

3. Service Data

3.1. DISMANTLING THE INSTRUMENT

3.1.1. Precautions

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations.

During dismantling procedures a careful note of all leads disconnected must be made to ensure correct reconnection to the appropriate terminals during assembly.

Always ensure that the mains supply is disconnected before removing any of the instrument cover plates. Damage may result if the instrument is switched on when a circuit-board has been removed, or if a circuit-board is removed within one minute of switching off the instrument.

3.1.2. Removing the screen bezel and the contrast plate

- Grip the bottom corners of the bezel and gently pull it from the front panel (see Fig. 3.5.).
- The contrast filter can be removed by pressing it gently out of the bezel.



Fig. 3.5. Removing the screen bezel and the contrast plate

3.1.3. Removing the graticule plate

- Gently ease the graticule plate from the CRT screen using your fingernails or a small screwdriver.
- Increase this space until it is possible to release the left-hand side of the graticule plate from the front profile.
- After releasing this side the graticule plate can be removed.
To refit the graticule plate; first install the right-hand side and then the left-hand side.

3.1.4. Removing the instrument covers

Before removing the instrument covers disconnect the instrument from the mains voltage.
Proceed as follows:

- Put the carrying handle in such a position that the instrument can stand on its protective front cover on a flat surface.
- Unscrew the two coin-slot screws on the rear panel.
- Lift the rear panel.
- Lift off the wrap-around cover.
- For access to the front panel, stand the instrument horizontally and snap off the cover.

3.1.5. Removing the carrying handle

- Prise off the centre knobs from each pivot, using a small screwdriver in one of the small slots at the sides of the knobs.
- Remove the cross-slotted screws and washers that are now accessible.
- Flex both arms of the handle slightly outwards and take it off the wrap-around cover.
- The plastic bearing bushes which are visible now, contain, in sequence of dismantling, a metal ratchet and a spring.
- Grip and arms of the carrying handle must be ordered separately (see list of mechanical parts).
A complete carrying handle can easily be constructed by pressing the arms into the grip.

3.1.6. Removal of the final amplifier unit

- Unplug five coaxial plugs, a three-pole and a seven-pole plug.
- Note the leads connecting this unit to the CRT socket and a four-pole plug or the power supply unit.
Unplug the CRT socket carefully, and also the four-pole plug on the power supply.
- Loosen the four screws attaching the unit to the rear chassis plate and the unit can be removed.

3.1.7. Removal of the cathode ray tube (CRT)

- Remove the screen bezel and graticule plate as explained in section 3.1.2. and 3.1.3.
- Loosen the plastic clamping supports on the top and bottom screen side of the CRT so that the screen is still supported, but can easily be taken out of the supports when removing it.
Every support is mounted to the front panel by means of two screws.
- Unsolder the two trace-rotation coil leads from the bottom side of the main unit.
- Remove the CRT socket carefully.
- Loosen the screw in the CRT bottom clamping spring.
- Disconnect the high-tension side connection from the CRT.
- Remove the CRT from the instrument.
- When mounting the CRT, handle in reversed sequence and take special care when screwing down the CRT clamping spring.
Ensure that the CRT screen is a close fit to the graticule plate.
After soldering the trace-rotation leads check that the rotation functions in the proper direction.

3.1.8. Removal of the power supply unit

- Unplug the four-pole and the three-pole plugs on the unit.
- Unplug the six-pole plug on the main unit and the seven-pole plug on the final amplifier unit and loosen the rubber clamps with which the two cables are attached to the chassis.
- Unsolder the two leads at the mains transformer, the high-tension cable, and the two leads from the mains switch at the bottom side of the unit.
- Loosen the four screws attaching the unit to the chassis.
- Lift the unit slightly at the mains transformer side and slide it sideways out of the plastic mounting strip and out of the chassis. The mounting strip also supports the main unit.

3.1.9. Removal of the mains transformer

- Unsolder the primary and secondary leads on the transformer. For mounting refer to Fig. 2.5. in the chapter "Replacing the thermal fuse" (chapter 2.4.2.).
- Loosen the four mounting screws and slide the transformer in the direction of the front panel out from the rear chassis plate.

3.1.10. Removal of the main unit

- Remove the attenuator screens. When remounting take care to locate them in the correct positions.
- Disconnect the calibration voltage lead from the terminal and unsolder the wires of the trace-rotation coil from the under-side of the printed-circuit board.
- Loosen two screws at the top of the control panel, the earth terminal at the bottom and the five screws attaching the printed-circuit board to the chassis.
When mounting the unit in the instrument, first insert all screws loosely, and then tighten when all screws are in place.
- Disconnect five coaxial leads from their sockets on the final amplifier unit.
- Remove the INTENSITY and FOCUS knob.
- Pull the unit about 5 cm forward and feed the coaxial leads from the final amplifier unit through two rubber clamps.
When remounting the unit ensure that the unit fits in its final position in the plastic mounting strip and under a mounting section of the plate between the power unit and main unit.
- Unsolder the leads from TRACE ROTATION potentiometer and POWER ON LED.
- Slide and till the unit out of the instrument.

3.1.11. Removal of the knobs and textplate

- Removal of the knobs:
Attenuator and time-base switches: take the shields out of the knobs and loosen the exposed nuts with a pair of pliers.
Horizontal position and magnifier: remove the shield and loosen screw inside knob.
Other knobs: these have a clamping spring inside that can be levered off the spindle.
- Removal of the textplate:
Remove the nuts from the attenuator and time-base switches and take off the textplate.

3.1.12. Replacing a switch of a pushbutton unit (Fig. 3.6.)

- Straighten the four retaining lugs of the relevant switch.
- 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 (for instance, with a sucking-iron).
- Solder the new switch on to the printed-wiring board.
- Bend the four retaining lugs back to their original positions.
- If the faulty pushbutton unit cannot be reached remove the main unit as described in section 3.1.10. and eventually the control panel.

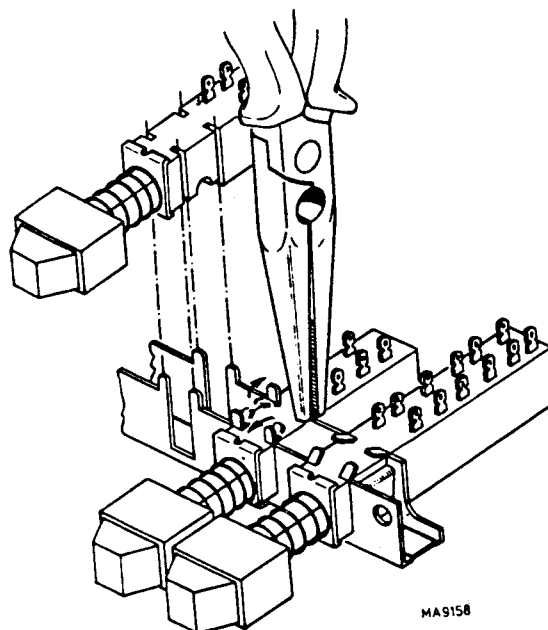


Fig. 3.6. Replacing a push-button switch

3.2. CHECKING AND ADJUSTING

3.2.1. Introduction

3.2.1.1. Measuring equipment and settings of oscilloscope under test

For checking and adjusting a signal generator is necessary that can produce at least the following voltages and frequencies:

- sinewaves with an amplitude between 30 mV and 1.4 V p-p (peak-peak) and a frequency between 10 Hz and 15 MHz.
- squarewaves with an amplitude of 1,2 V and 12 V and a frequency of 2 kHz.
- a squarewave with an amplitude of 60 mV a repetition rate of 100 kHz and a risetime of at least 3 ns.

The adjustment points with their function and location are indicated in Figs. 3.1., 3.2. and 3.3.

In the following adjustment procedure the controls have the positions as listed unless otherwise stated:

- CH. A and CH. B AC/DC buttons (S9 and S14) released.
- CH. A and CH. B 0-buttons (S10 and S15) released.
- CH. A and CH. B ON/OFF buttons (S11 and S13) released.
- ADD and CH. B INVERT buttons (S3 and S4) released.
- LEVEL control (R4 and S2) in the AUTO position.
- VARIABLE TIME/DIV control (R10 and S8) in the CAL position.
- X MAGN control (S1) must be depressed (X1 position).
- The +/– SLOPE button (S17) must be released (+ SLOPE position).
- FOCUS (R5), INTENS (R11), CH. A POSITION (R1), CH. B POSITION (R2), X POSITION (R3) adjusted to obtain a good display.

The adjustment points are located on the main unit unless otherwise stated in this procedure.

3.2.1.2. Trimming Tool Kit (Type 800/NTX)

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

Ordering number: 4822 310 50015.

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



Fig. 3.7. Trimming tool kit 800 NTX

3.2.2. C.R.T. display section

3.2.2.1. INTENSITY, adjustment (R708):

- TIME/DIV switch (S7) in position X VIA B
- CH. B ON/OFF button (S13) in ON position.
- FOCUS control (R5) in the mid-position.
- Turn the INTENS control (R11) approx. 90 degrees clockwise from the mains ON/OFF point.
- Adjust the CH. B. POSITION (R2) and X POSITION (R3) controls so that the spot is in the middle of the graticule.
- Adjust preset potentiometer R708 so that the spot is just visible. R708 is marked VG1 and located on the final amplifier unit.

3.2.2.2. FOCUS and ASTIGMATISM adjustment (R5 and R727):

- TIME/DIV switch (S7) in position 50 μ s/DIV
- Depress the CH. B ON/OFF button (S13)
- Depress button B (S16b) on the trigger source selector.
- Apply a sinewave of approx 10 kHz to the CH. B input (X3). This signal must give a deflection of approximately 6 divisions.
- Adjust R727 (AST). and R5 (FOCUS) in order to obtain sharp lines over the whole screen. R5 must be near to the mid-position after adjustment. R727 is located on the final amplifier unit.

3.2.2.3. TRACE ROTATION adjustment (R6):

- Depress the CH. B ON/OFF button (S13)
- TIME/DIV switch (S7) on 0,1 ms/DIV
- CH. B POSITION (R2) in middle of graticule
- Adjust the TRACE ROTATION control (R6) so that the time-base line is in parallel with the graticule. R6 is a front panel screw driver adjustment point.

3.2.3. Vertical deflection

The CH. A and CH. B amplifiers are nearly identical. For adjustment procedures that are identical for CH. A and CH. B the controls and adjustment points are noted as follows:
for instance the POSITION controls for CH. A/CH. B are (R1/R2).

3.2.3.1. DC BALANCE X1 adjustment CH.A/CH. B (R7/R9)

- Depress the CH. A/CH. B ON/OFF button (S11/S13).
- Depress the CH. A/CH. B 0-button (S10/S15).
- Adjust the frontpanel BAL (X1) adjustment point (R7/R9) to minimum time-base line jump when switching the CH. A/CH. B AMPL/DIV switch (S5/S6) between 2 and 5 mV/DIV. Max. allowed time-base line jump 0,3 DIV.

3.2.3.2. DC BALANCE X10 adjustment CH. A/CH. B (R208/R308)

- Depress the CH. A/CH. B ON/OFF button (S11/S13).
- Depress the CH. A/CH. B 0-button (S10/S15).
- Adjust preset potentiometer (R208/R308 marked BAL X10) to minimum time-base line jump when switching the CH. A/CH. B AMPL/DIV switch (S5/S6) between 10 and 20 mV/DIV. Maximum allowed time-base line jump 0,3 DIV.

3.2.3.3. NORMAL/INVERT BALANCE CH. B adjustment (R319)

- Depress the CH. B ON/OFF button (S13)
- Adjust R319 (marked BAL INVERT) to minimum time-base line jump when operating the NORMAL/INVERT button (S4),
Max. allowed time-base line jump 0,3 DIV.

3.2.3.4. GAIN X1 adjustment CH. B (R274)

- AMPL/DIV switch (S6) in 50 mV/DIV position
- TIME/DIV switch (S7) in 0,2 ms/DIV position
- Depress the CH. B ON/OFF button (S13).
- Depress button B (S16.b) on the trigger source selector.
- Apply to the CH. B input (X3) a calibrated signal of 300 mV and a frequency of approx. 2 kHz and adjust R274 (marked GAIN CH. B) to 6 divisions deflection on the screen.

3.2.3.5. GAIN X10 adjustment CH. B (R323)

- AMPL/DIV switch (S6) in 5 mV/DIV position.
- Other control positions as indicated in part. 3.2.3.4.
- Apply to the CH. B input (X3) a calibrated signal of 30 mV and a frequency of approx. 2 kHz and adjust R323 (marked GAIN X10) to 6 divisions deflection on the screen.

3.2.3.6. GAIN X1 adjustment CH. A (R8)

- AMPL/DIV switch (S5) in 50 mV/DIV position.
- Depress the CH. A ON/OFF button (S11).
- Depress button A (S16a) on the trigger source selector.
- Apply to the CH. A input (X2) a calibrated signal of 300 mV and a frequency of approx. 2 kHz and adjust front panel adjustment point R8 (marked GAIN) to 6 divisions on the screen.

3.2.3.7. GAIN X10 ADJUSTMENT CH. A. (R223)

- AMPL/DIV switch (S5) in 5 mV/DIV position
- Other control positions as indicated under point 6.
- Apply to the CH. A input (X2) a calibrated signal of 30 mV and a frequency of approx. 2 kHz and adjust R223 (marked GAIN X10) to 6 divisions deflection on the screen.

3.2.3.8. SQUARE WAVE ADJUSTMENT INPUT ATTENUATOR CH. A/CH. B (C59, C61/C159, C161)

- TIME/DIV switch (S7) in 0,2 ms/DIV position.
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress button A/B on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 0,2 V/DIV position and apply to the CH. A/CH. B input a 2 kHz squarewave signal of 1,2 V.
- Adjust C59/C159 for optimum squarewave response, without having removed the attenuator shield plates.
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 2 V/DIV position and apply to the CH. A/CH. B input a 2 kHz square-wave signal of 12 V.
- Adjust C61/C161 for optimum squarewave response, without having removed the attenuator shield plates.

3.2.3.9. SQUARE WAVE RESPONSE FINAL Y AMPLIFIER (C266)

- Put the TIME/DIV switch (S7) in position 2 μ s/DIV
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress button A/B on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 10 mV/DIV position
- Apply to the CH. A/CH. B input (X2/X3) a square-wave signals of 60 mV p-p a risetime ≤ 3 ns and a repetition rate of approx. 100 kHz.
- Adjust C266 for optimum square-wave response: maximal pulse droop 0,2 DIV
maximal pulse aberration 0,2 DIV

3.2.3.10. CHECKING THE BANDWIDTH OF CH. A/CH. B

- Put the TIME/DIV switch (S7) in the 0,1 ms/DIV position.
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress the A/B button on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 10 mV/DIV position.

- Apply to the CH. A/CH. B input (X2/X3) a sinewave of 60 mV p-p and a frequency of approx. 100 kHz
The vertical deflection now is 6 DIV
- Increase the frequency to 15 MHz and keep the amplitude to 60 mV p-p. Check that the vertical deflection on the screen is 4,2 DIV or more.
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 20 mV/DIV position
- Increase the voltage on the CH. A/CH. B input (X2/X3) to 120 mV p-p.
Check that the vertical deflection on the screen is 4,2 DIV or more.

3.2.3.11. HIGH FREQUENCY DYNAMIC RANGE AND SHIFT RANGE CH. A/CH. B

- Put the TIME/DIV switch (S7) in the 0,2 μ s/DIV position
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 5 mV/DIV position
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Apply to the CH. A/CH. B input (X2/X3) a sinewave signal of 120 mV p-p and a frequency of 5 MHz
- Check if it is possible to shift the top and bottom of the trace within the graticule by the use of the CH. A/CH. B POSITION control (R1/R2).

3.2.3.12. COMMON MODE REJECTION ADJUSTMENT (R8)

- Depress the ADD-button (S3)
- Depress the INVERT -button (S4)
- Put the CH. A and CH. B AMPL/DIV switches (S5 and S6) in the 10 mV/DIV position.
- Apply to the CH. A and CH. B inputs (X2 and X3) the same sinewave signal of 120 mV p-p and 1 MHz
- The common-mode rejection (CMR) must be better than 100 times; the amplitude on the screen must be smaller than 0,12 DIV.
If not, readjust the front-panel adjustment point CH. A GAIN (R8)

3.2.3.13. CHOPPED AND ALTERNATE MODE check

- Put the TIME/DIV switch (S7) in the 20 ms/DIV position
- Depress the CH. A and CH. B 0-buttons (S10 and S15)
- Depress the CH. A and CH. B ON/OFF buttons (S11 and S13)
- Release the CHOP/ALT button (S12)
- Check that two lines are written on the screen one by one.
- Depress the CHOP/ALT button (S12)
- Check that two lines are written on the screen simultaneous.
- Put the TIME/DIV switch in the 20 μ s/DIV position.
- Turn the INTENS control (R11) fully clockwise
- Check that the two lines on the screen are sharp and well-defined.

3.2.3.14. CROSS-TALK check CH. A to CH. B/CH. B to CH. A

- Release the CHOP/ALT button S12
- Put the CH. A and CH. B AMPL/DIV switches (S5 and S6) in the 20 mV/DIV position
- Put the TIME/DIV switch in the 0,5 μ s/DIV position
- Depress the CH. B/CH. A 0-button (S15/S10)
- Depress the CH. A and CH. B ON/OFF button (S11 and S13)
- Apply a 10 MHz sinewave of 8 divisions to the CH. A/CH. B input (X2/X3)
- Check that the CH. B/CH. A trace shows a signal with an amplitude of 0,08 divisions or less.

3.2.4. Time-base and horizontal deflection

3.2.4.1. TRIGGER SLOPE CHECK

- Put the TIME/DIV switch (S7) in the 0,2 ms/DIV position
- Put the CH. B AMPL/DIV switch (S6) in the 0.1 V/DIV position
- Depress the CH. B ON/OFF button (S13)
- Depress the B button on the trigger source selector (S16b).
- Apply to the CH. B input (X3) a sinewave voltage of 600 mV and a frequency of approx. 2 kHz.
- Adjust the LEVEL control (R4) so that the sinewave starts at about the 0 volt level.
- Depress the +/- SLOPE button (S17) and check that the trace starts on the negative-going slope of the signal.

- Release the +/– SLOPE button (S17) and check that the trace starts on the positive-going slope of the signal.
- Check that turning the LEVEL control (R4) clockwise results in an upward shift of the starting point of the trace.

3.2.4.2. INTERNAL LEVEL RANGE check

- Switch positions as described above.
- Apply to the CH. B input (X3) a sinewave voltage of 480 mV and a frequency of approx. 2 kHz.
- Change the position of the CH. B AMPL/DIV switch to 20 mV/DIV in order to obtain a vertical deflection of 24 divisions.
- Check if the starting point of the trace can be changed over the whole range of 24 divisions when operating the LEVEL control (R4).

3.2.4.3. EXTERNAL LEVEL RANGE check

- Apply to the EXTERNAL trigger input (X5) a sinewave voltage of 12 V p-p and a frequency of approx. 2 kHz
- Depress the EXT button of the trigger source selector (S16c)
- Check that when operating the LEVEL control (R4) the starting point of the trace is adjustable over the whole amplitude of the input signal.

3.2.4.4. MAINS TRIGGERING check

- Put the CH. A AMPL/DIV switch (S5) in the 50 mV/DIV position
- Put the TIME/DIV switch (S7) in the 10 ms/DIV position
- Apply a mains related signal of 10 mV to the CH. A input (X2)
- Depress button A on the trigger source selector (S16a)
- Because the amplitude on the screen is too small, triggering is not possible.
- Depress button A and B on the trigger source selector together (S16a and S16b) and check that stable triggering occurs.

3.2.4.5. TRIGGER SENSITIVITY check

- Adjust the TIME/DIV switch (S7) so that several sinewaves are written.
- Put the CH. A and CH. B AMPL/DIV switch in the 100 mV/DIV position.
- Check the trigger sensitivities according to the following table.

Trigger source (depress button ...)	AUTO/LEVEL operation	Input signal (sinewave)		
		Freq.	amplitude peak/peak	applied to socket
CH. A (S16a)	AUTO	100 Hz	75 mV	X2 (CH. A)
		5 MHz	75 mV	
		15 MHz	150 mV	
CH. B (S16b)	LEVEL	10 Hz	150 mV	X3 (CH. B)
		5 MHz	75 mV	
		15 MHz	150 mV	
EXT input (S16c)	LEVEL	10 Hz	0,8 V	X5 (EXT)
		15 MHz	1,4 V	

Trigger source (depress button ...)	TV operation	Video input signal	
		sync pulse amplitude peak/peak	applied to socket
CH. A (S16a)	TV	75 mV	X2 (CH. A)
EXT. input (S16c)	TV	0,8 V	X5 (EXT.)

3.2.4.6. TIME COEFFICIENT adjustment (R504, R527)

- Put the TIME/DIV switch (S7) in the $5\ \mu\text{s}/\text{DIV}$ position
- Apply to the CH. A input (X2) a pulse voltage with an accurate repetition rate of $5\ \mu\text{s}$
- Adjust the CH. A AMPL/DIV switch (S5) so that the time marker signal is displayed at a reasonable trace height (about 3 divisions)
- Depress the A button on the trigger source selector (S16a)
- Adjust R504 (marked $5\ \mu\text{sec}$) so that the central 8 periods occupy 8 divisions.
- Put the TIME/DIV switch (S7) in the $5\ \text{ms}/\text{DIV}$ position.
- Apply to the CH. A input (X2) a pulse voltage with an accurate repetition rate of $5\ \text{ms}$.
- Adjust R527 (marked $5\ \text{msec}$) so that the central 8 periods occupy 8 divisions.
- Put the TIME/DIV switch (S7) in the $5\ \mu\text{s}/\text{DIV}$ position and apply a signal with a repetition rate of $5\ \mu\text{s}$.
- Turn the VARIABLE TIME/DIV control (R10) fully anti clockwise and check if this control has a range between 1:2,6 and 1:3,5.
- Put the VARIABLE TIME/DIV control (R10/S8) in the CAL position.
- Pull the X MAGN control (S1)
- Put the TIME/DIV switch (S7) in the $10\ \mu\text{s}/\text{DIV}$ position and apply a signal with a repetition rate of $2\ \mu\text{s}$.
- Check that there are 8 periods that have a width of 8 divisions with a tolerance of $\pm 0,4$ division.
- Check that the beginning of the trace can be made visible when operating the X POSITION control (R3).
- Depress the X MAGN control (S1) and check all the remaining TIME/DIV switch positions.
- Check that the central 8 periods occupy 8 divisions ($\pm 0,24\ \text{div}$) and that at least 10 divisions are visible on the screen.

3.2.4.7. HORIZONTAL SENSITIVITY check

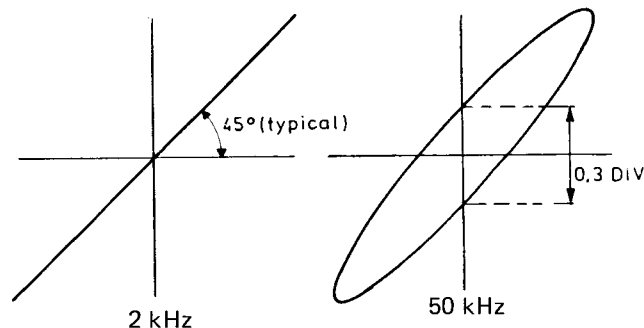
- Put the TIME/DIV switch (S7) in the X VIA B position
- Put the CH. B AMPL/DIV switch in the $0,1\ \text{V}/\text{DIV}$ position
- Apply to the CH. B input (X3) a $600\ \text{mV}$ sinewave with a frequency of approx. $2\ \text{kHz}$.
- Check that the horizontal deflection is 6 divisions with a tolerance of ± 1 division.

3.2.4.8. HORIZONTAL BANDWIDTH check

- Settings of controls as described above.
- Adjust the amplitude of the $2\ \text{kHz}$ signal so that a horizontal deflection of 6 divisions is obtained.
- Increase the frequency to $1\ \text{MHz}$ and check if the horizontal deflection is at least $4,2$ divisions.

3.2.4.9. PHASE DIFFERENCE BETWEEN X AND Y CHANNELS check

- Put the TIME/DIV switch (S7) in the X VIA B position
- Put the CH. A and CH. B AMPL/DIV switches in the $0,1\ \text{V}/\text{DIV}$ position.
- Apply to the CH. A and CH. B inputs the same sinewave of $600\ \text{mV}/2\ \text{kHz}$
- Check that a straight line is displayed under an angle between 40° and 50° (typical 45°) with the horizontal graticule lines as indicated in Fig. 3.8.
- Apply to the CH. A and CH. B inputs the same sinewave of $600\ \text{mV}/50\ \text{kHz}$.
- Check that the phase error between the horizontal and vertical channel does not exceed $3^\circ/0,3$ divisions (see Fig. 3.7.).



MA9865

Fig. 3.8. Checking the phase difference between X and Y channels

3.2.5. Mains voltage variation check

3.2.5. MAINS VOLTAGE VARIATION check

Check that the intensity, horizontal deflection and vertical deflection do not change when varying the mains voltage over $\pm 10\%$ and $\pm 10\%$ of the nominal value.

3.3. CIRCUIT DESCRIPTION (See Fig. 3.19)

3.3.1. Vertical deflection

As far as channel A and B are identical only channel A is described.

INPUT COUPLING STAGE

In the DC position (S9 released) the signal applied to input socket X2 reaches the high impedance attenuator via R51.

In the AC position (S9 depressed) the signal applied to X2 reaches the high impedance attenuator via R51 and blocking capacitor C51.

R52 discharges C51 when switching S9 from AC to DC position.

Depressing the 0-button (S10) earthens the attenuator input. In this position the signal applied to X2 is connected to ground via R51, C51 and R52.

Note that R51 (CH. A) and R151 (CH. B) don't have the same value. This difference makes the bandwidth of both channels equal. This is done because CH. A and CH. B are somewhat different: CH. A has a variable gain and CH. B has a normal/invert function.

HIGH IMPEDANCE ATTENUATOR

This block contains the 1, 10 and 100 times attenuator.

The 100 times attenuator is active in the 10, 5 and 2 V/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R54, R57, R58 and parallel capacitors in order to obtain an attenuation coefficient of 100.

Variable capacitor C61 makes adjusting possible of the square wave response of this section.

The 10 times attenuator is active in the 1, 0.5 and 0.2 V/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R53, R56, R58 and parallel capacitors in order to obtain an attenuation coefficient of 10.

Variable capacitor C59 makes adjusting possible of the square wave response of this section.

A 1 time attenuator is active in the 100, 50 and 20 mV/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R60, R58. R60 limits the current in V201 if HF signals with a high amplitude are applied to the input of the instrument.

Another 1 time attenuator is active in the 10, 5 and 2 mV/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R55, R58. R55 limits the current in V201 if HF signals with a high amplitude are applied to the input of the instrument.

Note that the attenuator coefficient is the same as used in the 100, 50 and 20 mV/DIV positions.

The necessary sensitivity in the 10, 5 and 2 mV/DIV positions is obtained by a 10 times gain increase in the PREAMPLIFIER block.

PREAMPLIFIER (V202, V203, V211, D201)

The output of the HIGH IMPEDANCE ATTENUATOR reaches via R59, C63 and R201 the input of a symmetrical impedance converter, which consists of two matched FET's V202 in source follower configuration. The DC BALANCE of this stage can be adjusted with the front panel potentiometer R7.

Diode V201 protects the FET input against excessive negative voltages.

The heart of the preamplifier is formed by integrated circuit D201. A simplified diagram of this IC and matched discrete components is indicated in Fig. 3.9. The preamplifier is now discussed in the following sentences.

The source signals from V202 reach the base of the input stages V15/V16 and V18/V17 (pin 3 and 6) of integrated circuit D201. The emitters of the transistors V16 and V17 are connected via pin 4 and 5 to a switchable resistor network R213, R214, R216 and R217. This network receives current from a constant current source with transistor V203.

The resistor network makes the 1-2-5 attenuator sequence:

- R213 and R214 always are in the circuit.
These resistors determine the amplification of the input stage of D201 in the attenuator switch positions 10 V, 1 V, 100 mV and 10 mV/DIV. In these positions R216 and R217 are not switched in the circuit.
- When R216 is switched into the circuit (S5/o, m closed) the amplification of the input stage of D201 increases 2 times. This takes place in the attenuator positions 5 V, 0.5 V, 50 mV and 5 mV/DIV.

- When R217 is switched into the circuit (S5/o, n closed) the amplification of the input stage of D201 increases 5 times. This takes place in the attenuator positions 2 V, 0.2 V, 20 mV and 2 mV/DIV.

Inside D201 the collector current from the input stages V15/V16 and V18/V17 flows through the transistors V13 and V14. These transistors operate in a common base configuration and their base is kept at a fixed voltage of +5,3 Volt if pin 9 receives a supply voltage of +9.8 Volt made by V211 and matched components.

The collector current from V13 and V14 reaches the transistors V7 and V8 via the 150 Ohm resistors R3 and R4. These transistors also work in a common base configuration and their base is kept at a fixed voltage of +8,3 Volt if pin 9 receives a supply voltage of +9,8 Volt.

A X10 GAIN increase for the three most sensitive attenuator switch positions occurs when pin 2 switches from earth to floating condition.

Inside D201 current source CS2 is activated if pin 2 is not connected to earth. Therefore the amplifier stage with the transistors V9/V10 and V12/V11 is activated. This stage receives the signal on R3 and R4 on its inputs. This gives a collector current which is nine times stronger than the collector current from V7 and V8. Both collector currents are added so that the gain increases ten times.

The GAIN X10 ADJUSTMENT is achieved by potentiometer R223 which is incorporated in the circuit connected to pin 7 and 8. Pin 7 and 8 are inside D201 connected to the emitter of V10 and V11 in the nine times amplifier stage.

In channel B does this circuit also incorporate the channel B NORMAL/INVERT BALANCE (R319).

The collector current from V7 and V8 and eventually (GAIN X10 mode) V10 and V11 reaches via R1 and R2 the emitters of a multiplier stage with V1/V2 and V3/V4. This multiplier stage is in channel A used for the GAIN X1 ADJUSTMENT and in channel B for the NORMAL/INVERT function.

NORMAL mode: pin 11 is floating and pin 10 connected to +12 Volt so that V2 and V3 are not conductive and V1 and V4 are conductive.

Now the emitter current of V1 reaches pin 13 and the emitter current of V4 reaches pin 12.

INVERT mode: pin 10 is floating and pin 11 is connected to +12 V so that V1 and V4 are not conductive and V2 and V3 are conductive.

Now the emitter current of V2 reaches pin 12 and the emitter current of V3 reaches pin 13.

Channel A: V1, V2, V3 and V4 are all more or less conductive. The gain can be adjusted by varying the conductivity of V1 and V4 with the base circuit with R241 and potentiometer R8.

The output pins of D201 are 13 and 12.

They are connected to emitter of transistor V219 and V221 in the channel switch.

Note that in the X1 GAIN position the current applied to the pins 13 and 12 is equivalent to the output current at pin 4 and 5.

The transistors V5, V6 and current source CS1 are used to drive the trigger pick off amplifiers via pin 15 and 14. In channel A pin 14 is not in use and connected to +12 Volt.

CHANNEL SWITCH (V219, V221)

This block is able to switch - depending on the output signal from the channel multivibrator - the signal on pin 13 and 12 of D201 through to the final Y-amplifier.

Diode V214 and V253 keep the voltage on the anodes of V216 and V218 at a fixed voltage of 11,3 Volt (provided the supply voltage is exact 12 Volt).

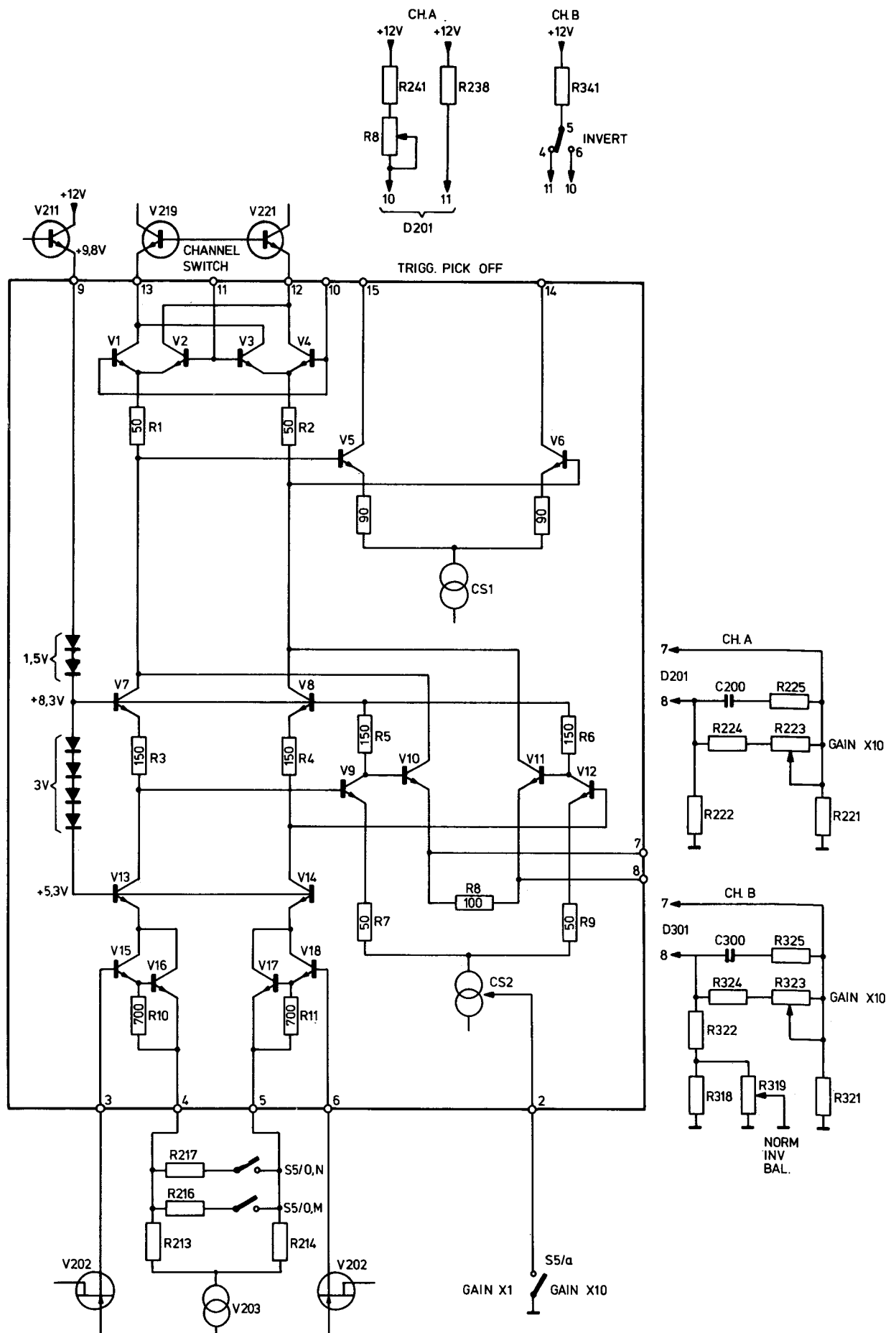
Ch. A switched off: the channel multivibrator output D101/6 is L. Zenerdiode V103 is conductive and diode V217 is not conductive. Also the transistors V219 and V221 are not conductive. The output signal from D201 does not reach the final Y-amplifier: the current which flows into the outputs of D201 (pin 13 and 12) is supplied by the diodes V216 and V218.

Ch. A switched on: the channel multivibrator output D101/6 is H. Zenerdiode V103 is not conductive and diode V217 is conductive. Also the transistors V219 and V221 are conductive. The output signal from pin 13 and 12 of D201 reaches the inputs of the final Y-amplifier: the current which flows into the outputs of D201 is supplied by the emitters of V219 and V221.

FINAL Y AMPLIFIER (V266) V267, V268, V270 ... V279)

The input stage consists of a series feedback stage with transistor V267 balanced by transistor V268. This stage has adjustment points for Ch. B gain adjustment (R274) and square wave compensation (C266).

Transistor V266 functions as a voltage source of which the emitter voltage becomes a little more positive in the ADDED mode because of R265 and S3. The current applied to the inputs of the final amplifier doubles in ADDED mode: Ch. A and Ch. B are both switched on. Without the compensation achieved by S3, R265 and



MA9850

Fig. 3.9. Simplified circuit diagram of D201/D301

V266 the gain would decrease a little.

The input stage is located on the main unit and the other parts are located on the final amplifier unit. The interconnections between both units are made by means of two coaxial cables. V278 and V279 form a common base circuit between the coaxial cables and output stage.

The output stage consists of V270, V271, V272 and V273 that drive deflection plate Y2 balanced by V274, V275, V276 and V277 that drive deflection plate Y1. The deflection plates are not driven directly from the amplifier; but via R292 and R293 in order to increase stability.

In the section that drives Y2, V272 and V273 function as a current source. Two transistors are used because of maximum permissible current and voltage on each transistor and to reduce stray capacitances. V270 and V271 form a shunt feedback stage in which two transistors are used because of maximum permissible current and voltage on each transistor and to reduce stray capacitances.

In the section that drives Y1 are V274 and V275 the current source and V276 and V277 are the shunt feedback stage.

CHANNEL MULTIVIBRATOR (D101, D102)

The logic circuitry which is used in this unit can have two logic in or output levels:

a low level (indicated as L) between 0 and 0.8 V and a high level (indicated as H) between 2 and 5 Volt.

The unit incorporates 4 nand gates D101 and 2 flip-flops D102, of which one functions as an inverter.

The unit has two outputs that switch respectively channel A and channel B on (output = H) and off (output = L). Output 6 of D101 switches channel A. Output 8 of D101 switches channel B.

The logic can occupy the following conditions depending on the position of the switches CH. A ON/OFF, CH. B ON/OFF, ADD, ALT/CHOP.

ADDED mode (S3 depressed): the nand gate inputs 4 and 10 of D101 are L. The nand gate outputs 6 and 8 are H and both channels are switched on at a time. Now addition takes place.

Ch. A ON (S11 depressed): the Clear input (pin 1) of the flip-flop D102 is L and the Preset input (pin 4) is H. Therefore output Q (pin 5) is L and inverted output Q (pin 6) is H.

Now output 6 of nand gate D101 is H (Ch. A switched on) and output 8 of nand gate D101 is L (Ch. B switched off).

Ch. B ON (S13 depressed): the Preset input (pin 4) of the flip-flop D102 is L and the Clear input (pin 1) is H. Therefore output Q (pin 5) is H and inverted output Q (pin 6) is L.

Now output 6 of nand gate D101 is L (Ch. A switched off) and output 8 of nand gate D101 is H (Ch. B switched on).

Ch. A ON, Ch. B ON and CHOPped mode (S11, S13 and S12 depressed):

The chopper oscillator D101/1, 2, 3 is switched on because pin 2 is H. This oscillator is a nand gate with RC feedback loop which produces a 500 kHz square wave signal at its output (pin 3). This output is H if the chopper oscillator is switched off in single channel or alternate operation.

The signal applied to the Clear input (pin 13) of D102 gives its inverse at the inverted Q output (pin 8) because the Preset input (pin 10) is L. This output signal is used to blank the display when switching over between the A and B channel.

The 500 kHz signal is also applied to input 13 of nand gate D101. Pin 12 of this gate is H in the chopped mode. In the chopped mode chopper pulses are present on pin 13 of D101. During the sweep the inverted chopper pulses reach the clock input (pin 3) of D102.

The Clear input (pin 1) and Preset input (pin 4) both are high; so they are inactive. Because of the feedback connection between inverted Q output (pin 6) and Data input (pin 2) the state of the flip-flop changes at every positive transition of the clock input (pin 3). Because of these changes in the state of the flip-flop the display switches between the A and B channel with a frequency of 500 kHz.

Ch. A ON, Ch. B ON and ALTERNATE mode (S11 and S13 depressed).

Input 13 of nand gate D101/12, 13, 11 is H.

Input 12 of this gate is H during the time base sweep and L during the hold off period.

Therefore the Clock input (pin 3) of the flip-flop goes from L to H at the end of every sweep and the state of the flip-flop changes. Thus the display switches over from one channel to the other.

The following truth table indicates the level on some important points of the logic as a function of the display mode switches A on/off, B on/off, Chop/alt.

	D101/2	D101/12	D102/4 preset	D102/1 clear	D102/5 output	D102/6 inv. output
A on/B off	L	H	H	L	L	H
B on/A off	L	H	L	H	H	L
A and B on/Alt mode	L	sweep = H hold off = L	H	H	H/L	L/H (*1)
A and B on/Chop mode	H	H	H	H	H/L	L/H (*2)
A off/B off	L	H	H	H	H/L	L/H (*3)

*1) State changes at the end of every sweep

*2) State changes with a frequency of 500 kHz

*3) State is not defined.

3.3.2. HORIZONTAL DEFLECTION AND TIME BASE

CH. A TRIGGER PICK OFF (V209, V212)

The trigger signal current is picked off from pin 15 of D201 by means of the shunt feedback stage V209. This stage is followed by the series feedback stage V212, which is switched by means of the trigger source selector switch S16b. Transistor V212 and Diode V213 become conductive if S16b applies +12 Volt to R244, and the triggering signal current from channel A reaches the trigger source selector.

If S16b does not apply R244 to any potential V212 and V213 are not conductive and the triggering signal from channel A is blocked.

R247 functions than as a pull resistor for the collector of V212.

CH. B TRIGGER PICK OFF (V304, V306, V307, V309, V312)

V309, V312 and V313 have the same function as in Ch. A respectively V209, V212 and V213.

The channel B trigger pick off stage has also an output which is used to drive the horizontal amplifier in the X via B mode.

For this function are in use V304 balanced by V309 and V306 balanced by V307. The current from the collector of V307 feeds the X deflection selector.

EXTERNAL TRIGGER AMPLIFIER (V403, V404)

The signal applied to the external trigger input socket (X5) reaches a voltage divider network R403/C402, R404/C403. The output signal from the divider feeds via a DC blocking capacitor C404 two emitter followers V403 and V404 that work in cascade. Diode V402 protects transistor V403 against too positive input voltages.

When S16c on the trigger source selector (EXT.) is depressed the emitter of V404 receives emitter current from the +12 Volt supply via R409, C407 and R411. The emitter output signal is applied to R412 and DC blocking capacitor C409, that feeds the +/– slope selector.

The external input signal is blocked if S16c is released and V404 does not receive emitter current.

TRIGGER SOURCE SELECTOR

This unit is build up around the trigger selector switch S16a, b, c. The following sources can be selected: Channel A (S16a depressed) or Channel B (S16b depressed):

See description "Channel A trigger pick off" or "Channel B trigger pick off". The output signal from V213 (Ch. A) or V313 (Ch. B) is split up into a DC component which flows into R401 and an AC component which flows via C406 to the input of the slope selector.

Zenerdiode V401 and R402 are necessary to suppress an eventual 100 Hz mains ripple from the power supply in the triggering signal.

External input signal (S16c depressed):

See description "External trigger amplifier".

Line signal (S16a and b depressed):

The line signal from the mains transformer T803 reaches via R816 a low pass filter consisting of C412, C411 and R414. This filtered signal is applied to the input of the slope selector via R412 and C409.

SLOPE SELECTOR (V451, V457)

The input signal first reaches a limiter consisting of the diodes V406 and V407.

This limiter is necessary if in the external trigger mode high amplitude signals are applied to the external input X5.

The output signal from the limiter circuit is applied to the base of shunt feedback amplifier V451.

The signal on the collector of this transistor is inverted by V457 so that there is a phase shift of 180 degrees between the collector signal of V451 and V457.

Negative slope: the anodes of diode V452 and V453 are connected to +12 V via R454 and S17.

These diodes are conductive and the collector signal from V451 is applied to the base of emitter follower V458. The anodes of diode V454 and V456 are connected to -12 V via R458 and S17.

Positive slope: the diodes V452 and V453 are not conductive and the diodes V454 and V456 are conductive so that the collector signal from V457 reaches the base of emitter follower V458.

TRIGGER COMPARATOR (V459, V461, V469, V467, V474, V472, V476)

The comparator function is achieved by V467 and V474. The output signal from the comparator is applied to a series feedback stage V472 and a shunt feedback stage V476. Those two stages together give a gain of 1,6 times.

The output signal from the emitter of V476 is applied to the sweep gating logic. The time base can start if the emitter of V476 goes from H to L.

The comparator can function in two modes:

AUTO mode with TOP leveling. The AUTO switch (S2) is closed so that V469 and V461 are conductive and V459 is not conductive.

The triggering signal which reaches the input of the comparator transistor V467 via C451 has a top level of about 8,3 Volt because of voltage divider R464 and R469 and the detection at the base of V467. Zenerdiode V471 and transistor V469 are conductive.

In the AUTO mode is the base of comparator transistor V474 applied to +12 Volt via diode V464 and S2. This comparator section and level potentiometer R4 are inoperative and diode V468 is not conductive. Diode V473 is incorporated to make the comparator symmetrical and protection of the base-emitter junction of V474 against too negative voltages.

NORMAL mode with level adjustment: V469 and V461 are not conductive and V459 is conductive.

The triggering signal which reaches the input of the comparator transistor V467 via C451 has an average value of about 1 Volt because of voltage divider R464, R469 and R467. R467 is switched on by transistor V459.

TV FILTER

The TV trigger unit contains a low-pass filter with two different cut-off frequencies. The filter is connected between the series feedback stage V472 and the shunt feedback stage V476 in the trigger comparator.

If the filter is switched on (S1A closed) the instrument functions in the AUTO mode with top leveling because V493 becomes conductive.

The unit contains two filter capacitors C491 and C492 that are switched into the circuit by respectively V491 and V492.

In the TIME/DIV switch positions 0,2 s ... 0,5 ms/DIV C491 and C492 are both switched into the circuit and triggering on frame pulses (TVF) is possible.

In the TIME/DIV switch positions 0,2 ms ... 0,5 μ s/DIV: C492 and V492 are switched off because V496 and V495 become conductive: triggering on line pulses (TVL) is possible. Transistor V496 is operated by the TIME/DIV switch.

SWEEP GATING LOGIC (D501, D502, D503)**TIME BASE (V501, V502, V503, V504, V506, V507, V508)****HOLD OFF CIRCUIT (V511, V512, D501/12, 13, 11)**

The three functional blocks mentioned above are not described separately because they function as an integral part. See Fig. 3.10 and Fig. 3.11 for circuit diagram detail and voltage waveforms.

The time base is build around the timing capacitors C502 — which is always in the circuit — and C503 which is switched in the circuit by V503 in the low sweep speeds 0,2 s ... 0,5 ms/DIV.

A constant current from current source V502 charges the capacitor(s) in order to produce a time linear voltage. The TIME/DIV control (S7) is incorporated in the emitter of the current source.

The VARIABLE TIME/DIV control (R10) is incorporated in the base circuit of the current source.

The voltage on the base circuit of current source V502 in the TIME/DIV positions 0,2 s ... 0,5 ms/DIV is determined by the emitter voltage of V503.

This emitter voltage is adjustable with R527.

The voltage on the base circuit of V502 in the TIME/DIV positions 0,2 ms ... 0,5 μ s/DIV is determined by the emitter voltage of V501.

This emitter voltage is adjustable with R504.

Charging of the time base capacitor(s) takes place during the time base sweep. In this situation is switching transistor V504, which is controlled by the sweep gating logic, not conductive. This transistor comes into conduction at the end of the sweep; discharges the timing capacitor(s) and takes over the current from V502. The switching transistor goes again out of conduction when the time base must run again.

The sawtooth voltage on the timing capacitors is picked off by two emitter followers V506 and V507 that are connected in cascade and applied to the X-deflection selector.

The output signal from V507 is also applied to emitter follower V512. This emitter follower feeds the hold-off capacitor(s). Capacitor C504 is always in the circuit and capacitor C506 is switched into the circuit by V511 in the sweep speeds from 0,2 s to 0,5 ms/DIV.

The sawtooth on the hold-off capacitor(s) is applied to the input of nand gate D501/12, 13, 11.

This gate is a Schmitt-trigger with a hysteresis of approximately 0,8 Volt. The output of the inverter becomes L if the positive going slope of the sawtooth reaches a level of about 1,8 Volt.

The two D type flip-flops D503 work in parallel.

The inverting output of one flip-flop (pin 6) feeds the switching transistor V504 and the inverting output of the other flip-flop (pin 8) feeds the Z amplifier.

When pin 8 is H the display is blanked.

D502 is a monostable multivibrator. The inverting output (pin 6) stays L during 100 msec. after reception of a positive going pulse on trigger inputs 3 and 4. This 100 msec. time is determined by C501. The inverting output (pin 6) becomes always H if the Clear input (pin 5) is L.

The three possible modes that are X via B, Auto and Normal mode are discussed separately:

X via B mode. Input 4 of D501 is L (because of conducting diode V500 —0,6 Volt) so that the trigger pulses on pin 5 of D501 are blocked.

Input 5 of D502 is L (—0,6 Volt) so that the inverting output (pin 6) is H. Thus input 9 of D501 is H.

Input 10 of D501 is H because the anode of diode V516 is about +12 Volt.

Now output 8 of D501 is L and a Preset command is given to the D flip-flops D503. The inverting outputs of the flip-flops are L. The L on pin 8 of D503 gives an unblanked display.

Auto mode without trigger pulses.

Input 4 of D501 is H via R502 so that trigger pulses on input 5 can reach the clock inputs of the flip-flops (pin 3 and 11). Input 5 becomes H when a trigger pulse is present; the clock inputs of the flip-flops become L then.

The flip-flops trigger on a positive going clock pulse.

The Clear input of monostable multivibrator D502 is H via R502 and inactive.

Input 9 of D501 is H if no trigger pulses are applied to input 5 of D502.

Now output 8 of D501 is L and a preset command is given to the flip-flops (pin 4 and 10). The flip-flops function in this situation as an inverter of which the Clear input (pin 1 and 13) signal reaches inverted the output pins 6 and 8.

If the time-base capacitor(s) are charging V504 is not conducting and output 6 of D503 is L.

Also the hold-off capacitors are charging and the voltage on input 12 and 13 of D501 is rising. If this voltage has reached a value of approximately 1,8 Volt the nand gate detects a H and its output becomes L. This L signal

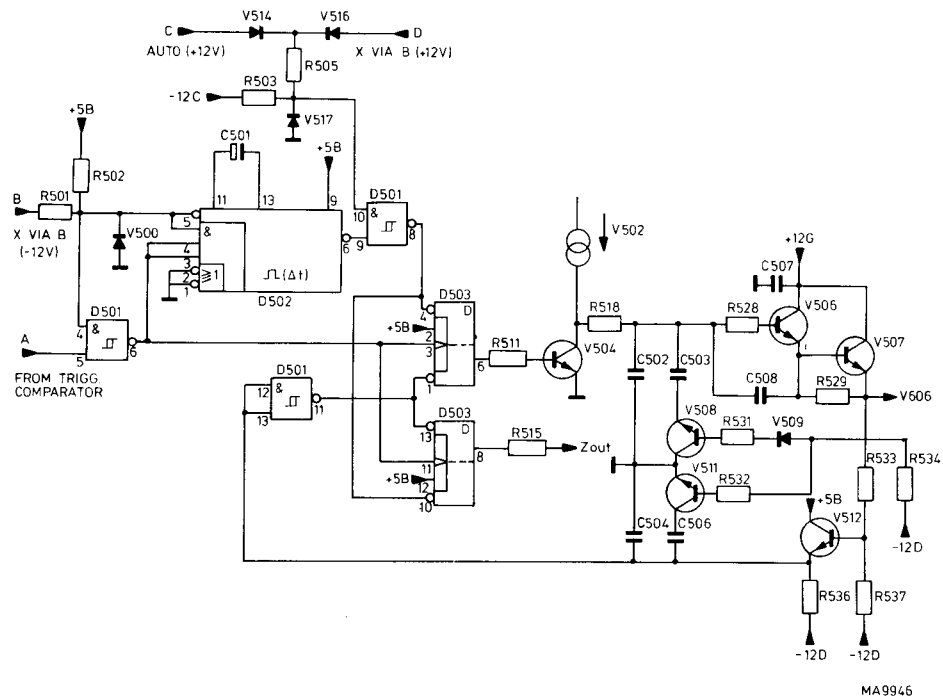


Fig. 3.10. Detail of sweep gating logic, time base and hold-off circuit

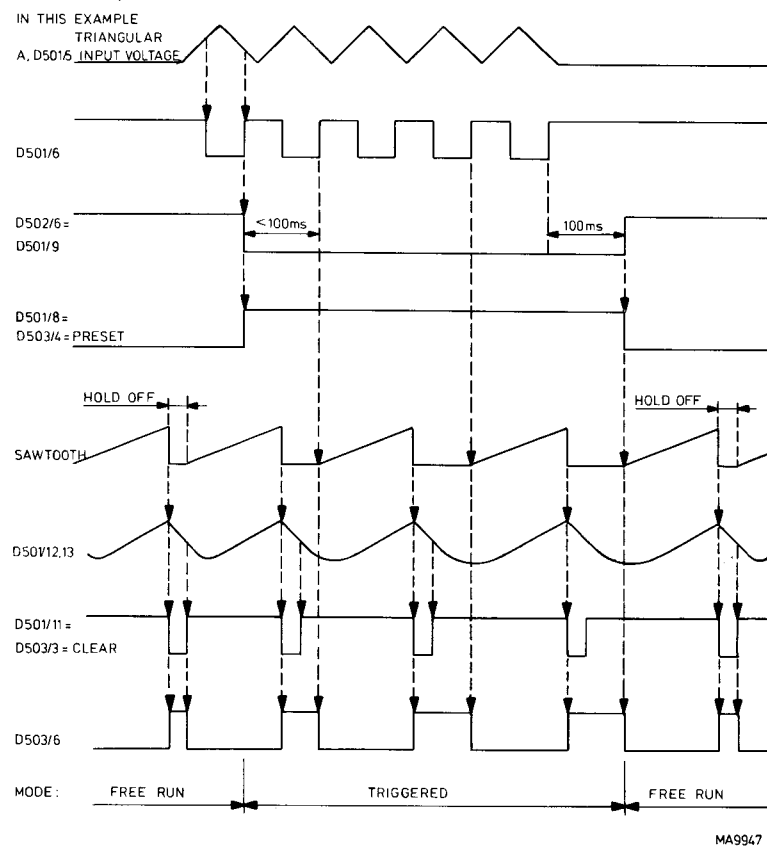


Fig. 3.11. Some voltage waveforms in the circuit shown in Fig. 3.10.

The circuit works in the auto mode and the time base runs free 100 ms after the last trigger pulse.

is applied to the Clear input of the flip-flops (pin 1 and 13). Because the flip-flops function as an inverter the output pins 6 and 8 become H and switching transistor V504 becomes conductive.

V504 discharges the time-base capacitor(s) and R536 discharges the hold-off capacitors. The voltage on input 12 and 13 of D501 decreases. If this voltage has reached a value of approximately 1 Volt output 11 of D101 becomes H again. Thus the output 6 and 8 of the flip-flops become L again and switching transistor V504 does not conduct anymore. The charging of the time-base capacitor(s) starts again, and so on: the time base runs free.

Auto mode with trigger pulses.

This mode is described as far as it is different from the "Auto mode without trigger pulses".

A positive going trigger pulse on output 6 of D501 triggers the monostable multivibrator D502 and its output (pin 6) becomes L for 100 msec. Thus pin 9 of D501 becomes L and the output H.

The Preset inputs of the flip-flops are not activated now, so that the flip-flops do not function as an inverter any longer. After discharge of the hold-off capacitor(s) the output of the flip-flops only become H at the reception of a positive going trigger pulse on the clock input (pin 3 and 11) so that the time base starts.

The behaviour in the Auto mode with and without trigger pulses is indicated in Fig. 3.11.

Normal mode with trigger pulses.

This mode is described as far as it is different from the "Auto mode without trigger pulses".

Input 10 of D501 is L and the output is H so that the Preset inputs of the flip-flops (pin 4 and 10) are inactive: the flip-flops do not function as an inverter as described in the AUTO mode. After discharge of the hold-off capacitor(s) the outputs of the flip-flops become L and only become H at the reception of a positive going trigger pulse on the clock inputs (pin 3 and 11) so that the time-base starts.

X-DEFLECTION SELECTOR (V602, V604, V605, V606, V607)

The output signal current from the Ch. B trigger pick off amplifier reaches the base of shunt feed-back stage V602.

The collector output signal from V602 is applied to the input of the final X-amplifier (base of V609) if the diodes V605 and V604 are made conductive.

This is done by pulling their cathodes to -12 Volt via R606 and a contact of the TIME/DIV switch, when this switch is in the X via B position. In the other switch positions the cathodes of V605 and V604 are pulled to +12 Volt by R606 and R610.

These diodes are not conductive then and the collector signal from V602 is blocked.

In the other switch positions are the diodes V606 and V607 conductive by pulling their cathodes to -12 Volt via R604 and a contact of the TIME/DIV switch. Now the time base sawtooth which is applied to the anode of V606 reaches the input of the final X-amplifier. In the X via B position is the sawtooth blocked because V606 and V607 are not conductive because their cathodes are pulled to +12 Volt via R604 and R603.

FINAL X-AMPLIFIER (V608, V609, V611, V612, V613, V614, V617, V618, V619)

The output signal from the X-deflection selector reaches the base of series feedback stage V608.

This stage is balanced by V611. The base circuit of this transistor incorporates the horizontal position control R3.

V608 and V611 receive their emitter-circuit from constant current source V609, via R618 and R619.

R618 and R619 are shunted by R621 in the X-magnifier X5 position so that a horizontal gain increase of 5 times is obtained.

The collector signal from V608 and V611 is fed via two coaxial cables to the output stage. This output stage consists of shunt feedback stage V614/V613 and current source V612, that drive the horizontal deflection plate X2.

The horizontal deflection plate X1 is driven by shunt feedback stage V617/V618 and current source V619.

In the shunt feedback stages V614/V613 and V617/V618 two transistors are used per stage because of maximum permissible current and voltage on each transistor and to reduce stray capacitances.

The horizontal deflection plates X1 and X2 are connected with the output stage via respectively R636 and R626 in order to increase stability.

Note that the horizontal output stage has a higher supply voltage than the vertical output stage.

This is because the horizontal deflection sensitivity is less (19 Volt/DIV) than the vertical sensitivity (9,5 Volt/DIV). Therefore the horizontal output stage must deliver a higher amplitude to the CRT for a certain deflection than the vertical output stage.

3.3.3. C.R.T. display section

Z-AMPLIFIER (V708, V709)

The input of the Z-amplifier is the cathode of V707 and receives signal from:

- The sweep gating logic in order to blank the display during the time base hold-off period.
- The channel multivibrator in order to blank the display in the chopped mode during the switching from one channel to the other.
- The intensity potentiometer R11 that influences the amount of current fed into the Z-amplifier.

The Z-amplifier is a shunt-feedback stage with V709 and V708.

The HF component in the output signal is fed via the 2 kV blocking capacitor C707 to the Wehnelt cylinder of the CRT.

MODULATOR (V701, V702)

The DC and LF components at the output of the Z-amplifier are fed to the modulator as a current to the emitter of V702. V701 and V702 form a 200 kHz multivibrator. The AC voltage on the collector of V702 has a peak to peak value which depends on the current fed to the emitter of V702.

The collector voltage of V702 is fed via the 2 kV blocking capacitor C703 to the demodulator.

DEMODULATOR (V704, V706)

The modulated LF and DC components in the Z-amplifier output are demodulated by the rectifier diodes V704 and V706 and smoothed by C704. The voltage on C704 is added to the cathode-voltage and after that added to the HF component and fed to the Wehnelt cylinder.

TRACE ROTATION (V711, V712)

The emitter followers V711 and V712 and preset potentiometer R6 determine the strength and sense of the current in the trace rotation coil L701.

Only one emitter follower is conductive at a time. Which emitter follower is determined by the position of R11.

3.3.4. POWER SUPPLY (V818, V819, V822, V823)

The mains voltage is transformed, rectified and smoothed to 46 Volt DC. The mains transformer is double insulated and equipped with a thermal fuse to protect the insulation against excessive temperatures.

The 46 Volt DC is applied to a regulated DC to AC balance converter. This converter incorporates the power transistors V818 and V819 with series feedback stabilisation. These transistors drive the power transformer T801 with a square wave signal of approximately 16 kHz. The base of the power transistors is driven by driver transformer T802 that works with a saturated core.

The regulator circuit incorporates V823 and V822 of which the collector is connected to the centre tap of T802.

The base current of V818 respectively V819 flows also through V822. Therefore, V822 can regulate the base current for the power transistors and thus the collector current. The collector-current influences the output voltage.

V822 is regulated by V823 which is regulated by the +12 Volt supply voltage. For instance if the +12 Volt increases the collector-current of V823 decreases.

As a result the collector-current of the power transistors decreases and also the output voltage decreases.

The power transformer T801 has a number of outputs that give the supply voltages for the instrument.

Bear in mind that the 6,3 Volt (CRT filament) is connected to -2 kV.

3.4. OPTIONAL EXTERNAL 24 V DC POWER SUPPLY

INTRODUCTION

This converter, which is available at the commercial department, enables the instrument to operate on an external DC supply voltage of 23 Volt, $\pm 10\%$.

The external power source must be able to deliver a current of at least 1,2 A.

The optional unit is located above the normal power supply unit as shown in Fig. 3.12.

The external supply voltage is applied to the socket that can be mounted to the rear panel of the instrument. The inner conductor of the socket must be connected to the negative pole and the outer conductor to the positive pole.

For external power supply the DC power input cord set with ordering number 4822 321 20125 can be used.

CIRCUIT DESCRIPTION

The unit converts 23 V DC into 46 V DC, which is the supply voltage of the instrument present on smoothing capacitor C824 in the power supply unit. The output of the converter is connected in parallel with the output of the bridge rectifier V828 in the power supply unit.

Fig. 3.23. shows the circuit diagram of the converter and Fig. 3.22. shows the components lay-out.

The active elements in the converter are V1001 and V1002 of which one is conductive at the time. The converter is of the sine-wave type. L1003 is a choke that supplies a constant current to the converter transformer T1001. L1004 is a choke that supplies a constant current to smoothing capacitor C1004 and the load which is the instrument.

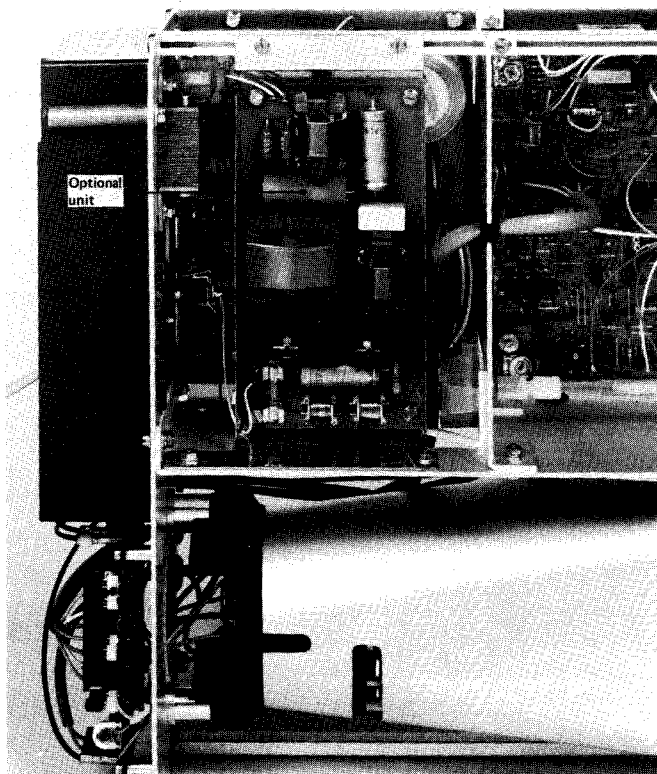


Fig. 3.12. Location of optional unit for external 24 Volt DC power supply.

HOW TO BUILD THE UNIT INTO THE OSCILLOSCOPE

- Remove the instrument covers as indicated in section 3.1.4. of this manual.
- Cut away so much material from the rear insulation plate that the external power socket can be mounted on the holes that are already present in the rear chassis plate.
- Mount the external power socket to the rear chassis plate with 2 screws M2x8, 2 washers, 2 spring-washers and 2 nuts.
- Solder the converter output wires in the holes already present in the power supply printed circuit board according to Fig. 3.20.
- Mount the converter to the centre chassis plate with 2 screws M3x6, 2 washers, 2 spring-washers and 2 nuts (see Fig. 3.21.).
- Mount the converter to the side profile with 2 screws M3x8, 2 washers, 2 spring-washers and 2 nuts (see Fig. 3.21.).
- Mount the instrument covers, and the instrument is ready for use.

PARTS LIST CONVERTER UNIT

Converter 24 V DC to 46 V DC.	5322 216 54185
Transistor BDX77	5322 130 44553
Diode BYX55/350	4822 130 30817
Fuse 2 A	4822 253 30025
DC power input socket	4822 265 20051
DC power input plug	4822 266 20014
DC power input cord set	4822 321 20125

3.5. INFORMATION FOR ASSISTENCE IN FAULT-FINDING

3.5.1. Voltages and waveforms

In the PM 3211(Q) circuit diagram (Fig. 3.19.) some DC voltage levels and waveforms are indicated in order to facilitate fault-finding. These voltages are typical values. Besides the waveforms in the PM 3211(Q) circuit diagram, some DC voltages and waveforms are shown in Fig. 3.9. and Fig. 3.11. in the circuit description. For measurement of the DC voltages and waveforms in the circuit diagram the following settings of the controls are necessary:

- CH. A and CH. B switched ON.
- Instrument in ALTERNATE mode.
- X-POSITION control in the mid position.
- CH. A and CH. B POSITION controls in the mid position.
- Input coupling switches in the AC mode.
- AMPL/DIV: apply a 2 kHz square wave signal giving a vertical deflection of 6 divisions on one of the attenuator positions 10 mV/DIV, 0,1 V/DIV, 1 V/DIV or 10 V/DIV.
For the waveform measurements 1 A, 2 A and 3 A the signal must be applied to the CH. A input socket.
For the waveform measurements 1 B, 2 B and 3 B the signal must be applied to the CH. B input socket.
- Trigger source: CH. A.
- LEVEL control in the AUTO position.
- Trigger slope switch in the + position.
- TIME/DIV switch in the 0,1 ms/DIV position.
- VARIABLE TIME/DIV control in the AUTO position.

The settings of time base, attenuator and vertical position of the measuring oscilloscope are indicated next to the waveform. The measuring oscilloscope must be equipped with a 10:1 attenuator probe.

3.5.2. Repair in a Philips Service workshop

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

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

3.6. PARTS LIST AND DIAGRAMS

Mechanical parts, front panel (Fig. 3.13.)

<i>Item</i>	<i>Designation</i>	<i>Ordering number</i>	<i>Quantity</i>
1	Front frame, alluminium	5322 464 94002	1
2	Screen bezel	5322 450 74009	1
3	Screen bezel clamping spring	5322 492 64629	2
4	Contrast filter, blue	5322 480 34074	1
5	Graticule plate	5322 450 64092	1
6	LED holder	5322 255 44088	1
7	Calibration terminal	5322 264 24015	1
8	Grommet for cal. terminal	5322 325 84013	1
9	Knob 10 mm dia, screw mount	5322 414 34091	1
10	Knob cover, grey with line	5322 414 74015	7
11	Knob 10 dia, spring mount	5322 414 34134	6
12	Spring for knob	5322 492 64337	6
13	Textplate PM 3211	5322 455 84069	1
14	Textplate mounting nut	5322 505 14228	3
15	Switch knob	5322 414 34079	3
16	Cover for switch knob	5322 414 74019	3
17	Pushbutton grey/green	5322 414 25613	6
18	Pushbutton grey	5322 414 14011	7
19	BNC connector complete	5322 267 10004	3
20	Earthing terminal	5322 535 84346	1
21	Knurled nut for earthing terminal	5322 505 14178	1
22	Hexagonal nut for earthing terminal	5322 506 14005	1
23	Front cover PM 3211	5322 464 94004	1
24	Grip profile	5322 466 64162	1
25	Adapter BNC/4 mm banane	5322 263 24005	1
26	Rubber foot	5322 462 44297	4
27	Handle arm	5322 498 54072	2
28	Pushbutton knob	5322 414 64053	2
29	Self-tapping screw	4822 502 30004	2
30	Washer	4822 532 10582	2
31	Bearing bush, plastic	5322 520 14267	2
32	Spring	5322 530 84075	2
33	Ratchet	5322 528 34128	2
34	Wrap around cover	5322 447 94366	1

Mechanical parts, rear panel (Fig. 3.14.)

<i>Item</i>	<i>Designation</i>	<i>Ordering number</i>	<i>Quantity</i>
35	Rear frame, alluminium	5322 464 94001	1
36	Coin slot screw	5322 500 14228	2
37	Circlip for coin slot screw	4822 530 70126	2
38	Mains section cover, plastic	5322 466 34012	1
39	Rear plate, plastic	5322 464 94005	1
40	Rear plate foot	5322 462 44298	2
41	Mains cable, European plug	4822 321 10084	1
42	Mains cable, USA plug	5322 321 14021	1
43	Mains voltage adapter	4822 272 10079	1

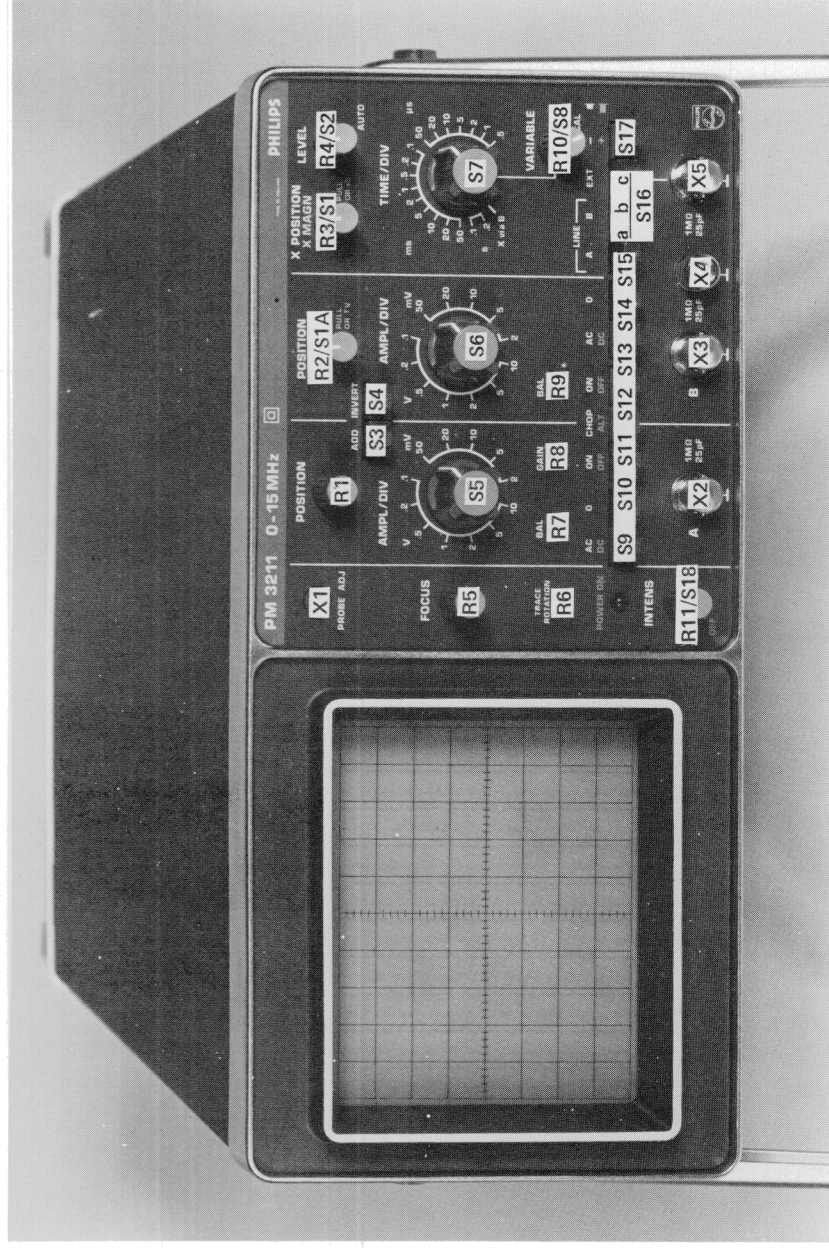


Fig. 3.4. Electrical item numbers, front panel