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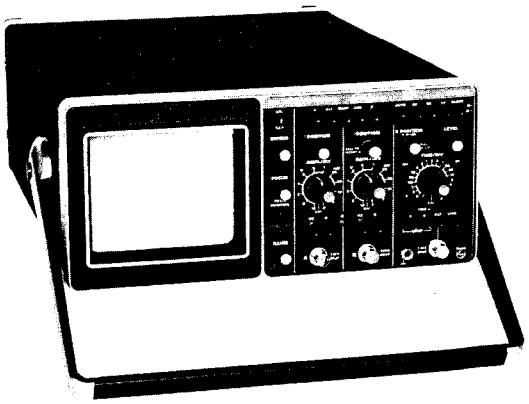

Instruction manual
Gerätehandbuch
Notice d'emploi et d'entretien

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

PM 3212

(9444 032 12 . . 1)

9499 440 15802

760915/1/01/02

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1. General information

1.1 INTRODUCTION

The 25MHz dual-channel oscilloscope PM 3212 is a compact, lightweight instrument, featuring ergonomic design and extensive measurement capabilities.

A large 8 x 10 cm screen, with internal graticule lines, a high intensity trace together with features such as TV triggering, switchable trigger modes and adding modes for the vertical channel, make this instrument suitable for a very wide range of use.

A double-insulated power supply allows the frame ground to be directly connected to floating ground circuits provided this ground does not carry live potentials.

Interference by ground currents, as is frequently experienced with grounded oscilloscopes, is also substantially reduced.

Use of the oscilloscope in the field is further facilitated by optional battery operation.

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

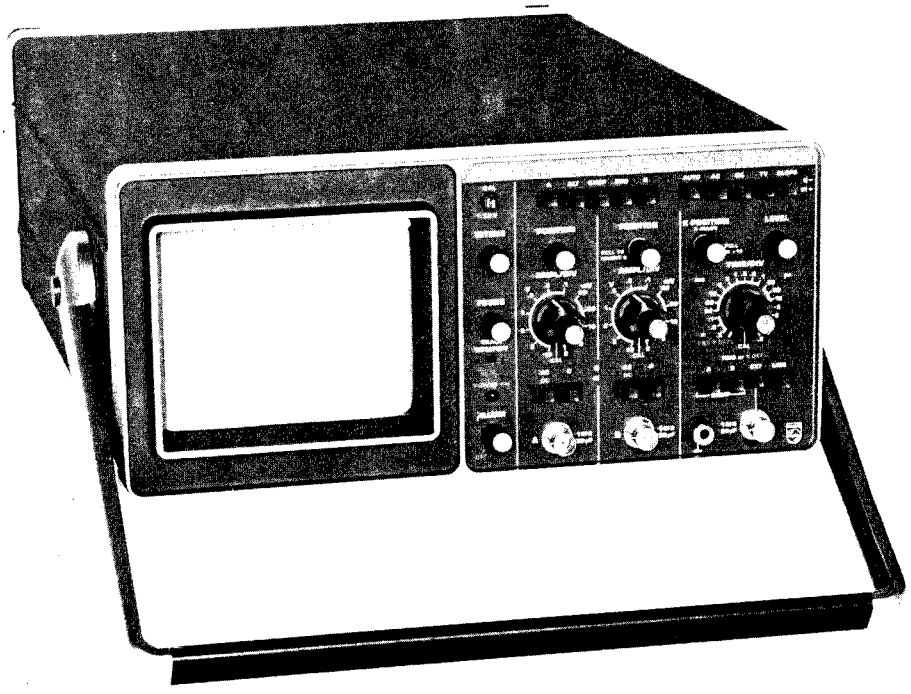


Fig. 1.1. 25 MHz dual-channel oscilloscope PM 3212

1.2 TECHNICAL DATA

Properties expressed in numerical values with stated tolerances are guaranteed for ambient temperatures of +5 °C .... + 40 °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 GH108	
Measuring area	8x10 divisions	1 div. equals 1 cm
Screen type	P31 (GH)	P7 (GM) optional
Total accelaration voltage	10 kV	
Graticule	Internal	Cont. variable illumination
1.2.2 Vertical amplifier		
Display modes	Channel A only Channel B only A and B chopped A and B alternated 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) I	Measured at 8 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	⩾ 40 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 Time base		
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%	

	Designation	*Specification*	*Additional Information*
1.2.4	**Triggering**		
	Source	Ch. A, Ch. B, Composite, External and Line (mains)	
	Trigger mode	Automatic, normal AC normal DC and TV	TV line or frame switched by TIME/DIV switch TV line: .2 µs/div .... 20 µs/div TV frame: 50 µs/div .... .5 s/div
	Trigger sensitivity	Internal: 1,0 div. at 25 MHz External: 0,5 Vpp at 25 MHz TV int.: 0,7 div. TV ext.: 0,35 Vpp	 Sync pulse amplitude Sync pulse amplitude
	Triggering frequency range	AUTO: 20 Hz..... ⩾ 25 MHz AC: 5 Hz..... ⩾ 25 MHz DC: 0 Hz..... ⩾ 25 MHz	Typically, stable triggering can still be obtained at 50 MHz and 2 div. or 1 Vpp amplitude
	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 screen
	Triggering slope	Positive or negative going	
	Input impedance	1 MΩ//20 pF	
	Maximum permissible input voltage	400 V, d.c. + a.c. peak	
1.2.5	**X Deflection**		
	Source	A, B, EXT. or LINE (MAINS)	As selected by trigger source switch, if TIME/DIV switch is in pos. X DEFL.
	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) AC: 5 Hz ..... 1 MHz (-3 dB)	
	Phase shift	⩽ 3° at 100 kHz	
	Dynamic range	24 divisions	For frequencies ⩽ 100 kHz
1.2.6	**Calibration generator**		
	Output voltage	1,2 Vpp	Square wave
	Accuracy	± 1%	
	Frequency	≈ 2 kHz	
1.2.7	**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	28 W max.	At nominal mains voltage
	DC supply:		
	Voltage range	21-27 V dc	Floating input
	Current consumption	**1,1 A max.**	

1.2.8 Environmental conditions

The environmental data are valid only if the instrument is checked in accordance with the official 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 HOLLAND.

Designation	*Specification*	*Additional Information*
Ambient temperature:		
Rated range of use	+ 5 °C ..... + 40 °C	
Limit range of operation	– 19 °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	
Altitude:		
Operating	5000 m (475 mbar)	
Not operating	15000 m (100 mbar)	
Recovery time	30 minutes if instrument temperature is raised from – 10 °C to + 20 °C at 60 % relative humidity	

1.2.9 Mechanical data

Dimensions:		
Length	410 mm	Handle and controls excluded
Width	297 mm	Handle excluded
Height	137 mm	Feet excluded
Weight	7,5 kg	

1.3 ACCESSORIES

1.3.1 Supplied with the instrument

Front cover
2 BNC-4 mm adaptors

1.3.2 Optional

Passive probe 1:1	PM 9335 (L)
Passive probe 10:1	PM 9336 (L), PM 9350 (L), or PM 9351 (L)
Passive probe 100:1	PM 9358
Miniature Fet probe	PM 9352
Fet probe	PM 9353
Current probe	PM 9355
Probe power supply	PM 9346
Oscilloscope trolley	PM 8991
Polaroid filter	PM 8910
Viewing hood	PM 9366
Long viewing hood	PM 8980
Oscilloscope camera	PM 9380
Adaptor for PM 9380	PM 8971
19-in rackmount	PM 8962
Accessory pouch	PM 8992-01
Battery pack	PM 8901

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 occured in transit. If any defects are apparent, do not connect 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 harzards 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), make sure 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 3.2)

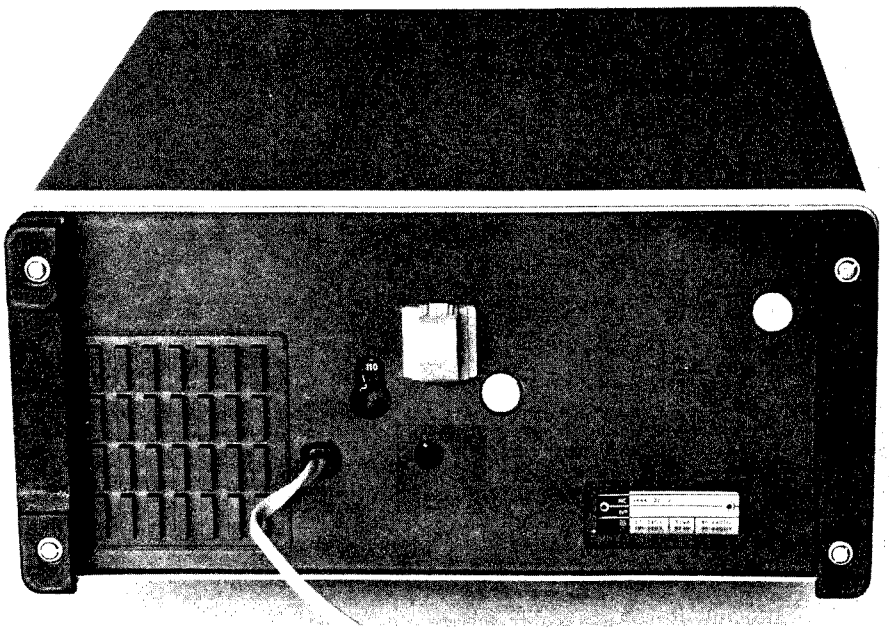


Fig. 2.1. Rear view of the oscilloscope showing the voltage adapter set to 110 V.

2.1.3 Connection to an external supply

An external supply or battery of 21 V to 27 V capable of delivering at least 1 A can be connected to the socket on the rear panel.

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 wrong polarity by an internal fuse and diode.

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. Pilot lamp indicates the ON state.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Allows beam to be focussed for minimum spot size
TRACE ROTATION	Screwdrive adjustment to align the trace with the horizontal graticule lines.

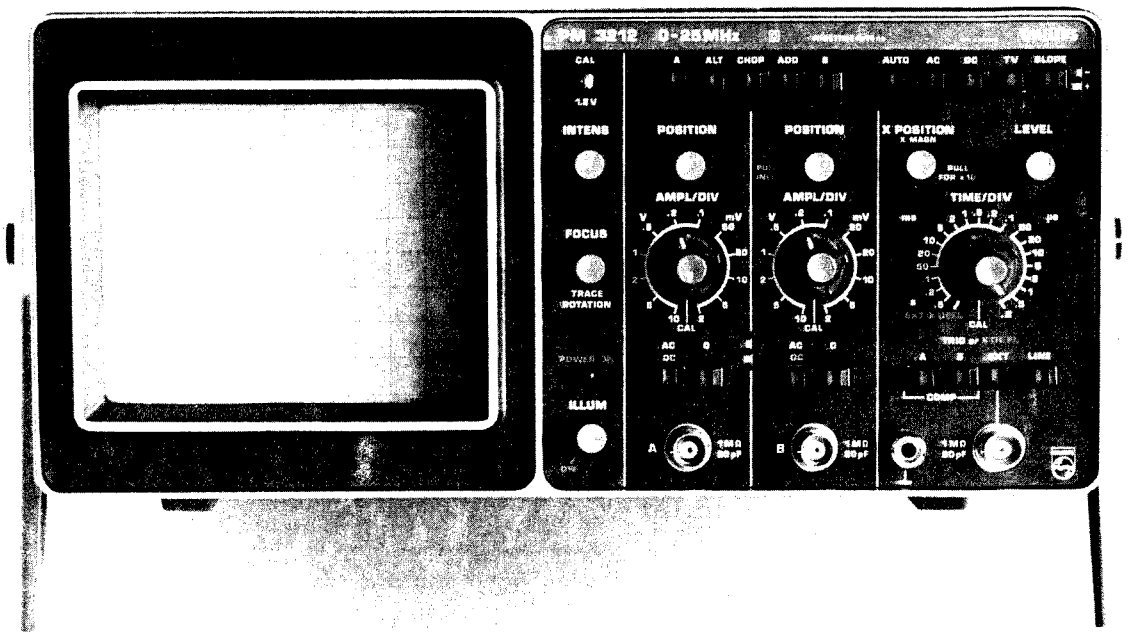


Fig. 2.2. Front view of the oscilloscope showing controls and sockets

2.2.2 Vertical channels

Display mode switch	*Function*
	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 time-base signal.
CHOP	The display is switched over from one vertical channel to the other at a fixed frequency. (f ≈ 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)	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 (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	BNC socket for channel A input
B	BNC socket for channel B input

2.2.3 Triggering

Trigger mode switch	*Function*
	5-way pushbutton switch, selecting the trigger mode and the polarity of the trigger transition. 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. DC component of trigger signal is blocked.
DC	Normal triggering and fixed range of the LEVEL control. DC component of trigger signal is passed.

TV	Line or frame synchronisation is obtained as dictated by TIME/DIV switch (frame from . 5 s/div to 50 μs/div and line from 20 μs/div to . 2 μs/div).
+/–	Sweeps are triggered on positive or negative-going trigger signal transitions. In TV, – must be selected for negative video signals and + for positive video signals.
LEVEL	Control for continuously varying the level of the waveform on which the display is to start.
TRIG OR X DEFL.	See TRIG or X DEFL source switch in section 2.2.4. below.

2.2.4 Horizontal channel

TRIG or X DEFL source switch	*Function*
	4-way pushbutton switch selects the trigger source or the source of horizontal deflection if the TIME/DIV switch is the X DEFL position. With all pushbuttons released source A is selected.
A	Signal derived from channel A
B	Signal derived from channel B
COMP (A & B both depressed; inoperative with X DEFL)	Signal derived after the electronic channel switch. Triggering occurs on the waveforms as presented on screen.
EXT	External signal as applied to the adjacent 1 Mohm//20 pF socket
LINE (MAINS)	Signal derived from the line (mains) voltage. (Not operable when instrument is supplied by battery.)

X POSITION, X MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection by a factor of 10.
TIME/DIV (outer part)	Selects the time coefficient from .2 μs/div to .5s/div in a 1-2-5 sequence. Dictates line or frame triggering in TV mode. In position X DEFL horizontal deflection is determined by TRIG or X DEFL switch.
TIME/DIV (centre knob)	Continuously variable control of the time coefficients. Must be in CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.

2.2.5 Miscellaneous

CAL	Output socket supplying a squarewave of ≈ 2 kHz and an amplitude of 3 $V_{p\text{-}p}$ ± 1%. To be used for probe compensation and/or checking vertical deflection accuracy.
External supply	Input socket at the rear of the instrument allows the instrument to be operated by an external d.c. supply. Rated supply voltage 21 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 waming-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 1.2.8.)

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 10ms/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 square-waves 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 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 .1ms/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.

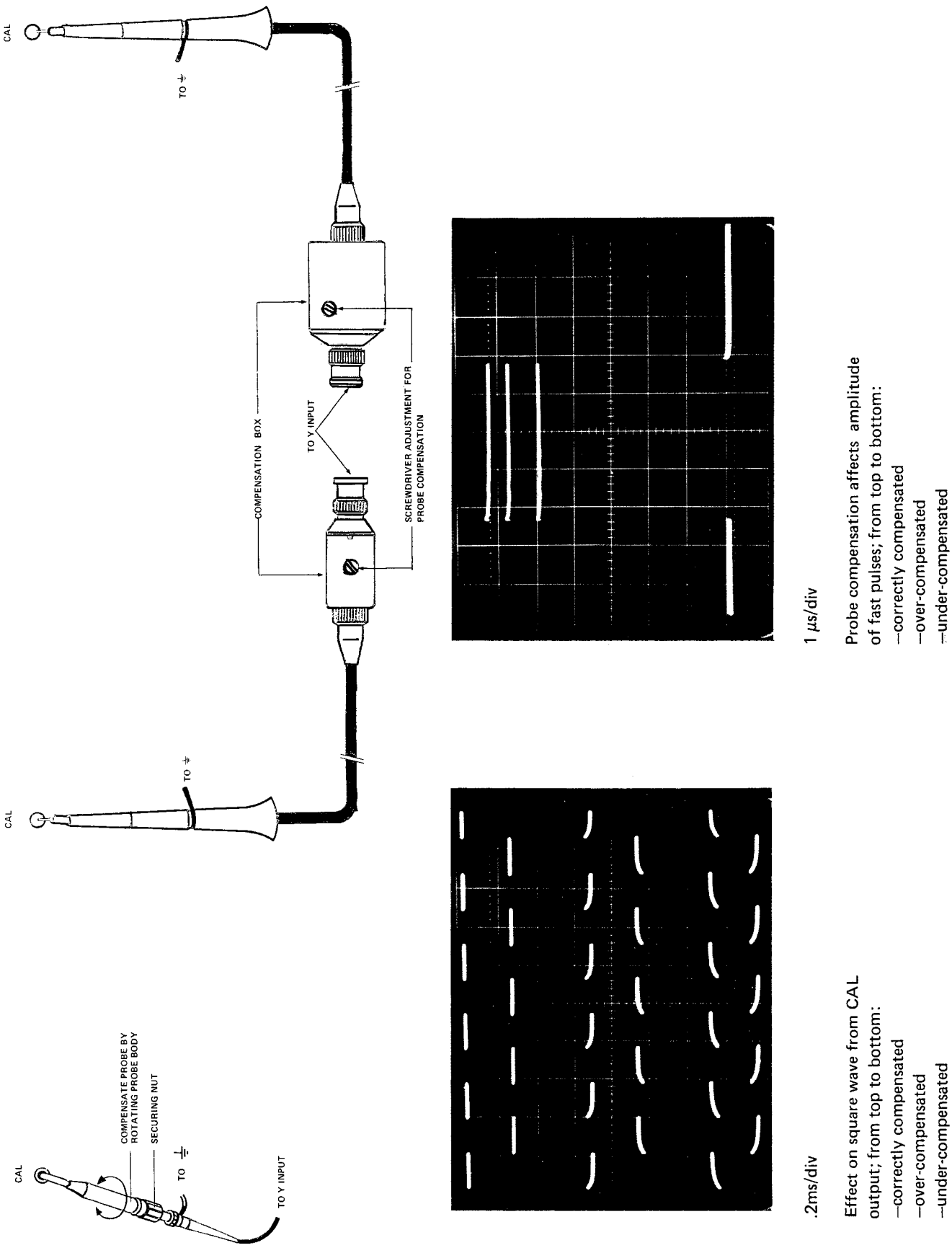


Fig. 2.3. How to compensate passive 10:1 probes and the effect on waveforms

2.3.6 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.

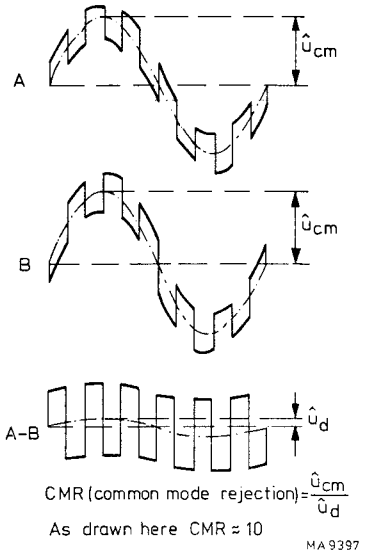


Fig. 2.4. Suppression of common mode signals

2.3.7 Selection of trigger mode

(AUTO AC DC TV +/–)

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 approprìately.

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.

2.3.8 Trigger sources

The trigger source is selected by the front-panel TRIG or X DEFL pushbuttons.

A B EXT LINE

COMP

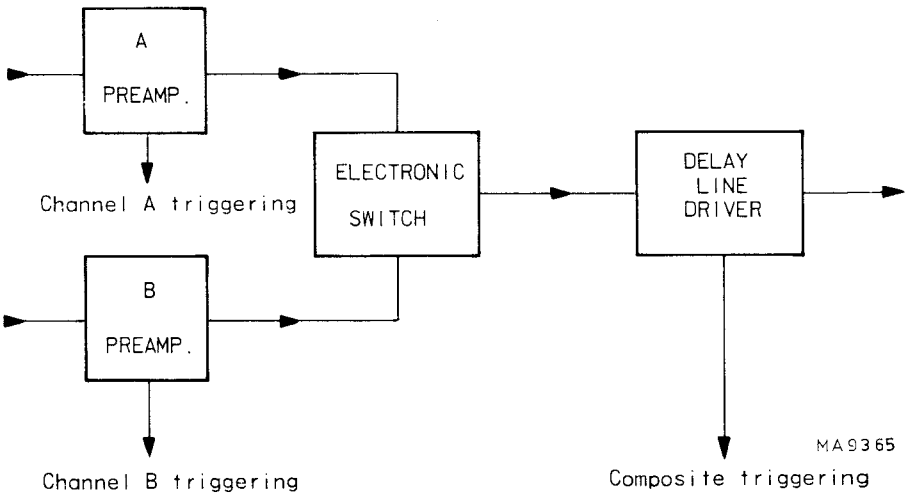
- **Internal triggering** will be most commonly used because it requires only one signal (the input signal) to obtain stable triggering.
- **External triggering.** When tracing many signals it is advantageous to use an external signal for triggering. There is no need to set and reset the trigger controls (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

2.3.9 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^{o} 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
LINE	8 divisions

1. Allgemeines

1.1. EINLEITUNG

Der 25 MHz Zweikanal-Oszillograf ist ein leichtes Kompaktgerät. Er ist ergonomisch kontruiert und besitzt vielseitige Messmöglichkeiten.
Ein grosser 8 x 10 cm Bildschirm mit Innenraster, eine sehr helle Schreibspur sowie solche Möglichkeiten, wie TV-Triggerung, umschaltbare Triggerungsarten und Addier-Betriebsarten für den vertikalen Kanal machen das Gerät für einen breiten Anwendungsbereich besonders geeignet.
Eine 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.

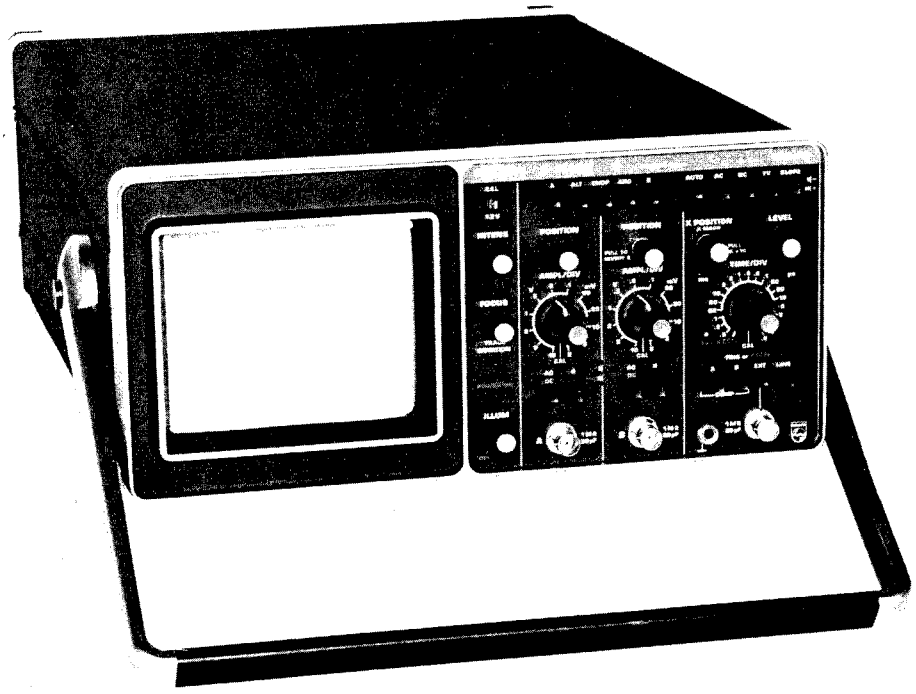


Fig. 1.1. 25 MHz Zweikanal-Oszillograf

1.2. TECHNISCHE DATEN

Zahlenwerte mit Toleranzangaben werden bei Umgebungstemperaturen von +5 °C ..... +4 °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 - 125 GH/08	
Nutzbare Bildschirmfläche	8 x 10 Teile	1 Teil entspricht 1 cm
Bildschirmtyp	P31 (GH)	P7 (GM) wahlweise
Gesamtbeschleunigungsspannung	10 kV	
Raster	Innenraster	Stufenlos einstellbare Rasterbeleuchtung
1.2.2. Vertikalverstärker		
Darstellungsarten	Kanal A allein	
	Kanal B allein	
	A und B gechopped	
	A und B alternierend	
	A und B addiert	
Kanal B Polarität	Normal oder invertiert	
Kennlinie; Frequenzbereich	DC : 0...25MHz (– 3 dB)	
	AC : 2 Hz... 25 MHz (– 3 dB)	
Anstiegszeit	⩽ 14 ns	
Impulsverformungen	⩽ ± 3% (⩽ 4% Spitze-Spitze)	Gemessen bei 8 Div. Amplituden mit einer Anstiegszeit von ⩾ 1 ns
Ablenkkoeffizienten	2 mV/div...10V/div	1 - 2 - 5 Folge
Stufenloser Einstellbereich	1 : ⩾ 2.5	
Ablenk-Fehlergrenze	± 3%	
Eingangsimpedanz	1 MΩ//20pF	
Zeitkonstante der Eingangsschaltung	0.1 s	Kopplungsschalter auf AC
Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Spitzenwert einer Wechselspannung
Chopperfrequenz	≈ 500 kHz	
Vertikale Strahlverschiebung	16 Teile	
Dynamischer Bereich	24 Teile	
Sichtbare Signalverzögerung	⩾ 40 ns	
Gleichtaktunterdrückung 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	
Instabilität des Leuchtflecks:		
Temperaturdrift	⩽ 0,3 Teil/Stunde	

	Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.3.	**Zeitablenkung**		
	Zeitkoeffizienten	0.5 s/div...0.2 µs/div	1 - 2 - 5 Folge
	Kontinuierlicher Einstellbereich	1: ⩾2.5	
	Fehlergrenze des Koefficienten	± 3%	
	Dehnung	x 10	
	Fehlergrenze der Dehnung	± 2%	
1.2.4.	**Triggerung**		
	Quelle	Kanal A, Kanal B, zusammengesetzt, extern und Netz	
	Triggerungsart	Automatisch, normal Wechselspannung, normal Gleichspannung und TV	TV-Zeile oder Bild geschaltet mit Schalter TIME/DIV TV-Zeile : .2 µs/Teil ... 20 µs/Teil TV-Bild : 50 µs/Teil ... .5 s/Teil
	Trigger-Empfindlichkeit	Intern: 1.0 Teil bei 25 MHz Extern: 0.5 V Spltze-Spitze bei 25 MHz TV int.: 0.7 div TV ext.:0,5 V Spitze-Spitze	 Sync. Impuls Amplitude Sync. Impuls Amplitude
	Triggerfrequenzbereich	AUTO: 20 Hz...⩾ 25 MHz AC: 5 Hz...⩾ 25 MHz DC: 0 Hz...⩾ 25 MHz	Durchschnittlich ist stabile Triggerung noch erreichbar bei 50 MHz und 2 div., oder 1 V_{ss} Amplitude
	Pegelbereich	AUTO: Proportional dem Spitze-Spitze Wert des Triggersignals	
		AC, DC: 16 Teile bei interner Triggerung und 8 V bei externer Triggerung	+ oder – 8 Teile und + oder –4 V bezogen auf Bildschirmmitte
	Triggerflanke	Positif oder negatif gehend	
	Eingangsimpedanz	1 MΩ//20 pF	
	Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Wechselspannungs-Spitzenwert
1.2.5.	**X-Ablenkung**		
	Quelle	A,B,EXT oder LINE (Netz)	Je nach Einstellung des Triggerquelle-Schalters, wenn Schalter TIME/DIV in Stand X DEFL
	Ablenkkoeffizienten	A oder B, wie eingestellt mit AMPL/DIV EXTERNAL : 0.5 V/div. LINE : 8 div.	
	Ablenk-Fehlergrenze	± 10% in A oder B	
	Frequenzbereich	Gleichspannungskopplung 0 ... 1 MHz (–3 dB) Wechselspannungskopplung 5 Hz ... 1 MHz (–3 dB)	

Bezeichnung	*Beschreibung*	*Nähere Angaben*
Phasenverschiebung	$\leqslant 3^{o}$ bei 100 kHz	
Dynamischer Bereich	24 Teile	Für Frequenzen $\leqslant$ 100 kHz

1.2.6. Kalibriergenerator

Ausgangsspannung	1,2 V Spitze-Spitze	Rechteckspannung
Fehlergrenze	± 1%	
Frequenz	≈ 2 kHz	

1.2.7. Stromversorgung

Wechselspannung-versorgung:	Doppelt isoliert	Schutzklasse II, IEC 348
Nominaler Spannungs-bereich (am Netzspan-nungsumschalter)	110, 127, 220 oder 240 V Wechselspannung ± 10%	
Nominaler Frequenz-bereich	50 ... 400 Hz ± 10 %	
Leistungsaufnahme	28 W max.	Bei Netz-Nennspannung
Gleichspannungs-versorgung:		
Spannungsbereich	21 - 27 V Gleichspannung	Erdfreier Eingang
Stromaufnahme	1,1 A max.	

1.2.8. Umgebungseigenschaften

Die Umgebungsdaten gelten nur, wenn das Gerät gemäss dem offiziellen Prüfverfahren kontrolliert wird. Einzelheiten betreffend diese Verfahren sowie Funktionsstörrungs-Kriterien sind auf Anfrage bei der Philips-Organisation Ihres Landes oder bei N.V. PHILIPS' GLOEILAMPENFABRIEKEN, ABTEILUNG TEST- UND MESSGERÄTE, EINDHOVEN, HOLLAND erhältlich.

Umgebungstemperatur:	
Nominaler Betriebsbereich	+ 5°C ... + 40°C
Zugelassener Betriebs-temperaturbereich	−10°C ... +55°C
Lagerung und Transport	−40°C ... +70°C
Feuchtigkeit	Entspricht den IEC 68 Db Bediengungen
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, 10-150Hz; 0.7 mm Spitze-Spitze und 5 g.
Höhe:	
Betriebsfähig	5000 m (475 mbar)
Nicht betriebsfähig	15 000 m (100 mbar)
Erholungszeit	30 Minuten wenn die Temperatur des Gerätes von -10°C auf + 20°C erhöht wird, bei 60% relativer Luftfeuchtigkeit

Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.9. Mechanische Daten		
Abmessungen:		
Länge:	410 mm	Ohne Handgriff und Bedienungselemente
Breite	297 mm	Ohne Handgriff
Höhe	137 mm	Ohne Füsse
Gewicht	7,5 kg	

1.3. ZUBEHÖR

1.3.1. Mitgeliefert

Abdeckhaube
Zwei 4 mm BNC Adapters

1.3.2. Wahlzubehör

Passiver 1 : 1 Messkopf	PM 9335 (L)
Passiver 10 : 1 Messkopf	PM 9336 (L), PM 9350 (L), PM 9351 (L)
Passiver 100 : 1 Messkopf	PM 9358
Miniatur FET-Messkopf	PM 9352
FET-Messkopf	PM 9353
Strom-Messkopf	PM 9355
Messkopfspeisung	PM 9346
Oszillograf-Rolltisch	PM 8991
Polaroidfilter	PM 8910
Lichtschutztubus	PM 9366
Langer Lichtschutztubus	PM 8980
Oszillografenkamera	PM 9380
Adapter für PM 9380	PM 8971
19 " Gestelleinbau	PM 8962
Zubehörtasche	PM 8992-01
Batteriespeisung	PM 8901

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, so 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 geignete 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 3.2.).

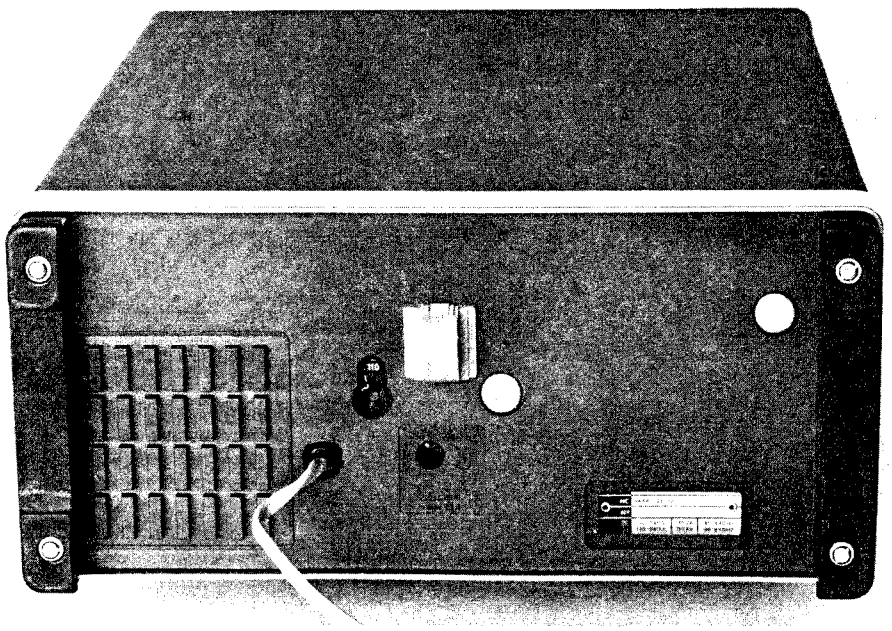


Fig. 2.1. Rückansicht des Oszillografen mit Spannungsumschalter in 110 V Stellung

2.1.3. Anschluss an eine externe Stromversorgung

Eine externe Stromversorgung oder eine 21 V bis 27 V Batterie die zumindest 1 A liefern kann lässt sich an die Buchse an der Geräterückwand anschliessen.
Der Innenleiter muss an den Minuspol und der Aussenleiter an den Pluspol angeschlossen werden, wie an der Rückwand angegeben. Gegen Überlastungen und Polaritätswechsel is das Gerät durch eine interne Sicherung und Diode geschützt.

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 POWER ON	Stufenlose Einstellung der Rasterbeleuchtung; zugleich Netzschalter. 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.

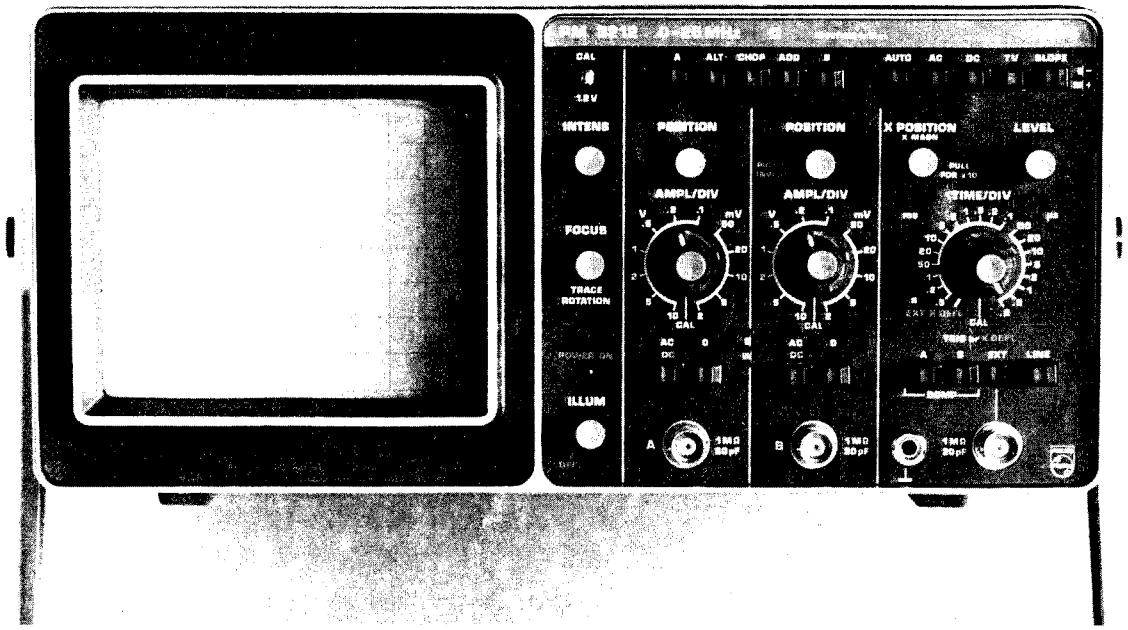


Fig. 2.2. Vorderansicht des Oszillografen mit Bedienungsorganen und Buchsen.

2.2.2. Vertikale Kanäle

Darstellungsart-Schalter	*Funktion*
	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 (eingedrückt)	Verbindung zwischen Eingangsschaltung und Eingangsbuchse unterbrochen und Eingangsschaltung geerdet.
A	BNC-Buchse für Kanal A Eingang
B	BNC-Buchse für Kanal B Eingang

2.2.3. Triggerung

Triggerungsart-Schalter	*Funktion*
	Fünffache Drucktaste zum Einstellen der Triggerungsart und der Polarität der Triggerflanke. Wenn keine der Drucktasten betätigt ist, dann ist Betriebsart AUTO gewählt, und der LEVEL Bereich auf einen festen Wert eingestellt.
AUTO	Ein Bild ist sichtbar auch wenn keine Triggersignale vorhanden sind. Der Bereich der LEVEL-Einstellung ist proportional dem Spitze-Spitze Wert des Triggersignals.
AC	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals ist gesperrt.
DC	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals wird durchgelassen.
TV	Zeilen oder Bild Synchronisation je nach Stellung des TIME/DIV Schalters (Bild von .5s/div bis 50 µs/div und Zeile von 20 µs/div bis .2 µs/div).

+/–	Triggerung auf der positiv oder negativ gerichteten Flanke des Signals. In TV muss '–' für negative Videosignale eingestellt werden und '+' für positive Videosignale.
LEVEL	Stufenlose Einstellung des Signalformpegels bei welchem das Oszillogram startet.
TRIG OR X DEFL	(siehe TRIG OR X DEFL -Quelle Schalter im nachstehenden Abschnitt 2.2.4).

2.2.4. Horizontaler Kanal

TRIG OR X DEFL-Quelle Schalter	*Funktion*
	4-fache Drucktaste zur Wahl der Triggerquelle oder der Horizontalablenkungsquelle wenn der Schalter TIME/DIV in Stellung X DEFL steht. Wenn keine der Drucktasten eingedrückt ist wird Quelle A gewählt.
A	Signal, Kanal A entnommen
B	Signal, Kanal B entnommen
COMP (sowohl A wie B eingedrückt; nicht wirksam mit X DEFL)	Signal ist jenem Kanal entnommen, der mit dem elektronischen Schalter durchverbunden ist.
EXT	Externes Signal wie an die angrenzende 1 Mohm//20 pF-Buchse gelegt.
LINE	Signal von der Netzspannung (Nicht wirksam wenn das Gerät batteriebetrieben ist).
X POSITION X MAGN	Stufenlose Einstellung der vertikalen Lage des Bildes, einbezogen ein Zug-Druckschalter für 10-fache Dehnung der Horizontalablenkung.
TIME/DIV (äusserer Teil)	Einstellung des Zeitkoeffizienten von .2 µs/div bis .5 s/div in 1 – 2 – 5 Folge. Bestimmt Zeilen-oder Bildtriggerung in TV-Betriebsart. In Stellung X DEFL wird die Horizontalablenkung vom Schalter TRIG OR X DEFL bestimmt.
TIME/DIV (mittlerer Knopf)	Stufenlose Einstellung des Zeitkoeffizienten. Muss in Stellung CAL stehen (d.h. ganz nach rechts) damit die Zeitachse gemäss der Anzeige des Schalters TIME/DIV kalibriert ist.

2.2.5. Übrige

CAL	Ausgangsbuchse an der eine Rechteckspannung von ≈ 2 kHz und eine Amplitude von 3 $V_{S\text{-}S}$ ±1% zur Verfügung steht. Für Messkopfkompensation und/oder Prüfung der Vertikalablenk-genauigkeit.
External Supply	Eingangsbuchse an der Rückseite des Geräts gestattet Betrieb mit einer externen Gleichspannung.
Netzspannungs-Umschalter	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 1.2.8.).

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.

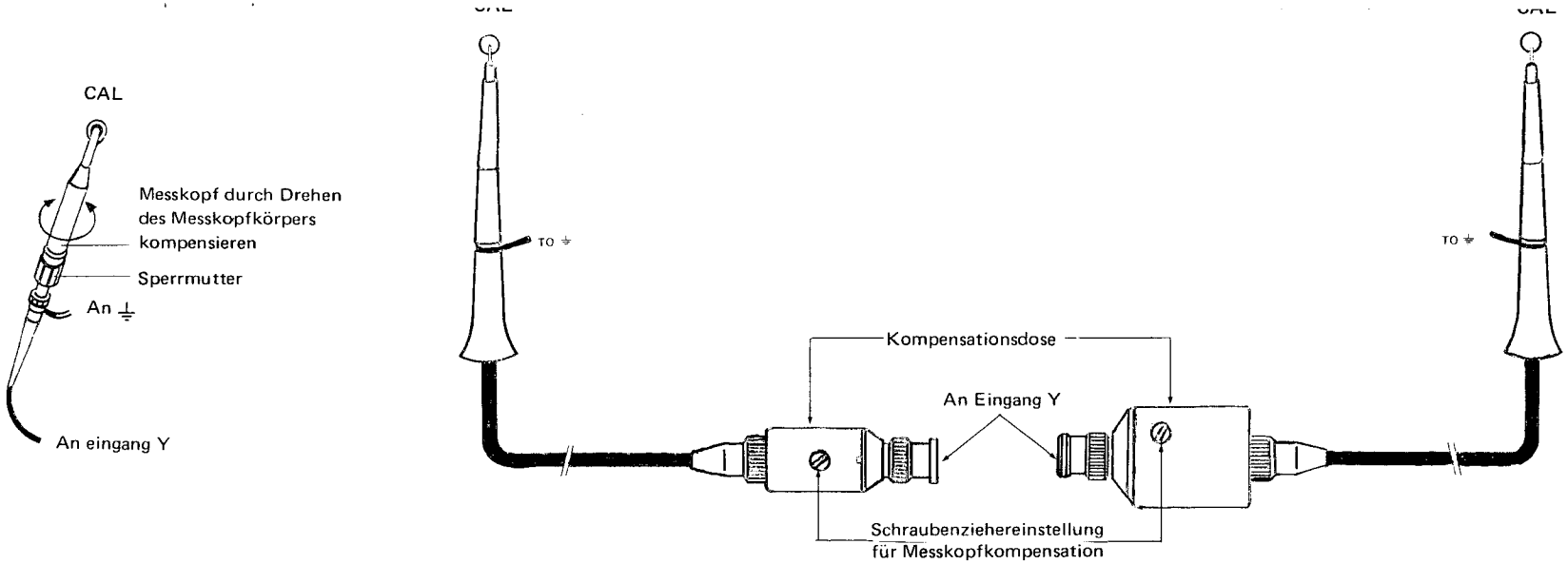
2.3.4. Anwendung von Messköpfen

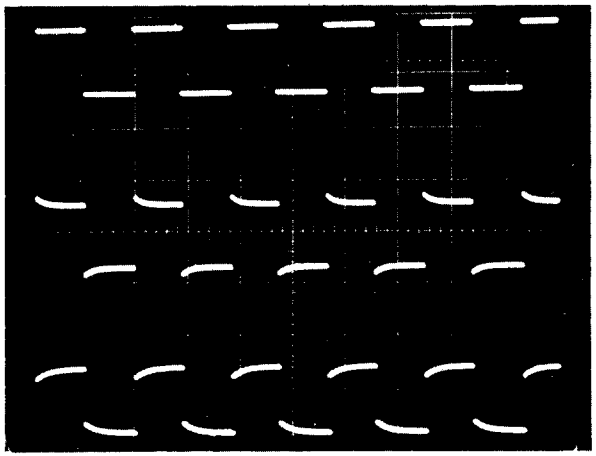
1 : 1 passive Messköpfe sollten nur für Gleichspannung und Niederfrequenzen eingesetzt werden.
Kapazitive Belastung schwächt hohe Frequenzen ab oder erhöht die Anstiegszeit von Messignalen (abhängig von Quellimpedanz).
10 : 1 passive Messköpfe besitzen eine kleinere kapazitive Belastung; gewöhnlich etwa 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 gechoppten (CHOP) oder der alternierenden (ALT) Darstellungsart

Im Zweikanalbetrieb (CHOP oder ALT eingedrückt) muss für relative lange Ablenkzeiten (von .1 ms/div bis .5s/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.

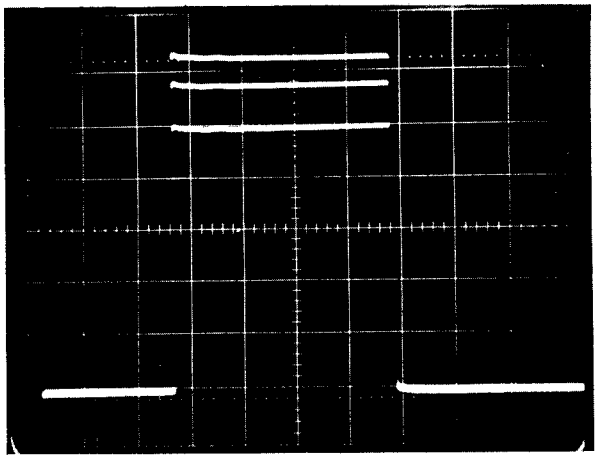
Fig. 2.3. Die Kompensation von passiven 10:1 Messköpfen und der Einfluss auf Signalformen





.2ms/div

Einfluss auf Rechtecksignal von Ausgang CAL; von oben nach unten:
—richtig kompensiert
—überkompensiert
—unterkompensiert



1 μs/div

Messkopfkompensation beeinflusst die Amplitude schneller Impulse; von oben nach unten:
—richtig kompensiert
—überkompensiert
—unterkompensiert

2.3.6 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.

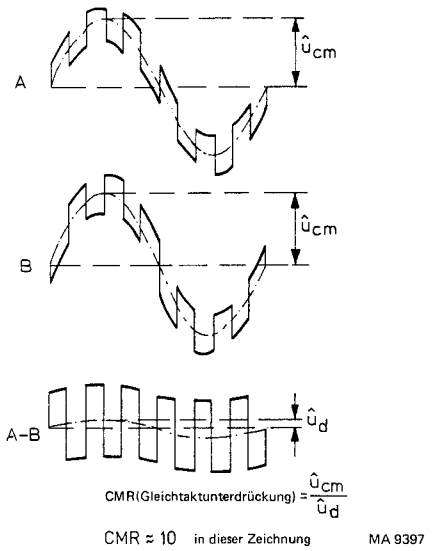


Fig. 2.4. Gleichtaktunterdrückung

2.3.7. Einstellen der Triggerart

(AUTO AC DC TV +/–)
Betriebsart AUTO ist 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 gedrücktem AC oder DC ist der Bereich des Einstellers LEVEL festgesetzt (+ oder – 8 Teile (div.) oder mehr in den äussersten Stellungen von LEVEL,bezogen auf die Bildschirmmitte).
Die Gleichspannungskomponente des Triggersignals 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 Änderungen 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.

2.3.8. Triggerquelle

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

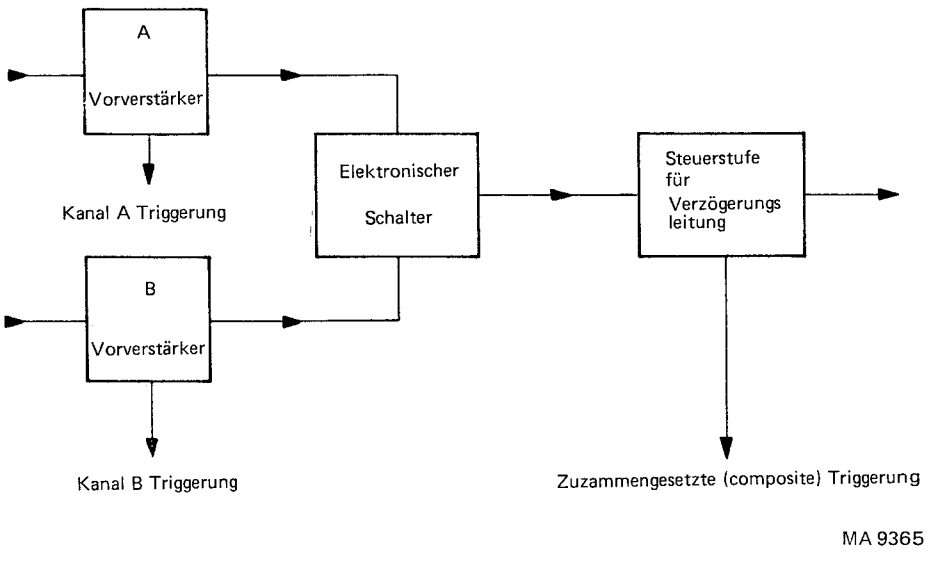


Fig. 2.5. Blockschaltbild der zusammengesetzte (composite) Triggerschaltung

3.3.9. 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^{o} 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
LINE	8 Teile (divisions)

1. Généralités

1.1. INTRODUCTION

L'oscilloscope 25 MHz à double trace PM 3212 est un instrument compact et léger, de conception ergonomique et à possibilités de mesure étendues.
Un écran de 8 x 10 cm, à graticule interne, une trace de forte intensité et des caractéristiques telles que le déclenchement TV, des modes de déclenchement commutables et des modes d'addition pour la voie verticale, rendent cet instrument approprié à une large gamme d'applications.
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.

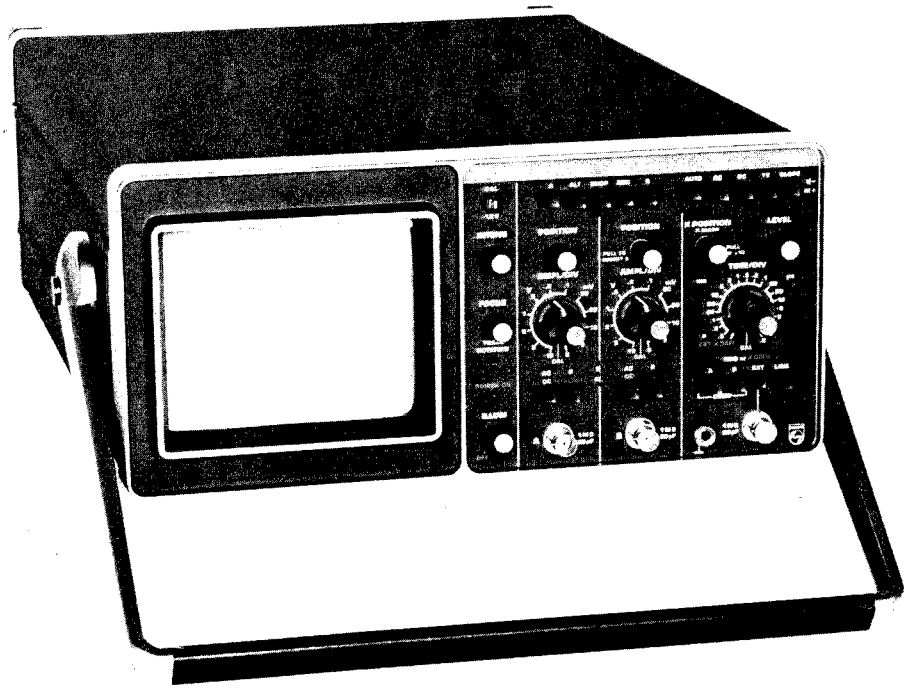


Fig. 1.1. Oscilloscope 25 MHz à double trace PM 3212

1.2. CARACTERISTIQUES

Sauf indications contraires, les propriétés 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 - 125 GH/08	
Surface utile de l'écran	8 x 10 divisions	1 division égale 1 cm
Type d'écran	P31 (GH)	P7 (GM) en option
Tension totale d'accélération	10 k V	
Graticule	Interne	Réglage continu de l'éclairement

1.2.2. AMPLIFICATEUR VERTICAL

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	
Réponse:		
Bande passante	DC: 0 Hz ...⩾ 25 MHz (-3 dB) AC: 2HZ ...⩾ 25MHz (- 3 dB)	
Temps de montée	⩽ 14 ns	
Précision de mesure	⩽ ± 3% (⩽ 4% c.c.)	Mesurée pour une amplitude de 8 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 MΩ//20 pF	
Temps d'entrée RC	0,1 s	couplage capacitif
Tension maximale admissible d'entrée	400 V	tension continue + tension alternative crête
Fréquence de commutation	≈ 500 kHz	
Décradage vertical	16 divisions	
Gamme dynamique	24 divisions	
Retard de signal visible	⩾ 40 ns	
Facteur de réjection en mode commun	⩾ 40 dB à 1 MHz	après réglage en continu ou sur basses fréquences
Diaphonie entre voies	-40 dB ou mieux à 10 MHz	

Désignation	*Spécification*	*Renseignements supplémentaires*
Instabilité de la position du spot :		
Dérive de température	⩽ 0,3 div/ heure	

1.2.3. BASE DE TEMPS

Vitesses de belayage	0,5 s/ div ... 0,2 µs / div	progression 1 - 2 - 5
Gamme de réglage continue	1: ⩾ 2,5	
Précision	± 3%	
Agrandissement	10 x	
Erreur d'agrandissement	± 2%	

1.2.4. Déclenchement

Source	Voie A, voie B, mixte, externe et fréquence secteur	
Mode de déclenchement	Automatique, normal alternatif, normal continu et TV	TV ligne ou trame choisi à l'aide du commutateur TIME / DIV TV trame: 50 µs/div - .5s/div TV ligne : 0.2 µs/div - 20 µs/div
Sensibilité de déclenchement	Interne: 1,0 div à 25 MHz Externe: 0,5 Vcc à MHz TV int.: 0,7 div TV ext. : 0,35 Vcc	 Amplitude de l'impulsion de synchronisation
Gamme de fréquence de déclenchement	AUTO: 20 Hz ... ⩾ 25 MHz AC: 5 Hz ...⩾ 25 MHz DC: 0 Hz ...⩾ 25 MHz	Un déclenchement stable peut être obtenu à 50 MHz et à une amplitude de 2 div ou 1 Vcc (caractéristique moyen)
Gamme de niveau	AUTO: proportionelle à la valeur crête à crête du signal de déclenchement DC, AC: 16 div en déclenchement interne et 8 V en déclenchement externe	 + ou - 8 div et + ou - 4 V par rapport au centre de l'écran
Pente	+ ou –	
Impédance d'entrée	1 MΩ // 20 pF	
Tension maximale d'entrée	400 V	tension continue + tension alternative crête

1.2.5. Déviation X

Source	A,B, EXT. ou LINE	en fonction de la position du commutateur de source de déclenchement , si le commutateur TIME / DIV est en position X. DEFL.

Désignation	*Spécification*	*Renseignements supplémentaire*
Coefficients de déviation	A , ou B: suivant la position de AMPL / DIV EXTERNAL: 0,5 V / div LINE: 8 divisions	
Précision	± 10 % en A ou B	
Gamme de fréquence	Coupage direct: 0 ... 1 MHz (-3 dB) Couplage capacitif: 5 Hz ... 1MHz (-3 dB)	
Déphasage	$\leqslant 3^{o}$ à 100 kHz	
Gamme dynamique	24 divisions	Pour fréquences $\leqslant$ 100 kHz

1.2.6. Générateur d'étalonnage

Tension de sortie	1,2 V cc	Onde carrée
Précision	± 1%	
Fréquence	≈ 2 kHz	

1.2.7. Alimentation

Alimentation alternative:	à double isolement	Classe de sécurité II, IEC 348
Tensions nominales (sur le carrousel)	110, 127, 220 ou 240 Vca ± 10%	
Gamme de fréquence nominale	50 ... 400 Hz ± 10 %	
Consommation	28 W maxi	A la tension secteur nominale
Alimentation continue:		
Gamme de tension	21-27 V cc	Entrée flottante
Consommation	1, 1 A maxi	

1.2.8. Conditions ambiantes

Les données relatives aux conditions ambiantes ne sont valables que si l'instrument est contrôlé conformément aux methodes 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, ½ sinus, d'une durée de 6 ms dans chacune des 3 directions

Désignation	*Spécification*	*Renseignements supplémentaires*
Essais de vibration	30 minutes dans chacune des 3 directions, 10-150 Hz; amplitude 0.7 $mm_{c.c.}$ et 5 g	
Altitude maximum :		
En fonctionnement	5000 m (475 m bars)	
Hors fonctionnement	15000 m (100 m bars)	
Temps de rétablissement	30 minutes si la température de l'instrument passe de -10° C à +20°C sous humidité relative de 60 %	

1.2.9. Caractéristiques mécaniques

Dimensions :		
Longueur	410 mm	Poignée et commandes non comprises
Largeur	297 mm	Poignée non comprise
Hauteur	137 mm	Pied non compris
Poids	7,5 kg	

1.3. ACCESSOIRES

1.3.1. Fournis avec l'instrument

Couvercle avant
2 adaptateurs BNC 4 mm

1.3.2. En option

Sonde passive 1:1	PM 9335 (L)
Sonde passive 10:1	PM 9336 (L), PM 9350 (L), ou PM 9351 (L)
Sonde passive 100:1	PM 9358
Sonde miniature à FET	PM 9352
Sonde à FET	PM 9353
Sonde de courant	PM 9355
Alimentation de sonde	PM 9346
Table roulante	PM 8991
Filtre Polaroïd	PM 8910
Visière	PM 9366
Visière longue	PM 8980
Caméra d'enregistrement	PM 9380
Adaptateur pour PM 9380	PM 8971
Adaptateur pour rack 19"	PM 8962
Sac à accessoires	PM 8992-01
Alimentation batteries	PM 8901

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 measure. 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 3.2.).

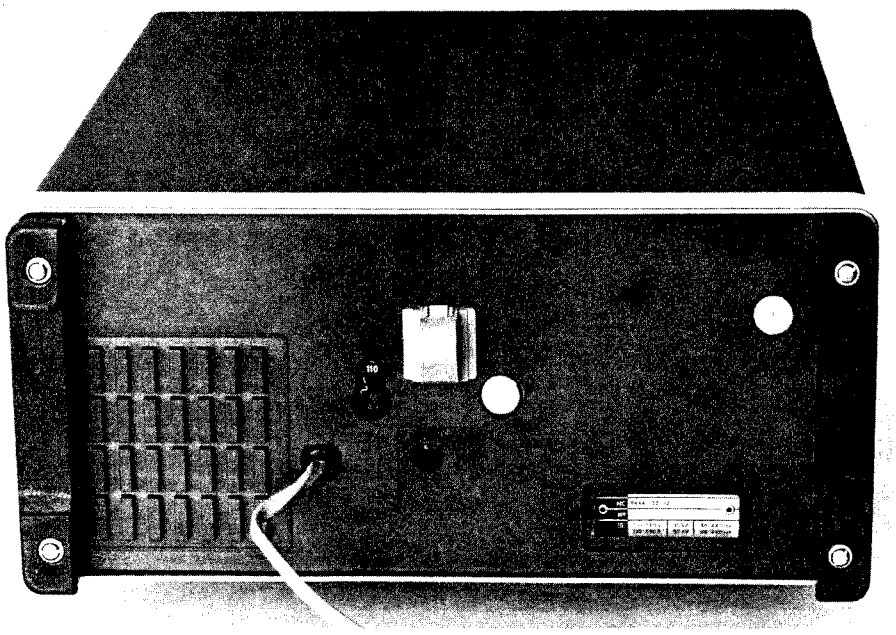


Fig. 2.1. Vue arrière de l'oscilloscope avec carrousel en position 110 V

2.1.3. Branchement sur une alimentation extérieure

On peut connecter une alimentation extérieure ou batterie de 21 à 27 V, capable de fournir au moins 1A, sur la prise du panneau arrière.
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.

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.

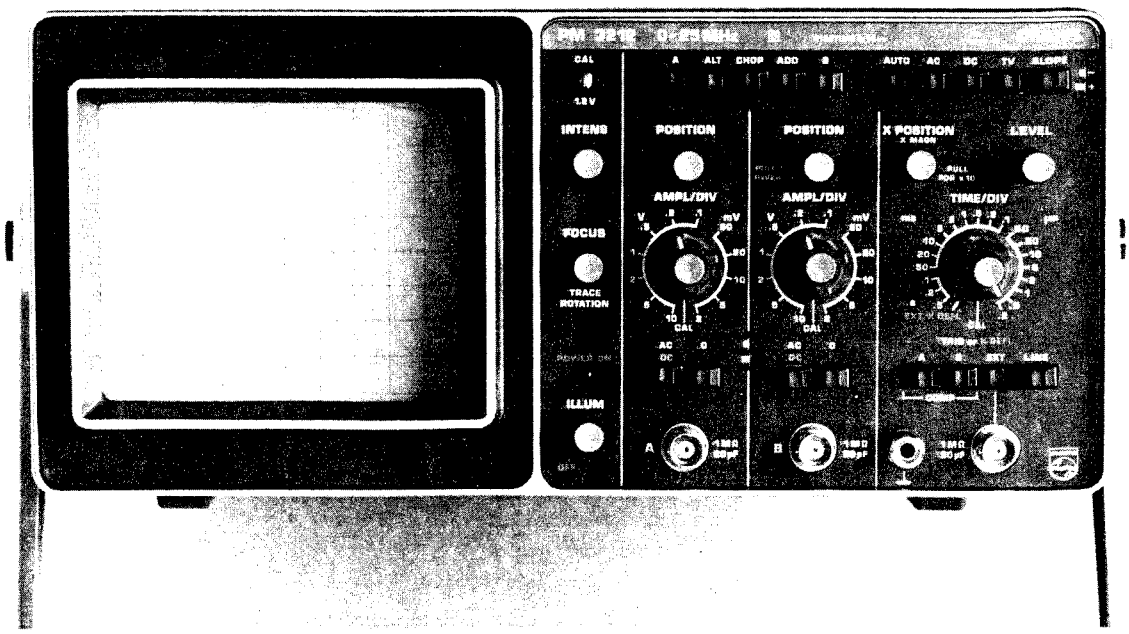


Fig. 2.2. Vue avant de l'oscilloscope montrant les commandes et douilles

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	Prise BNC pour entrée de la voie A
B	Prise BNC pour entrée de la voie B

2.2.3 Déclenchement

Commutateur de mode de déclenchement	*Fonction*
	Choix du mode de déclenchement et de la polarité de transition du déclenchement par cinq 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	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	Déclenchement normal et gamme fixe de réglage du niveau. Le composant continu du signal de déclenchement est bloqué.
DC	Déclenchement normal et gamme fixe de réglage du niveau. Le composant continu du signal de déclenchement est transmis.
TV	Il y a synchronisation ligne ou trame suivant la position du commutateur TIME / DIV (trame de .5s /div à 50µs/div et ligne de 20µs/div à .2µs/div)

+/-	Le balayage est déclenché sur les flancs positifs au négatifs du signal de déclenchement. En TV, il faut choisir — pour les signaux vidéo négatifs et + pour les signaux vidéo positifs.
LEVEL	Commande pour le réglage continu du niveau de la forme d'onde sur laquelle l'affichage doit commencer.
TRIG OR X DEFL	(voir commutateur de source TRIG OR X DEFL dans la section 2.2.4. ci-dessous).

2.2.4. Déviation horizontale

Commutateur de source

TRIG OR X DEFL	*Fonction*
	Quatre boutons-poussoirs permettent de choisir la source de déclenchement ou la source de déviation horizontale si le commutateur TIME/DIV est en position X DEFL. Si auccun des boutons-poussoirs n'est enfoncé, la source A est choisie.
A	Signal fourni par la voie A.
B	Signal fourni par la voie B.
COMP (A & B tous deux enfoncés; inopérant avec X DEFL)	Signal fourni après le commutateur électronique.
EXT	Signal externe fourni à prise adjacente 1 Mohm//20 pF.
LINE	Signal fourni par la tension secteur (inopérant si l'instrument est alimenté par batterie).
X POSITION X MAGN	Commande de réglage continu du décalage horizontal de la trace; comporte un bouton tirette qui multiplie par 10 la déviation horizontale.
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. Choisit entre déclenchement ligne ou trame dans le mode TV. En position X DEFL, la déviation horizontale est déterminée par le commutateur TRIG ou X DEFL.
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.

2.2.5 Divers

CAL	Prise de sortie fournissant une onde carrée de ≈ 2 kHz et une amplitude 3 Vcc ± 1%. A utiliser pour compenser la sonde et, ou contrôler la précision de la déviation verticale.
Alimentation externe	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 de référence 21 à 27 V, courant admissible > 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 1.2.8.).

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 inférieures, provoquant ainsi l'atténuation des signaux sinusdoidaux à faible fréquence et la distortion des ondes carrées à faible frequence. Le degré d'atténuation est dterminé par le temps d'entrée RC (0.1s). 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 déconnecte 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 de 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. 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. Le 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.

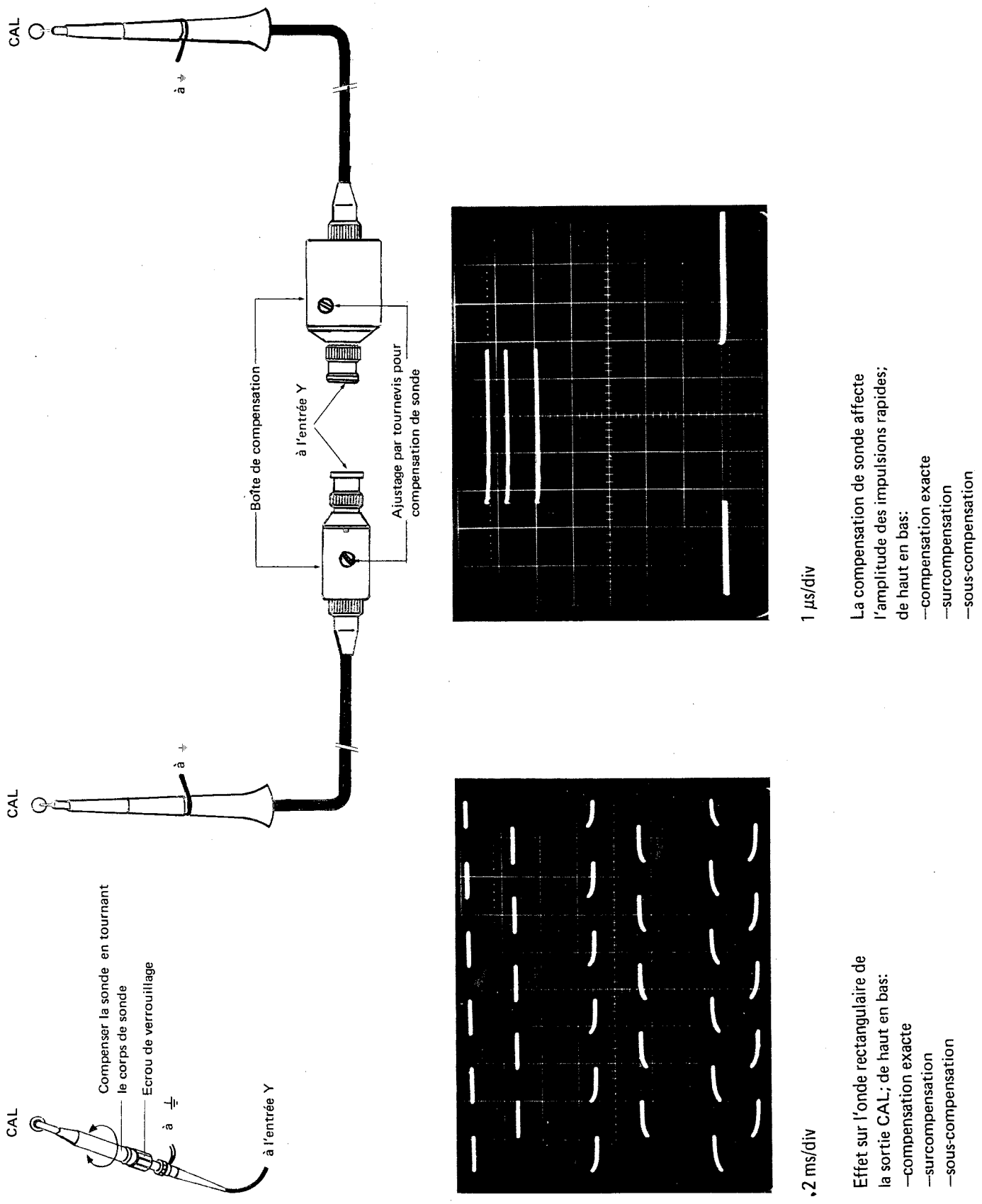


Fig. 2.3. Comment compenser les sondes passives 10:1 et l'effet sur les formes d'ondes.

2.3.6. 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'aptitude 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 methode d'égalisation similaire consistant à régler leurs commandes de compensation pour une déviation minimale.

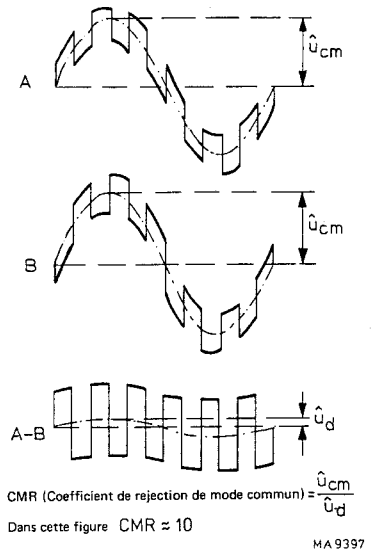


Fig. 2.4. Réjection en mode commun

2.3.7. Choix du mode de déclenchement

(AUTO .. AC .. DB .. TV .. +/–)
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.

2.3.8. Source de déclenchement

La source de déclenchement 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 frequence 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 différential et n'est donc pas perturbé par les signaux de mode commun.
2. Pour le fonctionnement monovoie, il n'est pas nècessaire 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.

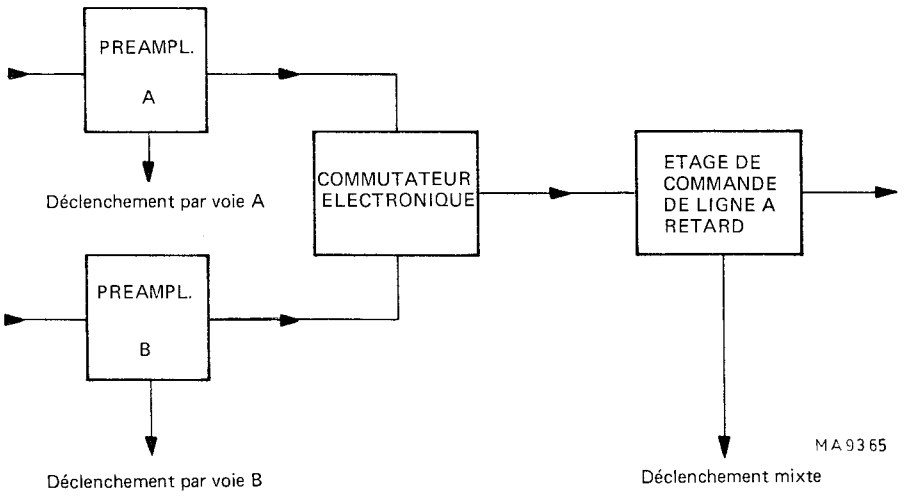


Fig. 2.5. Schéma synoptique du circuit de déclenchement mixte

2.3.9. 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 faire jusqu'à 100 kHz avec une erreur de phase inférieure à 3^{o} 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
LINE	8 divisions

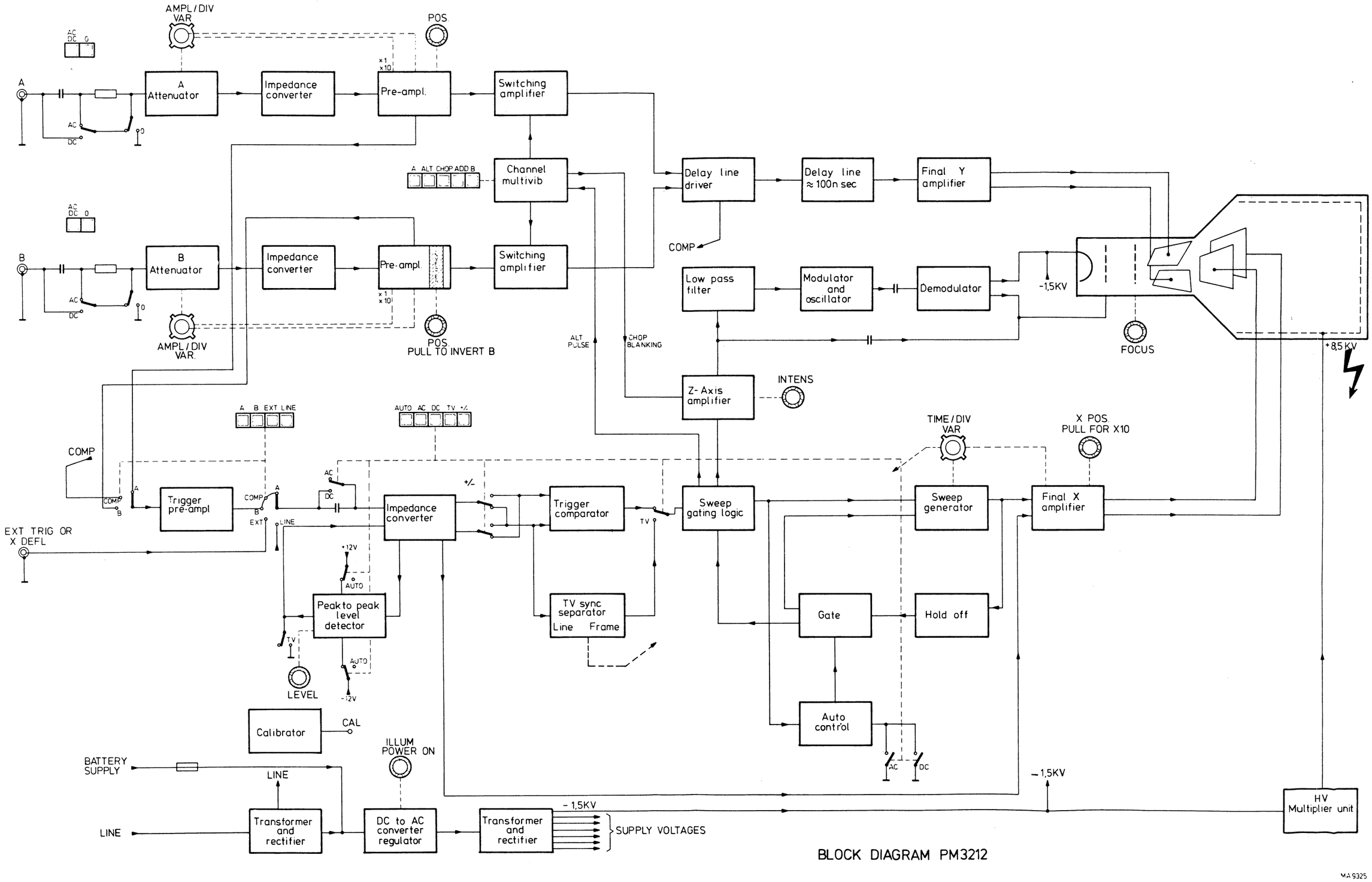
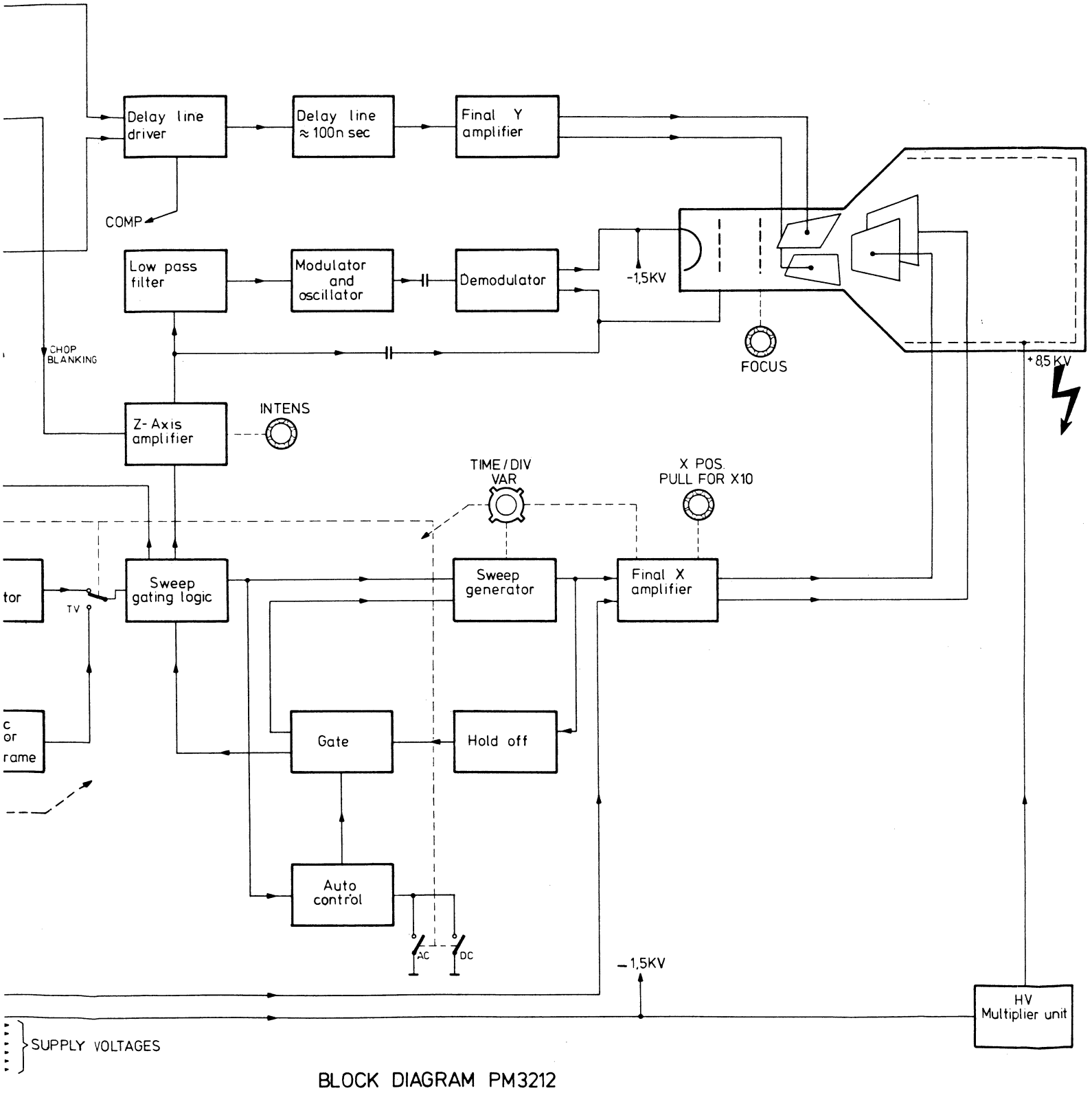


Fig. 3.1. Block diagram of the oscilloscope



BLOCK DIAGRAM PM3212

MA 9325

3. Service data

3.1 BLOCK DIAGRAM DESCRIPTION

3.1.1 Y Channel

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, and 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 CHOP mode the multivibrator is free-running and provides a chopped display of the two signals. In the ADD position, both switching amplifiers are connecting 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 x1 or x10 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.

3.1.2 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. With A and B pushbuttons both depressed, composite triggering 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 convertor.

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 TV mode the LEVEL control is inoperative and the TV sync separator is switched into circuit, thus initiating sweeps with line or frame pulses as dictated by the setting of the TIME/DIV switch.

3.1.3 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.

In the EXT position of the TIME/DIV switch, the sweep generator output to the final amplifier is inhibited and the impedance convertor 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.

3.1.4 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.

3.1.5 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.

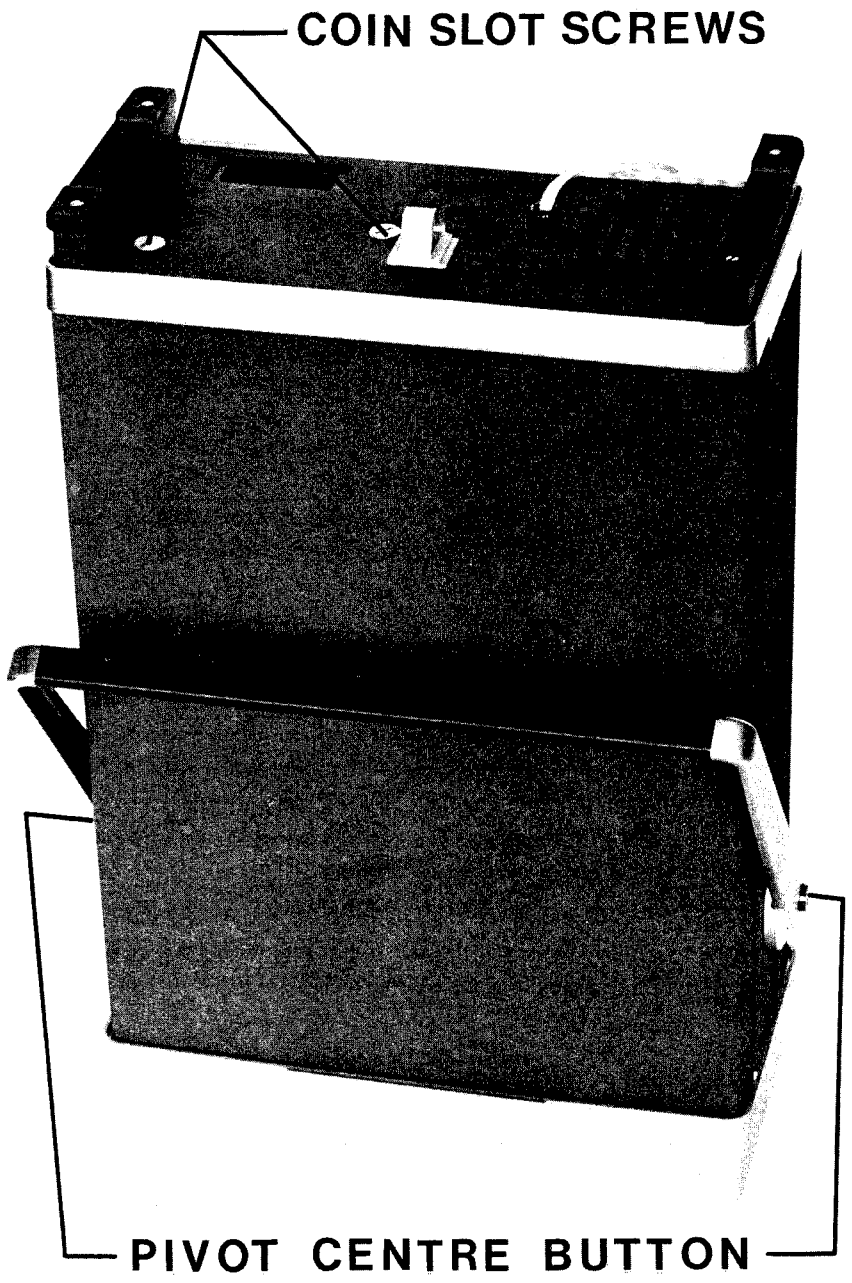


Fig. 3.2. Removing the instrument covers and the carrying handle

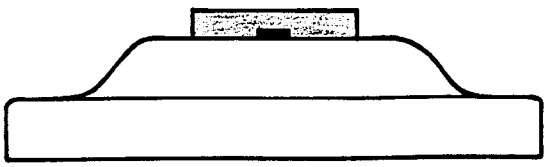


Fig. 3.3. Pivot centre button

3.1.6 Power supply

The mains (line) supply is transformed and rectified before being applied to a d.c. to a.c. regulator.

When the instrument is operated from a battery supply the battery output is connected directly to the d.c. to a.c. regulator.

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

3.2. DISMANTLING THE INSTRUMENT

3.2.1. 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 re-connected 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.

3.2.2. 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 A (Fig. 3.2.).
– 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.

3.2.3. Removing the carrying handle

– Prise off the centre knobs from each pivot, using a screwdriver (Fig. 3.3.) 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.

3.2.4. Removing the bezel and the contrast plate

– Take hold of the bezel's bottom corners and gently pull it from the front panel.

– The contrast filter can be removed by pressing it gently out of the bezel.

3.2.5. Removing the knobs and the text plate

– The channel B POSITION and the X POSITION 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

– 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.

3.2.6. 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 3.2.2.
- Remove the INTENS, FOCUS and ILLUM knobs by pulling them off the shaft
- Remove the earthing terminal at the front
- Remove the three screws A (Fig. 3.4.)
- Remove the two screws B that hold the attenuator to the frame bar (Fig. 3.5.)
- Remove the three screws C (Fig. 3.6.)
- 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
- 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 position control is rotated clockwise.

3.2.7. Replacing switches

3.2.7.1. General

- To replace the AMPL/DIV switches, first remove the front panel assembly (section 3.2.6.)
- To replace the TIME/DIV switch, first remove knobs and text plate (section 3.2.5.)
- If one of the push-button switches of the trigger source selector (A, B, EXT, LINE) or the input coupling switch (AC/DC 0) must be replaced, it is best to remove the front panel assembly first (section 3.2.6.). 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 mode switch (AUTO, AC, DC, TV, SLOPE), the amplifier board can be removed if so desired and the defective switch is then replaced as described below.

3.2.7.2. Replacing a switch of a push-button unit

- Straighten the 4 retaining lugs of the relevant switch as shown in Fig. 3.7.
- 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 origional positions

N.B. The ALT switch is a dummy switch which can be replaced by a not self-releasing type.

3.2.8. Replacing the cathode-ray tube

- Remove the instrument covers and rear frame (section 3.2.2.)
- Remove bezel and contrast plate (section 3.2.4.)
- 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

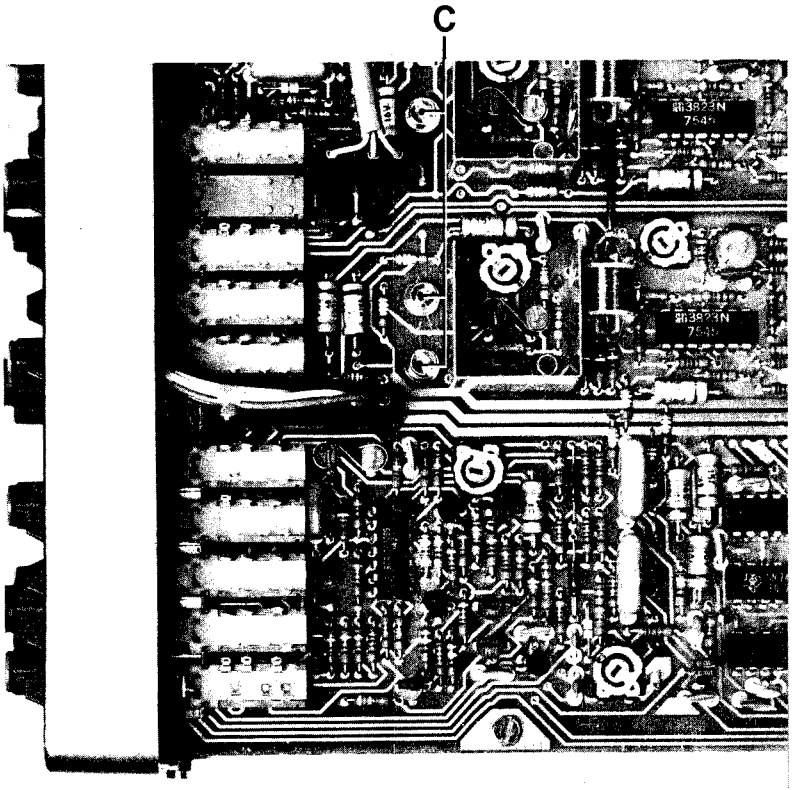


Fig. 3.6. Removing the front assembly (scews C)

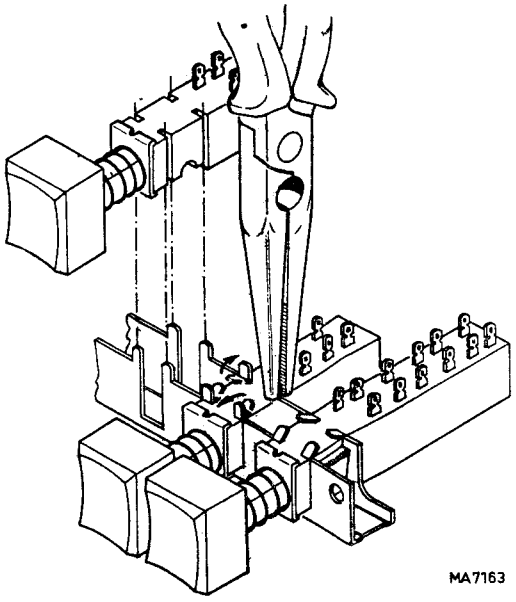


Fig. 3.7. Replacing a push-button switch

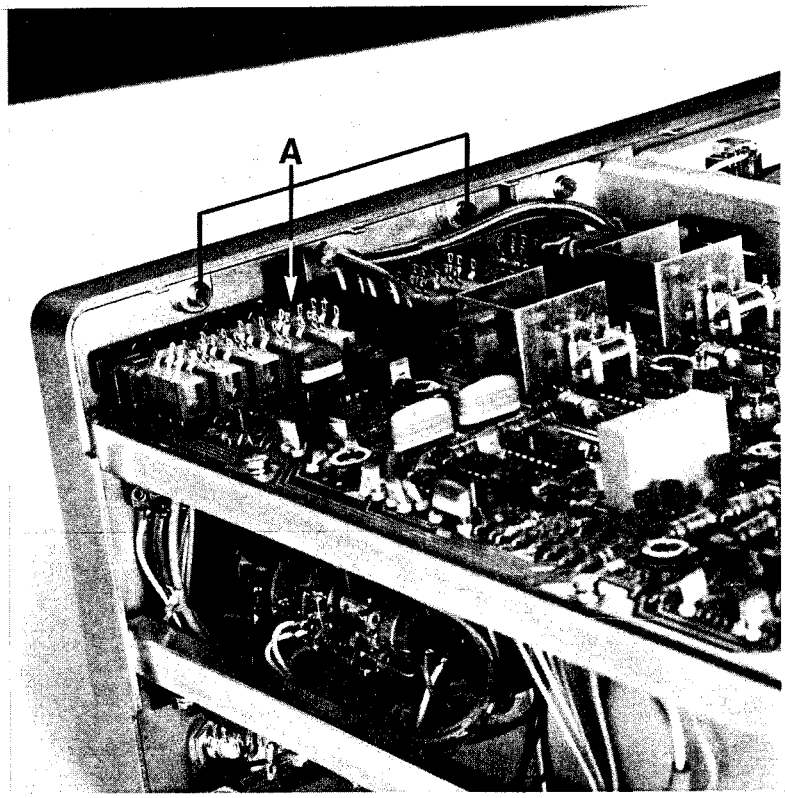


Fig. 3.4. Removing the front assembly (screws A)

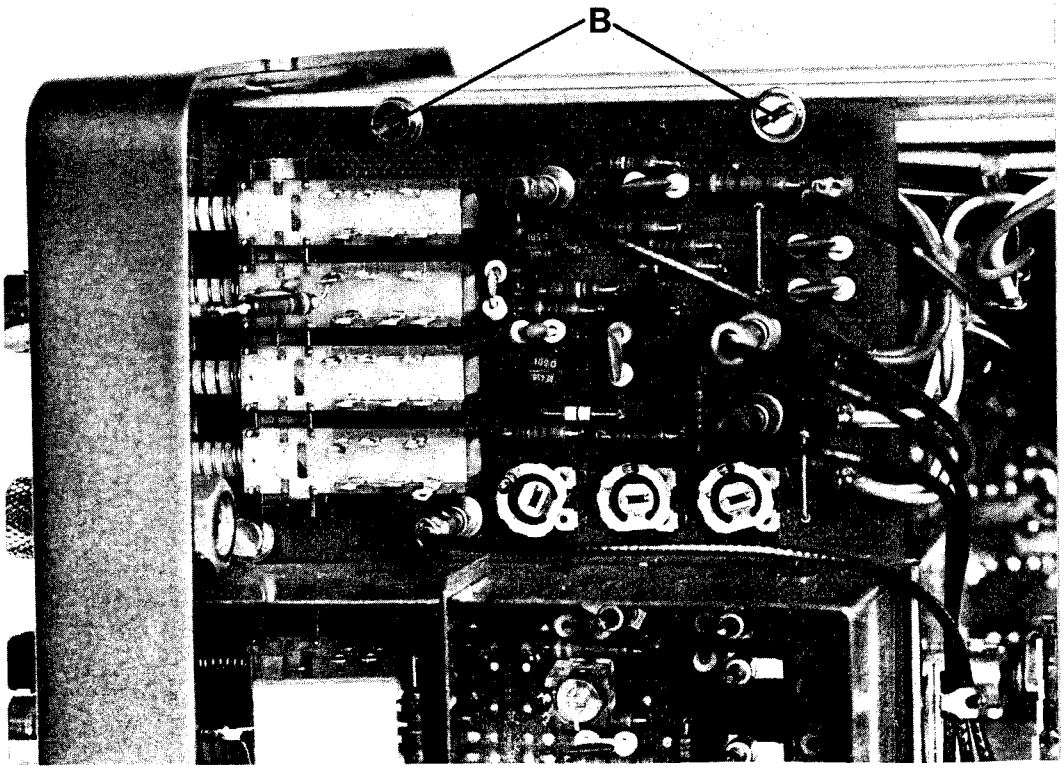
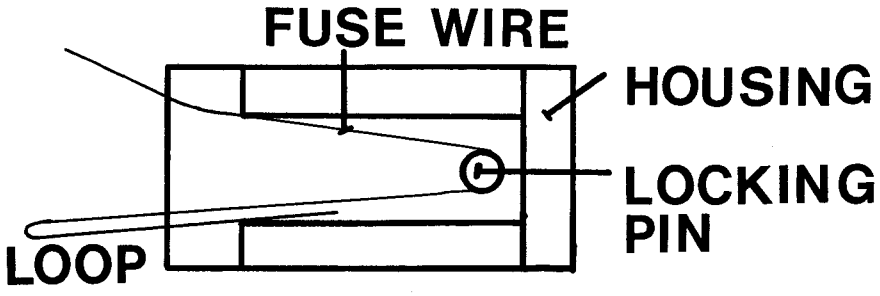


Fig. 3.5. Removing the front assembly (screws B)



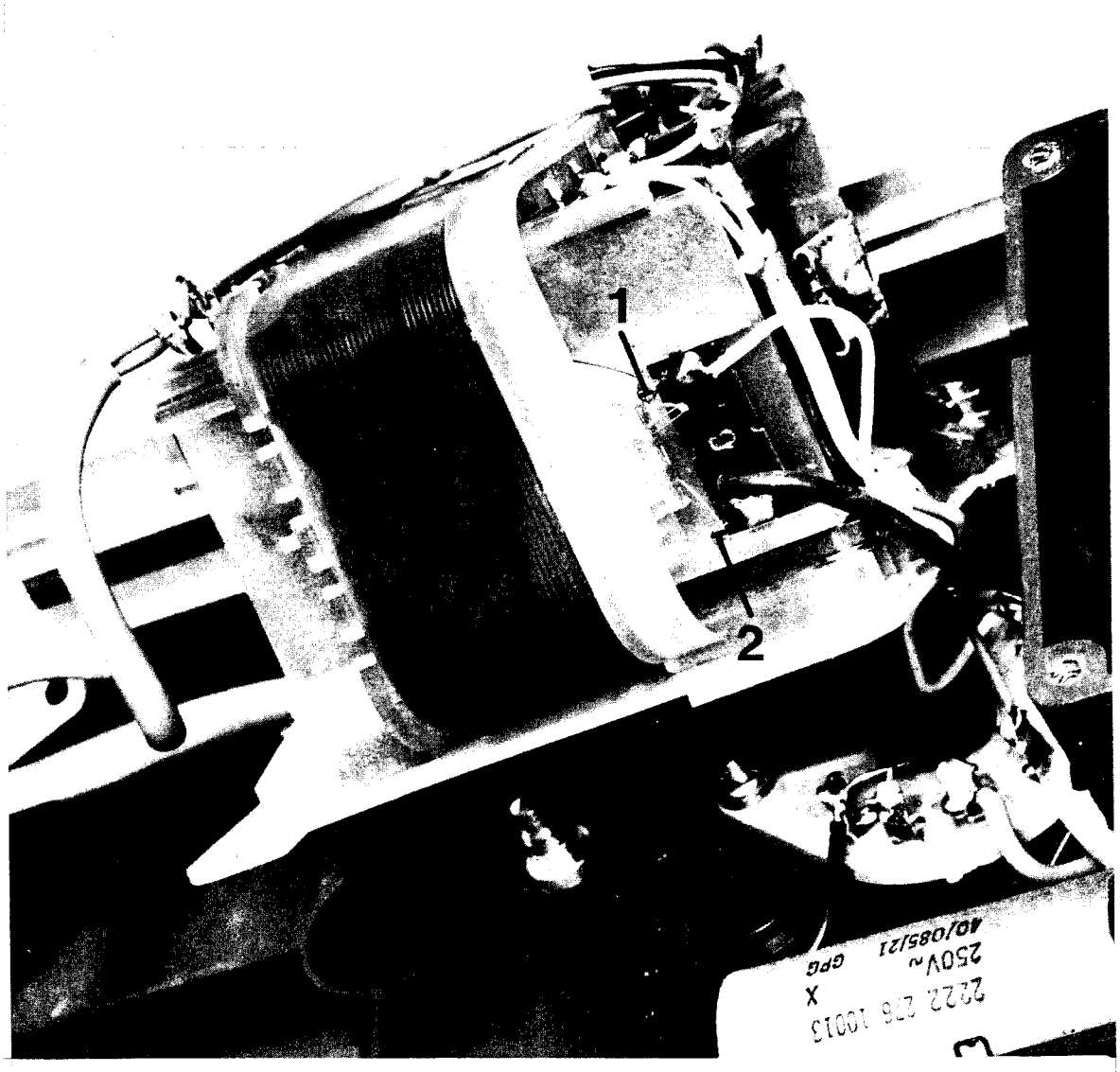


Fig. 3.8. Replacing the thermal fuse

- 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.

3.2.9. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 3.2.2)
- 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 form between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement

3.2.10. Replacing the thermal fuse

- Remove the mains transformer (section 3.2.10)
- Unsolder fuse terminals 1 and 2 (Fig. 3.8.)
- 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.

3.2.11. 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 the connections when rotating the POSITION control clockwise, results in a downward movement of the trace

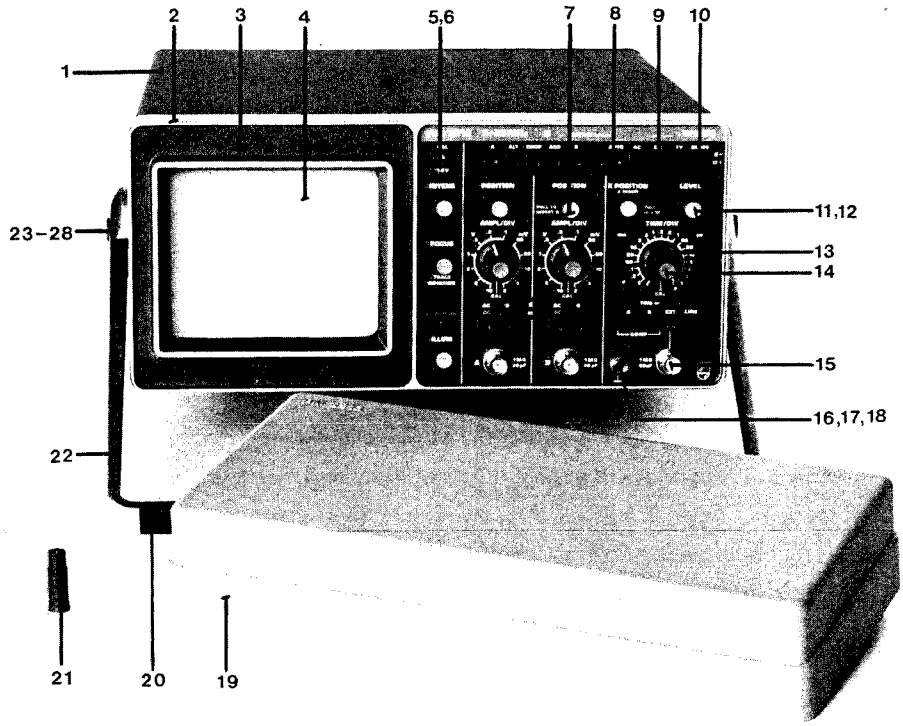


Fig. 3.9. Front view showing item numbers

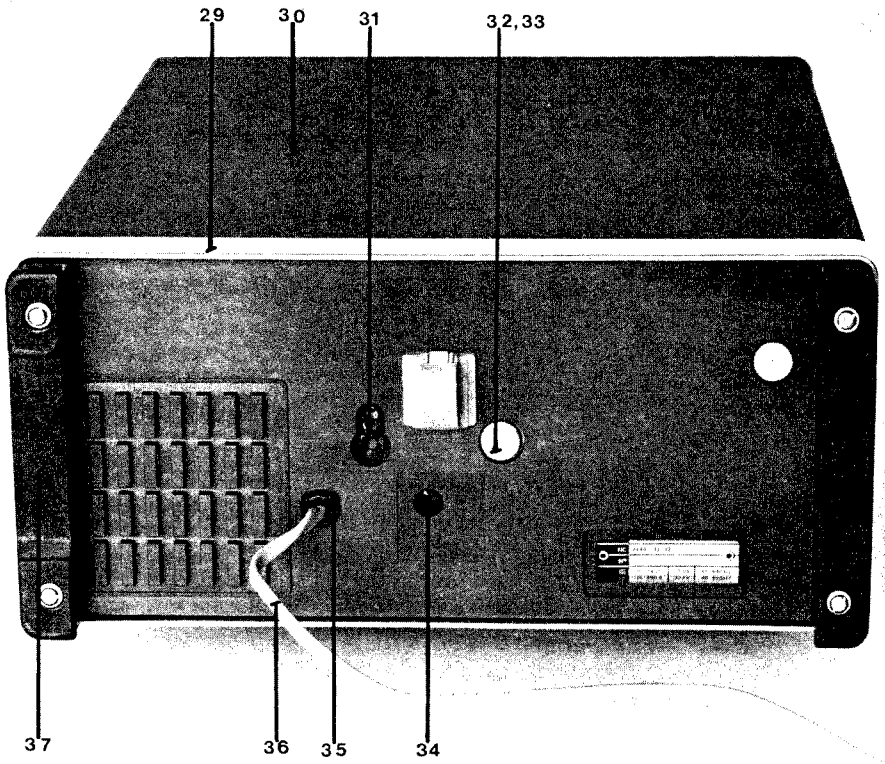


Fig. 3.10. Rear view showing item numbers

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

3.3.1. Mechanical parts

Figure 3.9.

Item	*Qty*	*Order number*	*Designation*
1	1	5322 447 94366	Cabinet without handle
2	1	5322 464 94002	Aluminium front frame
3	1	5322 450 74009	Bezel
4	1	5322 480 34046	Contrast filter blue
5	1	5322 264 24015	Calibration terminal
6	1	5322 325 84013	Grommet for calibration terminal
7	2	5322 414 34091	Knob
8	1	5322 455 84054	Text plate
9	15	5322 414 14011	Knob for push-button switch, grey
10	3	5322 414 25613	Knob for push-button switch, green
11	8	5322 414 34134	Knob
12	7	5322 414 74015	Knob cover grey
13	3	5322 414 34079	Knob
14	3	5322 414 74029	Knob cover blue
15	3	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 94367	Front cover
20	1	5322 498 54072	Grip
21	1	5322 263 24005	BNC-4 mm adapter
22	2	5322 466 64162	Profile
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 3.10			
29	1	5322 464 94001	Cast aluminium frame
30	1	5322 464 94003	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	5322 321 14001	Line cable, European type
		5322 321 14021	Line cable, U.S.A. type
37	2	5322 462 44298	Foot
Not shown			
38	5	5322 276 14102	Self-releasing push-button segment
39	13	5322 276 14117	Mutual-releasing push-button
40	1	5322 255 44088	LED holder
41	2	5322 255 24015	Lamp holder

3.3.2. Electrical parts

item	ordering number	farad	tol (%)	volts	remarks
capacitors					
C 101	5322 121 44189	330PF	20	250	POLYESTER FOIL
C 200	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 201	4822 122 30031	820PF	10	500	CERAMIC PLATE
C 202	4822 121 40443	680NF	10	100	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	1,6K	POLYESTER FOIL
C 219	4822 121 40196	22NF	10	1,6K	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 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 354	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 356	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 357	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 358	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
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

item	ordering number	farad	tol (%)	volts	remarks
capacitors					
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 501	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 502	4822 125 50045	22PF		250	TRIMMER
C 503	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 504	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 506	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 507	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 508	4822 125 50045	22PF		250	TRIMMER
C 509	4822 122 30103	22NF	-20+80	40	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 524	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 526	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 527	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 528	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 529	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 531	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 601	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 602	4822 125 50045	22PF		250	TRIMMER
C 603	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 604	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 606	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 607	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 608	4822 125 50045	22PF		250	TRIMMER
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 627	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 629	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 631	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
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 31172	180PF	10	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		250	TRIMMER
C 810	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 811	4822 125 50045	22PF		250	TRIMMER
C 813	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 814	4822 122 31061	18PF	2	100	CERAMIC PLATE

item	ordering number	farad	tol (%)	volts	remarks
capacitors					
C 815	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 816	4822 122 31061	18PF	2	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 40438	470NF	10	100	POLYESTER FOIL
C 1002	4822 121 40438	470NF	10	100	POLYESTER FOIL
C 1003	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1004	4822 122 30103	22NF	-20+80	40	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 1011	4822 122 31125	4,7NF	-20+80	40	CERAMIC PLATE
C 1012	4822 122 31125	4,7NF	-20+80	40	CERAMIC PLATE
C 1013	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1016	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1017	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1018	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1019	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1201	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 1202	4822 121 40423	150NF	10	100	POLYESTER FOIL
C 1203	4822 122 31168	270PF	10	100	CERAMIC PLATE
C 1204	5322 121 54127	3,9NF	1	63	POLYSTYRENE FOIL
C 1206	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1207	5322 121 40283	3,3UF	10	100	POLYESTER FOIL
C 1208	4822 124 20584	2,2UF	-10+50	63	ELECTROLYTIC
C 1209	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1210	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1211	5322 116 50868	22NF	-20+80	40	METAL FILM
C 1212	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1213	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1214	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1216	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1401	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1402	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1403	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 1404	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1406	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1407	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1408	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1409	4822 122 30104	1PF	0,25PF	100	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 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1416	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 1417	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1418	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1419	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1421	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 30103	22NF	-20+80	40	CERAMIC PLATE
C 1504	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1506	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1507	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1508	4822 122 30099	3,3NF	10	100	CERAMIC PLATE
C 1509	4822 121 40354	1,5NF	10	1,6K	POLYESTER FOIL
C 1511	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1512	4822 121 40354	1,5NF	10	1,6K	POLYESTER FOIL
C 1513	4822 121 40354	1,5NF	10	1,6K	POLYESTER FOIL
C 1601	4822 121 40434	330NF	10	100	POLYESTER FOIL
C 1602	4822 122 31072	47PF	2	100	CERAMIC PLATE

item	ordering number	ohm	tol (%)	type	remarks
resistors					
R 1	4822 101 20471	10K	20	0,1W	CARBON POTM LIN
R 2	4822 101 20472	1K	20	0,1W	CARBON POTM LIN
R 3	5322 101 64018	1K	20	0,1W	CARBON POTM LIN + SWITCH
R 4	5322 102 44004				CARBON TANDEM POTM + SWITCH
R 5	4822 101 20457	100K	20	0,1W	CARBON POTM LIN
R 6	5322 101 24098	2,2M	20	0,1W	CARBON POTM LIN
R 7	5322 101 44024	1K	20	0,1W	CARBON POTM LIN + SWITCH
R 8	5322 101 44024	1K	20	0,1W	CARBON POTM LIN + SWITCH
R 9	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 10	5322 101 20408	100K	20	0,1W	CARBON POTM LIN
R 11	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	4822 100 10026	220	20	0,05W	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 211	5322 111 50345	8,2M	5	1W	CARBON
R 212	5322 116 54619	10K	1	MR25	METAL FILM
R 227	5322 116 50679	237	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 50866	205K	1	MR30	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 354	5322 116 55078	806K	1	MR30	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	4822 100 10051	22K	20	0,05W	TRIMMING POTM
R 359	5322 116 54643	20,5K	1	MR25	METAL FILM
R 361	4822 100 10051	22K	20	0,05W	TRIMMING POTM
R 362	5322 116 54643	20,5K	1	MR25	METAL FILM
R 363	5322 116 54558	8,25K	1	MR25	METAL FILM
R 364	5322 116 54592	4,02K	1	MR25	METAL FILM
R 366	5322 116 50581	2,49K	1	MR25	METAL FILM
R 367	5322 116 54565	1,62K	1	MR25	METAL FILM
R 369	5322 116 54557	1,21K	1	MR25	METAL FILM
R 371	5322 116 51052	42,2	1	MR25	METAL FILM
R 372	5322 116 54714	154K	1	MR25	METAL FILM
R 373	5322 116 54335	750K	1	MR30	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 50866	205K	1	MR30	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

item	ordering number	ohm	tol (%)	type	remarks
resistors					
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	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 506	5322 116 50443	12,7K	1	MR25	METAL FILM
R 507	5322 116 54529	619	1	MR25	METAL FILM
R 508	5322 116 54603	6,49K	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 50569	95,3	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	4822 100 10037	1K	20	0.05W	TRIMMING POTM
R 521	5322 116 50678	20,5	1	MR25	METAL FILM
R 522	5322 116 50678	20,5	1	MR25	METAL FILM
R 523	5322 116 54442	51,1	1	MR25	METAL FILM
R 524	5322 116 50509	4,87K	1	MR25	METAL FILM
R 526	5322 116 54442	51,1	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 54508	301	1	MR25	METAL FILM
R 533	5322 116 54508	301	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 50457	215	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 581	5322 116 50568	4,99	1	MR25	METAL FILM
R 582	5322 116 50568	4,99	1	MR25	METAL FILM
R 583	5322 116 50568	4,99	1	MR25	METAL FILM
R 584	5322 116 50568	4,99	1	MR25	METAL FILM
R 586	5322 116 50568	4,99	1	MR25	METAL FILM
R 587	5322 116 50568	4,99	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	4822 100 10038	470	20	0.05W	TRIMMING POTM
R 606	5322 116 50443	12,7K	1	MR25	METAL FILM
R 607	5322 116 54529	619	1	MR25	METAL FILM

item	ordering number	ohm	tol (%)	type	remarks
resistors					
R 608	5322 116 54603	6,49K	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 50569	95,3	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	4822 100 10037	1K	20	0,05W	TRIMMING POTM
R 621	5322 116 50678	20,5	1	MR25	METAL FILM
R 622	5322 116 50678	20,5	1	MR25	METAL FILM
R 623	5322 116 54442	51,1	1	MR25	METAL FILM
R 624	5322 116 50509	4,87K	1	MR25	METAL FILM
R 626	5322 116 54442	51,1	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 54508	301	1	MR25	METAL FILM
R 633	5322 116 54508	301	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 54657	31,6K	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 682	5322 116 50568	4,99	1	MR25	METAL FILM
R 683	5322 116 50568	4,99	1	MR25	METAL FILM
R 684	5322 116 50568	4,99	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 54536	750	1	MR25	METAL FILM
R 704	5322 116 54519	402	1	MR25	METAL FILM
R 705	5322 116 50568	4,99	1	MR25	METAL FILM
R 706	5322 116 50555	1,27K	1	MR25	METAL FILM
R 707	5322 116 54643	20,5K	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 710	5322 116 50568	4,99	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

item	ordering number	ohm	tol (%)	type	remarks
resistors					
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 54852	100	1	MR30	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 808	5322 116 50671	2,61K	1	MR25	METAL FILM
R 809	5322 116 54561	1,33K	1	MR25	METAL FILM
R 811	5322 116 50556	4,42K	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 816	5322 116 50904	30,1	1	MR25	METAL FILM
R 817	4822 100 10075	100	20	0,05W	TRIMMING POTM
R 818	5322 116 50904	30,1	1	MR25	METAL FILM
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 54489	169	1	MR25	METAL FILM
R 824	5322 116 50458	7,87K	1	MR25	METAL FILM
R 825	5322 116 50568	4,99	1	MR25	METAL FILM
R 826	5322 116 50675	2,26K	1	MR25	METAL FILM
R 827	5322 116 50729	4,22K	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 54557	1,21K	1	MR25	METAL FILM
R 839	5322 116 54557	1,21K	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 1001	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1002	5322 116 50672	51,1K	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 1005	5322 116 54442	51,1	1	MR25	METAL FILM
R 1006	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1007	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1008	5322 116 54743	301K	1	MR25	METAL FILM
R 1009	5322 116 54725	196K	1	MR25	METAL FILM
R 1011	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1012	5322 116 54696	100K	1	MR25	METAL FILM
R 1013	5322 116 50443	12,7K	1	MR25	METAL FILM
R 1014	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 1016	5322 116 50443	12,7K	1	MR25	METAL FILM
R 1017	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1018	5322 116 54009	562	1	MR25	METAL FILM

item	ordering number	ohm	tol (%)	type	remarks
resistors					
R 1019	5322 116 54009	562	1	MR25	METAL FILM
R 1021	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1022	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1023	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1024	5322 116 50904	30,1	1	MR25	METAL FILM
R 1026	5322 116 50904	30,1	1	MR25	METAL FILM
R 1027	5322 116 54529	619	1	MR25	METAL FILM
R 1028	5322 116 54529	619	1	MR25	METAL FILM
R 1029	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1031	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1032	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1033	5322 116 54549	1K	1	MR25	METAL FILM
R 1034	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1036	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1037	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1038	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1039	5322 116 54188	1M	1	MR30	METAL FILM
R 1041	4822 100 10051	22K	20	0,05W	TRIMMING POTM
R 1042	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1043	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1044	5322 116 50728	1,87K	1	MR25	METAL FILM
R 1046	5322 116 54619	10K	1	MR25	METAL FILM
R 1047	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1048	5322 116 54188	1M	1	MR30	METAL FILM
R 1049	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1051	5322 116 54725	196K	1	MR25	METAL FILM
R 1052	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1053	5322 116 50568	4,99	1	MR25	METAL FILM
R 1054	5322 116 50568	4,99	1	MR25	METAL FILM
R 1056	5322 116 50568	4,99	1	MR25	METAL FILM
R 1201	5322 116 54696	100K	1	MR25	METAL FILM
R 1202	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1203	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1204	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1207	5322 116 50452	10	1	MR25	METAL FILM
R 1208	4822 110 63201	3,3M	10	CR25	CARBON
R 1209	5322 116 54619	10K	1	MR25	METAL FILM
R 1211	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1212	5322 116 54619	10K	1	MR25	METAL FILM
R 1213	5322 116 54534	681	1	MR25	METAL FILM
R 1214	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1216	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1217	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1218	5322 116 54461	80,6	1	MR25	METAL FILM
R 1219	5322 116 50904	30,1	1	MR25	METAL FILM
R 1221	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1222	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1223	5322 116 54575	2,32K	1	MR25	METAL FILM
R 1224	5322 116 50904	30,1	1	MR25	METAL FILM
R 1226	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1227	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1228	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1229	5322 116 54545	909	1	MR25	METAL FILM
R 1231	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1232	4822 100 10036	4,7K	20	0,05W	TRIMMING POTM
R 1233	5322 116 54515	348	1	MR25	METAL FILM
R 1234	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1236	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1237	5322 116 50568	4,99	1	MR25	METAL FILM
R 1238	5322 116 50568	4,99	1	MR25	METAL FILM
R 1239	5322 116 50568	4,99	1	MR25	METAL FILM
R 1276	5322 116 51017	787K	1	MR30	METAL FILM
R 1277	5322 116 54736	261K	1	MR25	METAL FILM
R 1278	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1279	5322 116 50443	12,7K	1	MR25	METAL FILM
R 1281	5322 116 54004	2,43K	1	MR25	METAL FILM
R 1282	5322 116 50459	422	1	MR25	METAL FILM
R 1283	5322 116 54928	523K	1	MR30	METAL FILM
R 1284	5322 116 54707	130K	1	MR25	METAL FILM
R 1286	5322 116 54649	25,5K	1	MR25	METAL FILM

item	ordering number	ohm	tol (%)	type	remarks
resistors					
R 1287	5322 116 50523	4,99K	1	MR25	METAL FILM
R 1288	5322 116 54556	1,18K	1	MR25	METAL FILM
R 1289	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1401	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1402	5322 116 54442	51,1	1	MR25	METAL FILM
R 1403	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1404	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1406	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1407	5322 116 54534	681	1	MR25	METAL FILM
R 1408	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1409	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1411	5322 116 54615	9,09K	1	MR25	METAL FILM
R 1412	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1414	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1416	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1417	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 1418	5322 116 54506	287	1	MR25	METAL FILM
R 1419	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 1421	5322 116 54613	8,66K	1	MR25	METAL FILM
R 1422	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1423	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1424	5322 116 50726	36,5K	1	MR25	METAL FILM
R 1425	5322 116 54469	100	1	MR25	METAL FILM
R 1426	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1427	5322 116 54714	154K	1	MR25	METAL FILM
R 1428	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1429	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1431	5322 116 54549	1K	1	MR25	METAL FILM
R 1432	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1433	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1434	5322 116 54714	154K	1	MR25	METAL FILM
R 1436	5322 116 54554	1,1K	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 1440	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1441	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1442	5322 116 54627	13,3K	1	MR25	METAL FILM
R 1443	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1444	5322 116 54762	365K	1	MR30	METAL FILM
R 1445	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1446	5322 116 54762	365K	1	MR30	METAL FILM
R 1447	5322 116 54469	100	1	MR25	METAL FILM
R 1448	5322 116 54469	100	1	MR25	METAL FILM
R 1449	5322 116 50568	4,99	1	MR25	METAL FILM
R 1450	5322 116 50514	64,9K	1	MR25	METAL FILM
R 1501	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1502	5322 116 54525	511	1	MR25	METAL FILM
R 1503	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1506	5322 116 54716	162K	1	MR25	METAL FILM
R 1507	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1508	5322 116 54696	100K	1	MR25	METAL FILM
R 1509	5322 116 54623	11K	1	MR25	METAL FILM
R 1511	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1512	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1513	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1514	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1516	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1517	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1518	5322 116 54525	511	1	MR25	METAL FILM
R 1519	5322 116 50536	464	1	MR25	METAL FILM
R 1521	5322 116 54729	226K	1	MR25	METAL FILM
R 1522	4822 116 30182	680	5	0,5W	NTC
R 1523	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1524	5322 116 54469	100	1	MR25	METAL FILM
R 1525	5322 116 54835	511	1	MR30	METAL FILM
R 1526	5322 116 50868	64,9K	1	MR30	METAL FILM
R 1527	5322 116 54637	17,8K	1	MR25	METAL FILM
R 1528	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1529	5322 116 50509	4,87K	1	MR25	METAL FILM

item	ordering number	ohm	tol (%)	type	remarks
resistors					
R 1531	5322 116 54629	14K	1	MR25	METAL FILM
R 1532	5322 116 54188	1M	1	MR30	METAL FILM
R 1533	5322 116 54469	100	1	MR25	METAL FILM
R 1534	4822 100 10035	10K	20	0.05W	TRIMMING POTM
R 1535	5322 116 54207	1K	1	MR30	METAL FILM
R 1536	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1537	5322 116 54188	1M	1	MR30	METAL FILM
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 54635	16,9K	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 50568	4,99	1	MR25	METAL FILM
R 1553	5322 116 50568	4,99	1	MR25	METAL FILM
R 1554	5322 116 50568	4,99	1	MR25	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 50483	38,3K	1	MR25	METAL FILM
R 1609	5322 116 54547	953	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 54585	3,48K	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

item	ordering number	type/description
semi conductors		
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 30759	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

item	ordering number	type/description
semi conductors		
V 231	5322 130 34594	BY409
V 232	5322 130 34594	BY409
V 233	5322 130 34442	BZX79/C75
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 30613	BAW62
V 501	5322 130 34037	BAV45
V 504	5322 130 44548	ON561
V 506	5322 130 44196	BC548C
V 507	5322 130 44196	BC548C
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 44548	ON561
V 606	5322 130 44196	BC548C
V 607	5322 130 44196	BC548C
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	QA95
V 1002	5322 130 30191	QA95
V 1003	5322 130 30613	BAW62
V 1004	5322 130 44196	BC548C

item	ordering number	type/description
semi conductors		
V 1006	5322 130 44548	ON561
V 1008	5322 130 44197	BC558B
V 1009	5322 130 44196	BC548C
V 1011	5322 130 44196	BC548C
V 1012	5322 130 44196	BC548C
V 1013	5322 130 44196	BC548C
V 1014	5322 130 44237	BF450
V 1016	5322 130 30613	BAW62
V 1017	5322 130 44197	BC558B
V 1201	5322 130 44196	BC548C
V 1202	5322 130 30613	BAW62
V 1203	5322 130 44197	BC558B
V 1204	5322 130 44196	BC548C
V 1206	5322 130 44197	BC558B
V 1207	5322 130 30613	BAW62
V 1208	5322 130 30613	BAW62
V 1209	5322 130 30613	BAW62
V 1211	5322 130 30613	BAW62
V 1212	5322 130 44197	BC558B
V 1213	5322 130 40417	BSX20
V 1214	5322 130 44196	BC548C
V 1216	5322 130 44196	BC548C
V 1217	5322 130 44196	BC548C
V 1218	5322 130 30613	BAW62
V 1219	5322 130 44196	BC548C
V 1221	5322 130 44196	BC548C
V 1222	5322 130 30613	BAW62
V 1223	5322 130 44196	BC548C
V 1401	5322 130 44196	BC548C
V 1402	5322 130 44196	BC548C
V 1403	5322 130 30613	BAW62
V 1404	5322 130 44197	BC558B
V 1406	5322 130 44154	BF199
V 1407	5322 130 44154	BF199
V 1408	5322 130 30613	BAW62
V 1409	5322 130 30613	BAW62
V 1411	5322 130 30613	BAW62
V 1412	5322 130 30767	BZX79-C5V1
V 1413	5322 130 44603	BFT45
V 1414	5322 130 44108	BF338
V 1416	5322 130 40417	BSX20
V 1417	5322 130 30613	BAW62
V 1419	5322 130 44237	BF450
V 1421	5322 130 44603	BFT45
V 1422	5322 130 44108	BF338
V 1423	5322 130 30767	BZX79-C5V1
V 1424	5322 130 34098	BZX79-C36
V 1426	5322 130 34098	BZX79-C36
V 1427	5322 130 34098	BZX79-C36
V 1428	5322 130 34442	BZX79/C75
V 1501	5322 130 30613	BAW62
V 1502	5322 130 30613	BAW62
V 1503	5322 130 30613	BAW62
V 1504	5322 130 30191	QA95
V 1506	5322 130 44196	BC548C
V 1508	5322 130 30613	BAW62
V 1511	5322 130 30613	BAW62
V 1512	5322 130 44197	BC558B
V 1513	5322 130 44196	BC548C
V 1514	5322 130 44196	BC548C
V 1516	5322 130 44196	BC548C
V 1517	5322 130 44247	BSS68
V 1518	4822 130 30842	BAV21
V 1519	4822 130 30842	BAV21
V 1521	5322 130 44196	BC548C
V 1522	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

item	ordering number	type/description	
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 1201	5322 209 85201	N74LS132A	SG
D 1202	5322 209 84167	N74S00A	SG
D 1203	5322 209 84954	N74S10A	SG
miscellaneous			
B 1	5322 130 34595	LED CQY24A-1	
E 1	5322 134 44177	LAMP 28V 80MA	
E 2	5322 134 44177	LAMP 28V 80MA	
F 201	4822 253 30021	FUSE	
K 501	4822 280 20064	SAM REED RELAIS	
K 601	4822 280 20064	SAM REED RELAIS	
K 1401	4822 280 20064	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	
T 201	5322 158 34074	BASE TRANSFORMER	
T 202	5322 146 24163	TRANSFORMER	
U2	5322 216 54142	POWER SUPPLY BOARD	
U3	5322 216 54143	ATTENUATOR BOARD	
U4	5322 218 64056	HIGH VOLTAGE UNIT	
S6 S8	5322 105 34034	ATTENUATOR SWITCH	
S10	5322 105 34035	TIME BASE SWITCH	
	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	

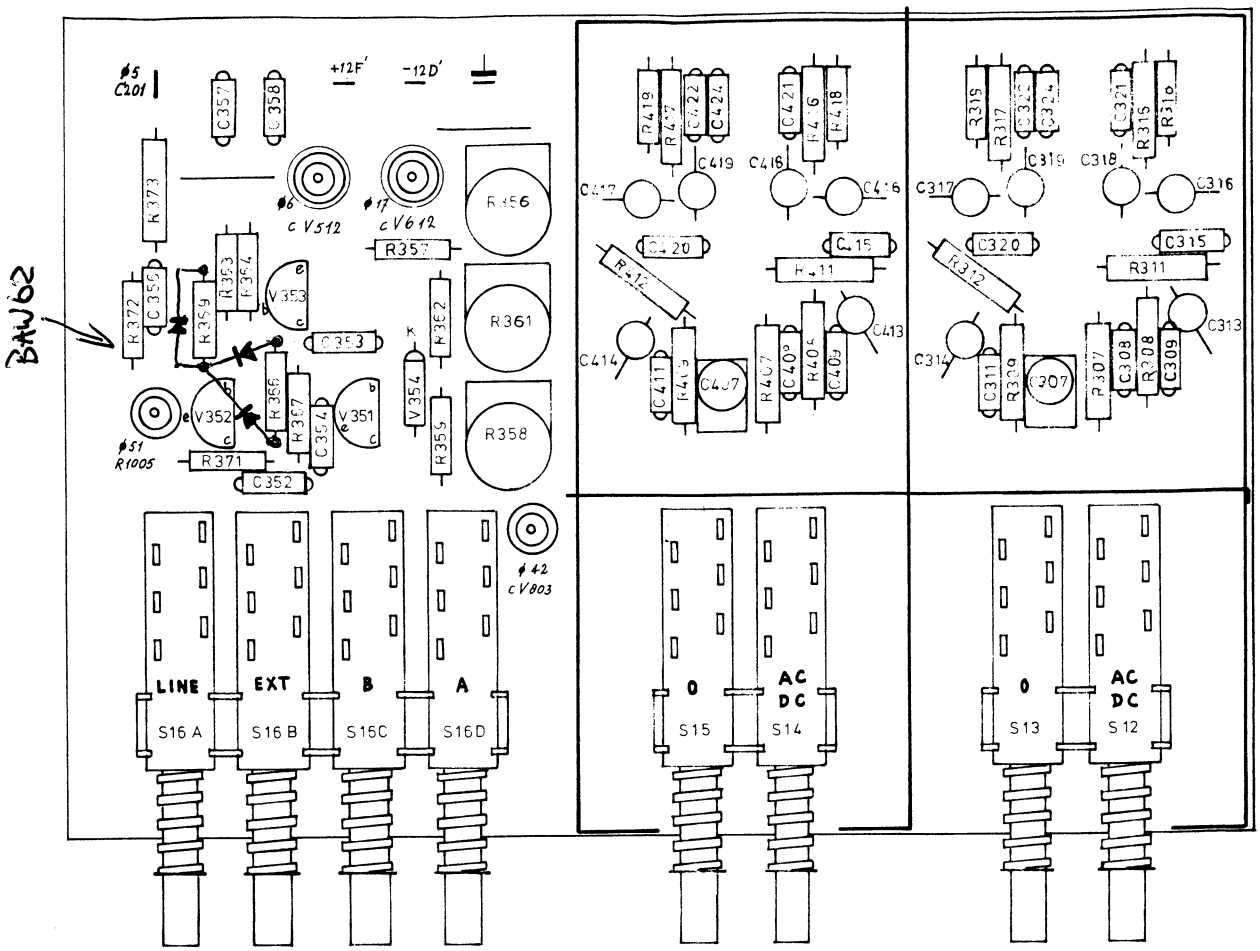


Fig. 3.11. Vertical attenuator unit

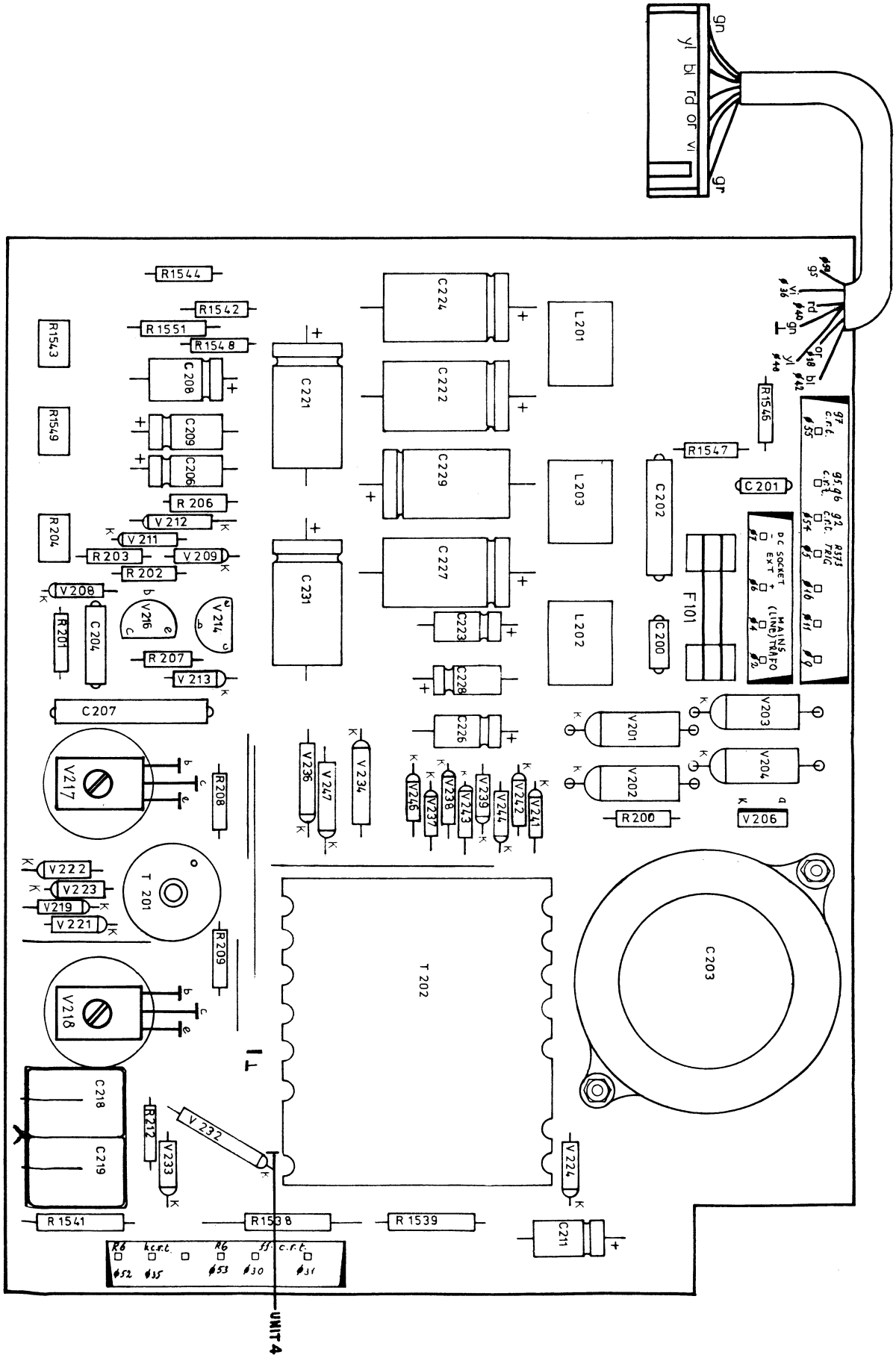
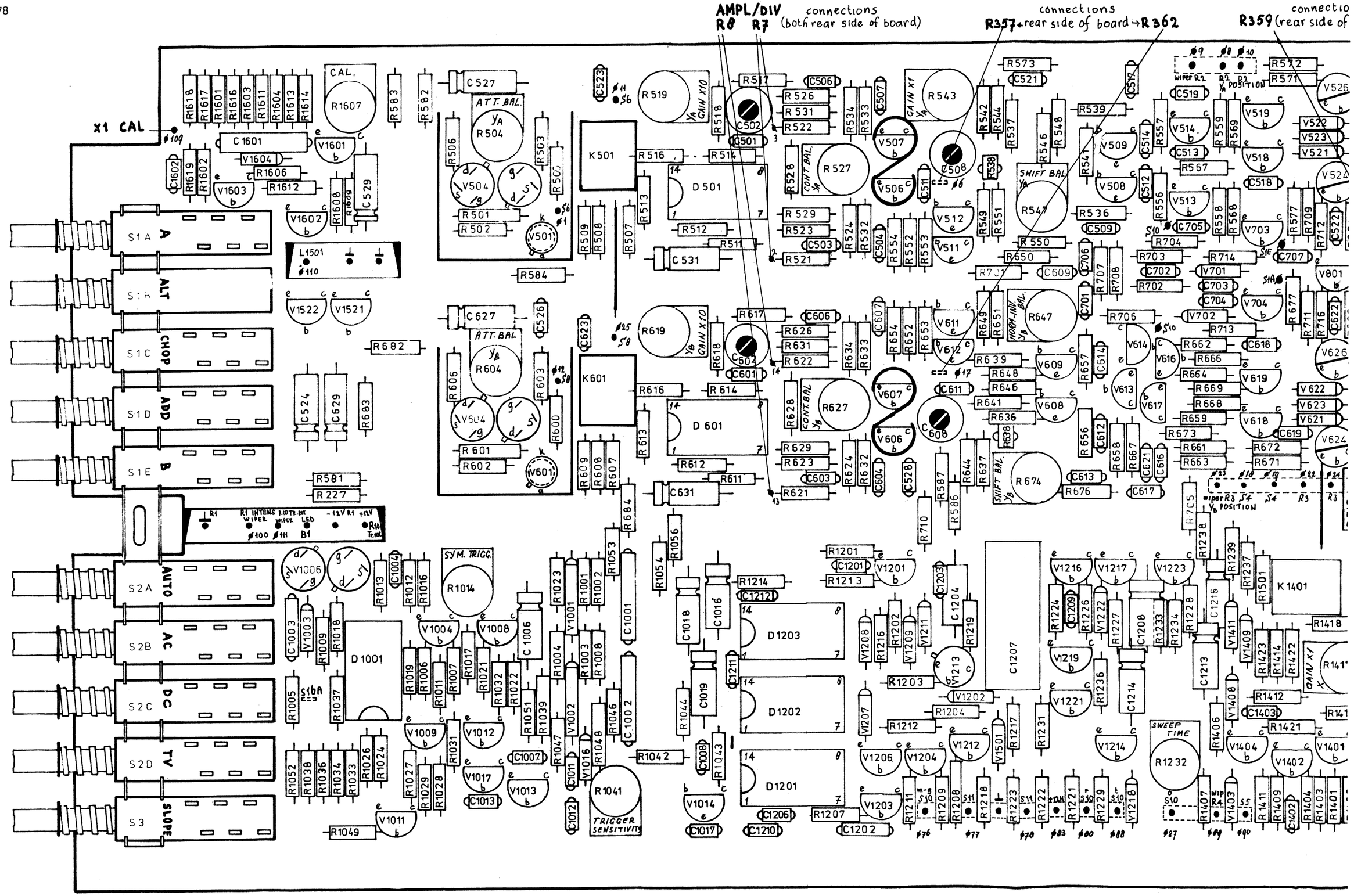


Fig. 3.12. Power supply unit



3.13. Vertical amplifier unit

AMPL/DIV R8 R7 connections (both rear side of board)

R357 ← rear side of board → R362 connections

R359 (rear side of board) connections

DELAY-LINE (rear side of board) connections

y defl. plate

X defl. plates

SWEEP TIME

TRIGGER SENSITIVITY

ASTIGM

10 V1

7 V1

GAIN 1 stage 141x
GAIN 2 stage 154x ± 20%

TIME BASE SWITCH S10

Trigg. sensitivity

sweep time

GAIN 1 stage 141x
GAIN 2 stage 154x ± 20%

TIME BASE SWITCH S10

sweep time

Voltages measured in relation to A

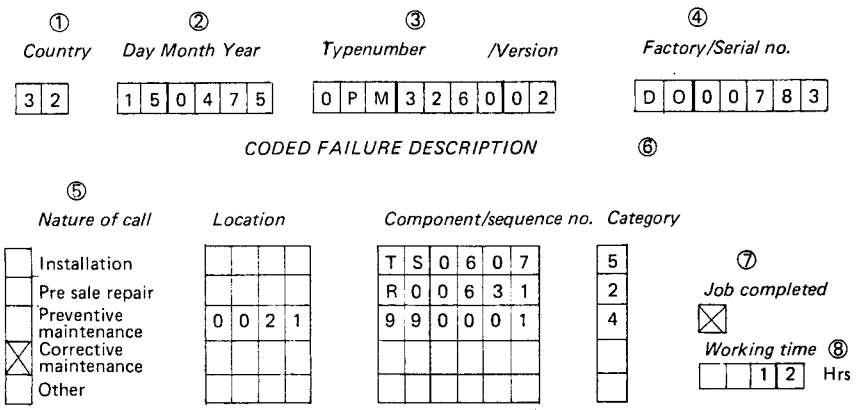
Fig. 3.14. Circuit diagram of the complete oscilloscope PM 3212

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.



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 O 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

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

⑥ Coded 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

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

⑧ Working 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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25MHz Dual channel oscilloscope PM3212

Re. Extra in- and output circuits;
Battery model PM 3212B

1. EXTRA IN- AND OUTPUT CIRCUITS

The PM 3212 is equipped with facilities to add three 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 (figure 1), on the positions as indicated.

1.1. External Z-modulation input

1.1.1. 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

1.1.2. 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

1.1.3. Fitting the input

Connect one end of the coax. cable to the points indicated in Fig. 2 and the other end to the BNC connector which has been mounted on to the rear of the oscilloscope as described in section 1. Make sure that the coaxial cable is also earthed at the BNC connector end.

1.2. Time-base sweep output

1.2.1. 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

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1.2.2. 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 126 50555
– Transistor BC548C	5322 130 44196

1.2.3. Fitting the output

– Fit the BNC connector as described in section 1.
– Fit the resistors as indicated in Fig. 2.
– Fit the transistor as indicated in Fig. 2.
– Connect one end of the coaxial cable to the points indicated in Fig. 2. and the other end to the BNC connector.
– Make sure that the coaxial cable is also earthed at the BNC connector end.

1.3. Time-base gate out

1.3.1. Characteristics

– Output voltage: high level more than +2,7 V
low level less than 0,5 V
– Internal resistance: 50 ohm
– The output is protected against short-circuits

1.3.2. 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 51,1 ohm	5322 116 54442

1.3.3. Fitting the output

– Fit the BNC connector as described in section 1
– Fit the resistor as indicated in Fig. 2.
– Connect one end of the coaxial cable to the points indicated in Fig. 2 and the other end to the BNC connector.
– Make sure that the coaxial cable is also earthed at the BNC connector end.

2. BATTERY-POWERED OSCILLOSCOPE PM 3212B

The oscilloscope PM 3212B is a model PM 3212 with built-in batteries and charging circuit. All data of the standard model PM 3212 also apply to the PM 3212B model with exception of the following (all these data apply with the batteries inside).

2.1. Temperature range

Without batteries		Same as standard model PM 3212
With batteries:	mains supply	–10 °C . . . +35 °C
	battery supply	–10 °C . . . +40 °C
	during quick charge	–10 °C . . . +45 °C

2.2. Batteries to be used

Maintenance-free lead-acid batteries, 8 V 3 Ah, e.g. Sonnenschein 4Gx3S.

2.3. Operating time with fully charged batteries and graticule illumination at minimum

With uninterrupted use 3 hours minimum; with 50 % on and 50 % off 3 hours and 15 minutes (maximum

'on' duration 30 minutes).
The internal battery is automatically switched off if the voltage drops below 22,3 V. This prevents excessive discharge of the batteries and use of the oscilloscope at a too low supply voltage.

2.4. Battery quick charge

Time required	approximately 10 hours from fully discharged to fully charged
Power consumption	13 W at maximum
Maximum charging current	0,3 A
Charge indication	POWER ON pilot LED blinks once every second
End of charge indication	POWER ON pilot LED blinks once every three seconds

Internal batteries are fully protected against overcharge when aparatus remains in "charge" position for an indefinite periode of time.

2.5. Power consumption with mains supply

Same as standard PM 3212. If the batteries are fully discharged the power consumption is approximately 1 W higher.

2.6. Weight

The instrument with built-in batteries weighs 11 kg.

2.7. Capacitance in relation to earth

Measured with instruments feet standing on an earthed metal plate $\geqslant 1\ m^2$: 160 pF.
Measured with instrument 30 cm above an earthed metal plate $\geqslant 1\ m^2$: 23 pF.

2.8. Supply possibilities

Requirements → / *Condition ↓*	*Mains plug connected to mains (line)*	*ON/OFF to ON*	*External battery connected to rear socket*
Instrument operates on mains supply and internal battery is trickle charged with 30 mA	Yes	Yes	No
Instrument operates on charged internal batteries	No	Yes	No
Internal battery is quickly charged	Yes	No	—
Instrument operates on external battery	No	Yes	Yes
Instrument operates on mains supply or external battery (depending on voltage) and internal battery is trickle charged with 30 mA	Yes	Yes	Yes
Instrument is switched off and batteries disconnected	No	No	—

2.9. Parts list (supplementary to the standard PM 3212)

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
CAPACITORS					
C 1701	4822 124 20484	15UF	-10+50	40	ELECTROLYTIC
C 1702	5322 121 40323	100 NF	10	100	POLYESTER FOIL
C 1703	5322 121 40323	100 NF	10	100	POLYESTER FOIL
C 1704	4822 124 20484	15UF	-10+50	40	ELECTROLYTIC
C 1706	4822 124 20484	15UF	-10+50	40	ELECTROLYTIC
C 1707	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 1708	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 1709	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 1711	4822 124 20482	2,2UF	-10 +100	40	ELECTROLYTIC
C 1712	4822 124 20484	15UF	0	40	ELECTROLYTIC

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
RESISTORS					
R 1701	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1702	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1703	5322 100 10118	22K	20	0,5W	TRIMMING POTM
R 1704	5322 116 50451	21,5K	1	MR25	METAL FILM
R 1706	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1707	5322 116 54629	14K	1	MR25	METAL FILM
R 1708	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1709	5322 116 50451	21,5K	1	MR25	METAL FILM
R 1711	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1712	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1713	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1714	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1716	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1717	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1718	4822 112 21045	4,7	5	4,2W	WIRE-WOUND
R 1719	5322 116 54448	59	1	MR25	METAL FILM
R 1721	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1722	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1723	5322 116 54627	13,3K	1	MR25	METAL FILM
R 1724	5322 116 54627	13,3K	1	MR25	METAL FILM
R 1726	5322 116 54696	100K	1	MR25	METAL FILM
R 1727	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1728	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1729	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1731	5322 100 10118	22K	20	0,5W	TRIMMING POTM
R 1732	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1733	5322 116 54619	10K	1	MR25	METAL FILM
R 1734	5322 116 54619	10K	1	MR25	METAL FILM
R 1736	5322 116 54619	10K	1	MR25	METAL FILM
R 1737	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1738	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1739	5322 116 54668	44,2K	1	MR25	METAL FILM
R 1741	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1742	5322 100 10118	22K	20	0,5W	TRIMMING POTM
R 1743	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1744	5322 116 54619	10K	1	MR25	METAL FILM
R 1746	5322 116 54549	1K	1	MR25	METAL FILM
R 1747	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1748	5322 116 54696	100K	1	MR25	METAL FILM
R 1749	5322 116 54696	100K	1	MR25	METAL FILM
R 1751	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1752	5322 116 54696	100K	1	MR25	METAL FILM
R 1753	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1754	5322 116 54619	10K	1	MR25	METAL FILM
R 1756	5322 116 54619	10K	1	MR25	METAL FILM
R 1757	5322 116 54549	1K	1	MR25	METAL FILM
R 1758	5322 116 50679	237	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
SEMI CONDUCTORS		
V 1701	5322 130 30414	BY164
V 1702	5322 130 30613	BAW62
V 1703	5322 130 34281	BZX79-C15
V 1704	5322 130 30613	BAW62
V 1706	5322 130 44461	BC546B
V 1707	5322 130 34499	BZX79-B20
V 1708	5322 130 34197	BZX79-C12
V 1709	5322 130 34048	BZX75-C2V8
V 1711	5322 130 30613	BAW62
V 1712	5322 130 34048	BZX75-C2V8
V 1713	5322 130 44461	BC546B
V 1714	5322 130 44461	BC546B
V 1716	5322 130 34499	BZX79-B20
V 1717	5322 130 34633	BY227
V 1718	5322 130 34633	BY227
V 1719	5322 130 30613	BAW62
V 1721	5322 130 30613	BAW62
V 1722	5322 130 44357	BD262
V 1723	5322 130 40665	BD138
V 1724	5322 130 30613	BAW62
V 1726	5322 130 44461	BC546B
V 1727	5322 130 34048	BZX75-C2V8
V 1728	5322 130 30613	BAW62
V 1729	5322 130 30432	BYX36-150
V 1731	5322 130 30432	BYX36-150
V 1732	5322 130 30432	BYX36-150
V 1733	5322 130 30768	BZX79-C6V8
V 1734	5322 130 30613	BAW62
V 1736	5322 130 30613	BAW62
V 1737	5322 130 34119	BZX79-C8V2
V 1738	5322 130 30765	BZX75-C3V6
V 1739	5322 130 30765	BZX75-C3V6
V 1741	5322 130 30765	BZX75-C3V6
V 1742	5322 130 44461	BC546B
V 1743	5322 130 34499	BZX79-B20
V 1744	5322 130 44461	BC546B
V 1746	5322 130 44461	BC546B
V 1747	5322 130 30613	BAW62
V 1748	5322 130 44461	BC546B
V 1749	5322 130 30613	BAW62
V 1751	5322 130 30613	BAW62
V 1752	5322 130 30613	BAW62
V 1753	5322 130 30613	BAW62
INTEGRATED CIRCUITS		
D 1701	5322 209 84163	LM741CN
D 1702	5322 209 84163	LM741CN
D 1703	5322 209 84163	LM741CN
D 1704	5322 209 84163	LM741CN
MISCELLANEOUS		
K 1701	4822 280 20064	SAM PEED RELAIS
K 1702	5322 280 84087	RELAIS 24V
L 1701	5322 281 64154	COIL
T 1701	5322 146 44038	TRANSFORMATOR
T 1702	5322 142 64068	TRANSFORMATOR
A1701	5322 216 54154	UNIT (COMPLETE)

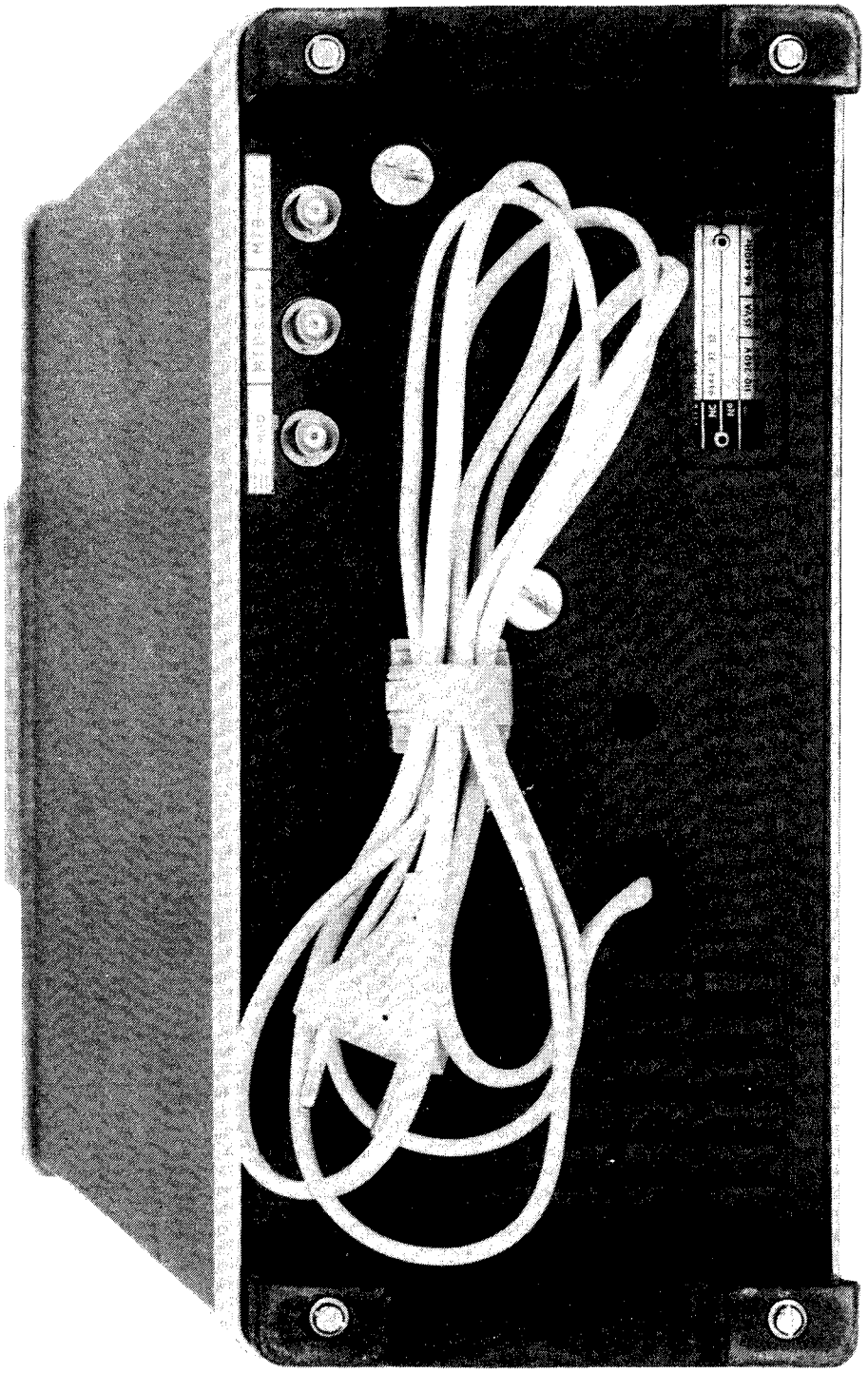

Fig. 1.

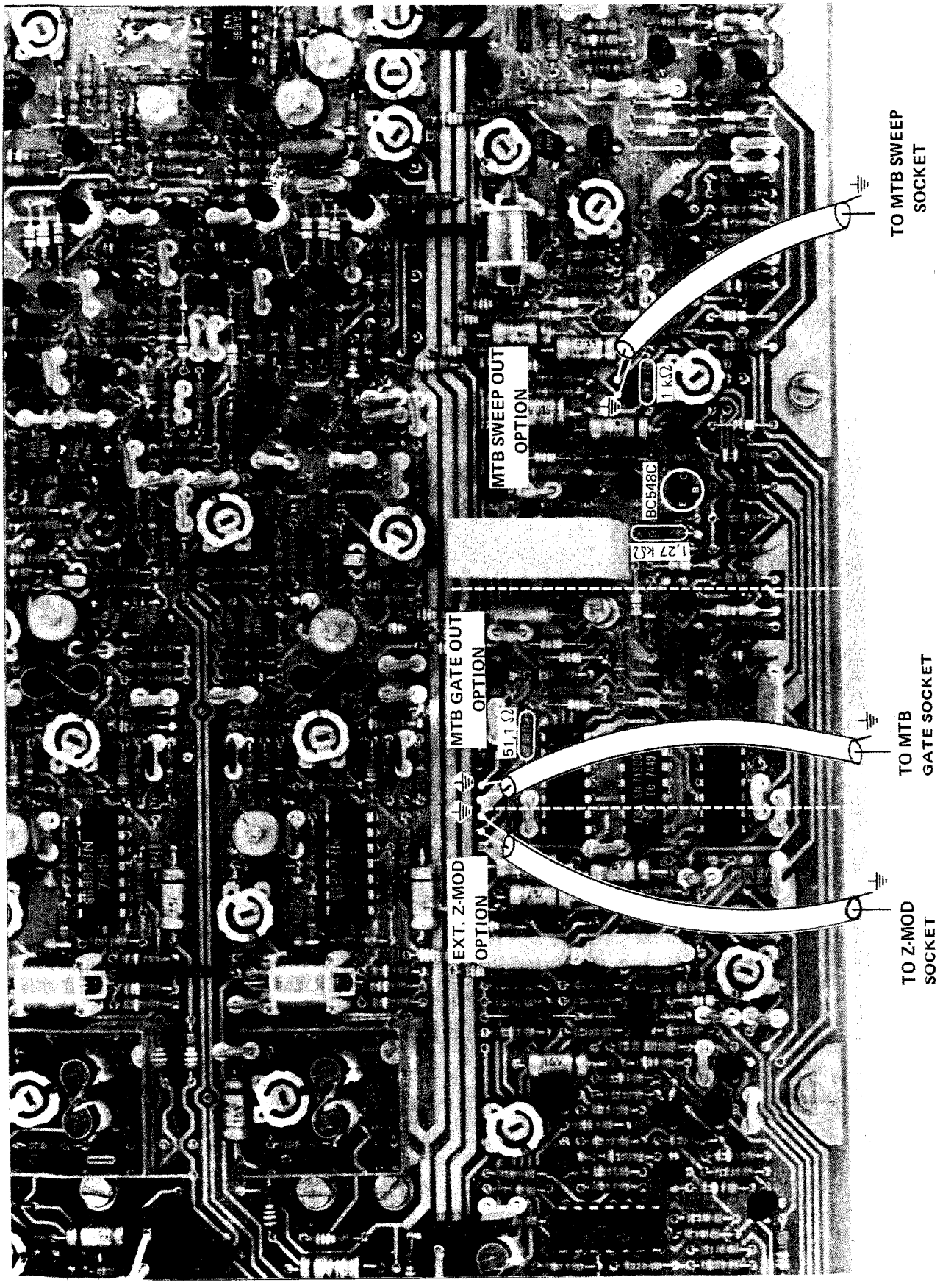
TO MTB SWEEP SOCKET
MTB SWEEP OUT OPTION
1 kΩ
BC548C
1.27 kΩ
MTB GATE OUT OPTION
51.1 Ω
TO MTB GATE SOCKET
EXT. Z-MOD OPTION
TO Z-MOD SOCKET

Fig. 2.

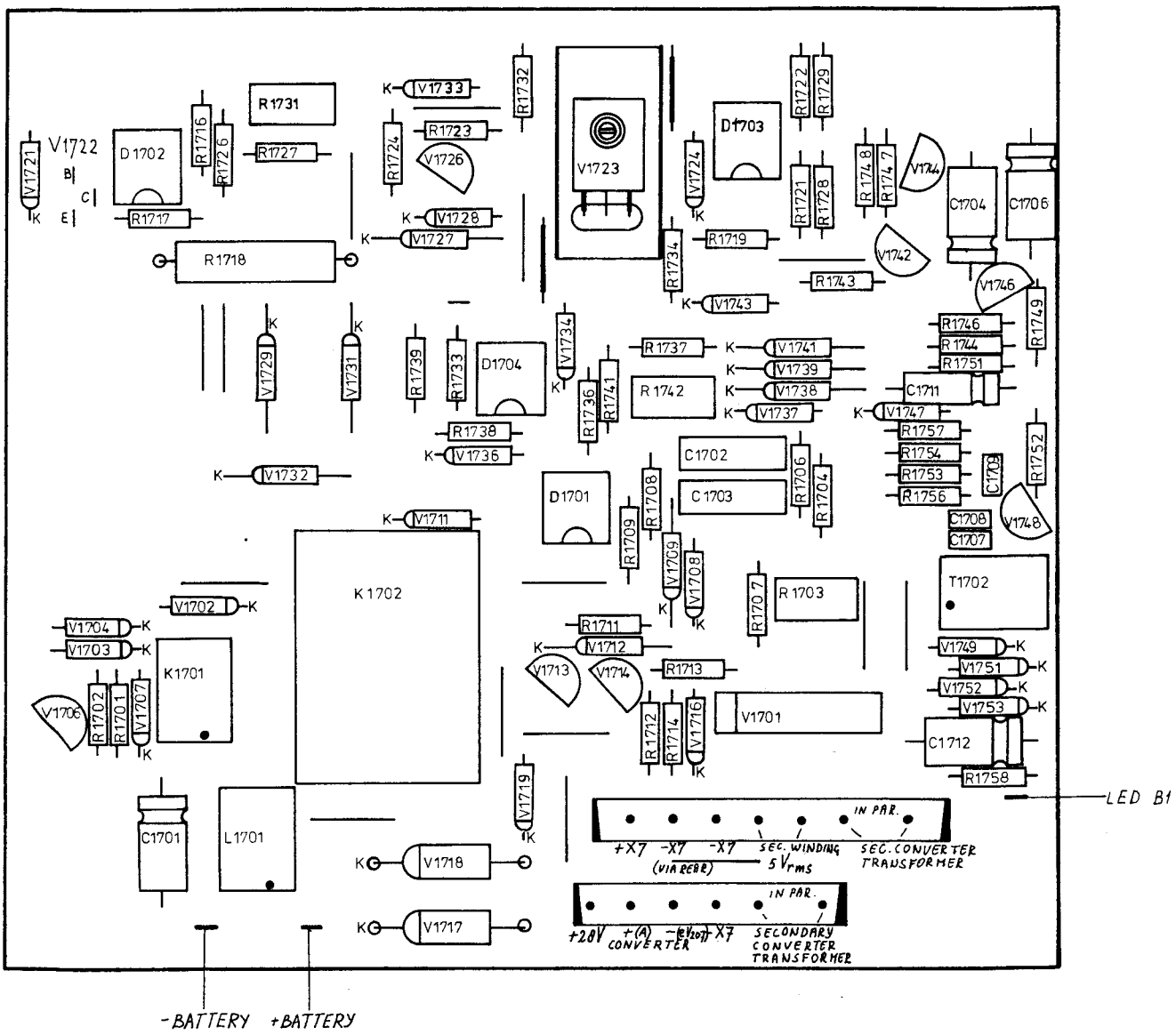
V1722
B
C
E
D1702
R1731
R1727
R1717
R1718
V1723
D1703
D1704
D1701
K1702
K1701
L1701
T1702
R1703
V1701
C1702
C1703
C1704
C1706
C1711
C1712
C1701
V1718
V1717
IN PAR.
+X7 -X7 -X7 SEC. WINDING SEC. CONVERTER TRANSFORMER
(VIA REAR)
5 Vrms
+20V +(A) CONVERTER -(B) X7 SECONDARY CONVERTER TRANSFORMER
LED B1
-BATTERY
+BATTERY

Fig. 3.

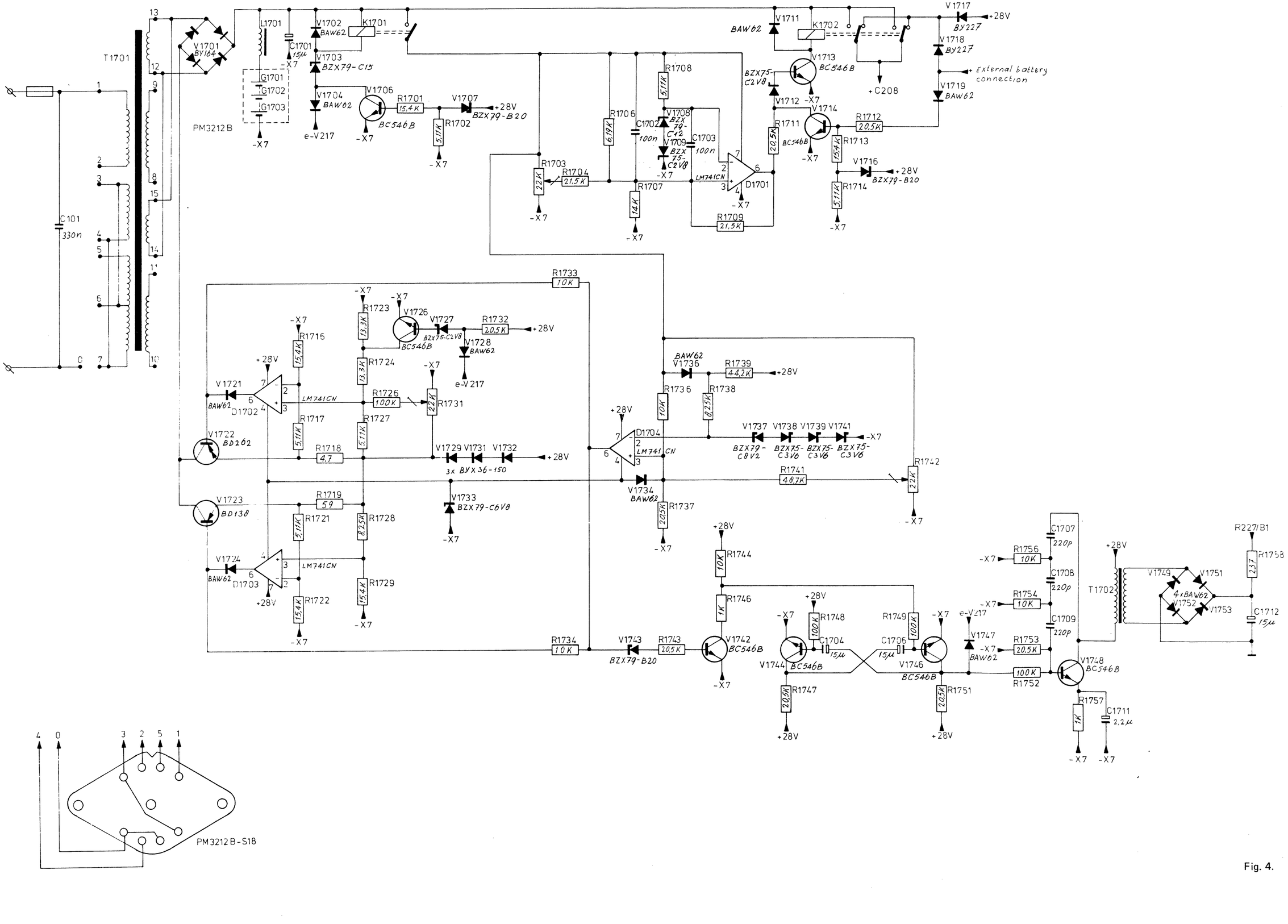
T1701
C101 330n
V1701 BY164
L1701
C1701 15µ
G1701
G1702
G1703
PM3212B
V1702 BAW62
K1701
V1703 BZX79-C15
V1704 BAW62
e-V217
V1706 BC546B
R1701 15,4K
V1707 BZX79-B20
+28V
R1702 5,11K
R1703 22K
R1704 21,5K
R1706 6,19K
R1707 14K
R1708 5,11K
C1702 100n
C1703 100n
V1708 BZX 79-C12
V1709 BZX 75-C2V8
LM741CN
D1701
R1709 21,5K
V1711 BAW62
K1702
V1712
V1713 BC546B
BZX75-C2V8
+C208
V1714
R1711 20,5K
BC546B
R1712 20,5K
R1713 15,4K
V1716 BZX79-B20
R1714 5,11K
V1717 BY227
V1718 BY227
External battery connection
V1719 BAW62
R1733 10K
R1723 13,3K
V1726 BC546B
V1727 BZX75-C2V8
R1732 20,5K
V1728 BAW62
R1716 15,4K
R1724 13,3K
V1721 BAW62
D1702
R1726 100K
R1731 22K
R1717 5,11K
R1727 5,11K
V1722 BD262
R1718 4,7
V1729 V1731 V1732
3x BYX36-150
V1733 BZX79-C6V8
R1719 59
V1723 BD138
R1721 5,11K
R1728 82,5K
V1724 BAW62
D1703
R1722 15,4K
R1729 15,4K
V1736 BAW62
R1739 4,42K
R1736 10K
R1738 0,25K
D1704
LM741CN
V1734 BAW62
R1737 20,5K
V1737 V1738 V1739 V1741
BZX79-C8V2
BZX75-C3V6
R1741 40,7K
R1742 2,2K
R1744 10K
R1746 1K
V1742 BC546B
V1743 BZX79-B20
R1734 10K
R1743 20,5K
V1744 BC546B
R1748 100K
C1704 15µ
R1747 20,5K
C1706 15µ
R1749 100K
V1746 BC546B
R1751 20,5K
V1747 BAW62
R1753 20,5K
R1754 10K
R1756 10K
R1752 100K
C1707 220p
C1708 220p
C1709 220p
T1702
V1748 BC546B
R1757 1K
C1711 2,2µ
V1749
V1751
4xBAW62
V1752
V1753
R1758 237
C1712 15µ
R227/B1
4 0 3 2 5 1
PM3212B-S18

Fig. 4.

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780517 **TEST AND MEASURING EQUIPMENT** OSC27

OSCILLOSCOPE PM 3212

Already published: OSC 1

Subject: Alteration of /01/02/03 versions.

- The service ordering number for the line cable clamp on the rear panel of the /01/ and /02/ versions is 5322 290 44028.
- Page 103 of Instruction Manual 9499 440 17402

  Item 20 must be grip 5322 466 64162
  Item 22 must be bracket 5322 498 54072
- The service ordering number of the GM-type C.R.T. D14-125 GM/08 is 5322 131 24049.
- During the production of the /02/ version the following modifications are introduced:
  - An improved type of line cable cleat is used (Item 35 on page 103 of the Instruction Manual 9499 440 17402) Service ordering number: 5322 325 64083.
  - Potentiometer R3 of 1 kΩ is replaced by a potentiometer with an improved switch. Service ordering number: 5322 101 44036.
  - To improve the bandwidth of the vertical amplifier the resistors R816 and R818 are removed and replaced by interconnection wires.
- During the prodcution of the /03/ version the under mentioned modifications are introduced:
  - To decrease the tolerance in the length of the trace when LINE is selected in the X-Deflection mode (the length of the trace should then be 8 divisions) capacitor C201 is replaced by a capacitor of 3,3 nF. Service ordering number: 4822 122 30099.
  - For improvement of drift properties FET transistor pairs V504 and V604 (ON 561) are replaced by the FET transistor pairs BFS 21A. Service ordering number: 5322 130 40709.
  - The turn of trimming potentiometer R1232 is increased from about 30° to about 270°.
    R1222 is replaced by 5,11 kΩ 5322 116 54595
    R1223 is replaced by 7,5 kΩ 5322 116 54608
    R1229 is replaced by 14,7 kΩ 5322 116 54632
    R1236 is replaced by 3,83 kΩ 5322 116 54589
    R1230 of 10,5 kΩ (5322 116 50731) is inserted between the junction of V1218 - R1229 and the junction of R1232 - R1236.
    The positions of R1229 and V1218 have been interchanged.

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OSCILLOSCOPE PM 3212

Already published: OSC 1 - OSC 27

Subject: Alteration of the /04 version.

- During the production of the /04 version the following modifications are introduced:
  - The REED relais K501, K601 and K1401 are replaced by the type with service ordering number 5322 280 24103.
  - Resistor R1416 is replaced by 287 Ω (5322 116 54506) for better adjustment of the GAIN X10 by R1419.
  - For better adjustment of the GAIN X1 of the A vertical amplifier the values of the following resistors have been changed.
    R541 is replaced by 215 Ω 5322 116 50457
    R542 is replaced by 169 Ω 5322 116 54489
  - 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.
  - To decrease the temperature effect on the bandwidth, capacitors C512 - C514 - C612 and C614 are removed. Also the resistors R556 - R557 - R656 and R657 are removed and replaced by interconnection wires.
  - An improved type of 50 Ω sockets and plugs is used.
    - Coaxial socket, vertically 5322 268 24116 mounted on p.c. boards.
    - Contact pin for coax. socket 5322 268 14141
    - Set of coaxial cables 5322 320 14102

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OSCILLOSCOPE PM 3212

Already published: OSC 1 – OSC 27 – OSC 36

Subject : Alteration of the /05 and /06 versions

– During the production of the /05 version the following modifications are introduced:
  - Diodes V201, 202, 203 and 204 (BY127) are replaced by diodes of type BY227. (Service ordering number 5322 130 34633).
  - For better performance in X-deflection via Y_A and Y_B the 30.1 Ω resistors R552, 553, 652, 653 are replaced by 34.8 Ω resistors (Service ordering number 5322 116 54027)

– During the production of the /06 version the following modifications are introduced:
  - To obtain a better bandwidth in the 2mV/div position the following components have been changed: C817 33pF connected between R822 and ground (Service ordering number 4822 122 31067) C819 22nF removed. R816, R818 30.1 Ω instead of interconnection wires. D801 instead of CA3085 now SL 3145E.
  - To prevent oscillations in the X-deflection circuit C1402 has been changed from 22nF into 100pF and C1403 is removed.

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800923 OSC 79

OSCILLOSCOPE PM 3212

Already published: OSC 1 - OSC 27 - OSC 36 - OSC 47

Subject: 1. Alteration of the /06 version
2. Alteration of the /07 version
3. Survey of publications to be used for the several versions

1. During the production of the /06 version the following modifications are introduced:

- To obtain a better square wave response capacitor C608, (8,2 pF) is replaced by a trimming capacitor of 22 pF (4822 125 50045)
- To prevent oscillations in the X-amplifier capacitor C1402 is changed from 100 pF to 1nF (4822 122 31175)

2. During production of the /07 version the following modifications have been introduced:

- To improve the quality trimming capacitor C318, 5,5 pF is changed to another type of 3pF (5322 125 54026)
- To prevent oscillations two capacitors of 33 pF (4822 122 31067) are added:
  C510 between R552/R553 and ground
  C610 between R652/R653 and ground
- To simplify production the following values are changed:

R812	was	2,2 kΩ	new	4,7 kΩ	5322 100 10114
R813	was	4,7 kΩ	new	10 kΩ	5322 100 10113
R814	was	1 kΩ	new	2,2 kΩ	5322 101 14008
C808	was	68 pF	new	47 pF	4822 122 31072
C809	was	22 pF	new	40 pF	4822 125 50092
C811	was	22 pF	new	40 pF	4822 125 50092

- To obtain a better "gain X1" adjustment R852 and R853 are changed from 44,2 Ωinto 55,1 Ω (5322 116 54442).

3. Publications to be used for version:

Version	Manual	Service information	Main differences
/01	9499 440 15802	OSC 1 + OSC 27	–
/02	9499 440 15802	OSC 1 + OSC 27	Bandwidth improvement
/03	9499 440 17402	OSC 27	Drift improvement
/04	9499 440 17402	OSC 27 + OSC 36	Temperature effect improvement
/05	9499 440 17402	OSC 27 + OSC 36 + OSC 47	BY 127 replaced by BY 227
/06	9499 440 17402	OSC 27 + OSC 36 + OSC 47 + OSC 79	Bandwidth improvement
/07	9499 443 00602	OSC 79 part 2 only	Complete upgrading*

* The amplifier PCB of the PM 3212/07 is identical to the PM 3216 amplifier PCB except for the hold-off circuit components and some bandwidth determining components.

NOTE: For the PM3212 B the above mentioned manuals together with manual 9499 443 01202 have to be used.

9499 448 15111

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OSCILLOSCOPES PM3212-FAM.

re: New AMPL/DIV and TIME/DIV switches with gold contacts.
reason: Better quality!

For Service purposes, the AMPL/DIV and TIME/DIV switches of the PM3212-fam. are replaced by gold contact versions.
In future automatically these switches are delivered from Concern Service.

The following list includes a survey of the new switches with gold contacts.

Description	Code nr.	Used in PM....	Remarks
AMPL/DIV switch	5322 105 30139	3212,3214,3215,3216 3217,3218,3219,3305	Set of 2 switches
TIME/DIV switch	5322 278 90511	3212	incl. var.control and inner shaft.
TIME/DIV switch	5322 282 10201	3215,3216	
MTB TIME/DIV switch	5322 278 90512	3214	incl. var.control and inner shaft.
MTB TIME/DIV switch	5322 282 10203	3217,3218	
MTB TIME/DIV switch	5322 276 11203	3219	
DTB TIME/DIV switch	5322 278 90513	3214	incl. var.control and inner shaft.
DTB TIME/DIV switch	5322 282 10204	3217,3218	
DTB TIME/DIV switch	5322 276 11204	3219	

As additional information the following list includes the inner shafts for the switches.

Inner shaft for AMPL/DIV switch, used in PM3215 and PM3217	5322 535 91655
Inner shaft for AMPL/DIV switch, used in PM3219	5322 535 91219
Inner shaft for TIME/DIV switch, used in PM3215	5322 535 91654
Inner shaft for MTB or DTB switch, used in PM3217	5322 535 91653
Inner shaft for MTB or DTB switch, used in PM3219	5322 535 70622

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Interne Mitteilung

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Von EWI VFN 52, Herrn Schäfer

An V E R T E I L E R

Ihre Zeichen	Ihre Nachricht vom	Unsere Zeichen/Hausruf	Datum
		VFN52/Sch/da 040 5070244	Hamburg, den 15.November 1979

Betr.: PM 3212 und PM 3214, Transistorausfall im Triggerverstärker

In der Betriebsart "Triggerung extern mit AC-Kopplung" werden beim Umschalten auf interne Triggerung die Transistoren V 352 bei PM 3212 bezw. V 352 oder V 453 bei PM 3214 zerstört, wenn an dem externen Triggereingang ein Gleichspannungspegel von z.B. 200 Volt anliegt.

C 1003 bezw. C 1001/1101 entlädt sich in vorgenannte Transistoren. Je nach Polarität der extern angelegten Gleichspannung können auch noch weitere Transistoren vor den genannten defekt werden.

Die Zerstörung von V 352 und V 453 kann durch Einbau von je 3 Schutzdioden BAW 62 verhindert werden.

Einbauposition siehe beiliegende Schaltbilder.

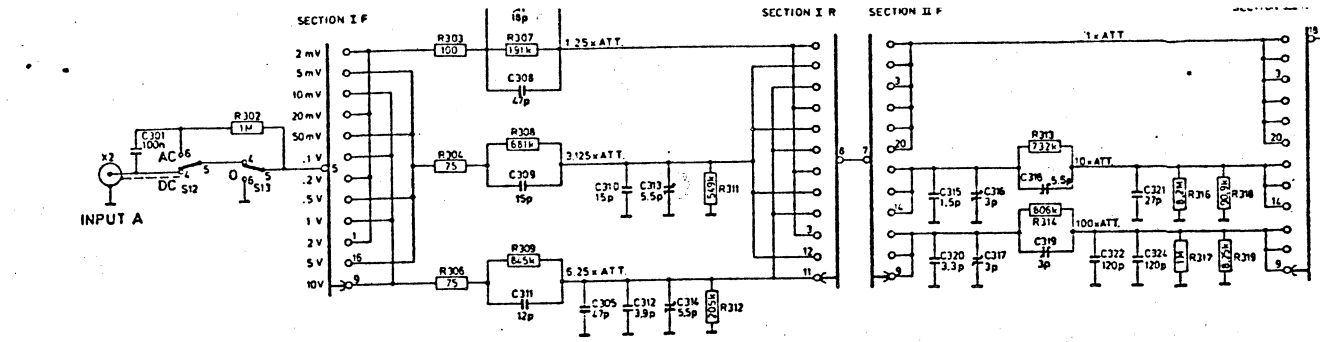
Mit freundlichen Grüssen
EWI - S E R V I C E -

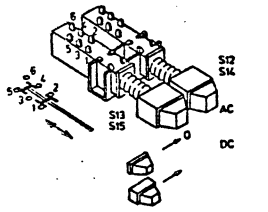
Schä
(Schäfer)

Verteiler:

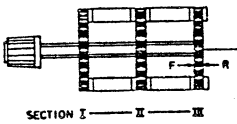
EWI-Service		Essen	Herr Gerstenberg
"		München	Herr Lauenstein
"		Stuttgart	Herr Loebell
"		Hamburg	Herr Mergelsberg
"		Berlin	Herr Rosacker
"	V S G	Kassel	Herr Schade

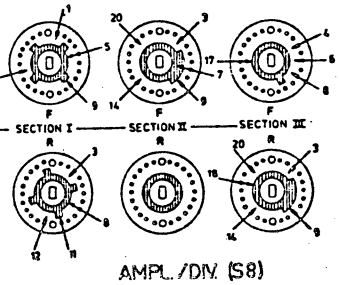
Form. 02001





AMPL./DIV. SWITCH (S6/S8)

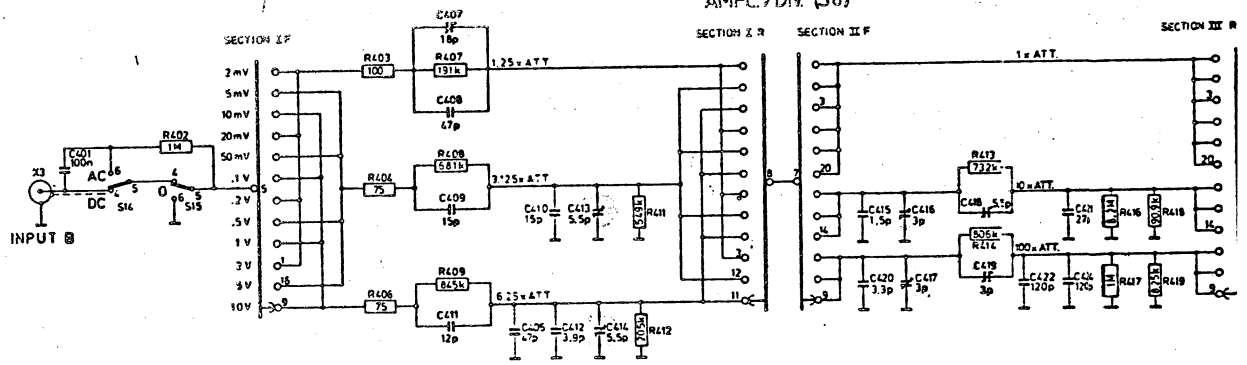




BOTH FRONT AND REAR SECTIONS OF THE AMPL. DIV. AND THE TIME/DIV. SWITCHES ARE SEEN FROM THE FRONT

ALL PUSHBUTTONS ARE DRAWN IN THE RELEASED POSITIONS.

AMPL./DIV. (S8)



PM 3212

3x BAW62