50 MHz Dual Channel Oscilloscope
PM3215 / PM3215U

Service Manual

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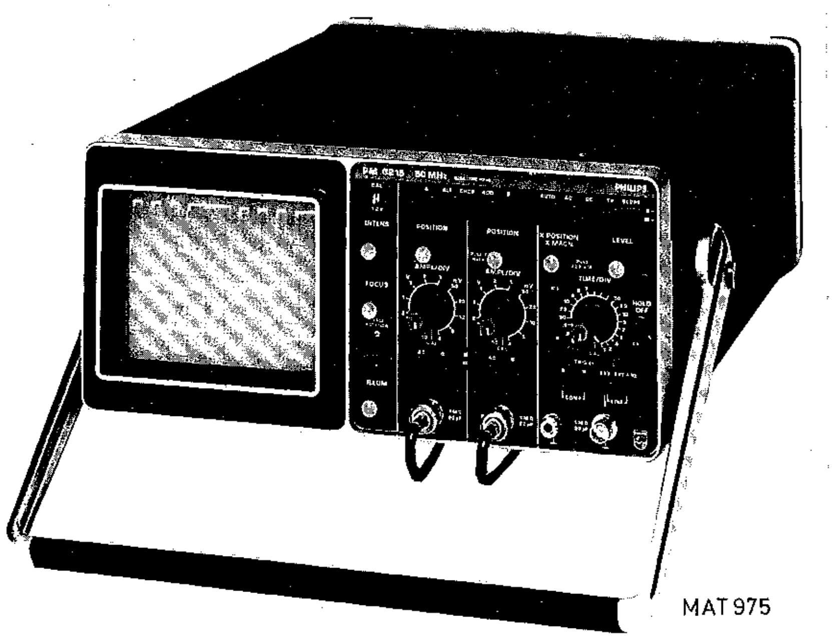


MAT 975

PHILIPS

IMPORTANT

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

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

WICHTIG

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

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

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparation)
Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

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

CONTENTS

1. INTRODUCTION

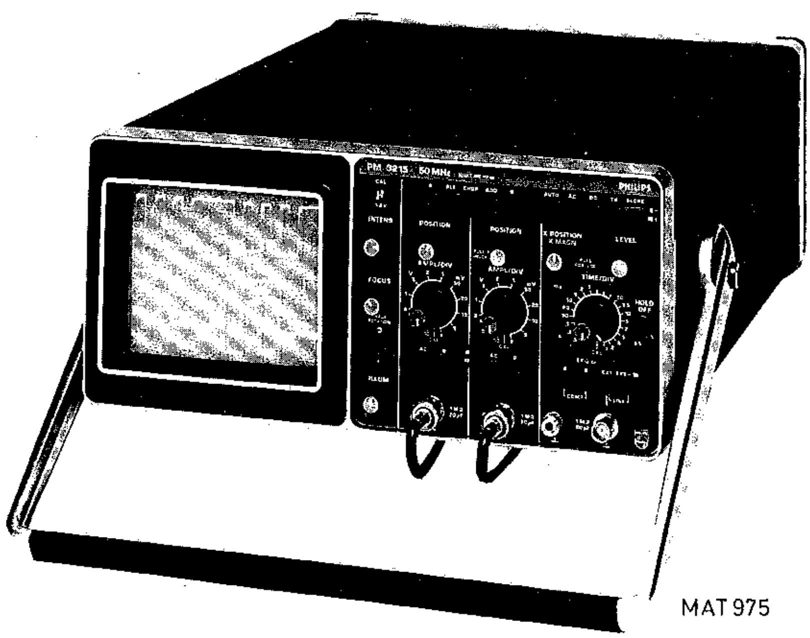
1.1. GENERAL

The 50 MHzdual-channel oscilloscope PM 3215 and PM 3215U 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.

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

This service manual contains all service information about the PM3215 and PM3215U.
For operating instructions, refer to the Operating Manual which also contains accessory information.



MAT 975

Fig. 1.

1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 first edition for Class I instruments* and UL1244** and has been supplied in a safe condition. The present Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- Properties expressed in numerical values with tolerance stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.
- Inaccuracies (absolute or in %) relate to the indicated reference value.

* : only PM3215
** : only PM3215U

	Designation	*Specification*	*Additional information*
1.2.1.	**C.R.T**		
	Type	D14-125 GH/08	
	Measuring area	8x10 divisions	1 div. equals 1 cm
	Screen type	P31 (GH)	P7 (GM) optional
	Total acceleration voltage	10kV	
	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 ... 50MHz (−3dB) AC : 2Hz ... 50MHz (−3dB)	
	Rise time	⩽ 7ns	
	Pulse aberrations	⩽ ± 3% (⩽ 5% pp)	Measured at 6 div. amplitude and applied rise time of ⩾ 1ns
	Deflection coefficients	2mV/DIV ... 10V/DIV	1-2-5 sequence
	Continuous control range	1 : ⩾ 2,5	
	Deflection accuracy	± 3%	
	Input impedance	1MΩ/20pF	
	Input RC time	0.1s	Coupling switch to AC
*	Rated input voltage	42V (dc + ac peak)	Test voltage: 500V (r.m.s.) according to IEC348
** ⚠	Maximum safe input voltage	400V (dc + ac peak)	
	Chopping frequency	≈ 500kHz	
	Vertical positioning range	16 divisions	

Designation	Specification	Additional Information
C.M.R.R. in A-B mode	⩾ 40dB at 1MHz	After adjustment at d.c. or low frequencies
Cross talk between channels	–40dB or better at 10MHz	Both attenuators in the same setting
Instability of the spot position:		
Temperature drift	⩽ 0,3div/hour	

1.2.3. Time base

Time coefficients	0.5s/DIV ... 0.1µs/DIV	1-2-5- sequence
Continuous control range	1 : ⩾ 2.5	
Coefficient error	± 3%	
Magnification	10x	
Magnifier error	± 2%	
Maximum effective Time coefficient	10ns/DIV	

1.2.4. Triggering

	Source	Ch. A, Ch.B, Composite, External and line	
	Trigger mode	Automatic, normal AC normal DC and TV	TV line or frame switched by TIME/DIV switch TV line: 1µs/div ... 20µs/div. TV frame: 50µs/div. ... .5s/div.
	Trigger sensitivity	Internal: 1.0 DIV at 50MHz External: 0.2Vpp at 50MHz Ext÷ 10 : 2Vpp at 50 MHz	
		TV int.:0.7 DIV TV ext.: 0.15Vpp	Sync pulse amplitude Sync pulse amplitude
	Triggering frequency range	AUTO: 20Hz ... ⩾50MHz AC: 5Hz ... ⩾ 50MHz DC: 0Hz ... ⩾ 50MHz	Typically, stable triggering can still be obtained at 50MHz and 2 div. or 1Vpp amplitude
	Level range	AUTO: proportional to peak-to peak value of trigger signal.	
		AC, DC: 8 div. at internal trigg., 1,6V at external trigg., and 16V at ext. ÷ 10	+ or –4 div. and + or –0,8V ref. to centre of screen + or –8V ref. to centre of screen
	Triggering slope	Positive or negative going	
	Input impendance	1MΩ/20pF	
*	Rated input voltage	42V (dc + ac peak)	Test voltage: 500V (r.m.s.) according to IEC348
** ⚠	Maximum safe input voltage	400V (dc + ac peak)	
	Hold-off time	variable	

	Designation	Specification	Additional Information
1.2.5.	**X Deflection**		
	Source	A, B, EXT., EXT., ÷ 10 or LINE	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: 0.2V/DIV EXT.: ÷ 10 : 2V/DIV LINE ≥ 8 divisions	
	Deflection accuracy	± 10%	
	Frequency range	DC: 0 ... 1MHz (−3dB) AC: 5Hz ... 1MHz (−3dB)	
	Phase shift	≤ 3° at 100kHz	
	Dynamic range	24 divisions	For frequencies ≤ 100kHz
1.2.6.	**Calibration generator**		
	Output voltage	1.2Vpp	Square wave
	Accuracy	± 1%	
	Frequency	≈ 2kHz	
1.2.7.	**Power supply**		
	AC supply:		
	Nominal voltage range (on line-mains voltage adaptor)	110, 127, 220 or 240 Vac ± 10%	
	Nominal frequency range	50 ... 400Hz ± 10%	
	Power consumption	28W max.	At nominal mains voltage
	Battery supply:		
	Voltage range	22-27Vd.c.	Battery minus (−) connected to chassis
		20-28V	With relaxed specifications
	Current consumption	1.1A max.	
	Capacity to earth	110pF	Measured with rubber feet on earthed metal plate of 1m²
		23pF	Measured 30cm above earthed plate of 1m²

1.2.8. Environmental characteristics

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, THE NETHERLANDS.

Ambient temperatures:	
Rated range of use	+ 5°C ... +40°C
Operating	−10°C ... +55°C
Storage and transport	−40°C ... +70°C
Altitude:	
Operating to	5000m (15000 ft)
Non-operating to	15000m (45000 ft)
Humidity	21 days cyclic damp heat 25°C–40°C, R.H. 95%
Shock	30g: half sinewave shock of 11ms duration: 3 shocks per direction for a total of 18 shocks.
Vibration	Vibrations in three directions with a maximum of 15min. per direction, 5 – 55Hz and amplitude of 0.7mm_{pp} and 4g max. acceleration. Unit mounted on vibration table without shock absorbing material.
Electromagnetic interference	Meets VDE 0871 and VDE 0875 Grenzwertklasse B.

1.2.9. Mechanical data

Dimensions:

Length	445mm	Handle and controls excluded
Width	300mm	Handle excluded
Height	137mm	Feet excluded
Weight	7.9kg	

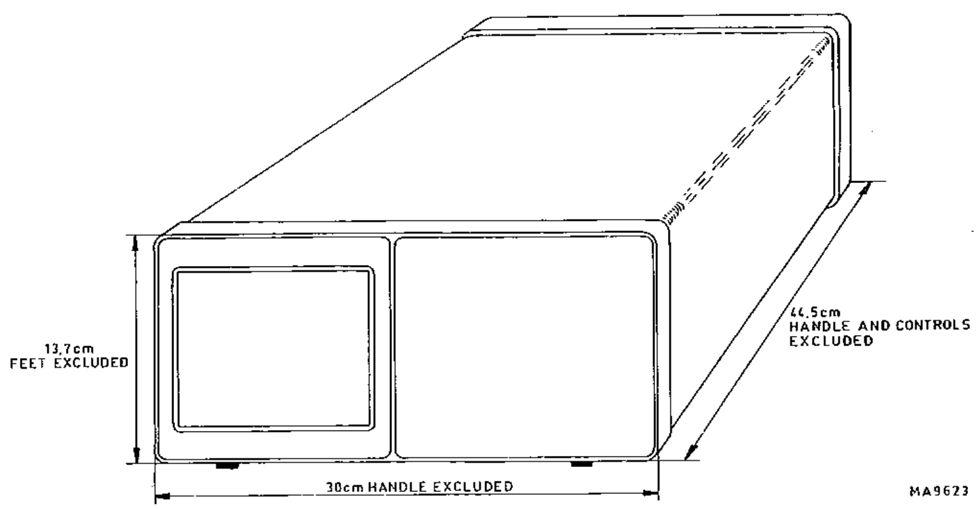


Fig 1.2.

1.2.10 Z-mod input

0V=off

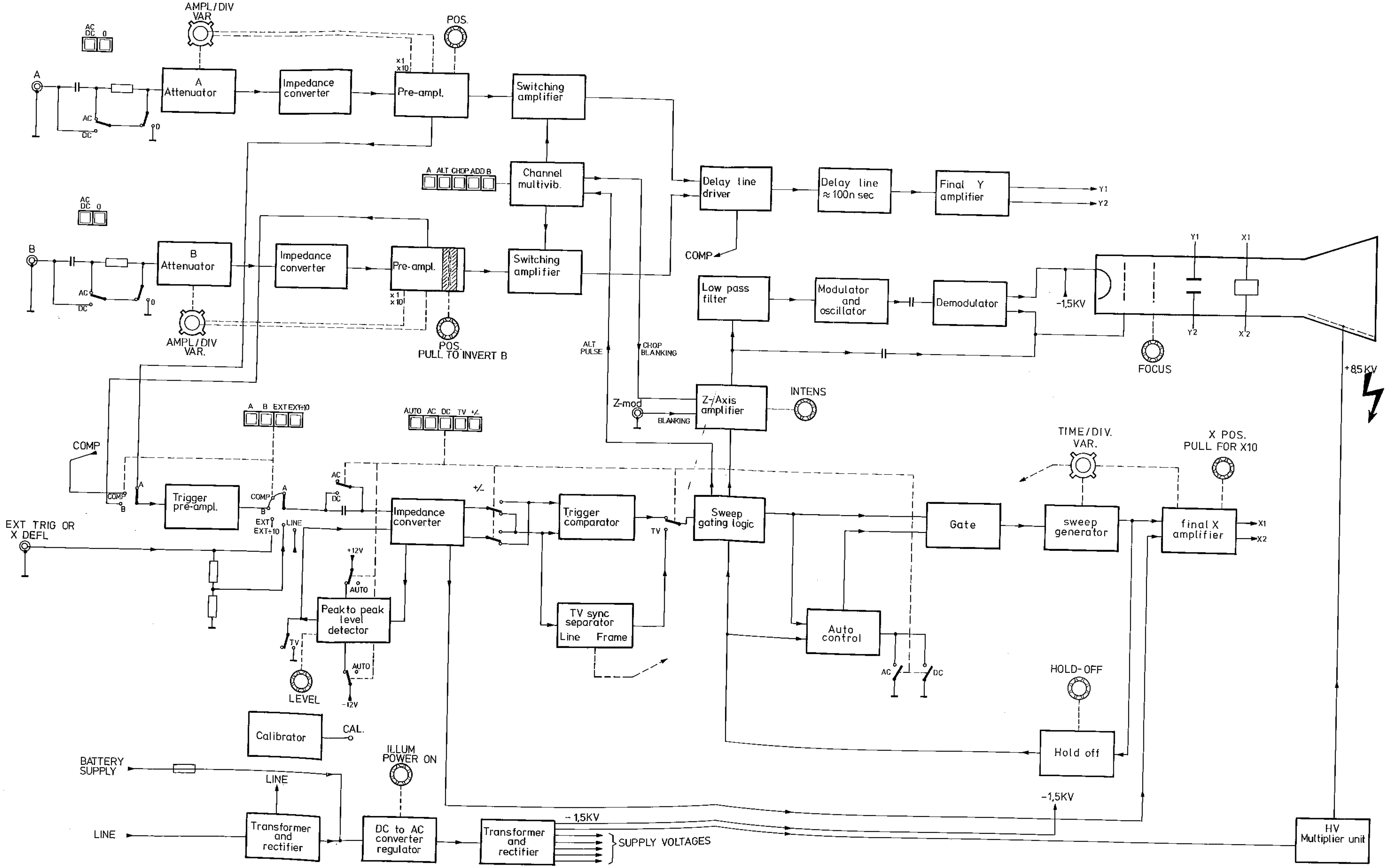


Fig. 2.1.

BLOCK DIAGRAM

2. CIRCUIT DESCRIPTIONS

In chapter 2.1. the block diagram description is given and in the chapters 2.2. – 2.7. the detailed circuit information is described.
Additional the most important characteristics of the analog and digital circuits are described in chapter 2.8.

2.1. BLOCK DIAGRAM DESCRIPTION

This chapter serves to explain the main functions of the oscilloscope.

2.1.1. Y Channel

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line. The channel multivibrator is operated by a pulse at the end of the sweep, and offers an uninterrupted display of the A and B waveforms in the ALT mode. In the 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.

2.1.2. 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.

2.1.3. 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. 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.

2.1.4. 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

2.1.5. 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. Moreover the trace can be blanked by a signal applied to the external Z-mod input.

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.

2.1.6. Power supply

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

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

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

2.2. DESCRIPTION OF THE VERTICAL SECTION

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

A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube.

The individual stages of the vertical deflection system are now described in some detail.

As the signal paths for channel A and channel B are basically identical, only the channel B signal path is described.

2.2.1. Input coupling

Input signals connected to the BNC input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected.

In the AC position of S14, there is a capacitor (C401) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier.

In position DC of switch S14, the input signal is coupled directly to the step attenuator.

At the same time, blocking capacitor C401 is discharged via R402, to prevent damage of the circuit under test by a possible high charge.

S15 (0) isolates the B input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

2.2.2. Input attenuator

The input attenuator is a frequency-compensated, high-impedance voltage divider with twelve positions. The overall attenuation of the stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the twelve positions of the frontpanel AMPL/DIV attenuator switch S8.

The first divider sections attenuate by factor of 1.25, 3.125 and 6.25 and the second divider sections attenuate by a factor of 1x, 10x and 100x.

With the overall combinations of attenuation, nine different deflection coefficients are realised from 20 mV/div to 10 V/div in a 1-2-5-sequence. Only for the most sensitive positions 2 mV/div, 5 mV/div and 10 mV/div of AMPL/DIV attenuator switch S8, the gain of the Y amplifier is increased by a factor of 10.

The input capacitance of the attenuator cannot be adjusted in the individual positions. Small differences of approx. 1 pF are allowed.

Capacitor networks are provided in the voltage divider sections to make them frequency independent.

2.2.3. Impedance converter

The impedance converter is formed by V604 (two matched field-effect transistors). The two FET transistors are used in source follower configuration.

The signal level on the gate (and on the source) of the upper FET amounts to 1,6 mV/div or 16 mV/div.

Diode V601 together with the output impedance of the attenuator and also the attenuator action protects the

2.2.4. Preamplifier

The input stage formed by D601 (5 transistors) is switched in a Cherry-Hooper configuration and direct coupling is employed throughout.

In the positions 20 mV/div — 10 V/div of the AMPL/DIV switch S8, contact K601 is open and the gain is determined by

$$\frac{R628 + R632}{R611 + R612} = \text{approx. } 1{,}8x$$

If K601 is closed (in positions 2 mV/div, 5 mV/div and 10 mV/div) the gain of this stage is increased by a factor of 10. This is accurately adjusted with R621.

To prevent jumping of the trace when K601 is switched with the input short circuited, no voltage must be present across these contacts. R604 (attenuator balance) serves this purpose.

R8 in conjuction with R622, R623, R624 and R626 forms the vernier control. In the calibrated position (R8 is 1 kohm) the transfer of this network is 0,85x. With R8 to its minimum position (0 ohm) the transfer is 0,3x. Thus we have a control range of 3x.

V608, V609, V613, V614, V616 and V617 form a symmetrical cascode circuit supplying an output CURRENT to the channel switch.

The transfer conductance of this stage is:

$$\frac{I_{out}}{U_{in}} = \frac{1}{R641 \,//\, (R637 + R638) \,//\, (R646 + R647 + R648)} = 7 \text{ mA/V}$$

The signal level at the input of this stage is approx. 24 mV/div equivalent to approx. 170 μA/div at the output.

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

2.2.5. Trigger pick-off

The trigger signal is picked-off at the emitters of V608 and V609, a signal source with a low internal resistance, by the series feed-back stage V611 and V612.

From this stage the trigger signal current is fed asymmetrically to the trigger selector via a 50 Ω cable.

2.2.6. Normal invert switch

The B channel has a provision for inverting the polarity of the Y signal. Push-pull switch S4, PULL TO INVERT B, is mounted on the shaft of front-panel control B POSITION. In the invert position of the switch the normal signal paths are blocked because V613 and V614 are switched off.

Inversion is achieved by V616 and V617 providing alternative paths for the signal when their bases are switched less positive by S4. Possible unbalance between the two positions of the switch can be compensated by preset potentiometer R647 (Norm invert balance).

2.2.7. Position control

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

2.2.8. Channel multivibrator

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

With ALT (S1B) depressed: channels A and B are alternately displayed.
This push-button is a dummy and has no contacts, but it releases all the other pushbuttons of the display-mode controls. In this mode there is a DC path via R704 between the two emitters, the circuit is bi-stable and one of the diodes is conductive.
V1201 is not conducting in ALT mode and negative going alternate pulses derived from the time-base generator are fed to the circuit. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.

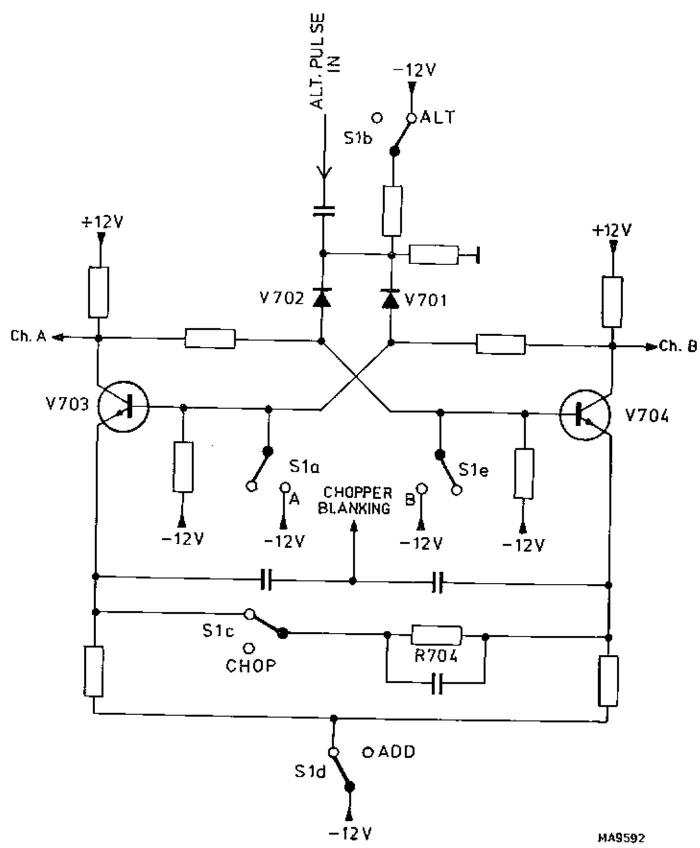


Fig. 2.2. Simplified diagram of the channel multivibrator

In the ALT mode −12 V is applied via S1A, S1C, S1D and S1E and R710 to transistor V1506 in the beam blanking amplifier.
This transistor is then blocked and the only control signal for the beam unblanking amplifier is the normal unblanking pulse coming from the time-base circuit.

With CHOP (S1C) depressed: channels A and B are chopped.
In this mode the circuit acts as a chopper generator. S1C is open then, the DC path between the emitters of V703 and V704 is interrupted and the circuit is a-stable. Both diodes V701 and V702 are then turned-off and the circuit starts oscillating, the oscillating frequency being approx. 500 kHz.
During the switching transients in the CHOP mode, the c.r.t. is blanked with the aid of differentiated chopper blanking pulses (at the junction of R703 and C702) which are fed to the Z-amplifier.

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

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

2.2.9. Delay line driver

The symmetrical delay line is sandwiched between a series feed-back push-pull amplifier (called CHERRY) and a shunt feed-back push-pull amplifier (called HOOPER), consisting of integrated circuit D801.
Such an amplifier combination is called "CHERRY-HOOPER".
The series feed-back stage receives a signal of approx. 30 mV/div which is obtained from a signal current of 0,17 mA/div from the channel switch, multiplied by the value of the load resistance R803 + R804 = 200 Ω.
The emitter impedance of the series feedback stage consists besides RE = R819 + R821 of the parallel circuit of a number of RC networks. As the delay line is a source of distortion for higher frequencies, these networks are realizing the necessary delay line compensation.
At the input side, delay line D802 terminates in R828 and R829 (totally 200 Ω).
The delay line itself is a symmetrically mount spiralized cable with a characteristic impedance of 200 Ω and a delay of 110 nsec/m. At the output side, the cable terminates via R831 and R832 in the virtual earth points of the parallel feed-back stage (HOOPER). The input impedance on these virtual earth points is 14 Ω. This value in series with the 86.6 Ω of R831 and R832 forms the correct termination for the delay line. C814 and C816 are for HF correction.

2.2.10. Composite trigger pick-off

The composite trigger signal is picked-off at the emitters of the CHERRY stage (D801), a signal source with a low internal resistance, by the series-feedback stage V802 and V803. From this stage the composite trigger signal current is fed asymmetrically to the trigger selector via a 50 Ω cable.

2.2.11. Final Y amplifier

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

2.3. TRIGGERING

The trigger source switches for triggering the time-base generator, can select any of the following input sources:
- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal composite signal of channel A and channel B
- a signal derived from the mains supply
- an external source
- an external source divided by 10

All these sources can be used for both triggering and X deflection purposes. Source selection is done by means

2.3.1. Trigger source selection and preamplifier

The signal currents (60 μA/div) of the three trigger pick-off stages are, after selection by S16C and S16D, amplified to a level of 100mV/div by a shunt feed-back stage + emitter follower stage consisting of V351 and V352. After this stage there is a selection between its output signal, a signal on the external socket and a signal with the line frequency by means of S16A and S16B. Signals that are not used are short-circuited to mass. The externally applied signal is attenuated by a factor of two or twenty (depending on position of EXT and EXT ÷ 10) allowing standardisation of the input impedance of the EXT socket to 1MΩ//20pF.

2.3.2. Impedance converter

The trigger signal of 100mV/div is fed via the AC-DC coupling switch S2C to a FET (V1006) in source follower configuration.
From here the signal is applied via an emitter follower to the ± slope selection switch S3. This selection switch enables triggering on either the positive-going or the negative-going edge of the triggering signal.

2.3.3. Trigger comparator

From the ± slope selector switch S3 the signal is fed via a common emitter amplifier D1001(123/345) to the output shunt feed-back amplifier V1014 via the TV mode switch S2D. The voltage gain is high (28x) but its dynamic range is small (2.8V_{p-p} at the output). This is because of the tail current of the symmetrical common emitter stage is 2mA. The current sweep at the output of this stage is consequently 2mA at max. which is transformed into a 2,8V max. voltage sweep at the output of the shunt feed-back amplifier V1014. This means that the trigger amplifier is completely driven at a trace height of 1 div. Which division on the screen this is, depends on the position of the LEVEL control R5.
With AC (S2B) or DC (S2C) depressed, the range of the LEVEL control is fixed. The DC voltage at the wiper of LEVEL control R5, which is fed to the FET (V1006) can very between +3.5V and –3.5V. Diodes V1001 and V1002 are then turned-off, and the voltage on the gate of the FET is then adjustable between +0.9 and –0.9V. At a signal level on the gate of the other FET of 100mV/div, there will be a control range of ± 9 div.

2.3.4. Peak to peak level detector

If the AUTO push-button S2A is depressed, the supply voltages for the level control circuit are interrupted. A trigger signal (300mV/div) which is derived from the emitter follower stage and amplified by V1008, gives after peak to peak detection a DC voltage across the level control. This DC voltage is approx. proportional to the amplitude of the trigger signal. This is the auto trigger level control. The peak-to-peak level of the signal then determines the range of the level control.

2.3.5. T.V. Synchronisation separator

If the TV mode push-button S2D is depressed, the LEVEL control is switched off. The wiper of R5 is then connected to mass. A synchronisation separator for the television signals is then inserted into the trigger signal path.

A composite video signal contains, besides the video information, also synchronisation pulses with line and frame frequency which can be distinguished by their pulse width.
The TV synchronisation separator circuit is able to:
1. separate the synchronisation pulses from the video information.
2. distinguish between frame synchronisation pulses and line synchronisation pulses.

The first requirement is met by V1013 acting as a DC restorer and limiter, the second requirement by the integrating network R1047, C1011 and C1012.
The TV signal is picked-off at the ± slope selector switch which in this case can be set for the right polarity of the TV signal. The TV trigger signal is then amplified by the series feed-back push-pull stage V1009, V1011 and applied to synchronisation separator V1013 via emitter follower V1012. The signal on the base of V1013 could be as follows:

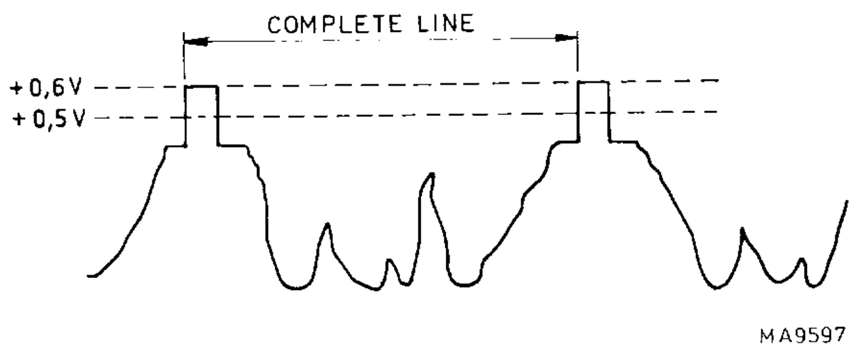
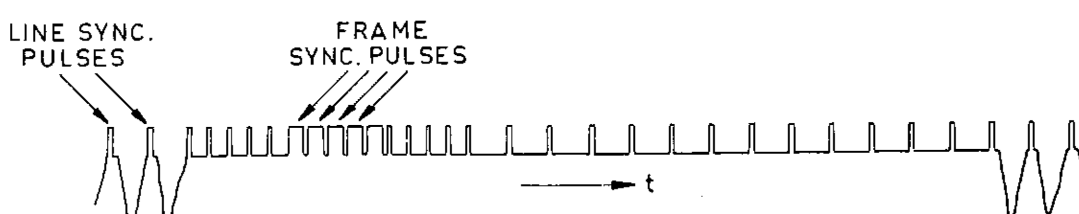


Fig. 2.3. Signal on the base of transistor V1013

The peaks of the synchronisation pulses are all at one level by the DC restorer action of C1007, R1039 and the base emitter diode of V1013. The base voltage will never exceed +0.6 V by a large amount, but the complete waveform will appear at the base. The signal level is at this point approx. 280 mV per screen div. Change in signal of approx. 100 mV is sufficient to turn off V1013. V1013 looks only to the peaks of the synchronisation pulses.
The rest of the TV signal has no influence. On the collector of V1013 we find exclusively the synchronisation signal consisting of line synchronisation pulses and the wider frame synchronisation pulses.

In the time base positions 20 μsec/div and faster, this complete signal is transmitted to the time base generator and we have line triggering.
In the time base positions 50 μsec/div. and slower, C1011 and C1012 are connected to mass. The narrower line synchronisation pulses are then, integrated out of the signal, but the wider frame synchronisation pulses remain, and frame triggering is obtained. A second threshold is built-up by V1016. V1017 reacts to the signal that still passes and consists of pure line or frame synchronisation pulses. After this the signal is fed to the time base generator via V1014.



2.4. TIME-BASE GENERATOR

The time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit, an auto sweep circuit and X final amplifier.
Before considering these stages in detail, the general principle is briefly described. Basically, the sweep gating logic, under the control of trigger signals from the trigger comparator and also feedback pulses from the hold-off circuit, supplies square-wave pulses to the switching transistor V1213 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed to the X-final amplifier.

2.4.1. Sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors are C1204 and C1207. Capacitor C1204 is always in circuit, the other one is selected by the transistor V1216. This transistor operates as an electronic switch and is either fully cut-off or fully-conducting. It is switched on by the application of a positive voltage to its base from the TIME/DIV switch S10. According to the position of S10, this transistor V1216 switches in the capacitor C1207 in parallel with C1204. As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistor V1212. This current can be adjusted in steps by selecting the emitter resistance of V1212 by means of the TIME/DIV switch S10. Continuous control of the charging current can be effected by varying the base drive to V1212 with the continuous sweep control, TIME/DIV potentiometer R9. In the CAL position of this potentiometer, switch S11 closes and the charging current is solely determined by the calibrated emitter resistance.

To compensate for the temperature coefficient of the transistor, the base voltage of V1212 is supplied via transistor V1214.
This also has the advantage of reducing the load on the TIME/DIV potentiometer R9.
This transistor, in turn, has its base controlled by preset potentiometer R1232 when TIME/DIV switch S10 is in one of the positions .5 s/div ... .5 ms/div. This provides a fine adjustment for the timing circuit in the slower sweep speeds. In these positions the preset potentiometer R1232 provides an additional measure of control over the base voltage of V1212. In the positions of S10 when C1207 is not in circuit, the diode V1218 is blocked and the preset control R1232 is inoperative.

The discharge circuit for the capacitors C1204 and C1207 consists of resistor R1219 and transistor V1213. This switching transistor is driven by the sweep gating logic via a number of diodes. Diodes V1207 and V1208 form an AND-gate for positive logic; V1209 and V1211 adapt the level to control transistor V1213. The resulting sawtooth voltage is taken from two transistors V1219 and V1221 in a kind of Darlington pair configuration.

C1209 improves the transfer of faster sawtooth signals at the expense of the input impedance which need not to be that high then. The sawtooth voltage amplitude is approx. 5 V. This sawtooth voltage is then fed to the X-final amplifier.

2.4.2. Hold-off circuit

The hold-off circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington pair V1219 and V1221 is applied to the base of emitter follower V1223.
The switching transistor V1217 switches the hold-off capacitor C1208 in circuit, parallel to C1206, according to the position of the TIME/DIV switch S10, in a similar manner to that described for the time-base integrator timing capacitor. Capacitor C1206 is always in circuit irrespective of the TIME/DIV switch position. Charging current for the hold-off capacitors flows via transistor V1223. When V1223 cuts off the discharge current flows through R1228 and hold-off control R12. This current is adjustable to change the hold-off time. The voltage across hold-off capacitor C1206 or C1206 + C1208 follows the sawtooth voltage fairly fast in positive going direction via emitter follower V1223. When a certain value is reached, integrated Schmitt-trigger D1201 reacts and the end of the sweep is initiated.
This is followed by a hold-off period in which the voltage across the hold-off capacitor decreases fairly slowly until the lower switching level of the Schmitt trigger is reached. The system

2.4.3. Sweep gating logic

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

The TTL circuit D1201 contains four 2-input NAND-gates with Schmitt-trigger properties.
D1202 contains four normal 2-input NAND-gates and D1203 contains three normal 3-input NAND-gates.
With the aid of the various gates two flip-flops are formed.

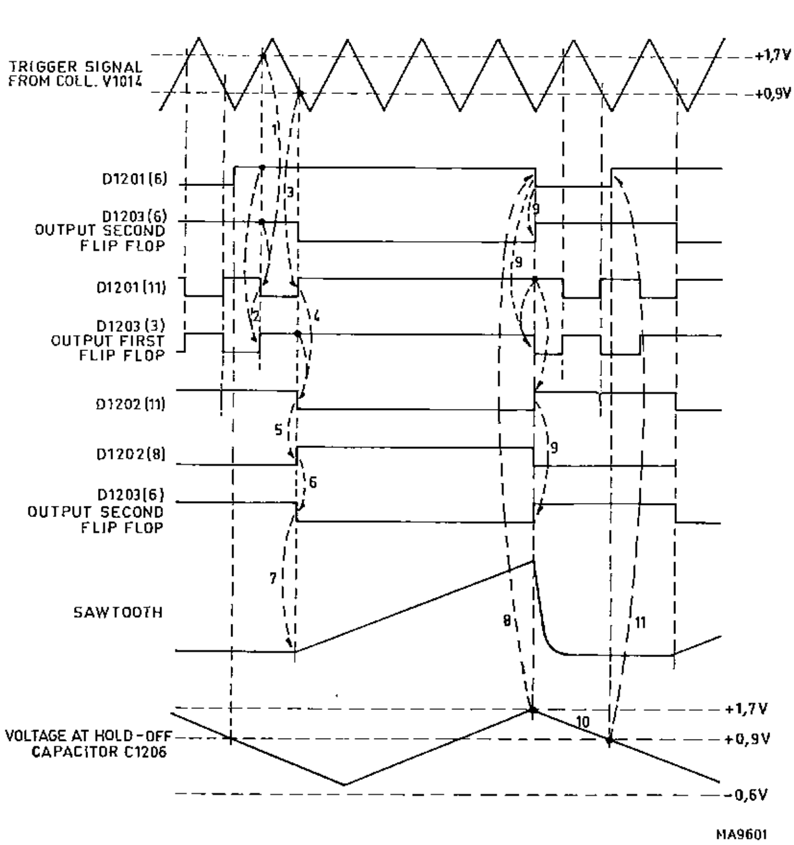


Fig. 2.5. Time relation diagram of the sweep-gating logic in the AC or DC mode

See for the following explanation time relation diagram Fig. 2.5.

1 The incoming trigger signal from the trigger comparator switches the Schmitt-trigger output (D1201, point 11) to zero after a positive going edge has exceeded the upper switching level (+1.7 V) of this Schmitt-trigger.

2 After this, the first flip-flop output (D1202, point 3) is set to the logic 1-state.

3 If the negative going edge of the incoming trigger signal drops below the lower switching level (+0.9 V) of the Schmitt trigger, the output (D1201, point 11) switches to logic 1 level again.

4,5,6 The logic 1 state of the first flip-flop and the output signal of the Schmitt-trigger allows the setting of the second flip-flop output (D1203, point 6) to the zero state by means of the NAND output (D1202, 7 The output signal of the second flip-flop is applied to switching transistor V1213 via an OR-gate which consists of R1216, V1207 and V1208. This signal causes the sweep to start.

8 The end of the sweep is reached when the signal across the hold-off capacitor C1206 exceeds the upper switching level (+1.7 V) of the hold-off Schmitt-trigger. The output of this Schmitt-trigger switches then to zero.

9 Both flip-flops are now reset. Switching transistor V1213 starts conducting and time-base capacitor C1204 will discharge.

10 The voltage across the hold-off capacitor C1206 decreases slowly until the lower switching level (+0.9 V) of the Schmitt-trigger is reached.

11 This is the end of the hold-off period. The output (D1201, point 6) of the hold-off Schmitt-trigger rises to 1 again and the system can be triggered again.

2.4.4. Auto sweep circuit

In the absence of a trigger signal we would still like to see a display on the screen. The auto sweep circuit serves this purpose. Transistor V1203 senses the state of the output of the second flip-flop, this is the output of the sweep gating logic. Whenever this point reaches the logic zero level, transistor V1203 starts conducting enabling C1202 to discharge. Transistors V1204 and V1206 are then turned off. The collector of V1206 lies on –0,7 V potential and the relevant gate of D1201 is then blocked. This means that output D1201 (3) is at logic 1 level (+5 V).
In the absence of a trigger signal, the output D1203 (6) of the sweep gating logic remains a logic 1 level (+5 V) and transistor V1203 remains turned-off. The voltage across capacitor C1202 remains increasing until after approximately 100 msec., transistor V1204 starts conducting and causes transistor V1206 to conduct. The collector of V1206 rises to approximately +5 V and the relevant gate of D1201 opens. The hold-off signal on point 6 of D1201 now can reach via gate D1201 (3) and the OR-gate, the switching transistor V1213. The loop is then closed and the time base generator is in the free running mode.

2.4.5. X-final amplifier

Transistor V1407 is driven by either the time-base generator via diodes V1411 and V1409 when R1406 is kept at +12 V level via TIME/DIV switch S10 (in all the TIME/DIV positions of this switch), or the amplifier stage V1404 when R1407 is kept at +12 V level via TIME/DIV switch S10 (in position X DEFL).
Transistor V1404 receives its input signal from D1001 point 8 of the trigger amplifier.
This signal is derived from one of the sources, channel A, channel B, line or an external source, depending on the setting of the X deflection selector switch S16.

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

The actual amplifier is the cascode circuit with transistors V1414 and V1416.
The resistors R1428 and R1429 are feedback resistors. The bias current for the amplifier is supplied by transistor V1413. The average voltage on the deflection plate is kept at +26 V by means of zener diodes V1424 and V1426. Capacitor C1413 improves the h.f. response.
This final stage is supplied from the +180 V and –180 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.
The cascode amplifier stages are controlled via the transistors V1406 and V1407.
The bias of transistor V1406 can be varied with the X POSITION potentiometer R4, which consists of a tandem potentiometer with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time base signal or one of the sources, channel A, channel B, line or an external signal. The deflection source is selected with the aid of the TIME/DIV switch S10 and the X-deflection source selector switch S16.

The X amplifier offers the possibility of using either the nominal gain (x1 position of X MAGN switch S5), or the gain increased by a factor of 10 (x10 position of the X MAGN switch S5).
When the front-panel X MAGN switch is operated for 10x magnification, the emitter resistance R1416 + R1417 of transistors V1406 and V1407 is shunted by resistors R1418 + R1419 reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.
The x1 gain can be set by potentiometer R1417 and the x10 gain by potentiometer R1419. The x10 gain is also operative when X DEFL is selected.

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

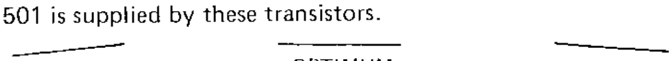
2.5. CATHODE-RAY TUBE CIRCUIT

The cathode-ray tube circuit consists of the c.r.t. and its associated controls: focus, intensity, trace rotation and the beam blanking amplifier.

2.5.1. C.R.T. controls

By means of the INTENS potentiometer R1, the brightness of the display can be continuously controlled.
The display can be focused by means of the FOCUS potentiometer R6. Both INTENS and FOCUS controls are front panel controls.
Furthermore the C.R.T. circuitry comprises preset potentiometers for trace rotation, astigmatism and geometry.
The FOCUS control R6 forms a part of a voltage divider network across the 1.5 kV output of the power supply.
The slider of this potentiometer is connected direct to the focus, grid G3.

TRACE ROTATION is achieved by means of the trace rotation coil L1501. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of front panel potentiometer R10 (screwdriver operated). The slider of R10 is connected to the bases of the complementary transistors V1521 and V1522.
The trace rotation coil L1501 is supplied by these transistors.

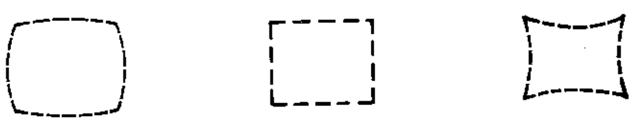


OPTIMUM

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

OPTIMUM

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



OPTIMUM

MA9595

2.5.2. Beam blanking amplifier

The beam blanking amplifier receives two input signals. One signal originates in the time-base generator and is applied to the amplifier to unblank the trace during the sweep.
The other one is supplied by the channel switch to blank the trace during switching from channel to channel in the chop mode.
The INTENS potentiometer R1 determines the amount of input current fed to the amplifier.

In all the time/div. positions of the TIME/DIV switch S10, the anode of diode V1202 is kept at approx. +12 V, resulting in a logic 1 level at input 1 of NAND D1203.
The output point 12 of this NAND is now at logic 1 level when either input 2 or input 3 is low. In other words only during a sweep.
In the X DEFL position of the TIME/DIV switch S10, input 1 of NAND D1203 is at a logic 0 level, and in that case the output point 12 of this NAND is steady at logic 1 level. This output signal is inverted by a NAND and fed via diodes V1501 to diodes V1502 and V1503 of the beam blanking amplifier.
The chop mode blanking signal from the channel switch is fed to transistor V1506 via R1502. The inverted and amplified signal is applied to diode V1508.
Both signals are joined together at the base of transistor V1514 (point A in figure 2.6.). This is the virtual earth point of a shunt feedback amplifier.

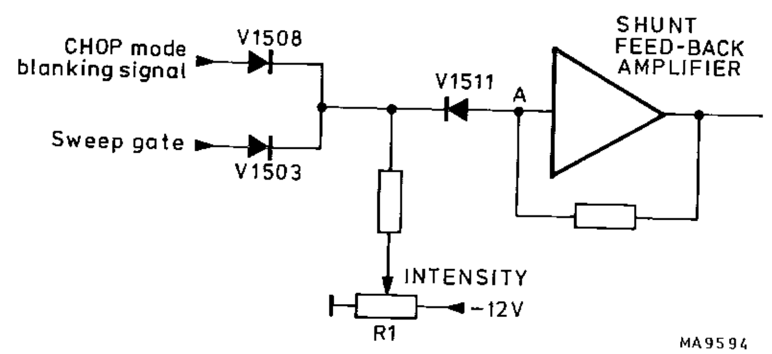


Fig. 2.6. Shunt feed back amplifier

Assume that V1503 and V1508 are turned-off by applying a logic zero to both inputs.
Then the output voltage of the amplifier can be varied with the aid of INTENS potentiometer R1. The light on the screen is variable then e.g. during a sweep or in the X deflection mode. A logic 1 on either one or both inputs of the diodes V1503 and V1508 turns V1511 off. The C.R.T. is then blank e.g. between sweeps or during the sweep when there is channel switching in the chop mode.

The blanking signal is amplified in the stage with transistors V1512, V1513 and V1514. At the output of this amplifier the a.c. and d.c. components of the blanking signal are guided along different paths. The a.c. path runs straight to the Wehnelt cylinder of the C.R.T. via capacitor C1512.
A d.c. signal is fed to the emitter of transistor V1517 via a low-pass filter R1528/C1508/R1527. Transistor V1517 constitutes a multivibrator together with transistor V1516. The a.c. voltage on the collector of V1517 has a peak-to-peak value which depends on the voltage fed to the emitter of V1516 by the shunt feed-back amplifier.

The a.c. voltage supplied by multivibrator V1516/V1517 is applied to a peak detector. This peak detector rectifies this a.c. voltage.

The reason for the a.c. and d.c. paths is isolation of the cathode and Wehnelt cylinder, which are on a −1,5 kV potential, from the other circuits. The a.c. component of the blanking signal is transmitted straight away to the high-voltage part via blocking capacitor C1512, which is a high voltage capacitor. The d.c. signal, however, is converted into an a.c. voltage and then transmitted to the high-voltage part, via capacitor C1509, after which it is rectified by means of diode V1519.
The dark level can be adjusted with the aid of potentiometer R1534 in the emitter circuit of transistor V1517

2.6. POWER SUPPLY

2.6.1. General

The power supply is designed on the switching regulator principle and permits the instrument to be connected to nominal mains voltages of 110V, 127V, 220V, or 240V by switch selection, or to an external battery supply of 22 ... 27V.
The mains supply via POWER ON switch S23 is protected by fuse F202. The battery input is protected by fuse F201 and diode V206 safe-guards the circuit against reversed battery connection.
Basically, the power supply consists of:

- Mains transformer
- Converter and stabilized power supply
- Illumination circuit

2.6.2. Mains transformer

An incoming mains voltage is fed via the thermal fuse (F101) and the voltage selector S18 to the appropriate primary taps on the mains transformer T101. Transformer T101 has three primary windings which can be combined by means of voltage adapter S18. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

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

Part of the a.c. voltage on the secondary winding of the mains transformer is fed via C201, R373 and R372 to LINE trigger source selector switch S16A, to enable internal triggering on the line frequency.

2.6.3. Converter and stabilized power supply

The converter is a square-wave generator operating at a frequency of approx. 18 kHz and driven by the d.c. voltage across the electrolytic capacitor C203.

A basic diagram of the converter is shown in Fig. 2.7.

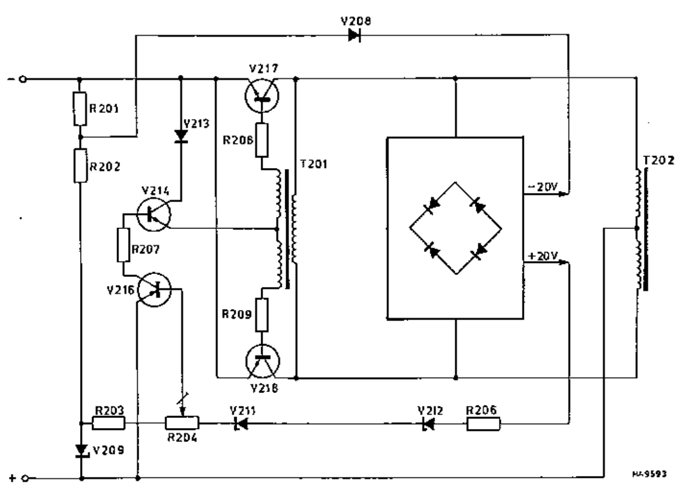


Fig. 2.7. Basic diagram of the converter

In the converter, transistors V217 and V218 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of T201/T202. Assume that transistor V217 has a slightly higher current gain than V218. Then the positive voltage from the feedback winding quickly drives transistor V217 into saturation. The current in the top half of the primary of T201/T202 increases linearly at a rate determined by the inductance of the primary. This current increase continues until the iron in transformer coil T201 is saturated.

Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feedback winding. When its base drive ceases, the transistor is cut off.

This reverses the polarity of the feedback voltage and transistor V218 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction.
The subsequent absence of feedback voltage initiates the switching back to V217 and the cycle starts again.

The regulation works as follows. When an input voltage is applied to the converter, the negative voltage across Zener diode V209 turns transistor V216 fully on, as there is no positive voltage from temperature compensation stabistors V211 and V212.

Then a bias current flows via transistor V216 through resistor R207, through the base-emitter junction of transistor V214 (operating as a diode since diode V213 interrupts the collector circuit) and from base to emitter of both transistors V217 and V218.

As there is then an a.c. voltage across the primary of T201/T202, diodes V222 and V223 produce a positive d.c. voltage of +20 V across capacitor C209. This voltage reduces the current through transistors V216 and V214 sufficiently to limit the drive to transistors V217 and V218 and produce the desired output level.
The setting of potentiometer R204 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via the temperature compensation stabistors V211 and V212 to transistor V216 so that the drive of transistors V217 and V218 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.

After rectifying and smoothing, the secundary voltages +5 V, +12 V, −12 V, +38 V, +180 V, −180 V, −1500 V and post acceleration voltage +8500 V are obtained. The voltage quintupler which supplies the +8500 V cannot be repaired and must be replaced when it breaks down.

T202 contains a separate secundary winding for the heater voltage for the C.R.T..

All supply voltages except the +8500 V and the −1500 V can be continuously short-circuited without damage to the components. Resistor R202 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors V217 and V218 at a safe level.
Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp B1, which indicates the ON state of the oscilloscope, failing to light up.

If supplied by an external d.c. voltage, the instrument is protected against overloads and wrong polarity by internal fuse F201 and diode V206.

2.6.4. Illumination circuit

The graticule of the C.R.T. can be illuminated by means of the bulbs E1. The intensity can be varied with the aid of ILLUM potentiometer R11 which controls the collector current (which is the current through the bulbs) of transistor V207. The illumination circuit is not short-circuit proof.

2.7. CALIBRATION UNIT

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

The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

2.8. BASIC ANALOG AND DIGITAL CIRCUITS

This section describes briefly the most important characteristics of the analog and digital circuits to be found in the instrument.

2.8.1. Basic analog circuits (See Fig. 2.8.)

– SERIES FEEDBACK AMPLIFIER

This is also called a Cherry configuration.
A voltage signal ΔU is applied to the input; the output produces a current signal $\Delta I = \frac{\Delta U}{R_E}$

– SHUNT FEEDBACK AMPLIFIER

This is also called a Hooper configuration.
A current signal ΔI is applied to the input; the output produces a voltage signal $\Delta U = \Delta I \cdot R_F$

– SERIES FEEDBACK AMPLIFIER followed by a SHUNT FEEDBACK AMPLIFIER

This combination of the two previous configurations is called a Cherry-Hooper circuit.
In this two-stage amplifier, both the input and the output are voltage signals. The gain of this amplifier is:

$$\frac{\Delta U_{OUT}}{\Delta U_{IN}} = \frac{R_F}{R_E}$$

– EMITTER-FOLLOWER

The emitter-follower is used as an impedance converter.
The input impendance is HIGH and the output impedance is LOW. The stage has a voltage gain of x1, and the output voltage signal is identical to the input voltage.

–DARLINGTON PAIR

This circuit consists of two emitter-followers connected in cascade. As a result, the input impedance is very high and the output impedance low.
Again, this stage has a voltage gain of x1 and the output voltage signal is identical to the input voltage signal.

– COMMON BASE CIRCUIT

This type of circuit is frequently used between amplifier stages for d.c. voltage level adaption or for buffering.
The input impedance is low and the output impedance is high.
It has a current gain of x1, the output current signal being identical to the input current signal.

– LONG-TAILED PAIR

In the diagram of Fig. 2.8, the long-tailed pair is formed by transistors V1 and V2. Transistor V3 functions as a constant-current source for V1 and V2.
The current drawn from V3 is divided between V1 and V2 , the proportion depending on the base voltages applied (U1 and U2).
The division is as follows:

$$I_1 - I_2 = \frac{U1}{R_{E1}} - \frac{U2}{R_{E2}}$$

2.8.2. Basic digital circuits (see Fig. 2.9.)

The type of logic used is TTL and the supply voltage +5V.
The logic levels used are defined as follows:

- a high level (H) constitutes an input between 2 ... 5V and an output between 2.4 ... 5V.
- a low level (L) constitutes an input between 0 ... 0.8V and an output of between 0 ... 0.4V.

The following types of logic circuit elements are used in this instrument.

AND-gate: In this gate, the output is only H if all the inputs are H. Therefore, if one input is low, the state of the other inputs is irrelevant and the output is L.

NAND-gate: The output is only L if all the inputs are H. Therefore, if one input is L the state of the other inputs is irrelevant and the output is H.

OR-gate: The output is only L if all inputs are L. If one input is H, then the state of the other inputs is irrelevant and the output is H.

NOR-gate: The output is only H if all inputs are L. Therefore, if one input is H, the state of the other inputs is irrelevant and the output is L.

D-FLIP-FLOP: One integrated circuit incorporates two flip-flops.
Each flip-flop has an output (pin 5 or 9) and an inverted output (pin 6 or 8). If the reset input R (pin 1 or 13) is made L it is activated and the flip-flop is forced to the reset state: output L and inverted output H. The set input S (pin 4 or 10) is active when L and forces the flip-flop to the set state: output H and inverted output L.
If the set and reset inputs are both H, the condition of the clock input CL (pin 3 or 11) and the data input D (pin 2 or 12) are important.
The logic level on the data input (L or H) is clocked into the flip-flop if the clock goes from L to H – now the output also becomes L or H.

JK FLIP-FLOP: One IC contains two flip-flops. Each flip-flop has an output (pin 5 or 9) and an inverted output (pin 6 or 7). If the reset input R (pin 15 or 14) is made L, it is activated and the flip-flop is forced to the reset condition: output L and inverted output H.

The set input S (pin 4 or 10) ia active when L and forces the flip-flop to the set condition: output is H and inverted output is L.

If both the set and reset inputs are H, the condition of the clock input C (pin 1 or 13), the J-input (pin 3 or 11) and the K-input (pin 2 or 12) are important.
If the clock input goes from H to L, the following occurs:

If J = L and K = L:	the output states remain unchanged.
If J = H and K = L:	the output becomes H and the inverting output L.
If J = L and K = H:	the output becomes L and the inverting output H.
If J = H and K = H:	the outputs switch to the opposite state.

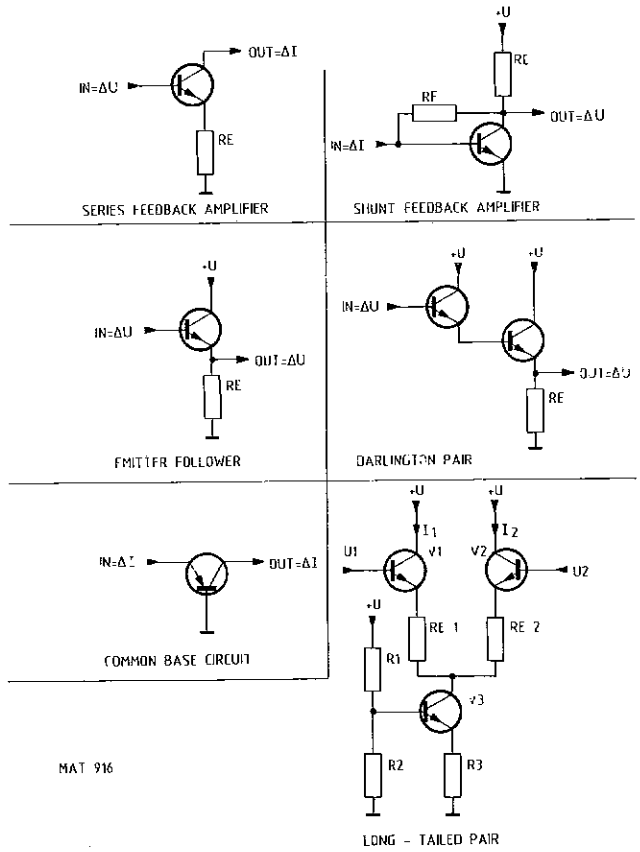


Fig. 2.8. Basic analog circuits

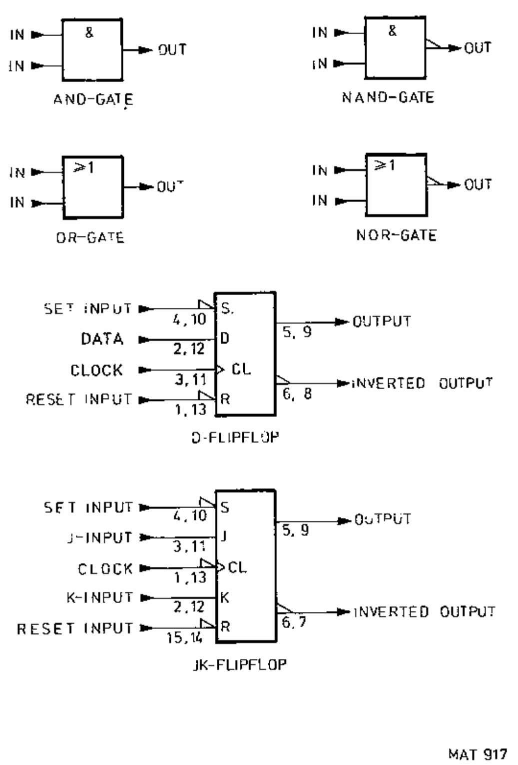


Fig. 2.9. Basic digital circuits

3. DISMANTLING THE INSTRUMENT

3.1. GENERAL INFORMATION

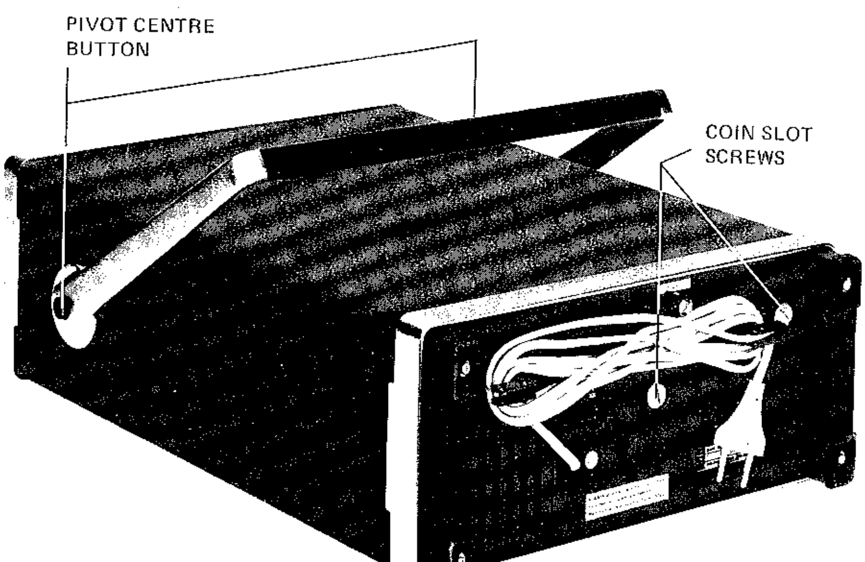
WARNING

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

ATTENTION: This section provides the dismantling procedures required for the removal of components during repair 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 must be made of all disconnected leads that they may be reconnected to their correct terminals during assembly.
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 after switching off the instrument.

3.2. REMOVING THE INSTRUMENT COVERS

The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.
To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.
Then proceed as follows:
- Hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 3.1.).
- 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.



3.3. REMOVING THE CARRYING HANDLE

- Prise off the centre knobs from each pivot, using a screwdriver (Fig. 3.2.) 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.

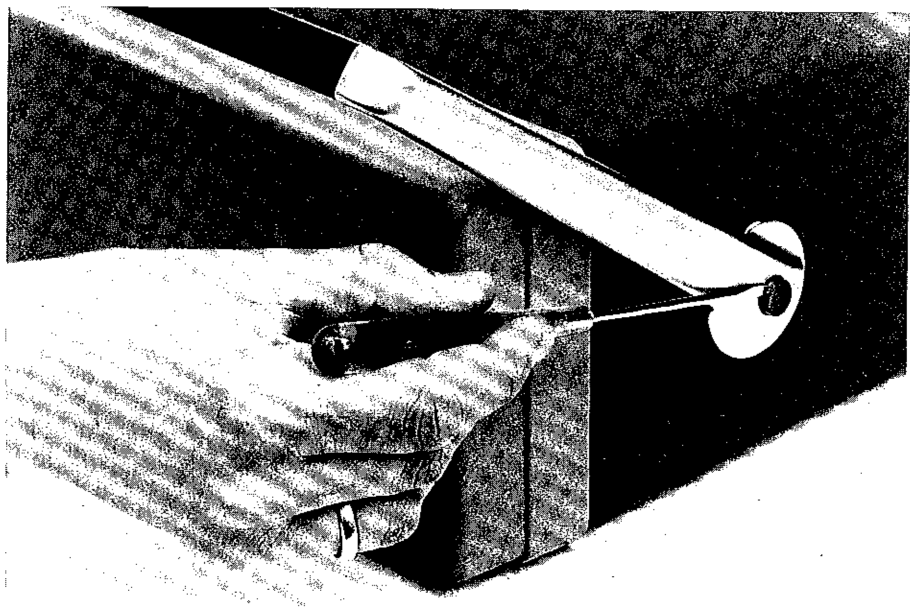


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Fig. 3.2. Removing the carrying handle

3.4. ACCESS TO PARTS FOR CHECKING AND ADJUSTING PROCEDURE

All the adjustment elements can be reached after removing the instrument cover.

NOTE: *For adjustment always use an insulated adjustment tool*

4. PERFORMANCE CHECK

4.1. GENERAL INFORMATION

WARNING: **Before switching on, ensure that the oscilloscope has been installed in accordance with the instructions outlined in chapter 2 of the operating manual, installation instructions.**

This procedure is intended to be used for incoming inspection to determine the acceptability of newly purchased or recently recalibrated instruments.
It does not check every facet of the instrument's calibratión; rather it is concerned primarily with those portions of the instrument which are essential to measurement accuracy and correct operation.
Removing the instrument's covers is not necessary to perform this procedure. All check's are made from the front panel.

If this test is start a few minutes after switching on, bear in mind that test steps may be out of specification, due to insufficient warming-up time. To avoid this situation, allow the specified warming-up tme.

The performance checks are made with a stable, well-focussed, low-intensity display. Unless otherwise noted, adjust the intensity and trigger-level controls as needed.

Note 1: At the start of every check, the controls always occupy the preliminary settings; unless otherwise stated.
Note 2: The input voltage has to be supplied to the A-input; unless otherwise stated.
Note 3: Set the TIME/DIV switch to a suitable position; unless otherwise stated.

4.2. PRELIMINARY SETTINGS OF THE CONTROLS

- Start this check procedure with **NO** input signals connected, **ALL** pushbuttons released and **ALL** switches in the CAL position.
- Depress the controls as indicated in figure 4.1.

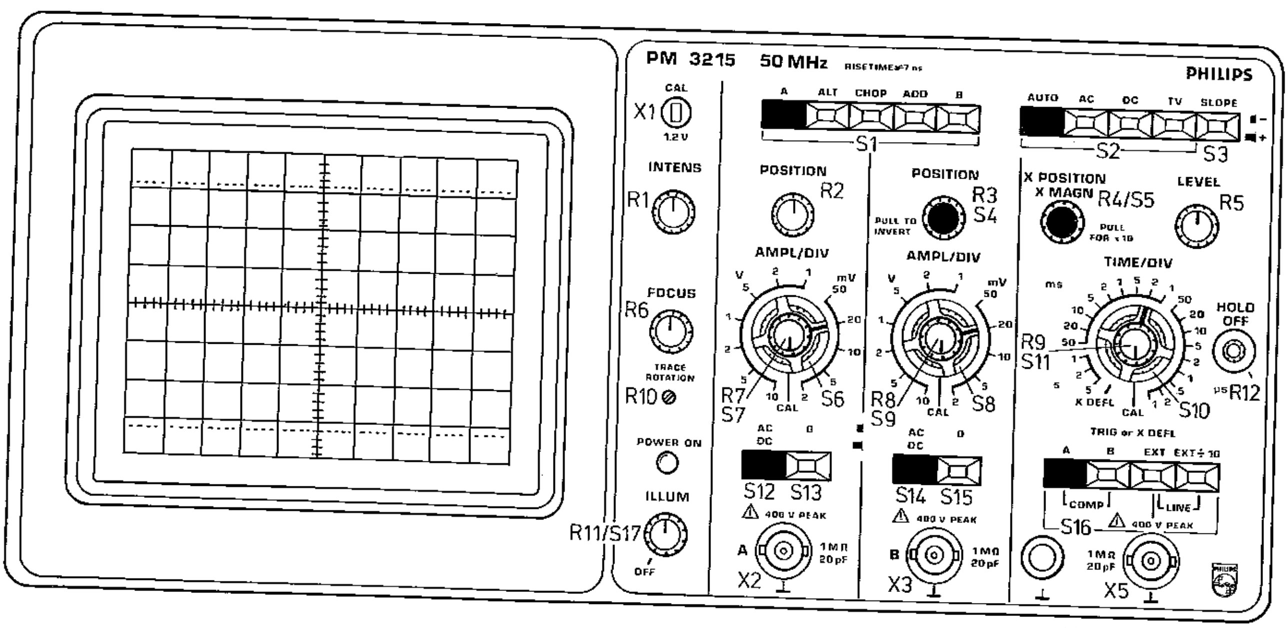

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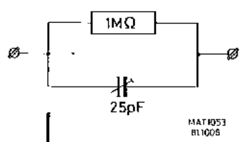
Fig. 4.1. Preliminairy settings of the cotrols

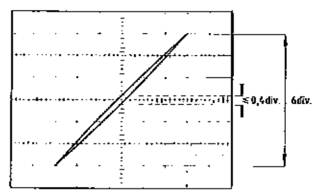
4.3. RECOMMENDED TEST EQUIPMENT

Type instrument	Required specification	Example of recommended instrument
Function generator	Freq.: 1 mHz ... 10 MHz Sine-wave/Square-wave Ampl.: 0 ... 40 Vp-p DC offset 0 ... ± 10 V Rise-time < 30 ns Duty cycle 50 %	Philips PM 5167
Constant amplitude sine-wave generator	Freq.: 100 kHz ... 60 MHz Constant ampl. of 120 mVp-p and 3 Vp-p	Tektronix SG 503
Square-wave calibration generator	Freq.: 10 Hz ... 1 MHz Ampl.: 50 mV ... 60 V Rise-time < 1 ns Duty cycle 50 %	Tektronix PG 506
Time-marker generator	Repetition rate: 0,5 s ... 0,05 μs	Tektronix TG 501
Variable mains transformer	Well-insulated output voltage 90 ... 264 Vac	Philips ord. number 2422 529 00005
DC power supply	Adjustable output: 20 ... 28 V Current: 1,5 A	Philips PE 1540
Moving-iron meter		
Dummy probe 2 : 1	1 MΩ ± 0,1%//25pF	
Cables, T-piece, terminations for the generators	General Radio types for fast rise-time square-wave and freq. sine-wave. BNC-typer for other applications	

4.4. CHECKING PROCEDURE

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.1.	POWER ON				
4.4.1.a.	Start POWER ON a.c.		Set POWER ON switch S17 to ON	– Starts at selected mains voltage ± 10% and mains frequency 50-400Hz ± 10%	
4.4.1.b.	Power consumption			-- Pilot lamp POWER ON lights up 28W from a.c.	
4.4.1.2.a.	Start POWER ON battery		Set POWER ON switch S17 to ON	– Starts at battery supply voltages between 21V and 30V	
4.4.1.2.b.	Current rating			- Pilot lamp POWER ON lights up 1,1A approx.	
4.4.2.	CRT SECTION				
4.4.2.1.	Intens		INTENS potentiometer R1	Normal intens adjusting	
4.4.2.2.	Focus		FOCUS potentiometer R6	Trace sharpness adjusting	
4.4.2.3.	Trace rotation		Srewdriver adjustment TRACE ROT R10	Trace must be in parallel with horizontal graticule lines; if necessary, readjust potentiometer TRACE ROT R10	
4.4.3.	VERTICAL AXIS				
4.4.3.1.	Display modes	Sine wave signal 60mVp-p, 2kHz to A and B input	– AMPL/DIV to 20mV/div		
			Depress A of S1	Signal of 3 div. is visible on the screen	
			Depress CHOP of S1	Traces of ch. A and ch. B are visible on the screen.	
			Depress ALT of S1	Traces of ch. A and ch. B are visible on the screen.	
			Depress ADD of S1	Signal of 6 div. is visible on the screen	
			Depress B of S1	Signal of 3 div. is visible on the screen	
4.4.3.2.	Polarity inversion ch.B.	as 4.4.3.1.	Pull the PULL TO INVERT switch S4	Display is inverted	
4.4.3.3.	Input coupling	Sine-wave signal, 2kHz + DC offset to A (B) input	Depress 0 of S13 (S15)	Set the trace in the centre of the screen	
			Release 0 of S13 (S15)	Signal is visible on the screen, centre of the sine-wave is on the vertical centre of the screen	
			Release S12 (S14) to DC	Signal is visible on the screen, centre of the sine-wave is on DC-offset level	
4.4.3.4.	Vertical deflection coefficients	Square wave signal, 2kHz to A (B) input	AMPL/DIV switch position of S6 (S8)		
		Ampl: 12mVp-p	2mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		30mVp-p	5mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		60mVp-p	10mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		120mVp-p	20mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		300mVp-p	50mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		600mVp-p	0,1V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		1,2Vp-p	0,2V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		3 Vp-p	0,5V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		6 Vp-p	1 V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		12 Vp-p	2 V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		30 Vp-p	5 V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		30 Vp-p	10 V	Trace height 3 div. ± 3% (± 0,45 subdiv.)	
4.4.3.5.	Continuous control	Square wave signal 120mVp-p, 2kHz to A (B) input	– AMPL/DIV switch position of S6 (S8) to 20mV/div. – Continuous control R7 (R8)	Continue range 1 : ⩾ 2,5 (⩽ 2,4 div.)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.3.6.	Vertical deflection via dummy	Square wave signal, 2kHz to A (B) input via dummy	AMPL/DIV switch position of S6 (S8)		
		AMPL: 24mVp-p	2mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		60mVp-p	5mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		120mVp-p	10mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		240mVp-p	20mV	Trace height 6 div. ± 3% (±0,9 subdiv.)	
		600mVp-p	50mV	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		1,2Vp-p	0,1V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		2,4Vp-p	0,2V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		6 Vp-p	0,5V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		12 Vp-p	1 V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		24 Vp-p	2 V	Trace height 6 div. ± 3% (± 0,9 subdiv.)	
		30 Vp-p	5 V	Trace height 3 div. ± 3% (± 0,45 subdiv.)	
		40 Vp-p	10 V	Trace height 2 div. ± 3% (± 0,3 subdiv.)	
4.4.3.7.	Common mode rejection	Sine-wave signal 480mV, 1MHz to A and B input	– AMPL/DIV switches to 20mV – Pull the PULL TO INVERT switch S4 – Depress ADD of S1	Rejection > 100 (signal < 0,25 div.)	
4.4.3.8.	Dynamic range	Sine-wave signal 2,4V, 10MHz to A (B) input	– AMPL/DIV to 0,1V – Position control R2 (R3) ↺	24 div. trace height distortion free visible on the screen	
4.4.3.9.	Vertical positioning	Sine-wave signal 2,4V 10kHz to A (B) input	as 4.4.3.8.	Top of sine-wave signal visible on the screen in both extreme positions of the POSITION CONTROL	
4.4.3.10.	Trace jump a. attenuator		– Depress 0 of S13 (S15) – Set trace in centre of the screen – All positions of AMPL/DIV S6 (S8) except b.	Trace jump ⩽ 0,1 div.	
	b. 20mV → 10mV		– AMPL/DIV switch S6 (S8) between 20mV → 10mV	Trace jump ⩽ 1 div.	
	c. normal/invert		– Pull and push switch S14	Trace jump ⩽ 1 div.	
4.4.3.11.	Square wave response	Square wave signal 120mVp-p, 1MHz risetime ⩽ 1nsec.	– AMPL/DIV switch S6 (S8) to 20mV	Trace height 6 div. Pulse abberations ⩽ 3% (⩽ 5% p-p) Risetime ⩽ 7nsec.	
4.4.3.12.	Visible signal delay	as 4.4.3.11.	– AMPL/DIV to 20mV – PULL X MAGN S5 – TIME/DIV to 0,1μs	Leading edge visible on the screen	
4.4.3.13.	Bandwith	Sine-wave signal to A (B) input 1MHz		Adjust the sine-wave amplitude for a trace height of 6 div.	
		1MHz - 50MHz		Trace height ⩾ 4,2 div.	
4.4.4.	HORIZONTAL AXIS				
4.4.4.1.	X positioning range		X POS control R4 ↻	Starting point of trace to horizontal centre of the screen	
			X POS control R4 ↺	End of trace to horizontal centre of the screen	
4.4.4.2.	Time coefficients	Marker pulse signal to A input	– TIME/DIV switch positions:		
		Repetition time: 0,1μsec	0,1μs	Coefficient error ⩽ 3% (c.i. 0,3 div. over 10 div. screenwidth)	
		0,2μsec	0,2μs		
		0,5μsec	0,5μs		
		1 μsec	1 μs		
		2 μsec	2 μs		
		5 μsec	5 μs		
		10 μsec	10 μs		
		20 μsec	20 μs		
		50 μsec	50 μs		
		0,1msec	0,1ms		
		0,2msec	0,2ms		
		0,5msec	0,5ms		
		1 msec	1 ms		
		2 msec	2 ms		
		5 msec	5 ms		
		10 msec	10 ms		
		20 msec	20 ms		
		50 msec	50 ms		

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.4.3.	X Magnifier	Marker pulse to A input, repetition time 0,1msec	– TIME/DIV switch to 1msec – PULL X MAGN S5	Coefficient error ⩽ 5% (c.i. 0,5 div. over 10 div. screenwidth)	
4.4.4.4.	Continuous control	as 4.4.4.3.	– TIME/DIV switch to 10µsec – Continuous control R9 ↻	Continuous range 1 : ⩾ 2,5	
4.4.5.	XY-DEFLECTION				
4.4.5.1.	Mode A (B)	Sine-wave signal 120mVp-p, 2kHz to A (B) input	Depress A (B) of S1 Depress A (B) of S16 Set TIME/DIV to X DEFL AMPL/DIV to 20mV	A line is visible with an angle of 45° with respect to the horizontal graticule line; trace heigh and trace width 6 div. ± 10% (c.i. ± 0,6 div.)	
4.4.5.2.	Mode EXT	Sine-wave signal 1,6Vp-p, 2kHz to EXT input X5	Depress EXT of S16 Set TIME/DIV to X DEFL	Trace width 8 div. ± 10%	
4.4.5.3.	Mode EXT ÷ 10	Sine-wave signal 16Vp-p, 2kHz to EXT input X5	Depress EXT ÷ 10 of S16 Set TIME/DIV to X DEFL	Trace width 8 div. ± 10%	
4.4.5.4.	Mode LINE		Depress LINE of S16 Set TIME/DIV to X DEFL	Trace width 8 div. ± 10%	
4.4.5.5.	Bandwidth	Sine-wave signal, 2kHz to EXT input X5 1MHz 1MHz 1MHz	Depress EXT of S16 Set TIME/DIV to X DEFL Depress DC of S2 Depress AC of S2	Adjust the input voltage for a trace width of 8 div. Trace width ⩾ 5,6 div. Trace width ⩾ 5,6 div. Trace width ⩾ 5,6 div.	
4.4.5.6.	Dynamic range	Sine-wave signal, 100kHz to A input	– Set TIME/DIV to X DEFL – Depress B of S1 – AMPL/DIV to 0,2V – AMPL/DIV to 50mV	Adjust the input voltage for a horizontal deflection of 6 div. Horizontal deflection 24 div.	
4.4.5.7.	Phase shift between X and Y ampl.	Sine-wave signal to A-input 2kHz 100kHz	– Set TIME/DIV to X DEFL – AMPL/DIV to 20mV	Adjust the input voltage for a horizontal deflection of 6 div. Phase shift ≤ 3° (c.i. ≤ 0,4 div.)  MAT 985 *(NOTE: If triggers the NOT TRIG'D lamp is extinguished)*	
4.4.6.	TRIGGERING				
4.4.6.1.	Trigger source A and B	Sine-wave signal, 10kHz to A input and square wave signal, 2kHz to B input	– Depress ALT of S1 – Adjust the input signals for a trace height of 6 div. approx. – Depress B of S16 – Depress COMP of S16	Well triggered display of channel A Well triggered display of channel B Well triggered display of channel A and channel B	
4.4.6.2.	Trigger source EXT	Sine-wave signal, 240mV, 2kHz to A input and EXT input X5	Depress EXT of S16	Well triggered display	
4.4.6.3.	Trigger source LINE	Sine-wave signal, related to mains frequency to A input	Depress LINE of S16	Well triggered display	
4.4.6.4.	Slope	Sine-wave signal, 120mV, 2kHz to A input	– Release SLOPE S3 – Depress SLOPE S3	Signal triggers on positive going edge Signal triggers on negative going edge	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.6.5.	Sensivity INT	Sine-wave signal to A input; Frequency: 1Hz 5Hz 20Hz 5MHz 50MHz	Depress DC of S2 Depress AC of S2 Depress AUTO of S2	Signal triggers at 0,5 div. Signal triggers at 0,5 div. Signal triggers at 0,5 div. Signal triggers at 0,5 div. Signal triggers at 1 div.	
4.4.6.6.	Sensitivity EXT	Sine-wave signal to A input and EXT input X6 frequency: 5MHz 50MHZ 5MHz 50MHz	Depress EXT of S16 Depress EXT ÷ 10 of S16	Signal triggers at 0,15Vp-p Signal triggers at 0,2Vp-p Signal triggers at 1,5Vp-p Signal triggers at 2Vp-p	
4.4.6.7.	Sensitivity TV	TV signal to A input	Depress TV of S2 Depress A of S16	Signal triggers at 0,7 div.	
4.4.6.8.	LEVEL range	Sine-wave signal 60mVp-p, 2kHz to A input	LEVEL control R5 ↶↷	Trace is triggered in the most extreme positions of the LEVEL control	
			Depress DC of S2 LEVEL control R5 ↶↷	Trace is not triggered in the most extreme positions of the LEVEL control	
			AMPL/DIV to 10mV LEVEL control R5 ↶↷	Trace is triggered in the most extreme positions of the LEVEL control (range ⩾ 4 div.)	
		Sine-wave signal 1Vp-p, 2kHz to A input and EXT input X5	Depress EXT of S16 LEVEL control R5 ↶↷	Trace is triggered in the most extreme positions of the LEVEL control (range ⩾ 0,8V)	
4.4.6.9.	EXT trigger input impedance	Sine-wave signal 1Vp-p, 2kHz to A input and to EXT input via dummy	Depress EXT of S16 LEVEL control R5 ↶↷	Trace is not triggered in the most extreme positions of the LEVEL control	
		Sine-wave signal 2Vp-p, 2kHz to A input and to EXT input via dummy	LEVEL control R5 ↶↷	Trace is triggered in the most extreme positions of the LEVEL control	
4.4.7.	CALIBRATION			Calibration voltage is 1,2Vp-p Calibration frequency is ≈ 2kHz square wave	
4.4.8.	Z-MODULATION. (additional	TTL compatible signal to Z-MOD input at the rear side		Logic "1" is normal intensity Logic "0" is blanked	

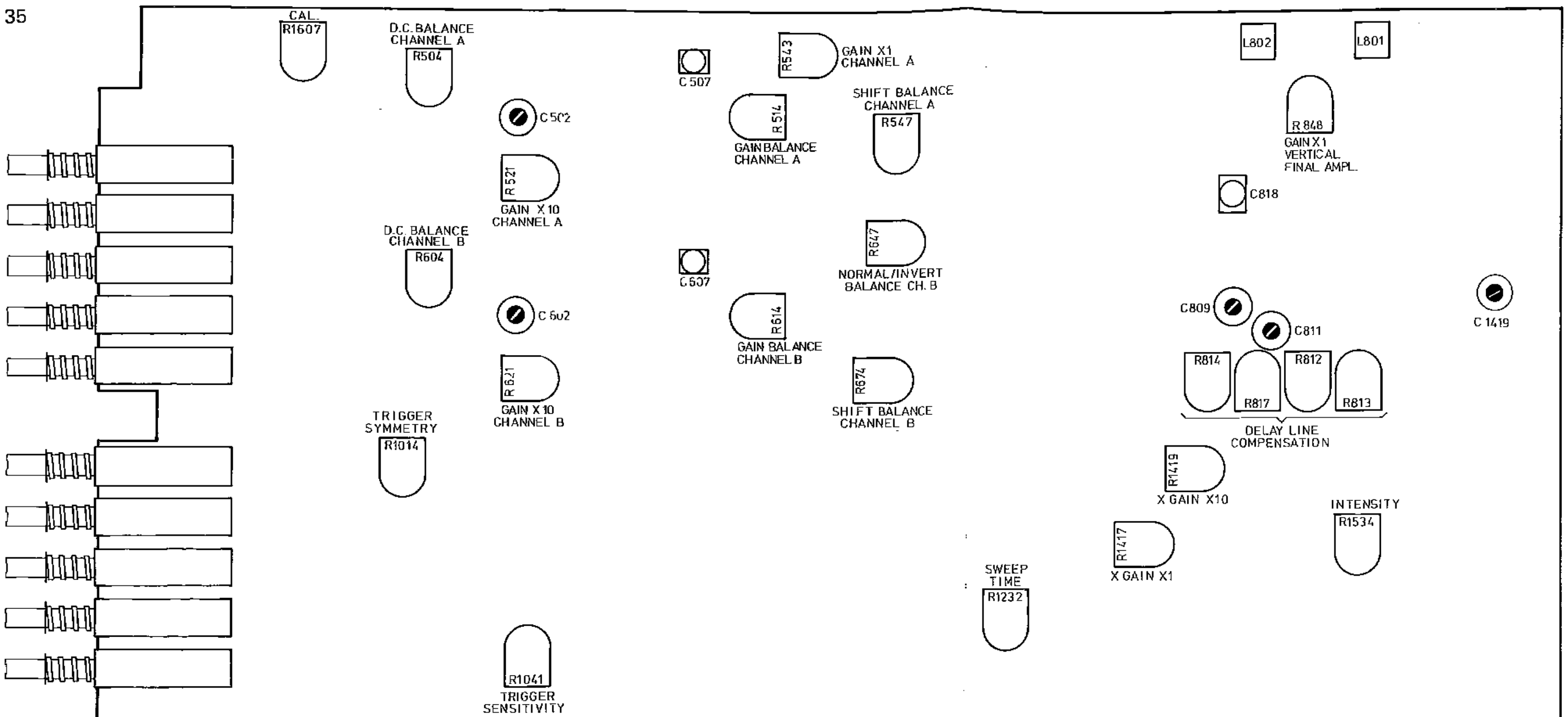
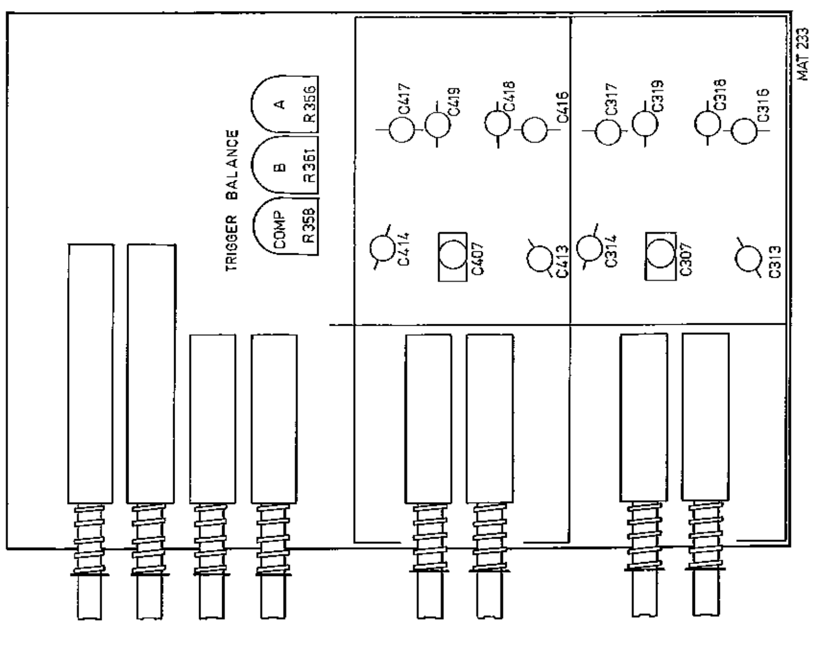
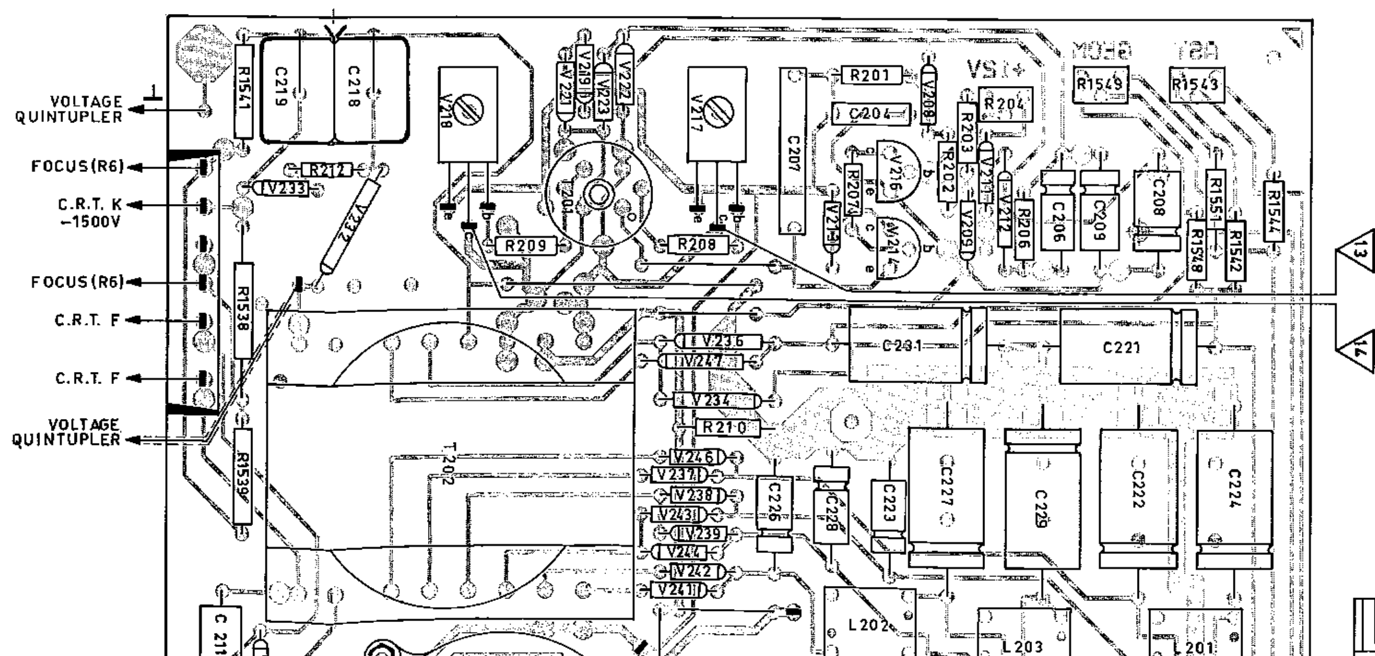


Fig. 5.1. Adjusting element amplifier board





5. CHECKING AND ADJUSTING

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

5.1. GENERAL INFORMATION

The following information provides the complete checking and adjusting procedure for the oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary.
The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment.
Before any check or adjustment, the instrument must attain its normal operating temperature.

- Where possible, instrument performance is checked before an adjustment is made.
- Warming-up time under average conditions is 30 minutes.
- All limits and tolerances given in this section are calibration guides and should not be interpreted as instrument specifications unless they are also published in chapter 1.2. characteristics.
- Tolerances given are for the instrument under test and do not include test equipment error.
- The most accurate display adjustments are made with a stable, well-focused, low-intensity display. Unless otherwise noted, adjust the Intensity, Focus and Trigger Level controls as needed.
- Unless otherwise noted the controls occupy the same position as in the previous check.

5.2. RECOMMENDED TEST EQUIPMENT

As indicated in chapter 4.3.
Additional equipment for the checking and adjusting procedure:
Digital multimeter e.g. PM 2522 (A).
Trimming tool set e.g. Philips 800 NTX.

5.3. PRELIMINARY SETTINGS OF THE CONTROLS

As indicated in chapter 4.2.

SURVEY OF ADJUSTING ELEMENTS AND AUXILIARY EQUIPMENT

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
Power supply					
Supply voltage adjustment	R204	+ 12V, + or – 0,25V	Digital multimeter	5.5.1.	5.3.
Cathode-ray tube circuit					
Intensity	R1534	Spot just not visible	–	5.5.2.	5.1.
Trace rotation	R10	Trace runs exactly in parallel with horizontal graticule lines.	–	5.5.2.	–
Focus and astigmatism	R1543	Sharp and well-defined trace.	Function generator, sine-wave signal 10kHz.	5.5.2.	5.3.
Geometrie	R1549	Displayed vertical lines as straight as possible and signal must fall in area.	Function generator, sine-wave signal 10kHz.	5.5.2.	5.3.
Y-Amplifier balance.					
DC balance	R504 (R604)	Minimum jump when switching 10mV - 20mV	–	5.5.3.	5.1.
Gain balance	R514 (R614)	Minimum jump when rotating AMPL/DIV control	–	5.5.3.	5.1.
Normal/invert balance ch.B	R647	Minimum jump when switching normal-invert.	–	5.5.3.	5.1.
Shift balance	R547 (R674)	Sine-wave displayed distortion free.	Function generator, sine-wave signal 10kHz.	5.5.3.	5.1.
Trigger balances					
A-balance	R356	Spot lies in centre of the screen.	–	5.5.4.	5.2.
B-balance	R361	Spot lies in centre of the screen.	–	5.5.4.	5.2.
COMP-balance	R358	Spot lies in centre of the screen.	–	5.5.4.	5.2.
Time-base generator.					
Time coefficients	R1417	Centre 8 cycles occupy 8 divisions.	Time marker generator, time marker pulse 1μsec.	5.5.5.	5.1.
	R1419	Centre 8 cycles occupy 8 divisions.	Time marker generator, time marker pulse 0,1μsec.	5.5.5.	5.1.
	R1232	Centre 8 cycles occupy 8 divisions	Time marker generator, time marker pulse 1msec.	5.5.5.	5.1.
	R1409	Beginning of the time-base as lineair as possible.	Time marker generator, time marker pulse 10nsec.	5.5.5.	5.1.

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT		RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
Vertical channels						
Gain sensitivity x1	R848 (R543)	Signal occupies 6 divisions.		Function generator, square-wave signal 2kHz.	5.5.6.	5.1.
Gain sensitivity x10	R621 (R521)	Signal occupies 6 divisions.		Function generator, square-wave signal 2kHz.	5.5.6.	5.1.
Square-wave resp. attenuators	C407 (C307)	Optimal square-wave response pulse top errors + or – 0,5 subdiv. trace height 6div. + or – 0,5 subdiv.	AMPL/DIV 20mV	Square-wave calibration generator, frequency 10kHz and risetime ⩽100nsec.	5.5.6.	5.2.
	C413 (C313)		AMPL/DIV 50mV			
	C414 (C314)		AMPL/DIV 0,1 V			
	C416 + C418 (C316 + C318)		AMPL/DIV 0,2 V			
	C417 + C419 (C317 + C319)		AMPL/DIV 2 V			
Square-wave response final amplifier	R813	Optimal square-wave response pulse top errors + or – 0,5 subdiv. and risetime ⩽7nsec.	freq. 10 Hz	Square-wave calibration generator frequency 10kHz - 1MHz and risetime ⩽3nsec.	5.5.6.	5.1.
	R812		100kHz			
	R814		100kHz-1MHz			
	C809		100kHz-1MHz			
	C811		100kHz-1MHz			
	R817		1MHz			
	C809		1MHz			
	C811		1MHz			
	L801		1MHz			
	L802		1MHz			
	C602 (C502)		1MHz			
	C508		1MHz			
Cross talk	R812 + R813	Minimum cross talk		Square-wave calibration generator, frequency 10kHz, risetime ⩽3nsec.	5.5.6.	5.1.
Triggering						
Trigger sensitivity	R1041	Lowest signal with a triggered trace.		Function generator, sine-wave signal 2kHz.	5.5.7.	5.1.
Calibration						
Calibration voltage	R1607	Squar-wave voltage 1,2Vp-p ± 0,7%		–	5.5.9.	5.1.

5.5. CHECKING AND ADJUSTING PROCEDURE

5.5.1. Power supply

Mains current

- Check that the mains voltage adapter has been set to the local mains voltage and connect the instrument to such a voltage.
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up.
- Check that the current consumption does not exceed 150mA at 220V local mains and 300mA at 117V local mains . (Measured with a moving iron meter).

Supply voltages (Fig. 5.3.)

- Check that the voltage on capcitor C224 is +12V, + or -0,25V; if necessary, readjust potentiometer R204.
- Check the supply voltages in accordance with the following table:

Voltage	Measuring point	Required value	Max. allowable ripple
+5 V	C227	+ 4,8 V to + 5,2 V	2mVp-p
+12V	C224	+11,75V to +12,25V	4mVp-p
- 12V	C229	- 11,75V to - 12,25V	4mVp-p
+38V	C222	+ 37 V to + 39 V	40mVp-p
+6,3V	C211	+5,7 V to +6,9 V	
+180V	C221	+171 V to +189 V	1 Vp-p
-180V	C231	-171 V to -189 V	1 Vp-p

- Vary the a.c. voltage to which the instrument is connected with + or -10% of the nominal voltage.
- Check that the supply voltage does not vary more than 2 ‰

5.5.2. Cathode-ray tube circuit

Intensity

- Set the controls as indicated in Fig. 4.1.
- Set the TIME/DIV switch to X DEFL.
- Set the INTENS control R1 to 90° from its left hand stop.
- Adjust potentiometer R1534 so that the spot is just not visible.
- Turn the INTENS control R1 fully anti-clockwise.

Trace rotation

- Set the TIME/DIV switch to 0,1ms/div.
- Centre the time-base line using the A POSITION control R2.
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines; if necessary readjust the front panel TRACE ROTATION potentiometer R10.

Focus and astigmatism

- Set A AMPL/DIV switch to 0,1V/div.
- Set the TIME/DIV switch to 50μs/div.
- Apply a sine-wave voltage of approx. 600mVp-p, 10kHz to the A input socket X2.
- Set the INTENS control R1 for normal brightness.
- Adjust the FOCUS control R6 for a sharp and well-defined trace over the whole screen area; if necessary, readjust potentiometer R1543 (astigmatism).

Geometrie

- Set the TIME/DIV switch to 0,1ms/div.
- Apply a sine-wave voltage of 1,2Vp-p, 10kHz to the channel A-input X2.
- Check that the displayed vertical lines are as straight as possible and that the signal falls between $95x75mm^2$ and $92{,}3x73{,}4mm^2$; if necessary, readjust potentiometer R1549.
- Remove the input signal.

5.5.3. Y-amplifier balance

General information

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

D.C. balance

- Set the controls as indicated in Fig. 4.1.
- Depress A (B) of S1.
- Depress O of S13 and S15.
- Centre the trace using the A (B) POSITION control R2 (R3).
- Check that the trace does not jump if AMPL/DIV switch S6 (S8) is rotated; if necessary, readjust potentiometer R504 (R604).

Gain balance

- Depress A (B) of S1.
- Check that the trace does not move when the AMPL/DIV control R6 (R7) is rotated; if necessary, readjust potentiometer R514 (R614).

Normal/invert balance channel B

- Depress B of S1.
- Check that the trace does not jump when PULL TO INVERT switch S4 is switched between normal and invert; if necessary, readjust potentiometer R647.

Shift balance

- Depress A (B) of S1.
- Depress A (B) of S16.
- Set the TIME/DIV switch to 50μs/div.
- Release O of S13 and S15.
- Apply a sine-wave voltage of 480mV p-p, 10kHz to the A (B) input socket X2 (X3).
- Check if the extremes of the sine-wave can be displayed distortion free on the screen by rotating the A (B) POSITION control R2 (R3); if necessary; readjust potentiometer R547 (R674).
- Remove the input signal.

5.5.4. Trigger balances

A-balance

- Set the controls as indicated in Fig. 4.1.
- Shift the trace to the first vertical graticule line using the X-pos control R4.
- Set the TIME/DIV switch to X DEFL.
- Depress EXT of S16.
- Check that the spot lies in the centre of the screen; tol. 2 div.
- Depress DC of S2.
- Depress A of S16.
- Check that the spot lies in the centre of the screen; if necessary, readjust potentiometer R356.

B-balance

- Depress B of S16.
- Check that the spot lies in the centre of the screen; if necessary, readjust potentiometer R361.

Comp.-balance

- Depress A and B (= COMP) of S16.
- Check that the spot lies in the centre of the screen; if necessary, readjust potentiometer R358.

5.5.5. Time-base generator

Time-coefficients

- Set the controls as indicated in Fig. 4.1.
- Set the TIME/DIV switch to 1μs/div.
- Depress DC of S2.
- Release S12 to DC.
- Apply a time-marker voltage with a repetition time of 1μs and an amplitude of 80mVp-p to the A input socket X2.
- Check that the central 8 cycles occupy 8 divisions; if necessary, readjust potentiometer R1417.
- Pull the X MAGN switch S5 to x10.
- Change the repetition time of the applied input signal to 0,1μs.
- Check that the central 8 cycles occupy 8 divisions; if necessary, readjust potentiometer R1419.
- Push the X MAGN switch S5 to x1.
- Set the TIME/DIV switch to 1ms/div.
- Change the repetition time of the applied input signal to 1ms.
- Check that the central 8 cycles occupy 8 divisions; if necessary, readjust potentiometer R1232.
- Pull the X MAGN switch S5 to x10.
- Set the TIME/DIV switch to 0,1μs/div.
- Change the repetition time of the applied input signal to 10ns.
- Set the X POS control R4 fully clockwise.
- Check that the beginning of the time-base is as linear as possible; if necessary, readjust trimmers C1406 and C1407.
- Push the X MAGN switch S5 to x1.
- Check all TIME/DIV switch positions.
  The repetition time of the applied input signal should correspond to the position of the TIME/DIV switch.
  The central 8 cycles should always occupy 8 divisions; tolerance + or - 1 subdivision (2 subdivisions with the X MAGN switch S5 to x10).
- Check that in all the positions of the TIME/DIV switch, the time-base length is at least 10 divisions.
- Check the control range of the TIME/DIV potentiometer R9 in the position 0,2ms/div. of the TIME/DIV switch. The range must be between 1 : 2,6 and 1 : 3,5.

Hold off

- Set the TIME/DIV switch to 1μs/div.
- Turn the HOLD OFF control R12 fully clockwise.

5.5.6. Vertical Channels

General Information

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

Gain sensitivity x1

- Set the controls as indicated in Fig. 4.1.
- Depress B (A) of S1.
- Release S14 and S12 to DC.
- Set B (A) AMPL/DIV switch to 20mV/div.
- Set TIME/DIV switch to 0,2ms/div.
- Depress B (A) of S16.
- Apply a square-wave voltage of 120mVp-p frequency 2kHz, to the B (A) input socket X3 (X2).
- Check that the signal occupies 6 divisions; if necessary, readjust potentiometer R848 (R543).
- Repeat the measurement for channel A.

Gain sensitivity x10

- Depress B (A) of S1.
- Set B (A) AMPL/DIV switch to 2mV/div.
- Depress B (A) of S16.
- Apply a square-wave voltage of 12mVp-p, frequency 2kHz, to the B (A) input socket X3 (X2).
- Check that the signal occupies 6 divisions; if necessary, readjust potentiometer R621 (R521).
- Repeat the measurement for channel A.

Square-wave response attenuators

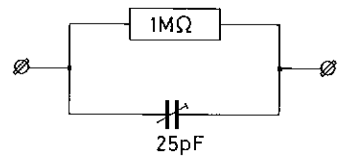
- Depress B (A) of S1.
- Set the TIME/DIV switch to 20μs/div.
- Depress B (A) of S16.
- Apply a square-wave voltage with an amplitude as indicated in the following table, a frequency of 10kHz and a risetime ⩽ 100ns to the B (A) input socket X3 (X2).
- Check that the pulse top errors do not exceed + or - 0,5 subdivision and that the trace height is 6 divisions + or - 0,5 subdivision; if necessary, readjust the relevant trimmer.

B (A) Ampl.	YB (YA) input signal	Adjuster
2mV	12mV	
5mV	30mV	
10mV	60mV	
20mV	120mV	C407 (C307)
50mV	300mV	C413 (C313)
0,1V	600mV	C414 (C314)
0,2V	1,2V	C416 + C418 (C316 + C318)
0,5V	3 V	
1 V	6 V	
2 V	12 V	C417 + C419 (C317 + C319)
5 V	30 V	
10 V	60 V	

- Remove the input signal.

Input capacitance

– Apply a square-wave voltage with an amplitude as indicated in the following table, frequency 10kHz and rise time ⩽ 100ns to the B (A) input socket X3 (X2) via a dummy probe.



Dummy probe
2 : 1 // 25pF

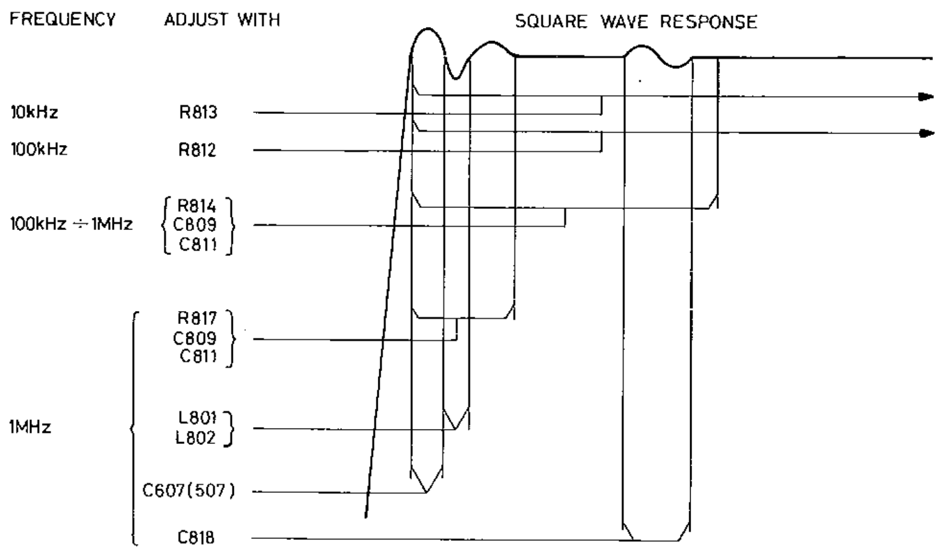
– Check that the pulse top errors do not exceed + or - 0,5 subdivision and that the trace height is 6 divisions + or - 0,5 subdivision.

B (A) Ampl.	YB (YA) input signal	Adjuster
2mV	24mV	Cv dummy
5mV	60mV	Cv dummy
10mV	120mV	Cv dummy

– Check that the difference in input capacitance do not exceed 1pF.
– Remove the input signal.

Square-wave response final amplifier

– Depress B of S1.
– Set the B AMPL/DIV switch to 20mV/div.
– Depress B of S22.
– Apply a square-wave voltage of 120mVp-p, risetime ⩽ 3ns to the B input socket X3. The frequency should be in accordance with the table below.
– Check the square-wave response; pulse top errors may not exceed 0,5 subdivision and the rise time may not exceed 7ns.



MAT269

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

Channel	*AMPL/DIV*	*Input signal*	*Trace height*	*Rep rate*	*TIME/DIV*	*Adj. with*	*Max. error*
B	2mV/div.	12mV	6div.	1MHz	.2μs	C602	0,5 subdivision
A	20mV/div.	120mV	6div.	1MHz	.2μs	C508	0,5 subdivision
A	2mV/div.	12mV	6div.	1MHz	.2μs	C502	0,5 subdivision

Cross talk

- Depress CHOP of S1.
- Set the A and B AMPL/DIV switches to 20mV/div.
- Set the TIME/DIV switch to 0,5ms/div.
- Depress O of S13.
- Depress B of S16.
- Apply a square-wave voltage of 120mVp-p, frequency 10kHz and a risetime ≤ 3ns to the B input socket X3.
- Check that the crosstalk between both channels is as small as possible; if necessary, readjust potentiometers R812 and R813.
- Remove the input signal.

Bandwidth

- Depress A (B) of S1.
- Set A (B) AMPL/DIV switch to 2mV/div.
- Set TIME/DIV switch to 0,1ms/div.
- Release O of S13 and S15.
- Depress A (B) of S16.
- Apply a sine-wave signal of 12mVp-p, frequency 100kHz and risetime ≤ 3ns to the A (B) input socket X2 (X3).
- Check that the trace height is 6 div.
- Increase the frequency of the input signal to 50MHz and check that the trace height is at least 4,8 div. at all input frequencies to 50MHz.
- Repeat the measurement for channel B.

Common-mode rejection

- Depress ADD of S1.
- Pull S4 to INVERT.
- Set A and B AMPL/DIV switches to 20mV/div.
- Apply a sine-wave signal of 480mVp-p frequency 1MHz to both A and B input sockets X2 and X3.
- Check that the rejection factor is ≥ 100x.
- Increase the frequency of the input signal to 10MHz.
- Check that the rejector factor is ≥ 50x.
- Push S4 to NORM.
- Remove the input signal.

Alternate and chopped mode

- Depress ALT of S1.
- Set TIME/DIV switch to 10ms.
- Depress O of S13 and S15.
- Check that the two traces are displayed alternately.
- Depress CHOP of S1.
- Check that the two traces are displayed simultaneously.

5.5.7. Triggering

Trigger slope

- Set the controls as indicated in Fig. 4.1.
- Depress O of S13.
- Set the LEVEL control R5 to its mid position.
- Check that the DC-output voltage of the trigger amplifier (c.i. collector of V1014) does not change if the SLOPE pushbutton is switched between + and –.
  If necessary, readjust potentiometer R1014.
- Release S12 to DC.
- Release O of S13.
- Apply a sine-wave signal of 120mVp-p, frequency 2kHz to the A input socket X2.
- Depress SLOPE switch S3 to the – position and check that the trace starts with a negative going edge.
- Release SLOPE switch S3 to the + position and check that the trace starts with a positive going edge.

Trigger sensitivity

- Find the lowest possible input signal at which it is still possible to obtain a triggered trace with the aid of the LEVEL control R5 and potentiometer R1041.

Trigger level internal

- Depress AC of S2.
- Apply a sine-wave signal of 80mVp-p, frequency 2kHz to the A input socket X2.
- Check that the starting point of the trace moves upwards when the LEVEL control R5 is turned clockwise.
- The trace may not be triggered if the LEVEL control is set in its both extreme positions.
- Increase the amplitude of the applied input signal to 400mVp-p.
- Check that the trace is triggered if the LEVEL control R5 is set in its both extreme positions.

Trigger level auto

- Depress AUTO of S2.
- Apply a sine-wave signal for a trace equivalent of 6 divisions, frequency 100Hz to the A input socket X2.
- Check that the starting point of the sine-wave can be shifted across approx. 3 divisions with the aid of the LEVEL control R5.

Trigger level EXT and EXT ÷ 10

- Depress AC of S2.
- Depress EXT of S16.
- Apply a sine-wave signal of 800mVp-p, frequency 2kHz to the A input socket X2 and the EXT input socket X5.
- Check that the starting point of the sine-wave can be shifted across the entire amplitude with the aid of the LEVEL control R5.
- Depress EXT ÷ 10 S16.
- Increase the input voltage to 8Vp-p.
- Check that the starting point of the sine-wave can be shifted across the entire amplitude with the aid of the LEVEL control R5.

Trigger sensitivity

- Apply a sine-wave signal with a frequency as given in the table below, to the A-input X2; B-input X3 or EXT input X5.
- Adapt the setting of TIME/DIV switch to the frequency of the input signal.
- Check the trigger sensitivities in accordance to the table below.

Signal to	*Frequency*	*S16*	*S2*	*Trace height*
YA	10 Hz	A	AUTO	⩽0,7div.
YA	10 kHz	A	AUTO	⩽0,7 div.
YA	50 MHz	A	AUTO	⩽0,8 div.
YA	20 Hz	A	AC	⩽0,7 div.
YA	50 MHz	A	AC	⩽0,8 div.
YA	50 MHz	A	DC	⩽0,8 div.
YB	20 Hz	B	DC	⩽0,7 div.
YB	50 MHz	B	DC	⩽0,8 div.
YB	50 MHz	COMP	DC	⩽0,8 div.
EXT	20 Hz	EXT	DC	⩽140mV
EXT	50 MHz	EXT	DC	⩽140mV
EXT	50 MHz	EXT ÷ 10	DC	⩽1,4V

Line-triggering

- Depress A of S1.
- Depress AUTO of S2.
- Depress B of S16.
- Set the TIME/DIV switch to 2ms/div.
- Release S12 to DC.
- Apply a mains voltage derived signal of 10mVp-p via a mains transformer to the A input X2.
- Check that the trace is not triggered.
- Depress EXT and EXT ÷ (= LINE) of S16.
- Check that the trace is triggered.
- Remove the input signal.

TV triggering

- Depress TV of S2.
- Depress A of S16.
- Apply a TV signal with a synchronisation pulse of 14mVp-p to the A input X2.
- Release SLOPE S3 for a TV signal with positive video.
- Check that a triggered display is visible on the screen.
- Depress SLOPE S3 for a TV signal with negative video.
- Check that a triggered display is visible on the screen.
- Increase the amplitude of the synchronisation pulse to 40mVp-p.
- Check that a triggered display is visible on the screen.
- Release SLOPE S3.
- Remove the input signal.

5.5.8. X-Deflection

Sensitivity

- Set the controls as indicated in Fig. 4.1.
- Set the TIME/DIV switch to X DEFL.
- Depress EXT of S16.
- Apply a sine-wave voltage of 1,6Vp-p, frequency 2kHz to the EXT input socket X5.
- Check that the trace length is 8 divisions ± 1 division.
- Remove the input signal.

Bandwidth X-ampl.

- Apply a sine-wave voltage with a frequency of 2kHz to the EXT input socket X5 and adjust the amplitude of the input voltage so that the trace length is 8 divisions.
- Increase the frequency of the input voltage to 1MHz.
- Check that the trace length is at least 5,6 divisions.
- Remove the input signal.

X-Deflection with a line signal

- Depress EXT and EXT ÷ 10 (= LINE) of S16.
- Check that the trace length is ⩾ 8 divisions.

Horizontal sensitivity via YA

- Depress B of S1.
- Depress A of S16.
- Apply a sine-wave voltage of 120mVp-p, frequency 2kHz to the A input socket X2.
- Check that the trace length is 6 divisions ± 0,6 division.
- Remove the input signal.

Horizontal sensitivity via YB

- Depress A of S1.
- Depress B of S16.
- Apply a sine-wave voltage of 120mVp-p, frequency 2kHz to the B input socket X3.
- Check that the trace length is 6 divisions ± 0,6 division.

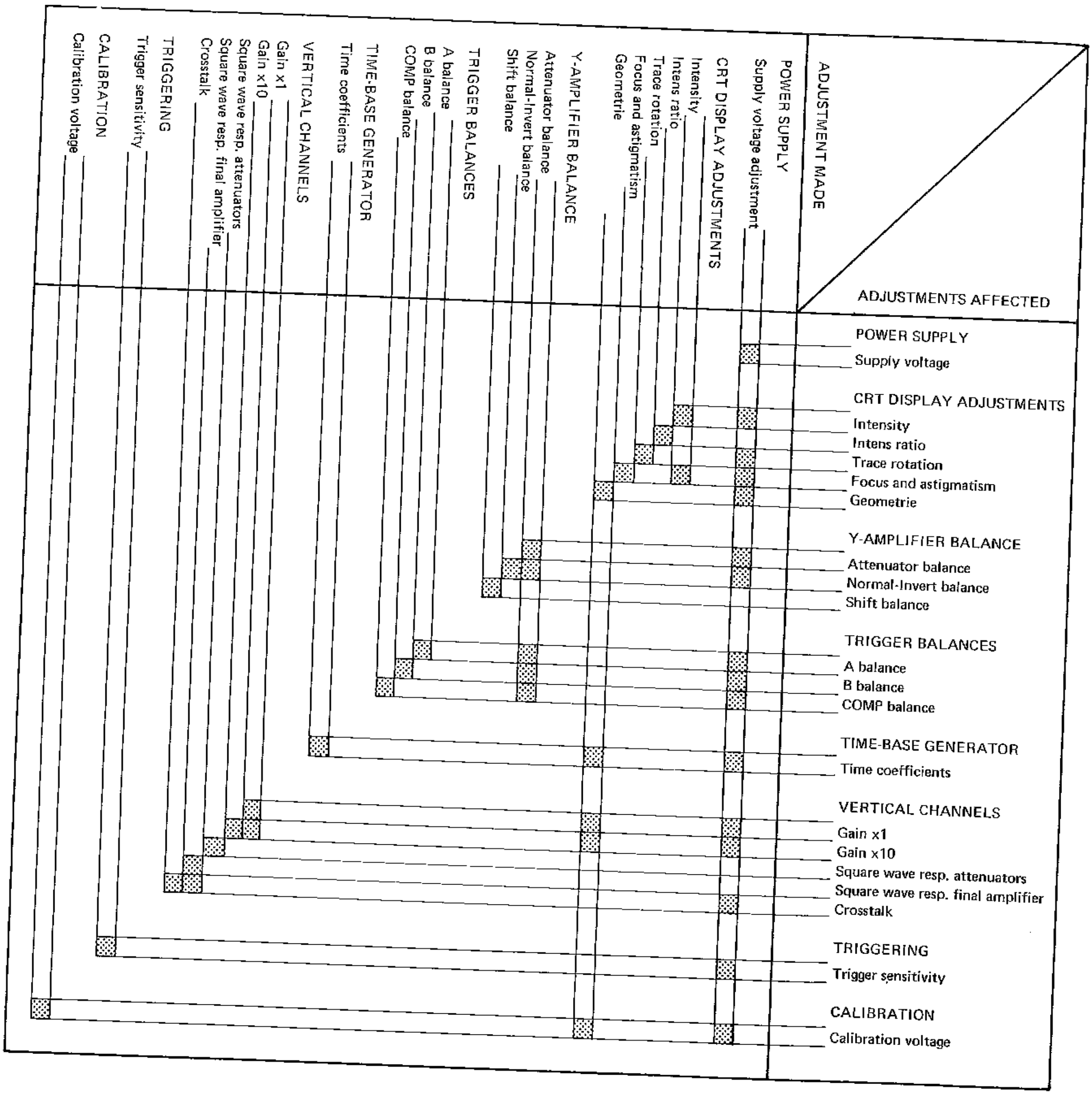
Phase difference between X and Y channels

- Depress B of S1.
- Check that the line is displayed under an angle of 45^o with the horizontal central line.
- Increase the frequency of the input to 100kHz.
- Check that the phase error does not exceed 3^o (⩽ 2 subdivisions).
- Remove the input signal.

5.5.9. Calibration voltage

- Check that the voltage on the CAL output X1 is a square-wave voltage of 1,2Vp-p ± 0,7%; if necessary, readjust potentiometer R1607.
- Check that the frequency of the CAL voltage is 2kHz ± 10%.

5.6. ADJUSTMENT INTERACTIONS



6. CORRECTIVE MAINTENANCE

6.1. REPLACEMENTS

WARNING: **The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.**
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

Standard parts

Electrical and mechanical replacement parts can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers.

Before purchasing or ordering replacement parts, check the parts list for value tolerance, rating and description.

Note: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special parts

In addition to the standard electronic components, some special components are used.
These components are manufactured or selected by Philips to meet specific performance requirements.

Transistors and integrated circuits

Transistors and I.C.'s (integrated circuits) should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

WARNING: **Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.**

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced.

6.1.1. Replacing internal fuses and mains transformer

- Remove the rear cover and instrument cover as described in chapter 3.2.
- Now three fuses are accessible:
  - Thermal fuse of the mains transformer.
  - Fuse 201 of external battery supply protection.
  - Fuse 202 of power supply protection

6.1.1.1. Replacing the mains transformer

- Take the lid of the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire from between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer is then accessible for replacement.

6.1.1.2 Replacing the thermal fuse

- Remove the mains transformer.
- Unsolder fuse terminals 1 and 2 (Fig. 6.1. and Fig. 6.2.).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

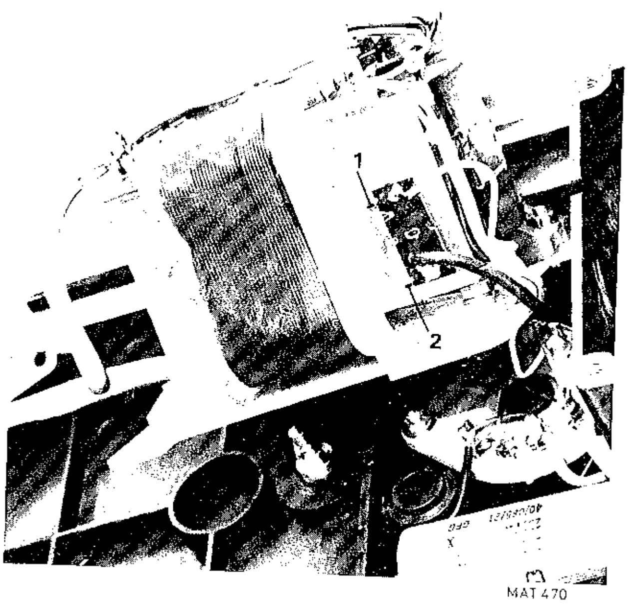


Fig. 6.1.

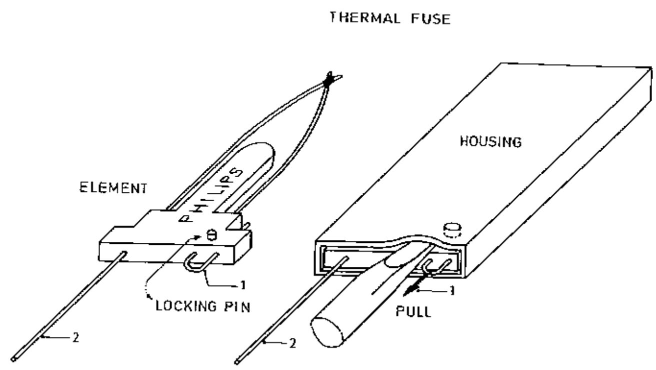


Fig. 6.2.

6.1.1.3. Replacing fuse F201 and F202

These fuses are situated on the power supply unit and can easily be replaced.

6.1.2. Replacing single knobs

- Prise off cap A.
- Slacken screw (or nut) B.
- Pull the knob from the spindle.

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

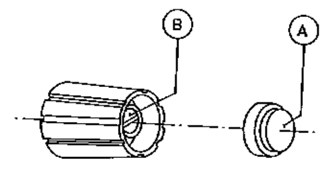


Fig. 6.3.

6.1.3. Replacing double knobs

- Prise off cap A and slacken screw B.
- Pull the inner knob from the spindle.
- Slacken nut C and pull the outer knob from the spindle.

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

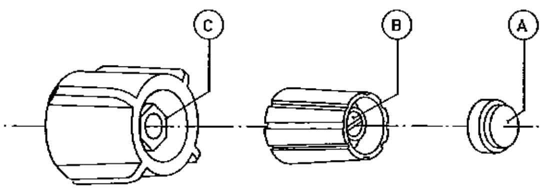


Fig. 6.4.

6.1.4. Removing the textplate

- After having removed all knobs the textplate can be removed by loosening the four hexaconal nuts of the AMPL/DIV and TIME/DIV switches.

6.1.5. Removing the front assembly

In order to gain acess 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.
- 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. 6.5.)
- Remove the two screws B that hold the attenuator to the frame bar (Fig. 6.6.).
- Remove the three screws C (Fig. 6.7.)
- 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.

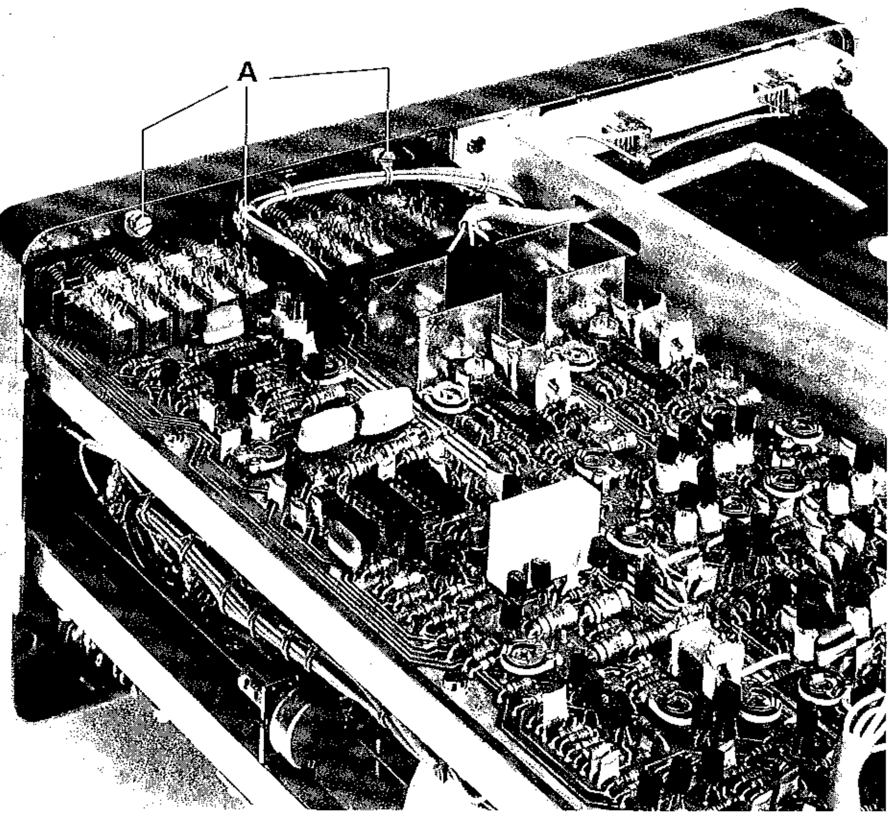


Fig. 6.5.

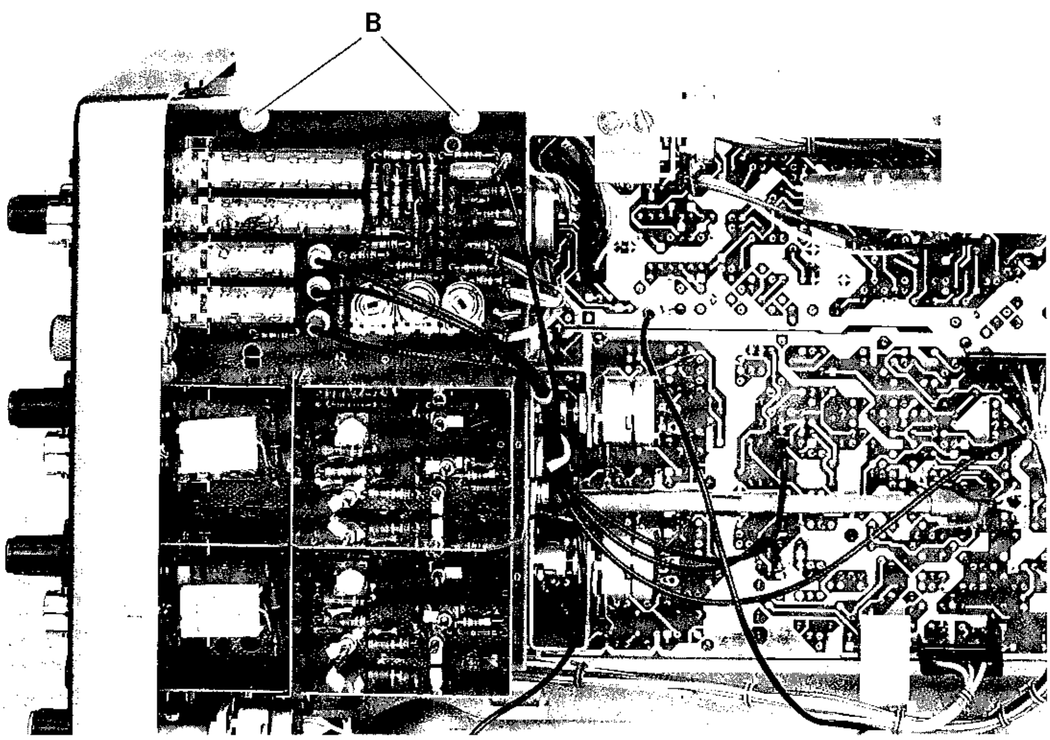


Fig. 6.6.

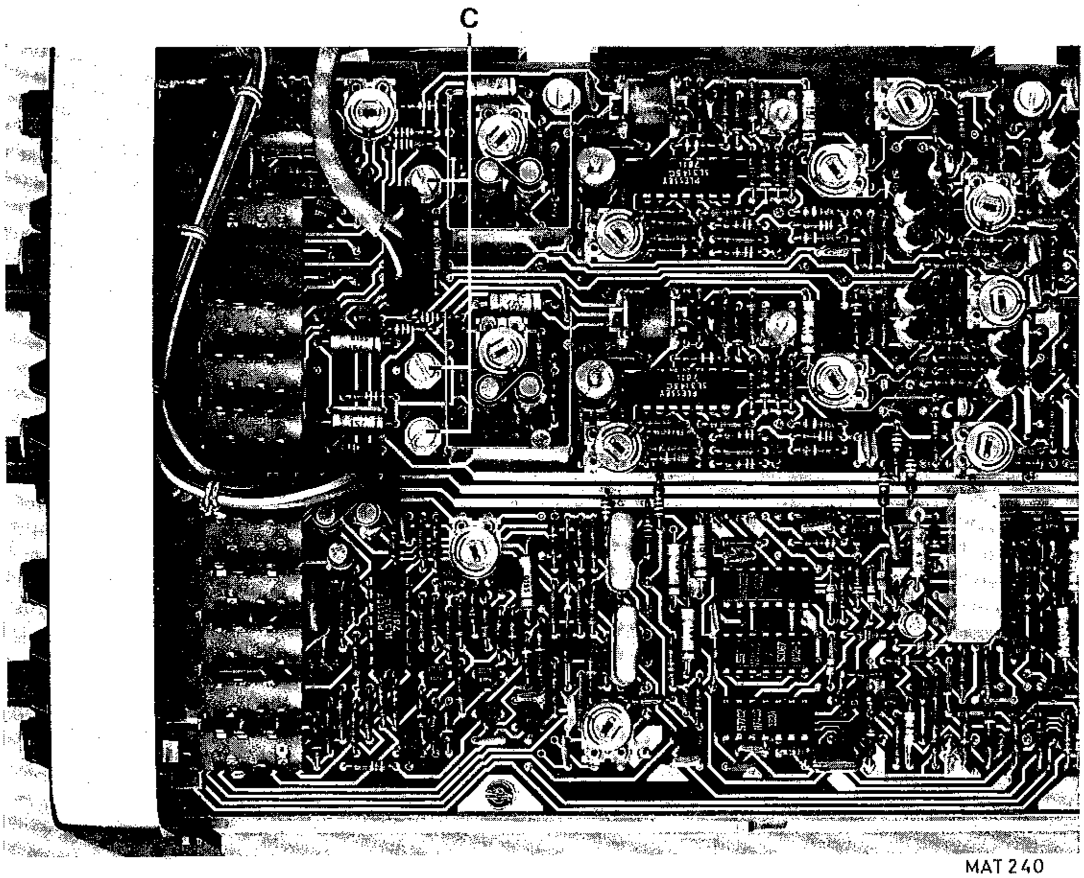


Fig. 6.7.

6.1.6. Replacing switches

6.1.6.1. General

- To replace the AMPL/DIV switches, first remove the front panel assembly (section 6.1.5.)
- To replace the TIME/DIV switch, first remove knobs and text plate (section 6.1.2. – 6.1.4.)
- If one of the pushbutton 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 6.1.5.). The defective switch is then replaced in accordance with the procedure described below.
- To replace one of the pushbutton 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.

6.1.6.2. Replacing a switch of a pushbutton unit

- Straighten the 4 retaining lugs of the relevant switch as shown in Fig. 6.8.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch on to the printed-wiring board.
- Bend the four retaining lugs back to their original positions.

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

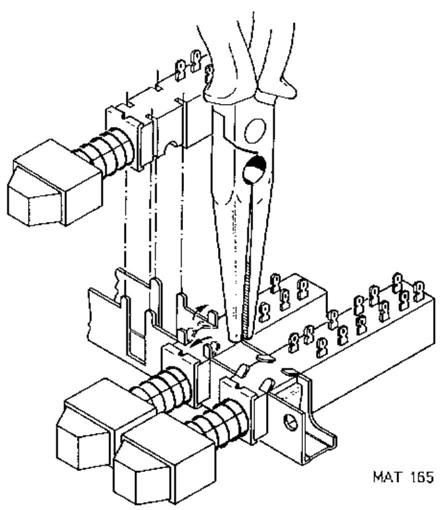


Fig. 6.8.

6.1.7. Replacing the delay line unit

- If there is a defect in the delay line, the complete delay line unit must be replaced.
- Replacement is self-evident, but take care not to interchange the connections at the same end of the delay line; interchange of the connections results in a downward movement of the trace when rotating the POSITION control clockwise.
- Before mounting it must be checked, that the new delay line is placed in its housing like shown in Fig. 6.9.

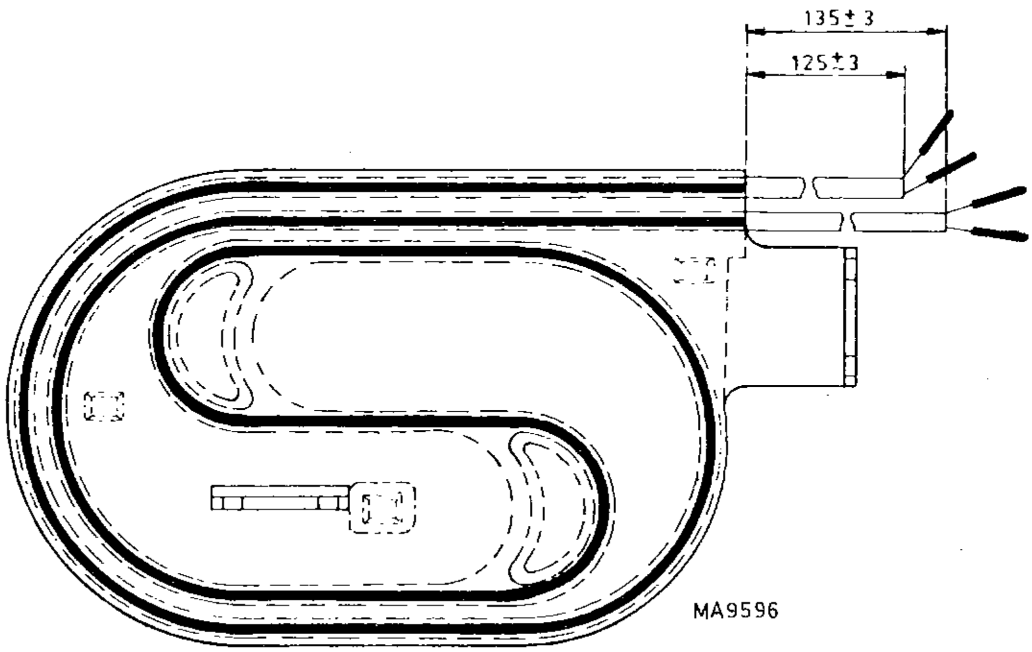


Fig. 6.9.

6.1.8. Replacing the cathode-ray tube

- Remove the instrument covers and rear frame.
- Remove bezel and contrast plate.
- Unplug the connectors on the c.r.t. neck.
- Ease the base socket off the c.r.t.
- Slacken the brace around the c.r.t. neck.
- Unplug the trace rotation coil connector on the amplifier board and pull cable and plug through the elongated hole in the centre frame.
- Withdraw the c.r.t. through the front panel until the e.h.t. connector at the side of the tube becomes accessible.
- Remove the e.h.t. connector.
- Take the c.r.t. out of the instrument via the front panel; mind the wire and plug of the trace rotation coil.
- Install a c.r.t. in reverse order; position the c.r.t. screen flush with the contrast plate. The torque applied to the screw of the brace around the c.r.t. neck must be between 0,4 and 0,6Nm.

WARNING: **Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode. In particular be very careful with the side connections of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.**

6.2. SOLDERING TECHNIQUES

Working method:

- Carefully unsolder one after the other the soldering tags of the semi-conductor.
- Remove all superfluous soldering material. Use a sucking iron or sucking copper litze wire.
- Check that the tags of the replacement part are clean and pre-tinned on the soldering places.
- Locate the replacement semi-conductor exactly on its place, and solder each tag to the relevant printed conductor on the circuit board.

Note: *Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 deg. C. The use of a solder with a low melting point is therefore recommended.*

Take care not damage the plastic encapsulation of the semi-conductor.

ATTENTION: When you are soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

Suitable soldering irons are:

- ORYX micro-miniature soldering instrument, type 6A, voltage 6 V, in combination with PLATO pin-point tip type 0-569.
- ERSA miniature soldering iron, type minot 040 B, voltage 6 V.
- Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1 mm-pin-point tip, order no. 4822 395 10012.

Ordinary 60/40 solder and 35- to 40-watt pencil-type soldering iron can be used to accomplish the majority of the soldering. If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material.

6.3. SPECIAL TOOLS

Trimming Tool Kit (Type 800/NTX)

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins. The wide variety of pin allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).
Ordering number 4822 310 50015.
(A spare set containing the 8 most commonly used pins is available under the ordering number 4822 310 50016).

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Fig. 6.10.

6.4. RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuit.
Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the power supply or if the transformer has been replaced.

6.5. INSTRUMENT REPACKAGING

If the instrument is to be shipped to a Servie Centre for service or repair, attach a tag showing owner (with address) and the name of an individual at your firm that can be contacted. The Service Centre needs the complete instrument serial number and a fault description.

Save and re-use the packing in which your instrument was shipped. If the original packing is unfit for use or not available, repack the instrument in such a way that no damage during transport occurs.

6.6. TROUBLE-SHOOTING

6.6.1. Introduction

The following information is provided to facilite trouble shooting. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used. Refer to the Circuit Description section for this information.

6.6.2. Trouble-shooting hints

If a fault appears, the following test sequence can be used to find the defective circuit part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the operating instructions in the Operating manual.
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not refer to section 5 (checking and adjusting).
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC's that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes. Check the voltage between base and emitter (0,7Volt approx. in conductive state) and the voltage between collector and emitter (0,2Volt approx. in saturation) with a voltmeter or oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/emitter and base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other direction. When measuring take care that the current from the ohmmeter does not damage the component under test.
  Replace the suspected component by a new one if you are sure that the circuit is not in such a condition that the new one will be damaged.
- Integrated circuit. In circuit testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under-test is essential. Therefore first read the circuit description in section 2.
- Capacitors. Leakage can be traced with an ohmmeter adjusted to the highest resistance range.
  When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can be used:
  compare the measured value with value and tolerance indicated in the parts list.
- Resistors. Can be checked with an ohmmeter after having unsoldered one side of the resistor from the p.c.b. Compare the measured value with value and tolerance indicated in the parts list.
- Coils and transformers. An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the wave-form response when HF signals are passed through the circuit. Also an inductance meter can be used.

NOTE: If a component must be replaced always use a direct-replacement. If not available use an equivalent after carefully checking that it does not degrade the instrument's performance. See also section 6.1. (replacement).
After replacement of a component the calibration of the instrument may be affected due to component tolerances. If necessary do the required adjustments.

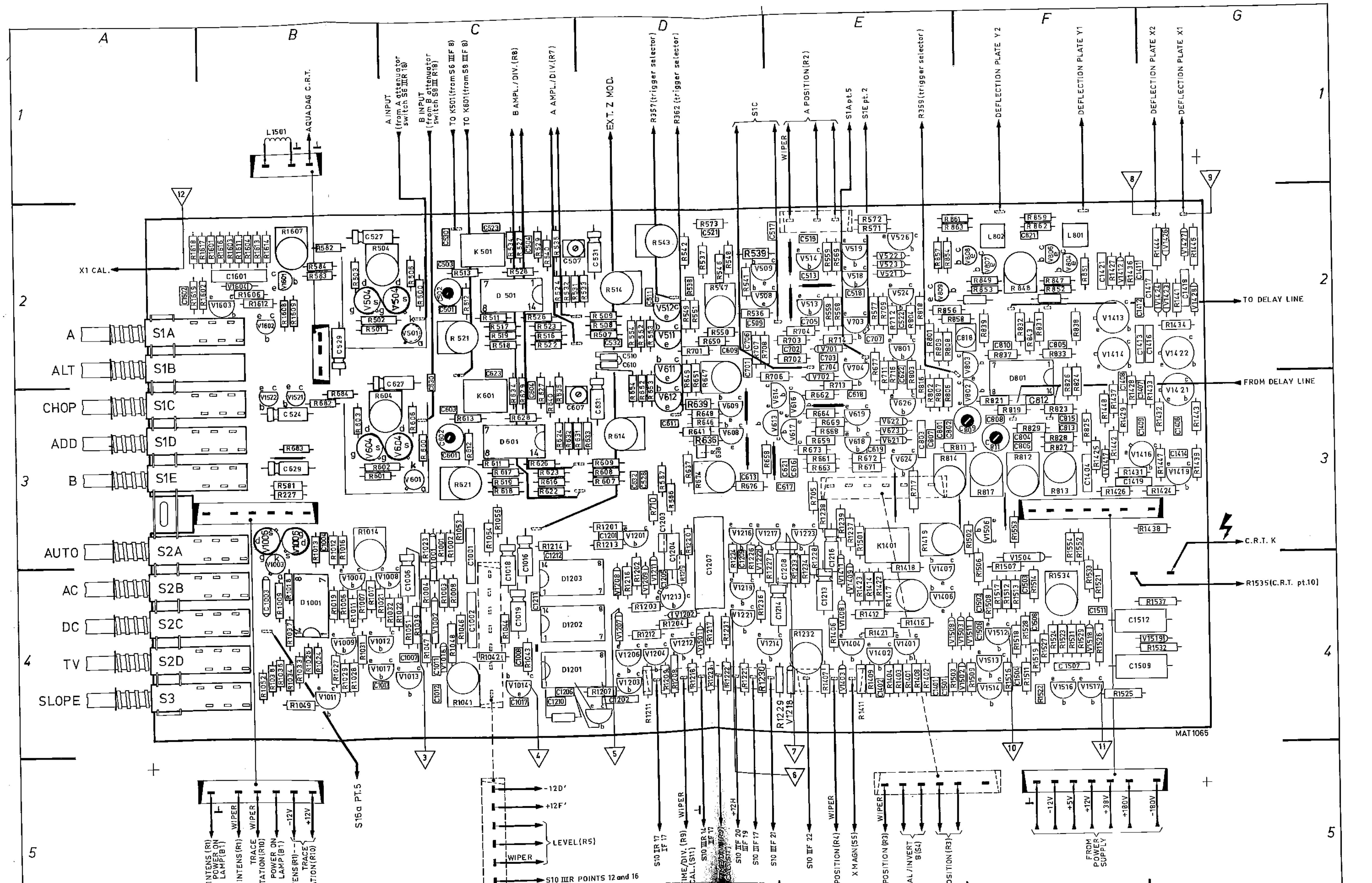
6.6.3. Mains transformer data

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram (Fig. 8.5) in the form of a table.

6.6.4. Voltages and waveforms in the instrument

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator are shown at the relevant points on the circuit diagram (Fig. 8.5.).
The oscilloscope under test must be set in the following way to measure the voltage wave-forms as shown in Fig. 8.5.

- X-POSITION potentiometer R4 at mid-range
- A-POSITION potentiometer R2 at mid-range
- LEVEL potentiometer R5 at mid-range
- SLOPE switch in position "+"
- TRIGGER source selector switch S16 in position "A"
- A and AUTO pushbuttons S1A and S2A depressed
- A AMPL/DIV switch to S6 to 1V/div. and potentiometer R7 to CAL
- TIME/DIV switch S10 to 0,2ms/div. potentiometer R9 to CAL and X MAGN switch S5 to x1
- Input signal on A input socket X2: 2,5kHz sine-wave voltage for 8 div. deflection.



A
B
C
D
E
F
G
AQUADAG C.R.T.
L1501
A INPUT (from A attenuator switch S6 IIR 18)
B INPUT (from B attenuator switch S8 III R 18)
TO K501 (from S6 III F 8)
TO K601 (from S8 III F 8)
B AMPL./DIV. (R8)
A AMPL./DIV. (R7)
EXT. Z MOD.
R357 (trigger selector)
R362 (trigger selector)
S1C
WIPER
A POSITION (R2)
S1A pt.5
S1E pt.2
R359 (trigger selector)
DEFLECTION PLATE Y2
DEFLECTION PLATE Y1
DEFLECTION PLATE X2
DEFLECTION PLATE X1
X1 CAL.
TO DELAY LINE
FROM DELAY LINE
C.R.T. K
R1535 (C.R.T. pt.10)
A
ALT
CHOP
ADD
B
AUTO
AC
DC
TV
SLOPE
S1A
S1B
S1C
S1D
S1E
S2A
S2B
S2C
S2D
S3
K501
K601
D501
D601
D801
D1001
D1201
D1202
D1203
K1401
MAT 1065
S16a PT.5
-12D'
+12F'
LEVEL (R5)
WIPER
S10 IIIR POINTS 12 and 16
INTENS (R1) POWER ON LAMP (B1)
INTENS (R1)
WIPER
TRACE ROTATION (R10)
POWER ON LAMP (B1)
-12V
+12V
S10 IR 17 IF 17
S10 IIF 20 IIF 19
S10 IIF 17
S10 IIF 21
S10 IIF 22
POSITION (R4)
X MAGN (S5)
POSITION (R3)
FROM POWER SUPPLY
-12V
+5V
+12V
+38V
+180V
-180V
1
2
3
4
5

6.6.5. Component location list

Item	Grid Loc.
C101	Rear panel
C200	Power supply
C201	Power supply
C202	Power supply
C203	Power supply
C204	Power supply
C206	Power supply
C207	Power supply
C208	Power supply
C209	Power supply
C211	Power supply
C212, C213, C214, C216, C217	High tension unit
C218	Power supply
C219	Power supply
C221	Power supply
C222	Power supply
C223	Power supply
C224	Power supply
C226	Power supply
C227	Power supply
C228	Power supply
C229	Power supply
C231	Power supply
C301	Att. unit
C305	Att. unit
C307	Att. unit
C308	Att. unit
C309	Att. unit
C310	Att. unit
C311	Att. unit
C312	Att. unit
C313	Att. unit
C314	Att. unit
C315	Att. unit
C316	Att. unit
C317	Att. unit
C318	Att. unit
C319	Att. unit
C320	Att. unit
C321	Att. unit
C322	Att. unit
C324	Att. unit
C351	Att. unit
C352	Att. unit
C353	Att. unit
C354	Att. unit
C356	Att. unit
C357	Att. unit
C358	Att. unit
C401	Att. unit
C405	Att. unit
C407	Att. unit

Item	Grid Loc.
C408	Att. unit
C409	Att. unit
C410	Att. unit
C411	Att. unit
C412	Att. unit
C413	Att. unit
C414	Att. unit
C415	Att. unit
C416	Att. unit
C417	Att. unit
C418	Att. unit
C419	Att. unit
C420	Att. unit
C421	Att. unit
C422	Att. unit
C424	Att. unit
C501	C-2
C502	C-2
C503	C-2
C504	C-2
C507	C-2/D-2
C508	D-2
C509	D-2
C510	D-2
C511	D-2
C513	E-2
C517	E-2
C518	E-2
C519	E-2
C521	D-2
C522	E-2
C523	C-2
C524	B-3
C527	B-2/C-2
C528	D-3
C529	B-2
C530	C-2
C531	C-2
C532	D-2
C601	C-3
C602	C-3
C603	C-3
C604	C-3
C607	C-3/D-3
C608	D-3
C609	D-2
C610	D-2
C611	D-3
C612	D-3
C613	D-3
C614	D-3
C616	E-3
C617	E-3
C618	E-3
C619	E-3
C621	E-3
C622	E-2/E-3

Item	Grid Loc.
C623	C-2
C627	B-2/C-2
C628	B-3/C-3
C629	B-3
C630	C-2/C-3
C631	D-3
C632	D-3
C701	D-2
C702	E-2
C703	E-2
C704	E-2
C705	E-2
C706	D-2
C707	E-2
C801	E-3
C802	E-3
C804	F-3
C805	F-2
C806	F-3
C807	E-3
C808	F-3
C809	F-3
C810	F-2
C811	F-3
C812	F-3
C813	F-3
C815	F-3
C818	F-2
C821	F-2
C1001	C-3/C-4
C1002	C-4
C1003	B-4
C1004	B-3
C1006	C-3/C-4
C1007	C-4
C1008	C-4
C1011	C-4
C1012	C-4
C1013	B-4
C1016	C-3/C-4
C1017	C-4
C1018	C-3/C-4
C1019	C-4
C1201	D-3
C1202	D-4
C1203	D-3
C1204	D-3/D-4
C1205	D-4
C1206	C-4
C1207	D-3/D-4
C1208	E-3/E-4
C1209	D-3/D-4
C1210	C-4
C1211	C-4
C1212	C-3
C1213	E-4
C1214	E-4
C1216	E-3/E-4

Item	Grid Loc.
C1401	E-4
C1402	E-4
C1403	E-4
C1404	F-3
C1406	G-3
C1407	F-3/G-3
C1408	F-3
C1409	F-3/G-3
C1411	F-2/G-2
C1412	F-2/G-2
C1413	F-2/G-2
C1414	G-3
C1416	G-2
C1417	G-2
C1418	G-2
C1419	F-3
C1421	F-2
C1501	E-4
C1502	F-4
C1503	F-4
C1504	F-4
C1506	F-4
C1507	F-4
C1508	F-4
C1509	F-4/G-4
C1511	F-4
C1512	F-4/G-4
C1513	On Tube
C1601	B-2
C1602	A-2
R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11	Front panel
R200	Power supply
R201	Power supply
R202	Power supply
R203	Power supply
R204	Power supply
R206	Power supply
R207	Power supply
R208	Power supply
R209	Power supply
R210	Power supply
R211	High t. u.
R212	Power supply
R227	B-3
R302	Att. unit
R303	On switch S6

Item	Grid Loc.
R304, R306	On switch S6
R307	Att. unit
R308	Att. unit
R309	Att. unit
R311	Att. unit
R312	Att. unit
R313, R314	On switch S6
R316	Att. unit
R317	Att. unit
R318	Att. unit
R319	Att. unit
R354	Att. unit
R356	Att. unit
R357	Att. unit
R358	Att. unit
R359	Att. unit
R361	Att. unit
R362	Att. unit
R363	Att. unit
R364	Att. unit
R366	Att. unit
R367	Att. unit
R369	Att. unit
R371	Att. unit
R372	Att. unit
R373	Att. unit
R402	Att. unit
R403, R404, R406	On switch S8
R407	Att. unit
R408	Att. unit
R409	Att. unit
R411	Att. unit
R412	Att. unit
R413, R414	On switch S8
R416	Att. unit
R417	Att. unit
R418	Att. unit
R419	Att. unit
R500	C-2
R501	B-2/C-2
R502	B-2/C-2
R503	B-2
R504	B-2/C-2
R506	C-2
R507	D-2
R508	D-2
R509	D-2
R511	C-2
R512	C-2
R513	C-2
R514	D-2

Item	Grid Loc.
R516	C-2
R517	C-2
R518	C-2
R519	C-2
R521	C-2/D-2
R522	C-2/D-2
R523	C-2/D-2
R524	C-2
R526	C-2/D-2
R527	C-2/D-2
R528	C-2
R529	C-2/D-2
R531	C-2/D-2
R532	C-2
R533	D-2
R534	C-2
R535	C-2
R536	D-2
R537	D-2
R538	D-2
R539	D-2
R540	C-2
R541	D-2
R542	D-2
R543	D-2
R546	D-2
R547	D-2
R548	D-2
R549	D-2
R550	D-2
R551	D-2
R552	D-2
R553	D-2
R554	D-2
R558	E-2
R559	E-2
R567	E-2
R568	E-2
R569	E-2
R571	E-2
R572	E-2
R573	D-2
R577	E-2
R581	B-3
R582	B-2
R583	B-2
R584	B-2
R586	D-3
R587	D-3
R600	C-3
R601	B-3/C-3
R602	B-3/C-3
R603	B-3
R604	B-3/C-3
R606	C-3

Item	Grid Loc.
R607	D-3
R608	D-3
R609	D-3
R611	C-3
R612	C-3
R613	C-3
R614	D-3
R616	C-3
R617	C-3
R618	C-3
R619	C-3
R621	C-3
R622	C-3
R623	C-3
R624	C-3
R626	C-3
R627	C-2/C-3
R628	C-3
R629	C-2/C-3
R631	C-3
R632	C-3
R633	D-3
R634	C-2/C-3
R635	C-2/C-3
R636	D-3
R637	D-3
R638	D-3
R639	D-3
R640	C-3
R641	D-3
R646	D-3
R647	D-2/D-3
R648	D-3
R649	D-2/D-3
R650	D-2
R651	D-2/D-3
R652	D-2/D-3
R653	D-2/D-3
R654	D-2/D-3
R658	D-3
R659	E-3
R661	E-3
R662	E-3
R663	E-3
R664	E-3
R666	E-3
R667	E-3
R668	E-3
R669	E-3
R671	E-3
R672	E-3
R673	E-3
R674	D-3
R676	D-3
R677	E-2/E-3

Item	Grid Loc.
R682	B-3
R683	B-3
R684	B-3
R701	D-2
R702	E-2
R703	E-2
R704	E-2
R705	E-3
R706	D-2/E-2
R707	D-2
R708	D-2
R709	E-2
R710	D-3
R711	E-2/E-3
R712	E-2
R713	E-3
R714	E-2
R716	E-2/E-3
R717	E-3
R801	E-2
R802	E-3
R803	E-2/E-3
R804	E-2
R806	E-3
R807	E-3
R808	E-2
R809	E-2
R811	E-3/F-3
R812	F-3
R813	F-3
R814	E-3
R816	E-2/E-3
R817	F-3
R818	E-2
R819	F-3
R821	F-3
R823	F-3
R824	F-2/F-3
R825	F-3
R826	F-2/F-3
R827	F-3
R828	F-3
R829	F-3
R831	F-2
R832	F-2
R833	F-2
R837	F-2
R838	F-2
R839	F-2
R843	F-2
R847	F-2

Item	Grid Loc.
R848	F-2
R849	F-2
R851	F-2
R852	F-2
R853	F-2
R854	E-2
R856	E-2/F-2
R857	E-2
R858	E-2/F-2
R859	F-2
R861	E-2/F-2
R862	F-2
R863	E-2/F-2
R1001	C-3
R1002	C-3
R1003	C-4
R1004	C-4
R1006	B-4
R1007	B-4
R1008	C-4
R1009	B-4
R1011	B-4
R1012	B-3
R1013	B-3
R1014	B-3
R1016	B-3
R1017	B-4
R1018	B-4
R1019	B-4
R1021	B-4
R1022	C-4
R1023	C-3
R1024	B-4
R1026	B-4
R1027	B-4
R1028	B-4
R1029	B-4
R1031	B-4
R1032	B-4/C-4
R1033	B-4
R1034	B-4
R1036	B-4
R1037	B-4
R1038	B-4
R1039	C-4
R1041	C-4
R1042	C-4
R1043	C-4
R1044	C-4
R1046	C-4
R1047	C-4
R1048	C-4
R1049	B-4
R1051	C-4
R1052	B-4

Item	Grid Loc.
R1053	C-3
R1054	C-3
R1056	C-3
R1201	D-3
R1202	D-4
R1203	D-4
R1204	D-4
R1207	D-4
R1208	D-4
R1209	D-4
R1211	D-4
R1212	D-4
R1213	D-3
R1214	C-3
R1216	D-4
R1217	D-4
R1218	D-4
R1219	D-4
R1220	D-3
R1221	D-4
R1222	D-4
R1223	D-4
R1224	D-3/D-4
R1226	D-3/D-4
R1227	D-4
R1228	E-3/E-4
R1229	D-4
	D-4
R1231	D-4
R1232	E-4
R1233	E-4
R1234	E-4
R1236	D-4
R1237	E-3
R1238	E-3
R1239	E-3
R1276, R1277, R1278, R1279, R1281, R1282, R1283, R1284, R1286, R1287, R1288, R1289	On switch S10
R1401	E-4
R1402	E-4
R1403	E-4
R1404	E-4
R1406	E-4
R1407	E-4
R1408	E-4
R1409	E-4
R1411	E-4
R1412	E-4

Item	Grid Loc.
R1414	E-4
R1416	E-4
R1417	E-4
R1418	E-4
R1419	E-3
R1421	E-4
R1422	E-4
R1423	E-4
R1424	G-3
R1425	F-3
R1426	F-3
R1427	F-2
R1428	F-3
R1429	F-3
R1431	F-3
R1432	G-3
R1433	G-3
R1434	G-2
R1436	F-2
R1437	F-3
R1438	F-3/G-3
R1439	G-3
R1440	On R4
R1441	G-2
R1442	F-3
R1443	G-3
R1444	G-2
R1445	On R4
R1446	G-2
R1447	G-3
R1448	F-3
R1450	On R4
R1501	E-3
R1502	F-3
R1503	E-4
R1506	F-4
R1507	F-4
R1508	F-4
R1509	F-4
R1511	F-4
R1512	F-4
R1513	F-4
R1514	F-4
R1516	F-4
R1517	F-4
R1518	F-4
R1519	F-4
R1521	F-4
R1522	F-4
R1523	F-4
R1524	F-4
R1525	F-4
R1526	F-4
R1527	F-4
R1528	F-4
R1529	F-4

Item	Grid Loc.
04	On switch S6
06	On switch S6
07	Att. unit
08	Att. unit
09	Att. unit
11	Att. unit
12	Att. unit
13	On switch S6
14	On switch S6
16	Att. unit
17	Att. unit
18	Att. unit
19	Att. unit
54	Att. unit
56	Att. unit
57	Att. unit
58	Att. unit
59	Att. unit
61	Att. unit
62	Att. unit
63	Att. unit
64	Att. unit
66	Att. unit
67	Att. unit
69	Att. unit
71	Att. unit
72	Att. unit
73	Att. unit
02	Att. unit
03	On switch S8
04	On switch S8
06	On switch S8
07	Att. unit
08	Att. unit
09	Att. unit
11	Att. unit
12	Att. unit
13	On switch S8
14	On switch S8
16	Att. unit
17	Att. unit
18	Att. unit
19	Att. unit
00	C-2
01	B-2/C-2
02	B-2/C-2
03	B-2
04	B-2/C-2
06	C-2
07	D-2
08	D-2
09	D-2
11	C-2
12	C-2
13	C-2
14	D-2

Item	Grid Loc.
R516	C-2
R517	C-2
R518	C-2
R519	C-2
R521	C-2/D-2
R522	C-2/D-2
R523	C-2/D-2
R524	C-2
R526	C-2/D-2
R527	C-2/D-2
R528	C-2
R529	C-2/D-2
R531	C-2/D-2
R532	C-2
R533	D-2
R534	C-2
R535	C-2
R536	D-2
R537	D-2
R538	D-2
R539	D-2
R540	C-2
R541	D-2
R542	D-2
R543	D-2
R546	D-2
R547	D-2
R548	D-2
R549	D-2
R550	D-2
R551	D-2
R552	D-2
R553	D-2
R554	D-2
R558	E-2
R559	E-2
R567	E-2
R568	E-2
R569	E-2
R571	E-2
R572	E-2
R573	D-2
R577	E-2
R581	B-3
R582	B-2
R583	B-2
R584	B-2
R586	D-3
R587	D-3
R600	C-3
R601	B-3/C-3
R602	B-3/C-3
R603	B-3
R604	B-3/C-3
R606	C-3

Item	Grid Loc.
R607	D-3
R608	D-3
R609	D-3
R611	C-3
R612	C-3
R613	C-3
R614	D-3
R616	C-3
R617	C-3
R618	C-3
R619	C-3
R621	C-3
R622	C-3
R623	C-3
R624	C-3
R626	C-3
R627	C-2/C-3
R628	C-3
R629	C-2/C-3
R631	C-3
R632	C-3
R633	D-3
R634	C-2/C-3
R635	C-2/C-3
R636	D-3
R637	D-3
R638	D-3
R639	D-3
R640	C-3
R641	D-3
R646	D-3
R647	D-2/D-3
R648	D-3
R649	D-2/D-3
R650	D-2
R651	D-2/D-3
R652	D-2/D-3
R653	D-2/D-3
R654	D-2/D-3
R658	D-3
R659	E-3
R661	E-3
R662	E-3
R663	E-3
R664	E-3
R666	E-3
R667	E-3
R668	E-3
R669	E-3
R671	E-3
R672	E-3
R673	E-3
R674	D-3
R676	D-3
R677	E-2/E-3

Item	Grid Loc.
R682	B-3
R683	B-3
R684	B-3
R701	D-2
R702	E-2
R703	E-2
R704	E-2
R705	E-3
R706	D-2/E-2
R707	D-2
R708	D-2
R709	E-2
R710	D-3
R711	E-2/E-3
R712	E-2
R713	E-3
R714	E-2
R716	E-2/E-3
R717	E-3
R801	E-2
R802	E-3
R803	E-2/E-3
R804	E-2
R806	E-3
R807	E-3
R808	E-2
R809	E-2
R811	E-3/F-3
R812	F-3
R813	F-3
R814	E-3
R816	E-2/E-3
R817	F-3
R818	E-2
R819	F-3
R821	F-3
R823	F-3
R824	F-2/F-3
R825	F-3
R826	F-2/F-3
R827	F-3
R828	F-3
R829	F-3
R831	F-2
R832	F-2
R833	F-2
R837	F-2
R838	F-2
R839	F-2
R843	F-2
R847	F-2

Item	Grid Loc.
R848	F-2
R849	F-2
R851	F-2
R852	F-2
R853	F-2
R854	E-2
R856	E-2/F-2
R857	E-2
R858	E-2/F-2
R859	F-2
R861	E-2/F-2
R862	F-2
R863	E-2/F-2
R1001	C-3
R1002	C-3
R1003	C-4
R1004	C-4
R1006	B-4
R1007	B-4
R1008	C-4
R1009	B-4
R1011	B-4
R1012	B-3
R1013	B-3
R1014	B-3
R1016	B-3
R1017	B-4
R1018	B-4
R1019	B-4
R1021	B-4
R1022	C-4
R1023	C-3
R1024	B-4
R1026	B-4
R1027	B-4
R1028	B-4
R1029	B-4
R1031	B-4
R1032	B-4/C-4
R1033	B-4
R1034	B-4
R1036	B-4
R1037	B-4
R1038	B-4
R1039	C-4
R1041	C-4
R1042	C-4
R1043	C-4
R1044	C-4
R1046	C-4
R1047	C-4
R1048	C-4
R1049	B-4
R1051	C-4
R1052	B-4

Item	Grid Loc.
R1053	C-3
R1054	C-3
R1056	C-3
R1201	D-3
R1202	D-4
R1203	D-4
R1204	D-4
R1207	D-4
R1208	D-4
R1209	D-4
R1211	D-4
R1212	D-4
R1213	D-3
R1214	C-3
R1216	D-4
R1217	D-4
R1218	D-4
R1219	D-4
R1220	D-3
R1221	D-4
R1222	D-4
R1223	D-4
R1224	D-3/D-4
R1226	D-3/D-4
R1227	D-4
R1228	E-3/E-4
R1229	D-4
	D-4
R1231	D-4
R1232	E-4
R1233	E-4
R1234	E-4
R1236	D-4
R1237	E-3
R1238	E-3
R1239	E-3
R1276	On switch S10
R1277	On switch S10
R1278	On switch S10
R1279	On switch S10
R1281	On switch S10
R1282	On switch S10
R1283	On switch S10
R1284	On switch S10
R1286	On switch S10
R1287	On switch S10
R1288	On switch S10
R1289	On switch S10
R1401	E-4
R1402	E-4
R1403	E-4
R1404	E-4
R1406	E-4
R1407	E-4
R1408	E-4
R1409	E-4
R1411	E-4
R1412	E-4

Item	Grid Loc.
R4	E-4
R6	E-4
R7	E-4
R8	E-4
R9	E-3
R1	E-4
R2	E-4
R3	E-4
R4	G-3
R5	F-3
R6	F-3
R7	F-2
R8	F-3
R9	F-3
R1	F-3
R2	G-3
R3	G-3
R	G-2
R6	F-2
R7	F-3
R8	F-3/G-3
R9	G-3
R0	On R4
R	G-2
R	F-3
R	G-3
R	G-2
R	On R4
R	G-2
R	G-3
R	F-3
R	On R4
R	E-3
R	F-3
R	E-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4
R	F-4

Item	Grid Loc.
R1531	F-4
R1532	G-4
R1533	F-4
R1534	F-4
R1535	On tube
R1536	On tube
R1537	G-4
R1538	Power supply
R1539	Power supply
R1541	Power supply
R1542	Power supply
R1543	Power supply
R1544	Power supply
R1546	Power supply
R1547	Power supply
R1548	Power supply
R1549	Power supply
R1551	Power supply
R1552	F-3/F-4
R1553	F-3
R1554	F-3/F-4
R1601	B-2
R1602	B-2
R1603	B-2
R1604	B-2
R1606	B-2
R1607	B-2
R1608	B-2
R1609	B-2
R1611	B-2
R1612	B-2
R1613	B-2
R1614	B-2
R1616	B-2
R1617	B-2
R1618	A-2
R1619	A-2
V1	Tube
V201	Power supply
V202	Power supply
V203	Power supply
V204	Power supply
V206	Power supply
V207	Power supply
V208	Power supply
V209	Power supply
V211	Power supply
V212	Power supply
V213	Power supply
V214	Power supply
V216	Power supply
V217	Power supply
V218	Power supply
V219	Power supply
V221	Power supply
V222	Power supply

Item	Grid Loc.
V223	Power supply
V224	Power supply
V226	High tension unit
V227	High tension unit
V228	High tension unit
V229	High tension unit
V231	High tension unit
V232	Power supply
V233	Power supply
V234	Power supply
V236	Power supply
V237	Power supply
V238	Power supply
V239	Power supply
V241	Power supply
V242	Power supply
V243	Power supply
V244	Power supply
V246	Power supply
V247	Power supply
V351	Att. unit
V352	Att. unit
V353	Att. unit
V354	Att. unit
V501	C-2
V504	B-2/C-2
V508	D-2/E-2
V509	D-2/E-2
V511	D-2
V512	D-2
V513	E-2
V514	E-2
V518	E-2
V519	E-2
V521	E-2
V522	E-2
V523	E-2
V524	E-2
V526	E-2
V601	C-3
V604	B-3/C-3
V608	D-3
V609	D-3
V611	D-2/D-3
V612	D-3
V613	D-3/E-3
V614	E-3
V616	E-3
V617	E-3
V618	E-3
V619	E-3
V621	E-3

Item	Grid Loc.
V622	E-3
V623	E-3
V624	E-3
V626	E-3
V701	E-2
V702	E-2/E-3
V703	E-2
V704	E-2
V801	E-2
V802	F-3
V803	F-2
V804	F-2
V806	F-2
V807	F-2
V808	F-2
V809	E-2
V1001	C-3/C-4
V1002	C-4
V1003	B-3/B-4
V1004	B-4
V1006	B-3/C-3
V1008	B-4/C-4
V1009	B-4
V1011	B-4
V1012	B-4/C-4
V1013	C-4
V1014	C-4
V1016	C-4
V1017	B-4/C-4
V1201	D-3
V1202	D-4
V1203	D-4
V1204	D-4
V1206	D-4
V1207	D-4
V1208	D-4
V1209	D-4
V1211	D-4
V1212	D-4
V1213	D-4
V1214	D-4/E-4
V1216	D-3
V1217	D-3/E-3
V1218	E-4
V1219	D-4
V1221	D-4
V1222	D-3/D-4
V1223	E-3
V1401	E-4
V1402	E-4
V1403	E-4
V1404	E-4
V1406	E-4
V1407	E-4
V1408	E-4
V1409	E-4

Item	Grid Loc.
V1411	E-4
V1412	F-2
V1413	F-2
V1414	F-2
V1416	F-3/G-3
V1417	F-3
V1419	G-3
V1421	G-3
V1422	G-2
V1423	G-2
V1424	G-2
V1426	G-2
V1427	G-2
V1428	G-2
V1501	D-4
V1502	E-4/F-4
V1503	E-4/F-4
V1504	F-4/F-3
V1506	F-3
V1508	E-4
V1511	F-4
V1512	F-4
V1513	F-4
V1514	F-4
V1516	F-4
V1517	F-4
V1518	F-4
V1519	F-4/G-4
V1521	B-3
V1522	B-3
V1601	B-2
V1602	B-2
V1603	B-2
V1604	B-2
D501	C-2
D601	C-3
D801	F-2/F-3
D802	Delay line
D1001	B-4
D1201	C-4/D-4
D1202	C-4/D-4
D1203	C-4/D-4
B1	LED
F201	Power supply
F202	Power supply
K501	C-2
K601	C-2/C-3
K1401	E-3
L201	Power supply
L202	Power supply
L203	Power supply
L801	F-2
L802	F-2
L1501	Trace rot. coil
T101	Rear panel
T201	Power supply
T202	Power supply

6.7. MAINS VOLTAGE SETTING (PM3215U only)

If the instrument is to be used with 127V, 220V or 240V mains supply, the appropriate voltage should be selected by switching the adaptor on the rear panel until the required voltage is indicated.
If the mains plug has to be adapted, the mains cord must be connected as stated below:

green	: protective earth
black	: phase
white	: neutral

6.8. CHECKS AFTER REPAIR AND MAINTENANCE

6.8.1. Checking the protective leads.

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet.
The resistance should be $< 0{,}5\Omega$. During measurement the mains cable should be moved. Resistance variations indicate a defect.

6.8.2. Checking the insulating resistance.

Measure the insulating resistance at U dc = 500V between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulating resistance should be $> 2M\Omega$.

6.9. EXTRA IN- AND OUTPUT CIRCUITS

The PM3215 is equipped with Z-mod input mounted at the rear panel and with facilities to add two extra output circuits with a minimum of components. The in- and output BNC sockets are mounted in the holes above the c.r.t. socket; only 15-mm-holes must be drilled in the plastic rear cover (Fig. 6.11.) on the positions as indicated.

6.9.1. External Z-modulation input

Characteristics

- TTL Compatible
- Current drain at 0 V: –3 mA; at +5 V: +1 mA
- Brightness: light from +2 V to +7 V maximum
  dark from +0.8 V to –1.2 V minimum
- Rise time from light to dark and vice versa: 50 ns
- Delay time from input socket to screen: 85 ns

Used components

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

6.9.2. Time-base sweep output

Characteristics

- Output voltage: minimum level –1,8 V
  maximum level +3,8 V ± 0.5 V
- Internal resistance: 1 kohm
- The output is protected against short-circuits

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Resistor 1 kohm	5322 116 54549
– Resistor 1.27 kohm	5322 116 50555
– Transistor BC548C	5322 130 44196
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 6.9.
- Fit the resistors as indicated in Fig. 6.12.
- Fit the transistor as indicated in Fig. 6.12.
- Connect one end of the coaxial cable to the points indicated in Fig. 6.12. and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

6.9.3. Time-base gate output

Characteristics

- Output voltage: high level more than +2.7 V
  low level less than 0.5 V
- TTL output via 50 ohm resistor
- The output is protected against short-circuits

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Resistor 51.1 ohm	5322 116 54442
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 6.9.
- Fit the resistor as indicated in Fig. 6.12.
- Connect one end of the coaxial cable to the points indicated in Fig. 6.12. and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

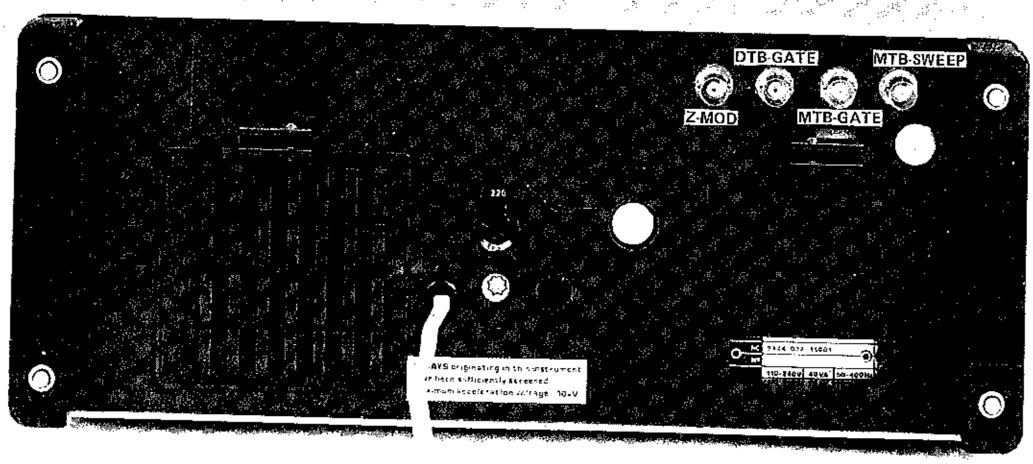


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Fig. 6.11. Rear view of the oscilloscope

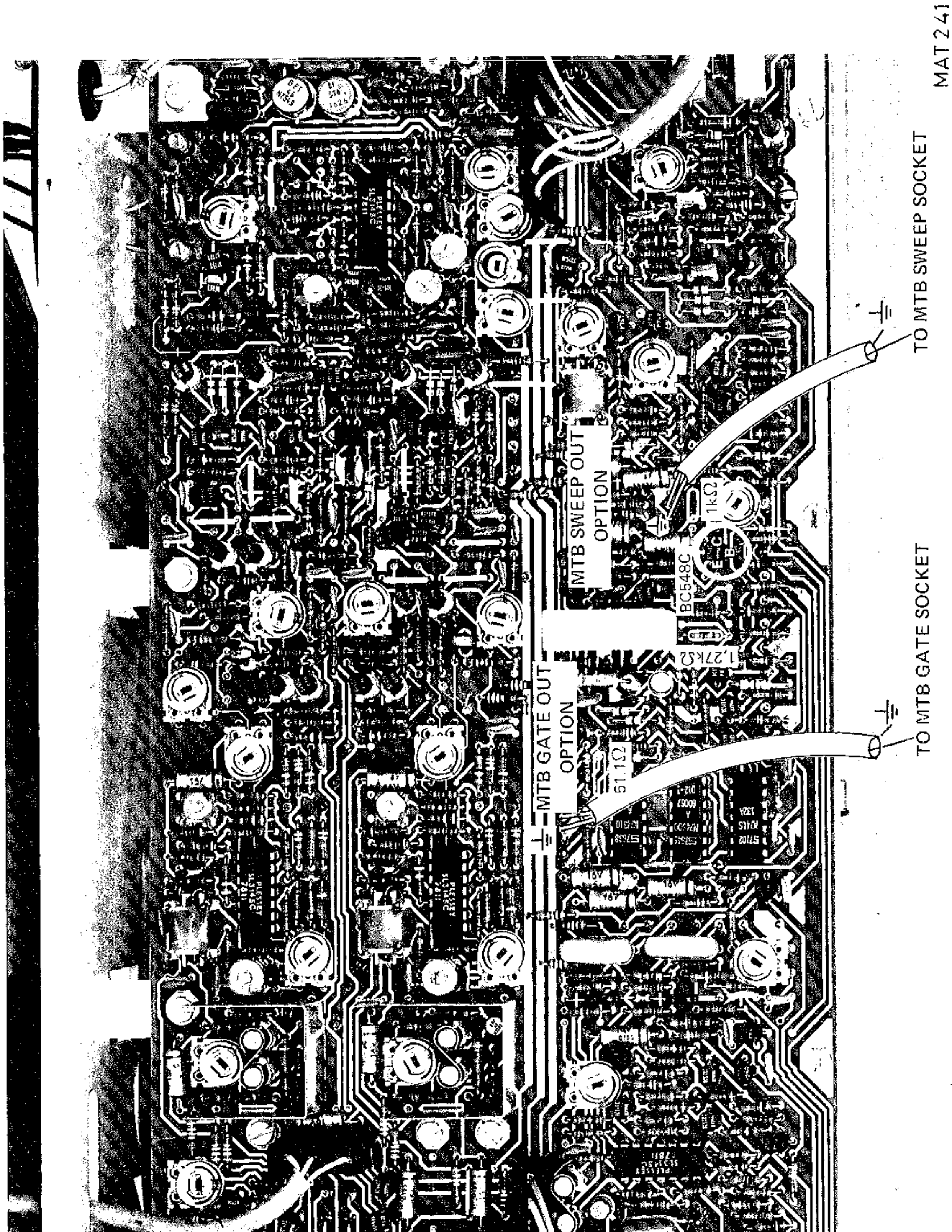


Fig. 6.12. Mounting the components and the cables

6.10. ACCESSORY INFORMATION

Dismantling

Dismantling the probe (see Fig.6.13.)

The front part 11 of the probe can be screwed from the rear part 13. Item 11 can then be slid from 12 and 13. The RC combination 12 is soldered to 13. For replacement of 12 refer to the next section.

Dismantling the compensation box (see Fig. 6.13.)

Unscrew the ribbed collar of the compensation box to the cable. The case 14 can then be slid sideways off the compensation box. The electrical components on the printed-wiring board are then accessible.

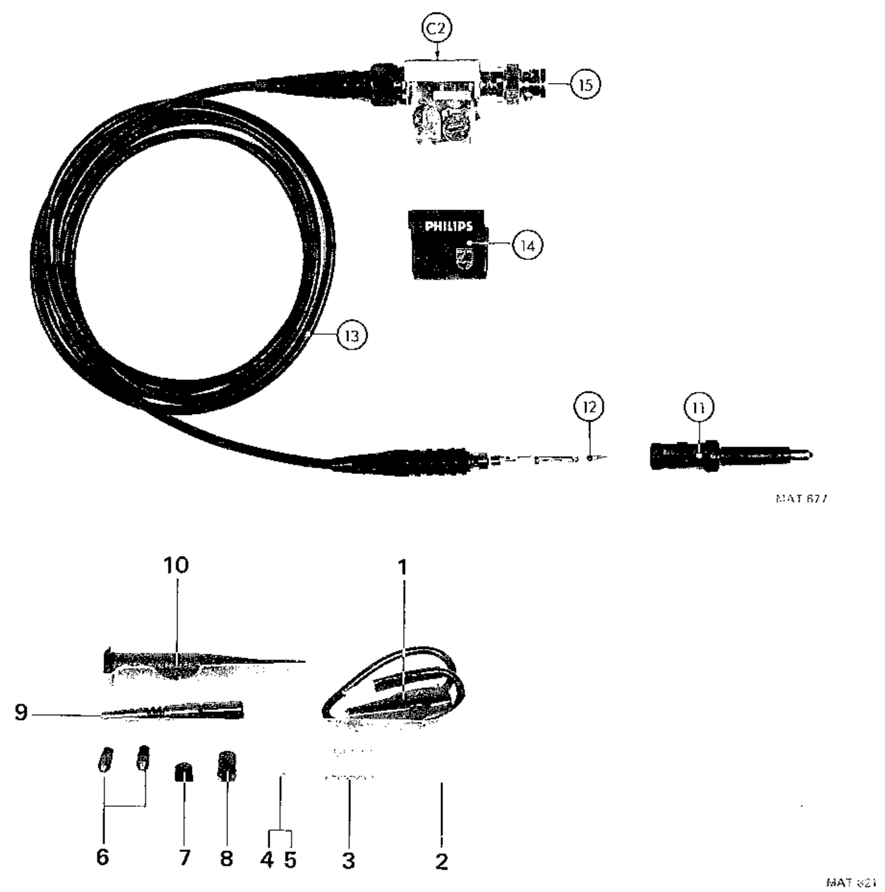


Fig. 6.13.

Replacing parts

Assembling the probe

A new RC network is slid over the cable nipple, after which the cable core is soldered on to the resistor wire. When a measuring probe is assembled, the RC network must be at dead centre in the probe tip.

Replacing the cable assembly

Dismantle the compensation box.
Unsolder the connection between the inner conductor and the printed-wiring board. Keep the frame of the compensation box steady and loosen the cable nipple with a 5 mm spanner on the hexagonal part. Replace the cable and fit it, working in the reverse order.

Replacing the BNC

Dismantle the compensation box.
Unsolder the connection to the printed-wiring board. Hold the frame of the compensation box firmly and

Parts list

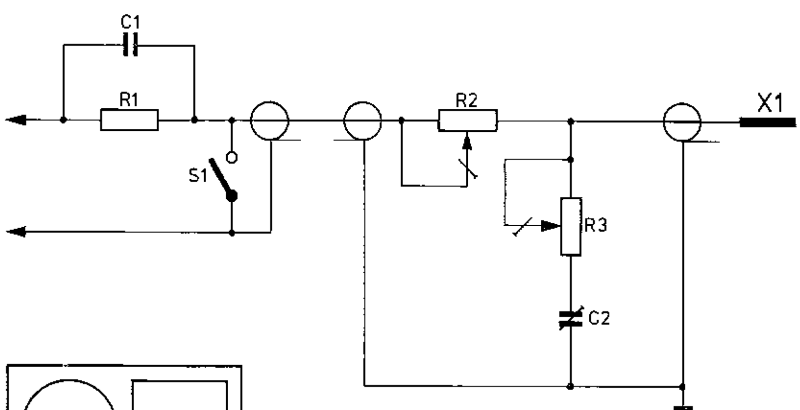
Mechanical parts (see Fig. 6.13. and 6.14.)

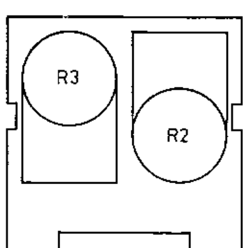
Items 1 to 10 are standard accessories supplied with the probe.

Item	Order number	Qty	Description
1	5322 321 20223	1	Earth cable
2	5322 256 94136	1	Probe holder
3	5322 255 44026	10	Soldering terminals which may be incorporated in circuits as routine test points
4	5322 532 64223	2	Marking ring red
5	5322 532 64224	2	Marking ring white
	5322 532 64225	2	Marking ring blue (not shown)
6	5322 268 14017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	5322 462 44318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	5322 264 24018	1	Wrap pin adaptor
10	5322 264 24019	1	Spring-loaded test clip
11	5322 264 24021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network
13	5322 320 14063	1	Cable assembly
14	5322 447 64016	1	Cap
15	5322 268 44019	1	BNC connector

Electrical parts

Item	Order number	Description
C1	–	Part of RC network (not supplied separately)
C2	5322 125 54003	Trimmer 60 pF, 300 V
R1	–	Part of RC network (not supplied separately)
R2	5322 101 14047	Potmeter 470 Ω, 20 %, 0.5 W
R3	5322 100 10112	Potmeter 1 kΩ, 20 %, 0.5 W





7. PARTS LISTS (Subject to alteration without notice)

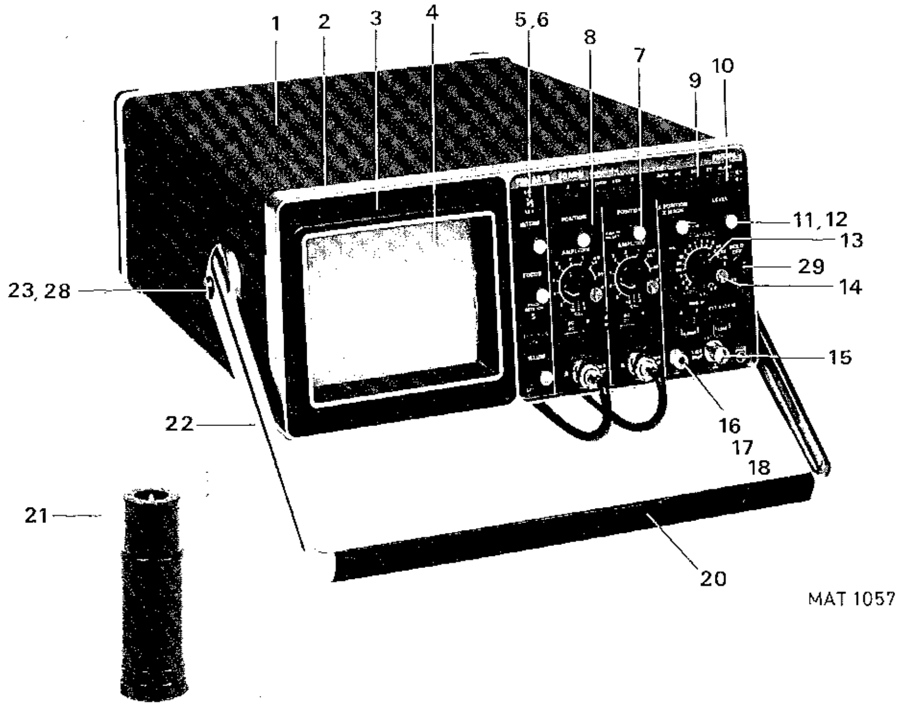
7.1. Mechanical parts

Fig.7.1.

Item	*Qty.*	*Ordering number*	*Designation*
1	1	5322 447 94366	Cabinet without handle
2	1	5322 464 94002	Cast aluminium front frame
3	1	5322 450 74009	Bezel
4	1	5322 480 34074	Contrast filter blue
5	1	5322 264 24015	Calibration terminal
6	1	5322 325 84013	Grommet for calibration terminal
7	2	5322 414 34091	Knob
8	1	5322 456 90011	Text plate PM3215
		5322 456 90012	Text plate PM3215U
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
11	8	5322 492 64337	Clamping spring for 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
20	1	5322 466 64162	Grip
21	1	5322 263 24005	BNC-4 mm adapter
22	2	5322 498 54072	Bracket
23	2	5322 520 14267	Bearing bush
24	2	5322 528 34128	Ratchet
25	2	5322 530 84075	Spring
26	2	5322 414 64053	Knob
27	2	4822 502 30054	Screw
28	2	4822 532 10582	Washer
29	1	5322 414 34217	Knob
	1	5322 492 64337	Spring

Fig.7.2.

Item	*Qty.*	*Ordering number*	*Designation*
	1	5322 464 94001	Cast aluminium rear 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 socket
35	1	5322 325 64083	Line cable cleat
36	1	4822 321 10084	Line cable, European type
		4822 321 10092	Line cable, U.S.A. type
37	2	5322 462 44298	Foot (rear panel)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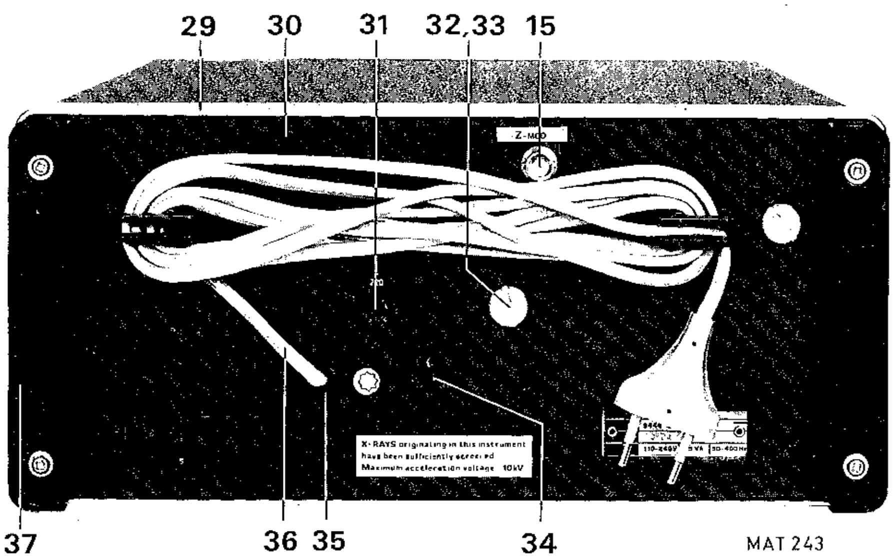
MAT 1057

Fig. 7.1.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Z-MOD
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MAT 243

Fig. 7.2.

Item	*Qty.*	*Ordering number*	*Designation*
Not shown			
38	5	5322 276 14102	Self-releasing push-button segment
49	13	5322 276 14117	Mutual-releasing push-button segment
40	1	5322 255 44088	LED holder
41	2	5322 255 24015	Lamp holder
42	4	5322 462 44297	Foot (cabinet)
43	1	4822 266 20014	D.C. Power input plug
44	1	4822 321 20125	D.C. Power input cord set
45	1	5322 447 94367	Front cover

Spare parts for pushbutton switches

- Dual change over switch with spring for use with a reset bar.
  Ordering number 5322 276 14101
  In each instrument there are 11 pieces.
- Dual change over switch with spring for use with reset bar (push on - push off function).
  Ordering number 5322 276 14117.
  In each instrument there are 5 pieces.
- Four change over switch with spring for use with a reset bar.
  Ordering number 5322 276 14102.
  In each instrument there are 2 pieces.
- Reset bar for max. 6 switches.
  The bar can be used for max. 6 switches that have a distance of 10,16mm. from each other.
  When the bar is needed for a unit with e.g. four switches it must be sawn to the required size.
  When doing this take care that the distance between the last stud and the end of the bar is exactly 4,1mm.
  When one switch in a unit needs no reset bar (e.g. an independent switch such as "erase" then remove at the relevant spot the stud from the bar with a pair of pincers.
  The spring for the reset bar will be delivered together with the switch segments.
  Ordering number 5322 278 74007.
  In each instrument are 3 pieces.
- Support for max. 11 switches
  The supports can be sawn to the required size.
  Ordering number:
  Max. 11 switches : 5322 466 85843 — Notch distances 10 x 10,16mm.
  In each instrument there are 4 pieces.

7.2, ELECTRICAL PARTS

CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE
C 101	220N 10%	275V	5322 121 06001
C 200	100NF 10%	250V	4822 121 41161
C 201	22NF-20+80	40	4822 122 30103
C 202	680NF 10%	100V	4822 121 40443
C 203	4700UF-10+50	40	4822 124 70226
C 204	100NF 10%	250V	4822 121 41161
C 206	3,3UF-10+50	63	4822 124 20725
C 207	680NF 10%	100V	4822 121 40443
C 208	47UF-10+50	25	4822 124 20699
C 209	10UF-10+50	25	4822 124 20697
C 211	68UF-10+50	6,3	4822 124 20671
C 218	22NF 10%	1600V	4822 121 40196
C 219	22NF 10%	1600V	4822 121 40196
C 221	4UF-10+50	250	4822 124 20316
C 222	100UF-10+50	40	4822 124 20715
C 223	33UF-10+50	16	4822 124 20688
C 224	220UF-10+50	16	4822 124 20693
C 226	68UF-10+50	6,3	4822 124 20671
C 227	470UF-10+50	6,3	4822 124 20673
C 228	33UF-10+50	16	4822 124 20688
C 229	220UF-10+50	16	4822 124 20693
C 231	4UF-10+50	250	4822 124 20316
C 301	100NF 10%	400V	4822 121 40012
C 305	47PF 2	500	4822 122 31072
C 307	18PF		5322 125 50051
C 308	47PF 2	500	4822 122 31072
C 309	15PF 2	500	4822 122 31197
C 310	15PF 2	500	4822 122 31197
C 311	12PF 2	500	4822 122 31196
C 312	3,9PF 0,25PF	500	4822 122 31217
C 313	5,5PF		5322 125 54027
C 314	5,5PF		5322 125 54027
C 315	1,5PF 0,25PF	500	4822 122 31184
C 316	3PF		5322 125 54026
C 317	3PF		5322 125 54026
C 318	3PF		5322 125 54026
C 319	3PF		5322 125 54026
C 320	3,3PF 0,25PF	500	4822 122 31188
C 321	27PF 2	100	4822 122 30045
C 322	120PF 2	100	4822 122 31348
C 324	120PF 2	100	4822 122 31348
C 351	39PF 2	500	4822 122 31203
C 353	22NF-20+80	40	4822 122 30103
C 354	2,2PF 0,25PF	100	5322 122 34198
C 356	150NF 10%	100V	4822 121 40423
C 357	22NF-20+80	40	4822 122 30103
C 358	22NF-20+80	40	4822 122 30103
C 359	15PF 2	500	4822 122 31197
C 361	18PF 2	500	4822 122 31198
C 362	150PF 2	100	4822 122 31413
C 401	100NF 10%	400V	4822 121 40012
C 405	47PF 2	500	4822 122 31072
C 407	18PF		5322 125 50051
C 408	47PF 2	500	4822 122 31072
C 409	15PF 2	500	4822 122 31197
C 410	15PF 2	500	4822 122 31197

POSNR	DESCRIPTION		ORDERING CODE
C 804	180PF 2	100	4822 122 31352
C 805	0,56PF 0,25PF	100	5322 122 34039
C 806	1NF 10	100	4822 122 30027
C 807	56PF 2	100	4822 122 31521
C 808	82PF 2	100	4822 122 31243
C 809	40PF		4822 125 50092
C 810	0,56PF 0,25PF	100	5322 122 34039
C 811	40PF		4822 125 50092
C 812	33PF 2	100	4822 122 31067
C 813	22NF-20+80	40	4822 122 30103
C 815	22NF-20+80	40	4822 122 30103
C 818	3,5PF		5322 125 50048
C 819	22PF 2	100	4822 122 31063
C 821	22NF-20+80	40	4822 122 30103
C 1001	470NF 10%	100V	4822 121 40438
C 1002	470NF 10%	100V	4822 121 40438
C 1003	220NF 10%	100V	4822 121 40427
C 1004	22NF-20+80	40	4822 122 30103
C 1006	15UF-10+50	16	4822 124 20687
C 1007	22NF-20+80	40	4822 122 30103
C 1008	0,56PF 0,25PF	100	5322 122 34039
C 1011	4,7NF 10	100	4822 122 30128
C 1012	4,7NF 10	100	4822 122 30128
C 1013	3,9NF 10	100	4822 122 30098
C 1016	15UF-10+50	16	4822 124 20687
C 1017	22NF-20+80	40	4822 122 30103
C 1018	15UF-10+50	16	4822 124 20687
C 1019	15UF-10+50	16	4822 124 20687
C 1201	150PF 2	100	4822 122 31085
C 1202	150NF 10%	100V	4822 121 40423
C 1203	270PF 10	100	4822 122 30095
C 1204	2.4NF 1%	63V	5322 121 54054
C 1205	82PF 2	100	4822 122 31243
C 1206	10NF-20+50	100	4822 122 31414
C 1207	2.2UF 5%	100V	5322 121 44246
C 1208	4,7UF-10+50	63	4822 124 20726
C 1209	1NF 10	100	4822 122 30027
C 1210	22NF-20+80	40	4822 122 30103
C 1211	22NF-20+80	40	4822 122 30103
C 1212	22NF-20+80	40	4822 122 30103
C 1213	15UF-10+50	16	4822 124 20687
C 1214	15UF-10+50	16	4822 124 20687
C 1216	15UF-10+50	16	4822 124 20687
C 1401	22NF-20+80	40	4822 122 30103
C 1402	1NF 10	100	4822 122 30027
C 1404	220NF 10%	100V	4822 121 40427
C 1406	0,56PF 0,25PF	100	5322 122 34039
C 1407	0,56PF 0,25PF	100	5322 122 34039
C 1408	0,56PF 0,25PF	100	5322 122 34039
C 1409	3,5PF		5322 125 50048
C 1411	22NF-20+80	40	4822 122 30103
C 1412	22NF-20+80	40	4822 122 30103
C 1413	22NF 10%	250V	4822 121 40407
C 1414	22NF-20+80	40	4822 122 30103
C 1416	22NF 10%	250V	4822 121 40407
C 1417	100NF 10%	250V	4822 121 41161
C 1418	100NF 10%	250V	4822 121 41161
C 1419	100NF 10%	250V	4822 121 41161
C 1421	100NF 10%	250V	4822 121 41161
C 1501	22NF-20+80	40	4822 122 30103
C 1502	22NF-20+80	40	4822 122 30103
C 1503	22NF-20+80	40	4822 122 30103

POSNR		DESCRIPTION			ORDERING CODE
C	412	3,9PF 0,25PF		500	4822 122 31217
C	413	5,5PF			5322 125 54027
C	414	5,5PF			5322 125 54027
C	415	1,5PF 0,25PF		500	4822 122 31184
C	416	3PF			5322 125 54026
C	417	3PF			5322 125 54026
C	418	5,5PF			5322 125 54027
C	419	3PF			5322 125 54026
C	420	3,3PF 0,25PF		500	4822 122 31188
C	421	27PF	2	100	4822 122 30045
C	422	120PF	2	100	4822 122 31348
C	424	120PF	2	100	4822 122 31348
C	501	33PF	2	100	4822 122 31067
C	502	20PF			4822 125 50045
C	503	180PF	2	100	4822 122 31352
C	504	3,9PF 0,25PF		100	5322 122 34107
C	507	3,5PF			5322 125 50048
C	509	22NF-20+80		40	4822 122 30103
C	510	33PF	2	100	4822 122 31067
C	511	18PF	2	100	4822 122 31061
C	513	22NF-20+80		40	4822 122 30103
C	517	22NF-20+80		40	4822 122 30103
C	518	22NF-20+80		40	4822 122 30103
C	519	22NF-20+80		40	4822 122 30103
C	521	22NF-20+80		40	4822 122 30103
C	522	150PF	2	100	4822 122 31085
C	523	22NF-20+80		40	4822 122 30103
C	524	15UF-10+50		16	4822 124 20687
C	527	15UF-10+50		16	4822 124 20687
C	528	22NF-20+80		40	4822 122 30103
C	529	15UF-10+50		16	4822 124 20687
C	530	22NF-20+80		40	4822 122 30103
C	531	15UF-10+50		16	4822 124 20687
C	532	22NF-20+80		40	4822 122 30103
C	601	33PF	2	100	4822 122 31067
C	602	20PF			4822 125 50045
C	603	180PF	2	100	4822 122 31352
C	604	3,9PF 0,25PF		100	5322 122 34107
C	607	3,5PF			5322 125 50048
C	609	22NF-20+80		40	4822 122 30103
C	610	33PF	2	100	4822 122 31067
C	611	10PF	2	100	4822 122 31054
C	613	22NF-20+80		40	4822 122 30103
C	616	22NF-20+80		40	4822 122 30103
C	617	22NF-20+80		40	4822 122 30103
C	618	22NF-20+80		40	4822 122 30103
C	619	22NF-20+80		40	4822 122 30103
C	621	22NF-20+80		40	4822 122 30103
C	622	150PF	2	100	4822 122 31085
C	623	22NF-20+80		40	4822 122 30103
C	627	15UF-10+50		16	4822 124 20687
C	629	15UF-10+50		16	4822 124 20687
C	630	22NF-20+80		40	4822 122 30103
C	631	15UF-10+50		16	4822 124 20687
C	632	22NF-20+80		40	4822 122 30103
C	701	22NF-20+80		40	4822 122 30103
C	702	270PF	10	100	4822 122 30095
C	703	2,7NF	10	100	4822 122 30057
C	704	2,7NF	10	100	4822 122 30057
C	705	4,7NF-20+80		40	4822 122 31125
C	706	22NF-20+80		40	4822 122 30103
C	707	22NF-20+80		40	4822 122 30103
C	801	22NF-20+80		40	4822 122 30103

POSNR	DESCRIPTION			ORDERING CODE
C 1508	3,3NF	10	100	4822 122 30099
C 1509	1,5NF	10%	1600V	4822 121 40354
C 1511	22NF-20+80		40	4822 122 30103
C 1512	1,5NF	10%	1600V	4822 121 40354
C 1513	1,5NF	10%	1600V	4822 121 40354
C 1601	330NF	10%	100V	4822 121 40434
C 1602	47PF	2	100	4822 122 31072

RESISTORS

POSNR		DESCRIPTION			ORDERING CODE
R	1	10K	20	0.1W	5322 101 24117
R	2	1K	20	0.1W	5322 101 24118
R	3	1K	20	0.1W	5322 101 64018
R	4	5K 10T	LIN		5322 102 40061
R	5	100K	20	0.1W	4822 101 20457
R	6	2,2M	20	0.1W	5322 101 24098
R	7	1K	20	0.1W	5322 101 44024
R	8	1K	20	0.1W	5322 101 44024
R	9	10K	20	0.1W	5322 101 44023
R	10	100K	20	0,1W	5322 101 24178
R	11	22K	20	0.1W	5322 101 44025
R	12	47K	20	0.1W	4822 101 20371
R	200	10K	1	MR25	4822 116 51253
R	201	23,7K	1	MR25	5322 116 54646
R	202	1,21K	1	MR25	5322 116 54557
R	203	1K	1	MR25	5322 116 54549
R	204	220	20	0.5W	5322 101 14051
R	206	2,87K	1	MR25	5322 116 50414
R	207	2,74K	1	MR25	5322 116 50636
R	208	30,1	1	MR25	5322 116 50904
R	209	30,1	1	MR25	5322 116 50904
R	210	1M	1	MR30	5322 116 54188
R	212	10K	1	MR25	4822 116 51253
R	227	237	1	MR25	5322 116 50679
R	302	1M	1	MR30	5322 116 54188
R	303	100	1	MR25	5322 116 54469
R	304	75	1	MR25	5322 116 54459
R	306	75	1	MR25	5322 116 54459
R	307	191K	1	MR30	5322 116 55319
R	308	681K	1	MR30	5322 116 54263
R	309	845K	1	MR30	5322 116 55379
R	311	549K	1	MR30	5322 116 55139
R	312	205K	1	MR25	5322 116 54727
R	313	732K	1	MR30	5322 116 55321
R	314	806K	1	MR30	5322 116 55078
R	316	8,2M	10	CR25	4822 110 72212
R	317	1M	1	MR30	5322 116 54188
R	318	90,9K	0,25	MR24C	5322 116 50859
R	319	8,25K	0,25	MR24C	5322 116 50979
R	351	1M	1	MR30	5322 116 54188
R	352	1K	1	MR25	5322 116 54549
R	353	953K	1	MR30	5322 116 55257
R	354	487K	1	MR30	5322 116 55243
R	355	133K	1	MR25	5322 116 54708
R	356	22K	20	0.5W	5322 101 14069
R	357	20,5K	1	MR25	5322 116 54643
R	358	22K	20	0.5W	5322 101 14069
R	359	20,5K	1	MR25	5322 116 54643
R	360	121	1	MR25	5322 116 54426
R	361	22K	20	0.5W	5322 101 14069
R	362	20,5K	1	MR25	5322 116 54643
R	363	8,25K	1	MR25	5322 116 54558
R	364	4,02K	1	MR25	5322 116 55448
R	365	5,11	1	MR25	5322 116 54192
R	366	2,49K	1	MR25	5322 116 50581
R	367	1,62K	1	MR25	5322 116 55359
R	368	5,11	1	MR25	5322 116 54192
R	369	1,62K	1	MR25	5322 116 55359
R	370	10	1	MR25	5322 116 50452

POSNR		DESCRIPTION			ORDERING CODE
R	374	10	1	MR25	5322 116 50452
R	402	1M	1	MR30	5322 116 54188
R	403	100	1	MR25	5322 116 54469
R	404	75	1	MR25	5322 116 54459
R	406	75	1	MR25	5322 116 54459
R	407	191K	1	MR30	5322 116 55319
R	408	681K	1	MR30	5322 116 54263
R	409	845K	1	MR30	5322 116 55379
R	411	549K	1	MR30	5322 116 55139
R	412	205K	1	MR25	5322 116 54727
R	413	732K	1	MR30	5322 116 55321
R	414	806K	1	MR30	5322 116 55078
R	416	8,2M	10	CR25	4822 110 72212
R	417	1M	1	MR30	5322 116 54188
V	232	90,9K	0,25	MR24C	5322 116 50859
R	419	8,25K	0,25	MR24C	5322 116 50979
R	500	51,1	1	MR25	5322 116 54442
R	501	51,1	1	MR25	5322 116 54442
R	502	806K	1	MR30	5322 116 55078
R	503	12,7K	1	MR25	5322 116 50443
R	504	470	20	0,5W	5322 101 14047
R	506	12,7K	1	MR25	5322 116 50443
R	507	6,19K	1	MR25	5322 116 50608
R	508	6,49K	1	MR25	5322 116 54603
R	509	619	1	MR25	5322 116 54529
R	511	511	0,5	MR25	4822 116 51282
R	512	511	0,5	MR25	4822 116 51282
R	513	105	1	MR25	5322 116 54472
R	514	22K	20	0.5W	5322 101 14069
R	516	51,1K	1	MR25	5322 116 50672
R	517	5,9K	1	MR25	5322 116 50583
R	518	100	1	MR25	5322 116 54469
R	519	162	1	MR25	5322 116 50417
R	521	1K	20	0,5W	5322 100 10112
R	522	44,2	1	MR25	5322 116 50818
R	523	44,2	1	MR25	5322 116 50818
R	524	100	0,5	MR25	5322 116 55549
R	526	100	0,5	MR25	5322 116 55549
R	527	5,62K	0,5	MR25	4822 116 51281
R	528	909	0,5	MR25	5322 116 55278
R	529	51,1	1	MR25	5322 116 54442
R	531	51,1	1	MR25	5322 116 54442
R	532	909	0,5	MR25	5322 116 55278
R	533	5,62K	0,5	MR25	4822 116 51281
R	534	825	1	MR25	5322 116 54541
R	535	825	1	MR25	5322 116 54541
R	536	30,1	1	MR25	5322 116 50904
R	537	866	1	MR25	5322 116 54543
R	538	1,5K	5	0.5W	5322 116 34054
R	539	30,1	1	MR25	5322 116 50904
R	540	402	1	MR25	5322 116 54519
R	541	348	1	MR25	5322 116 54515
R	542	249	1	MR25	5322 116 54499
R	543	100	20	0,5W	5322 101 14011
R	546	909	1	MR25	5322 116 55278
R	547	220	20	0,5W	5322 101 14009
R	548	909	1	MR25	5322 116 55278
R	549	100	1	MR25	5322 116 54469
R	550	10	1	MR25	5322 116 50452
R	551	100	1	MR25	5322 116 54469
R	552	121	1	MR25	5322 116 54426
R	553	121	1	MR25	5322 116 54426
R	554	909	1	MR25	5322 116 55278
R	558	17,8K	1	MR25	5322 116 54637
R	559	[illegible]			

POSNR		DESCRIPTION			ORDERING CODE
R	569	5,9K	1	MR25	5322 116 50583
R	571	178	1	MR25	5322 116 54492
R	572	178	1	MR25	5322 116 54492
R	573	2,26K	1	MR25	5322 116 50675
R	577	100	1	MR25	5322 116 54469
R	581	4,99	1	MR25	5322 116 50568
R	582	4,99	1	MR25	5322 116 50568
R	583	4,99	1	MR25	5322 116 50568
R	584	4,99	1	MR25	5322 116 50568
R	586	4,99	1	MR25	5322 116 50568
R	587	4,99	1	MR25	5322 116 50568
R	600	51,1	1	MR25	5322 116 54442
R	601	51,1	1	MR25	5322 116 54442
R	602	806K	1	MR30	5322 116 55078
R	603	12,7K	1	MR25	5322 116 50443
R	604	470	20	0,5W	5322 101 14047
R	606	12,7K	1	MR25	5322 116 50443
R	607	6,19K	1	MR25	5322 116 50608
R	608	6,49K	1	MR25	5322 116 54603
R	609	619	1	MR25	5322 116 54529
R	611	511	0,5	MR25	4822 116 51282
R	612	511	0,5	MR25	4822 116 51282
R	613	105	1	MR25	5322 116 54472
R	614	22K	20	0.5W	5322 101 14069
R	616	51,1K	1	MR25	5322 116 50672
R	617	5,9K	1	MR25	5322 116 50583
R	618	100	1	MR25	5322 116 54469
R	619	162	1	MR25	5322 116 50417
R	621	1K	20	0,5W	5322 100 10112
R	622	44,2	1	MR25	5322 116 50818
R	623	44,2	1	MR25	5322 116 50818
R	624	100	0,5	MR25	5322 116 55549
R	626	100	0,5	MR25	5322 116 55549
R	627	5,62K	0,5	MR25	4822 116 51281
R	628	909	0,5	MR25	5322 116 55278
R	629	51,1	1	MR25	5322 116 54442
R	631	51,1	1	MR25	5322 116 54442
R	632	909	0,5	MR25	5322 116 55278
R	633	5,62K	0,5	MR25	4822 116 51281
R	634	825	1	MR25	5322 116 54541
R	635	825	1	MR25	5322 116 54541
R	636	30,1	1	MR25	5322 116 50904
R	637	866	1	MR25	5322 116 54543
R	638	1,5K	5	0.5W	5322 116 34054
R	639	30,1	1	MR25	5322 116 50904
R	640	402	1	MR25	5322 116 54519
R	641	158	0,5	MR25	5322 116 55418
R	646	953	1	MR25	5322 116 54547
R	647	100	20	0,5W	5322 101 14011
R	648	953	1	MR25	5322 116 54547
R	649	100	1	MR25	5322 116 54469
R	650	10	1	MR25	5322 116 50452
R	651	100	1	MR25	5322 116 54469
R	652	121	1	MR25	5322 116 54426
R	653	121	1	MR25	5322 116 54426
R	654	909	1	MR25	5322 116 55278
R	658	17,8K	1	MR25	5322 116 54637
R	659	5,11K	1	MR25	5322 116 54595
R	661	31,6K	1	MR25	5322 116 54657
R	662	17,8K	1	MR25	5322 116 54637
R	663	14K	1	MR25	5322 116 54629
R	664	8,25K	1	MR25	

POSNR		DESCRIPTION			ORDERING CODE
R	673	2,26K	1	MR25	5322 116 50675
R	674	47K	20	0,5W	5322 101 14048
R	676	33,2K	1	MR25	4822 116 51259
R	677	100	1	MR25	5322 116 54469
R	682	4,99	1	MR25	5322 116 50568
R	683	4,99	1	MR25	5322 116 50568
R	684	4,99	1	MR25	5322 116 50568
R	701	100	1	MR25	5322 116 54469
R	702	1,27K	1	MR25	5322 116 50555
R	703	750	1	MR25	4822 116 51234
R	704	402	1	MR25	5322 116 54519
R	705	4,99	1	MR25	5322 116 50568
R	706	1,27K	1	MR25	5322 116 50555
R	707	20,5K	1	MR25	5322 116 54643
R	708	6,81K	1	MR25	5322 116 54012
R	709	2,49K	1	MR25	5322 116 50581
R	710	4,99	1	MR25	5322 116 50568
R	711	2,49K	1	MR25	5322 116 50581
R	712	4,02K	1	MR25	5322 116 55448
R	713	4,02K	1	MR25	5322 116 55448
R	714	4,02K	1	MR25	5322 116 55448
R	716	4,02K	1	MR25	5322 116 55448
R	717	100	1	MR30	5322 116 54852
R	801	4,02K	1	MR25	5322 116 55448
R	802	8,25K	1	MR25	5322 116 54558
R	803	100	1	MR25	5322 116 54469
R	804	100	1	MR25	5322 116 54469
R	806	121	1	MR25	5322 116 54426
R	808	2,61K	1	MR25	5322 116 50671
R	809	1,33K	1	MR25	5322 116 54561
R	811	7,87K	1	MR25	5322 116 50458
R	812	4,7K	20	0.5W	5322 100 10114
R	813	10K	20	0,5W	5322 100 10113
R	814	2,2K	20	0.5W	5322 101 14008
R	816	30,1	1	MR25	5322 116 50904
R	817	121	1	MR25	5322 116 54426
R	817	100	20	0.05W	4822 100 10075
R	818	30,1	1	MR25	5322 116 50904
R	819	28,7	1	MR25	5322 116 54068
R	821	28,7	1	MR25	5322 116 54068
R	823	169	1	MR25	5322 116 54489
R	824	7,87K	1	MR25	5322 116 50458
R	825	4,99	1	MR25	5322 116 50568
R	826	2,26K	1	MR25	5322 116 50675
R	827	4,22K	1	MR25	5322 116 50729
R	828	100	1	MR25	5322 116 54469
R	829	100	1	MR25	5322 116 54469
R	831	90,9	1	MR25	5322 116 54466
R	832	90,9	1	MR25	5322 116 54466
R	833	909	1	MR25	5322 116 55278
R	837	909	1	MR25	5322 116 55278
R	838	909	1	MR25	5322 116 55278
R	839	909	1	MR25	5322 116 55278
R	843	464	1	MR25	5322 116 50536
R	847	90,9	1	MR25	5322 116 54466
R	848	100	20	0,5W	5322 101 14011
R	849	90,9	1	MR25	5322 116 54466
R	851	90,9	1	MR25	5322 116 54466
R	852	51,1	1	MR25	5322 116 54442
R	853	51,1	1	MR25	5322 116 54442
R	854	90,9	1	MR25	5322 116 54466
R	856	127	1	MR25	5322 116 54479
R	857	3,48K	1	MR25	5322 116 54585
R	858	3,01K	[illegible]	[illegible]	[illegible]

POSNR	DESCRIPTION			ORDERING CODE
R 861	1,62K	1	MR25	5322 116 55359
R 862	1,62K	1	MR25	5322 116 55359
R 863	1,62K	1	MR25	5322 116 55359
R 1001	110K	1	MR25	5322 116 54701
R 1002	51,1K	1	MR25	5322 116 50672
R 1003	51,1K	1	MR25	5322 116 50672
R 1004	110K	1	MR25	5322 116 54701
R 1006	3,65K	1	MR25	5322 116 54587
R 1007	8,25K	1	MR25	5322 116 54558
R 1008	301K	1	MR25	5322 116 54743
R 1009	511K	1	MR30	5322 116 54123
R 1011	4,02K	1	MR25	5322 116 55448
R 1012	100K	1	MR25	4822 116 51268
R 1013	12,7K	1	MR25	5322 116 50443
R 1014	470	20	0,5W	5322 101 14047
R 1016	12,7K	1	MR25	5322 116 50443
R 1017	2,87K	1	MR25	5322 116 50414
R 1018	562	1	MR25	5322 116 54009
R 1019	562	1	MR25	5322 116 54009
R 1021	3,65K	1	MR25	5322 116 54587
R 1022	1,54K	1	MR25	5322 116 50586
R 1023	1,54K	1	MR25	5322 116 50586
R 1024	30,1	1	MR25	5322 116 50904
R 1026	30,1	1	MR25	5322 116 50904
R 1027	619	1	MR25	5322 116 54529
R 1028	619	1	MR25	5322 116 54529
R 1029	10,5K	1	MR25	5322 116 50731
R 1031	4,02K	1	MR25	5322 116 55448
R 1032	12,1K	1	MR25	5322 116 50572
R 1033	1K	1	MR25	5322 116 54549
R 1034	16,2K	1	MR25	5322 116 55361
R 1036	3,65K	1	MR25	5322 116 54587
R 1037	8,25K	1	MR25	5322 116 54558
R 1038	2,61K	1	MR25	5322 116 50671
R 1039	1M	1	MR30	5322 116 54188
R 1041	22K	20	0.5W	5322 101 14069
R 1042	20,5K	1	MR25	5322 116 54643
R 1043	1,4K	1	MR25	5322 116 54562
R 1044	1,54K	1	MR25	5322 116 50586
R 1046	10K	1	MR25	4822 116 51253
R 1047	3,01K	1	MR25	4822 116 51246
R 1048	1M	1	MR30	5322 116 54188
R 1049	4,64K	1	MR25	5322 116 50484
R 1051	196K	1	MR25	5322 116 55364
R 1052	5,9K	1	MR25	5322 116 50583
R 1053	4,99	1	MR25	5322 116 50568
R 1054	4,99	1	MR25	5322 116 50568
R 1056	4,99	1	MR25	5322 116 50568
R 1201	100K	1	MR25	4822 116 51268
R 1202	48,7K	1	MR25	5322 116 50442
R 1203	3,48K	1	MR25	5322 116 54585
R 1204	6,19K	1	MR25	5322 116 50608
R 1207	10	1	MR25	5322 116 50452
R 1208	3,3M	10	CR25	4822 110 72201
R 1209	10K	1	MR25	4822 116 51253
R 1211	2,49K	1	MR25	5322 116 50581
R 1212	10K	1	MR25	4822 116 51253
R 1213	681	1	MR25	4822 116 51233
R 1214	5,11K	1	MR25	5322 116 54595
R 1216	1,05K	1	MR25	5322 116 54552

POSNR	DESCRIPTION			ORDERING CODE
R 1217	7,87K	1	MR25	5322 116 50458
R 1218	32,4	0,5	MR25	5322 116 55421
R 1219	30,1	1	MR25	5322 116 50904
R 1220	9,09	1	MR25	5322 116 50863
R 1221	1,4K	1	MR25	5322 116 54562
R 1222	9,53K	1	MR25	5322 116 54617
R 1223	15,4K	1	MR25	5322 116 50479
R 1224	30,1	1	MR25	5322 116 50904
R 1226	1,54K	1	MR25	5322 116 50586
R 1227	7,5K	1	MR25	5322 116 54608
R 1228	11K	1	MR25	5322 116 54632
R 1229	37,4K	1	MR25	5322 116 54663
R 1230	26,1K	1	MR25	5322 116 54651
R 1231	33,2K	1	MR25	4822 116 51259
R 1232	22K	20	0.05W	4822 100 10051
R 1233	487	1	MR25	5322 116 50508
R 1234	2,26K	1	MR25	5322 116 50675
R 1236	21,5K	1	MR25	5322 116 50451
R 1237	4,99	1	MR25	5322 116 50568
R 1238	4,99	1	MR25	5322 116 50568
R 1239	4,99	1	MR25	5322 116 50568
R 1276	412K	0,5	MR25	5322 116 55424
R 1277	205K	0,5	MR25	5322 116 55387
R 1278	41,2K	0,5	MR25	5322 116 55423
R 1279	8,06K	0,5	MR25	5322 116 55428
R 1281	2K	0,5	MR25	4822 116 51243
R 1282	365	0,5	MR25	5322 116 55422
R 1283	412K	0,5	MR25	5322 116 55424
R 1284	82,5K	0,5	MR25	5322 116 55374
R 1286	20,5K	0,5	MR25	5322 116 55419
R 1287	4,02K	0,1	MR24E	5322 116 54283
R 1288	768	0,5	MR25	5322 116 55427
R 1289	6,19K	0,5	MR25	5322 116 55426
R 1290	953K	0,5	MR30	5322 116 55382
R 1291	261K	0,5	MR25	5322 116 54736
R 1401	3,16K	1	MR25	5322 116 50579
R 1402	51,1	1	MR25	5322 116 54442
R 1403	4,02K	1	MR25	5322 116 55448
R 1404	3,16K	1	MR25	5322 116 50579
R 1406	5,11K	1	MR25	5322 116 54595
R 1407	681	1	MR25	4822 116 51233
R 1408	8,25K	1	MR25	5322 116 54558
R 1409	3,01K	1	MR25	4822 116 51246
R 1411	9,09K	1	MR25	4822 116 51284
R 1412	2,37K	1	MR25	5322 116 54576
R 1414	3,01K	1	MR25	4822 116 51246
R 1416	3,32K	1	MR25	5322 116 54005
R 1417	1K	20	0,5W	5322 100 10112
R 1418	287	1	MR25	5322 116 54506
R 1419	100	20	0,5W	5322 101 14011
R 1421	8,66K	1	MR25	5322 116 54613
R 1422	16,2K	1	MR25	5322 116 55361
R 1423	20,5K	1	MR25	5322 116 54643
R 1424	36,5K	1	MR25	5322 116 50726
R 1425	100	1	MR25	5322 116 54469
R 1426	12,1K	1	MR25	5322 116 50572
R 1427	154K	1	MR25	5322 116 54714
R 1428	33,2K	1	MR25	4822 116 51259
R 1429	33,2K	1	MR25	4822 116 51259
R 1431	1K	1	MR25	5322 116 54549
R 1432	33,2K	1	MR25	4822 116 51259
R 1433	33,2K	1	MR25	4822 116 51259
R 1434	154K	1	MR25	5322 116 54714
R 1436	1,1K	1	MR25	4822 116 51236
R 1437	30,1	1	MR25	[illegible]

POSNR	DESCRIPTION			ORDERING CODE
R 1438	3,01K	1	MR25	4822 116 51246
R 1439	30,1	1	MR25	5322 116 50904
R 1440	5,11K	1	MR25	5322 116 54595
R 1441	1,1K	1	MR25	4822 116 51236
R 1442	13,3K	1	MR25	5322 116 55276
R 1443	6,19K	1	MR25	5322 116 50608
R 1444	365K	1	MR30	5322 116 54762
R 1445	5,11K	1	MR25	5322 116 54595
R 1446	365K	1	MR30	5322 116 54762
R 1447	100	1	MR25	5322 116 54469
R 1448	100	1	MR25	5322 116 54469
R 1450	64,9K	1	MR25	5322 116 50514
R 1501	6,81K	1	MR25	5322 116 54012
R 1502	511	1	MR25	4822 116 51282
R 1503	3,48K	1	MR25	5322 116 54585
R 1506	162K	1	MR25	5322 116 54716
R 1507	3,48K	1	MR25	5322 116 54585
R 1508	100K	1	MR25	4822 116 51268
R 1509	11K	1	MR25	5322 116 54623
R 1511	51,1K	1	MR25	5322 116 50672
R 1512	6,19K	1	MR25	5322 116 50608
R 1513	26,1K	1	MR25	5322 116 54651
R 1514	6,19K	1	MR25	5322 116 50608
R 1516	22,6K	1	MR25	5322 116 50481
R 1517	2,05K	1	MR25	5322 116 50664
R 1518	511	1	MR25	4822 116 51282
R 1519	464	1	MR25	5322 116 50536
R 1521	226K	1	MR25	5322 116 54729
R 1522	680	5	0.5W	5322 116 34049
R 1523	4,02K	1	MR25	5322 116 55448
R 1524	100	1	MR25	5322 116 54469
R 1525	511	1	MR30	5322 116 54835
R 1526	64,9K	1	MR30	4822 116 51175
R 1527	17,8K	1	MR25	5322 116 54637
R 1528	33,2K	1	MR25	4822 116 51259
R 1529	4,87K	1	MR25	5322 116 50509
R 1531	11,5K	1	MR25	5322 116 55358
R 1532	1M	1	MR30	5322 116 54188
R 1533	100	1	MR25	5322 116 54469
R 1534	10K	20	0,5W	5322 100 10113
R 1535	1K	1	MR30	5322 116 54207
R 1536	4,64K	1	MR25	5322 116 50484
R 1537	1M	1	MR30	5322 116 54188
R 1538	1,2M	5	VR37	4822 110 42189
R 1539	2,2M	5	VR37	4822 110 42196
R 1541	5,6M	5	VR37	4822 110 42207
R 1542	78,7K	1	MR25	5322 116 50533
R 1543	100K	20	0.05W	4822 100 10072
R 1544	121K	1	MR25	5322 116 54704
R 1546	16,2K	1	MR25	5322 116 55361
R 1547	26,1K	1	MR25	5322 116 54651
R 1548	196K	1	MR25	5322 116 55364
R 1549	1M	20	0.05W	4822 100 10103
R 1551	383K	1	MR30	5322 116 54761
R 1552	4,99	1	MR25	5322 116 50568
R 1553	4,99	1	MR25	5322 116 50568
R 1554	4,99	1	MR25	5322 116 50568
R 1601	301	1	MR25	5322 116 54508
R 1603	2,05K	1	MR25	5322 116 50664
R 1604	10K	1	MR25	4822 116 51253
R 1606	681	1	MR25	4822 116 51233
R 1607	22K	20	0.5W	5322 101 14069

POSNR	DESCRIPTION			ORDERING CODE
R 1612	681	1	MR25	4822 116 51233
R 1613	6,19K	1	MR25	5322 116 50608
R 1614	3,48K	1	MR25	5322 116 54585
R 1616	2,05K	1	MR25	5322 116 50664
R 1617	301	1	MR25	5322 116 54508
R 1618	26,1K	1	MR25	5322 116 54651
R 1619	12,1K	1	MR25	5322 116 50572

SEMI CONDUCTORS

POSNR		DESCRIPTION	ORDERING CODE
V	1	D14-125GH/08	5322 131 24029
V	201	BY225-200	4822 130 50312
V	206	BYX49-300	5322 130 34304
V	207	BD237	4822 130 44235
V	208	BAW62	4822 130 30613
V	209	BZX79-C5V6	4822 130 34173
V	211	BZX75-C3V6	4822 130 30765
V	212	BZX75-C3V6	4822 130 30765
V	213	BAW62	4822 130 30613
V	214	BC548C	4822 130 44196
V	216	BC558B	4822 130 44197
V	217	BD237	4822 130 44235
V	218	BD237	4822 130 44235
V	219	BAW62	4822 130 30613
V	221	BAW62	4822 130 30613
V	222	BAW62	4822 130 30613
V	223	BAW62	4822 130 30613
V	224	BAW62	4822 130 30613
V	233	BZX61-C110	5322 130 34671
V	234	BY206	4822 130 30839
V	236	BY206	4822 130 30839
V	237	BAW62	4822 130 30613
V	238	BAX12	5322 130 34605
V	239	BAX12	5322 130 34605
V	241	BAX12	5322 130 34605
V	242	BAX12	5322 130 34605
V	243	BAX12	5322 130 34605
V	244	BAX12	5322 130 34605
V	246	BAW62	4822 130 30613
V	247	BY206	4822 130 30839
V	351	BF450	4822 130 44237
V	352	BF450	4822 130 44237
V	353	BC548C	4822 130 44196
V	354	BAW62	4822 130 30613
V	356	BAW62	4822 130 30613
V	357	BAW62	4822 130 30613
V	501	BAV45	5322 130 34037
V	504	BFS21A	5322 130 40709
V	508	BF450	4822 130 44237
V	509	BF450	4822 130 44237
V	511	BF450	4822 130 44237
V	512	BF450	4822 130 44237
V	513	BC558B	4822 130 44197
V	514	BC558B	4822 130 44197
V	518	BC548C	4822 130 44196
V	519	BC548C	4822 130 44196
V	521	BAW62	4822 130 30613
V	522	BAW62	4822 130 30613
V	523	BAW62	4822 130 30613
V	524	BF324	4822 130 41448
V	526	BF324	4822 130 41448
V	601	BAV45	5322 130 34037
V	604	BFS21A	5322 130 40709
V	608	BF450	4822 130 44237
V	609	BF450	4822 130 44237
V	611	BF450	4822 130 44237
V	612	BF450	4822 130 44237
V	613	BC558B	4822 130 44197
V	614	BC558B	4822 130 44197

POSNR	DESCRIPTION	ORDERING CODE
V 619	BC548C	4822 130 44196
V 621	BAW62	4822 130 30613
V 622	BAW62	4822 130 30613
V 623	BAW62	4822 130 30613
V 624	BF324	4822 130 41448
V 626	BF324	4822 130 41448
V 701	BAW62	4822 130 30613
V 702	BAW62	4822 130 30613
V 703	BC548C	4822 130 44196
V 704	BC548C	4822 130 44196
V 801	BC558B	4822 130 44197
V 802	BC548C	4822 130 44196
V 803	BC548C	4822 130 44196
V 804	BF199	4822 130 44154
V 806	BF199	4822 130 44154
V 807	BF199	4822 130 44154
V 808	BF199	4822 130 44154
V 809	BC548C	4822 130 44196
V 1001	OA95	4822 130 30191
V 1002	OA95	4822 130 30191
V 1003	BAV45	5322 130 34037
V 1004	BC548C	4822 130 44196
V 1006	ON561	5322 130 40709
V 1008	BC558B	4822 130 44197
V 1009	BC548C	4822 130 44196
V 1011	BC548C	4822 130 44196
V 1012	BC548C	4822 130 44196
V 1013	BC548C	4822 130 44196
V 1014	BF450	4822 130 44237
V 1016	BAW62	4822 130 30613
V 1017	BC558B	4822 130 44197
V 1201	BC548C	4822 130 44196
V 1202	BAW62	4822 130 30613
V 1203	BC558B	4822 130 44197
V 1204	BC548C	4822 130 44196
V 1206	BC558B	4822 130 44197
V 1207	BAW62	4822 130 30613
V 1208	BAW62	4822 130 30613
V 1209	BAW62	4822 130 30613
V 1211	BAW62	4822 130 30613
V 1212	BC558B	4822 130 44197
V 1213	BSX20	5322 130 40417
V 1214	BC548C	4822 130 44196
V 1216	BC548C	4822 130 44196
V 1217	BC548C	4822 130 44196
V 1218	BAW62	4822 130 30613
V 1219	BC548C	4822 130 44196
V 1221	BC548C	4822 130 44196
V 1222	BAW62	4822 130 30613
V 1223	BC548C	4822 130 44196
V 1401	BC548C	4822 130 44196
V 1402	BC548C	4822 130 44196
V 1403	BAW62	4822 130 30613
V 1404	BC558B	4822 130 44197
V 1406	BF199	4822 130 44154
V 1407	BF199	4822 130 44154
V 1408	BAW62	4822 130 30613
V 1409	BAW62	4822 130 30613
V 1411	BAW62	4822 130 30613
V 1412	BZX79-C5V1	4822 130 34233
V 1413	BFT45	5322 130 44603
V 1414	BF338	4822 130 44108
V 1416	BSX20	5322 130 40417
V 1417	BAW62	[illegible]
V [illegible]	[illegible]	[illegible]

POSNR	DESCRIPTION	ORDERING CODE
V 1421	BFT45	5322 130 44603
V 1422	BF338	4822 130 44108
V 1423	BZX79-C5V1	4822 130 34233
V 1424	BZX79-C36	4822 130 34368
V 1426	BZX79-C36	4822 130 34368
V 1427	BZX79-C36	4822 130 34368
V 1428	BZX79-C75	4822 130 34685
V 1501	BAW62	4822 130 30613
V 1502	BAW62	4822 130 30613
V 1503	BAW62	4822 130 30613
V 1504	OA95	4822 130 30191
V 1506	BC548C	4822 130 44196
V 1508	BAW62	4822 130 30613
V 1511	BAW62	4822 130 30613
V 1512	BC558B	4822 130 44197
V 1513	BC548C	4822 130 44196
V 1514	BC548C	4822 130 44196
V 1516	BC548C	4822 130 44196
V 1517	BSS68	5322 130 44247
V 1518	BAV21	4822 130 30842
V 1519	BAV21	4822 130 30842
V 1521	BC548C	4822 130 44196
V 1522	BC558B	4822 130 44197
V 1601	BC548C	4822 130 44196
V 1602	BC548C	4822 130 44196
V 1603	BC548C	4822 130 44196
V 1604	BAW62	4822 130 30613

INTEGRATED CIRCUITS

POSNR	DESCRIPTION	ORDERING CODE
D 201	R	5322 218 61003
D 501	SL3145E	5322 130 34854
D 601	SL3145E	5322 130 34854
D 801	SL3145E	5322 130 34854
D 1001	SL3145E	5322 130 34854
D 1201	SN74S132N	5322 209 85267
D 1202	N74S00N	5322 209 84167
D 1203	N74S10N	5322 209 84954

Additional partslist information:

V1: DY-125 GM-08 5322 131 24049 CRT with long persistence time

Amber contrast filter 5322 705 34232

MISCELLANEOUS

POSNR	DESCRIPTION	ORDERING CODE
B 1	CQY24B/IV	4822 130 31144
E 1	LAMP 28 V 80 mA	5322 134 44177
E 2	LAMP 28 V 80 mA	5322 134 44177
F 201	Fuse 1,4 A	4822 253 30023
F 202	Fuse 1,4 A	4822 253 30023
K 501	REED RELAIS ASSY	5322 280 24131
K 601	REED RELAIS ASSY	5322 280 24131
K 1401	REED RELAIS ASSY	5322 280 24131
L 201	COIL	5322 281 64154
L 202	COIL	5322 281 64154
L 203	COIL	5322 281 64154
L 801	COIL	5322 157 51296
L 802	COIL	5322 157 51296
L 1501	ROTARY COIL	5322 150 14015
T 101	MAINS TRANSFORMER	5322 146 24166
T 201	BASE TRANSFORMER	5322 158 34074
T 202	TRANSFORMER	5322 146 24163
	POWER SUPPLY BOARD	5322 216 54142
	ATTENUATOR BOARD	5322 216 54143
	HIGH VOLTAGE UNIT	5322 218 64056
	DELAY LINE UNIT	5322 320 44029
S6 S8	ATTENUATOR SWITCH	5322 273 74011
S10	TIME BASE SWITCH	5322 273 84032
	3-POLE PLUG	4822 266 30071
	3-POLE SOCKET	4822 265 30121
	4-POLE PLUG	4822 266 30072
	4-POLE SOCKET	4822 265 30119
	6-POLE PLUG	4822 266 30073
	6-POLE SOCKET	4822 265 30117
	7-POLE PLUG	4822 266 40057
	7-POLE SOCKET	4822 265 40119

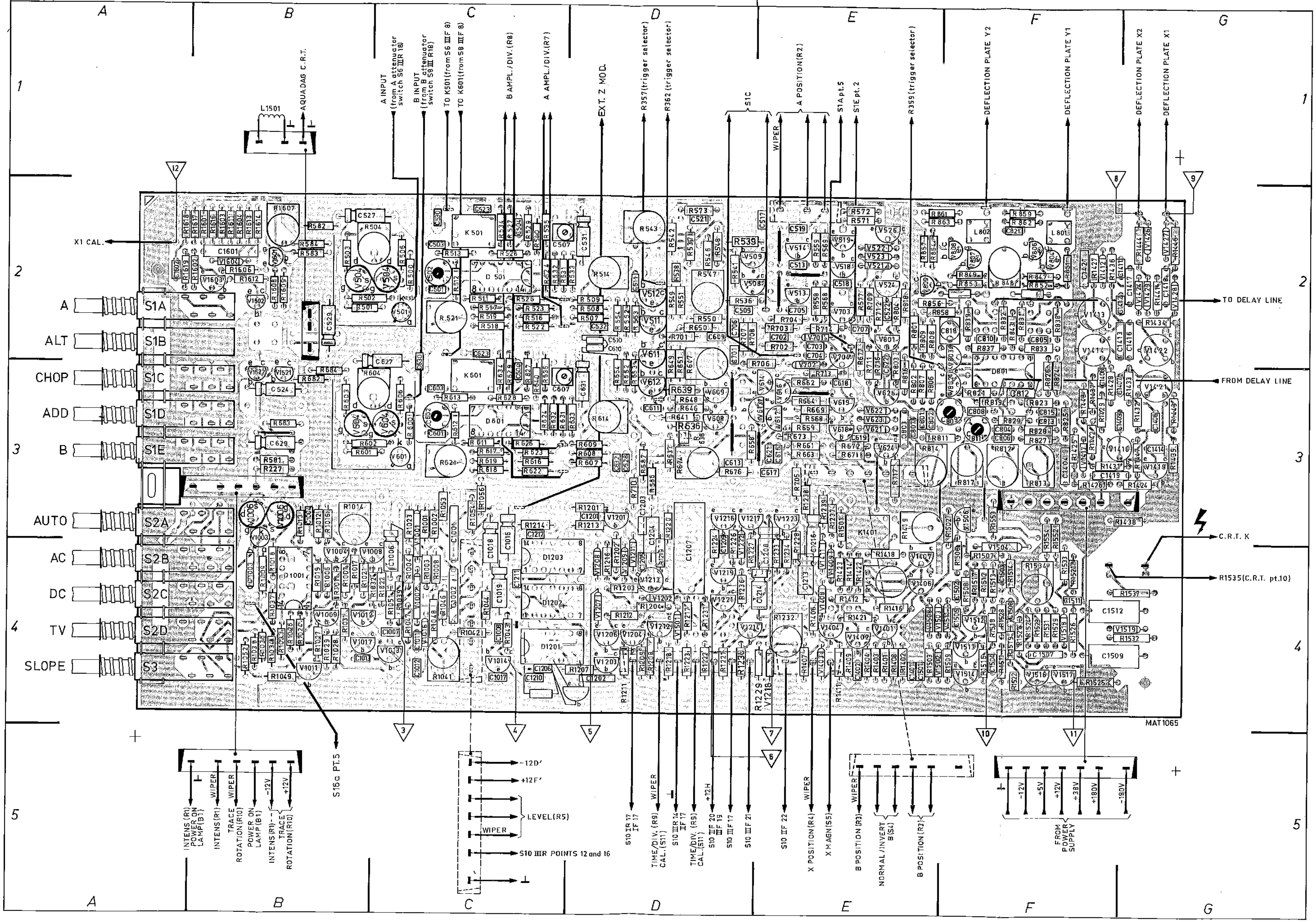


Fig. 8.1. Vertical amplifier unit with rear side tracks

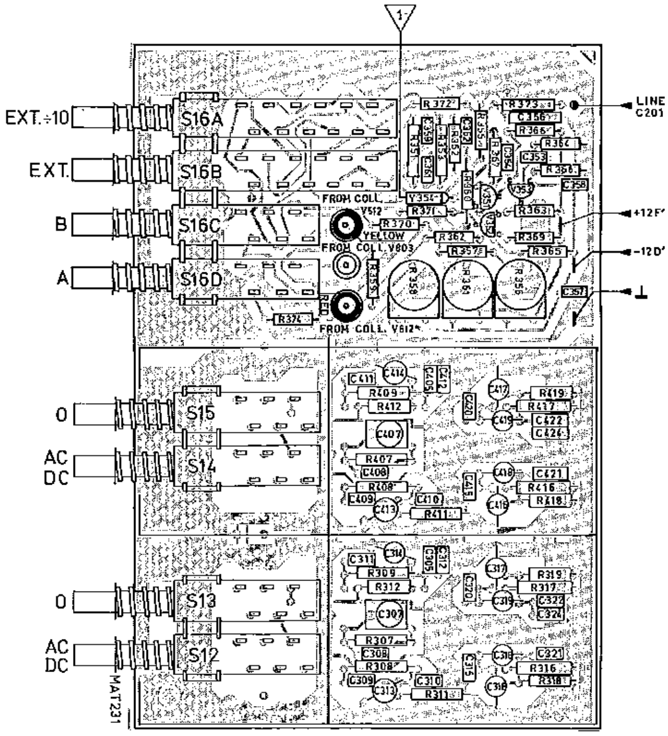
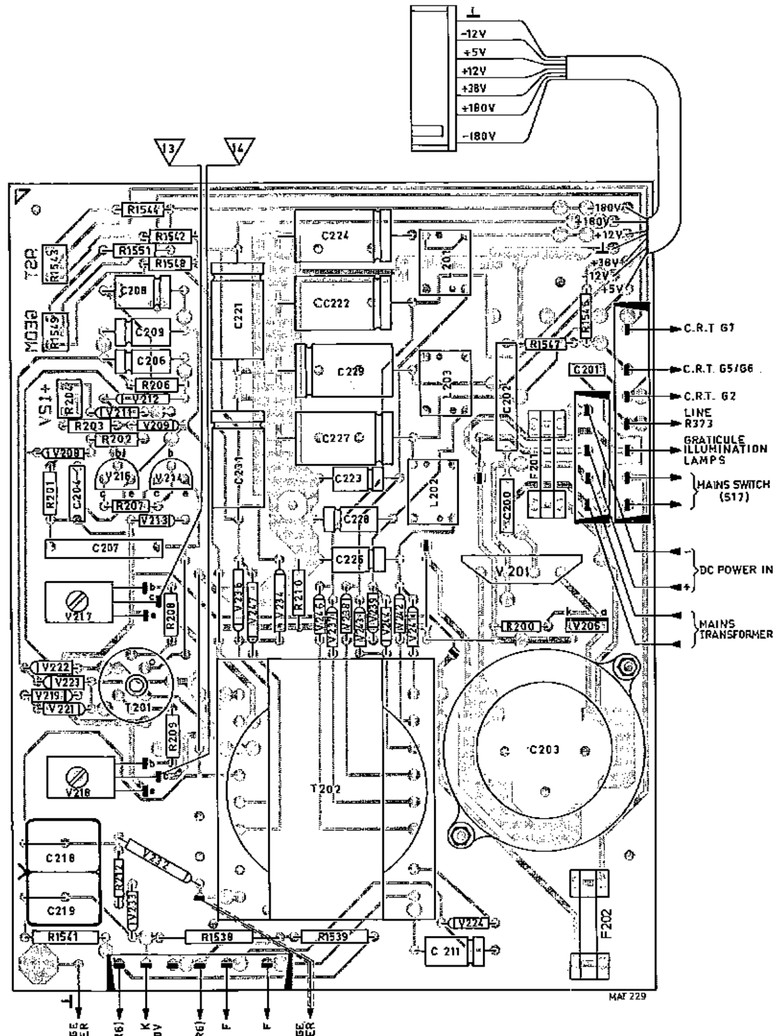
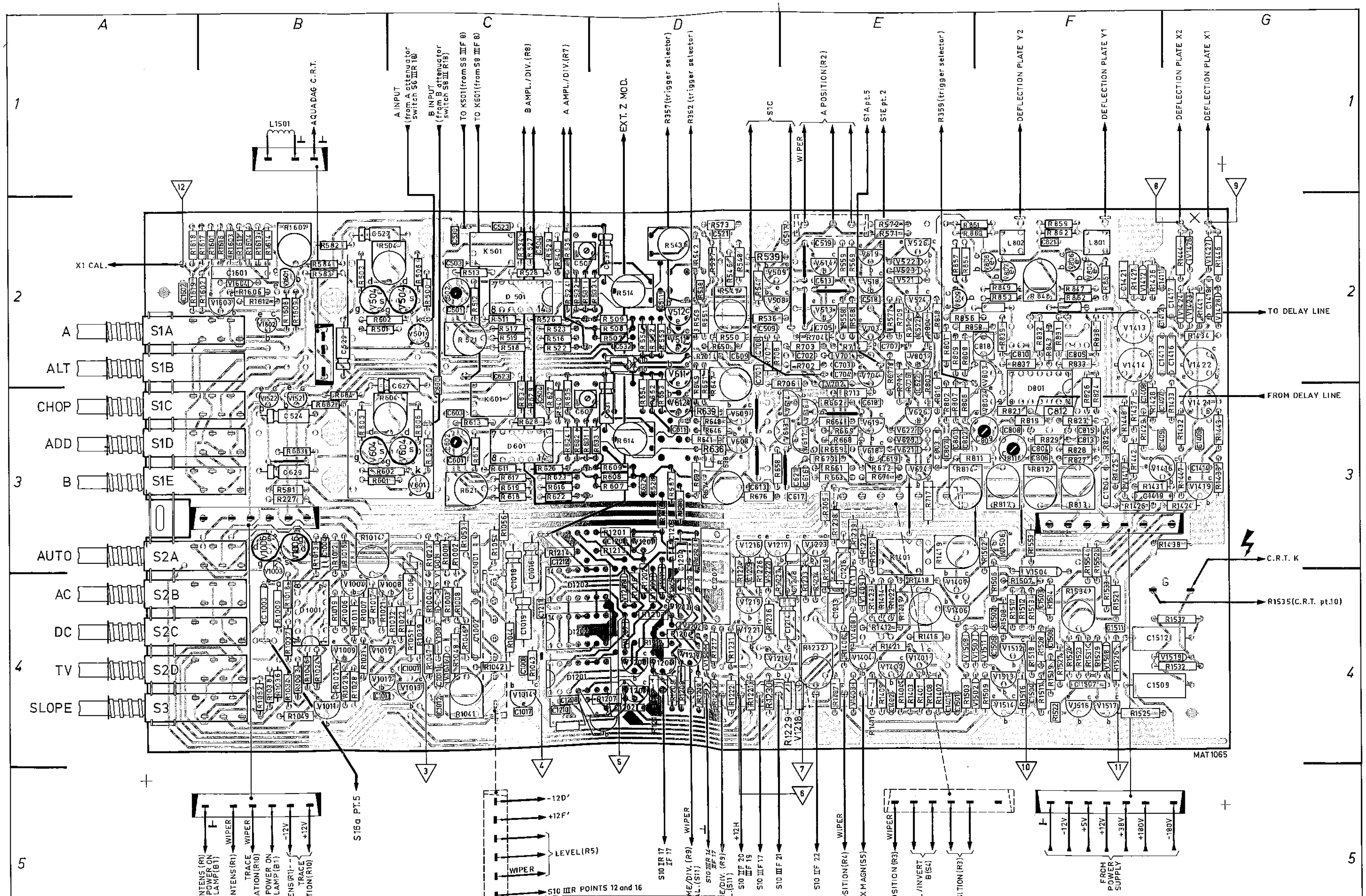
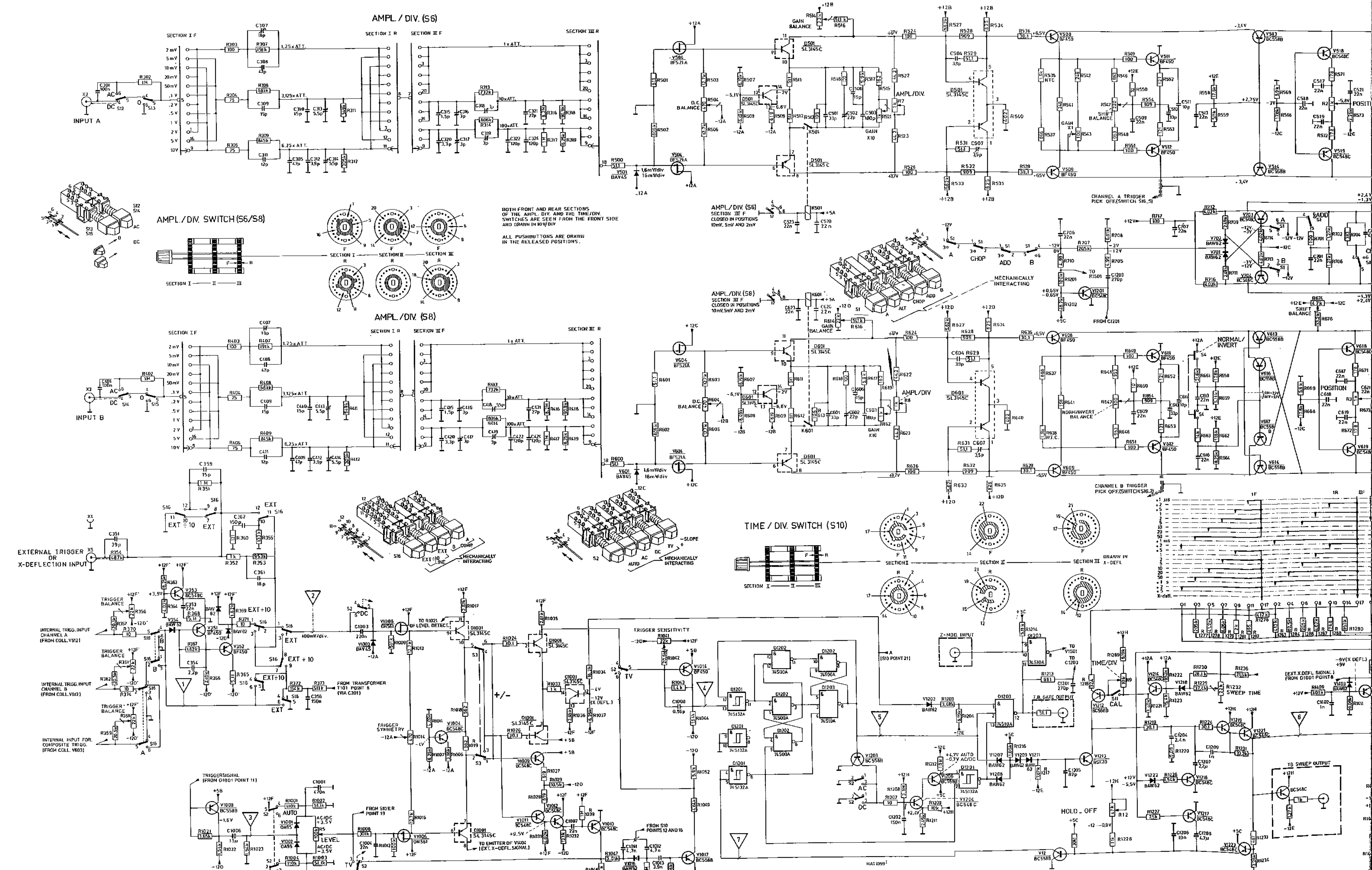


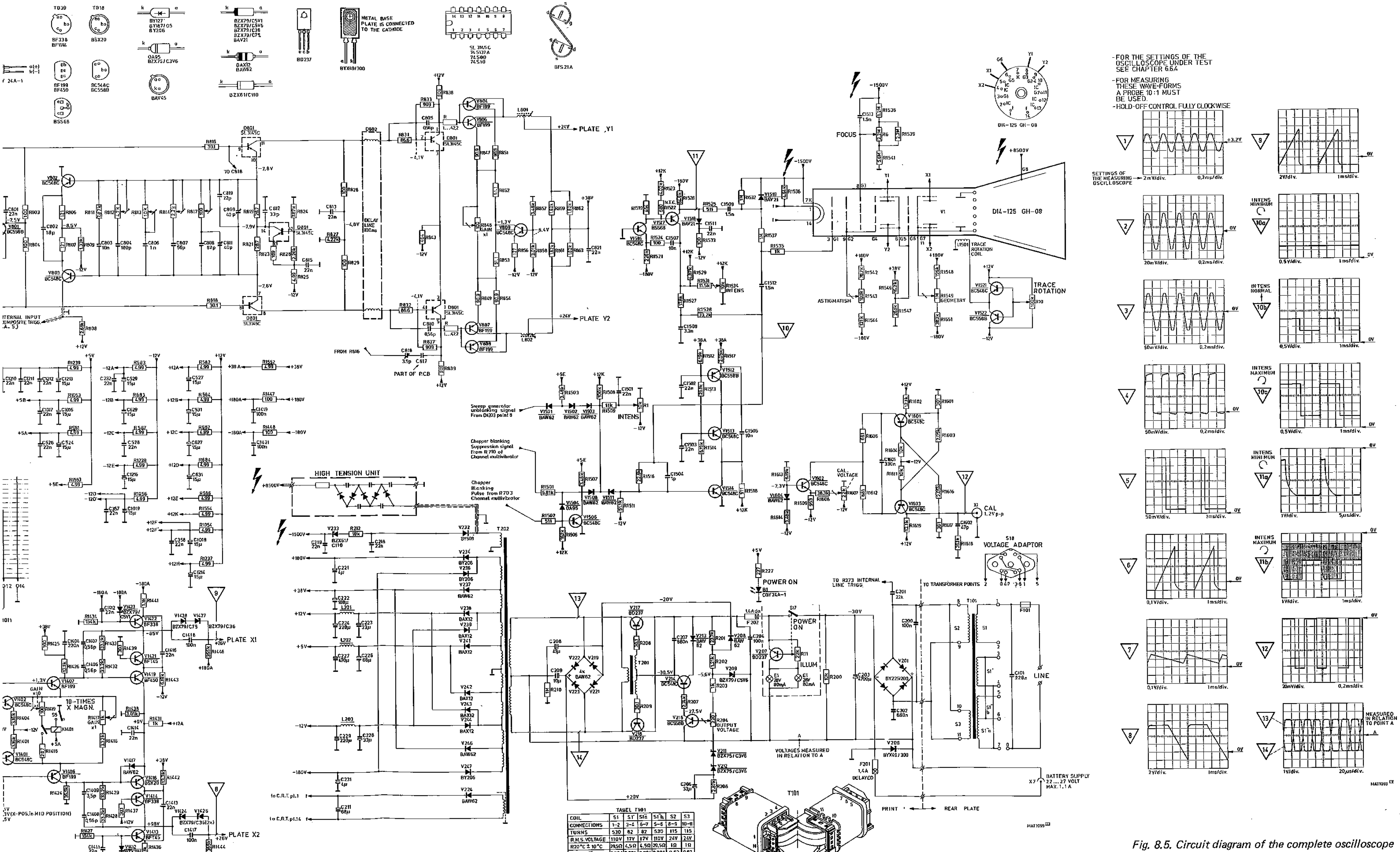
Fig. 8.2. Vertical attenuator unit




A
B
C
D
E
F
G
A INPUT (from A attenuator switch S6 III R 18)
B INPUT (from B attenuator switch S8 III R18)
TO K501 (from S6 III F 8)
TO K601 (from S8 III F 8)
B AMPL./DIV. (R8)
A AMPL./DIV. (R7)
EXT. Z MOD.
R357 (trigger selector)
R362 (trigger selector)
S1C
WIPER
A POSITION (R2)
S1A pt.5
S1E pt.2
R359 (trigger selector)
DEFLECTION PLATE Y2
DEFLECTION PLATE Y1
DEFLECTION PLATE X2
DEFLECTION PLATE X1
L1501
AQUADAG C.R.T.
X1 CAL.
A
ALT
CHOP
ADD
B
S1A
S1B
S1C
S1D
S1E
AUTO
AC
DC
TV
SLOPE
S2A
S2B
S2C
S2D
S3
TO DELAY LINE
FROM DELAY LINE
C.R.T. K
R1535 (C.R.T. pt.10)
MAT 1065
S15a PT.5
-12D'
+12F'
LEVEL (R5)
WIPER
S10 IIIR POINTS 12 and 16
-12V
+5V
+12V
+38V
+180V
-180V
FROM POWER SUPPLY



AMPL. / DIV. (S6)
INPUT A
AMPL./DIV. SWITCH (S6/S8)
SECTION I — II — III
BOTH FRONT AND REAR SECTIONS OF THE AMPL. DIV. AND THE TIME/DIV. SWITCHES ARE SEEN FROM THE FRONT SIDE AND DRAWN IN 10V/DIV
ALL PUSHBUTTONS ARE DRAWN IN THE RELEASED POSITIONS.
AMPL./DIV. (S8)
INPUT B
AMPL./DIV. (S6) SECTION III F CLOSED IN POSITIONS 10mV, 5mV AND 2mV
AMPL./DIV. (S8) SECTION III F CLOSED IN POSITIONS 10mV, 5mV AND 2mV
CHANNEL A TRIGGER PICK OFF (SWITCH S16_5)
CHANNEL B TRIGGER PICK OFF (SWITCH S16_2)
MECHANICALLY INTERACTING
CHOP
ADD
ALT
NORMAL/INVERT
POSITION
SHIFT BALANCE
GAIN BALANCE
D.C. BALANCE
EXTERNAL TRIGGER OR X-DEFLECTION INPUT
TRIGGER BALANCE
INTERNAL TRIGG. INPUT CHANNEL A (FROM COLL. V512)
INTERNAL TRIGG. INPUT CHANNEL B (FROM COLL. V612)
INTERNAL INPUT FOR COMPOSITE TRIGG. (FROM COLL. V603)
TRIGGER SYMMETRY
TRIGGERSIGNAL (FROM O1001 POINT 11)
LEVEL
AUTO
TRIGGER SENSITIVITY
TIME / DIV. SWITCH (S10)
SECTION I — II — III
DRAWN IN X-DEFL
Z-MOD. INPUT
T.B. GATE OUTPUT
TIME/DIV.
CAL
SWEEP TIME
HOLD - OFF
TO SWEEP OUTPUT
SLOPE
MAT1059



COIL	S1	S1'	S1a	S1"b	S2	S3
CONNECTIONS	1–2	3–4	6–7	5–6	8–9	10–11
TURNS	530	82	82	530	115	115
R.M.S. VOLTAGE	110V	17V	17V	110V	24V	24V
R20°C ± 10°C	29,5Ω	4,5Ω	4,5Ω	29,5Ω	1Ω	1Ω

Fig. 8.5. Circuit diagram of the complete oscilloscope