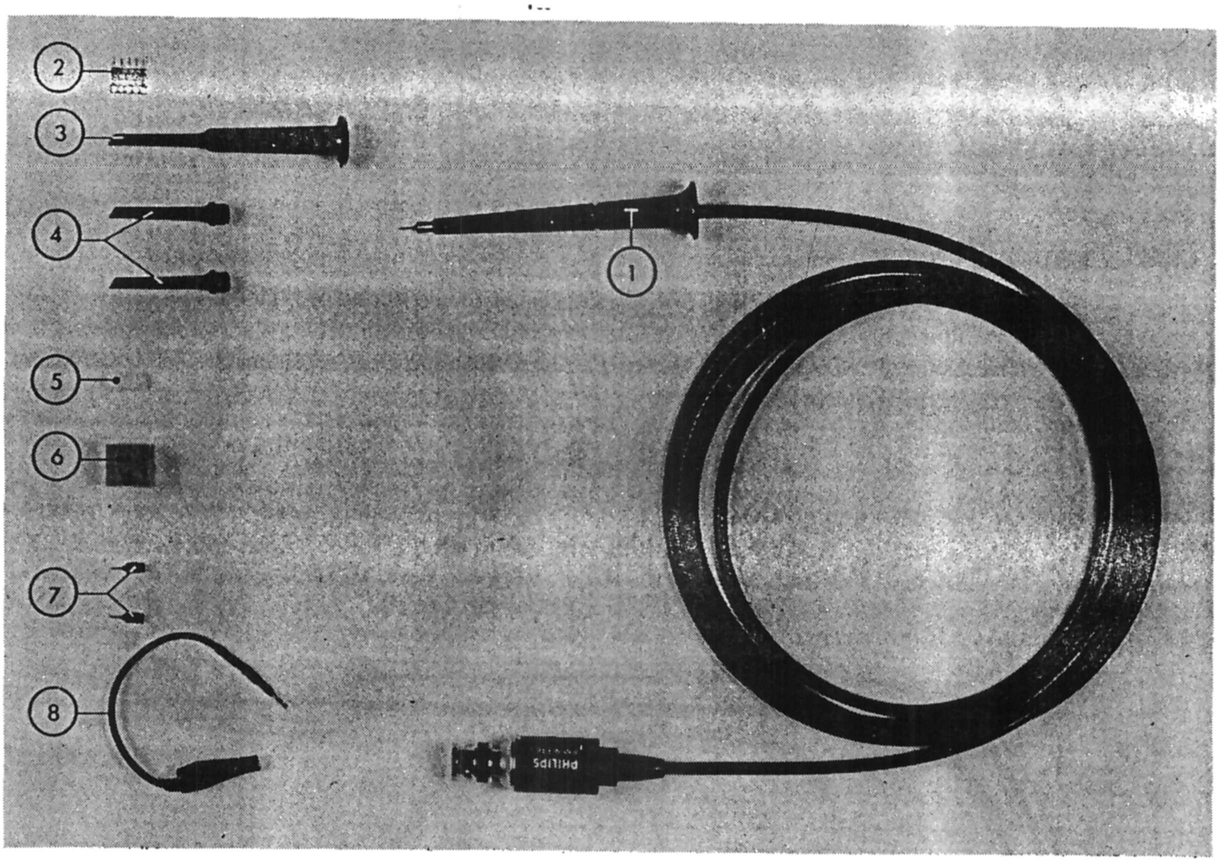


Fig. 3.33. Attenuator probe set PM 9336 (PM 9336L)

3.5.1.1. *Technical data*

Attenuation	1:10 ± 3 %		
Input resistance	PM 9336	10 MOhm	± 2 %
	PM 9336L	10 MOhm	± 2 %
Input capacitance	PM 9336	11 pF	± 1 pF
	PM 9336L	14 pF	± 1 pF
Maximum allowable input voltage	500 V (D.C. + A.C. peak)		

3.5.1.2. *Adjustment*

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to socket CAL of the oscilloscope.
A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.
See the following examples.

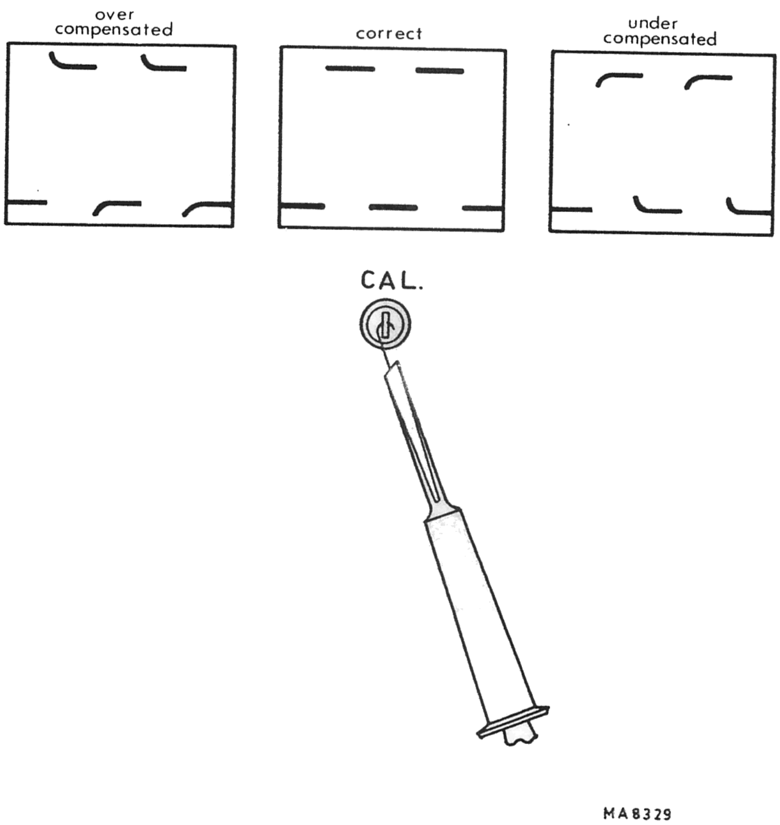


Fig. 3.34. Probe compensation

3.5.1.3. *Parts of attenuator probe sets PM 9336 and PM 9336L*

Item	*Qty.*	*Ordering code*	*Description*
1	1	5322 320 14004	Cable assembly PM 9336 (1.5 m)
1	1	5322 320 14013	Cable assembly PM 9336L (2.5 m)
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 20024	Test hook
4	1	5322 264 20028	Test hook sleeve
5	1	5322 532 60535	Protective cap
6	1	5322 256 94034	Probe holder
7	1	5322 268 14017	Probe tip
8	1	5322 321 20223	Earthing cord
9	1	5322 600 34002	Box

3.5.2. Trimming Tool Kit (Type 800/NTX)

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins. The wide variety of pins allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).

Ordering number: 4822 310 50015.
(A spare set containing the 8 most commonly used pins is available under the Ordering number: 4822 310 50016).

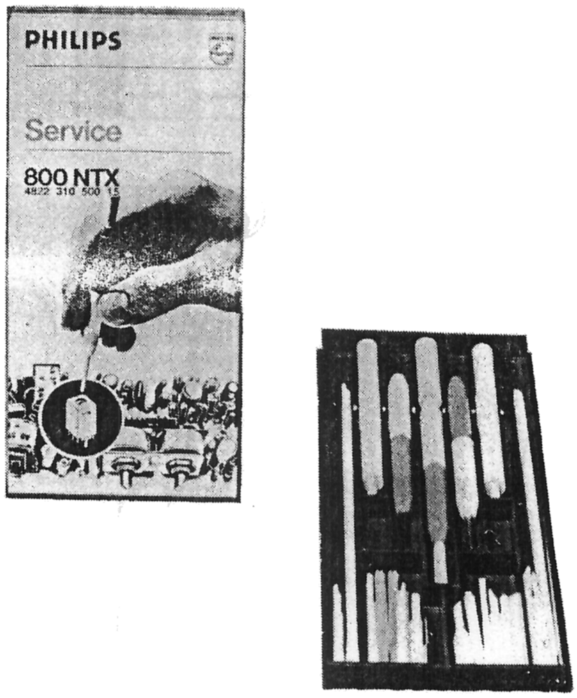


Fig. 3.35. Trimming tool kit

3.6. EXTRA IN- AND OUTPUT CIRCUITS

The PM 3214 is equipped with facilities to add four extra in- and output circuits with a minimum of components. The in- and output BNC sockets are mounted in the holes above the c.r.t. socket; only 15-mm-holes must be drilled in the plastic rear cover (Fig. 3.36) on the positions as indicated.

3.6.1. External Z-modulation input

Characteristics

- TTL Compatible
- Current drain at 0 V: –3 mA; at +5 V: +1 mA
- Brightness: light from +2 V to +7 V maximum
  dark from +0,8 V to –1,2 V minimum
- Rise time from light to dark and vice versa: 50 ns
- Delay time from input socket to screen: 85 ns

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Solder tag	5322 290 34022

Fitting the input

Connect one end of the coax. cable to the points indicated in Fig. 3.37 and the other end to the BNC connector which has been mounted on to the rear of the oscilloscope as described in section 3.6. Make sure that the coaxial cable is also earthed at the BNC connector end.

3.6.2. Main time base sweep output

Characteristics

- Output voltage: minimum level –1,8 V
  maximum level +3,8 V ± 0,5 V
- Internal resistance: 1 kohm
- The output is protected against short-circuits

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Resistor 1 kohm	5322 116 54549
– Resistor 1,27 kohm	5322 116 50555
– Transistor BC548C	5322 130 44196
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 3.6.
- Fit the resistors as indicated in Fig. 3.37.
- Fit the transistor as indicated in Fig. 3.37.

- Connect one end of the coaxial cable to the points indicated in Fig. 3.37 and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

3.6.3. Main time base gate output

Characteristics

- Output voltage: high level more than +2,7 V
  low level less than 0,5 V
- TTL output.
- The output is protected against short-circuits.

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 3.6.
- Connect one end of the coaxial cable to the points indicated in Fig. 3.37 and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

3.6.4. Delayed time base gate output

Characteristics

- Output voltage: high level more than +2,7 V
  low level less than 0,5 V
- TTL output.
- The output is protected against short-circuits.

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 3.6.
- Connect one end of the coaxial cable to the points indicated in Fig. 3.37 and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

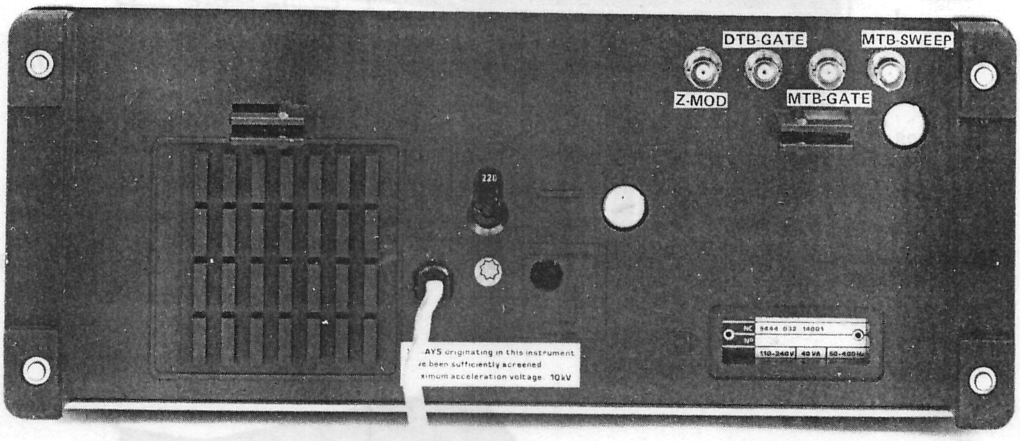


Fig. 3.36. Rear view of the oscilloscope.

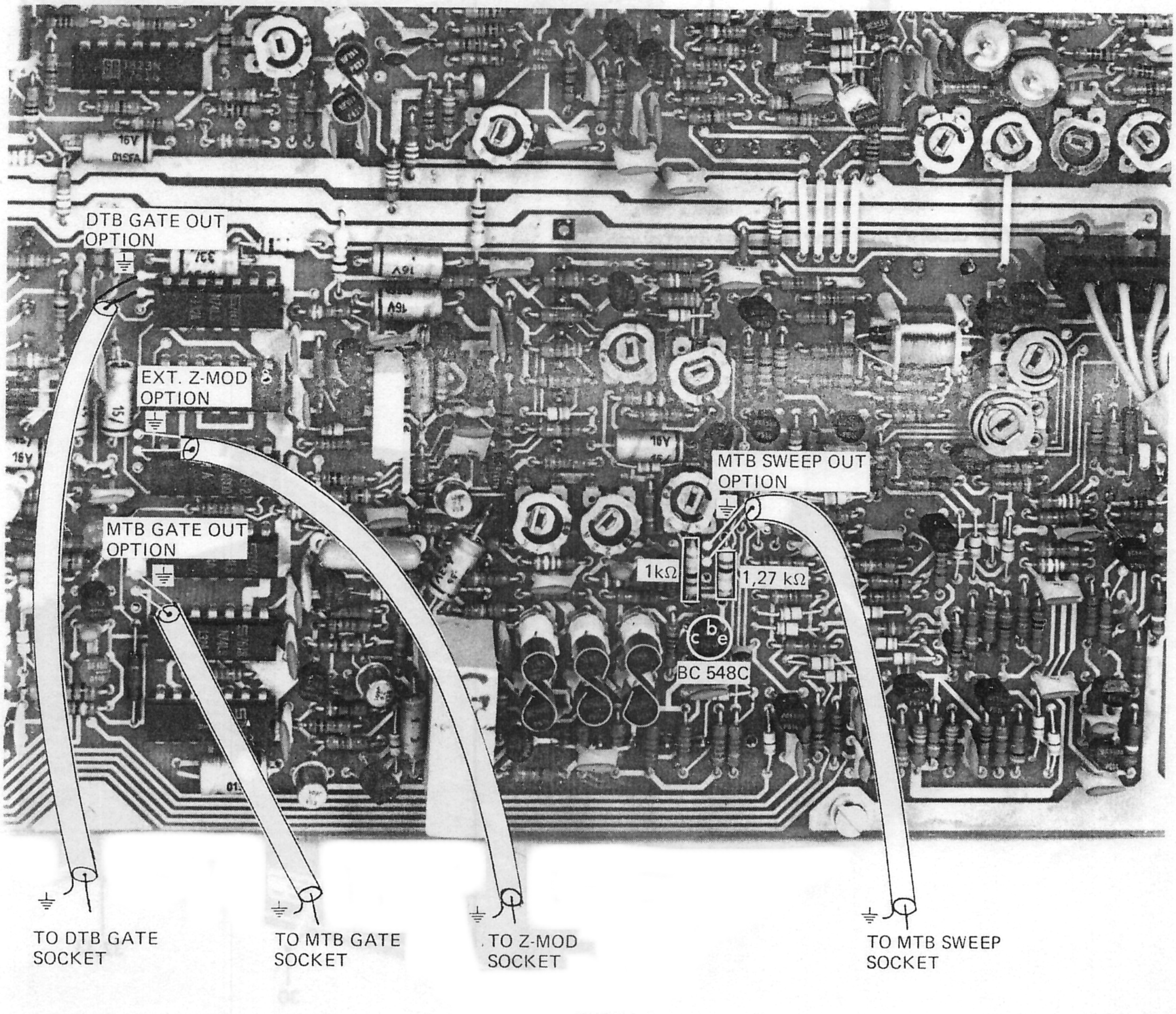


Fig. 3.37. Mounting the components and the cables

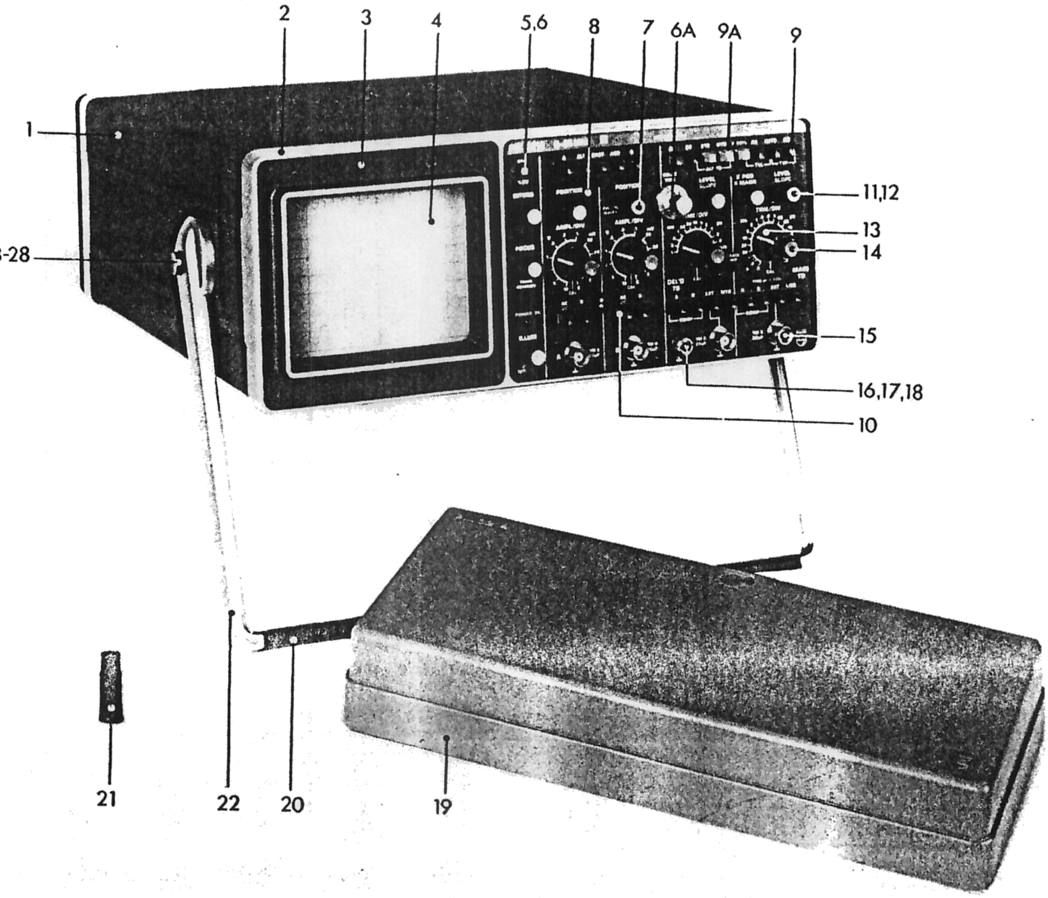


Fig. 3.38. Front view showing item numbers

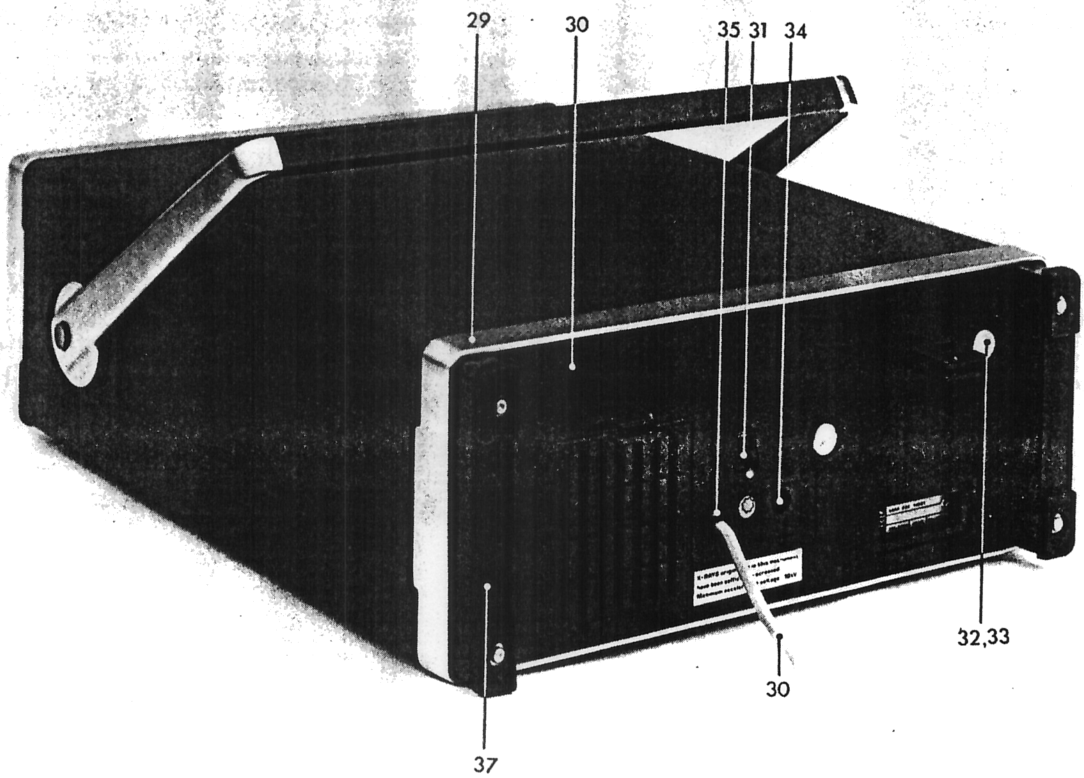


Fig. 3.39. Rear view showing item numbers

3.7. PARTS LISTS AND DIAGRAMS (Subject to alteration without notice)

3.7.1. Mechanical parts

Figure 3.38.

Item	*Qty*	*Order number*	*Designation*
1	1	5322 447 94399	Cabinet without handle
2	1	5322 447 94401	Cast aluminium front frame
3	1	5322 450 74009	Bezel
4	1	5322 480 34074	Contrast filter blue
5	1	5322 264 24015	Calibration terminal
6	1	5322 325 84013	Grommet for calibration terminal
6A	1	5322 414 34147	Counter knob
7	2	5322 414 34091	Knob
8	1	5322 455 84058	Text plate
9	20	5322 414 14011	Knob for push-button switch, dark grey
9A	3	5322 414 26019	Knob for push-button switch, light grey
10	2	5322 414 25613	Knob for push-button switch, green
11	10	5322 414 34134	Knob
12	9	5322 414 74015	Knob cover grey
13	4	5322 414 34079	Knob
14	4	5322 414 74029	Knob cover blue
15	4	5322 267 10004	BNC connector
16	1	5322 535 84346	Earthing terminal
17	1	5322 505 14178	Knurled nut for earthing terminal
18	1	5322 506 14005	Hexagonal nut for earthing terminal
19	1	5322 447 94403	Front cover
20	1	5322 498 54077	Grip
21	1	5322 263 24005	BNC-4 mm adapter
22	2	5322 498 54072	Bracket
23	2	5322 520 14267	Bearing bush
24	2	5322 528 34128	Ratchet
25	2	5322 530 84075	Spring
26	2	5322 414 64053	Knob
27	2	4822 502 30054	Screw
28	2	4822 532 10582	Washer
Figure 3.39.			
29	1	5322 447 94402	Cast aluminium rear frame
30	1	5322 447 94404	Rear panel
31	1	4822 272 10079	Line voltage adapter
32	2	5322 500 14228	Coin slot screw
33	2	4822 530 70126	Circlip
34	1	4822 265 20051	D.C. Power input connector
35	1	5322 325 50101	Line cable cleat
36	1	4822 321 10084	Line cable, European type
		4822 321 10092	Line cable, U.S.A. type
37	2	5322 462 44298	Foot (rear panel)
Not shown			
38	5	5322 276 14102	Self-releasing push-button segment
39	19	5322 276 14117	Mutual-releasing push-button
40	1	5322 255 44088	LED holder
41	2	5322 255 24015	Lamp holder
42	4	5322 462 44297	Foot (cabinet)
43	1	4822 266 20014	D.C. Power input plug
44	1	4822 321 20125	D.C. Power input cord set

CAPACITORS

C 101	5322 121 44189	330NF		250	POLYESTER FOIL
C 200	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 201	4822 122 30099	3,3NF	10	100	CERAMIC PLATE
C 202	4822 121 40443	680NF	10	250	POLYESTER FOIL
C 203	4822 124 70226	4700UF	-10+50	40	ELECTROLYTIC
C 204	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 206	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 207	4822 121 40443	680NF	10	100	POLYESTER FOIL
C 208	4822 124 20477	47UF	-10+50	25	ELECTROLYTIC
C 209	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 211	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 212	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 213	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 214	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 216	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 217	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 218	4822 121 40196	22NF	10	1600	POLYESTER FOIL
C 219	4822 121 40196	22NF	10	1600	POLYESTER FOIL
C 221	4822 124 20316	4UF	-10+50	250	ELECTROLYTIC
C 222	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 223	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 224	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 226	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 227	4822 124 20457	470UF	-10+50	6,3	ELECTROLYTIC
C 228	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 229	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 231	4822 124 20316	4UF	-10+50	250	ELECTROLYTIC
C 251	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 252	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 253	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 254	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 255	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 256	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 257	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 258	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 259	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 261	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 262	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 263	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 266	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 267	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 268	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 269	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 271	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 272	4822 124 20452	33UF	-10+50	6,3	ELECTROLYTIC
C 273	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 274	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 276	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 277	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 278	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 279	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 280	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 281	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 282	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 283	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 284	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 286	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 301	4822 121 40012	100NF	10	400	POLYESTER FOIL
C 305	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 307	5322 125 50051	18PF		300	TRIMMER
C 308	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 309	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 310	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 311	4822 122 31196	12PF	2	500	CERAMIC PLATE
C 312	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 313	5322 125 54027	5,5PF		400	TRIMMER

C 314	5322 125 54027	5,5pF		400	TRIMMER
C 315	4822 122 31184	1,5PF	0,25PF	500	CERAMIC PLATE
C 316	5322 125 54026	3PF		400	TRIMMER
C 317	5322 125 54026	3PF		400	TRIMMER
C 318	5322 125 54026	3PF		400	TRIMMER
C 319	5322 125 54026	3PF		400	TRIMMER
C 320	4822 122 31186	2,2PF	0,25PF	500	CERAMIC PLATE
C 321	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 322	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 324	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 351	4822 122 31199	22PF	2	500	CERAMIC PLATE
C 352	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 353	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 356	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 401	4822 121 40012	100NF	10	400	POLYESTER FOIL
C 405	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 407	5322 125 50051	18PF		300	TRIMMER
C 408	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 409	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 410	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 411	4822 122 31196	12PF	2	500	CERAMIC PLATE
C 412	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 413	5322 125 54027	5,5PF		400	TRIMMER
C 414	5322 125 54027	5,5PF		400	TRIMMER
C 415	4822 122 31184	1,5PF	0,25PF	500	CERAMIC PLATE
C 416	5322 125 54026	3PF		400	TRIMMER
C 417	5322 125 54026	3PF		400	TRIMMER
C 418	5322 125 54026	3PF		400	TRIMMER
C 419	5322 125 54026	3PF		400	TRIMMER
C 420	4822 122 31186	2,2PF	0,25PF	500	CERAMIC PLATE
C 421	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 422	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 424	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 451	4822 122 31199	22PF	2	500	CERAMIC PLATE
C 452	4822 122 31076	68PF	2	100	CERAMIC PLATE
C 453	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 501	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 502	4822 125 50045	22PF		100	TRIMMER
C 504	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 507	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 508	4822 125 50045	22PF		100	TRIMMER
C 509	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 510	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 511	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 512	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 513	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 514	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 517	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 518	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 519	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 521	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 522	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 523	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 601	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 602	4822 125 50045	22PF		100	TRIMMER
C 604	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 607	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 608	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 609	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 611	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 612	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 613	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 614	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 616	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 617	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 618	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 619	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 621	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 622	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 623	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

C 701	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 702	4822 122 31168	270PF	10	100	CERAMIC PLATE
C 703	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 704	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 705	4822 122 31125	4,7NF	-20+80	40	CERAMIC PLATE
C 706	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 707	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 801	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 802	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 803	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 804	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 805	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 806	4822 122 31221	1,5NF	10	100	CERAMIC PLATE
C 807	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 808	4822 122 31078	82PF	2	100	CERAMIC PLATE
C 809	4822 125 50045	22PF		100	TRIMMER
C 810	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 811	4822 125 50045	22PF		100	TRIMMER
C 813	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 814	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 815	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 816	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 817	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 818	5322 125 50048	3,5PF		300	TRIMMER
C 819	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 821	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1001	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1002	4822 121 40438	470NF	10	100	POLYESTER FOIL
C 1003	4822 121 40438	470NF	10	100	POLYESTER FOIL
C 1004	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1005	4822 122 31043	3,9PF	0,25PF	100	CERAMIC PLATE
C 1006	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1007	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1008	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1009	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1011	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1012	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1101	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1102	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1103	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1104	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1201	4822 124 20476	22UF	-10+50	25	ELECTROLYTIC
C 1202	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1203	5322 121 54127	3,9NF	1	63	POLYSTYRENE FOIL
C 1204	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1205	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 1206	5322 121 40283	3,3UF	5	100	POLYESTER FOIL
C 1207	4822 121 40434	330NF	10	100	POLYESTER FOIL
C 1208	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1209	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1210	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1301	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1302	5322 121 54087	1,8NF	1	125	POLYSTYRENE FOIL
C 1303	4822 121 40231	150NF	10	100	POLYESTER FOIL
C 1304	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1305	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1306	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1307	4822 124 20452	33UF	-10+50	6,3	ELECTROLYTIC
C 1308	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1309	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1310	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1311	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1312	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1313	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1314	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1315	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 1316	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1402	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1403	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 1404	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE

C 1405	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1406	5322 125 50048	3,5PF		300	TRIMMER
C 1407	5322 125 50048	3,5PF		300	TRIMMER
C 1408	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1409	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1411	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1412	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1413	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 1414	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 1416	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1417	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1501	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1502	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1503	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1504	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1506	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1507	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1508	4822 121 40354	1,5NF	10	1600	POLYESTER FOIL
C 1509	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1511	4822 121 40354	1,5NF	10	1600	POLYESTER FOIL
C 1512	4822 121 40354	1,5NF	10	1600	POLYESTER FOIL
C 1601	4822 121 40434	330NF	10	100	POLYESTER FOIL
C 1602	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 1651	4822 122 31076	68PF	2	100	CERAMIC PLATE
C 1652	4822 122 31172	180PF	10	100	CERAMIC PLATE
C 1653	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1654	4822 122 31202	33PF	2	100	CERAMIC PLATE
C 1655	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 1656	4822 122 31202	33PF	2	100	CERAMIC PLATE
C 1657	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1658	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1659	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1660	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

RESISTORS

R 1	5322 101 24117	10K	20	0.1W	CARBON POTM LIN
R 2	5322 101 24118	1K	20	0.1W	CARBON POTM LIN
R 3	5322 101 44036	1K	20		CARBON POTM LIN + SWITCH
R 4	5322 103 64016	5K	5	2W	WIRE-WOUND POTENTIOMETER
R 5	5322 101 44014	100K	20		CARBON POTM LIN + SWITCH
R 6	5322 102 44004	2x47K	20		CARBON TANDEM POTM + SWITCH
R 7	5322 101 44014	100K	20		CARBON POTM LIN + SWITCH
R 8	5322 101 24098	2,2M	20	0.1W	CARBON POTM LIN
R 9	5322 101 44024	1K	20	0.1W	CARBON POTM LIN + SWITCH
R 10	5322 101 44024	1K	20	0.1W	CARBON POTM LIN + SWITCH
R 11	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 12	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 13	5322 101 20408	100K	20	0.1W	CARBON POTM LIN
R 14	5322 101 24119	4,7K	20	0.1W	CARBON POTM LIN
R 15	5322 101 44025	22K	20	0.1W	CARBON POTM LIN + SWITCH
R 200	5322 116 54619	10K	1	MR25	METAL FILM
R 201	5322 116 54646	23,7K	1	MR25	METAL FILM
R 202	5322 116 54557	1,21K	1	MR25	METAL FILM
R 203	5322 116 54549	1K	1	MR25	METAL FILM
R 204	5322 101 14051	220	20	0.5W	TRIMMING POTM
R 206	5322 116 50414	2,87K	1	MR25	METAL FILM
R 207	5322 116 50636	2,74K	1	MR25	METAL FILM
R 208	5322 116 50904	30,1	1	MR25	METAL FILM
R 209	5322 116 50904	30,1	1	MR25	METAL FILM
R 210	5322 116 54188	1M	1	MR30	METAL FILM
R 211	5322 111 50345	8,2M	5	1W	CARBON
R 212	5322 116 54619	10K	1	MR25	METAL FILM
R 227	5322 116 54499	249	1	MR25	METAL FILM
R 251	5322 116 50568	4,99	1	MR25	METAL FILM
R 252	5322 116 50568	4,99	1	MR25	METAL FILM
R 253	5322 116 50568	4,99	1	MR25	METAL FILM
R 254	5322 116 50568	4,99	1	MR25	METAL FILM
R 256	5322 116 50568	4,99	1	MR25	METAL FILM

R 257	5322 116 50568	4,99	1	MR25	METAL FILM
R 258	5322 116 50568	4,99	1	MR25	METAL FILM
R 259	5322 116 50568	4,99	1	MR25	METAL FILM
R 261	4822 110 63027	1	5	CR25	CARBON
R 262	5322 116 50568	4,99	1	MR25	METAL FILM
R 263	5322 116 50568	4,99	1	MR25	METAL FILM
R 264	5322 116 50568	4,99	1	MR25	METAL FILM
R 266	5322 116 50568	4,99	1	MR25	METAL FILM
R 267	5322 116 50568	4,99	1	MR25	METAL FILM
R 268	4822 110 63027	1	5	CR25	CARBON
R 269	5322 116 50568	4,99	1	MR25	METAL FILM
R 271	5322 116 50568	4,99	1	MR25	METAL FILM
R 272	5322 116 50568	4,99	1	MR25	METAL FILM
R 273	4822 110 63027	1	5	CR25	CARBON
R 274	5322 116 50568	4,99	1	MR25	METAL FILM
R 276	4822 110 63027	1	5	CR25	CARBON
R 277	4822 110 63027	1	5	CR25	CARBON
R 278	5322 116 50568	4,99	1	MR25	METAL FILM
R 279	5322 116 54469	100	1	MR25	METAL FILM
R 281	5322 116 54469	100	1	MR25	METAL FILM
R 302	5322 116 54188	1M	1	MR30	METAL FILM
R 303	5322 116 54469	100	1	MR25	METAL FILM
R 304	5322 116 54459	75	1	MR25	METAL FILM
R 306	5322 116 54459	75	1	MR25	METAL FILM
R 307	5322 116 50924	191K	1	MR30	METAL FILM
R 308	5322 116 54263	681K	1	MR30	METAL FILM
R 309	5322 116 50642	845K	1	MR30	METAL FILM
R 311	5322 116 55139	549K	1	MR30	METAL FILM
R 312	5322 116 54727	205K	1	MR25	METAL FILM
R 313	5322 116 50814	732K	1	MR30	METAL FILM
R 314	5322 116 55078	806K	1	MR30	METAL FILM
R 316	4822 110 63212	8,2M	10	CR25	CARBON
R 317	5322 116 54188	1M	1	MR30	METAL FILM
R 318	5322 116 50859	90,9K	0,25	MR24C	METAL FILM
R 319	5322 116 50979	8,25K	0,25	MR24C	METAL FILM
R 351	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 352	5322 116 54643	20,5K	1	MR25	METAL FILM
R 353	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 354	5322 116 54643	20,5K	1	MR25	METAL FILM
R 355	5322 116 50515	1,78K	1	MR25	METAL FILM
R 356	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 357	5322 116 54643	20,5K	1	MR25	METAL FILM
R 358	5322 116 55078	806K	1	MR30	METAL FILM
R 359	5322 116 54012	6,81K	1	MR25	METAL FILM
R 360	5322 116 54549	1K	1	MR25	METAL FILM
R 361	5322 116 54603	6,49K	1	MR25	METAL FILM
R 362	5322 116 54567	1,69K	1	MR25	METAL FILM
R 363	5322 116 50664	2,05K	1	MR25	METAL FILM
R 364	5322 116 54557	1,21K	1	MR25	METAL FILM
R 365	5322 116 54499	249	1	MR25	METAL FILM
R 366	5322 116 50818	44,2	1	MR25	METAL FILM
R 367	5322 116 54714	154K	1	MR25	METAL FILM
R 368	5322 116 54335	750K	1	MR30	METAL FILM
R 369	5322 116 50568	4,99	1	MR25	METAL FILM
R 374	5322 116 54587	3,65K	1	MR25	METAL FILM
R 402	5322 116 54188	1M	1	MR30	METAL FILM
R 403	5322 116 54469	100	1	MR25	METAL FILM
R 404	5322 116 54459	75	1	MR25	METAL FILM
R 406	5322 116 54459	75	1	MR25	METAL FILM
R 407	5322 116 50924	191K	1	MR30	METAL FILM
R 408	5322 116 54263	681K	1	MR30	METAL FILM
R 409	5322 116 50642	845K	1	MR30	METAL FILM
R 411	5322 116 55139	549K	1	MR30	METAL FILM
R 412	5322 116 54727	205K	1	MR25	METAL FILM
R 413	5322 116 50814	732K	1	MR30	METAL FILM
R 414	5322 116 55078	806K	1	MR30	METAL FILM
R 416	4822 110 63212	8,2M	10	CR25	CARBON
R 417	5322 116 54188	1M	1	MR30	METAL FILM
R 418	5322 116 50859	90,9K	0,25	MR24C	METAL FILM
R 419	5322 116 50979	8,25K	0,25	MR24C	METAL FILM

R 451	5322 116 54589	3,83K	1	MR25	METAL FILM
R 452	5322 116 54643	20,5K	1	MR25	METAL FILM
R 453	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 454	5322 116 54643	20,5K	1	MR25	METAL FILM
R 456	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 457	5322 116 54643	20,5K	1	MR25	METAL FILM
R 458	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 459	5322 116 50568	4,99	1	MR25	METAL FILM
R 461	5322 116 55078	806K	1	MR30	METAL FILM
R 462	5322 116 50581	2,49K	1	MR25	METAL FILM
R 463	5322 116 54549	1K	1	MR25	METAL FILM
R 464	5322 116 54567	1,69K	1	MR25	METAL FILM
R 466	5322 116 54541	825	1	MR25	METAL FILM
R 467	5322 116 54567	1,69K	1	MR25	METAL FILM
R 468	5322 116 50524	3,01K	1	MR25	METAL FILM
R 469	5322 116 50818	44,2	1	MR25	METAL FILM
R 500	5322 116 54442	51,1	1	MR25	METAL FILM
R 501	5322 116 55078	806K	1	MR30	METAL FILM
R 502	5322 116 54442	51,1	1	MR25	METAL FILM
R 503	5322 116 50443	12,7K	1	MR25	METAL FILM
R 504	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 506	5322 116 50443	12,7K	1	MR25	METAL FILM
R 507	5322 116 50561	590	1	MR25	METAL FILM
R 508	5322 116 50608	6,19K	1	MR25	METAL FILM
R 509	5322 116 50608	6,19K	1	MR25	METAL FILM
R 511	5322 116 50571	715	1	MR25	METAL FILM
R 512	5322 116 54525	511	1	MR25	METAL FILM
R 513	5322 116 54525	511	1	MR25	METAL FILM
R 514	5322 116 50571	715	1	MR25	METAL FILM
R 516	5322 116 54469	100	1	MR25	METAL FILM
R 517	5322 116 50664	2,05K	1	MR25	METAL FILM
R 518	5322 116 54519	402	1	MR25	METAL FILM
R 519	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 521	5322 116 50818	44,2	1	MR25	METAL FILM
R 522	5322 116 50818	44,2	1	MR25	METAL FILM
R 523	5322 116 54469	100	1	MR25	METAL FILM
R 524	5322 116 50509	4,87K	1	MR25	METAL FILM
R 526	5322 116 54469	100	1	MR25	METAL FILM
R 527	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 528	5322 116 54508	301	1	MR25	METAL FILM
R 529	5322 116 54632	14,7K	1	MR25	METAL FILM
R 531	5322 116 54632	14,7K	1	MR25	METAL FILM
R 532	5322 116 54513	332	1	MR25	METAL FILM
R 533	5322 116 54513	332	1	MR25	METAL FILM
R 534	5322 116 54525	511	1	MR25	METAL FILM
R 536	5322 116 54442	51,1	1	MR25	METAL FILM
R 537	5322 116 50508	487	1	MR25	METAL FILM
R 538	5322 116 34014	1K	5	0.5W	NTC
R 539	5322 116 54442	51,1	1	MR25	METAL FILM
R 541	5322 116 54492	178	1	MR25	METAL FILM
R 542	5322 116 50669	205	1	MR25	METAL FILM
R 543	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 544	5322 116 50452	10	1	MR25	METAL FILM
R 546	5322 116 54549	1K	1	MR25	METAL FILM
R 547	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 548	5322 116 54549	1K	1	MR25	METAL FILM
R 549	5322 116 54469	100	1	MR25	METAL FILM
R 550	5322 116 50452	10	1	MR25	METAL FILM
R 551	5322 116 54469	100	1	MR25	METAL FILM
R 552	5322 116 50904	30,1	1	MR25	METAL FILM
R 553	5322 116 50904	30,1	1	MR25	METAL FILM
R 554	5322 116 54549	1K	1	MR25	METAL FILM
R 556	5322 116 54508	301	1	MR25	METAL FILM
R 557	5322 116 54508	301	1	MR25	METAL FILM
R 558	5322 116 54637	17,8K	1	MR25	METAL FILM
R 559	5322 116 54595	5,11K	1	MR25	METAL FILM
R 567	5322 116 50904	30,1	1	MR25	METAL FILM
R 568	5322 116 54637	17,8K	1	MR25	METAL FILM
R 569	5322 116 50583	5,9K	1	MR25	METAL FILM
R 571	5322 116 54538	787	1	MR25	METAL FILM

R 572	5322 116 54538	787	1	MR25	METAL FILM
R 573	5322 116 54571	1,96K	1	MR25	METAL FILM
R 577	5322 116 54469	100	1	MR25	METAL FILM
R 600	5322 116 54442	51,1	1	MR25	METAL FILM
R 601	5322 116 55078	806K	1	MR30	METAL FILM
R 602	5322 116 54442	51,1	1	MR25	METAL FILM
R 603	5322 116 50443	12,7K	1	MR25	METAL FILM
R 604	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 606	5322 116 50443	12,7K	1	MR25	METAL FILM
R 607	5322 116 50561	590	1	MR25	METAL FILM
R 608	5322 116 50608	6,19K	1	MR25	METAL FILM
R 609	5322 116 50608	6,19K	1	MR25	METAL FILM
R 611	5322 116 50571	715	1	MR25	METAL FILM
R 612	5322 116 54525	511	1	MR25	METAL FILM
R 613	5322 116 54525	511	1	MR25	METAL FILM
R 614	5322 116 50571	715	1	MR25	METAL FILM
R 616	5322 116 54469	100	1	MR25	METAL FILM
R 617	5322 116 50664	2,05K	1	MR25	METAL FILM
R 618	5322 116 54519	402	1	MR25	METAL FILM
R 619	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 621	5322 116 50818	44,2	1	MR25	METAL FILM
R 622	5322 116 50818	44,2	1	MR25	METAL FILM
R 623	5322 116 54469	100	1	MR25	METAL FILM
R 624	5322 116 50509	4,87K	1	MR25	METAL FILM
R 626	5322 116 54469	100	1	MR25	METAL FILM
R 627	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 628	5322 116 54508	301	1	MR25	METAL FILM
R 629	5322 116 54632	14,7K	1	MR25	METAL FILM
R 631	5322 116 54632	14,7K	1	MR25	METAL FILM
R 632	5322 116 54513	332	1	MR25	METAL FILM
R 633	5322 116 54513	332	1	MR25	METAL FILM
R 634	5322 116 54525	511	1	MR25	METAL FILM
R 636	5322 116 54442	51,1	1	MR25	METAL FILM
R 637	5322 116 50508	487	1	MR25	METAL FILM
R 638	5322 116 34014	1K	5	0.5W	NTC
R 639	5322 116 54442	51,1	1	MR25	METAL FILM
R 641	5322 116 54472	105	1	MR25	METAL FILM
R 644	5322 116 50452	10	1	MR25	METAL FILM
R 646	5322 116 54549	1K	1	MR25	METAL FILM
R 647	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 648	5322 116 54549	1K	1	MR25	METAL FILM
R 649	5322 116 54469	100	1	MR25	METAL FILM
R 650	5322 116 50452	10	1	MR25	METAL FILM
R 651	5322 116 54469	100	1	MR25	METAL FILM
R 652	5322 116 50904	30,1	1	MR25	METAL FILM
R 653	5322 116 50904	30,1	1	MR25	METAL FILM
R 654	5322 116 54549	1K	1	MR25	METAL FILM
R 656	5322 116 54508	301	1	MR25	METAL FILM
R 657	5322 116 54508	301	1	MR25	METAL FILM
R 658	5322 116 54637	17,8K	1	MR25	METAL FILM
R 659	5322 116 54595	5,11K	1	MR25	METAL FILM
R 661	5322 116 50482	33,2K	1	MR25	METAL FILM
R 662	5322 116 54637	17,8K	1	MR25	METAL FILM
R 663	5322 116 54629	14K	1	MR25	METAL FILM
R 664	5322 116 54558	8,25K	1	MR25	METAL FILM
R 666	5322 116 50904	30,1	1	MR25	METAL FILM
R 667	5322 116 50904	30,1	1	MR25	METAL FILM
R 668	5322 116 54637	17,8K	1	MR25	METAL FILM
R 669	5322 116 50583	5,9K	1	MR25	METAL FILM
R 671	5322 116 54538	787	1	MR25	METAL FILM
R 672	5322 116 54538	787	1	MR25	METAL FILM
R 673	5322 116 54571	1,96K	1	MR25	METAL FILM
R 674	4822 100 10079	47K	20	0.05W	TRIMMING POTM
R 676	5322 116 50672	51,1K	1	MR25	METAL FILM
R 677	5322 116 54469	100	1	MR25	METAL FILM
R 701	5322 116 54469	100	1	MR25	METAL FILM
R 702	5322 116 50555	1,27K	1	MR25	METAL FILM
R 703	5322 116 50571	715	1	MR25	METAL FILM
R 704	5322 116 54519	402	1	MR25	METAL FILM
R 706	5322 116 50555	1,27K	1	MR25	METAL FILM

R 707	5322 116 50481	22,6K	1	MR25	METAL FILM
R 708	5322 116 54012	6,81K	1	MR25	METAL FILM
R 709	5322 116 50581	2,49K	1	MR25	METAL FILM
R 711	5322 116 50581	2,49K	1	MR25	METAL FILM
R 712	5322 116 54592	4,02K	1	MR25	METAL FILM
R 713	5322 116 54592	4,02K	1	MR25	METAL FILM
R 714	5322 116 54592	4,02K	1	MR25	METAL FILM
R 716	5322 116 54592	4,02K	1	MR25	METAL FILM
R 717	5322 116 54469	100	1	MR25	METAL FILM
R 801	5322 116 54592	4,02K	1	MR25	METAL FILM
R 802	5322 116 54558	8,25K	1	MR25	METAL FILM
R 803	5322 116 50506	154	1	MR25	METAL FILM
R 804	5322 116 50506	154	1	MR25	METAL FILM
R 806	5322 116 54459	75	1	MR25	METAL FILM
R 807	5322 116 54459	75	1	MR25	METAL FILM
R 809	5322 116 54561	1,33K	1	MR25	METAL FILM
R 811	5322 116 50729	4,22K	1	MR25	METAL FILM
R 812	4822 100 10029	2,2K	20	0.05W	TRIMMING POTM
R 813	4822 100 10036	4,7K	20	0.05W	TRIMMING POTM
R 814	4822 100 10037	1K	20	0.05W	TRIMMING POTM
R 817	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 819	5322 116 54014	23,7	1	MR25	METAL FILM
R 821	5322 116 54014	23,7	1	MR25	METAL FILM
R 822	5322 116 50904	30,1	1	MR25	METAL FILM
R 823	5322 116 54492	178	1	MR25	METAL FILM
R 824	5322 116 54558	8,25K	1	MR25	METAL FILM
R 825	5322 116 50568	4,99	1	MR25	METAL FILM
R 826	5322 116 50581	2,49K	1	MR25	METAL FILM
R 827	5322 116 54619	10K	1	MR25	METAL FILM
R 828	5322 116 54469	100	1	MR25	METAL FILM
R 829	5322 116 54469	100	1	MR25	METAL FILM
R 831	5322 116 54464	86,6	1	MR25	METAL FILM
R 832	5322 116 54464	86,6	1	MR25	METAL FILM
R 833	5322 116 54545	909	1	MR25	METAL FILM
R 837	5322 116 54545	909	1	MR25	METAL FILM
R 838	5322 116 50415	1,15K	1	MR25	METAL FILM
R 839	5322 116 50415	1,15K	1	MR25	METAL FILM
R 841	5322 116 50904	30,1	1	MR25	METAL FILM
R 842	5322 116 50904	30,1	1	MR25	METAL FILM
R 843	5322 116 54534	681	1	MR25	METAL FILM
R 844	5322 116 50904	30,1	1	MR25	METAL FILM
R 846	5322 116 50904	30,1	1	MR25	METAL FILM
R 847	5322 116 54466	90,9	1	MR25	METAL FILM
R 848	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 849	5322 116 54466	90,9	1	MR25	METAL FILM
R 851	5322 116 54466	90,9	1	MR25	METAL FILM
R 852	5322 116 50818	44,2	1	MR25	METAL FILM
R 853	5322 116 50818	44,2	1	MR25	METAL FILM
R 854	5322 116 54466	90,9	1	MR25	METAL FILM
R 856	5322 116 54484	140	1	MR25	METAL FILM
R 857	5322 116 54585	3,48K	1	MR25	METAL FILM
R 858	5322 116 50524	3,01K	1	MR25	METAL FILM
R 859	5322 116 50515	1,78K	1	MR25	METAL FILM
R 861	5322 116 50515	1,78K	1	MR25	METAL FILM
R 862	5322 116 50515	1,78K	1	MR25	METAL FILM
R 863	5322 116 50515	1,78K	1	MR25	METAL FILM
R 864	5322 116 54549	1K	1	MR25	METAL FILM
R 866	5322 116 54549	1K	1	MR25	METAL FILM
R 1001	5322 116 54442	51,1	1	MR25	METAL FILM
R 1002	5322 116 54685	71,5K	1	MR25	METAL FILM
R 1003	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1004	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1006	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1007	5322 116 54725	196K	1	MR25	METAL FILM
R 1008	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1009	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1011	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1012	5322 116 54729	226K	1	MR25	METAL FILM
R 1013	5322 116 54696	100K	1	MR25	METAL FILM
R 1014	5322 116 50443	12,7K	1	MR25	METAL FILM

R 1016	4822	100	10038	470	20	0.05W	TRIMMING POTM
R 1017	5322	116	50443	12,7K	1	MR25	METAL FILM
R 1018	5322	116	50414	2,87K	1	MR25	METAL FILM
R 1019	5322	116	54009	562	1	MR25	METAL FILM
R 1021	5322	116	54009	562	1	MR25	METAL FILM
R 1022	5322	116	54587	3,65K	1	MR25	METAL FILM
R 1023	5322	116	50586	1,54K	1	MR25	METAL FILM
R 1024	5322	116	50586	1,54K	1	MR25	METAL FILM
R 1026	5322	116	54499	249	1	MR25	METAL FILM
R 1027	5322	116	54499	249	1	MR25	METAL FILM
R 1028	5322	116	50608	6,19K	1	MR25	METAL FILM
R 1029	5322	116	54592	4,02K	1	MR25	METAL FILM
R 1031	5322	116	54005	3,32K	1	MR25	METAL FILM
R 1032	5322	116	54558	8,25K	1	MR25	METAL FILM
R 1034	5322	116	54643	20,5K	1	MR25	METAL FILM
R 1036	5322	116	54696	100K	1	MR25	METAL FILM
R 1037	5322	116	50581	2,49K	1	MR25	METAL FILM
R 1038	5322	116	54587	3,65K	1	MR25	METAL FILM
R 1039	5322	116	54637	17,8K	1	MR25	METAL FILM
R 1041	5322	116	50572	12,1K	1	MR25	METAL FILM
R 1042	5322	116	54188	1M	1	MR30	METAL FILM
R 1043	5322	116	54619	10K	1	MR25	METAL FILM
R 1044	5322	116	50524	3,01K	1	MR25	METAL FILM
R 1046	5322	116	54562	1,4K	1	MR25	METAL FILM
R 1047	5322	116	50515	1,78K	1	MR25	METAL FILM
R 1048	5322	116	50583	5,9K	1	MR25	METAL FILM
R 1049	5322	116	54188	1M	1	MR30	METAL FILM
R 1051	5322	116	54725	196K	1	MR25	METAL FILM
R 1052	5322	116	54592	4,02K	1	MR25	METAL FILM
R 1101	5322	116	54442	51,1	1	MR25	METAL FILM
R 1102	5322	116	54714	154K	1	MR25	METAL FILM
R 1103	5322	116	54725	196K	1	MR25	METAL FILM
R 1104	5322	116	50558	18,7K	1	MR25	METAL FILM
R 1106	5322	116	50443	12,7K	1	MR25	METAL FILM
R 1107	4822	100	10038	470	20	0.05W	TRIMMING POTM
R 1108	5322	116	50443	12,7K	1	MR25	METAL FILM
R 1109	5322	116	54009	562	1	MR25	METAL FILM
R 1111	5322	116	54009	562	1	MR25	METAL FILM
R 1112	5322	116	54592	4,02K	1	MR25	METAL FILM
R 1113	5322	116	54587	3,65K	1	MR25	METAL FILM
R 1114	5322	116	54558	8,25K	1	MR25	METAL FILM
R 1116	5322	116	54696	100K	1	MR25	METAL FILM
R 1117	5322	116	54005	3,32K	1	MR25	METAL FILM
R 1118	5322	116	54558	8,25K	1	MR25	METAL FILM
R 1119	5322	116	54592	4,02K	1	MR25	METAL FILM
R 1121	5322	116	50586	1,54K	1	MR25	METAL FILM
R 1122	5322	116	50581	2,49K	1	MR25	METAL FILM
R 1123	5322	116	54562	1,4K	1	MR25	METAL FILM
R 1124	5322	116	50515	1,78K	1	MR25	METAL FILM
R 1201	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1202	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1203	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1204	5322	116	50818	44,2	1	MR25	METAL FILM
R 1206	5322	116	50555	1,27K	1	MR25	METAL FILM
R 1207	5322	116	54519	402	1	MR25	METAL FILM
R 1208	5322	116	54619	10K	1	MR25	METAL FILM
R 1209	5322	116	54619	10K	1	MR25	METAL FILM
R 1210	5322	116	54442	51,1	1	MR25	METAL FILM
R 1211	5322	116	50527	33,2	1	MR25	METAL FILM
R 1212	5322	116	50671	2,61K	1	MR25	METAL FILM
R 1213	5322	116	54565	1,62K	1	MR25	METAL FILM
R 1214	5322	116	54545	909	1	MR25	METAL FILM
R 1216	4822	100	10036	4,7K	20	0.05W	TRIMMING POTM
R 1217	5322	116	50675	2,26K	1	MR25	METAL FILM
R 1218	5322	116	54646	23,7K	1	MR25	METAL FILM
R 1219	5322	116	50818	44,2	1	MR25	METAL FILM
R 1221	5322	116	50672	51,1K	1	MR25	METAL FILM
R 1222	5322	116	50482	33,2K	1	MR25	METAL FILM
R 1223	5322	116	54511	316	1	MR25	METAL FILM
R 1224	5322	116	50664	2,05K	1	MR25	METAL FILM

R 1226	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1227	5322 116 54575	2,32K	1	MR25	METAL FILM
R 1276	5322 116 55163	787K	1	MR30	METAL FILM
R 1277	5322 116 54737	267K	1	MR25	METAL FILM
R 1278	5322 116 54674	53,6K	1	MR25	METAL FILM
R 1279	5322 116 54627	13,3K	1	MR25	METAL FILM
R 1281	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1282	5322 116 50508	487	1	MR25	METAL FILM
R 1283	5322 116 54758	536K	1	MR30	METAL FILM
R 1284	5322 116 54708	133K	1	MR25	METAL FILM
R 1286	5322 116 54652	26,7K	1	MR25	METAL FILM
R 1287	5322 116 55198	5,23K	0,1	MR24E	METAL FILM
R 1288	5322 116 50555	1,27K	1	MR25	METAL FILM
R 1289	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1291	5322 116 54545	909	1	MR25	METAL FILM
R 1301	5322 116 50568	4,99	1	MR25	METAL FILM
R 1302	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1303	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1304	5322 116 54545	909	1	MR25	METAL FILM
R 1305	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1306	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1307	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1308	5322 116 54469	100	1	MR25	METAL FILM
R 1309	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1311	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1312	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1313	5322 116 54516	365	1	MR25	METAL FILM
R 1314	5322 116 50506	154	1	MR25	METAL FILM
R 1316	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1317	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1318	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 1319	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 1321	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1322	5322 116 54619	10K	1	MR25	METAL FILM
R 1324	5322 116 54519	402	1	MR25	METAL FILM
R 1326	5322 116 54619	10K	1	MR25	METAL FILM
R 1327	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1328	5322 116 50452	10	1	MR25	METAL FILM
R 1329	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1331	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1332	5322 116 54589	3,83K	1	MR25	METAL FILM
R 1333	5322 116 50818	44,2	1	MR25	METAL FILM
R 1334	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1336	4822 100 10036	4,7K	20	0.05W	TRIMMING POTM
R 1337	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1338	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1339	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1341	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1342	5322 116 54511	316	1	MR25	METAL FILM
R 1343	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1344	4822 100 10036	4,7K	20	0.05W	TRIMMING POTM
R 1346	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1347	5322 116 50818	44,2	1	MR25	METAL FILM
R 1376	5322 116 54677	57,6K	1	MR25	METAL FILM
R 1377	5322 116 50667	28K	1	MR25	METAL FILM
R 1378	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1379	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1381	5322 116 50629	1,74K	1	MR25	METAL FILM
R 1382	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1383	5322 116 54545	909	1	MR25	METAL FILM
R 1401	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1402	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1403	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1404	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1406	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1407	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1408	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1409	5322 116 50571	715	1	MR25	METAL FILM
R 1411	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1412	5322 116 54558	8,25K	1	MR25	METAL FILM

R 1413	5322 116 54615	9,09K	1	MR25	METAL FILM
R 1414	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1416	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1417	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 1418	5322 116 54502	261	1	MR25	METAL FILM
R 1419	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 1421	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1422	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1423	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1424	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1425	5322 116 54469	100	1	MR25	METAL FILM
R 1426	5322 116 50726	36,5K	1	MR25	METAL FILM
R 1427	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1428	5322 116 54714	154K	1	MR25	METAL FILM
R 1429	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1431	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1432	5322 116 54549	1K	1	MR25	METAL FILM
R 1433	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1434	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1436	5322 116 54714	154K	1	MR25	METAL FILM
R 1437	5322 116 50904	30,1	1	MR25	METAL FILM
R 1438	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1439	5322 116 50904	30,1	1	MR25	METAL FILM
R 1441	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1442	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1443	5322 116 54619	10K	1	MR25	METAL FILM
R 1444	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1446	5322 116 54762	365K	1	MR30	METAL FILM
R 1447	5322 116 54762	365K	1	MR30	METAL FILM
R 1448	5322 116 50514	64,9K	1	MR25	METAL FILM
R 1449	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1451	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1501	5322 116 54525	511	1	MR25	METAL FILM
R 1502	5322 116 54729	226K	1	MR25	METAL FILM
R 1503	5322 116 54619	10K	1	MR25	METAL FILM
R 1504	5322 116 54619	10K	1	MR25	METAL FILM
R 1506	5322 116 54619	10K	1	MR25	METAL FILM
R 1507	4822 100 10051	22K	20	0,05W	TRIMMING POTM
R 1508	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1509	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1511	5322 116 54624	11,5K	1	MR25	METAL FILM
R 1512	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1513	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1514	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1516	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1517	5322 116 54646	23,7K	1	MR25	METAL FILM
R 1518	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1519	5322 116 54525	511	1	MR25	METAL FILM
R 1521	5322 116 50508	487	1	MR25	METAL FILM
R 1522	5322 116 54759	464K	1	MR30	METAL FILM
R 1524	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1526	5322 116 54469	100	1	MR25	METAL FILM
R 1527	5322 116 50868	64,9K	1	MR30	METAL FILM
R 1528	5322 116 54835	511	1	MR30	METAL FILM
R 1529	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1531	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1532	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1533	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1534	5322 116 54188	1M	1	MR30	METAL FILM
R 1535	5322 116 54207	1K	1	MR30	METAL FILM
R 1536	5322 116 54469	100	1	MR25	METAL FILM
R 1537	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1538	4822 110 42189	1,2M	5	VR37	CARBON
R 1539	4822 110 42196	2,2M	5	VR37	CARBON
R 1541	4822 110 42207	5,6M	5	VR37	CARBON
R 1542	5322 116 50533	78,7K	1	MR25	METAL FILM
R 1543	4822 100 10072	100K	20	0,05W	TRIMMING POTM
R 1544	5322 116 54704	121K	1	MR25	METAL FILM
R 1546	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1547	5322 116 54651	26,1K	1	MR25	METAL FILM

R 1548	5322 116 54725	196K	1	MR25	METAL FILM
R 1549	4822 100 10103	1M	20	0.05W	TRIMMING POTM
R 1551	5322 116 54761	383K	1	MR30	METAL FILM
R 1552	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1553	5322 116 54188	1M	1	MR30	METAL FILM
R 1601	5322 116 54508	301	1	MR25	METAL FILM
R 1602	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1603	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1604	5322 116 54619	10K	1	MR25	METAL FILM
R 1606	5322 116 54534	681	1	MR25	METAL FILM
R 1607	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 1608	5322 116 50726	36,5K	1	MR25	METAL FILM
R 1609	5322 116 54545	909	1	MR25	METAL FILM
R 1611	5322 116 54619	10K	1	MR25	METAL FILM
R 1612	5322 116 54534	681	1	MR25	METAL FILM
R 1613	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1614	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1616	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1617	5322 116 54508	301	1	MR25	METAL FILM
R 1618	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1619	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1651	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1652	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1653	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1654	5322 116 54696	100K	1	MR25	METAL FILM
R 1656	5322 116 54696	100K	1	MR25	METAL FILM
R 1657	5322 116 54637	17,8K	1	MR25	METAL FILM
R 1658	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1659	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1661	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1662	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1663	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1664	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1666	5322 116 50729	4,22K	1	MR25	METAL FILM
R 1667	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1668	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1669	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1671	5322 116 54655	30,1K	1	MR25	METAL FILM
R 1672	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1673	5322 116 54009	562	1	MR25	METAL FILM
R 1674	5322 116 54009	562	1	MR25	METAL FILM
R 1676	5322 116 54632	14,7K	1	MR25	METAL FILM
R 1677	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1678	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1679	5322 116 54632	14,7K	1	MR25	METAL FILM
R 1681	5322 116 54619	10K	1	MR25	METAL FILM
R 1682	5322 116 54619	10K	1	MR25	METAL FILM
R 1683	5322 116 54525	511	1	MR25	METAL FILM
R 1684	5322 116 54525	511	1	MR25	METAL FILM
R 1686	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1687	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1688	5322 116 54534	681	1	MR25	METAL FILM

V 1	5322 131 24049	D14-125GM/08
V 1	5322 131 24029	D14-125GH/08
V 201	5322 130 30259	BY127
V 202	5322 130 30259	BY127
V 203	5322 130 30259	BY127
V 204	5322 130 30259	BY127
V 206	5322 130 34304	BYX49-300
V 207	5322 130 44235	BD237
V 208	5322 130 30613	BAW62
V 209	5322 130 34173	BZX79-C5V6
V 211	5322 130 30765	BZX75-C3V6
V 212	5322 130 30765	BZX75-C3V6
V 213	5322 130 30613	BAW62
V 214	5322 130 44196	BC548C
V 216	5322 130 44197	BC558B
V 217	5322 130 44235	BD237
V 218	5322 130 44235	BD237
V 219	5322 130 30613	BAW62
V 221	5322 130 30613	BAW62
V 222	5322 130 30613	BAW62
V 223	5322 130 30613	BAW62
V 224	5322 130 30613	BAW62
V 226	5322 130 34594	BY409
V 227	5322 130 34594	BY409
V 228	5322 130 34594	BY409
V 229	5322 130 34594	BY409
V 231	5322 130 34594	BY409
V 232	5322 130 34594	BY409
V 233	5322 130 34671	BZX61-C110
V 234	4822 130 30839	BY206
V 236	4822 130 30839	BY206
V 237	5322 130 30613	BAW62
V 238	5322 130 30424	BAX12
V 239	5322 130 30424	BAX12
V 241	5322 130 30424	BAX12
V 242	5322 130 30424	BAX12
V 243	5322 130 30424	BAX12
V 244	5322 130 30424	BAX12
V 246	5322 130 30613	BAW62
V 247	4822 130 30839	BY206
V 351	5322 130 44237	BF450
V 352	5322 130 44237	BF450
V 353	5322 130 44196	BC548C
V 354	5322 130 34174	BZX79-C4V7
V 451	5322 130 44237	BF450
V 452	5322 130 44154	BF199
V 453	5322 130 44196	BC548C
V 501	5322 130 34037	BAV45
V 504	5322 130 40709	BFS21A
V 506	5322 130 44154	BF199
V 507	5322 130 44154	BF199
V 508	5322 130 44237	BF450
V 509	5322 130 44237	BF450
V 511	5322 130 44237	BF450
V 512	5322 130 44237	BF450
V 513	5322 130 44197	BC558B
V 514	5322 130 44197	BC558B
V 518	5322 130 44196	BC548C
V 519	5322 130 44196	BC548C
V 521	5322 130 30613	BAW62
V 522	5322 130 30613	BAW62
V 523	5322 130 30613	BAW62
V 524	5322 130 44197	BC558B
V 526	5322 130 44197	BC558B
V 601	5322 130 34037	BAV45
V 604	5322 130 40709	BFS21A
V 606	5322 130 44154	BF199
V 607	5322 130 44154	BF199
V 608	5322 130 44237	BF450
V 609	5322 130 44237	BF450
V 611	5322 130 44237	BF450
V 612	5322 130 44237	BF450
V 613	5322 130 44197	BC558B
V 614	5322 130 44197	BC558B
V 616	5322 130 44197	BC558B
V 617	5322 130 44197	BC558B
V 618	5322 130 44196	BC548C
V 619	5322 130 44196	BC548C
V 621	5322 130 30613	BAW62
V 622	5322 130 30613	BAW62
V 623	5322 130 30613	BAW62
V 624	5322 130 44197	BC558B
V 626	5322 130 44197	BC558B
V 701	5322 130 30613	BAW62
V 702	5322 130 30613	BAW62
V 703	5322 130 44196	BC548C
V 704	5322 130 44196	BC548C
V 801	5322 130 44197	BC558B
V 802	5322 130 44196	BC548C
V 803	5322 130 44196	BC548C
V 804	5322 130 44154	BF199
V 806	5322 130 44154	BF199
V 807	5322 130 44154	BF199
V 808	5322 130 44154	BF199
V 809	5322 130 44196	BC548C
V 1001	5322 130 30191	OA95
V 1002	5322 130 30191	OA95
V 1003	5322 130 30613	BAW62
V 1004	5322 130 30613	BAW62
V 1006	5322 130 44302	ON561
V 1007	5322 130 44237	BF450
V 1008	5322 130 44196	BC548C
V 1009	5322 130 44196	BC548C
V 1011	5322 130 44196	BC548C
V 1012	5322 130 30613	BAW62
V 1013	5322 130 30613	BAW62
V 1014	5322 130 30613	BAW62
V 1016	5322 130 30613	BAW62
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V 1019	5322 130 30613	BAW62
V 1020	5322 130 30613	BAW62
V 1021	5322 130 30613	BAW62
V 1022	5322 130 44196	BC548C
V 1023	5322 130 44196	BC548C
V 1024	5322 130 44196	BC548C
V 1026	5322 130 44237	BF450
V 1027	5322 130 30613	BAW62
V 1028	5322 130 44197	BC558B
V 1101	5322 130 30613	BAW62
V 1102	5322 130 44302	ON561
V 1103	5322 130 44196	BC548C
V 1104	5322 130 30613	BAW62
V 1106	5322 130 30613	BAW62
V 1107	5322 130 30613	BAW62
V 1108	5322 130 30613	BAW62
V 1109	5322 130 44237	BF450
V 1201	5322 130 30191	OA95
V 1202	5322 130 30613	BAW62
V 1206	5322 130 30613	BAW62
V 1207	5322 130 40417	BSX20
V 1208	5322 130 40417	BSX20
V 1209	5322 130 44197	BC558B
V 1211	5322 130 30613	BAW62
V 1212	5322 130 44196	BC548C
V 1213	5322 130 44196	BC548C
V 1214	5322 130 44196	BC548C
V 1216	5322 130 30613	BAW62
V 1217	5322 130 30613	BAW62

V 1218	5322 130 44196	BC548C
V 1219	5322 130 44196	BC548C
V 1221	5322 130 44196	BC548C
V 1301	5322 130 44197	BC558B
V 1302	5322 130 44196	BC548C
V 1303	5322 130 44196	BC548C
V 1304	5322 130 44196	BC548C
V 1305	5322 130 30613	BAW62
V 1306	5322 130 44196	BC548C
V 1307	5322 130 44196	BC548C
V 1308	5322 130 30613	BAW62
V 1314	5322 130 40417	BSX20
V 1316	5322 130 44197	BC558B
V 1318	5322 130 44196	BC548C
V 1319	5322 130 44196	BC548C
V 1321	5322 130 44196	BC548C
V 1322	5322 130 44196	BC548C
V 1323	5322 130 30613	BAW62
V 1324	5322 130 44196	BC548C
V 1326	5322 130 30613	BAW62
V 1401	5322 130 30613	BAW62
V 1402	5322 130 30613	BAW62
V 1403	5322 130 30613	BAW62
V 1404	5322 130 30613	BAW62
V 1406	5322 130 44196	BC548C
V 1407	5322 130 44196	BC548C
V 1408	5322 130 30613	BAW62
V 1409	5322 130 44197	BC558B
V 1411	5322 130 30613	BAW62
V 1412	5322 130 30613	BAW62
V 1413	5322 130 44154	BF199
V 1414	5322 130 44154	BF199
V 1416	5322 130 34233	BZX79-C5V1
V 1417	5322 130 44603	BFT45
V 1418	5322 130 44108	BF338
V 1419	5322 130 40417	BSX20
V 1421	5322 130 30613	BAW62
V 1422	5322 130 44237	BF450
V 1423	5322 130 44603	BFT45
V 1424	5322 130 34233	BZX79-C5V1
V 1426	5322 130 44108	BF338
V 1427	5322 130 34098	BZX79-C36
V 1428	5322 130 34098	BZX79-C36
V 1429	5322 130 34098	BZX79-C36
V 1431	5322 130 34442	BZX79-C75
V 1501	5322 130 44196	BC548C
V 1502	5322 130 30613	BAW62
V 1503	5322 130 30613	BAW62
V 1504	5322 130 30613	BAW62
V 1506	5322 130 30613	BAW62
V 1507	5322 130 30191	OA95
V 1508	5322 130 30613	BAW62
V 1509	5322 130 30613	BAW62
V 1511	5322 130 44196	BC548C
V 1512	5322 130 30613	BAW62
V 1514	5322 130 44196	BC548C
V 1516	5322 130 30613	BAW62
V 1517	5322 130 30613	BAW62
V 1518	5322 130 44197	BC558B
V 1519	5322 130 44196	BC548C
V 1521	5322 130 44196	BC548C
V 1522	5322 130 44196	BC548C
V 1523	5322 130 44247	BSS68
V 1524	4822 130 30842	BAV21
V 1526	4822 130 30842	BAV21
V 1527	5322 130 44196	BC548C
V 1528	5322 130 44197	BC558B
V 1601	5322 130 44196	BC548C
V 1602	5322 130 44196	BC548C
V 1603	5322 130 44196	BC548C
V 1604	5322 130 30613	BAW62
V 1651	5322 130 30613	BAW62
V 1652	5322 130 30613	BAW62
V 1653	5322 130 30613	BAW62
V 1654	5322 130 30613	BAW62
V 1655	5322 130 30613	BAW62
V 1656	5322 130 30613	BAW62
V 1657	5322 130 30613	BAW62
V 1658	5322 130 44197	BC558B
V 1659	5322 130 44197	BC558B
V 1661	5322 130 30613	BAW62
V 1662	5322 130 44197	BC558B
V 1663	5322 130 30613	BAW62
V 1664	5322 130 44197	BC558B
V 1666	5322 130 44197	BC558B
V 1667	5322 130 30613	BAW62
V 1668	5322 130 44196	BC548C

INTEGRATED CIRCUITS

D 501	5322 209 84862	SG3823N
D 601	5322 209 84862	SG3823N
D 801	5322 209 84111	CA3086
D 1001	5322 209 84111	CA3086
D 1101	5322 209 84111	CA3086
D 1201	5322 209 85201	N74LS132N
D 1202	5322 209 84231	N74122N
D 1203	5322 209 84986	N74LS74N
D 1204	5322 209 84167	N74S00N
D 1301	5322 209 85201	N74LS132N
D 1302	5322 209 84167	N74S00N

Miscellaneous

Item	*Order number*	*Designation*
B 1	5322 130 34595	LED CQY 24 A-I
E 1	5322 134 44177	Lamp 28 V 80 mA
E 2	5322 134 44177	Lamp 28 V 80 mA
F 201	4822 253 30023	Fuse 1, 4A
K 501	5322 280 24103	Sam Reed Relais
K 601	5322 280 24103	Sam Reed Relais
K 1401	5322 280 24103	Sam Reed Relais
L 201	5322 281 64154	Coil
L 202	5322 281 64154	Coil
L 203	5322 281 64154	Coil
L 801	5322 156 14074	Coil
L 802	5322 156 14074	Coil
L 1501	5322 150 14015	Rotary Coil
	4822 252 20007	Thermal Fuse
42	5322 320 44029	Delay Line Unit
43	5322 462 44298	Foot
A 201	5322 216 54142	Power Supply Board
A 301	5322 216 54151	Attenuator Board
A 4	5322 218 64056	High Voltage Unit
S 9 – S 11	5322 105 34041	Attenuator Switch
S 13	5322 105 34043	DTB Switch
S 15	5322 105 34042	MTB Switch
S 24	4822 272 10079	Carrousel
T 101	5322 146 24166	Transformer
T 201	5322 158 34074	Base Transformer
T 202	5322 146 24163	Transformer
	4822 266 30071	3-pole Plug
	4822 265 30121	3-pole Socket
	4822 266 30072	4-pole Plug
	4822 265 30119	4-pole Socket
	4822 266 30073	6-pole Plug
	4822 265 30117	6-pole Socket
	4822 266 40057	7-pole Plug
	4822 265 40119	7-pole Socket

Item	Grid loc.
C101	rear panel
C200	power supply
C201	power supply
C202	power supply
C203	power supply
C204	power supply
C206	power supply
C207	power supply
C208	power supply
C209	power supply
C211	power supply
C212	
C213	high
C214	tension
C216	unit
C217	
C218	power supply
C219	power supply
C221	power supply
C222	power supply
C223	power supply
C224	power supply
C226	power supply
C227	power supply
C228	power supply
C229	power supply
C231	power supply
C251	C-2
C252	C-2/D-2
C253	C-3
C254	C-3/D-3
C255	att. unit
C256	att. unit
C257	B-4/B-5
C258	B-3
C259	D-4
C261	E-4
C262	F-5
C263	E-4
C266	C-3
C267	D-4
C268	D-4
C269	C-4
C271	C-4
C272	D-4
C273	B-2/B-3
C274	B-3/C-3
C276	D-3
C277	att. unit
C278	B-4/B-5
C279	B-3
C280	att. unit
C281	D-4
C282	D-4
C283	F-4
C284	G-2

Item	Grid loc.
C286	G-3
C301	att. unit
C305	att. unit
C307	att. unit
C308	att. unit
C309	att. unit
C310	att. unit
C311	att. unit
C312	att. unit
C313	att. unit
C314	att. unit
C315	att. unit
C316	att. unit
C317	att. unit
C318	att. unit
C319	att. unit
C320	att. unit
C321	att. unit
C322	att. unit
C324	att. unit
C351	att. unit
C352	att. unit
C353	att. unit
C356	att. unit
C401	att. unit
C405	att. unit
C407	att. unit
C408	att. unit
C409	att. unit
C410	att. unit
C411	att. unit
C412	att. unit
C413	att. unit
C414	att. unit
C415	att. unit
C416	att. unit
C417	att. unit
C418	att. unit
C419	att. unit
C420	att. unit
C421	att. unit
C422	att. unit
C424	att. unit
C451	att. unit
C452	att. unit
C453	att. unit
C501	C-2
C502	D-2
C504	D-2
C507	D-2
C508	D-2
C509	E-2
C510	E-2
C511	D-2
C512	E-2
C513	E-2

Item	Grid loc.
C514	E-2
C517	E-2
C518	E-2
C519	E-2
C521	E-2
C522	F-2
C523	C-2
C601	C-3
C602	D-3
C604	D-3
C607	D-3
C608	D-3
C609	E-2/E-3
C611	D-3
C612	E-3
C613	E-3
C614	E-3
C616	E-3
C617	E-3
C618	E-3
C619	F-3
C621	E-3
C622	F-3
C623	C-3
C701	E-3
C702	E-2/E-3
C703	E-3
C704	E-3
C705	E-2
C706	E-2
C707	F-2
C801	F-3
C802	F-3
C803	F-3
C804	F-3
C805	G-2
C806	F-3
C807	F-3
C808	F-3
C809	F-3
C810	F-2
C811	F-3
C813	G-3
C814	G-2
C815	G-3
C816	F-2
C817	F-2
C818	F-2
C819	G-2
C821	F-2
C1001	B-5
C1002	C-4
C1003	C-4
C1004	B-5
C1005	C-4/D-4
C1006	C-4

Item	Grid loc.
C1007	C-5
C1008	C-5/D-5
C1009	C-5
C1011	C-5
C1012	C-5
C1101	B-4
C1102	B-4
C1103	C-4
C1104	C-4
C1201	D-5
C1202	E-5
C1203	D-5
C1204	D-5
C1205	D-5
C1206	E-5
C1207	D-4
C1208	E-5
C1209	E-5
C1210	E-4
C1301	E-5
C1302	D-4
C1303	D-4
C1304	E-4
C1305	E-5
C1306	E-4
C1307	D-5/E-5
C1308	E-5
C1309	D-5
C1310	D-4
C1311	D-5
C1312	D-5
C1313	D-4
C1314	E-4
C1315	D-4
C1316	D-4
C1402	F-5
C1403	E-5
C1404	G-3
C1405	G-3
C1406	G-3
C1407	G-3
C1408	G-3
C1409	G-2
C1411	G-3
C1412	G-2
C1413	G-2/G-3
C1414	G-2/G-3
C1416	G-2
C1417	G-2
C1501	G-5
C1502	G-5
C1503	G-5
C1504	G-5
C1506	G-4
C1507	G-5
C1508	G-5

Item	Grid loc.
C1509	G-4
C1511	G-5
C1512	on tube
C1601	B-2
C1602	B-2
C1651	F-4
C1652	F-4
C1653	F-5
C1654	F-5
C1655	F-4
C1656	F-5
C1657	F-5
C1658	F-5
C1659	F-5
C1660	E-3
R1	
R2	
R3	
R4	
R5	
R6	
R7	
R8	front panel
R9	
R10	
R11	
R12	
R13	
R14	
R15	
R200	power supply
R201	power supply
R202	power supply
R203	power supply
R204	power supply
R206	power supply
R207	power supply
R208	power supply
R209	power supply
R210	power supply
R211	high t.u.
R212	power supply
R227	B-3/C-3
R251	B-2/C-2
R252	B-3/C-3
R253	B-3/C-3
R254	C-3
R256	D-3
R257	att. unit
R258	B-4
R259	B-3
R261	E-3/E-4
R262	F-5
R263	E-3/E-4
R264	C-3
R266	D-4

Item	Grid loc.
R267	C-4
R268	D-4
R269	B-2/C-2
R271	B-3/C-3
R272	D-3
R273	att. unit
R274	B-4
R276	B-3
R277	D-4
R278	F-4
R279	G-3
R281	G-3
R302	att. unit
R303	on switch
R304	S9
R306	
R307	att. unit
R308	att. unit
R309	att. unit
R311	att. unit
R312	att. unit
R313	on switch
R314	S9
R316	att. unit
R317	att. unit
R318	att. unit
R319	att. unit
R351	att. unit
R352	att. unit
R353	att. unit
R354	att. unit
R355	att. unit
R356	att. unit
R357	att. unit
R358	att. unit
R359	att. unit
R360	att. unit
R361	att. unit
R362	att. unit
R363	att. unit
R364	att. unit
R365	att. unit
R366	att. unit
R367	att. unit
R368	att. unit
R369	att. unit
R374	att. unit
R402	att. unit
R403	on switch
R404	S11
R406	
R407	att. unit
R408	att. unit
R409	att. unit
R411	att. unit
R412	att. unit

Item	Grid loc.
R413	on switch
R414	S11
R416	att. unit
R417	att. unit
R418	att. unit
R419	att. unit
R451	att. unit
R452	att. unit
R453	att. unit
R454	att. unit
R456	att. unit
R457	att. unit
R458	att. unit
R459	att. unit
R461	att. unit
R462	att. unit
R463	att. unit
R464	att. unit
R466	att. unit
R467	att. unit
R468	att. unit
R469	att. unit
R500	C-2
R501	C-2
R502	C-2
R503	C-2
R504	C-2
R506	C-2
R507	C-2
R508	C-2
R509	C-2
R511	D-2
R512	C-2/D-2
R513	C-2
R514	D-2
R516	C-2
R517	C-2
R518	D-2
R519	C-2
R521	D-2
R522	D-2
R523	D-2
R524	D-2
R526	D-2
R527	D-2
R528	D-2
R529	D-2
R531	D-2
R532	D-2
R533	D-2
R534	D-2
R536	E-2
R537	E-2
R538	D-2/E-2
R539	E-2
R541	E-2

Item	Grid loc.
R542	D-2
R543	D-2
R544	E-2
R546	E-2
R547	E-2
R548	E-2
R549	D-2
R550	E-2
R551	E-2
R552	D-2
R553	D-2
R554	D-2
R556	E-2
R557	E-2
R558	E-2
R559	E-2
R567	E-2
R568	E-2
R569	E-2
R571	F-2
R572	F-2
R573	E-2
R577	F-2
R600	C-3
R601	C-3
R602	C-3
R603	C-3
R604	C-3
R606	C-3
R607	C-3
R608	C-3
R609	C-3
R611	D-3
R612	C-3/D-3
R613	C-3
R614	D-3
R616	C-3
R617	C-3
R618	D-3
R619	C-3
R621	D-3
R622	D-3
R623	D-3
R624	D-3
R626	D-3
R627	D-3
R628	D-3
R629	D-3
R631	D-3
R632	D-3
R633	D-3
R634	D-3
R636	E-3
R637	D-3/E-3
R638	E-3
R639	D-3/E-3

Item	Grid loc.
R641	D-3/E-3
R644	D-3
R646	E-3
R647	E-3
R648	E-3
R649	D-3
R650	E-2
R651	E-3
R652	D-3
R653	D-3
R654	D-3
R656	E-3
R657	E-3
R658	E-3
R659	E-3
R661	E-3
R662	E-3
R663	E-3
R664	E-3
R666	E-3
R667	E-3
R668	E-3
R669	E-3
R671	E-3/F-3
R672	E-3/F-3
R673	E-3
R674	E-3
R676	E-3
R677	F-3
R701	E-2/E-3
R702	E-3
R703	E-2
R704	E-2
R706	E-3
R707	E-2/E-3
R708	E-2/E-3
R709	F-2
R711	F-3
R712	F-2
R713	E-3
R714	E-2
R716	F-3
R717	F-3
R801	F-2
R802	F-3
R803	F-3
R804	F-2
R806	F-3
R807	F-3
R809	F-2/F-3
R811	F-3
R812	F-3
R813	G-3
R814	F-3
R817	F-3
R819	F-3

Item	Grid loc.
R821	F-3
R822	F-3/G-3
R823	G-3
R824	G-3
R825	G-3
R826	G-3
R827	G-3
R828	G-3
R829	F-3
R831	F-2
R832	F-2
R833	G-3
R837	F-3
R838	G-2
R839	F-2
R841	F-2/G-2
R842	F-2/G-2
R843	F-2
R844	F-2
R846	F-2
R847	F-2/G-2
R848	F-2
R849	F-2
R851	G-2
R852	F-2/G-2
R853	F-2
R854	F-2
R856	F-2
R857	F-2
R858	F-2
R859	F-2
R861	F-2
R862	F-2
R863	F-2
R864	G-2
R866	F-2/F-3
R1001	B-5
R1002	C-4
R1003	C-4
R1004	C-4
R1006	C-4
R1007	C-5
R1008	C-5
R1009	C-5
R1011	C-5
R1012	B-4
R1013	B-5
R1014	C-5
R1016	B-4
R1017	C-5
R1018	C-4
R1019	C-5
R1021	C-5
R1022	C-4
R1023	C-4
R1024	C-4

Item	Grid loc.
R1026	C-5
R1027	C-5
R1028	C-5
R1029	C-4
R1031	C-4
R1032	C-4
R1034	C-4
R1036	C-4
R1037	C-5
R1038	C-4
R1039	C-4
R1041	C-4
R1042	C-5
R1043	C-5
R1044	C-5
R1046	C-5
R1047	C-5
R1048	C-5
R1049	C-5
R1051	C-5
R1052	C-5
R1101	B-4
R1102	C-4
R1103	B-4
R1104	B-4
R1106	B-4
R1107	B-4
R1108	B-4
R1109	C-4
R1111	C-4
R1112	C-4
R1113	C-4
R1114	C-4
R1116	C-4
R1117	C-4
R1118	C-4
R1119	C-4
R1121	C-4
R1122	C-4
R1123	C-4
R1124	C-4
R1201	D-5
R1202	D-4
R1203	D-4
R1204	D-4
R1206	D-5
R1207	D-5
R1208	D-5
R1209	G-4
R1210	D-5
R1211	E-5
R1212	E-5
R1213	E-4
R1214	E-4
R1216	E-4
R1217	D-5

Item	Grid loc.
R1218	D-5
R1219	E-5
R1221	D-5
R1222	E-5
R1223	D-5
R1224	D-5
R1226	D-5
R1227	E-4
R1276	
R1277	
R1278	
R1279	
R1281	
R1282	
R1283	on switch
R1284	S15
R1286	
R1287	
R1288	
R1289	
R1291	
R1301	E-5
R1302	E-4
R1303	E-5
R1304	E-5
R1305	E-4
R1306	E-5
R1307	E-5
R1308	E-5
R1309	E-5
R1311	E-5
R1312	E-5
R1313	D-4
R1314	E-5
R1316	E-4
R1317	E-5
R1318	E-4
R1319	E-4
R1321	D-4
R1322	E-4
R1324	D-4
R1326	D-4
R1327	E-4
R1328	D-4
R1329	E-4
R1331	E-4
R1332	E-4
R1333	D-4/E-4
R1334	E-4
R1336	E-4
R1337	E-4
R1338	E-4
R1339	E-4
R1341	E-4
R1342	E-4
R1343	E-4

Item	Grid loc.
R1344	E-4
R1346	E-4
R1347	D-4
R1376	
R1377	
R1378	
R1379	on switch
R1381	S13
R1382	
R1383	
R1401	F-4
R1402	F-4
R1403	F-4
R1404	F-5
R1406	F-4/F-5
R1407	F-5
R1408	F-5
R1409	F-5
R1411	F-5
R1412	F-5
R1413	F-5
R1414	F-4
R1416	F-4
R1417	F-4
R1418	F-4
R1419	F-4
R1421	F-4
R1422	F-4
R1423	F-4
R1424	F-5
R1425	G-3
R1426	G-3
R1427	G-3
R1428	G-2
R1429	G-3
R1431	G-3
R1432	G-3
R1433	G-3
R1434	G-3
R1436	G-2
R1437	G-3
R1438	G-3/G-4
R1439	G-3
R1441	G-2
R1442	G-2
R1443	G-3
R1444	G-3
R1446	G-2
R1447	G-2
R1448	
R1449	on R6
R1451	
R1501	F-4/G-4
R1502	G-4
R1503	G-4
R1504	G-4

Item	Grid loc.
R1506	F-5
R1507	G-4
R1508	G-4
R1509	G-4
R1511	G-4
R1512	G-4
R1513	G-5
R1514	G-5
R1516	G-5
R1517	G-5
R1518	F-5/G-5
R1519	G-4
R1521	G-5
R1522	G-4
R1524	G-4
R1526	G-4
R1527	G-4
R1528	G-5
R1529	G-4
R1531	G-5
R1532	G-4
R1533	G-4
R1534	G-5
R1535	on tube
R1536	G-4
R1537	G-4
R1538	power supply
R1539	power supply
R1541	power supply
R1542	power supply
R1543	power supply
R1544	power supply
R1546	power supply
R1547	power supply
R1548	power supply
R1549	power supply
R1551	power supply
R1552	on tube
R1553	G-5
R1601	B-2
R1602	B-2
R1603	B-2
R1604	B-2
R1606	B-2
R1607	B-2
R1608	B-2
R1609	B-2
R1611	B-2
R1612	B-2
R1613	B-2
R1614	B-2
R1616	B-2
R1617	B-2
R1618	B-2
R1619	B-2
R1651	F-5

Item	Grid loc.
R1652	F-5
R1653	F-5
R1654	F-5
R1656	F-5
R1657	F-5
R1658	F-5
R1659	F-5
R1661	F-5
R1662	F-5
R1663	F-5
R1664	F-4
R1666	F-4
R1667	F-4
R1668	F-4
R1669	F-5
R1671	F-4
R1672	F-4
R1673	E-4
R1674	F-4
R1676	F-5
R1677	F-4
R1678	F-4
R1679	F-5
R1681	F-5
R1682	F-5
R1683	F-4
R1684	F-4
R1686	F-4
R1687	F-4
R1688	F-4
V1	tube
V201	power supply
V202	power supply
V203	power supply
V204	power supply
V206	power supply
V207	power supply
V208	power supply
V209	power supply
V211	power supply
V212	power supply
V213	power supply
V214	power supply
V216	power supply
V217	power supply
V218	power supply
V219	power supply
V221	power supply
V222	power supply
V223	power supply
V224	power supply
V226	
V227	high
V228	tension
V229	unit
V231	

Item	Grid loc.
V232	power supply
V233	power supply
V234	power supply
V236	power supply
V237	power supply
V238	power supply
V239	power supply
V241	power supply
V242	power supply
V243	power supply
V244	power supply
V246	power supply
V247	power supply
V351	att. unit
V352	att. unit
V353	att. unit
V354	att. unit
V451	att. unit
V452	att. unit
V453	att. unit
V501	C-2
V504	C-2
V506	D-2
V507	D-2
V508	E-2
V509	E-2
V511	D-2
V512	D-2
V513	E-2
V514	E-2
V518	E-2
V519	E-2
V521	F-2
V522	F-2
V523	F-2
V524	F-2
V526	F-2
V601	C-3
V604	C-3
V606	D-3
V607	D-3
V608	E-3
V609	E-3
V611	D-3
V612	D-3
V613	E-3
V614	E-3
V616	E-3
V617	E-3
V618	E-3
V619	E-3
V621	F-3
V622	F-3
V623	F-3
V624	F-3
V626	F-3

Item	Grid loc.
V701	E-2/E-3
V702	E-3
V703	E-2
V704	E-3
V801	F-2/F-3
V802	F-3
V803	F-3
V804	G-2
V806	F-2/G-2
V807	F-2
V808	F-2
V809	F-2
V1001	C-4
V1002	C-4
V1003	C-4
V1004	C-5
V1006	B-5
V1007	C-4
V1008	C-5
V1009	C-5
V1011	C-4
V1012	C-5
V1013	C-5
V1014	C-5
V1016	C-5
V1017	C-5
V1018	C-5
V1019	C-5
V1020	C-5
V1021	C-5
V1022	C-4
V1023	C-4
V1024	C-5/D-5
V1026	C-5/D-5
V1027	C-5
V1028	C-5
V1101	B-4
V1102	B-4
V1103	C-4
V1104	C-4
V1106	C-4
V1107	C-4
V1108	C-4
V1109	C-4/D-4
V1201	D-5
V1202	D-5
V1206	D-4
V1207	D-5
V1208	D-5
V1209	E-5
V1211	D-5
V1212	D-5
V1213	D-5
V1214	E-4
V1216	D-5
V1217	E-4

Item	Grid loc.
V1218	E-5
V1219	D-5
V1221	E-5
V1301	E-4/E-5
V1302	E-5
V1303	E-5
V1304	E-5
V1305	E-5
V1306	E-5
V1307	E-5
V1308	D-4
V1314	E-4
V1316	E-4
V1318	E-4
V1319	D-4
V1321	E-4
V1322	E-4
V1323	E-4
V1324	D-4
V1326	E-4
V1401	E-4
V1402	F-5
V1403	F-5
V1404	F-4
V1406	F-4
V1407	F-4
V1408	F-5
V1409	F-5
V1411	F-5
V1412	F-4/F-5
V1413	F-4
V1414	F-4
V1416	G-2
V1417	G-2
V1418	G-3
V1419	G-3
V1421	G-3
V1422	G-3
V1423	G-3
V1424	G-2
V1426	G-3
V1427	G-2
V1428	G-2
V1429	G-2
V1431	G-2
V1501	G-4
V1502	G-4
V1503	G-4
V1504	G-4
V1506	G-4
V1507	G-4
V1508	G-4
V1509	G-4
V1511	G-4
V1512	G-4
V1514	G-4

Item	Grid loc.
V1516	G-4
V1517	G-4
V1518	G-5
V1519	G-5
V1521	G-4
V1522	G-4/G-5
V1523	G-4/G-5
V1524	G-4
V1526	G-5
V1527	B-2
V1528	B-2
V1601	B-2
V1602	B-2
V1603	B-2
V1604	B-2
V1651	F-5
V1652	B-4/B-5
V1653	F-5
V1654	F-5
V1655	F-5
V1656	F-5
V1657	F-5
V1658	F-5
V1659	F-5
V1661	F-4
V1662	E-4
V1663	F-4/F-5
V1664	E-4
V1666	F-4
V1667	F-4/F-5
V1668	F-4
D501	C-2/D-2
D601	C-3/D-3
D801	F-3
D1001	C-5
D1101	B-4/C-4
D1201	D-5
D1202	D-5
D1203	D-4/D-5
D1204	D-4
D1301	D-4
D1302	D-4
B1	LED
T101	rear panel
T201	power supply
T202	power supply
F201	power supply
K501	C-2
K601	C-3
K1401	F-4
L201	power supply
L202	power supply
L203	power supply
L801	G-2
L802	F-2
L1501	trace rot. coil

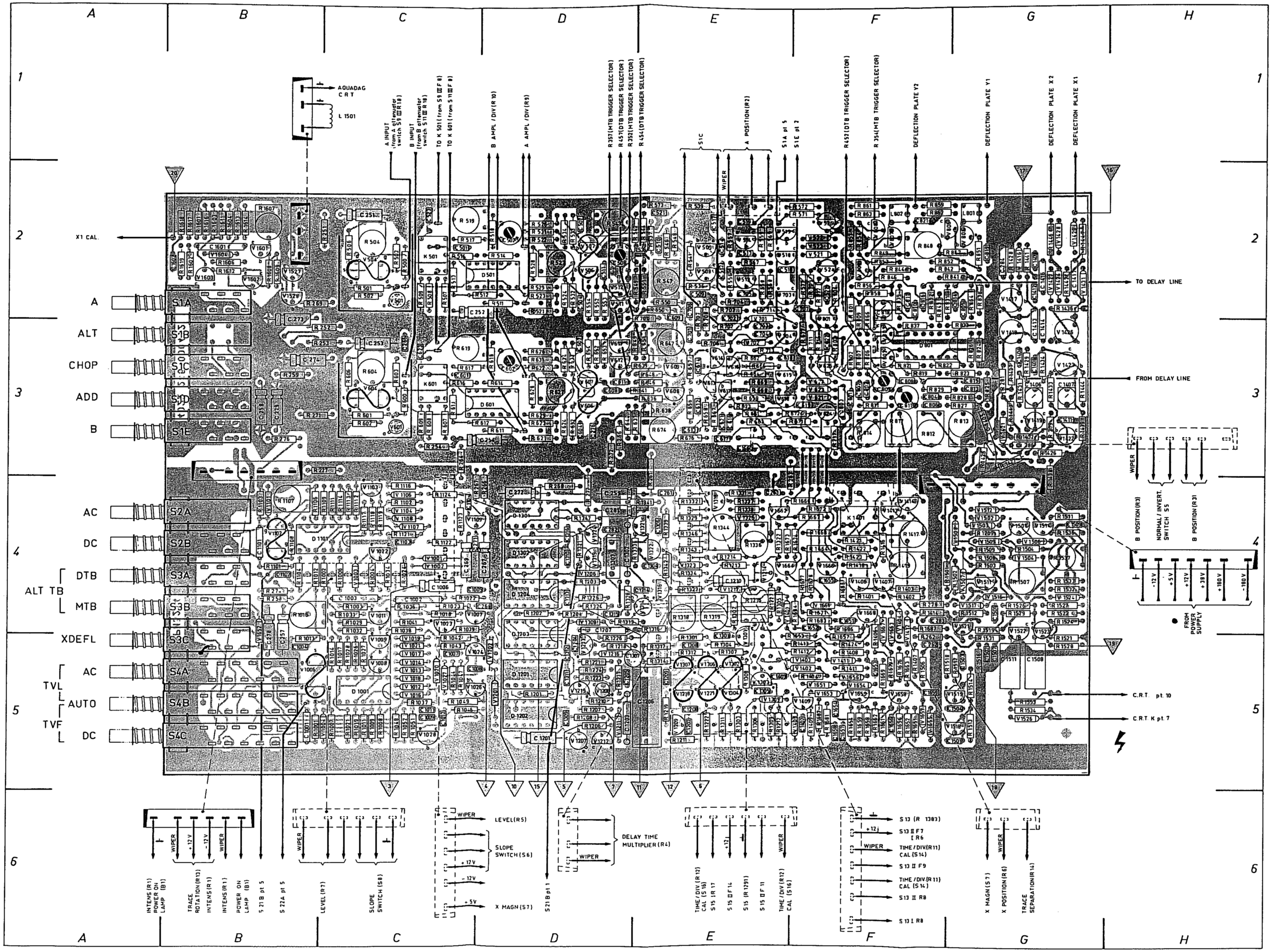


Fig. 3.40. Vertical amplifier unit with rear side tracks

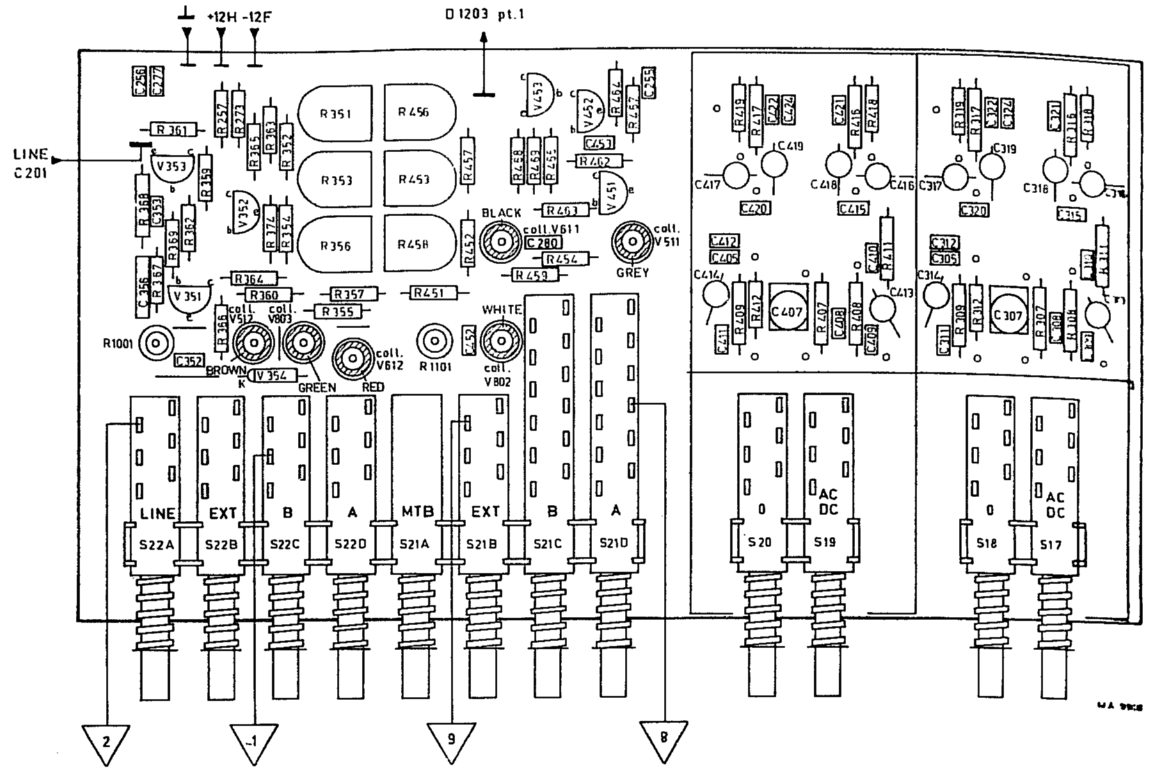


Fig. 3.41. Vertical attenuator unit

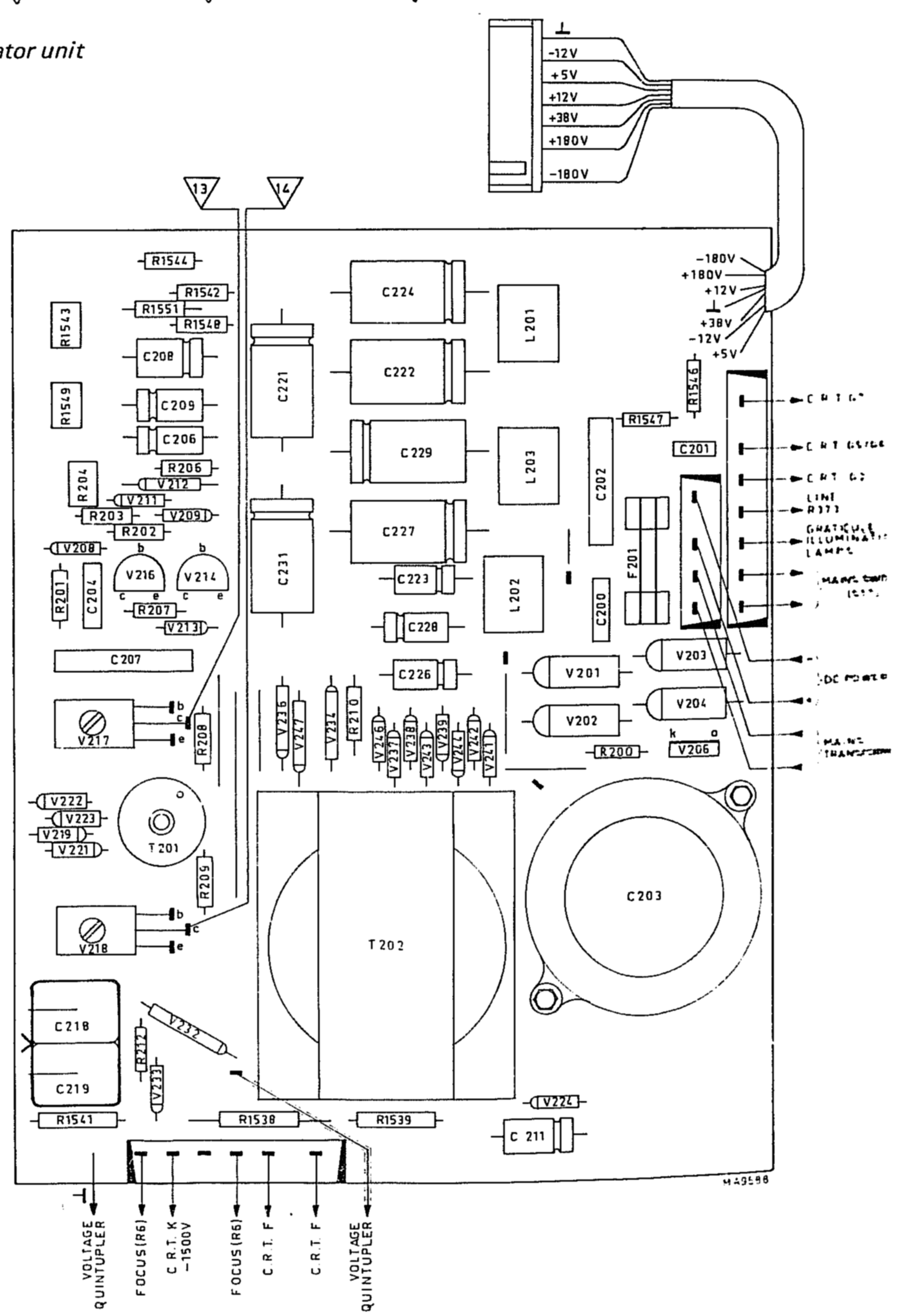


Fig. 3.42. Power supply unit

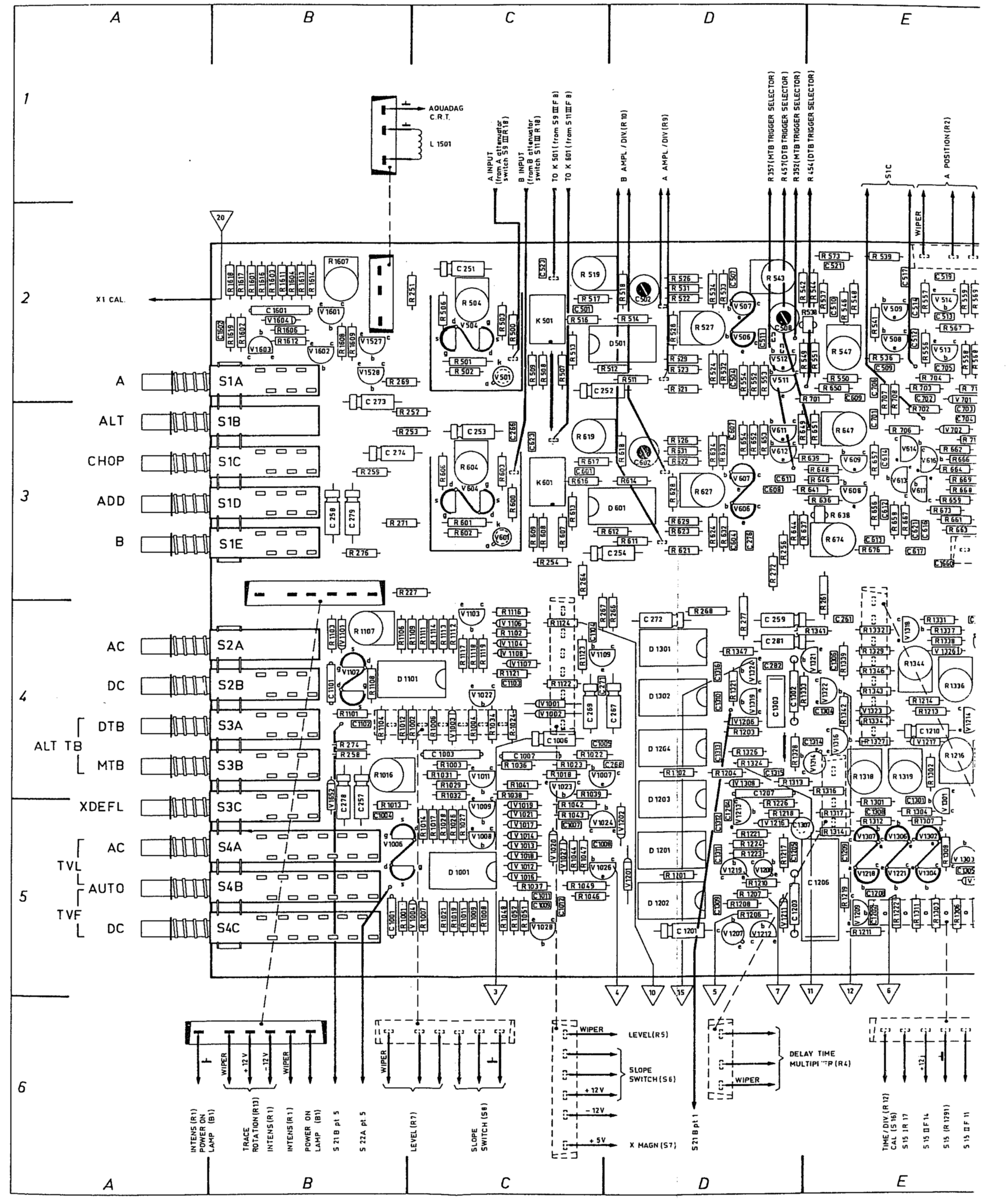
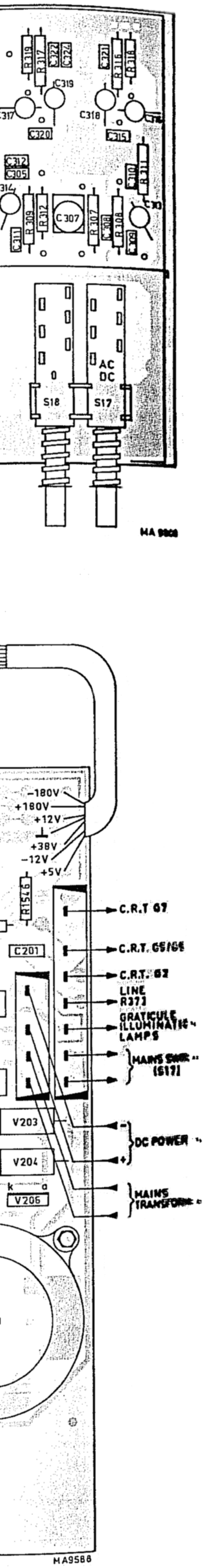


Fig. 3.43. Vertical amplifier unit with upper side tracks



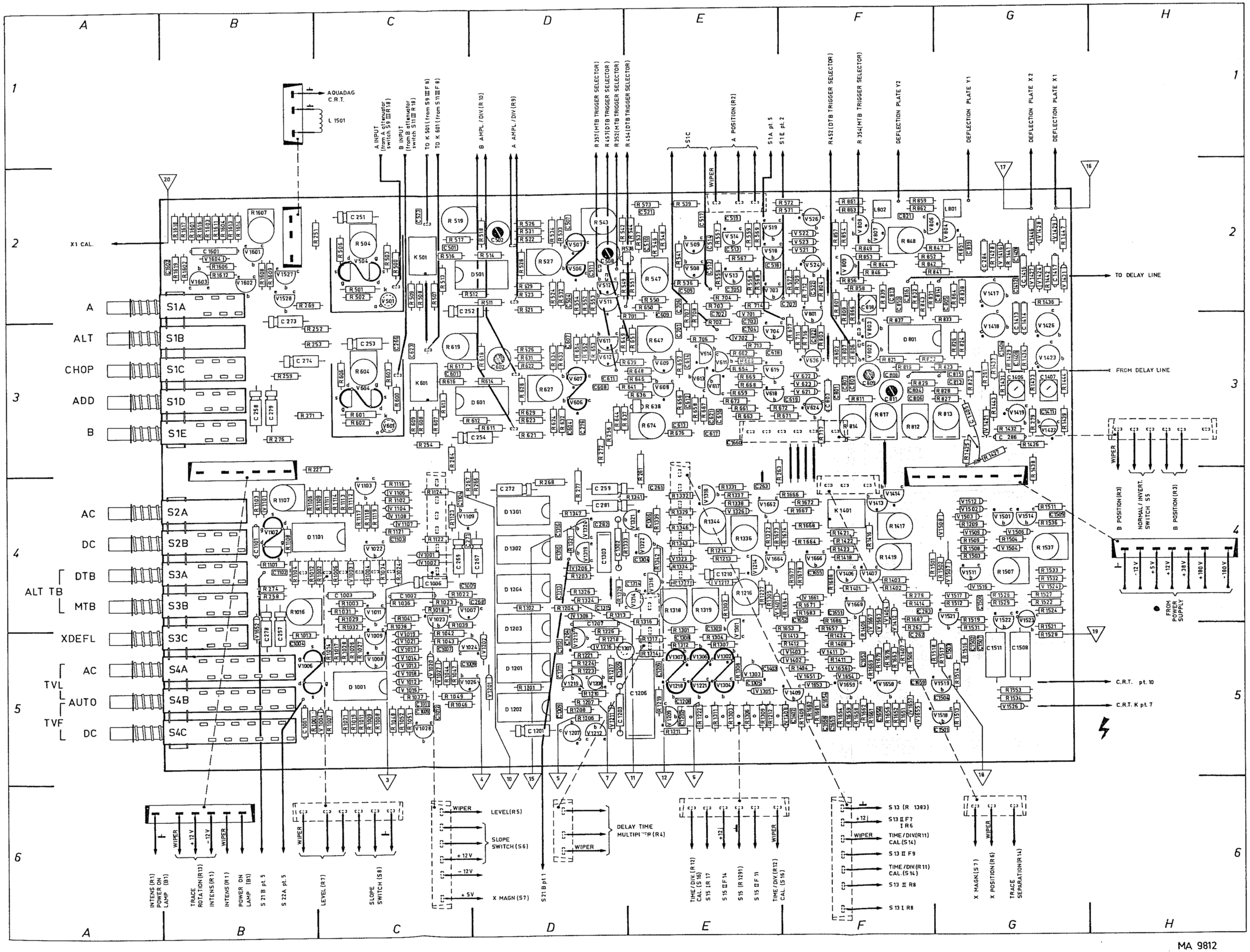
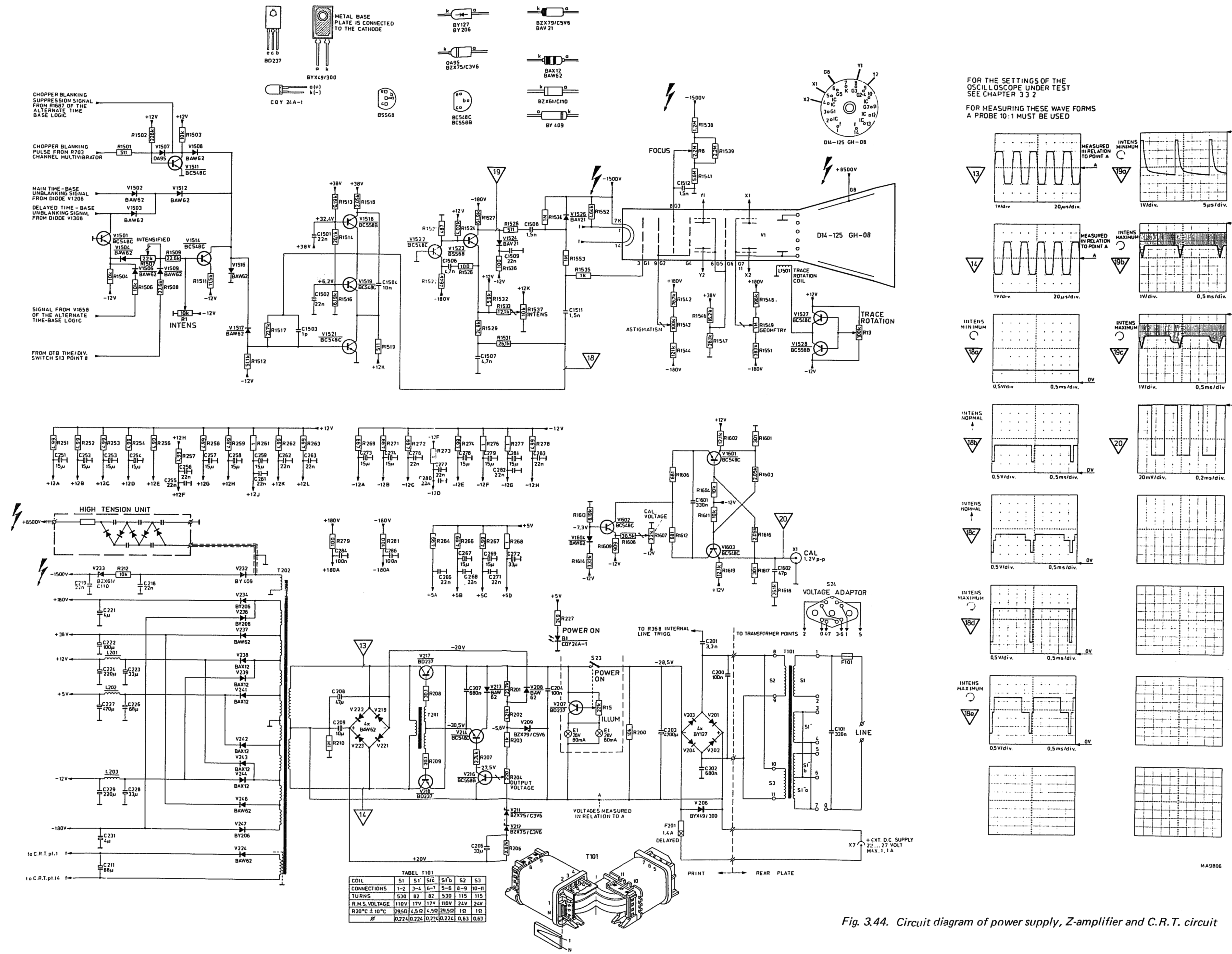


Fig. 3.43. Vertical amplifier unit with upper side tracks



TABEL T101

COIL	S1	S1'	S1'c	S1''b	S2	S3
CONNECTIONS	1–2	3–4	6–7	5–6	8–9	10–11
TURNS	530	82	82	530	115	115
R.M.S. VOLTAGE	110V	17V	17V	110V	24V	24V
R20°C ± 10°C	29,5Ω	4,5Ω	4,5Ω	29,5Ω	1Ω	1Ω
Ø	0,224	0,224	0,224	0,224	0,63	0,63

Fig. 3.44. Circuit diagram of power supply, Z-amplifier and C.R.T. circuit

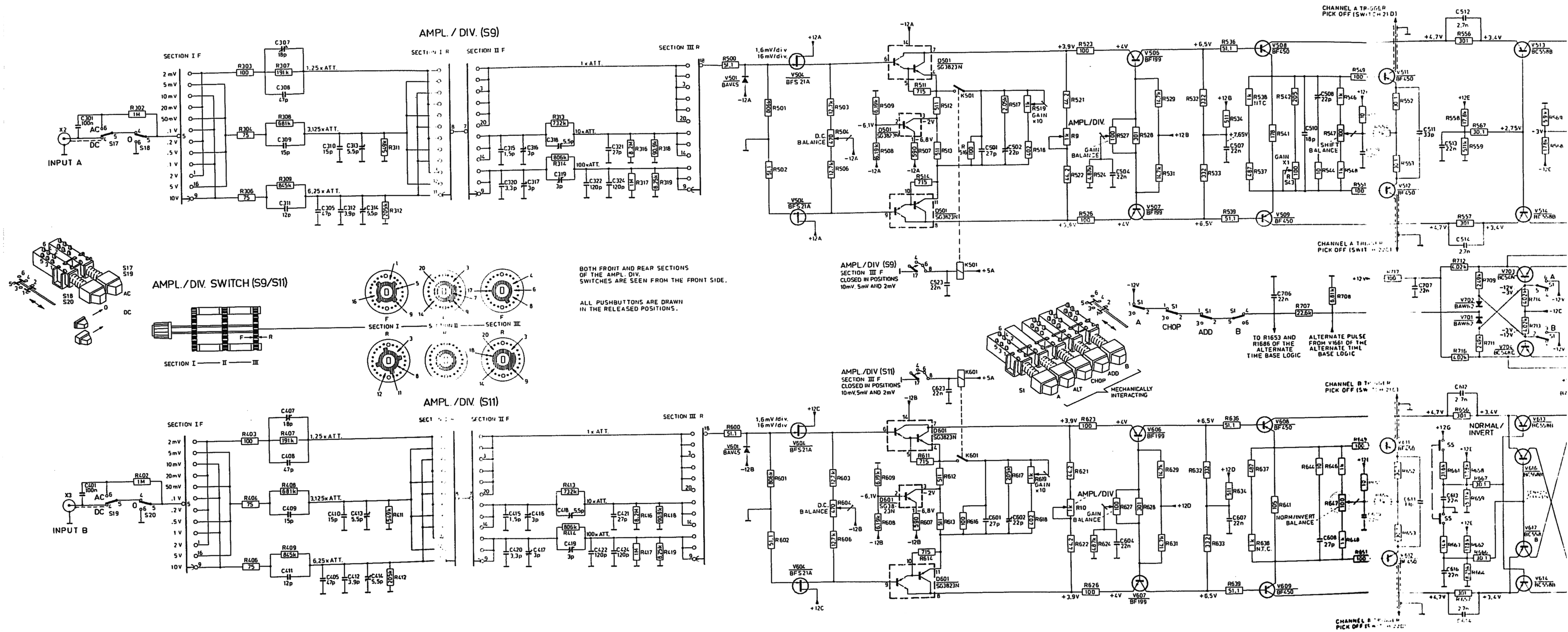
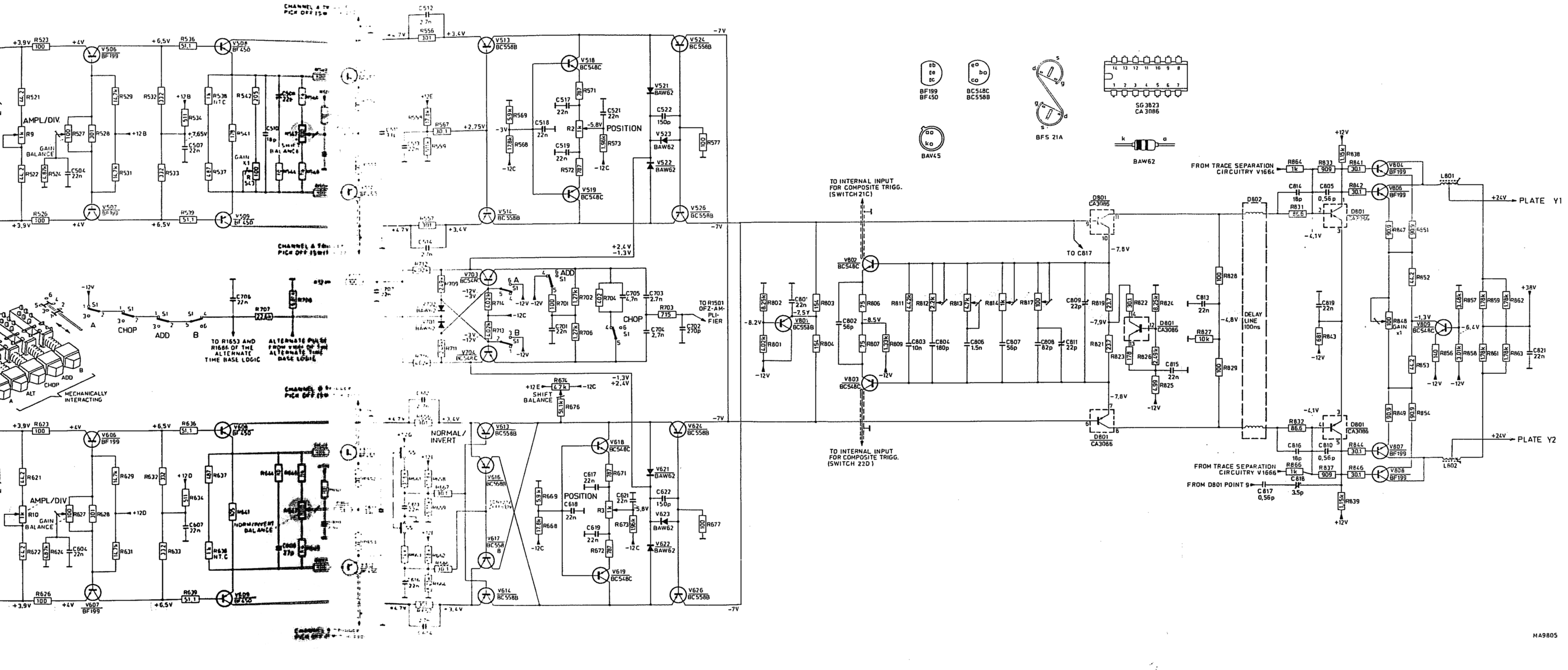
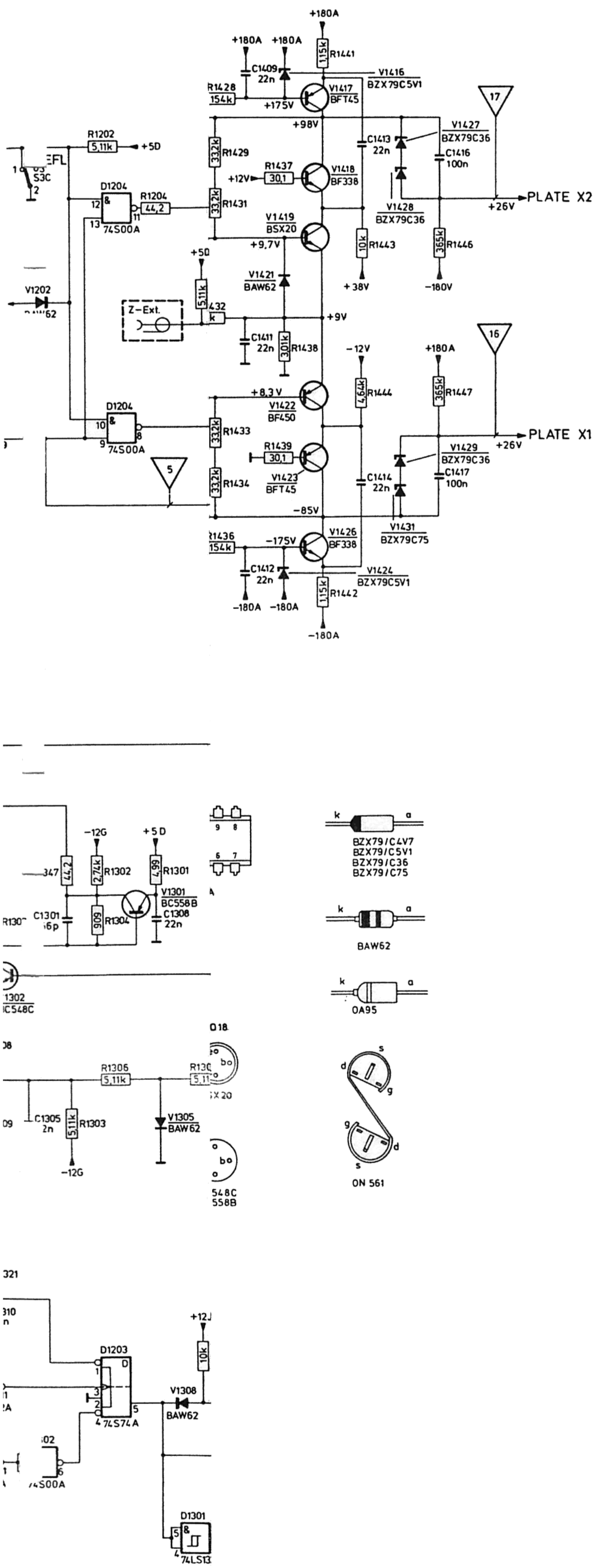


Fig. 3.45. Circuit diagram of the vertical amplifiers



AMPL/DIV.
GAIN BALANCE
POSITION
CHOP
ADD
NORMAL/ INVERT
SHIFT BALANCE
MECHANICALLY INTERACTING
TO R1653 AND R1686 OF THE ALTERNATE TIME BASE LOGIC
TO R1501 OFZ-AMPLIFIER
TO INTERNAL INPUT FOR COMPOSITE TRIGG. (SWITCH 21C)
TO INTERNAL INPUT FOR COMPOSITE TRIGG. (SWITCH 22D)
TO C817
DELAY LINE 100ns
FROM TRACE SEPARATION CIRCUITRY V1664
FROM TRACE SEPARATION CIRCUITRY V1666
FROM D801 POINT 9
PLATE Y1
PLATE Y2
BF199 BF450
BC548C BC558B
BFS 21A
SG3823 CA3086
BAV45
BAW62
MA9805



FOR THE SETTINGS OF THE OSCILLOSCOPE UNDER TEST SEE CHAPTER 3.3.2.

FOR MEASURING THESE WAVE-FORMS A PROBE 10:1 MUST BE USED

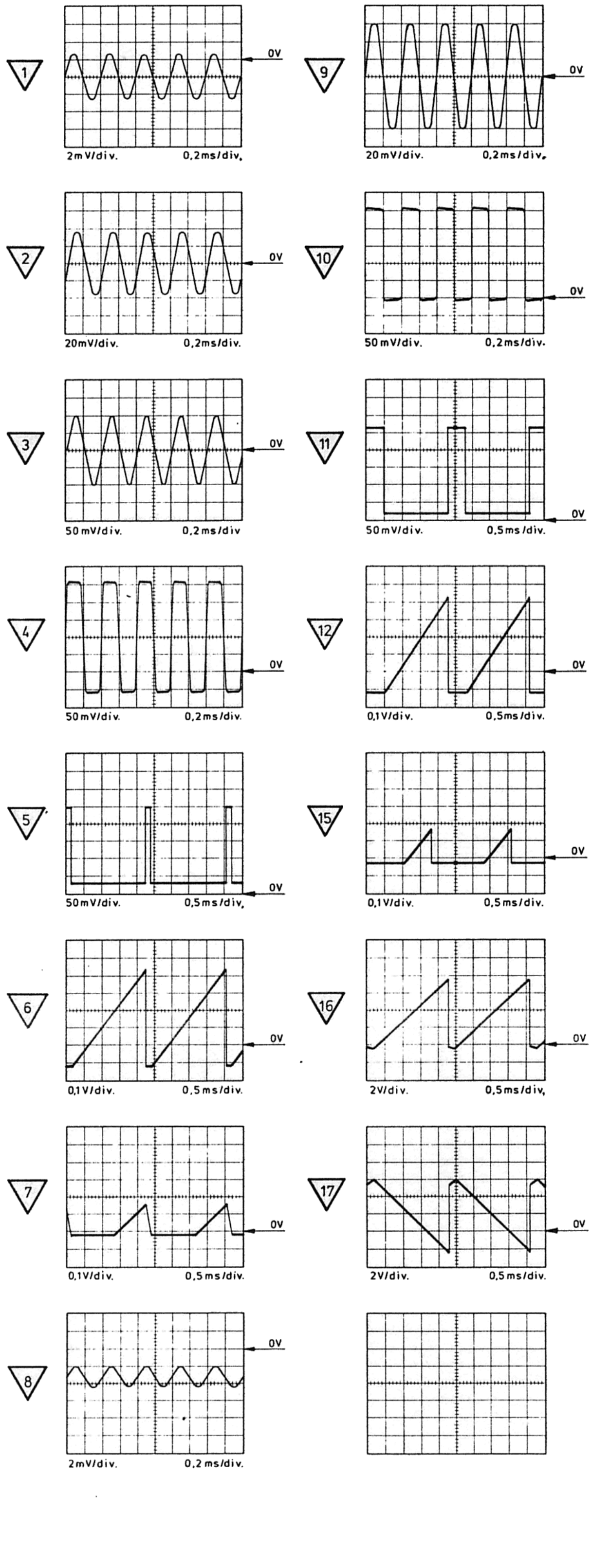
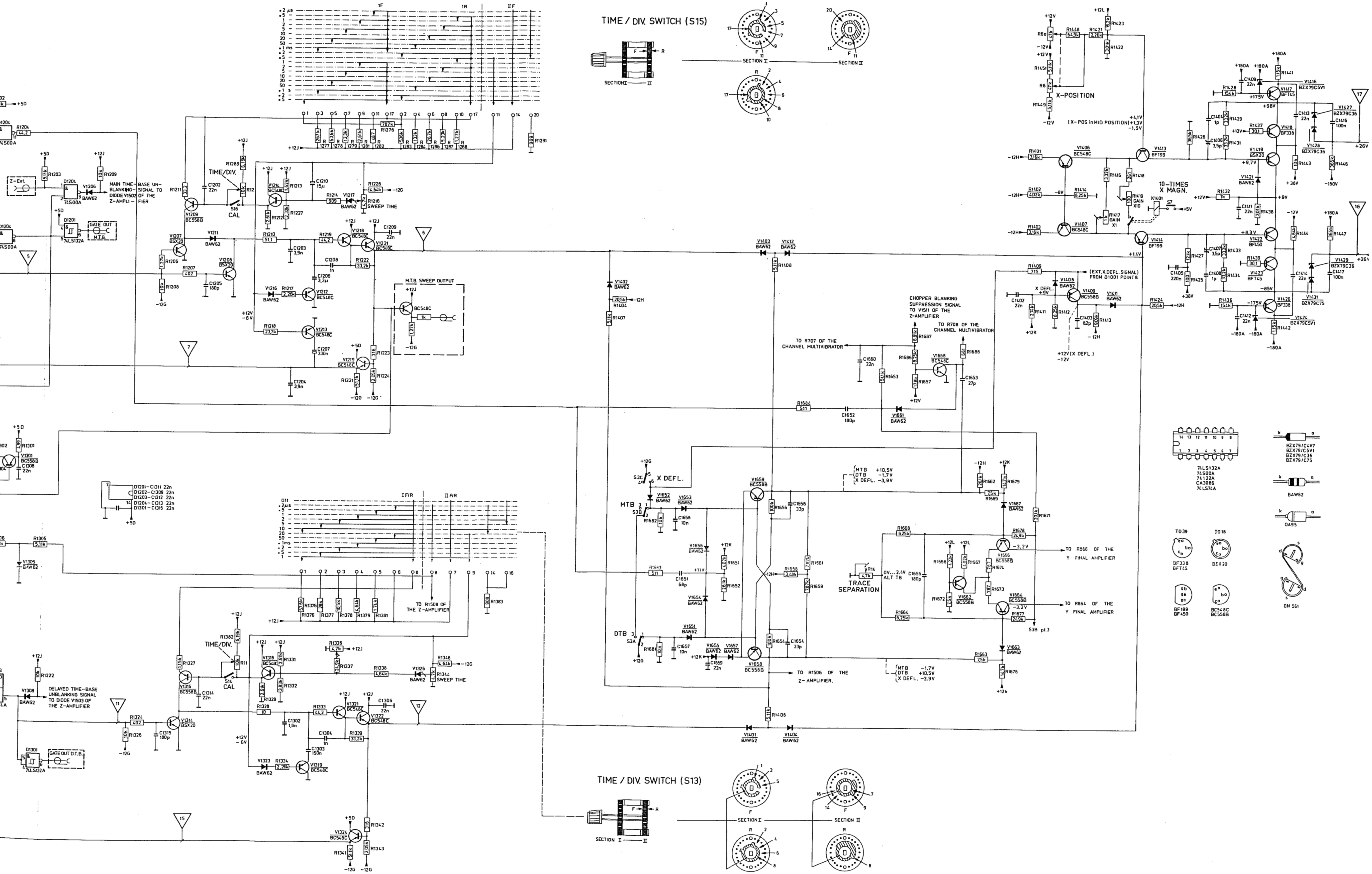
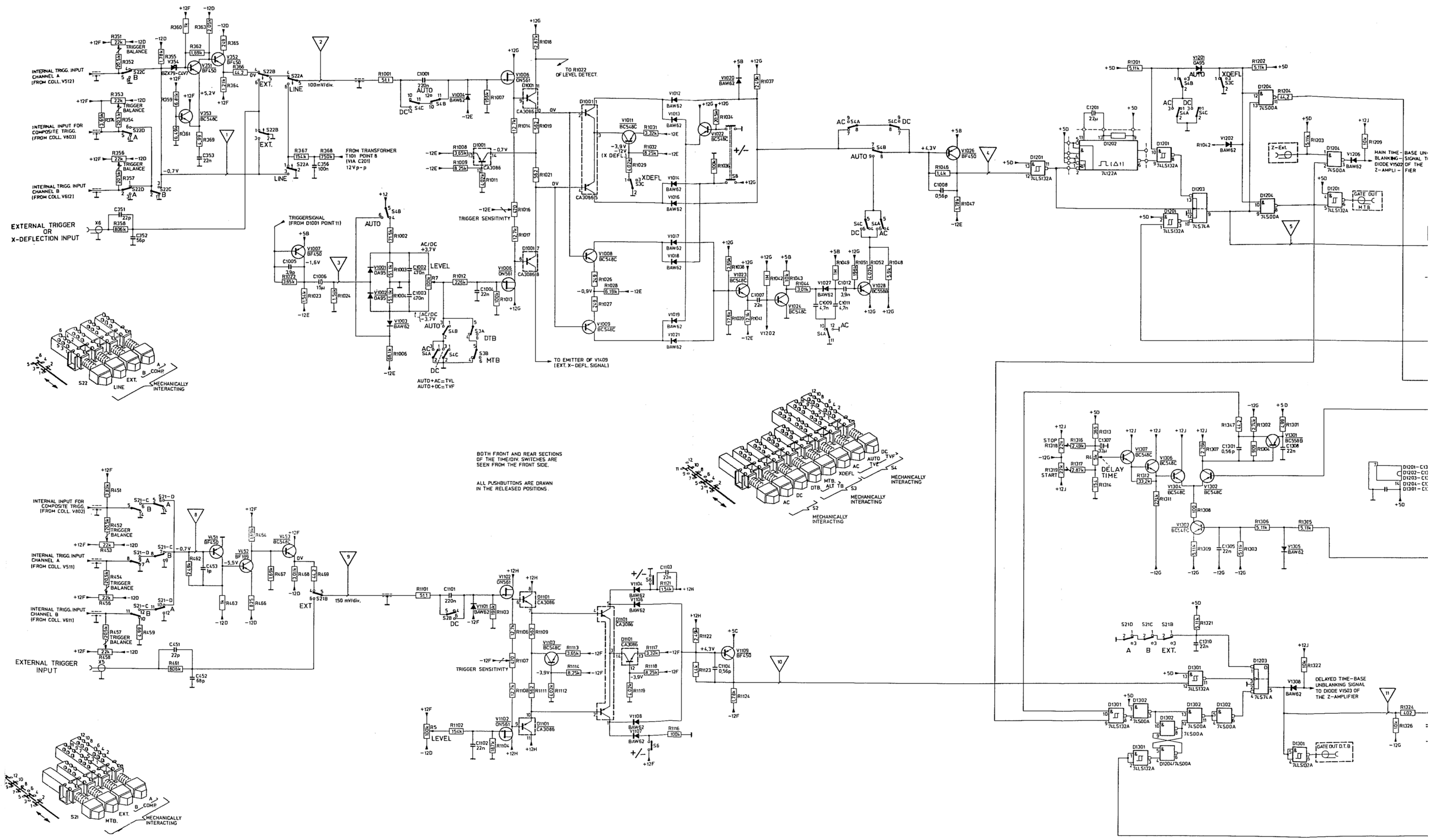


Fig. 3.46. Circuit diagram of the main and delayed time-bases.



TIME / DIV. SWITCH (S15)
SECTION I
SECTION II
X-POSITION
(X-POS in MID POSITION)
10-TIMES X MAGN.
TIME/DIV.
CAL
MAIN TIME-BASE UNBLANKING-SIGNAL TO DIODE V1502 OF THE Z-AMPLIFIER
GATE OUT M.T.B.
M.T.B. SWEEP OUTPUT
SWEEP TIME
CHOPPER BLANKING SUPPRESSION SIGNAL TO V1511 OF THE Z-AMPLIFIER
TO R708 OF THE CHANNEL MULTIVIBRATOR
TO R707 OF THE CHANNEL MULTIVIBRATOR
(EXT.X DEFL. SIGNAL) FROM D1001 POINT 8
X DEFL.
MTB
DTB
TRACE SEPARATION
TO R866 OF THE Y FINAL AMPLIFIER
TO R864 OF THE Y FINAL AMPLIFIER
TO R1506 OF THE Z-AMPLIFIER
TO R1508 OF THE Z-AMPLIFIER
DELAYED TIME-BASE UNBLANKING SIGNAL TO DIODE V1503 OF THE Z-AMPLIFIER
GATE OUT D.T.B.
TIME / DIV. SWITCH (S13)
SECTION I - II
74LS132A
74S00A
74122A
CA3086
74LS74A
BZX79/C4V7
BZX79/C5V1
BZX79/C36
BZX79/C75
BAW62
OA95
BF338
BFT45
BSX20
BF199
BF450
BC548C
BC558B
ON 561



INTERNAL TRIGG. INPUT CHANNEL A (FROM COLL. V512)
INTERNAL INPUT FOR COMPOSITE TRIGG. (FROM COLL. V803)
INTERNAL TRIGG. INPUT CHANNEL B (FROM COLL. V612)
EXTERNAL TRIGGER OR X-DEFLECTION INPUT
TRIGGER BALANCE
LINE
EXT.
100mV/div.
FROM TRANSFORMER T101 POINT 8 (VIA C201) 12Vp-p
TO R1022 OF LEVEL DETECT.
TRIGGERSIGNAL (FROM D1001 POINT 11)
TRIGGER SENSITIVITY
LEVEL
AUTO
DC
AC
DTB
MTB
AUTO+AC=TVL
AUTO+DC=TVF
TO EMITTER OF V1409 (EXT. X-DEFL. SIGNAL)
XDEFL
MECHANICALLY INTERACTING
COMP.
BOTH FRONT AND REAR SECTIONS OF THE TIME/DIV. SWITCHES ARE SEEN FROM THE FRONT SIDE.
ALL PUSHBUTTONS ARE DRAWN IN THE RELEASED POSITIONS.
MTB. ALT TB
Z-Ext.
MAIN TIME-BASE UN-BLANKING SIGNAL TO DIODE V1502 OF THE Z-AMPLIFIER
GATE OUT MTB
STOP
START
DELAY TIME
INTERNAL INPUT FOR COMPOSITE TRIGG. (FROM COLL. V802)
INTERNAL TRIGG. INPUT CHANNEL A (FROM COLL. V511)
INTERNAL TRIGG. INPUT CHANNEL B (FROM COLL. V611)
EXTERNAL TRIGGER INPUT
150 mV/div.
DELAYED TIME-BASE UNBLANKING SIGNAL TO DIODE V1503 OF THE Z-AMPLIFIER
GATE OUT D.T.B.

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS
(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① *Country*	② *Day Month Year*	③ *Typenumber /Version*	④ *Factory/Serial no.*
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version 0 P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric,the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve,transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐ 1 2 = 1,2 working hours (1 h 12 min.)

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