100 MHz Dual-Channel Oscilloscope

PM3267/ PM3267U

H17. F.M. FLAPPER
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Service Manual

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840316/04

S&I
Scientific & Industrial Equipment Division

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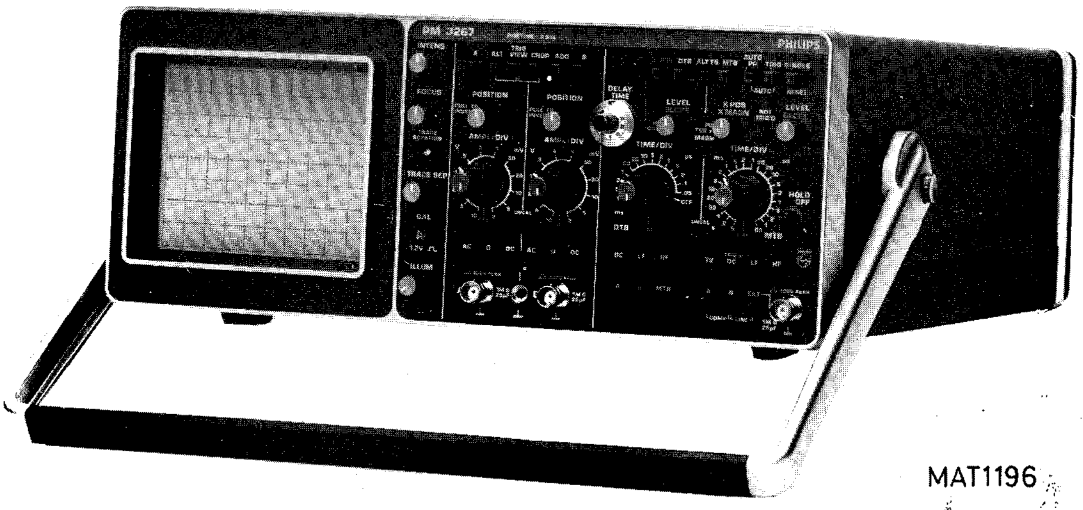

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1. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class II instruments* and UL1244** and has been supplied in a safe condition. The present Service Manual contains information and warnings that 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 15 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.

1.1. CATHODE RAY TUBE

Measuring area	8cm x 10cm.
Screen type	P31 phosphor (GH). Phosphors optionally available: P7 (GM), long persistence. P11 (BE), blue, high photographic writing speed.
Acceleration voltage	10kV.
Display resolution	20 lines/div in vertical and horizontal direction.
Orthogonality	Angle between X and Y trace 90° ± 1°.
Engravings	cm divisions with 2mm subdivisions along central axes and 3rd and 7th horizontal graticule lines. Dotted lines at 1.5 and 6.5 div from top of display area.
Trace rotation	Provides adjustment of a horizontal trace in parallel with graticule lines. Screwdriver-operated adjustment at front panel. Minimum overrange 4°.
Graticule illumination	Continuously variable graticule illumination

1.2. VERTICAL OR Y-AXIS

Display modes	– Channel A only – Channel B only – Trigger view only – Channels A and B chopped – Channels A and B alternated – Channels A, B and trigger view chopped – Channels A, B and trigger view alternated – Channel A and B added
Polarity inversion	Channel A and B can be inverted
Chopped mode: display time per channel	900ns
blanking time per channel	100ns
Frequency response (Ch. A and B) DC coupled	DC .. 100MHz (–3dB)
AC coupled	2Hz ... 100MHz (–3dB)
Derated bandwidth in 2, 5 and 10mV/div	DC ... 80MHz (–3dB)
Rise-time (Ch. A and B)	⩽ 3.5ns
Derated rise-time in 2, 5 and 10mV/div	⩽ 4.4ns

Pulse aberrations (Ch. A and B)	⩽ 3% (⩽ 4% p.p.) Outside the centre 6 div additional pulse aberrations of 1%. In added and invert mode additional pulse aberrations of 1%.
Deflection coefficients	2mV/div ... 10V/div in 1-2-5 sequence. Uncalibrated continuous control between the steps. Operation indicated by uncal LED.
Error limit	3%
Input impedance	1MΩ (± 1%) in parallel with 25pF (± 2.5pF). Difference in input cap. of vertical and trigger inputs ⩽ 2pF.
** ⚠ Max. safe input voltage	400V (DC + AC peak)
* Rated input voltage	42V (DC + AC peak) Test voltage 500V (rms) according to IEC348.
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Dynamic range	24 div up to 40MHz. 8 div up to 100MHz.
Shift range	+ and – 8 div from screen centre.
Linearity error	⩽ 3% Non linearity of CRT included. Measured at a frequency of 50kHz.
Visible signal delay	30ns approx. at max. intensity and well-focused display.
Base line instability	⩽ 0.2 div between AMPL/DIV steps. Additional 0.2 div when switching between 20mV/div, 10mV/div, 5mV/div and 10mV/div ⩽ 1 div when operating the invert switch. ⩽ 2 div: 10mV ... 2mV/div ⩽ 0.6 div when switching to or from added mode. ⩽ 0.3 div when rotating the continuous AMPL/DIV control.
Base line drift	⩽ 0.5div/h. measured in 2mV/div
Base line temp. coefficient	⩽ 0.025 div/K. measured in 2mV/div
Decoupling factor	⩾ 40 dB at 50MHz ⩾ 35 dB at 100MHz Input signal at one channel (up to full screen) shall not cause a display via the other channel, more than given by the stated value, according to IEC351. ⩽ 0.2 div at equal AMPL/DIV settings.
Common mode rejection ratio (CMRR)	⩾ 100 at 2MHz ⩾ 20 at 50MHz ⩾ 10 at 100MHz All measured at 8 div common mode signal, after adjustment of continuous AMPL/DIV for max. CMRR and in equal AMPL/DIV settings.

1.3. TRIGGER VIEW

Trigger view	Display of internal or external main time-base trigger signal.
Frequency response	internal: DC ... 60 MHz external: DC ... 70 MHz Both in DC trigger coupling.
Rise-time	internal: ⩽ 5.8 ns external: ⩽ 5 ns Both in DC trigger coupling.
Pulse aberrations	internal: 10% p.p. pushbutton MTB of S22 depressed. external: ⩽ 6% (⩽ 8% p.p.)
Deflection coefficients	internal: see Ch. A or B deflection coefficients. external: 200 mV/div.
Error limit	internal: ⩽ 10% external: ⩽ 3%
Trigger point	In screen centre ± 0.3 div.
Time delay between trig. view via external trigger input and vertical channels	6 ns
Dynamic range	+ and − 8 div up to MHz.

1.4. HORIZONTAL OR X-DEFLEXTION

Display modes	MTB (main time-base) MTB intensified DTB (delayed time-base) MTB and DTB in alternate time-base mode EXT X delfection via MTB trigger source
Trace separation	Symmetrical vertical separation between MTB and DTB of 5 div
Main time-base	
MTB modes	Auto pp, Auto, Trig, Single In Auto pp and Auto modes a bright base line is displayed if no trigger signal is present. In Auto pp the trigger level is adjustable between the max and min value of the trigger signal. In Auto mode the trigger level range is independent on the trigger signal. In SINGLE the NOT TRIG'D LED is on after reset of the time-base and extinguishes after the start of the time-base.
Position range	+ and − 5 div from screen centre
Horizontal drift	⩽ 0.5 div/h.
Horizontal temp. coefficient	⩽ 0.025 div/K.
MTB time coefficients	50 ns/div ... 0.5 s/div in 1-2-5-sequence. Uncalibrated continuous control between the steps. Operation indicated by uncal LED.
Error Limit	± 3%. Measured over centre 8 div of screen.
Expansion (X MAGN pulled)	X10

Additional error in X MAGN mode	± 2%. Excluded are the first and last 50ns of which additional error is ± 5%. Measured over centre 8 div of screen.
Expansion balance	1 div 0-jump between expanded and unexpanded sweep should not deviate from centre graticule more than the specified value.
Linearity	5%. Excluded are the first and last 50ns. Deviation of first and last div with respect to centre 8 div.
Hold off	Continuously adjustable up to 10x minimum value.
Delayed time-base	
DTB modes	Started after delay time. Triggered upon first trigger after delay time.
Position range	see main time-base
Horizontal drift	see main time-base
Horizontal temp. coefficient	see main time-base
Error limit	see main time-base
Expansion (X MAGN pulled)	see main time-base
Additional error in X MAGN mode	see main time-base
Expansion balance	see main time-base
Linearity	see main time-base
DTB time coefficients	50ns/div ... 1ms/div in 1-2-5- sequence. Uncalibrated continuous control between the steps. Operation indicated by uncal LED.
Delay time	Variable between 5s and 500ns.
Delay time error limit	± 3% + 60ns.
Incremental delay error limit	0.5%, measured at room temperature +5 ... 25°C
Delay time jitter	1 : ≥20.000. Regardless of sweep speed.
External X deflection	
Frequency response	DC ... 100kHz (−0.5dB). MTB trigger coupling in DC. For frequency response in non DC coupling refer to MTB trigger coupling.
Deflection coefficients	internal: see Ch. A and B deflection coefficients. external X input: 200mV/div.
Error limit	10%. Via Ch. A, Ch. B or external X input.
Expansion	X10
Additional error limit	2%
Input impedance	1MΩ (± 1%) in parallel with 25pF (± 2.5pF). Input impedance such that a 10 : 1 attenuator probe after being adjusted on Ch. A or B can be applied to the ext. trig. input without readjustment.
** ⚠ Max. safe input voltage	400V (DC + AC peak)
* Rated input voltage	42V (DC + AC peak) Test voltage 500V (rms) according to IEC348.

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Dynamic range	⩾ 20 div
Position range	+ or − 5 div from screen centre
Linearity error	⩽ 5%
Compression	⩽ 1%
Phase shift between X and Y deflection	⩽ 3^{o} at 100kHz
Horizontal drift	⩽ 0.5 div/h. Measured at 2mV/div.
Horizontal temp. coefficient	⩽ 0.025 div/K. Measured at 2mV/div.
X-deflection via line	8 div (± 10%) at line frequency.

1.5. TRIGGERING

Triggering of main time-base	
Source	Ch. A, Ch. B, composite, external line.
Trigger coupling	DC, LF, HF. Bandpass: DC: DC ... full bandwidth LF: 2Hz ... 25kHz (External 7Hz ... 25kHz). HF: 25kHz ... full bandwidth Lower frequency limit 10Hz in auto and auto pp mode.
Slope	Positive or negative
Level range: trig, auto, single	internal: + and − 8 div external: + 1.6V and − 1.6V
auto pp	Within pp value of trigger signal.
TV	Fixed level.
Sensitivity (in TRIG or AUTO mode, DC coupling)	internal: 0.5 div up to 40MHz 1.5 div up to 100MHz external: 100mV up to 40MHz 300mV up to 100MHz
TV triggering	Positive and negative video selection via slope switch. TV frame triggering at MTB TIME/DIV 0.5 s/div ... 50μs/div. TV line triggering at MTB TIME/DIV 20μs/div ... 50ns/div.
TV trigger sensitivity	internal: 0.7 div synch. pulse. external: 150mV synch. pulse.
NOT TRIG'D LED	LED is on in absence of trigger signal.
Triggering of delayed time-base	
Source	Ch. A, Ch. B, MTB. In MTB mode the DTB starts immediately after the delay time.
Trigger coupling **Slope** Level range Sensitivity	See main time-base triggering.

1.6. ADDITIONAL CHARACTERISTICS

Calibration voltage generator	
output	1.2V rectangular. Starting from zero level negative going.
Error limit	± 1%. (⩾ 1MΩ load impedance)
Frequency	2kHz approx.
Additional input	
External Z-modulation	DC coupled TTL compatible "1" is normal intensity "0" blanks display
Min. required pulse width	10ns
Power supply	
AC ranges	90 ... 132V 195 ... 245V 210 ... 270V
Power consumption	45W
AC frequency	46 ... 440Hz
DC range	20 ... 32V
DC current	1.45A at 24V

1.7. OPTIONS

TTL triggering	
Internal	The correct TTL level is obtained with the AMPL/DIV in position 2V/div.
External	The correct TTL level is obtained via a 10 : 1 attenuator probe.
ECL triggering	
Internal	The correct ECL level is obtained with the AMPL/DIV in position 0.5V/div.

MOTE:* *Instead of TV triggering, you can modify the instrument for TTL or ECL triggering. If modified the main time-base triggering is automatically set for TTL or ECL triggering. The level control is not operative then.

Sweep out **MTB**	
Output voltage	From – 1.8V to + 3.8V. Output short-circuit protected.
Gate out MTB	
Output voltage	At TTL level: "high" during MTB sweep. Output short-circuit protected.
Gate out DTB	
Output voltage	At TTL level: "high" during OTB sweep. Output short-circuit protected.

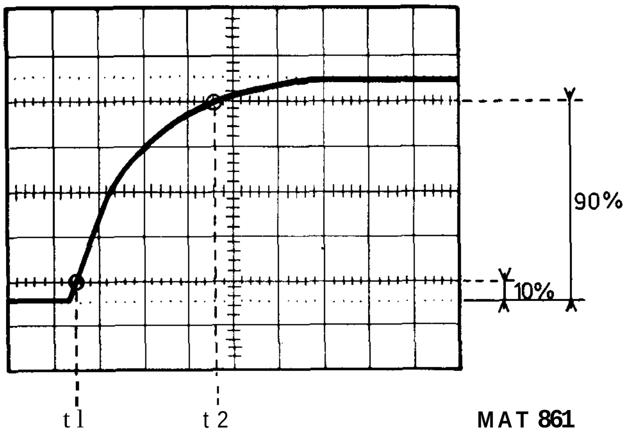


Fig. 1.1. Rise-time measurement $t_R = t_2$ (90%) – t_1 (10%) (general formula)

$$\text{Rise-time of oscilloscope} = \frac{0.35}{\text{bandwidth (Hz) of the instrument}}$$

***NOTE:** Bear in mind that inaccuracies of CRT and time-base and rise-time of generator (measured with an input pulse with a rise-time ⩽ lns) influence this measurement.*

Rise-time measurement of a signal applied to the vertical inputs:
Bear in mind that the rise-time measured on the oscilloscope screen is influenced by the rise-time of the oscilloscope according to the formula:

$$T_R \text{ (measured)} = \sqrt{(T_R \text{ (signal)})^2 + (T_R \text{ (oscilloscope)})^2}$$

The measuring fault ⩽ 3%, if the rise-time of the input pulse is ⩾ 4 times the rise-time of the oscilloscope.

1.8. MECHANICAL DATA

Dimensions:

Depth	445mm.	Handle and controls excluded
Width	335mm.	Handle excluded
Height	137mm.	Feet excluded
Mass	10.6 kg. (23,3 lb)	

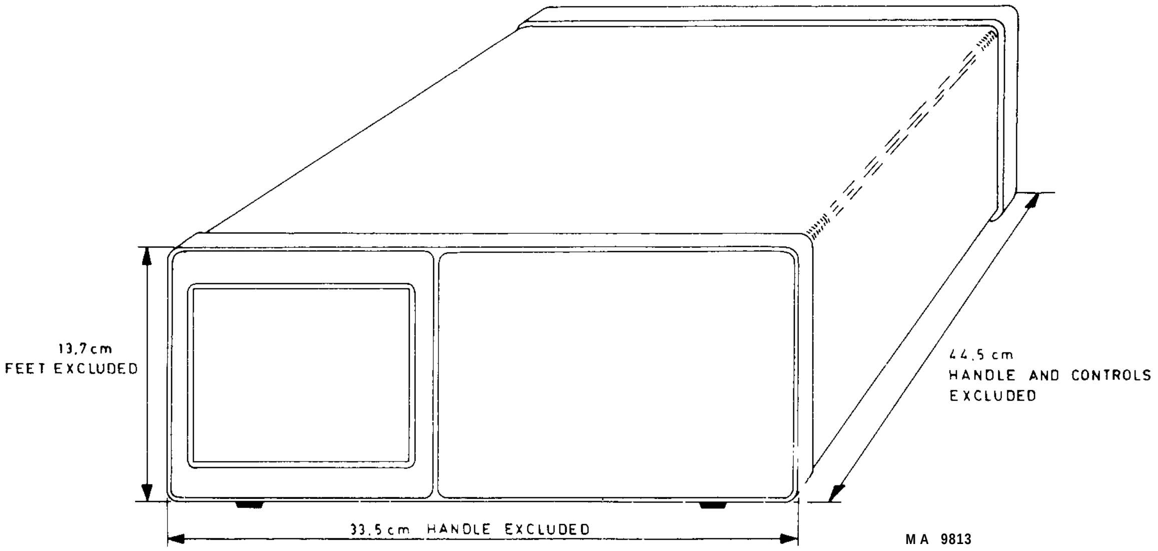


Fig. 1.2. Dimensions of instrument

1.9. ENVIRONMENTAL CHARACTERISTICS

***NOTE:** The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Derails on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by N. V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.*

Ambient temperature	
Rated range of use	0°C ... +40°C
Limit range of operation	–10°C ... +55°C
Storage conditions	–40°C ... +70°C
Humidity	According to IEC68 dB
Bump	300 m/s² half sine 11 ms duration, 3 shocks per direction with a total of 18
Vibration	20 minutes in each of 3 directions, 5 ... 55 Hz 1 mm (PP) and 40 m/s² max. acceleration
Altitude	Limit range of operation: 5000 m (15000 feet) Limit range of transport: 15000 m (50000 feet)
Recovery time	30 min. if ambient temperature is raised from –10°C to +20°C at 60% relative humidity.
Electromagnetic interference	Meets VDE 0871 and VDE 0875 Grenzwertklasse B.

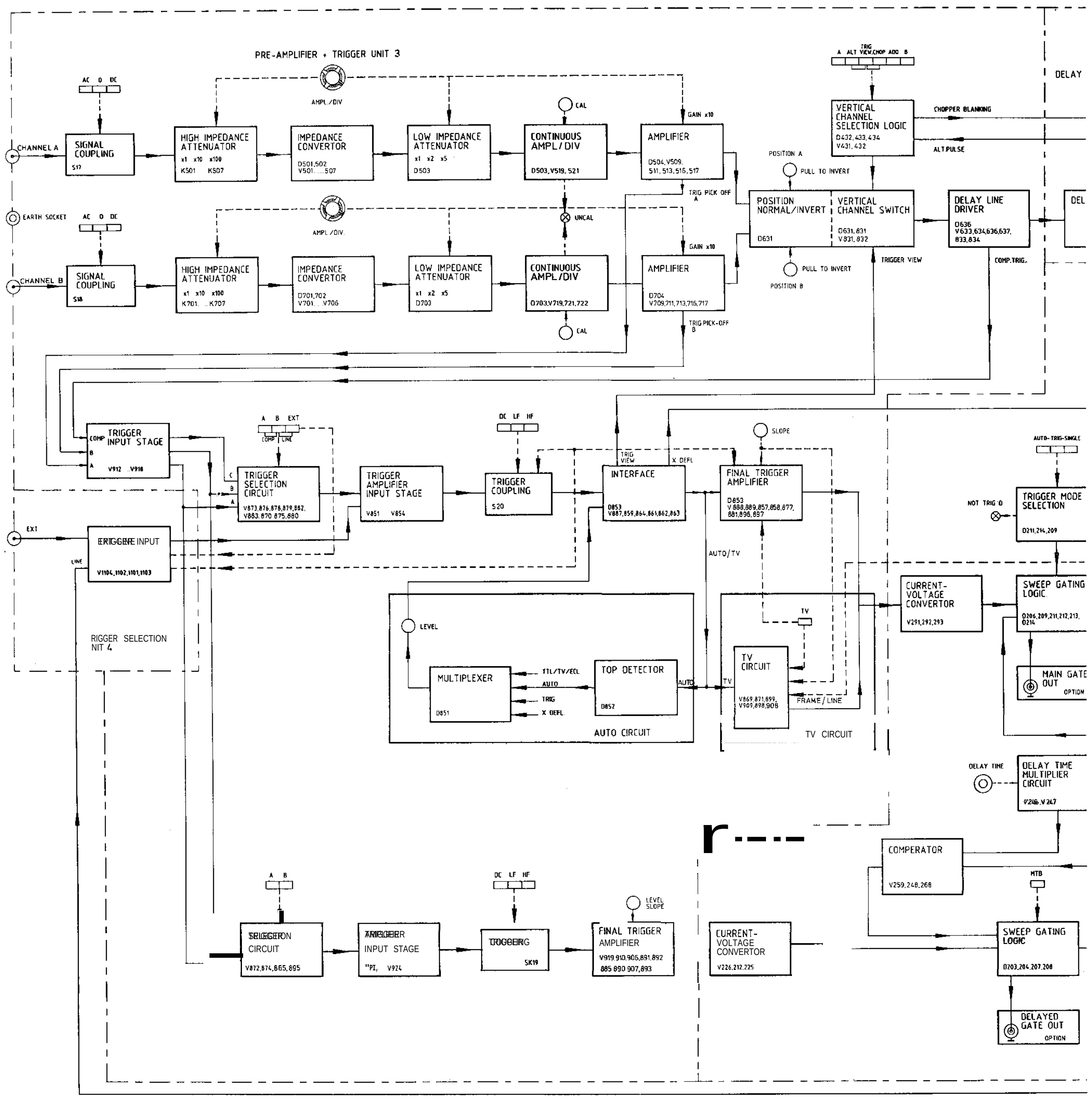
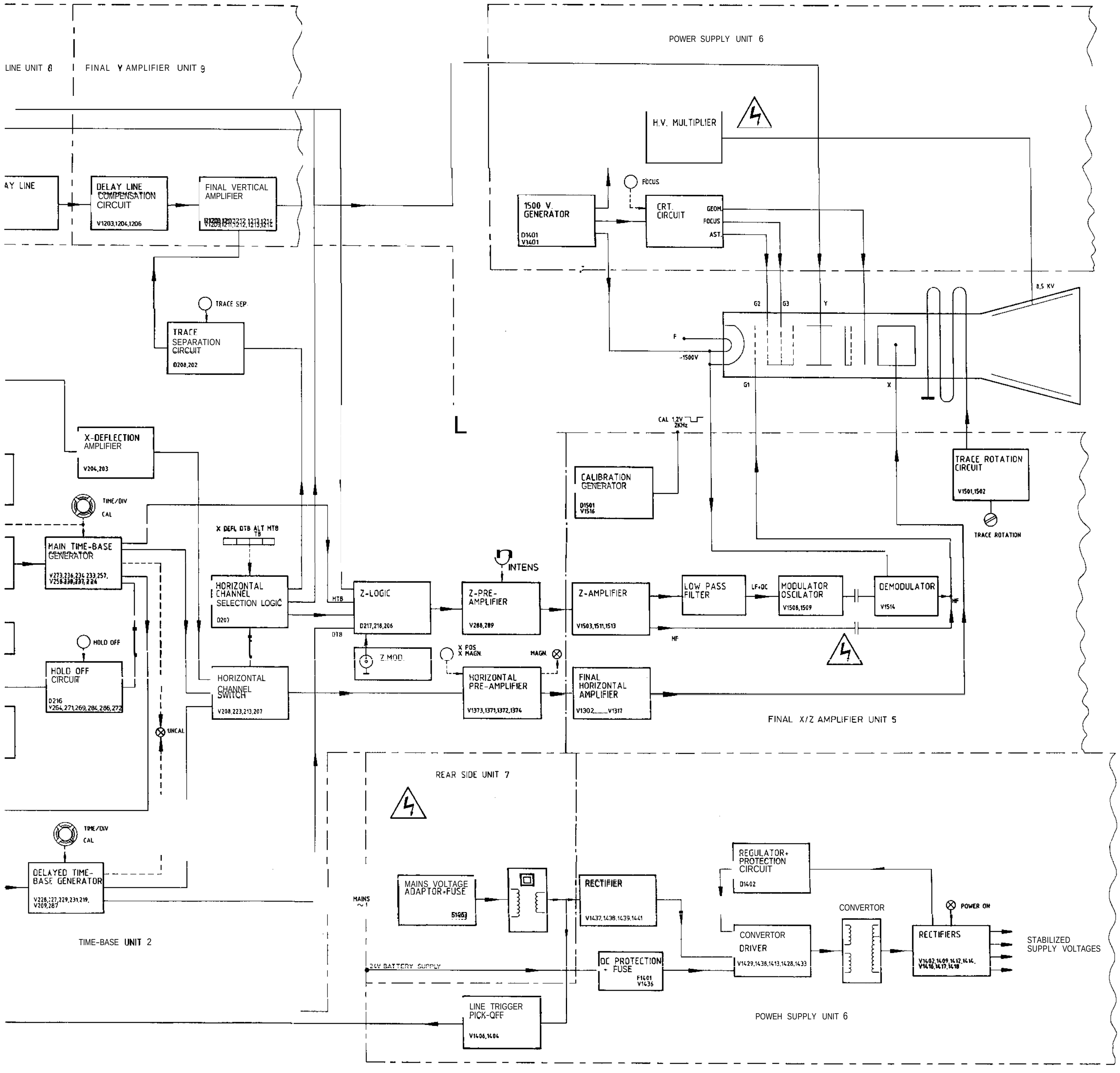


Fig. 2 1. Bockdiagram


LINE UNIT 8
FINAL Y AMPLIFIER UNIT 9
POWER SUPPLY UNIT 6
H.V. MULTIPLIER
1500 V. GENERATOR
D1401
V1401
FOCUS
CRT. CIRCUIT
GEOM.
FOCUS
AST.
DELAY LINE COMPENSATION CIRCUIT
V1203,1204,1206
FINAL VERTICAL AMPLIFIER
TRACE SEP.
TRACE SEPARATION CIRCUIT
D208,202
8,5 KV
G2
G3
Y
F
-1500V
G1
X
X-DEFLECTION AMPLIFIER
V204,203
CAL 1,2V 2KHz
CALIBRATION GENERATOR
D1501
V1516
TRACE ROTATION CIRCUIT
V1501,1502
TRACE ROTATION
TIME/DIV
CAL
MAIN TIME-BASE GENERATOR
X DEFL DTB ALT MTB
INTENS
HORIZONTAL CHANNEL SELECTION LOGIC
D207
MTB
DTB
Z-LOGIC
D217,218,206
Z-PRE-AMPLIFIER
V288,289
Z-AMPLIFIER
V1503,1511,1513
LOW PASS FILTER
LF+DC
MODULATOR OSCILATOR
V1508,1509
DEMODULATOR
V1514
HF
HOLD OFF
HOLD OFF CIRCUIT
D216
Z MOD.
X POS
X MAGN.
MAGN.
HORIZONTAL CHANNEL SWITCH
V208,223,213,207
HORIZONTAL PRE-AMPLIFIER
V1373,1371,1372,1374
FINAL HORIZONTAL AMPLIFIER
V1302 V1317
FINAL X/Z AMPLIFIER UNIT 5
UNCAL
REAR SIDE UNIT 7
TIME/DIV
CAL
DELAYED TIME-BASE GENERATOR
REGULATOR+ PROTECTION CIRCUIT
D1402
MAINS VOLTAGE ADAPTOR+FUSE
RECTIFIER
V1437,1438,1439,1441
MAINS
CONVERTOR
POWER ON
CONVERTOR DRIVER
RECTIFIERS
STABILIZED SUPPLY VOLTAGES
TIME-BASE UNIT 2
24V BATTERY SUPPLY
DC PROTECTION + FUSE
F1401
V1435
LINE TRIGGER PICK-OFF
V1406,1404
POWER SUPPLY UNIT 6

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2. CIRCUIT DESCRIPTION

2.1. BLOCK DIAGRAM DESCRIPTION (see Fig. 2.1.)

2.1.1. Vertical Deflection

The vertical deflection system is located on the PRE-AMPLIFIER + TRIGGER UNIT 3, DELAY LINE UNIT 8 AND FINAL AMPLIFIER UNIT 9.
The instrument has two identical vertical channels, A and B: only channel A is described.

Channel **A** vertical input signal is fed via the SIGNAL COUPLING switch AC-0-DC (S17) to the HIGH IMPEDANCE ATTENUATOR, which is controlled via reed relays by the AMPL/DIV switch.
Attenuation factors of x1, x10 and x100 are achieved in this portion of the attenuator circuit.

The IMPEDANCE CONVERTER adapts the output of the HIGH IMPEDANCE ATTENUATOR to the input of the LOW IMPEDANCE ATTENUATOR, which is also controlled via reed relays by the AMPL/DIV switch to give attenuatons of x1, x2 and x5.
For the three most sensitive ranges (2-5-10 mV/div), the signal is amplified by a factor of 10. This is achieved in the AMPLIFIER circuit controlled by the AMPL/DIV switch.

Via the CONTINUOUS AMPL/DIV, controlled by the AMPL/DIV continuous control, the signal is fed to the AMPLIFIER circuit. The AMPLIFIER stage converts the voltage signal into a current signal.
From the TRIG. PICK-OFF of the AMPLIFIER, the channel A trigger signal is routed to both time-bases.

Returning to the display signal path, the output signal of the AMPLIFIER is fed to an integrated circuit comprising the vertical POSITION, the NORMAL/INVERT circuit and the VERTICAL CHANNEL SWITCH circuit.
The vertical POSITION control circuit allows vertical shift of the c.r.t. trace. Incorporated in the POSITION control, the PULL TO INVERT switch controls the NORMAL/INVERT circuit.
The VERTICAL CHANNEL SWITCH is controlled by the vertical display mode switches A, ALT, TRIG VIEW, CHOP, ADD, B, via the VERTICAL CHANNEL SELECTION LOGIC circuit. In ALT mode, the A and B channel switching is controlled by the ALT pulse derived from the HORIZONTAL CHANNEL SELECTION LOGIC.
In the CHOP mode, the switching period between channels A and B is blanked by the Z amplifier (via the Z-logic) controlled by the CHOPPER BLANKING signal derived from the VERTICAL CHANNEL SELECTION LOGIC.
The TRIG VIEW signal, derived from the MTB trigger INTERFACE, can also be selected by the vertical display mode switches to enable display of the MTB trigger signal.
When the pushbutton ADD is depressed, the input signals of both vertical channels are added.

From the VERTICAL CHANNEL SWITCH, the selected vertical signal is fed via the DELAY LINE DRIVER to the DELAY LINE.
In the DELAY LINE DRIVER the current signal is converted to a voltage signal and the common-mode signals are also suppressed in this stage.
The COMP. TRIG. signal is routed to the TRIGGER INPUT STAGE of the time-base for composite triggering.
From the DELAY LINE DRIVER, the adapted output signal is fed to the DELAY LINE, which gives sufficient delay to ensure that the steep leading edges of fast signals are displayed.
To reduce and to compensate for interference and distortion originating in the DELAY LINE, the signal is fed to the DELAY LINE COMPENSATION CIRCUIT before being applied to the FINAL VERTICAL AMPLIFIER.
The vertical distance on the screen between the traces of the two time-bases in the ALT TB mode, is controlled by the trace separation signal applied to the FINAL VERTICAL AMPLIFIER.
The output signal of the FINAL VERTICAL AMPLIFIER feeds the vertical deflection plates of the c.r.t.

2.1.2. Horizontal Deflection

The triggering circuits for both the MTB and the DTB are located on the PRE-AMPLIFIER – TRIGGER UNIT 3.
Both the main time-base and the delayed time-base are located on the TIME-BASE UNIT 2.
The FINAL HORIZONTAL AMPLIFIER and the Z-AMPLIFIER are situated on the FINAL AMPLIFIER UNIT 5.

The trigger signals derived from the AMPLIFIER circuits of channel A and B, and from the DELAY LINE DRIVER are routed to the TRIGGER INPUT STAGE. These signals are in current form, which makes them less sensitive to interference; often a problem with long signal wires. In the TRIGGER INPUT STAGE, these current signals are converted into voltage form, and fed to the TRIGGER SELECTION CIRCUIT.
The EXT trigger signal from the EXT input socket, and the LINE signal from the LINE TRIGGER PICK-OFF are fed to the TRIGGER SELECTION CIRCUIT via the EXT-LINE TRIGGER INPUT circuit.
In this stage, the EXT and LINE trigger signals are converted to symmetrical current signals and adapted to the A, B and COMP signals.
The EXT-LINE TRIGGER INPUT stage is controlled by the EXT pushbutton and LINE (pushbuttons B and EXT depressed simultaneously).
In addition, the A and B trigger signals are fed to the TRIGGER SELECTION CIRCUIT of the DTB.

2.1.2.1. Main time-base

The trigger signals are selected by the MTB trigger source switches A, B, EXT, COMP, LINE, which control the TRIGGER SELECTION CIRCUIT.
Common-mode interference is reduced by using a symmetrical configuration for the TRIGGER SELECTION CIRCUIT output signal. This output current signal is fed to the TRIGGER AMPLIFIER INPUT STAGE.
This stage converts the symmetrical current signal to an asymmetrical voltage signal, which is fed to the INTERFACE via the TRIGGER COUPLING stage. The coupling is controlled by the MTB trigger coupling switches DC, LF, HF.
Several signals are produced by the INTERFACE, e.g. X DEFL, TRIG VIEW and AUTO/TV.
The X-DEFL signal is an asymmetrical signal that is fed to the X DEFLECTION AMPLIFIER.
The symmetrical TRIG VIEW signal is routed to the VERTICAL CHANNEL SWITCH; the asymmetrical AUTO/TV signal is routed to the AUTO and TV CIRCUIT.
The FINAL TRIGGER AMPLIFIER comprises the SLOPE circuit under the control of the SLOPE switch incorporated in the LEVEL control. It permits positive and negative triggering.
The output of the FINAL TRIGGER AMPLIFIER is fed to the CURRENT-VOLTAGE CONVERTER.
In the AUTO CIRCUIT, the TOP DETECTOR detects the amplitude of the AUTO SIGNAL. When in the AUTO Mode, the LEVEL range is determined by this detected amplitude. The MULTIPLEXER is an electronic switch which, depending on the selected mode, selects the different ranges for the LEVEL control.
Each mode has its own specific LEVEL range, for example:

TV	: fixed level
AUTO	: determined by TOP DETECTOR
TRIG	: ± 8 divisions
X DEFL	: 0 divisions (LEVEL inoperative)

If the instrument is provided with the TTL/ECL option, the TV pushbutton will function as the TTL or ECL mode switch.
The TV trigger signal is fed to the TV CIRCUIT.
When the TV pushbutton is selected, the TV CIRCUIT is inserted between the INTERFACE and the CURRENT-VOLTAGE CONVERTER of the MTB.

In the TV mode, the FINAL TRIGGER AMPLIFIER is switched off and also the LEVEL control is inoperative, a fixed trigger level being set.

For FRAME and LINE synchronisation, a frame or line filter is selected with the MTB TIME/DIV switch. Via the CURRENT-VOLTAGE CONVERTER, the trigger signal is routed to the SWEEP-GATING LOGIC.
The SWEEP-GATING LOGIC determines the start of the MAIN TIME-BASE GENERATOR sweep.
The SWEEP-GATING LOGIC is controlled by signals derived from the TRIGGER MODE SELECTION, the HOLD-OFF CIRCUIT and the CURRENT-VOLTAGE CONVERTER.
The TRIGGER MODE SELECTION is controlled by the MTB trigger mode selection pushbuttons AUTO, TRIG, SINGLE. In the AUTO mode, the MAIN TIME-BASE GENERATOR runs automatically when no trigger pulses are available.
In the TRIG mode, the MAIN TIME-BASE GENERATOR must be normally triggered by trigger signals derived fromthe CURRENT-VOLTAGE CONVERTER.
If the SINGLE pushbutton is selected, the SWEEP-GATING LOGIC will start the MAIN TIME-BASE GENERATOR for one sweep.
The MAIN GATE OUT signal (optional) is taken from the SWEEP-GATING LOGIC
This MAIN GATE OUT signal output is at logic H during the MTB sweep and L for other conditions.
The NOT TRIG LED lights up when the MTB is not triggered.

The MAIN TIME-BASE GENERATOR produces a sawtooth voltage, the repetition time being controlled by the TIME/DIV switch. To enable the capacitors that determine the repetition rate sufficient time to discharge, the HOLD-OFF CIRCUIT is employed. This time is adjustable with the HOLD-OFF control.
After the HOLD-OFF time, the HOLD-OFF CIRCUIT sends a signal to the SWEEP-GATING LOGIC, which in turn starts the next time-base sweep.
The repetition rate of the MTB sawtooth voltage is continuously variable with the continuous control CAL.
The output sawtooth voltage from the MTB is fed to the HORIZONTAL CHANNEL SWITCH circuit.

2.1.2.2. *Delayed time-base*

Channel A and B trigger signals are fed to the DTB TRIGGER SELECTION CIRCUIT via the TRIGGER INPUT STAGE.
Trigger selection is controlled by the DTB trigger source selection pushbuttons A, B.
The symmetrical output current signal from the TRIGGER SELECTION CIRCUIT is converted to an asymmetrical voltage signal in the TRIGGER AMPLIFIER INPUT STAGE. This signal is then fed via the TRIGGER COUPLING circuit to the FINAL TRIGGER AMPLIFIER. Trigger coupling is selected by the DC, LF, HF pushbuttons.
The FINAL TRIGGER AMPLIFIER comprises the LEVEL/SLOPE controls and their associated circuits. The asymmetrical input voltage signal is converted to an asymmetrical current signal, which is fed to the CURRENT-VOLTAGE CONVERTER.

The output of the CURRENT-VOLTAGE CONVERTER and the output of the COMPARATOR are fed to the SWEEP-GATING LOGIC.

The COMPARATOR circuit compares the amplitude of the MTB sawtooth voltage with a d.c. voltage selected by the DELAY TIME control. If the amplitude of the MTB sawtooth is equal to the d.c. voltage, the COMPARATOR produces a signal that is then fed to the SWEEP-GATING LOGIC.
If the MTB pushbutton of the delayed time-base trigger source switches is depressed, the SWEEP-GATING LOGIC starts the DELAYED TIME-BASE GENERATOR immediately after the DELAY TIME selected.

If the A or B pushbutton is depressed, the SWEEP-GATING LOGIC detects the end of the delay time but waits for a trigger signal (A or B) from the CURRENT-VOLTAGE CONVERTER, after which the TIME-BASE GENERATOR starts.

The DELAYED GATE OUT is taken from the SWEEP-GATING LOGIC when this option is available. The output is at logic H during the DTB sweep and L for other conditions.
The DTB sawtooth voltage is produced in the DELAYED TIME-BASE GENERATOR under the control of the TIME/DIV switch and its continuous CAL control.
If the UNCAL LED lights up, it indicates that the continuous controls of one or both time-bases are not in the CAL position.

2.1.2.3. *Horizontal channel selection and final horizontal amplifier*

In the X DELFECTION AMPLIFIER the X DEFL signal derived from the MTB INTERFACE is amplified and fed to the HORIZONTAL CHANNEL SWITCH circuit.

The HORIZONTAL CHANNEL SWITCH selects the X DEFL, MTB and/or DTB signals under the control of the HORIZONTAL CHANNEL SELECTION LOGIC, which in turn is controlled by the horizontal display mode switches X DEFL, DTB, ALT TB, MTB.

If the X DEFL pushbutton is selected, the signal chosen by the MTB trigger source selection switches A, B, EXT, LINE, will determine the horizontal deflection.

Horizontal deflection is performed by the sawtooth output of the DELAYED TIME-BASE GENERATOR if the DTB pushbutton is selected.
Similarly, the MTB pushbutton selects the MAIN TIME-BASE GENERATOR sawtooth for horizontal deflection.

If the ALT TB pushbutton is selected, the HORIZONTAL CHANNEL SWITCH alternates from the MTB sawtooth to the DTB sawtooth voltage at the end of everty time-base sweep.

The selected signal is routed to the FINAL HORIZONTAL AMPLIFIER via the HORIZONTAL PRE-AMPLIFIER. This pre-amplifier comprises the X **POS** potentiometer for horizontal shift of the trace, and its associated circuit. **It** also includes the X MAGNIFIER for **x10** magnification of the horizontal deflection. **If** the X MAGN push-pull switch, incorporated in the X POS control, is pulled for **x10** magnification the MAGN LED lights-up.

The signal is converted into symmetrical current form in the HORIZONTAL PRE-AMPLIFIER and fed to the FINAL HORIZONTAL AMPLIFIER to drive the horizontal deflection plates of the **c.r.t.**

2.1.3. **CRT** Display Section

The Z-LOGIC and ***Z*** PRE-AMPLIFIER stages are part of the TIME-BASE UNIT 2.
The Z-AMPLIFIER, CALIBRATION GENERATOR and TRACE ROTATION CIRCUIT are located on the FINAL AMPLIFIER UNIT 5. The supply voltages for the **c.r.t.** are derived from the POWER SUPPLYY UNIT 6.

The Z-LOGIC receives the following inputs to drive the Z PRE-AMPLIFIER and Z-AMPLIFIER:
- The external Z-MOD signal applied to the BNC connector on the rear panel. This 2-MOD signal must be TTL-compatible. An L level in gives trace blanking.
- **Two** signals produced in the MTB and DTB to unblank the trace during the sweeps.
- The chopper blanking signal from the VERTICAL CHANNEL SELECTION LOGIC to blank the trace during switching between channels A and B in the chopped mode.

The output signal from the Z-LOGIC that determines trace blanking or unblanking is routed to the Z PRE-AMPLIFIER. Here the trace intensity is determined by the front-panel **INTENS** potentiometer setting.
In the ***Z*** AMPLIFIER, after amplification the Z-signal is split into two paths, an **l.f.** + **d.c.** and an **h.f.** path, because of the potential difference that exists between the Z AMPLIFIER output and the **c.r.t.** cathode (-1500 V).

The **h.f.** signals are fed via a high voltage capacitor directly to grid G I of the **c.r.t.**
However, the **d.c.** and **l.f.** signals are blocked by this capacitor. These signals therefore are used to modulate an oscillator frequency, which is then passed via another high voltage capacitor and demodulated in the DEMO-DULATOR stage to retrieve the original signal.
The original h.f. and **d.c.** + **l.f.** signals are recombined on the grid G I

The **c.r.t.** supply voltages are derived from the 1500 V GENERATOR.
The CRT CIRCUIT comprises the FOCUS control circuit for the electron beam, and the preset potentiometers for GEOMETRY and ASTIGMATISM.

The post-acceleration anode potential of 8,5 **kV** is produced in the HV MULTIPLIER and derived from the -1500 V cathode supply.

A preset front-panel control TRACE ROTATION enables the trace to be aligned in parallel with the graticule lines. This preset controls the TRACE ROTATION CIRCUIT that drives the trace rotation coil situated on the **c.r.t.**

2.1.4. **Power** Supply

The instrument may be powered either by an **a.c.** supply voltage or by a 24 V battery supply voltage.

By means of the MAINS VOLTAGE ADAPTOR the instrument can be set to the local mains voltage. This circuit incorporates a fuse for the **a.c.** supply.

This **a.c.** supply voltage is fed via the double-insulated mains transformer to the full-wave RECTIFIER.
A LINE trigger signal at mains frequency is fed via the LINE TRIGGER PICK-OFF circuit to the EXT-LINE TRIGGER INPUT.
From the RECTIFIER the unregulated **d.c.** supply is fed to the CONVERTER DRIVER. When a 24 V battery supply is used, this is fed via the DC PROTECTION + FUSE stage to the CONVERTER DRIVER. This protection stage safeguards the instrument against reversed polarity of the battery supply source.

THE CONVERTER DRIVER stage drives the CONVERTER transformer. The rectified +14V output-voltage is fed back as control via the REGULATOR + PROTECTION circuit.
In this way, the voltages on the secondary windings of the CONVERTER transformer are stabilised. After rectification and smoothing, the stabilised supply voltages are fed to the various electronic circuits in the instrument.

2.2. CIRCUIT DESCRIPTION OF THE VERTICAL SECTION

As the channel A and B attenuators are almost identical, only the channel A is described.

2.2.1. Input Signal Coupling (see Fig. 8.3.)

Input signals applied to input socket A (X2) can be either a.c.-coupled, d.c.-coupled or internally disconnected, depending on the coupling mode switch position of S17 (AC-O-DC).
In the AC position (S17A points 2 and 3) a blocking capacitor C501 paralleled by series circuit R502 and C502 are inserted in the signal path which prevents the d.c. component being applied to the attenuator. In this mode, the lower frequency limit is 2 Hz and some pulse droop may occur when low-frequency square-wave signals are displayed.

When DC is selected (S17A points 1 and 2 and S17B points 4 and 5) the complete input signal (a.c. + d.c. components) is fed to the attenuator input R503, R504, R506. Thus the full bandwidth of the oscilloscope is available.

If the 0 pushbutton is depressed, the input signal is isolated from the attenuator and the attenuator input is earthed, as a reference for calibration or trace centering, etc.

2.2.2. Attenuator and Impedance Converter (see Fig. 2.2. and 8.3)

The attenuator consists of a triple high-impedance voltage divider, an impedance converter and a low-impedance voltage divider.

High-impedance and low-impedance attenuator

The overall attenuation is determined by the combinations of the selected sections of the high- and low-impedance attenuator.
The voltage dividers of the high-impedance attenuator are controlled by reed relays.
Read relay K503 and K504 are activated in the AMPL/DIV (S9) positions 2 mV/DIV ... 100 mV/DIV (x 1 stage).
In the 0.2 V/DIV ... 1 V/DIV positions of S9, reed relays K506 and K507 are activated. The input signal is x10 attenuated by voltage divider R514 and R516.
When positions 2 V/DIV ... 10 V/DIV are selected, reed relays K501 and K502 are activated, and the input signal is x100 attenuated by voltage divider R509 and R511.

Attenuation positions	FET switches conductive
x5	D503/9, 11, 12
x2.5	D503, 5, 6, 8
x1	D503/1, 3, 4

The AMPL/DIV switch S9 controls the FET switches via resistors R557, R559 and R562. These resistors have high-ohmic values to eliminate parasitic capacitance effects on the FET gates, thus preventing any loss of bandwidth. The trimmers C504 and C512 are adjustable to obtain constant input capacitance in all attenuator settings. The high-impedance attenuator sections are made independent of frequency (i.e. the capacitive attenuation for a.c. signals is adjusted to conform with the resistive attenuation for d.c. signals) by means of trimmers C503, C508 and C511.

Impedance converter (see Fig, 2.2. and 8.3.)

The input signal is fed via FET V501 (in source-follower configuration), transistors V503, V504 and V508 to the low-impedance attenuator.
The special type FET V501, with very fast rise-time response, reduces the source impedance which prevents bandwidth loss.
The FET consists of a double gate. One gate is not used and connected to the drain via R521.
The input signal is applied to the other gate.
The diodes inside this FET protect the input source follower of the impedance converter against excessive voltage swings.
The l.f. part of the signal is fed to the inverting input, pin 2, of D502 via the LF gain potentiometer R538.
This l.f. signal is compared with a d.c. voltage on pin 3 of D502 that is adjustable with R547 (attenuator balance).
The output of D502 (frequencies up to 300 Hz, determined by R539 and C527 is routed to the voltage divider R543, R518.
The input signal of the impedance converter is fed to the other end of the voltage divider. The average value of both signals is fed to the inverting input of the correction amplifier D501. To reduce distortion originated in the current source V507, transistor V506 is mounted between the low-ohmic output of D501 and the base of V507.
The collector of V506 is high-ohmic, so the distortion on the base and on the emitter of V507 is equal and is eliminated.
If the feedback l.f. signal is, for example, too small, the correction amplifier will drive transistor V507 so that the amplitude of the l.f. part of the input signal is compensated.
Potentiometer R538 permits adjustment of the l.f. feedback gain. The d.c. offset of the operational amplifiers D502, D501 can be compensated by preset R547 (A, ATT. BAL.).

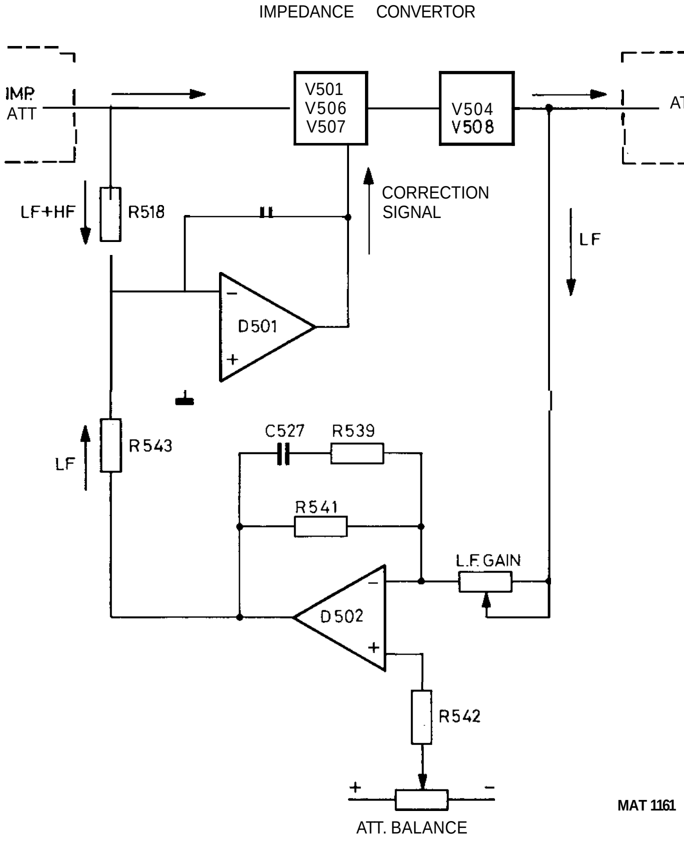

Fig. 2.2. Impedance converter

Continuous Control Circuit** (see **Fig. 2.3. and 8.3.)

The output signal of the lowimpedance attenuator is fed to the integrated circuit **D504 (3.6)** via the continuous circuit comprising FET **D503 (13, 14, 16).**
This FET is located between the signal path, pin **6** of **D504** and earth, via resistor **R584.** This resistor compensates the output impedance of the low-impedance attenuator **(50Ω)** and the impedance of the selected FET switch **(30Ω),** as shown in Fig. **2.3.**
This compensation is necessary to obtain an equal bias current for the inputs **(6,3)** of integrated circuit **D504**
The continuous control **R7** drives the FET (pin **14)** more, or less conductive via transistor **V519** and resistors **R567, R566** and **R568.**
In the CAL position of the CONT. control **R7,** the FET drain-source junction (pin **13** and **16)** is at a high ohmic level and thus the signal is not attenuated.

The CONT. control **R7** is connected between **+5 V** and transistor **V722,** which functions as a voltage source. This also supplies the CONT. control (R8) of channel B.
If R7 is not in the CAL position, the current I increases (Fig. **2.3.).** This increased the gate-source voltage of the FET, which results in a low drain-source resistance. The lower drain-source resistance reduces the amplitude of the signal fed to pin **6** of integrated circuit **D504.**
The CAL position of the CONT. control can be adjusted with the CAL CONT. potentiometer **R622** that controls the current **I** through transistor **V521.** The CONT. control range can be adjusted with potentiometer **R619.**

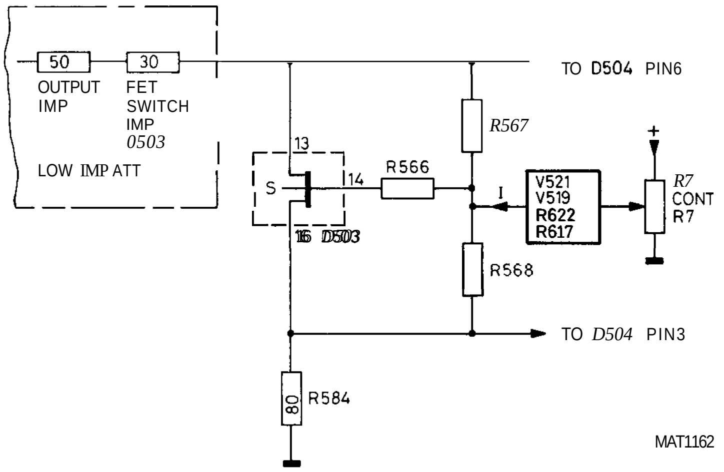

Fig. 2.3. Continuous control circuit

2.2.3. Amplifier

The channel A trigger signals for both time-bases are picked-off from pins 14 and 15 of integrated circuit D504 The circuit of D504 (known as a Cherry-stage) converts the voltage input signal into a current output signal (pins 12 and 13). Transistor V509 serves as a current source for D504.
In the three most sensitive AMPL/DIV positions (2,5, 10 mV/DIV) the amplifier has a gain of ten, controlled via D504, pin 2, from the AMPL/DIV switch.
Potentiometer R571 controls the current source circuit to give adjustment of the x1/x10 gain balance.
The x10 gain of the amplifier in the AMPL/DIV positions 2,5, 10 mV/DIV can be adjusted by potentiometer R586.
The supply voltage of D504 is applied to pin 9 via transistor V513.
In this way the temperature drift in the x10 gain mode is compensated to prevent bandwidth loss.
The gain x1 of channel B can be adjusted by potentiometer R779 to equalise the x1 gain of both vertical channels.
From the amplifier D504 (pins 12 and 13) the output current signal is routed to the vertical channel switch via transistors V516 and V517. These transistors function as a current mirror and also compensate for trace shift when the signal is inverted (POSITION control pulled). Potentiometer R604 (NORMAL/INVERT BAL) provides the shift compensation.

2.2.4. Vertical channel selection logic

VERTICAL DISPLAY MODE SWITCH S1	X501						D634				A D632	B D632	TRIG VIEW D632
	B4	A1	A3	A4	B2	A2	P5	P6	P7	P9	P8	P11	P3
4	*	*	0	1	0	1	1	0	0	1	[1]	0	0
B	0	1	1	0	0	1	0	1	0	1	0	[1]	0
TRIG VIEW	1	0	1	0	0	1	0	1	1	0	0	0	[1]
CHOP	0	1	1	1	1	1	1→0 0→1	0→1 1→0	0	1	1→0 0→1	0→1 1+1	0 0
4LT	0	1	1	1	0	0	1→0 0→1	o-tl 1→0	0	1	1→0 0→1	0→1 1→0	0 0
ADD	0	1	0	0	0	1	1	1	0	1	[1]	[1]	0
CHOP + TRIG VIEW	1	1	1	1	1	1	1 0 0	0 1 1	1 1 0	0 0 1	[1] 0 0	0 0 [1]	0 [1] 0
ALT + TRIG VIEW	1	1	1	1	0	0	1 0 0	0 1 1	1 1 0	0 0 1	[1] 0 0	0 0 [1]	0 [1] 0

* = don't care

[1] = vertical channel is selected

Fig. 2.4. Vertical channel selection logic

The vertical channel switches D831 and D631 are controlled by the vertical channel selection logic (D632, D634, D633) which, in turn, is controlled by the vertical display mode switches: A, ALT, TRIG VIEW, CHOP, ADD, B.

These switches control the vertical logic via connectors X204 (on SWITCH UNIT A102) and X501.
Positive logic is used in the digital circuits; i.e. '1' is +5 V (H) and logic '0' is 0 V (L).
The table, Fig. 2.4., indicates the logic used for vertical mode selection.

Selection of the various vertical display mode pushbuttons has the following result:

A depressed: Pin 8 of D632 is H in this mode, opening the signal path for channel A in integrated circuit D631.
Signals on D631 pins 5 and 6 are routed to output pin 13, 14.

B depressed: Pin 11 of D632 is at H level in this mode, opening the signal path for channel B in integrated circuit D631.
Signals on D631 pins 3 and 4 are routed to the output (pins 13, 14).

TRIG VIEW depressed: Pin 3 of D632 is H in this mode, opening the path for trigger view signals in integrated circuit D831.
The trigger view signal from the INTERFACE of the trigger amplifier (V861, V862) is routed to D831, pins 5 and 6, via transistors V831, V832.
In this mode, the TRIG VIEW signal is fed to the DELAY LINE DRIVER via the outputs (13, 14) of D831.

CHOP depressed: Pins 8 and 11 of D632 are alternately H and L at a fixed frequency of 500 kHz approx., generated by the chopper oscillator, consisting of transistor V632 and two NAND gates of D633 (11, 12, 13) (4, 5, 6) and capacitor C643.
If D632-6 is at H level, transistor V631 starts the chopper oscillator. Transistor V632 is blocked and C632 charges via R653.
If pins 12 and 13 of D633 are both H, its output goes to an L level, giving an H on pin 6 of D633. This H signal is fed back to the base of V632, which conducts and discharges C643 to give an L on D633-12.
Pin 6 of D633 goes L and blocks transistor V632, etc.
The chopper signal is applied to the clock inputs of the flip-flops D634 via D633, pins 10 and 8. The alternate pulse applied at D633-9 is overruled.
The J and K inputs (pins 2 and 3) and the preset and clear inputs (pins 4 and 15) of D634 are at level H, so this flip-flop switches on the chopper frequency applied to the clock input.
The input pin 10 of D634 is L and pin 14 is H, so output pin 7 is L in this mode, resulting in a level L on D632-3 (TRIG VIEW is off).

ALT depressed: In the ALT mode, the chopper oscillator is switched off (D632-6 = L).
However, D633-10 is H, which means that the alternate pulses from the HORIZONTAL CHANNEL SELECTION LOGIC are applied to the clock inputs of flip-flops D634 (pins 1 and 13), which make the D632 outputs (pins 8 and 11) alternately H and L.

ADD depressed: With ADD selected, D632 outputs 8 and 11 are both at H level.
Channel A and B signals are selected via pins 10 and 11 of D631, and are added in integrated circuit D631.

CHOP+TRIG VIEW depressed: Vertical channels A, B and TRIG VIEW are displayed, the switching between these channels is being determined by the chopper oscillator. The choppper frequency is applied to the clock inputs of flip-flops D634 (pins 1 and 13).
The outputs of D832 (pins 8, 11, 3) are alternately H and L, controlled by the clock frequency (see Fig. 2.4.).

The display sequence is as follows:
Channel A
TRIG VIEW
Channel B

ALT+TRIG VIEW depressed — Vertical channels A, B and TRIG VIEW are displayed, and in this mode the chopper oscillator is switched off, so D633-10 is at level H.
The alternate pulses are applied to the clock inputs of flip-flop D634, which control the switching between the three vertical channels. The display sequence is as follows:
Channel A
TRIG VIEW
Channel B

2.2.5. Vertical Channel Switch

The VERTICAL CHANNEL SWITCH consists of the two integrated circuits D831 and D631 (0Q0020), this IC being specially designed for application in vertical deflection systems.
This IC enables the following functions:

- Two differential input signals can be chopped (CHOP).
- One or two differential input signals can be selected (A and/or B).
- Two differential input signals can be added (ADD).
- Normal/invert mode is available per channel (PULL TO INVERT).
- Vertical Y shift is available per channel (POSITION).

The 000020 is controlled by the outputs of D632 (pins 8, 11, 3) as follows:

0Q0020 pins 10	0Q0020 pins 11	OUTPUT pins 13 and 14
0	0	NO
1	0	A
0	1	B
1	1	A + B

The normal/invert function is controlled by the PULL TO INVERT switches S4 and **S5** via pins 7 and 2 of D631. If these inputs (7.2) are at level L the signal is inverted.
The vertical Y shift is controlled by the POSITION controls R1 and R2.
The variable voltages derived from the sliders of these controls are applied to pin 8 (channel A) and pin 1 (channel B).

The TRIG VIEW signal is derived from the INTERFACE of the MTB trigger amplifier and applied to D831 (pins 5 and 6) via transistors V831, V832, which adapt the trigger view signal to the input level of the channel switch D831.
The balance of the symmetrical TRIG VIEW signal is adjustable with R841. The trigger view signal is controlled by the signal applied to D831.
If this input is H, it opens the trigger view signal path to the DELAY LINE DRIVER.

2.2.6. Delay-line driver

The delay-line driver consists of the Hooper stage **V633/V634** and Cherry stage **V636/V637.** The Hooper stage has an additional compensation circuit with operational amplifier **D636.** One input of **D636** measures the emitter voltage of **V633/V634;** the other input is connected to a reference voltage derived from voltage divider **R692/R693.** In the event of voltage differences between both inputs, the output of **D636** compensates for this via **R662/R663** to the bases of **V663** and **V664. As** a result, under no signal conditions, the collector voltages of **V633** and **V634** are constantly held at **9 V.** This is necessary in order to obtain equivalent dynamic ranges for both halves of the amplifier stage.
The Cherry stage **V636/V637** output is applied to the delay line (Unit **8).** The output impedance of this stage matches the impedance of the delay line.

A signal used for composite triggering is picked off from the collectors of **V 633** and **V634** by Cherry stage **V833/V834.**

2.2.7. Final vertical amplifier

The signal from the delay line (Unit **8)** is terminated by the delay line compensation circuit consisting of Cherrry stage **V1204/V1206** together with the common-current source **V1203.** The emitter circuit of **V1204/V1206** comprises a number of square-wave signal adjustments, one of them formed by two varicapdiodes **V1208** and **V1207.** Their capacitance value is determined by a d.c. voltage originating from NTC-resistor **R1228.** In this way, the amplifier is compensated for a decrease of rise-time in the event of higher ambient temperature. The Cherry stage **V1204/V1206** is followed by a Hooper stage **V1209/V1211.** This stage also receives the trace separation control signal that gives a vertical shift between the main and delayed time-base displays in the alternate time-base mode.
The Hooper stage is followed by another Cherry stage **V1213/V1214** with common-current source **V1212.** This stage incorporates a gain adjustment preset **R1256** and a square-wave adjustment **C1224.** The Cherry stage drives output amplifier IC, **D1201.** The collector load resistors of the output amplifier are part of IC **D1202.** The vertical deflection plates of the CRT are driven by the output amplifier via coils **D1203** and **D1204.** These coils form a resonant circuit together with the capacitive deflection plates of the CRT that results in an increase at the high frequency end of the bandwidth of the oscilloscope.

2.2.6. Delay-line driver

The delay-line driver consists of the Hooper stage **V633/V634** and Cherry stage **V636/V637.** The Hooper stage has an additional compensation circuit with operational amplifier **D636.** One input of **D636** measures the emitter voltage of **V633/V634;** the other input is connected to a reference voltage derived from voltage divider **R692/R693.** In the event of voltage differences between both inputs, the output of **D636** compensates for this via **R662/R663** to the bases of **V663** and **V664. As** a result, under no signal conditions, the collector voltages of **V633** and **V634** are constantly held at **9 V.** This is necessary in order to obtain equivalent dynamic ranges for both halves of the amplifier stage.
The Cherry stage **V636/V637** output is applied to the delay line (Unit **8).** The output impedance of this stage matches the impedance of the delay line.

A signal used for composite triggering is picked off from the collectors of **V 633** and **V634** by Cherry stage **V833/V834.**

2.2.7. Final vertical amplifier

The signal from the delay line (Unit **8)** is terminated by the delay line compensation circuit consisting of Cherrry stage **V1204/V1206** together with the common-current source **V1203.** The emitter circuit of **V1204/V1206** comprises a number of square-wave signal adjustments, one of them formed by two varicapdiodes **V1208** and **V1207.** Their capacitance value is determined by a d.c. voltage originating from NTC-resistor **R1228.** In this way, the amplifier is compensated for a decrease of rise-time in the event of higher ambient temperature. The Cherry stage **V1204/V1206** is followed by a Hooper stage **V1209/V1211.** This stage also receives the trace separation control signal that gives a vertical shift between the main and delayed time-base displays in the alternate time-base mode.
The Hooper stage is followed by another Cherry stage **V1213/V1214** with common-current source **V1212.** This stage incorporates a gain adjustment preset **R1256** and a square-wave adjustment **C1224.** The Cherry stage drives output amplifier IC, **D1201.** The collector load resistors of the output amplifier are part of IC **D1202.** The vertical deflection plates of the CRT are driven by the output amplifier via coils **D1203** and **D1204.** These coils form a resonant circuit together with the capacitive deflection plates of the CRT that results in an increase at the high frequency end of the bandwidth of the oscilloscope.

2.3. CIRCUIT DESCRIPTION OF THE HORIZONTAL SECTION

2.3.1. Main Time-base Triggering (see Fig. 8.5.)

a) Trigger selection circuit and trigger input stage (A, B, COMP)

The trigger signal from the vertical channel A is applied to shunt feedback amplifier V912, V913, as a symmetrical current signal. The output is a symmetrical voltage signal that is routed to the series feedback stage V873, V876 for MTB triggering, and to series feedback stage V872, V874 for DTB triggering.
Channel A is selected as MTB trigger source if R918 in the emitter circuit of V873, V876 is connected to earth via the MTB trigger source selector switch S23, to switch on these transistors.

The trigger signal from vertical channel B is applied to shunt feedback amplifier V914, V916, which is followed by a series feedback stage V878, V879, for MTB triggering and a series feedback stage V877, V881 for DTB triggering. These amplifier stages are identical to those described above for channel A.

The composite trigger signal obtained from V833 and V834 in the delay line driver is applied to shunt feedback amplifier V917, V918.
This amplifier is followed by a series feedback stage, V882, V883 for MTB triggering. If R892 in the emitter circuit of V882, V883 is connected to earth via the MTB trigger source switch S23 via switching transistor V870, the composite signal is used for MTB triggering.

If in composite trigger mode TRIG VIEW is selected, a logic H level from D634-10 makes V880 conductive via R994 and V870 is switched off. Consequently, composite triggering is inhibited. In this event, V875 is conductive and an earth potential is applied to R918 via V860 to select channel A as MTB trigger source.
As a result, it is not possible to switch on the trigger view and composite trigger modes together.

b) External and line trigger input

The external trigger signal can be applied to input socket X5. The signal is routed via a network that gives the correct external input impedance and sensitivity, and via C1109 (a.c.-component), R1122, R1123 (d.c.-component) to the gate of FET V1104. In the LF and HF trigger coupling modes the d.c. component of the signal is interrupted because the junction of R1122, R1123 is connected to earth via LF and HF switches S20.

FET V1104 is part of the balanced source-follower stage. One FET receives the external trigger signal and the other, the LINE trigger signal. The trigger source signal not desired is short-circuited to earth.

The LINE trigger signal, originated in the power supply, is routed via the potentiometer R891 (LINE) to the TRIGGER SELECTION UNIT.

The amplifier stage V1104 is followed by a series feedback stage V1102, V1103 that converts the asymmetrical input voltage signal into a symmetrical output current signal.
Transistor V1101 provides a common current-source in the emitter circuit, which is only switched in if EXT or LINE triggering is selected (an earth potential from trigger source selector switch S23).

For instruments with TTL trigger facilities (optional), the gain of the amplifier stage V1102, V1103 can be increased by a factor of 2.5 (relay contact K1101 closes in the TTL trigger mode).

c) Trigger amplifier input stage

This amplifier has two balanced inputs that apply an input signal to the common-base circuit V852, V853.
The input current is routed via socket X859 and socket X863 for MTB triggering via channel A, B or composite.
The input current signal is routed via sockets X861 and X862 for MTB triggering via the EXT input or LINE.

The common-base circuit V852, V853 is followed by a shunt feedback stage V851, V854 that converts the input current signal into an output voltage signal. This output signal is taken off asymmetrically and applied to the DC, LF, HF filter.

d) Trigger coupling

In the DC mode, relay contact K851 is closed and the signal is passed unattenuated via R868.
In the LF mode, K851 is open and switch contact S20C is closed. The signal is now passed via the series low-pass filter R872, C858, R869.
In the HF mode, K851 is open and switch contact S20D is closed (moving contact to earth). The signal is now passed via the high-pass filter C858, R872. Both in LF and HF modes, the d.c. component is blocked by C868.
In the AUTO PP mode, the trigger signal is a.c.-coupled (K851 is open).
Only in the external X deflection mode together with AUTO PP mode can d.c. coupling be selected.
If TTL trigger mode is available on the instrument, the signal is always d.c.-coupled (K851 closed).

e) Interface

This stage receives its input signal from the DC, LF, HF trigger coupling and produces asymmetrical output signals for the TOP DETECTOR, TV CIRCUIT and X DEFLECTION AMPLIFIER.

The INTERFACE also produces symmetrical output signals for TRIGGER VIEW and the FINAL TRIGGER AMPLIFIER.

The asymmetrical voltage signal from the TRIGGER COUPLING stage is applied to one gate of the symmetrical FET source-follower stage V887. The other gate of V887 receives a d.c. voltage that can be adjusted with the LEVEL control R6. As a result, the source outputs of V887 show a symmetrical voltage signal, the level of which can be varied by the LEVEL control.

The source-follower V887 is followed by an emitter-follower D853 (9,10,11) (6,7,8) with a common-current source V859. As the emitter-follower transistors are part of one IC, it results in better stability and closer-matched characteristics for these transistors. This technique is featured widely in the MTB and DTB trigger circuits.

An asymmetrical current signal for external X deflection is picked-off from D853-11 and routed via the switch unit to the horizontal channel switch on the time-base unit.
Another asymmetrical current signal is taken from D853-6 end is routed via shunt feedback amplifier V863 to the TOP DETECTOR and the TV CIRCUIT.

The symmetrical output voltage signal is available on D853-10 and D853-7, and applied to series feedback stage V862, V861, with common current source V864. This stage sends a symmetrical current signal to the vertical channel switch to facilitate trigger view.

f) Final trigger amplifier

The signal available on D853-10 and D853-7 is also applied to the series feedback amplifier D853 (12,13,14) and D853 (1,15,16). The common current source for this stage is D853 (2,3,4), switched on by an earth potential applied to R996 via selection switch S20A. In the external X deflection and TV trigger modes this is switched *off* and R996 floats.
In the TTL trigger mode (optional) the amplification of this stage is increased as relay contact K852 closes.
The symmetrical output current signals are available on D853-12 and D853-1 and have phase shift of 180 degrees. Depending on the position of the +/- SLOPE switch S8, one of the two signals is used for MTB triggering. Selection is by switching diodes: V888, V889 for the + slope, V857, V858 for the - slope.

If the + slope is selected (S8 open), V889 blocks and the signal from D853-12 is routed via V888 to the MTB. Transistor V896 is not conducting so transistor V897 switches on. The positive potential on its emitter switches on diode V857 and the signal from D853-1 leaks away. Diode V858 is blocked and the connection between D853-1 and the MTB is interrupted.

If the - slope is selected (S8 closed), V889 conducts, so the signal from D853-12 leaks away. Diode V888 blocks so any signal at this point is also prevented from reaching the MTB.

In this event, transistor V896 conducts because the positive-going base potential and switches off transistor V897. Diode V857 blocks as a result, so diode V858 conducts and the output signal on D853-1 collector is routed to the input of the MTB.

g) TV circuit

With the TV CIRCUIT it is possible to trigger the MTB on television line signals (TIME/DIV = 20 µs... 0,05 µs/DIV) or TV frame signals (TIME/DIV = 0,5 s...50 µs/DIV).
In the TV mode, the FINAL TRIGGER AMPLIFIER is inoperative and instead, the TV CIRCUIT triggers the MTB. The LEVEL control R6 is also inoperative and the +/- slope switch S8 permits selection between positive and negative video signals.
The input of the TV circuit is the base of transistor V869. For positive video signals V869 functions as an amplifier with a phase shift of 180 degrees between base and collector. In this mode, collector resistor R983 is connected to +14 V via transistor V897, which is conducting.
For negative video signals, V896 functions as an emitter-follower. As a result, there is no phase shift between base and collector. This collector now functions as an emitter, connected to -7 V via R1011 and R983. In this situation, transistor V897 is not conducting. The collector of V869 is direct-coupled to the base of emitter-follower V871. This is followed by a clamping stage formed by C904 and the base-emitter junction of V899, the synchronisation pulses being available on its collector. These pulses have a top level of +5 V and a bottom level of 0 V approx. In the TV line trigger mode, the pulses are routed via diode V901, transistor V898 and switching diode V894 to the MTB trigger circuit.

In the TV frame trigger mode (MTB TIME/DIV = 0,5 s...50 µs/DIV), switching transistor V909 conducts via the TIME/DIV switch. As a result, C917 and C918 are switched into the circuit and line trigger pulses are suppressed.
Only frame trigger pulses can now reach the MTB trigger circuit.

Transistor V908 functions as a 'current mirror' in order to give the correct current ratio between the current in the diode V894 and in transistor V898.

The TV CIRCUIT is switched off by a 0 V applied to the cathode of diode V901.

h) Multiplexer

This circuit stage produces the supply voltage for the MTB LEVEL control R6. The integrated circuit multiplexer 0851 contains two 4-way analog switches that select the voltages applied to both ends of the LEVEL control. These voltages depend on the selected trigger mode.
The four possible modes are:

- TV (TTL, ECL) mode
- AUTO (peak-peak level mode)
- TRIG mode
- EXT X DEFL mode

Switch position depends on the logic levels at control inputs pins 10 and 9 of multiplexer D851.
In the TV (TTL, ECL) mode, the control input D851-10 is at logic L and input D851-9 is also L.
Thus, inside the multiplexer points 1+3 are interconnected and also points 12+13.
As a result, the potential from voltage divider R907,R909 is connected to both ends of R6. The position of R6 is now irrelevant and the trigger level is fixed.
Note that circuit differences necessary to adapt the instrument from TV into TTL, ECL triggering are indicated in the table given in the circuit diagram.
In the AUTO mode, the control input D851-10 is at logic H and D851-9 is L. Internally, multiplexer points 2+3 and points 15+13 are interconnected. This results in one end of R6 being connected to D852-1 output, which carries a voltage proportional to the top level of the trigger signal. The other end of R6 is connected to output D852-7. This operational amplifier output carries a voltage that is proportional to the bottom level of the trigger signal. In this mode the MTB stays triggered in all positions of the LEVEL control since the voltage on R6 is proportional to the signal voltage.

In the TRIG mode, the control input D851-10 is at logic H, D851-9 is H and internally, points 4+3 and points 11+13 are interconnected. As a result, one end of R6 is connected to -3 V approx. from voltage divider R884, R903, and the other end of R6 is connected to +3 V approx. from voltage divider R951, R952.
The MTB trigger level can now be adjusted over approximately +8 or -8 divisions of the displayed signal.

In the modes described above, transistor V866 conducts and D851-6 is at logic L; as a result, the multiplexer input levels are applied to output pins 3 and 13. In the EXT X DEFLECTION mode however, transistor V866 **blocks** and D851-6 is at logic H. In this case, the multiplexer input levels are isolated from the outputs, which now float.

i) Top detector

This stage produces positive and negative output d.c. voltages that are proportional to the positive and negative top of the trigger signal. In the AUTO mode, these voltages are applied to the two ends of the LEVEL control R6. The input signal for the TOP DETECTOR is derived from shunt feedback stage V863. The positive top of this signal is rectified by diode V867 and smoothed by C872. The negative top is rectified by diode V868 and smoothed by C873.

Both voltages are applied to the non-inverting input of an operational amplifier D852 (inputs 3 and 5). The feedback loop of each amplifier is such that the gain is one These operational amplifiers operate as emitter-followers with a high input impedance and a low output impedance.

2.3.2. Delayed Time-base Triggering (see Fig. *8.6.)*

***a) Trigger selection circuit** (A, **B**)*

Series feedback amplifier V872, V874 receives the channel A signal for DTB triggering. Channel A is selected as a DTB trigger source if R886 in the emitter circuit of V872, V874 is connected to earth via the DTB trigger source switchcontacts S22A to make this stage conductive.

Series feedback amplifier V865, V895 receives the channel B signal for DTB triggering if R888 in the emitter circuit of V865, V895 is connected to earth via switch contacts S22B of the trigger source switch, which makes this stage conductive.

b) Trigger amplifier input stage

This is a balanced input amplifier that accepts input current signals via soxkets X871 and X872 when triggering the DTB via channel A or B. The common-base circuit V921, V922 is followed by a shunt feedback stage V923, V924 that converts the input current signal into an output voltage signal.
This output signal is taken off asymmetrically from V923 collector and applied to the DC, LF, HF filter.

***c) Trigger coupling (DC, LF,** HF)*

In the DC mode, switch contact S19A is closed and the trigger signal is passed via R1080 without frequency attenuation.
In the LF mode, the d.c. path is interrupted and switch contact S19B is closed. The signal is now passed via the low-pass filter R1057, C929.

In the HF mode, the d.c. path is interrupted and switch contact S19C is now closed. The signal is passed via the high-pass filter C929, R1057. Both in the LF and HF modes, the d.c. component is blocked by the series capacitor C931.

d) Final trigger amplifier

The asymmetrical voltage signal from the TRIGGER COUPLING stage is applied to one gate of the symmetrical FET source-follower stage V919. The other gate receives a d.c. voltage, adjustable by the LEVEL control R4. As a result, the source outputs of V919 show a symmetrical voltage signal, the d.c. level of which is adjustable by R4. This signal is fed to an emitter-follower stage D854 (9,10,11) and D854 (6,7,8), part of integrated circuit D854. The symmetrical output voltage signal on emitters D854-10 and D854-7 is applied to the series feedback amplifier D854 (12,13,14) and D854 (2,3,4), with common-current source D854 (1,15,16).

The symetrical output current signals are available on collectors D854-12 and D854-2 and have a phase shift of 180 degrees. Depending on the position of the SLOPE switch S6, one of the two signals is selected for DTB triggering by means of switching diodes: V910, V906 for + slope, V892, V891 for – slope.

If the +SLOPE is selected (S6 open), V906 is not conducting and the signal from collector D854-12 is routed via diode V910 to the DTB.
Transistor V907 is not conducting and transistor V893 is therefore switched on. Diode V892 is blocked and the connection between collector D854-2 and the DTB is interrupted.

If the - SLOPE is selected (S6 closed), diode V906 now conducts, so the signal from collector D854-12 leaks away. Furthermore, diode V910 blocks and prevents any signal from collector D854-12 being passed to the DTB. The positive voltage applied to the base of V907 from S6 causes this transistor to conduct, which then turns off transistor V893. As a result, diode V891 is blocked and the output signal on collector D854-2 is routed via V892 to the input of the DTB.

2.3.3. **Main** Time-base (see Fig. **8.9)**

For a fuller understanding of the functioning of the main time-base, important voltage waveforms in the MTB control logic are given in Fig. 2.5.

a) Auto mode without triggering (free-running time-base)

Consider the situation at the moment the main time-base starts.
With AUTO selected (S3A closed), NOR-gate output D209-13 is L and the switching transistors V233 and V234 are turned off. The MTB is therefor? able ro run and produces a time-linear sawtooth voltage. This is picked-off by the Darlington pair V257, V258 and applied to the X deflection selector via emitter-follower V224 and switching diode V217.

b) Main time-base generator

The MTB is based upon the principle that a timing capacitance charged by a constant-current source is capable of generating a time-linear sawtooth voltage that is ideal for c.r.t. forward trace sweep and flyback.

Transistor V236 provides the current source, the base of which is connected to a fixed voltage in the CAL position of R10. This voltage is only varied when the continuous control R10 is moved from the CAL position. The emitter resistance of V236 may have ten different values (R109...R113) selectable by the TIME/DIV switch S15, which has 22 positions. Three timing capacitors are also selectable. Capacitor C226 is permanently in circuit, capacitor C234 is selectable via switching transistor V238 and C241, C242 and C243 paralleled capacitance via transistor V237. These transistors function in 'reversed' mode (collector-emitter reversed) during charging of the timing capacitors and in the 'normal' way during the discharge period.
The following table indicates the capacitors and adjustment potentiometers that are brought into circuit in the various positions of S15.

TIME/DIV range	Timing capacitors in circuit	Adjustment point
0,05 µs ... 5 µs/DIV	C226	—
10 µs ... 2 ms/DIV	C234 (via V238) (+C226)	R348
5 ms ... 0,5 s/DIV	C241, C242, C243 (via V237) (+C226)	R347

The L level from the inverting output pin 6 of flip-flop D212 is applied to the base of switching transistor V271, to switch it off. The hold-off time now starts.

c) Hold-off circuit

The hold-off time-base circuit operates according to the same principle as for the MTB and DTB. Timing capacitors are charged by a constant-current source to generate a time-linear sawtooth voltage. The charging current can be adjusted in steps via the MTB TIME/DIV switch, which influences the voltage applied to the non-inverting input (pin 3) of operational amplifier D216. The HOLD-OFF potentiometer R11 permits continuous adjustment of the current.
The voltage on the hold-off timing capacitors is applied to the input of Schmitt trigger D214 (12,13,11) via Darlington pair V286, V272 and the voltage divider R339, R308.
If this voltage has reached a level of +1,9 V, an H level is detected. In this event, output D214-11 becomes L. This L level is applied to the reset input D212-1, which gives an H on inverting output pin 6. Switching transistor V271 conducts again and the hold-off time-base is switched off: the timing capacitance is discharge.

Schmitt output D214-11 and NAND gate input D211-3 are at level H when the hold-off capacitors are discharged. The H level on output pin 6 of flip-flop D212 is routed via D211 (3,4,5,6) and D209 (2,3,1) to D209-12 input and the time-base restarts.

VOLTAGE WAVEFORMS IN SWEEP GATING LOGIC.

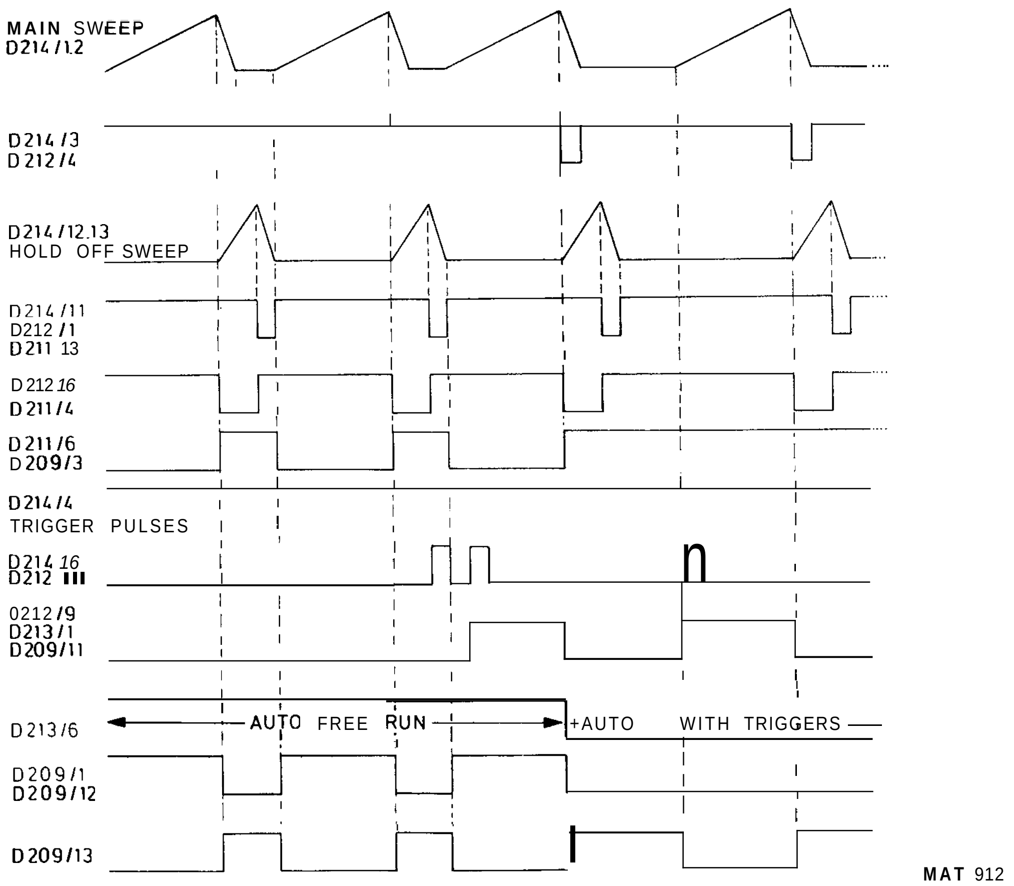

*Fig. 2.5. Important voltage waveforms in the **MTB** control logic*

d) AUTO mode with trigger pulses

MTB trigger pulses are applied as a current signal to the CURRENT-VOLTAGE CONVERTER. If a trigger pulse occurs in this mode, transistors V291 and V292 convert the selected trigger source current signal into a voltage signal, and emitter-follower V293 makes D214-4 input logic L. This trigger pulse is applied at H level to clock input pin 11 of flip-flop D212, which switches over to make output pin 9 logic H. This cannot occur during the hold-off period because D214-5 is L, or reset input D212-13 is L.
The H level from D212-9 output switches off transistor V233 and diode V234 via NOR gate D209 (11,12,13) to start the time-base.
As described for the free-run mode, the end of the time-base sweep is detected and the hold-off time-base is started.
When this occurs, output pin 6 of flip-flop D212 becomes L. This L level is routed via NAND gate D211 (1,2,13,12) and NOR gate D209 (8,9,10) to the reset input (13) of flip-flop D212. As a result, output pin 9 does L and the time-base is switched off. Moreover, the one-shot multivibrator D213 is triggered and output D213-6 stays at level L for 100 ms after the H to L transition of the clock input on pin 1.

If D213-6 is L, then D211-5 is also L. This means that it is not possible to start the time-base at the end of the hold-off period via the path D211 (3,4,5,6) and D209 (2,3,1). Now the MTB can only be started if a trigger pulse appears. An incoming trigger pulse is applied to the clock input (11) of flip-flp D212 to make output pin 9 logic H. This H level is applied to pin 11 of NOR gate D209, which makes output pin 13 a logic L and the MTB starts.

e) Triggered mode (see also AUTO mode with and without triggering)

In the triggered mode, the signal path that starts the MTB directly after the hold-off period (in auto free-run mode) is interrupted by an H level on NAND gate D209-2. This interrupted signal path is via D211 (3,4,5,6) and D209 (2,3,1).

The finish of the MTB sweep at the start of the hold-off period is identical to the situation described for AUTO mode. At the start of the hold-off period, input pin 2 of NAND gate D211 becomes L. As inputs 1 and 13 are both H, output pin 12 becomes H. This produces via NOR gate D209 (8,9,10) a logic L that is applied to reset input (13) of flip-flop D212. Consequently, the flip-flop switches over and the MTB stops.

D211 INPUTS	LEVEL		OUTPUTS	
2 1 13	H H H	only L in EXT X DEFL	12	L
11 9 10	L H H	only L in AUTO and TRIG	8	H

Only by forcing the SR flip-flop back to the reset condition (output 12 at L, output 8 at H) is it possible to re-trigger the time-base. Reset is achieved if the SINGLE/RESET pushbutton is depressed, to give an L level to input 10 of the SR flip-flop. However, the time-base can only be triggered if the SINGLE/RESET pushbutton is in the normal position. If it is depressed, the reset input (pin 13) of flip-flop D212 remains at level L via D214 (9,10,8) and D209 (8,9,10).

In the SINGLE mode, the signal path that starts the time-base directly after the hold-off period (in AUTO free-run mode) is interrupted by an H level on D209-2. This interrupted signal path is D211 (3,4,5,6) and D209 (2,3,1).

g) EXT X-DEFL mode

Input pin 1 of SR flipflop D211 is permanently at level L. Consequently, output D211-12 is H. This H level gives an L level on reset input pin 13 of D212, which inhibits the start of the time-base in this mode.

h) NOT TRIG'D indicator

The not triggered indicator, LED B1, is supplied with current from the current source V1512 on the FINAL AMPLIFIER UNIT A5 via X202-7.
If the time-base is running, flip-flop output D212-8 is L, this level being applied via diode V252 and via X202-7 to the anode of B1 to hold it off (see Fig. 8.12).

When trigger pulses occur with a time interval of 100 ms or less, pin 6 of one-shot multivibrator D213 is permanently at logic L. This L output is fed via diode V251 to the anode of B1 to switch it off.

In the SINGLE mode, the output 8 of flip-flop D211 is L from the start of the hold-off period until the moment when the SINGLE/RESET pushbutton is depressed. This L level is applied via diode V249 to the anode of B1 to hold it off.

The NOT TRIG'D indicator normally glows when awaiting a single-shot trigger.

i) HORIZONTAL CHANNEL SELECTION LOGIC & HORIZONTAL CHANNEL SWITCH

MTB only (S2D depressed or all horizontal display mode switches S2 released)

In this mode, S2D feeds a logic L to the set input (10) of flip-flop D207. The reset input (13) is H, therefore output pin 9 is H and inverting output pin 8 is L. This L level causes transistor V208 to conduct and thus opens a signal path for the MTB sweep via transistor V224 and the diode V217 to the input of the final X amplifier.

DTB only (S2B depressed)

In this mode, an L level is applied to the reset input pin 13 of D207. The set input (10) is H and inverting output pin 8 is H. The L output on pin 9 causes transistor V223 to conduct and thus opens the signal path for the DTB sweep via diodes V211 and V214 to the final X amplifier.

EXT X-DEFL only (S2A depressed)

In this mode, both the set input (10) and the reset input (13) of D207 are made logic L via diodes V294 and V295 and S2A-6 of the horizontal display mode switch. Consequently, outputs (pins 9 and 8) of flip-flop D207 are H and both the MTB and DTB sawtooths are prevented from reaching the input of the final X amplifier.

The external X deflection signal is now routed via transistors V203 and V204, in the X DEFLECTION AMPLIFIER, and switching diode V216 to the X FINAL AMPLIFIER.

ALT TB mode (S2C depressed)

Flip-flop D207 functions as a divide-by-two stage in this mode because the set and reset inputs are both at level H, and the data input (12) is connected to the inverting output (8). The signal applied to clock input (11) is the END OF SWEEP pulse. This signal goes L at the end of the MTB sweep and goes H when the MTB sweep reaches the 0 V level. When the clock-pulse input goes from L to H the condition of the flip-flop changes.
For instance, output 9 goes H and the inverting output 8 goes L, so the MTB sawtooth is applied to the final X amplifier. After the L to H transition, on the clock input, output 9 is L and inverting output 8 is H, which applies the DTB sawtooth to the final X amplifier. At the next transition, the MTB is again applied, and so on.

j) Trace separation circuit

This stage is formed by integrated circuit D202, of which the transistors connected to pins 1, 15, 16 and 8, 9, 10 are not used (all pins wired to –7V). The TRACE SEPARATION CIRCUIT receives, via two outputs, current from R1238 and R1244 in the FINAL VERTICAL AMPLIFIER. These currents provide the trace shift in the ALT TB mode.
The transistor connected to pins 2 and 1, and the transistor connected to pins 7 and 8 are current sources.

If the ALT TB mode is not selected, the currents from both sources are equal because the switch contact S2C between pins 2 and 7 is closed. The output pin 1 of NOR gate D208 is at logic L. Therefore the current from R1244 is routed to D202-11 and via an internal transistor to the current source connected to pins 7, 8. The current from R1238 is routed to D202-14 and then via an internal transistor to the current source on pins 2, 1. When ALT TB mode is selected, the contact between pins 2 and 7 of D202 is open. Consequently, the current of both current sources is no longer equal. Current source pin 2, 1 carries a lower current than current source pin 7, 8. The difference depends on the setting of the TRACE SEPARATION potentiometer R15. With R15 at zero resistance both currents are identical. If the DTB is displayed, NOR gate output D208-1 is L and the routing of the currents of R1244 and R1238 over both current sources are identical to the situation without ALT TB selected. Only the magnitude of the currents differs, that from R1238 being higher than that from R1244. This results in a downwards shift of the time-base line in comparison with the situation where the currents in R1238 and R1244 are equal.

In the MTB sweep that follows, the MTB is displayed and the output D208-1 is now H. As a result, the currents from R1238 and R1244 in the FINAL VERTICAL AMPLIFIER are routed via another path in D202. The current from R1244 is routed to D202-12 and is lower than the current from R1238, which is routed to D202-13. In this case, the result is an upwards shift of the time-base line compared with the situation where the currents in R1238 and R1244 are equal.

k) Z-LOGIC

This stage sends a current signal to the Z amplifier to control the intensity of the spot on the c.r.t. screen. The spot intensity depends on the mode selected; e.g. MTB, MTB intensified by DTB, DTB, ALT TB, EXT X DEFL, and also on the position of the INTENS control R12.
During the hold-off period the display must be blanked. The current that determines the intensity is a summation of the collector currents of transistors V288 and V289. Both transistors are controlled by the logic circuits: V288 by NAND-gate output D218-12 and V289 by NAND-gate output D218-6.
If both logic outputs are L, V288 and V289 conduct and the display is unblanked. The logic levels on D218-12 and D218-6 as a function of the mode selected are given in Fig. 2.6.

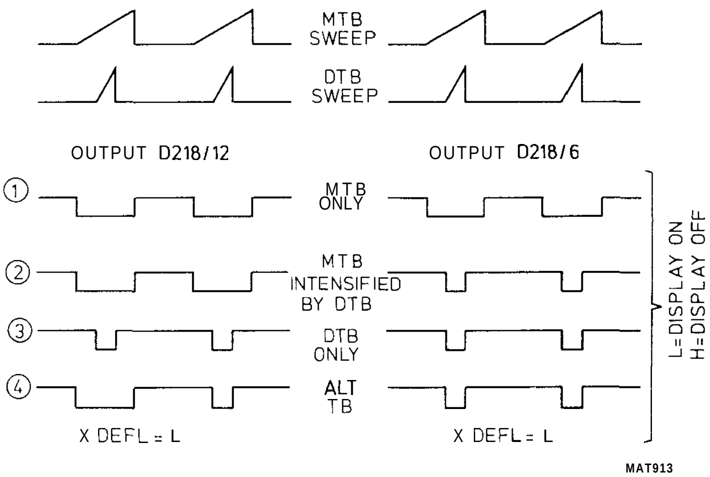

Fig. 2.6 Important voltage waveforms in the Z-modulation control logic

MTB only

During the MTB sweep, input D217-2 is **H**, resulting in OR-gate output D217-3 and D218-13 becoming H during the sweep.

Input D217-5 is **H** if the MTB output signal is routed to the final X amplifier. As a result, OR-gate output D217-6 is **H** during this time, and also D218-1.
NAND-gate input D218-2 is permamently **H** so output **D218-12** is **L** during the **MTB** sweep (see Fig. 2.6/1 for comparison).

input D217-12 is H during the MTB sweep, so OR-gate output D217-11 is **H** and also D218-5.
Input D217-9 is **H**. As a result for gate output D217-8 is H and also D218-4.
Input D218-3 is H. Output **D218-6** is **L** during the **MTB** sweep (compare with Fig. 2.6/1).

DTB only

Input D217-4 is **H** during the DTB sweep, which makes output D217-6 and input D218-1 logic H.
Input D217-1 is **H** and consequently output D217-3 is **H** and also input D218-13.

Input D218-2 is permanently H, so output **D218-12** *is* **L** during the **DTB** sweep (compare this with Fig. 2.6/3).
Input D217-10 is **H** during the DTB sweep, which makes output D217-8 and also input D218-4 at logic H during the DTB sweep.

Input D206-2 is L, so output D206-3 and also input D217-13 go to logic H. Consequently, the OR-gate output D217-11 and input D218-5 are at logic H.
Input D218-3 is permanently at **H** so output **D218-6** is **L** during the **DTB** sweep (compare this with Fig. 2.6/3).

MTB intensified **by DTB**

When this mode is selected, the input of the FINAL HORIZONTAL AMPLIFIER is derived from the MTB output and the DTB TIME/DIV switch does not occupy the OFF position.

Input D217-2 is H during the MTB sweep, which means that D217-3 and input D218-13 are also H during the sweep period.

Input D217-5 is H if the MTB output signal is routed to the final X amplifier. As a result, OR-gate output D217-6 and input D218-1 are also H.
With input D218-1 also H, the output of this 3 -input NAND gate **D218-12** is **L** during the **MTB** sweep (compare this with Fig. 2.6/2).

Input D217-10 is H during the DTB sweep, which means that output D217-8 is H during the DTB sweep and also input D218-4.
A logic L on input D206-2 makes output D206-3 and also input D217-13 logic H. Output D217-11 is therefore H and also input D218-5.

Input D218-3 is H, so output **D218-6** is **L** during the **DTB** sweep (compare this with Fig. 2.6/2).

Therefore with L signal on NAND-gate output D218-12 during the MTB sweep, transistor V288 conducts. With an L signal on NAND-gate output D218-6 during the DTB sweep, transistor V289 conducts, and during that time the current from the Z amplifier doubles providing that preset R401 is in mid-position. This increase in current produces the intensified part of the MTB trace during the DTB sweep.

ALT TB mode

When ALT TB is selected, NAND-gate output **D218-6** is **L** during the **DTB** sweep, in the same way as described for the 'DTB only' mode (compare with Fig. 2.6/4 and Fig. 2.6/3).
For NAND-gate output **D218-12** this situation is as follows:
- for one MTB sweep, the output is **L** during that **MTB** sweep,
- for the next MTB sweep the output is **L** during the **DTB** sweep.

This depends on the condition of flip-flop D207 (8...13), which switches the final X amplifier input alternately between MTB (**D218-12 L** during **MTB** sweep) and DTB (**D218-12 L** during **DTB** sweep).
The generation of these pulses occurs as follows:
- If the MTB is used for X-deflection then D217-1 is L. Pin 2 is H during the MTB sweep, so D217-3 and D218-13 are also H during the MTB sweep.
  Input D217-5 is also H, which makes output D217-6 a logic H.
  Thus input D218-1 is H and since input D218-2 is H, the three inputs of the NAND-gate are at H, which gives a logic **L** on output **D218-12** during the **MTB** sweep (compare with Fig. 2.6/4).
- If the DTB is used for X-deflextion (the next MTB sweep) then D217-5 is L. Pin 4 is H during the DTB sweep, so D217-6 and D218-1 are also H during the DTB sweep.
  Input D217-1 is H, which makes output D217-3 and input D218-13 logic H. As the remaining input, D218-2 is H, then the NAND-gate output **D218-12** is **L** during the **DTB** sweep (compare with Fig. 2.6/4).
- At the next MTB sweep, the MTB is again selected for X-deflection and D218-12 is L during the MTB sweep, and so on.

Display Blanking

In the foregoing circuit descriptions for display blanking in MTB, MTB intensified DTB and ALT TB modes, it is assumed that inputs 2 and 3 of D218 are permanently at logic H. However, there are certain conditions, listed below, when these inputs are L and the display is blanked.
- In the chopped mode of the vertical channels the display is blanked during switching over between channels, by connecting the cathode of diode V296 to earth for this period.
- If a logic L is applied to the external Z MOD input on the rear-panel, this signal is routed via diode V297 to inputs 2 and 3 of D218 for blanking purposes.
- The display is blanked if an incorrect mode is selected. This condition is detected by NAND gates Q218 (9,10,11,8) and D206 (4,5,6) which together give a logic L on the cathode of diode V298.

Inputs D218-9/10 are H if X DEFL is selected or if the DTB TIME/DIV switch in OFF (V285 non-conductive).
Input D218-11 is H if ALT TB is selected or if the final X amplifier is fed from the DTB signal. As a result, output D218-8 is L (i.e. display blanked), if DTB TIME/DIV switch is OFF while DTB or ALT TB selected on S2. The display is also blanked if X DEFL is selected together with DTB or ALT TB for horizontal display.

l) ALTERNATE mode control logic (see Fig. 2.7)

This circuit produces clock-pulses for the vertical display mode logic. It consists of NOR gates D208 (1,2,3), D208 (11,12,13), D208 (8,9,10) and NAND gate D206 (8,9,10).
The pulses are routed via the switch unit to UNIT 3.
The vertical display switches from one channel to the other if output D206-8 goes from L to H.

The circuit operates as follows:
If the horizontal deflection is initiated by MTB or DTB only, input D208-11 is L. Normally, input D208-12 is H, but is L during the flybackperiod of the MTB (= discharge of timing capacitance). If input D208-12 goes from H to L (at start of MTB flyback) this transition is routed via D208 (11,12,13), D208 (8,9,10) and D206 (8,9,10), this triple inversion making output D206-8 go from L to H to switch the vertical channel display from one to the other.

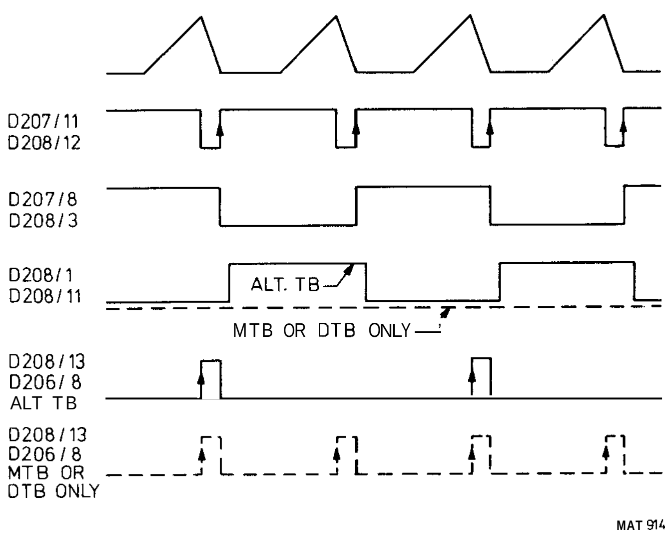

Fig. 2.7 Important voltage-waveforms in the alternate mode control logic

If the ALT TB mode is selected, input D208/12 also goes from H to L at the start of the MTB flyback period. Input D208/11 is H if the MTB drives the final X amplifier, and L if the DTB drives the final X amplifier.
As a result, the H to L transition of input D208/12 only gives a L to H transition of output D206/8 if the DTB drives the final X amplifier.
Thus the display sequence in the ALT TB mode combined with ALTernate vertical display is:
- Channel A with MTB intensified by DTB
- Channel A with DTB
- Channel B with MTB intensified by DTB
- Channel B with DTB
- Channel A with MTB intensified by DTB, and so on.

m) Stabilisation circuit

This circuit consists of operational amplifier D201 and transistor V200. The circuit converts +14 V into +12 V for the time-base, and the current drain from +14 V is constant. The reference voltage for the positive input of D201 is obtained via voltage divider R201, R202 from the +14 V supply. The negative input of D201 is connected to the +12 V output voltage. Any variation between reference voltage and output voltage is corrected via output D201-6 and emitter-follower V200.

2.3.4. Delayed Time-base (see Fig. 8.11)

The DELAYED TIME-BASE GENERATOR itself generates a time-linear sawtooth in the same way as described for the main time-base.
Transistor V229 is the constant-current source, with its base fed from a fixed d.c. voltage that is derived via the continuous TIME/DIV control R9. The base voltage of V229 is only changed if R9 is moved out of the CAL position. By means of the TIME/DIV switch S13, eight different emitter resistors can be selected for current source V229. Depending on the position of S13, only one timing capacitor C219 (fast sweep speeds) or two timing capacitors C219/C218 (slow sweep speeds) are switched into the circuit. Capacitor C218 is switched into the circuit by means of transistor V231.
This transistor functions in the 'reversed' mode (collector and emitter are reversed) during the charge of the timing capacitor and in the 'normal' way during the discharge.
Switching of V231 is controlled by TIME/DIV switch S13. The table below indicates the capacitors and adjustment potentiometers that are in circuit as a function of the position of S13.

TIME/DIV range	Timing capacitors in circuit	Adjustment point
0,05 µs...5 µs/DIV	C219	R349
10 µs...1 ms/DIV	C219, C218	R351

a) COMPARATOR

This part of the circuit consists of transistors V259, V248 and current source V268 and it compares the MTB sawtooth voltage (applied to the base of V259) with an adjustable d.c. voltage from DELAY TIME potentiometer R3 (applied to the base of V248 via Darlington pair V246, V247).
At the moment that the instantaneous d.c. value of the MTB sawtooth exceeds the voltage on the base of V248, this transistor switches off, V259 conducts and the comparator switches over. Now V261 conducts and NAND-gate input D203-4 becomes H.
The comparator has a current source V268, which is switched on if the lower end of R358 is connected to earth via S13. With the DTB TIME/DIV switch S13 in the OFF position, R358 is floating and the current source is switched off. As a result, the comparator is inoperative and the DTB cannot be started.
The voltage at both ends of the DELAY TIME control R3 is adjustable by presets R262 and R268.

b) START and STOP of DTB (see timing diagram Fig. 2.8)

Before the start of the DTB, the position of the SR flip-flop D204 (1,2,3) and D204 (4,5,6) is as follows:
Output D204-1 – L
Output D204-4 – H
Input D203-4 becomes H if the comparator switches over. Input D203-5 is H (during the MTB sweep).
Consequently, output D203-6 becomes L together with input D204-12.
Input D204-11 is L, thus output D204-13 becomes H and is applied to the reset input, pin 1 of flip-flop D207.
There are now two start possibilities for the DTB:

- Pushbutton MTB of S22 is depressed: the 'START' mode is selected and the DTB starts directly after the selected DELAY TIME.
  In this mode, the set input, pin 4 of flip-flop D207 is connected to earth, so the inverted form of the signal on onput pin 1 of D207 appears on the output pin 6. If pin 1 goes H, then output pin 6 goes L, the switching transistor V228 turns off and the DTB starts.
- Pushbutton A or B of S22 is depressed: the TRIGGERED mode is selected and the DTB starts after the pre-selected time delay, only upon receipt of a trigger pulse.
  In this mode, the set input D207-4 is H, and 0207 now functions as a normal flip-flop.
  After pin 1 has gone H, a clock-pulse on D207-3 is necessary to make output pin 6 logic L.
  This clock-pulse occurs if V226, V212 (the CURRENT-VOLTAGE CONVERTER for the selected trigger source) and emitter-follower V225 make inverter inputs D203-12/13 logic L. As a result, the clock input D207-3 goes H and the flip-flop switches over: output pin 6 goes L and switch V228 now goes non-conductive and the time-base starts.

If the timing capacitance of the DTB is charged, the voltage across it rises linearly with time. This voltage is applied via the Darlington pair V219, V209, the voltage divider R239, R238 and emitter-follower V221 to the input of the Schmitt trigger D203 (1,2,3), which is the end-of-sweep detector.
If this voltage has reached a value of +1,9 V, the input level is detected as being H.
Output D203-3 now becomes L and is inverted to give H on output D203-8, which is applied to pin 6 of SR flip-flop D204 (1...6). The flip-flop switches over and gives a logic H on input D204-11.
Output D204-13 becomes L and also the reset input D207-1 and the DTB stops as switching transistor V228 conducts again. In this way, the charging of the timing capacitance stops, and these are discharged via V227 at the start of the hold-off period.
The situation described above is valid if the DTB sweep is completed before the MTB sweep (see Fig. 2.8. indicating the voltage waveforms for the DTB SWEEP COMPLETED mode, and also for the DTB SWEEP NOT COMPLETED mode).
In the DTB SWEEP NOT COMPLETED mode, the state of the RS flip-flop is not changed and the DTB is stopped if input D203-5 becomes L at the end of the MTB sweep. Now input D204-12 becomes H and flip-flop reset input D207-1 becomes L.

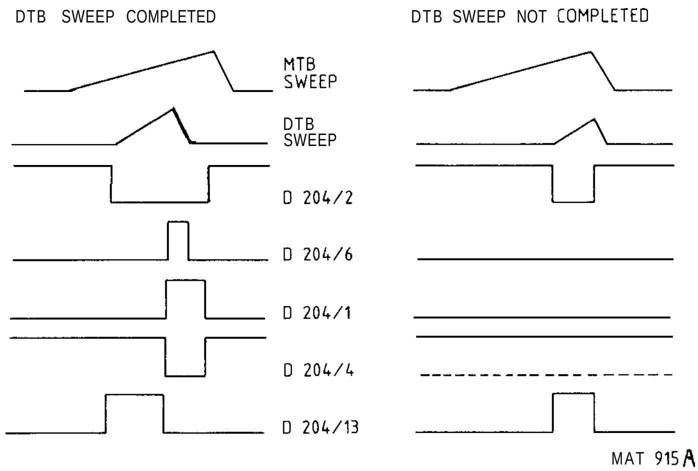

Fig. 2.8 Important voltage-waveforms in the DTB control logic

2.3.5. Final X Amplifier (see Fig. 8.13)

The input stage comprises a balanced series-feedback amplifier, V1371, V1372 with common current source V1373. The base of V1371 receives the output signal from the X-deflection selector. This signal can be the MTB or DTB sawtooth or the X DEFL. signal. The base of V1372 receives an adjustable d.c. voltage derived from the X POSITION control R5.
This control, R5, consists of two ganged sections, one of which has a degree of backlash to enable fine and coarse adjustment of the X position with one knob.
The amplification of the V1371, V1372 stage in increased by x10 if the X MAGN control is pulled. Relay K1371 is energised in this mode and additional emitter resistance (R1378 and R1381) is switched into circuit.

The collector of transistor V1371 drives one half of the final X amplifier, the other half being driven by the collector of V1372. The configuration of both amplifier halves is the same, but corresponding transistors are complementary (PNP vs NPN) so corresponding supply voltages are therefore reversed (V1316 vs V1312).
One half of the final X amplifier consists of V1302 (NPN to adapt d.c. level). V1306 (PNP shunt-feedback amplifier), V1311 (PNP, to adapt d.c. level), V1312 (NPN, current source) and V1313 (NPN, output emitter. follower).

The signal conditions are as follows:
If the sawtooth voltage on the base of V1371 rises, the collector current falls. The voltage level on the junction R1307-R1318 does not change. Therefore the current is fed via transistor V1302 to the base of V1306. The base becomes more negative, so the collector potential of V1306 rises. Also the potential on the junction of collectors V1311, V1312 rises and is applied via emitter-follower V1313 to one horizontal deflection plate.
During the flyback of the sawtooth, diode V1308 can conduct. The feedback components of V1306 are R1323, R1318 and C1308.

The other half of the final X amplifier consists of V1303 (PNP, to adapt d.c. level) V1307 (NPN, shunt-feedback amplifier), V1317 (NPN, to adapt d.c. level), V1316 (PNP, current source) and V1314 (PNP output emitter-follower).

The signal conditions are as follows:
If the sawtooth voltage on the base of V1371) rises, the collector current of V1372 also rises. The emitter of V1303 becomes more positive. (Resistor R1308 has a higher value than R1307 in the other half of the amplifier.)
Transistor V1303 starts conducting so the current to the base of V1307 rises. The voltage level on the collector of V1307 decreases and the potential on the base of V1314 also.
Via emitter-follower V1314 the signal is fed to the horizontal deflection plate XI.
The feedback components for V1307 are R1319, R1324 and C1309

2.4. CRT DISPLAY SECTION, CAL GENERATOR AND FRONT-PANEL SIGNAL LAMPS (see Fig. 8.13.)

a) 2-Amplifier

The signal from the 2-LOGIC on the time-base unit 2 that determines the c.r.t. spot intensity is applied to the base of emitter-follower V1503. From the emitter the signal feeds the output stage with shunt-feedback amplifier V1513 and current source V1511.
The output signal may contain d.c., I.f. and h.f. components to be applied to the Wehnelt cylinder G I of the c.r.t. Since G I is at a cathode potential of -1500 V, blocking capacitors are required between G I and the Z amplifier output.
The h.f. component is routed via blocking capacitor C1512 to G I.
However, the d.c. and I.f. components are blocked. These components are filtered by the low-pass filter R1529, C1514 and applied to the modulator V1508, V1509. Here, the d.c. and I.f. components modulate an h.f. carrier signal to pass blocking capacitor C1513, and are-then demodulated by V1514. Finally, the reconstituted d.c. and I.f. components are added to the h.f. component and applied to G1 of the c.r.t.

b) Signal lamps

The front-panel LED indicators POWER ON, VERT UNCAL, HOR UNCAL, MAGN X10 and NOT TRIG'D are connected in series, and fed from constant-current source V1504.

The POWER ON LED always glows when the instrument is switched on. The other are short-circuited by the relevant switches when not in operation, as listed below:
- Vertical and horizontal UNCAL LEDs short-circuited if continuous controls R7, R8, R9, R10 are in CAL position.
- The MAGN x10 LED is short-circuited by V1512, which is blocked if the MAGN x10 mode is selected.
- The NOT TRIG'D LED is short-circuited if a logic L from the MTB logic is applied to its anode.

c) Trace rotation circuit

This circuit determines the magnitude and sense of the current in the trace rotation coil around the neck of the c.r.t. Either npn transistor V1501 or pnp transistor V1502 conducts depending on the setting of the front-panel adjustment R14. This control also determines the magnitude of the current.

d) Calibration generator

The square-wave generator consists basically of an operational amplifier D1501 with an RC feedback loop. This feedback loop consisting of R1543 and C1517 determines the frequency of oscillation (2 kHz).
The generator is followed by output stage V1516, which is used in the 'reversed' mode; i.e. the collector is used as 'emitter' and the emitter used as 'collector'.
In this way, the saturation voltage is very low, which gives an accurate output voltage on socket X1. Resistors R 1547, R 1548, R1549 in the output circuit are high-precision types.

e) Graticule illumination lamps

The graticule illumination lamps are supplied via transistor V2, which is mounted on the chassis for an optimal heat-conduction.

2.5. THE POWER SUPPLY

The stabilised power supply for the oscilloscope consists of the following:

- an input circuit
- a converter driver
- a flyback converter
- a regulator and protection circuit
- secondary output rectifiers

2.5.1. Input circuit

The instrument can be set to operate from the following mains supply voltages: 110 V, 220 V and 240 Va.c., these nominal voltages being selected by the mains voltage selector S25 at the rear of the instrument.

Fuse F1402 protects the instrument against incorrect mains voltage settings or high mains fluctuations.
A thermal fuse F1403 is located in the mains transformer T1406.

The secondary winding of T1406 is connected to the diode bridge V1431, where the input is rectified and smoothed by capacitor C1452.

The instrument may alternatively be powered by a battery supply of 20...28 V. This battery supply must be connected via the d.c. input connector X7 at the rear of the instrument.
If a battery supply is used, it is applied to resistor R1460 via the POWER ON switch S21 and connector X1407 pins 6 and 8. Protection is provided by the 2 A delayed-action fuse F1401. Diode V1436 also safeguards the input against incorrect polarity of the battery supply. This diode blocks in the event of reversed input.
Resistor R1447 prevents capacitor C1452 being charged to excessive values by spikes that may be present on the battery supply.
To reduce the current flowing the C1441 at switch-on, resistor R1460 is mounted in series with the POWER ON switch S21.

2.5.2. Converter Driver and **Flyback** Converter

The converter driver consists of transistors V1438, V1413 and transformer T1404.
The converter itself consists of the converter transformer T1402.

– ***The converter driver (see Fig. 2.9 and** 8.14)*

The circuit functions as follows:
The pulse-width of the square-wave current I 1 that is applied to the base of transistor V1438 is determined by the integrated circuit D1402.
The frequency of the square-wave current is 26 kHz approximately.
If transistor V1438 starts to conduct (see point A of Fig. 2.9), its collector current I2 increases to 0,4 A during the period T I.

The current I2 is flowing via the primary winding of T1404 to the base of transistor V1413 (I3) and to the secondary winding of T1404 (14).
The base current of V1413 (I3) will increase by the same amount as the collector current of V1438 (I2).
Transistor V1413 will conduct and its collector current I 6 will increase to 4 A.
If the transistor V1438 is blocked (see point B of Fig. 2.9) its collector current I2 is switched off.
Because of this sudden switch-off, the current I4 will be maximum at this moment.

The current I4 is in anti-phase with respect to I2 and flows via diode V1437 to the supply voltage.
In this way, the base current I3 of V1413 becomes negative (-0,4 A) during period T2, which rapidly blocks V1413.

The collector current I6 of V1413 is also switched off rapidly at this moment. The energy present in the transformer T1404 is fed to earth via diode V1419. This is realised by the negative current I1 during period T3.
After ≈ 40 μs, the procedure is repeated.
Resistor R1446 provides the base of V1413 with a d.c. current to speed-up the switching-on of this transistor.

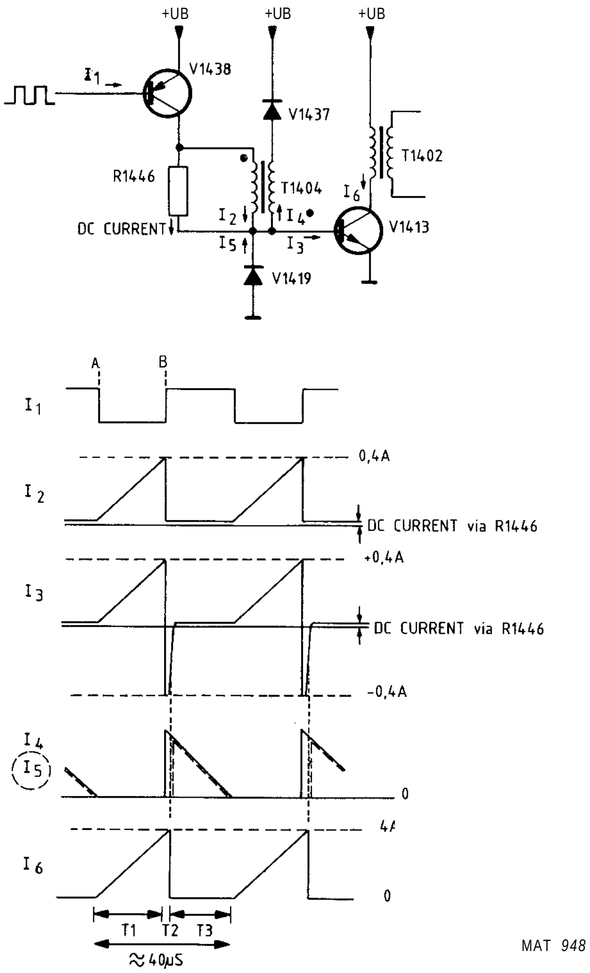

Fig. 2.9 Converter-driver

– *The flyback converter (see Fig. 2.10)*

The flyback converter functions as follows:
If transistor V1413 conducts under the control of base current I3, the collector current I6 increases to 4 A. During the period T1, the voltage level on the collector of V1413 is eat earth potential.
At the moment when V1413 is blocked its collector current 16 is switched off (see point B of Fig. 2.10).
At the same time, the energy present in T1402, built up during period T1, is discharged via the secondary winding of T1402 during period T2.
This results in current I7 which, after rectification and smoothing, is fed to the various circuits in the instrument.

The energy that was present in T1402 is consumed at point A and the procedure described above is repeated after ≈ 40 μs.

Diode V1415, capacitor C1430 and resistors R1418, R1425 serve to eliminate the switching spikes present on the collector of transistor V1413.

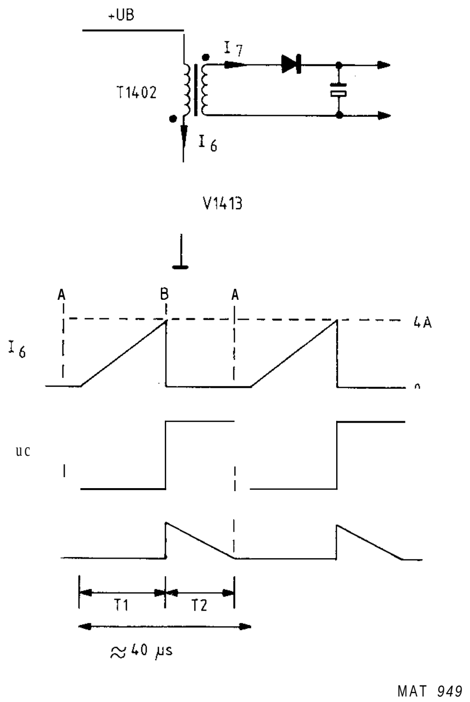

Fig. ***2.10*** *Fly-back converter*

2.5.3. The Regulator and Protection Circuit (see Fig. **8.15)**

The regulator circuit D1402, via transistors V1433 and V1428, controls the pulse-width of the square-wave current applied to the base of V 1438.
At the moment of switch-on, the supply voltage for D1402 is delivered via the emitter-follower V1429 to pin 1 of D1402.
When the power supply has started, the transistor V1429 is blocked and the supply voltage for D1402 is derived from the secondary +14 V supply via diode V1426.

The regulator circuit is controlled by the following:

- The +14 V secondary output voltage fed back to D1402-3 via potentiometer R1474 and resistors R1452, R 1453 and R1456 for output voltage sensing.
  Potentiometer R 1474 permits adjustment of the output voltages.
- The frequency of the sawtooth generator, determined by the value of C1448 and R1466 connected to pins 8 and 7 of D1402 respectively (26 kHz approx.).
- The current-limit circuit, adjustable by preset R1476, for output current sensing.

a) Output voltage sensing

The voltage level of the feedback voltage (on D1402-3) is compared with the amplitude of the sawtooth voltage in the pulse-width modulator (see Fig. 2.11). The pulse-width modulator is part of integrated circuit D1402.

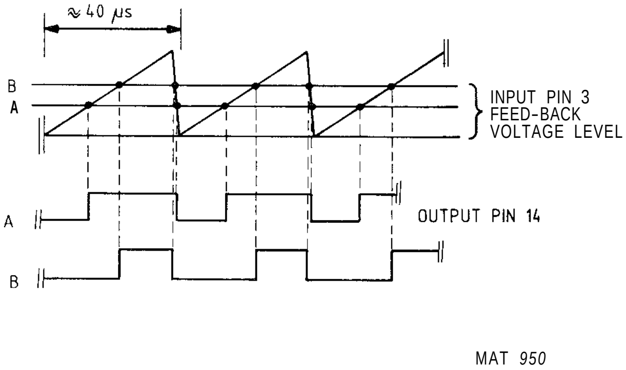

Fig. 2.11 Pulse-width modulation

The pulse-width of the output square-wave voltage is determined by the level of the feedback voltage to D1402-3.
For instance, if the output voltage is too high (see level B of Fig. 2.11), the pulse-width of the output voltage on pin 14 and pin 15 will be reduced.
If the output voltage is too low (see level A of Fig. 2.11), the pulse-width will increase.
Via transistor V1428, the square-wave current is applied to the base of V1438. Transistor V1428 functions as a current source, started by the pulse from D1402-14. The square-wave voltage from D1402-15 switches-off transistor V1438 rapidly via transistor V1433 and C1449.

A 'slow' start of the power supply is achieved by capacitor C1447, which is charged slowly by the reference voltage from D1402-2 via resistors R1448 and R1462.
The voltage level on pin 6 determines the duty cycle of the output square-wave voltage.
The maximum duty-cycle is also determined by the voltage level on D1402-6 which prevents the converter transformer T1402 going into saturation.
The +14 V feedback voltage is continuously checked. A voltage level is applied to D1402-10 via the Zener diode V1422 and R1439.

In the event of a short-circuit longer than approximately two seconds, the voltage level on pin 10 will fall to such a value that the output pulses on pins 14 and 15 of D1402 are blocked.

b) Output current sensing

The voltage level derived from potentiometer R1476 is applied to D1402-11 for current sensing. This voltage level is taken from the current transformer T1403, This transformer has no power losses so its dissipation is low.

If the voltage level on D1402-11 exceeds 0,48 V, the output pulses from pins 14 and 15 are cut-off. This means that the duty-cycle of the square-wave output voltage is reduced, which in turn reduces the output current of the power supply (e.g. in the event of a small overload).

If the voltage level on pin 11 of D1402 exceeds 0,6 V (e.g. in the event of a short-circuit), the power supply is immediately switched-off.

2.5.4. Output Circuits (see Fig. **8.15)**

The output voltages taken from the secondary windings of transformer T1402 are rectified by diodes and smoothed by capacitors in conventional circuits.
The d.c. output voltages are fed to the various circuits of the instrument. The c.r.t. filament is also supplied by a secondary winding of T1402, via connector X1406, pins 1 and 2.

WARNING Note that pin 2 of connector X1406 is at -1500 V level.

If connector X1406 is removed from its socket, the +14 V supply voltage for the -1500 V converter is also interrupted for safety reasons. In this case, the connection between the connector pins 9 and 10 is interrupted.

2.5.5. **-1500 V** Generator and **HV** Multiplier (see Fig. **8.15)**

The -1500 V supply consists of an oscillator and a regulator circuit.

The oscillator comprises transistor V1401, transformer T1401, capacitor C1415 and resistor R1417. The output signal voltage on the secondary winding of T1401 is rectified by diode V1403 and smoothed by C1408 and C1409.

The -1500 V is divided by resistors R1408, R1413 and fed back to the positive input of operational amplifier D1401-3 for output voltage sensing.
This part of the -1500 **V** output is compared with a reference voltage applied to the inverting input D1401-2.
The reference voltage is extremely stable, and independent of temperature variations. This is achieved by Zener diode V1408. Tolerances in this Zener diode can be compensated for by preset R1471.
Resistor R1434 and capacitor C1436 prevent unwanted oscillation in D1401.

The regulator part of the circuit functions as follows:
If for example the -1500 V output increases (i.e. goes more negative), the voltage level on the positive input D1401-3 decreases.
The output voltage of the comparator D1401-6 decreases to such a value that current is drawn from the oscillator via diode V1410.
Consequently, the oscillator amplitude decreases, resulting in a lower output voltage.

If the -1500 V is short-circuited, the voltage level on D1401-3 becomes positive, and the output voltage of the comparator D1401-6 increases. The current to the base of transistor V1401 increases as a result, and V1401 dissipates this current.
Diode V1410 prevents the transistor V1401 getting excessive base current when the instrument is switched on. At switch-on the diode blocks and the base current for V1401 is delivered via resistor R1426.

The -1500 V output is converted to 8,5 kV in the high-voltage multiplier D1403 and fed via connector X1414 to the post-acceleration anode of the c.r.t.

2.5.6. Line Trigger Pick-off (see Fig. 8.15)

The line trigger signal is derived from the secondary winding of the mains transformer via the connector X1407, pins 4 and 7.

The mains voltage sine-wave signal is applied to the transistor V1406 via resistors R1422 and R1423. The square-wave signal on the collector of V1406 is routed to a filter consisting of R1419, R1416, R1414 and C1416, C1417 and C1407, and transistor V1404.
This filter re-converts the square-wave voltage to a sine-wave voltage at the mains frequency.

This line trigger signal is routed via electrolytic capacitor C1406 to the TRIGGER SELECTION UNIT via the connector X858, pin 6.

2.6. 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.

2.6.1. Basic Analog Circuits (see Fig. 2.12)

– *Series feedback amplifier*

This is also called a Cherry configuration.

A voltage signal AU is applied to the input; the output produces a current signal $\Delta I = \frac{AU}{R_E}$

– *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 $AU = \Delta I \cdot R_F$

– *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 impedance 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 signal.

– *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. 2.12, 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:

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

2.6.2. Basic Digital Circuits **(see** Fig. **2.13)**

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

- a high level (H) constitutes an input between **2...5 V** and an output between 2.4 ...5 **V.**
- a low level (L) constitutes an input between 0...0,8 V and an output of between 0...0,4 **V.**

The following types of logic circuit elements are used 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 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) is 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.

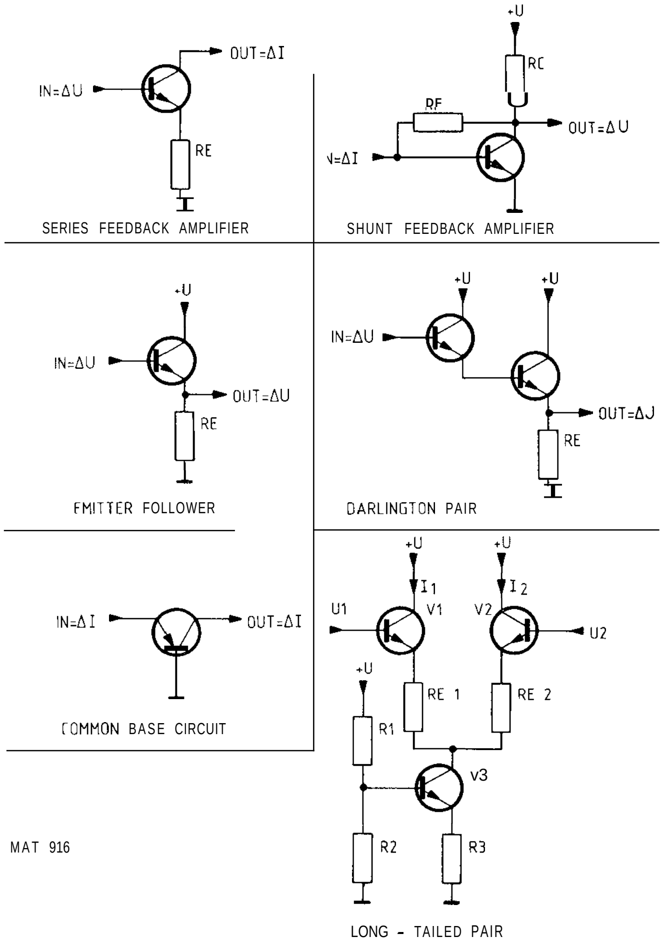

Fig. 2. 12 Basic analog circuits

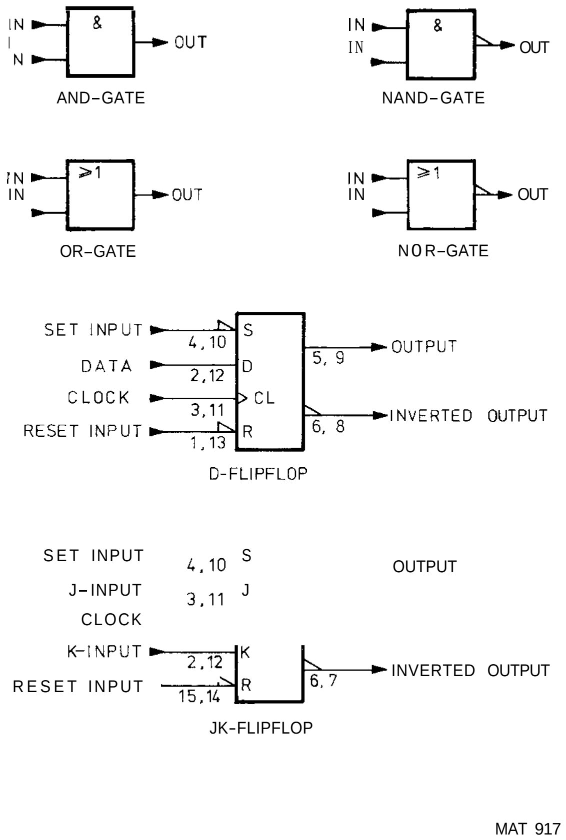

Fig. 2. 13 Basic digital circuits

3. DISMANTLING THE INSTRUMENT

3.1. GENERAL INFORMATION

WARNING: The opening of covers or removal of parts, except those of 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, an instrument cover with carrying handle, and a rear panel.
To facilitate the removal of the instrument cover and rear panel, first ensure that the front cover is in position.
Then proceed as follows:
- Hinge the carrying handle clear of the front cover by pushing both pivot centre buttons simultaneously.
- 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 at the right-hand side. slit it a little to the right and take it off.
- Remove the four screws fixing the cast-aluminium profile.
- Remove the cast-aluminium profile.
- Remove the instrument cover by lifting it clear of the instrument.

NOTE: Bend out the cover at the side of the rubber feet so that the feet do not catch behind the frame parts.

3.3. ACCESS TO ADJUSTING ELEMENTS

All instrument adjustment points are accessible after removing the instrument cover, the screening plate of the time-base (secured by two star-screws) and the screening plate of the attenuator (secured by six star-screws).
The correct adjustment of the channel A and B attenuator sections is not disturbed if the screening plate is remounted.
Five adjustment points on the power supply (Unit 6) are accessible via holes in the right-hand chassis plate of the instrument.

NOTE: 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 calibration; rather it is concerned primarily with those portions of the instrument which are essential to measurement accuracy and correct operation. Removing the instrument covers is not necessary to perform this procedure. All checks are made from the front panel.

If this test is started 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 time.

The performance checks are made with a stable, well-focused, 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 switches 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.

4.3. RECOMMENDED TEST EQUIPMENT

Type of instrument	Required specification	Example of recommended instrument
Function generator	Freq: 1 Hz ... 10MHz Sine-wave/Square-wave Ampl.: 0 ... 20Vpp DC offset 0 ... ± 5V Rise-time < 30ns Duty cycle 50%	Philips PM5134
Constant amplitude sine-wave generator	Freq: 100kHz ... 100MHz Constant ampl. of 120mVpp and 3Vpp	Tektronix SG503
Square-wave calibration generator	Freq: 10Hz ... 1MHz Ampl.: 50mV ... 60V Rise-time < 1ns Duty cycle 50%	Tektronix PG506
Time-marker generator	Repetition rate: 0.5s ... 0.05μs	Tekstronix TG501
TV pattern generator	Must have video output	Philips PM5519
Variable mains transformer	Well insulated output voltage 90 ... 264Vac	Philips ord. number 242252900005
DC power supply	Adjustable output: 20 ... 32V Current: 1,8A	Philips PE1540
Moving-iron meter		
Dummy probe 2 : 1	1MΩ ± 0.1% //25pF	
Cables, T-piece, terminations, 20dB attenuator for the generators	General Radio types for fast rise-time square-wave and high freq. sine-wave BNC-types for other applications	

PUT ABOUT IN MID POSITION AND DEPRESS: R1/S4, R2/S5, R4/S6, R5/S7, R6/S8

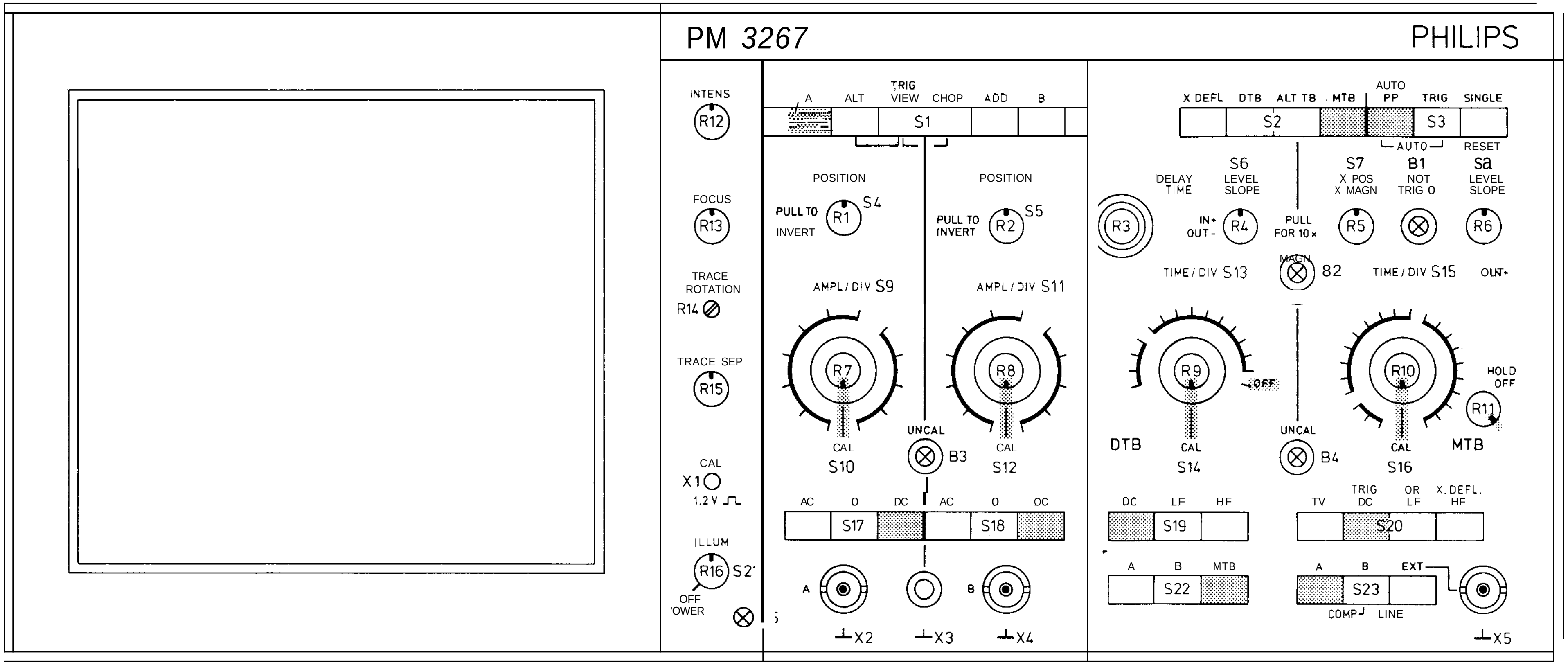

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Fig. 4.1 Preliminary settings

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.

4.3. RECOMMENDED TEST EQUIPMENT

Type of instrument	Required specification	Example of recommended instrument
Function generator	Freq: 1 Hz ... 10MHz Sine-wave/Square-wave Ampl.: 0 ... 20Vpp DC offset 0 ... ± 5V Rise-time < 30ns Duty cycle 50%	Philips PM5134
Constant amplitude sine-wave generator	Freq: 100kHz ... 100MHz Constant ampl. of 120mVpp and 3Vpp	Tektronix SG503
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Time-marker generator	Repetition rate: 0.5s ... 0.05μs	Tekstronix TG501
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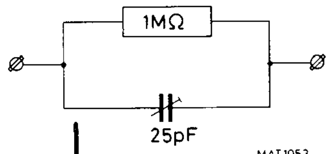
DC power supply	Adjustable output: 20 ... 32V Current: 1,8A	Philips PE1540
Moving-iron meter		
Dummy probe 2 : 1	1MΩ ± 0.1% //25pF	
Cables, T-piece, terminations, 20dB attenuator for the generators	General Radio types for fast rise-time square-wave and high freq. sine-wave BNC-types for other applications	

4.4. **CHECKING PROCEDURE**

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.1.	Power **on**				
4.1.1a	Start power supply	Mains voltage 50Hz - 400Hz ± 10%	– Switch power on s21	– Start at selected mains voltage ± 10% – Pilot lamp B5 lights up.	
4.1.2a	Power consumption			45W from ac	
4.1.1b	Start POWER SUPPLY	24V (x7 - rear side)	– Switch power on s21	– Starts at dc supply voltages between 20V and 32V – Pilot lamp B5 light ups.	
4.1.2b	Power consumption			37W from dc.	
4.2.	CRT display				
4.2.1.	INTENS		– INTENS potentiometer R12	Normal INTENS adjusting	
4.2.2.	FOCUS		– FOCUS potentiometer R13	Trace sharpness adjusting	
4.2.3.	TRACE ROTATION		– Screwdriver adjustment R14	Trace must be in parallel with horizontal graticule lines; if necessary readjust potentiometer TRACE ROTATION R14	
4.3.	Vertical or Y-axis				
4.3.1.	Display modes	Square-wave signal 10kHz ampl. 100mV to A input	– Depress A S1 – Ampl/div. to 20mV	Square-wave 10kHz 5 div. high must be visible	
			– Depress B S1	Trace channel B visible	
			– Depress TRIG VIEW S1	Trigger signal derived from A visible	
			– Depress CHOP S1	Traces of A and B visible	
			– Depress TRIG VIEW and CHOP S1	Traces of A and B and TRIG VIEW visible	
			– Depress ALT S1	Traces of A and B visible	
			– Depress TRIG VIEW and ALT S1	Traces of A and B and TRIG VIEW visible	
		Square-wave signal 10kHz, ampl. 200mV to A and B input	– Depress ADD S1 – AMPL/DIV switches to 50mV	Square-wave signal 10kHz, trace height 8 div. visible	
4.3.2.	Polarity inversion	Square-wave signal to A (B) input	Pull switch S4 (S5)	Square-wave signal is inverted	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	EASURING RESULTS
4.3.3.	Vertical deflection coefficients	Square-wave signal 10kHz to A input (B)	AMPL/DIV S9 (S11)		
		AMPL 10mVp-p	2mV	Trace height 5 DIV., + or −3%(± 0.15 div.	
		20mVp-p	5mV	Trace height 4 DIV., + or −3%(± 0.12 div.	
		50mVp-p	10mV	Trace height 5 DIV., + or −3%(± 0.15 div.	
		100mVp-p	20mV	Trace height 5 DIV., + or −3%(± 0.15 div.	
		200mVp-p	50mV	Trace height 4 DIV., + or −3%(± 0.12 div.	
		500mVp-p	0.1V	Trace height 5 DIV., + or −3%(± 0.15 div.	
		1 VP-P	0.2V	Trace height 5 DIV., + or −3%(± 0.15 div.	
		2 VP-P	0.5V	Trace height 4 DIV., + or −3%(± 0.12 div.	
		5 VP-P	1 V	Trace height 5 DIV., + or −3%(± 0.15 div.	
		10 vp-p	2 v	Trace height 5 DIV., + or −3%(± 0.15 div.	
		20 vp-p	5 v	Trace height 4 DIV., + or −3%(± 0.12 div.	
		50 Vp-p	10 V	Trace height 5 DIV., + or −3%(± 0.15 div.	
4.3.3.	Continuous control	Square-wave signal 10kHz to A input (B) ampl. 100mV	– AMPL/DIV to 20mV – Continuous control S10 ↺ (S12 ↺)	– Continuous range 1 : > 2.5 (≤ 2 div.) – Uncal led B3 lights up	
4.3.4.	Vertical positioning	Sine-wave signal 10kHz to input A (B) Amplitude 160mVp-p	– AMPL/DIV to 20mV – Set signal in vertical centre by means of position R1 (R2) – Set AMPL/DIV to 10mV – Position control R1 (R2) fully ↺ – Position control R1 (R2) fully ↻	– Top of sine-wave visible on the screen on the vertical centre line. – Bottom of sine-wave visible on the vertical centre line.	
4.3.5.	Vertical deflection via dummy (Input impedance)	Square-wave signal 10kHz to input A via dummy (B)	AMPL/DIV S9 (S11)		
		AMPL 20mVp-p	2mV	Trace height 5 div., + or −3%(± 0.15 div.)	
		50mVp-p	5mV	Trace height 5 div., + or −3%(± 0.15 div.)	
		100mVp-p	10mV	Trace height 5 div., + or −3%(± 0.15 div.)	
		200mVp-p	20mV	Trace height 5 div., + or −3%(± 0.15 div.)	
		500mVp-p	50mV	Trace height 5 div., + or −3%(± 0.15 div.)	
		1 VP-P	0.1V	Trace height 5 div., + or −3%(± 0.15 div.)	
		2 Vp-p	0.2V	Trace height 5 div., ɛ or −3%(± 0.15 div.)	
		5 VP-P	0.5V	Trace height 5 div., + or −3%(± 0.15 div.)	
		10 vp-p	1 V	Trace height 5 div., + or −3%(± 0.15 div.)	
		20 vp-p	2 v	Trace height 5 div., + or −3%(± 0.15 div.)	



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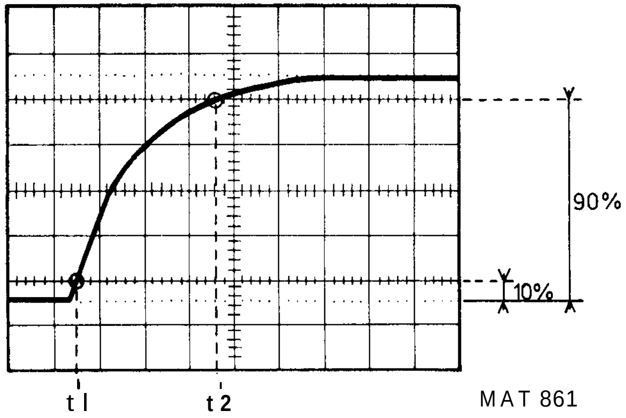
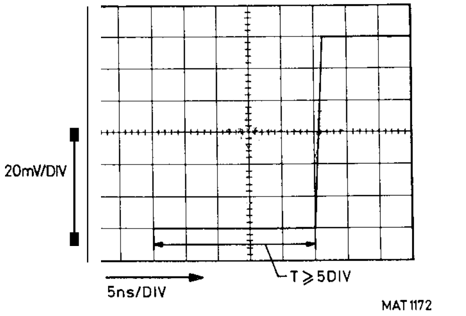
STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
		50Vp-p 50Vp-p	5 v 10V	Trace height 5 div., + or –3%(± 0.15 div.) Trace height 2.5 div., + or –3%	
4.3.6.	Input coupling	Sine-wave signal 2kHz + DC offset to A input (B)	– Depress 0 of S17 (S18) – Set the trace in the centre of the screen R1 ↻ (R2 ↻) – Depress AC of S17 (S18) – Depress DC of S17 (S18)	Signal is visible on the screen, centre of the sine-wave is on the vertical centre of the screen. Signal is visible Centre of the sine-wave is on DC offset level.	
4.3.7.	Common mode rejection	Sine-wave signal 2MHz ampl. 0.16V to A and B input	– AMPLIDIV switches to 20mV – Pull N/I switch S5 – Set the continuous controls for minimum trace height difference – Depress ADD of S1	Rejection 40dB +trace height ⩽ 0.08 div	
4.3.8.	Dynamic range	Sine-wave signal 40MHz, ampl. 2.4V to input A (B)	– Depress AC of S17 (S18) – AMPLIDIV to 0.1V – Shift trace with POSITION control R1 ↻ (R2 ↻)	24 div. trace height distortion-fre visible on screen	
		Sine-wave signal 100MHz, ampl. 0.8V to input A (B)	– AMPLIDIV to 0.1V	8 div. trace height distortion-free visible on screen.	
4.3.9.	Decoupling factor	Sine-wave signal 100MHz to A input ampl. 160mV	– AMPLIDIV switches to 20mV – Depress B of S1	Cross talk from A to B⩽ 0.1 div	

STEP	VOLTAGE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.3.10.	Pulse aberration, rise time	Square-wave signal 1MHz, rise-time ⩽ 1ns, ampl. 12mV to A input (B) Square-wave signal 1MHz, rise-time ⩽ 1ns, ampl. 0.6V to input A (B) Square-wave signal 1MHz, rise-time ⩽ Ins, ampl. 50mV to input A (B)	– AMPLIDIV to 2mV – Position controls R1 R2) ↶↷ – AMPLIDIV to 0.1V – Positions control R1 R2) ↶↷ – AMPLIDIV to 10mV – Set signal between dotted lines ***NOTE:*** ***Trigger instrument on negative going slope (pull S8). This is necessary because the first 50 ns of the sweep have certain inaccuracies.***	 Rise time measurement $t_R = t_2$ (90%) $- t_1$ (10%).	
4.3.11.	Visible signal delay	Square-wave signal 1MHz, rise-time ⩽ 1ns ampl. 300mV to A input	– AMPLIDIV to 50mV – Pull X MAGN switch (S7) – TIME/DIV switch to 0.05μs	– Visible signal delay 30ns approx. (6 div.) – MAGN led B2 lights up 	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.3.1 2.	Trace jump a) attenuator		– Depress 0 of S17 (S18) – Set trace in the centre of the screen – Switch AMPLIDIV switch between 10V ... 20 div – Switch AMPLIDIV switch between 2mV and 20mV	Trace jump ⩽ 0.2 div. Trace jump ⩽ 0.4 div.	
	b) normal/invert		– Depress 0 of S17 (S18) – Trace in the centre of the screen – Pull and push switch S4 (S5) – AMPLIDIV: 10V ... 20mV/div – AMPLIDIV: 10mV ... 2mV/div	Trace jump ⩽ 1 div Trace jump ⩽ 2 div	
	c) continuous control		– Depress 0 of S17 (S18) – Set trace in the centre of the screen – Rotate the continuous control R7 (R8)	Trace jump ⩽ 0.3 div.	
4.3.1 3.	Bandwith channel A (B)	Sine-wave signal 500kHz ... ampl. 120mV to input A (B) Sine-wave signal 500kHz, 100MHz, ampl. 120mV to input A (B).	– TIME/DIV switch S15 to 5µs – AMPLIDIV switch to 20mV – Adjust generator to ampl. of input signal to trace height 6 div.	Trace height must be ⩾ 4.2 div.	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.	**Trigger view**				
4.4.1.	Sensitivity A (B)	Square-wave signal 1kHz to A input (B)	– Depress TRIG VIEW S1. – AMPL/DIV switch S9 (S11) to		
		AMPL. 10mV	2mV	Trace height 5 div. + or – 10%(± 0.5 div.)	
		20mV	5mV	Trace height 4 div. + or – 10% (± 0.4 div.)	
		50mV	10mV	Trace height 5 div. + or – 10% (± 0.5 div.)	
		100mV	20mV	Trace height 5 div. + or – 10%(± 0.5 div.)	
		200mV	50mV	Trace height 4 div. + or – 10%(± 0.4 div.)	
		500mV	0.1V	Trace height 5 div. + or – 10%(± 0.5 div.)	
		1 V	0.2V	Trace height 5 div. + or – 10% (± 0.5 div.)	
		2 v	0.5V	Trace height 4 div. + or – 10%(± 0.4div.)	
		5 v	1 V	Trace height 5 div. + or – 10%(± 0.5 div.)	
		10 V	2 v	Trace height 5 div. + or – 10%(± 0.5 div.)	
		20 V	5 v	Trace height 4 div. + or – 10% (± 0.4div.)	
		50 V	10 V	Trace height 5 div. t or – 10% (± 0.5 div.)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.2.	Sensitivity EXT	Sine-wave signal 1kHz to EXT input X5 Ampl. 1.2V	– Depress EXT of S23 – Depress TRIG VIEW of S1	Trace height 6 div. ± 3%(± 0.18 div.)	
4.4.3.	Pulse aberrations	Square-wave signal 1MHz, Ampl. 120mV, rise time ⩽ 1ns, to input A (B)	– AMPLIDIV to 20mV – Depress TRIG VIEW S1 – Depress A (B) of S23.	Trace height 6 div. Pulse aberrations 10%p-p	
		Square-wave signal 1MHz, ampl. 1.2V, rise-time ⩽ 1μs to input EXT X5.	– Depress TRIG VIEW S1 – Depress EXT of S23	Trace height 6 div. Pulse aberrations ⩽ 6%(⩽ 8%p-p)	
4.4.4.	Trigger threshold	Sine-wave signal 10kHz, ampl. 200mV to input A	– Depress TRIG VIEW S1 – Set AMPLIDIV to 0.2V – Continuous control R7	Minimum triggered trace height ± 0.3 div. from screen centre	
4.4.5.	Time delay between vertical input displayed via A or B and external input displayed via trigger view.	Square-wave signal 1MHz, ampl. 1.2V, rise-time 1ns to A (B) input and to EXT input	– AMPLIDIV to 0.2V/DIV – Depress ALT and TRIG VIEW of S1 – TIME/DIV switch S15 to 0.05μs – Pull X MAGN S7 – Depress EXT of S23	– Time delay between A (B) signal and EXT (via TRIG VIEW) signal must be 6ns approx.	
4.4.6.	Bandwith INT	Sine-wave signal 500kHz, ampl. 120mV to input A	– Depress TRIG VIEW S1 – AMPLIDIV to 20mV – Adjust the generator to ampl. of the input signal to 6 div. trace height		
		Sine-wave signal 500kHz ... 60MHz, ampl. 120mV to input A		Trace height must be ⩾ 4.2 div.	
	Bandwidth EXT	Sine-wave signal 500kHz, ampl. 3V to EXT input X5	– Depress TRIG VIEW S1 – Depress EXT of S23 – Adjust the generator to ampl. of the input signal to trace height 6 div.		
		Sine-wave signal 500kHz ... 70MHz, ampl. 1.2V to EXT input X5		Trace height must be ⩾ 4.2 div.	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.5.	Horizontal or X-axis				
4.5.1.	Display modes	Square-wave signal 2kHz, ampl. 120mV to input A	– AMPL/DIV to 50mV – TIME/DIV MTB (S15) to 0.2ms – Depress MTB of S2 – TIME/DIV DTB (S13) to 50µs – Depress DTB of S2 – Depress ALT TB of S2 – Depress X DEFL of S2	– Square-wave signal 2.4 div. high MTB (trace) – Intensified part DTB visible – Intensified part (DTB) visible over the entire screen width – MTB trace with intensified part and DTB trace visible. Adjust vertical spacing between both displays with TRACE SEP control R15. – Horizontal deflection is determined by the input signal A (2.4 div.)	
4.5.2.	Horizontal positioning range		– X POS control R5 ↻ – X POS control R5 ↺	Starting point trace to horizontal centre of the screen End of trace to horizontal centre of the screen	
4.6.	Triggering **of** the main time-base			*NOTE: If signal is triggered the NOT TRIG'D led B1 is off.*	
4.6.1.	Trigger source and trigger coupling	Square-wave signal 2kHz ampl. 300mV to input A	– AMPL/DIV switch (S9) to 50mV – Depress LF of S20 – Depress TRIG VIEW of S1 – Depress HF of S20 – Depress B of S1	Well triggered display Square-wave signal visible with roundings (LF filter) Differentiated square-wave visible	
		Square-wave signal 2kHz, 300mV to input B and EXT (X5)	– AMPL/DIV (S11) to 50mV – Depress DC of S20 – Depress B of S23 – Depress EXT of S23	Well triggered display Well triggered display	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
		TV signal from TV pattern generator to input A (B)	– Depress TV of S20 – Adjust A (B) AMPL/DIV to ⩾ 0.7 div. sync. pulse amplitude – Depress A (B) of S23 – Depress A (B) of S1	Check for stable triggering on TV frame pulses at MTB TIME/DIV settings 0.5s/div. ... 50μs/div. and on TV line pulses at MTB TIME/DIV settings 20μs/div. ... 50ns/div	
		Sine-wave signal 10kHz, ampl. 120mV to input A and CAL signal to input B	– AMPL/DIV to 50mV – Depress A and B (COMP) of S23 – Depress ALT of S1	Both input signals (that have no time relation) well triggered displayed (both input signals must overlap each other)	
		Sine-wave signal, derived from mains freq., ampl. 120mV to input A (B)	– Depress A (B) of S1 – Depress Band EXT (LINE) of S23	Well triggered display	
4.6.2.	Trigger sensitivity INTERNAL	Sine-wave signal freq. ⩽ 40MHz, ampl. 100mVp-p to input A	– AMPL/DIV to 0.2V – Adjust generator to 0.5 div. trace height	Signal triggers at trace height of ⩾ 0.5 div.	
		Sine-wave signal freq. ⩽ 100MHz, ampl. 150mVp-p to input A	– AMPL/DIV to 0.1V – Adjust generator to 1.5 div. trace height	Signal triggers at trace height of ⩾ 1.5	
4.6.3.	Trigger sensitivity EXTERNAL	Sine-wave signal freq. ⩽ 40MHz, ampl. 100mVp-p to inputs A and EXT (X5)	– AMPL/DIV to 50mV – Depress EXT of S23 – Decrease amplitude of input signal	Signal is well triggered at an amplitude ⩾ 100mV (2 div trace height)	
		Sine-wave signal freq. ⩽ 100MHz, ampl. 300mV p-p to inputs A and EXT (X5)	– AMPL/DIV to 0.1V – Decrease amplitude of input signal	Signal is well triggered at an amplitude ⩾ 300mV (3 div trace height)	
4.6.4.	Level range and triggering slope	Sine-wave signal ampl. 160mV, p-p freq. 1kHz to input A	– AMPL/DIV to 10mV – Depress TRIG of S3 – Depress TRIG VIEW of S1 – LEVEL R6 ↶↷ – Depress LF of S20 – LEVEL R6 ↶↷	Trace is triggered over ± 8 div., trigger point on positive slope	
			– Pull SLOPE S8	Trigger point on negative slope	
			– AMPL/DIV to 20mV – Depress AUTO PP of S3 – LEVEL R6 ↶↷	Triggered signal over the complete LEVEL range	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
		Sine-wave signal 1kHz,	– Depress EXT of S23 – LEVEL R6	Trigger point adjustable over the complete amplitude (± 1.6V)	
4.6.5.	Trigger bandwith	Sine-wave signal 25kHz, ampl. 300mV to input A	– Depress DC of S20 – Depress TRIG of S3 – AMPL/DIV to 50mV – Depress TRIG VIEW – Set trace in the centre by means of R6	Trace must be triggered	
			– Decrease freq. of input signal to ≈ 1Hz (trace height *6* div.)	Trace must be triggered	
			– Increase freq. of input signal to 100MHz	Trace must be triggered	
		Sine-wave signal, 25kHz to input A	– Depress DC of S20 – Adjust ampl. of input signal so that trace height is 6 div.	Trace height *6* div.	
			– Depress LF of S20	Trace height ≥ 4.2 div.	
			– Decrease freq. of input signal to 2Hz	Trace height increases and signal must be triggered	
			Depress HF of S20 – Freq. of input signal 25kHz	Trace height ≥ 4.2 div.	
			– Increase freq. of input signal to 100MHz	Trace height increases and signal must be triggered	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
1.7.	Main time-base			Measured over 8 div. in horizontal screen centre:	
1.7.1.	Time coefficients	Time-marker signal, repetition time:	– MTB TIME/DIV S15 to		
		0.05 µs	0.05 µs	Coefficient error ⩽ +/– 3%	
		0.1 µs	0.1 µs	Coefficient error ⩽ +/– 3%	
		0.2 µs	0.2 µs	Coefficient error ⩽ +/– 3%	
		0.5 µs	0.5 µs	Coefficient error ⩽ +/– 3%	
		1 µs	1 µs	Coefficient error ⩽ +/– 3%	
		2 µs	2 µs	Coefficient error ⩽ +/– 3%	
		5 µs	5 µs	Coefficient error ⩽ +/– 3%	
		10 µs	10 µs	Coefficient error ⩽ +/– 3%	
		20 µs	20 µs	Coefficient error ⩽ +/– 3%	
		50 µs	50 µs	Coefficient error ⩽ +/– 3%	
		0.1 ms	0.1 ms	Coefficient error ⩽ +/– 3%	
		0.2 ms	0.2 ms	Coefficient error ⩽ 3/– 3%	
		0.5 ms	0.5 ms	Coefficient error ⩽ 3/– 3%	
		1 ms	1 ms	Coefficient error ⩽ +/– 3%	
		2 ms	2 ms	Coefficient error ⩽ t/- 3%	
		5 ms	5 ms	Coefficient error ⩽ +/– 3%	
		10 ms	10 ms	Coefficient error ⩽ +/– 3%	
		20 ms	20 ms	Coefficient error ⩽ +/– 3%	
		50 ms	50 ms	Coefficient error ⩽ +/– 3%	
		0.1 s	0.1 s	Coefficient error ⩽ +/– 3%	
		0.2 s	0.2 s	Coefficient error ⩽ +/– 3%	
		0.5 s	0.5 s	Coeffcient error ⩽ +/– 3%	
1.7.2.	Magnifier	Square-wave signal repetition time 0.1µs to input A	– TIME/DIV to 1µs – Pull X MAGN. S7 – X pos R5	– MAGN. led 62 lights up – Coefficient error ⩽ +/– 5% – Trace adjustable over 100 div. ←→	
1.7.3.	Continuous control	As 4.7.2.	– TIME/DIV to 0.1µs – Continuous control CAL R10	– UNCAL led **64** lights up – Continuous range 1 : ⩾ 2.5	

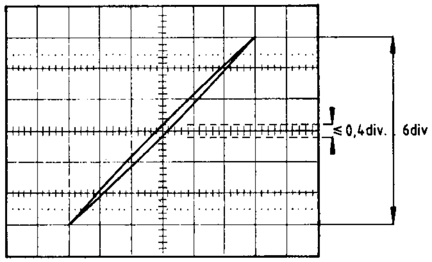
TEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULT!
.7.4.	Single shot	Square-wave signal 10kHz to input A	– TIME/DIV to 0.1ms – Depress SINGLE of S3	– Trace once visible – During SINGLE shot action NOT TRIG'D led B1 lights up	
4.7.5.	Hold off	Square-wave signal repetition time 10µs to input A	– TIME/DIV to 2µs – HOLD OFF R11	– Sweep HOLD OFF time can be varied by a factor of 10 → trace intensity decreases.	
.8.	**Triggering of the** delayed time-base				
.8.1.	Trigger source, trigger coupling and trigger bandwith	Sine-wave signal 2kHz ampl. 300mV to input A	– AMPL/DIV to 0.1V – TIME/DIV MTB (S15) to 0.5ms – TIME/DIV DTB (S13) to 50µs	– Well triggered intensified part (DTB signal)	
			– Depress A of S22 – Adjust LEVEL R4	– Well triggered intensified part	
			– Depress DTB of S2 – Increase freq. of input signal to 100MHz.	– Trace must be well triggered	
			– Depress HF of S19 – Decrease freq. of input signal to 25kHz.	– Trace must be well triggered.	
			– Depress LF of S19 – Decrease freq. of input signal to 2Hz.	– Trace must be well triggered	
		Sine-wave signal 2kHz ampl. 300mV to input B	– Depress DC of S19 – Depress MTB of S2 – Depress B of S1 – Depress B of S23 – Depress B of S22 – Adjust LEVEL R4	– Well triggered intensified part	
			– Depress MTB of S22	– Intensified part well triggered independent of R4.	

TEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	IEASURING RESULTS
.8.2.	Trigger sensitivity	Sine-wave signal freq. ≤ 40MHz, ampl. 100mVp-p to input A ine-wave signal freq. ≤ 100MHz, ampl. 00mVp-p to input A	– AMPL/DIV to 0.2V – TIME/DIV MTB (S15) to 0.05μsec. – TIME/DIV DTB (S13) to 0.05μsec. – Depress A of S22 – Depress DTB of S22 – Adjust LEVEL R4 – Adjust generator to 0.5 div. trace height – Adjust level R4 – Adjust generator to 0.5 div. trace height	Signal triggers at trace height of ≥ 0.5 div. Signal triggers at trace height of ≥ 1.5 div.	
.8.3.	Level range and triggering slope	ine-wave signal 1kHz mpl. 160mV to input A B)	– AMPL/DIV to 10mV – TIME/DIV MTB (S15) to 0.5ms – TIME/DIV DTB (S13) to 0.1ms – Depress A (B) of S22 – Depress DTB of S2 – Adjust LEVEL R4 – Pull slope S6	Trace is triggered over ± 8 div., trigger point on positive slope Trigger point on negative slope	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS		REQUIREMENTS	MEASURING RESULTS
.9.	**Delayed time-base**					
.9.1.	Time coefficients	Time-marker signal repetition time:	– Depress DTB of S2			
			– MTB TIME/DIV S15	DTB TIME/DIV S13	Measured over *8* div. in horizontal screen centre:	
		0.05 µs	0.1 µs	0.05 µs	Coefficient error ⩽ +/– 3%	
		0.1 µs	*0.2* µs	**0.1** µs	Coefficient error ⩽ +/– 3%	
		0.2 µs	0.5 µs	*0.2* µs	Coefficient error ⩽ +/– 3%	
		0.5 µs	1 µs	0.5 µs	Coefficient error ⩽ +/– 3%	
		1 µs	2 µs	1 µs	Coefficient error ⩽ +/– 3%	
		2 µs	5 P	2 µs	Coefficient error ⩽ +/– 3%	
		5 P	10 µs	*5 P*	Coefficient error ⩽ +/– 3%	
		10 µs	20 µs	10 µs	Coefficient error ⩽ +/– 3%	
		20 µs	50 µs	20 µs	Coefficient error ⩽ +/– 3%	
		50 µs	0.1 ms	50 µs	Coefficient error ⩽ +/– 3%	
		0.1 ms	**0.2 ms**	0.1 ms	Coefficient error ⩽ +/– 3%	
		0.2 ms	**0.5 ms**	0.2 ms	Coefficient error ⩽ +/– 3%	
		0.5 ms	1 ms	0.5 ms	Coefficient error ⩽ t/ – 3%	
		1 ms	*2* ms	1 ms	Coefficient error ⩽ +/– 3%	
.9.2.	Magnifier	Square-wave signal repetition time 1 µs	– Depress DTB of *S2* – TIME/DIV MTB (S15) to 2 µs – TIME/DIV DTB (S13) to 1 µs – Pull X MAGN S7 – X pos R5		– MAGN led B2 lights up – Coefficient error ⩽ +/– 5% – Trace adjustable over 100 div. ←→	
.9.3.	Continuous control	As 4.9.2.	– TIME/DIV MTB (S15) to 5 µs – TIME/DIV DTB (S13) to 1 µs – Depress DTB of S2 – Continuous control R9		– UNCAL led B4 lights up – Continuous range 1 : ⩾ 2.5	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
1.9.4.	Delay time	As 4.9.2.	– TIME/DIV MTB (S15) to 5μs – TIME/DIV DTB (S13) to 0.05μs – Delay time R3 to 1.0 – Set start of MTB-trace on the first vertical graticule line – DELAY TIME R3 to 9.0	– Intensified part (DTB) starts at the same point as the MTB trace (2nd vertical line) – Start of the intensified part at the 10nd vertical graticule line (incremental delay time error + or – 0.5%)	
1.9.5.	Delay time jitter	Sine-wave signal 1MHz to input A	– Set trace height to 6 div. – TIME/DIV MTB (S15) to Ims – TIME/DIV DTB (S13) to 0.5μs – Delay time R3 to 9 – Depress DTB of S2	Jitter of DTB trace ≤ 1 div.	
4.9.6.	Incremental delay time error limit	Marker pulse to A-input, repetition time 0.5msec, ampl. 3 div.	– MTB TIME/DIV to 0.5ms – DTB TIME/DIV to 20μs – Depress ALT TB of S2 – Depress MTB of S22 – DELAY TIME control R3 – DELAY TIME control S4	– Intensified part to 2nd marker-pulse-pos. slope of DTB signal to vertical centre of the screen. – Note the value of R3 in 3 digits. – Intensified part to 3nd ... 10th marker pulse - pos. slope of DTB signal to vertical centre of the screen. – Note the values of R3 in 3 digits. – Calculate the steps between the sequential values. – The maximum difference between the steps is ≤ 0.05.	

STEP	3BJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.10.	**K-Y** Operation				
4.10.1	Mode and deflection coefficients	Sine-wave signal 10kHz to input A	– Set trace height to 6 div. – Depress A of S23 – Depress X DEFL of S2	A line under an angle of 45° with respect	
		Sine-wave signal 10kHz to input B	– Depress MTB of S2 – Depress B of S23 – Depress B of S1 – Set trace height to 6 div, – Depress X DEFL of S2		
		Sine-wave signal 10kHz ampl. 1.6V to EXT input X5	– Depress EXT of S23 – Depress B and EXT (LINE) of S23	Trace width 8 div. ± 10% Trace width 8 div. at 50Hz mains frequenc	
4.10.2.	3andwidth via A	Sine-wave signal 1OkHz to input A	– Depress A of S23 – Depress DC of S20 – Depress X DEFL of S2 – Depress B of S1 – Adjust ampl. of input signal for horizontal deflection 8 div. – Increase freq. of input signal to 100kHz	Horizontal deflection 8 div. Horizontal deflection 8 div. (–5%	
		Sine-wave signal 1kHz to input A	– Depress LF of S20 – Adjust ampl. of input signal for horizontal deflection 8 div. – Increase freq. of input signal to 20kHz (ampl. same as above) – Depress HF of S20 – Increase freq. of input signal to 1MHz	Horizontal deflection 8 div. Horizontal deflection decreases Horizontal deflection decreases Horizontal deflection increases	
	3andwidth via EXT nput (X5)	Sine-wave signal 1OkHz to input EXT (ampl. 1.6V)	– Depress EXT of S23 – Adjust ampl. of input signal for 8 div. horizontal deflection – Increase freq. of input signal to 100kHz.	Trace width 8 div. (–3%)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULT!
4.10.3.	Dynamic range	Sine-wave signal 100kHz to input A	– Depress X DEFL of S2 – Depress B of S1 – AMPL/DIV to 0.2V – Set ampl. of input signal for horizontal deflection 5 div. – AMPL/DIV to 50mV	Horizontal deflection 20 div.	
4.10.4.	Phase shift between X and *Y* ampl.	Sine-wave signal 2kHz, ampl. 120mV to input A	– Depress X DEFL of S2 – Depress DC of S20 – Adjust amplitude of input signal for a trace height of 6 div. – Increase the freq. of the input signal to 100kHz – Put A AMPL/DIV in 20mV position	A line under an angle of 45° with respect to the horizontal graticule line visible Phase shift ≤ 3°  MAT 985	
4.11.	**Calibration**		CAL X1	≈ 2kHz square-wave signal, ampl. 1.2Vp-p short-circuit protected	
4.12.	**Z-Modulation**	TTL compatible square-wave signal to input Z-MOD X6		Logic "1" is normal intensity Logic "0" is blanked	

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 2 hours.
- 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. 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 stated, adjust the Intensity, Focus and Trigger Level controls as needed.
- Unless otherwise stated, 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) or PM 2524
H.T. probe	e.g. PM 9246
Trimming tool set	e.g. Philips 800NTX
Resistor 130 Ω, 1,5 W	e.g. 120 Ω WR (4822 112 21083) in serial with 10 Ω WR (482211251054)

5.3. Preliminary settings of the controls

See Fig. 4.1.

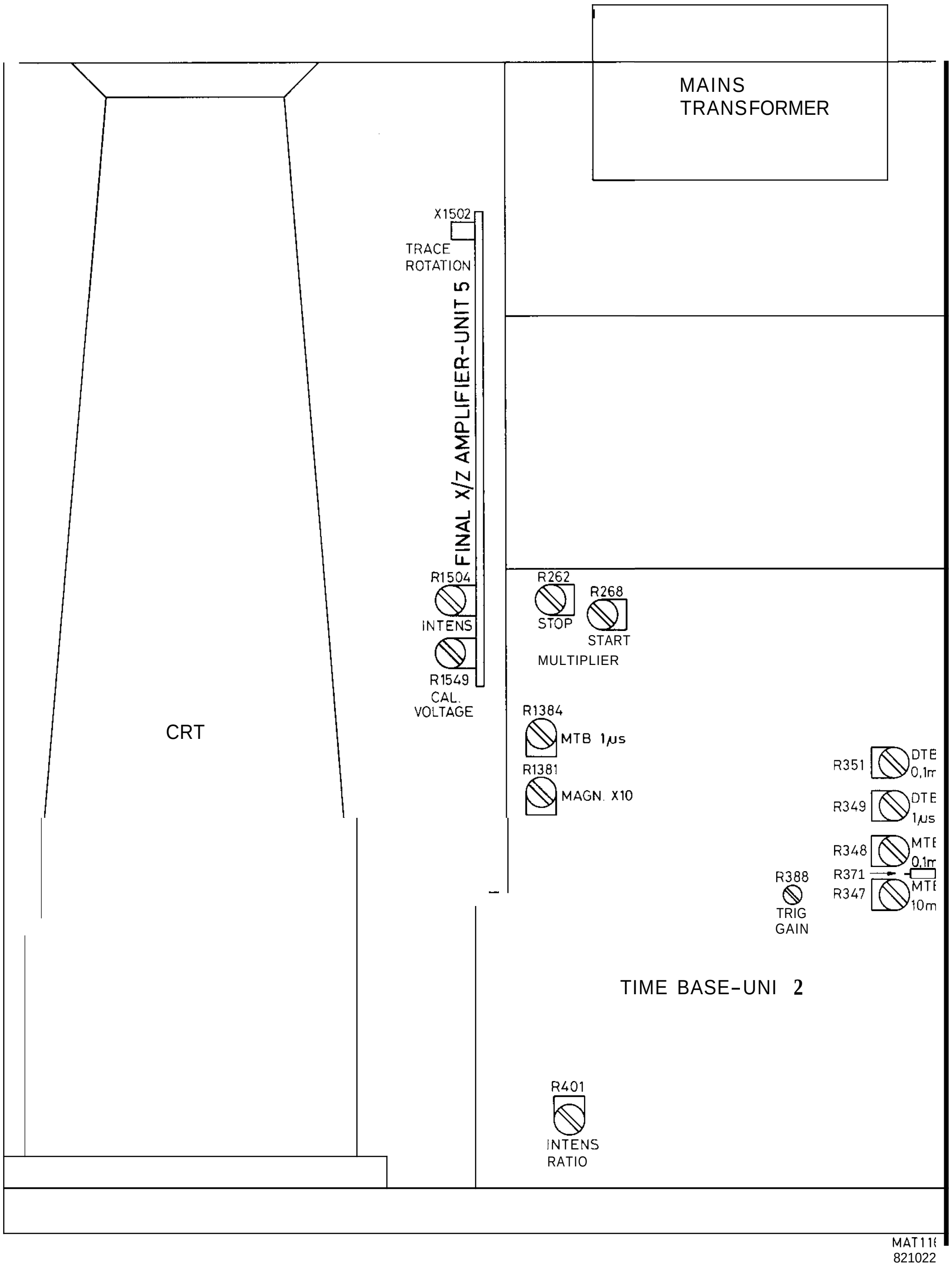


Fig. 5.1. Adjustment points top view

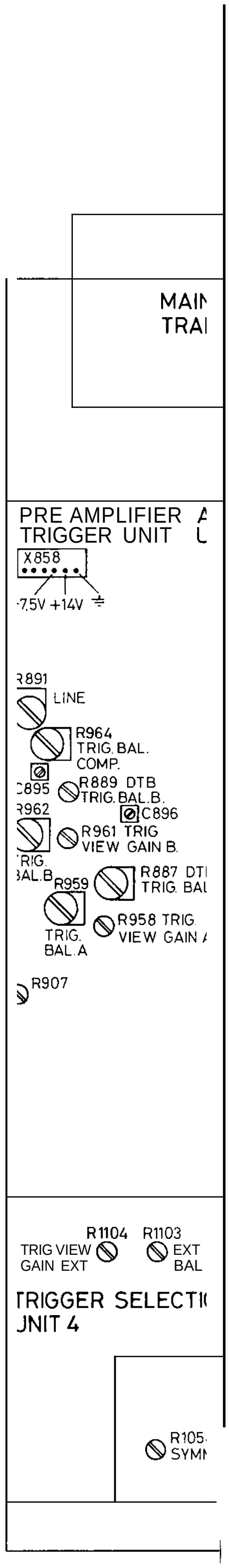
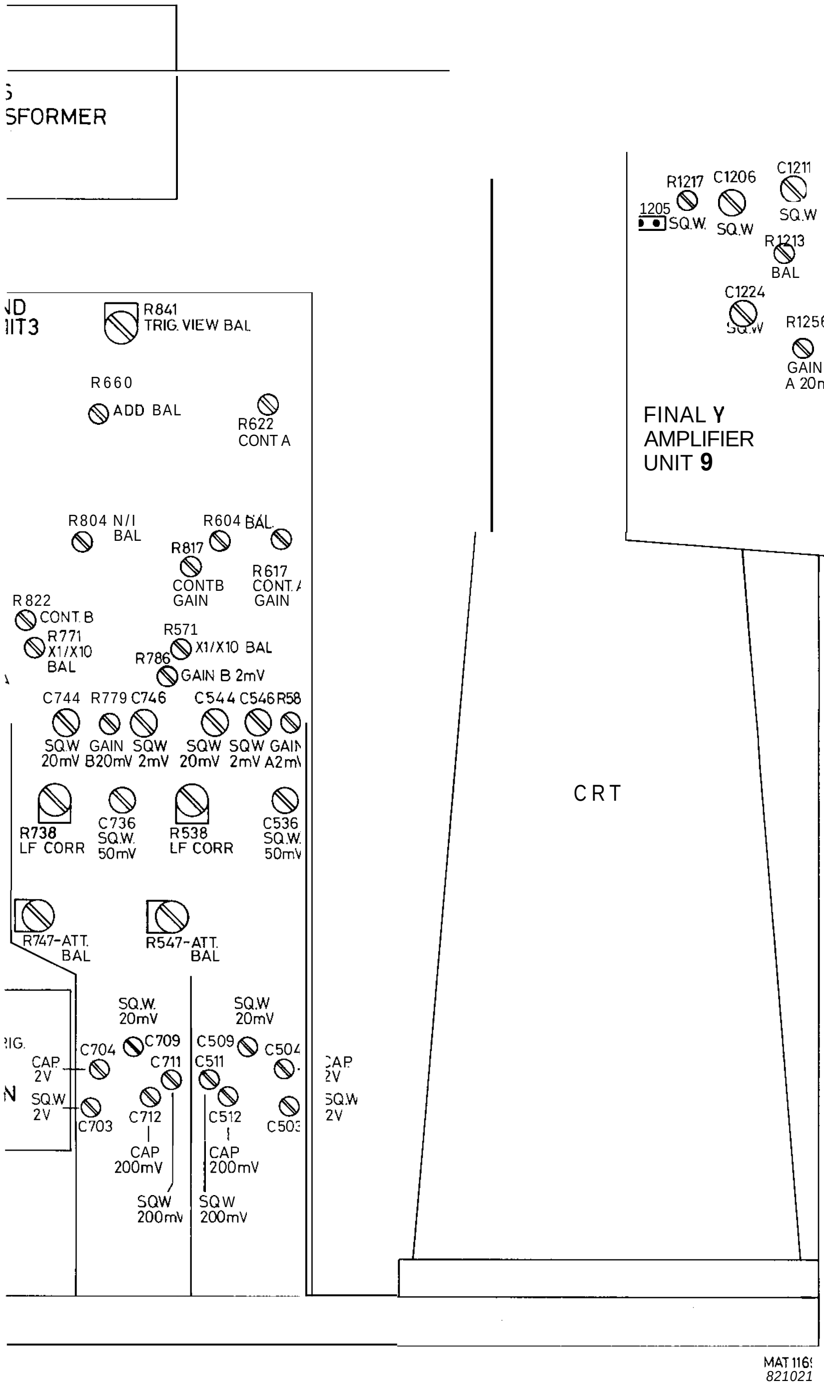


Fig. 5.2. Adjustment



points bottom view

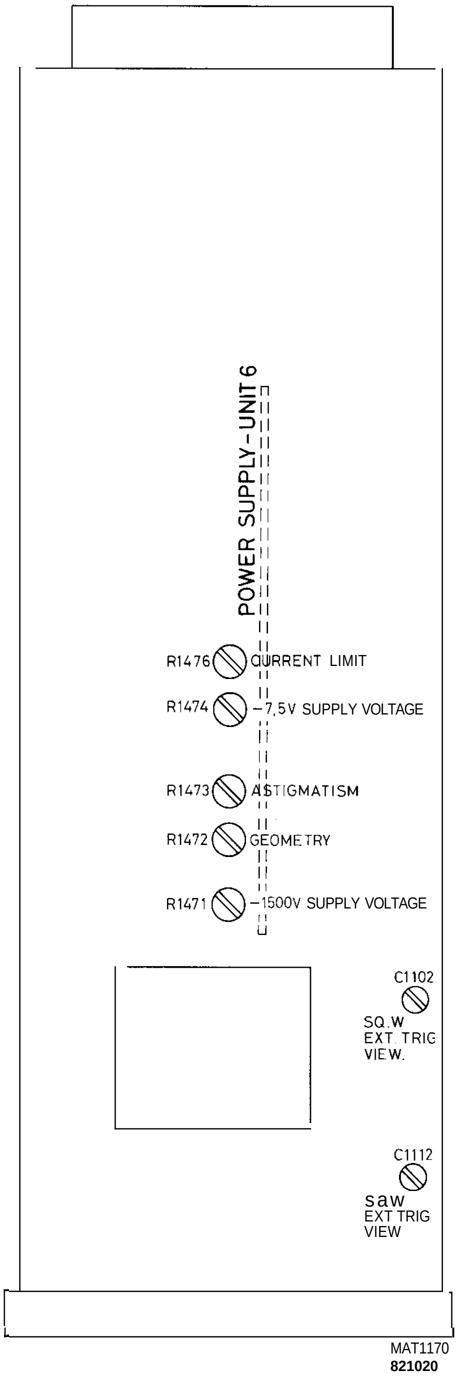


Fig. 5.3. Adjustment points right side

5.4. SURVEY OF ADJUSTING ELEMENTS AND AUXILIARY EQUIPMENT

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
POWER SUPPLY					
Supply voltage adjustment	31474	– 7.5V + or – 3^{o}/oo on pin 3 of X858	Digital multimeter	5.5.1.1.	5.2./5.3.
Current sensing	R1476	Extra load between pin 2 (+14V) and pin 1 of X858. Adjust so that current limit point is just not reached.	–	5.5.1.2.	5.3.
–1500V supply voltage	31471	–1500V + or –3^{o}/oo on pins 7 and 14 of the c.r.t. socket.	Digital multimeter and HV probe	5.5.1.3.	5.3.
CRT DISPLAY ADJUSTMENTS					
Intensity	31504	Point is just visible	–	5.5.2.1.	5.1.
Intens ratio	3401	DTB-trace must be well distinguished from MTB-trace	–	5.5.2.2.	5.1.
Trace rotation	R14	Trace runs exactly in parallel with the horizontal graticule line	–	5.5.2.3.	4.1.
Astigmatism	R1473	Trace as sharp as possible	Function generator (sine-wave signal 10kHz)	5.5.2.4.	5.3.
Geometry	R1472	Displayed vertical lines as straight as possible and signal must fall between hatched area shown in Fig. 5.4.	Function generator (sine-wave signal 100kHz and ≈ 50Hz)	5.5.2.5.	5.3./5.4.
BALANCE ADJUSTMENTS					
Attenuator balance channel A (B)	R547 (R747)	Trace jump minimal (AMPLIDIV setting 2mV and 5mV)	–	5.5.3.1.	5.2.
	R571 (R771)	Trace jump minimal (AMPL/DIV setting 10mV and 20mV)	–	5.5.3.1.	5.2.
Normal-Invert balance channel A (B)	R604 (R804)	Trace jump minimal	–	5.5.3.2.	5.2.
Final Y-amplifier balance	R1213	Trace in vertical mid of screen	–	5.5.3.3.	5.2.
Added balance	R660	Trace jump minimal when switching to added.			

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
LF CORRECTIONS AND SENSITIVITIES					
Continuous control of channel A (B)	R622 (R822)	Continuous attenuation starts at 15° from counter clockwise-stop of R7 (R8)	Function generator (square-wave signal 1OkHz)	5.5.4.	5.2.
	R617 (R817)	Trace height from 5 div. to ⩽ 2 div. when R7 (R8) are fully counter clockwise.	Function generator (square-wave signal 10kHz)	5.5.4.	5.2.
LF correction of channel A (B)	R538 (R738)	Pulse top as straight as possible	Function generator (square-wave signal 100kHz)	5.5.4.2.	5.2.
Gain x 1 channel A (B)	R1256 (R779)	Trace height 5 div. + or −3%	Calibration generator (square-wave signal 10kHz)	5.5.4.3.	5.2.
Gain x10 channel A (B)	R586 (R786)	Trace height 5 div. + or − 3%	Calibration generator (square-wave signal 10kHz)	5.5.4.4.	5.2.
Trigger view sensitivity EXT, A and B	R1104 R958 (A) R961 (B)	Trace height 4 div.	Calibration generator (square-wave signal 10kHz)	5.5.4.5.	5.2.
VERTICAL CHANNELS					
Attenuator square-wave response channel A (B)		Pulse top errors ⩽ + or −1%	Square-wave generator,	5.5.5.1	5.2.
		AMPL/DIV switch setting — Trace height	Freq. 10kHz amplitude:		
		2-5-10mV	12mV-30mV-60mV		
	C509 (C709)	20 mV — 6 div.	120mV		
		50 mV — 6 div.	300mV		
		0.1 V — 6 div.	600mV		
	C511 (C711)	0.2 V — 6 div.	1.2V		
		0.5 V — 6 div.	3 v		
		1 V — 6 div.	6 V		
	C503 (C703)	2 V — 6 div.	12 V		
		5 v — 3 div.	15 V		
		10 V — 3 div.	30 V		

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
Input capacitance channel A (B)		Pulse top errors ⩽ + or − 1%	Square-wave generator. rise-time ⩽ 100ns, via dummy-probe 2 : 1 (fig. 5.5.) Freq. 10kHz	5.5.5.2.	5.2.
		AMPL/DIV setting / Trace height	Amplitude		
		2 mV / 6 div.	24 mV		
		5 mV / 6 div.	60 mV		
		10 mV / 6 div.	120 mV		
	Adjust C of dummy	20 mV / 6 div.	240 mV		
		50 mV / 6 div.	600 mV		
		0.1 V / 6 div.	1.2 V		
	C512 (C712)	0.2 V / 6 div.	2.4 V		
		0.5 V / 6 div.	6 V		
		1 V / 6 div.	12 V		
	C504 (C704)	2 v / 6 div.	24 V		
		5 v / 3 div.	30 V		
		10 V / 1.5 div.	30 V		
Square-wave response channel A		AMPL/DIV setting:	Square-wave calibration generator, frequency 1MHz, rise-time ⩽ 1ns, amplitude:	5.5.5.3.	5.2./5.6.
	C1211	20mV	120mV		
	C1224				
	C1206				
	R1217				
	C 544				
	C 536	50mV	300mV		
	C 546	2mV	12mV		
Square-wave response channel B.		AMPL/DIV setting:	Square-wave calibration generator, frequency 1MHz, rise-time ⩽ Ins, amplitude:	5.5.5.4.	5.2./5.6.
	c744	20mV	120mV		
	C736	50mV	300mV		
	C746	2mV	12mV		

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
Square-wave response trigger view via channel A (B)	C895 (C896)		Square-wave function generator, frequency 1MHz/rise-time ⩽ Ins, 6 div. deflection.	5.5.5.6.	5.2.
Square-wave response trigger view via external trig. input	C1112 C1102		Square-wave function generator, frequency 10kHz, amplitude 2V. Square-wave calibration generator, frequency 1MHz, amplitude 2V, rise-time ⩽ 1ns.	5.5.5.6.	5.3.
TRIGGERING					
Trigger symmetry	R1054	The distances between the trigger points and the top respectively the bottom of the sine-wave signal must be equal.	Sine-wave signal, 10kHz, ampl. 0.8V.	5.5.6.1.	5.2.
Trigger sensitivity	R388	Push and pull S8; trace must be triggered at trace height of 0.4 div.	Sine-wave signal, 10kHz, ampl. 0.8V.	5.5.6.2.	5.1.
Trigger balance channel A, B and EXT	R959 R962 R1103	Trace in vertical centre Trace in the vertical centre Trace in the vertical centre	– – –	5.5.6.3. 5.5.6.3.	5.2. 5.2.
Composite balance	R964	Starting point of trace does not shift when switching to DC trigger coupling	Sine-wave signal, 10kHz, ampl. 0.8V	5.5.6.4.	5.2.
Trigger view balance	R841	Trace in the vertical centre	–	5.5.6.5.	5.2.
Trigger balance	R887 (A)	Start of trace on the vertical centre line	Sine-wave signal, 10kHz	5.5.6.6.	5.2.
DTB via A and B	R889 (B)	Start of trace on the vertical centre line	Sine-wave signal, 10kHz	5.5.6.6.	5.2.

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
TIME-BASE GENERATORS					
Main-time-basetime coefficients		Check that the centre 8 cycles have a total width of **8** div.	Time-marker generator, pulse repetition rate:	5.5.7.1.	
		MTB TIME/DIV			
		0.05 μs horizont. **lin.** of first three cycle	0.05 μs		
		0.1 μs	0.1 μs		
		0.2 μs	0.2 μs		
		0.5 μs	0.5 μs		
	R 1384	1 μs	**1** μs		5.1.
	R1381	1 μs	0.1 μs		5.1.
		Pull **X** MAGN switch			
		2 μs	**2** μs		
		5 P	5 P		
		10 μs	**10** μs		
		20 μs	**20** μs		
		50 μs	*50* μs		
	R348	0.1 ms	0.1 ms		5.1.
		0.2 ms	0.2 ms		
		0.5 ms	0.5 ms		
		1 ms	1 ms		
		2 ms	2 ms		
		5 ms	5 ms		
	R347	**10** ms	**10** ms		5.1.
		20 ms	20 ms		
		50 ms	50 ms		
		1 s	1 s		
		2 s	2 s		
		5 s	5 s		
		Continuous control range of R10 must be between 1 : **2.6** and 1 : 3			

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	IECOMMENDED INSTRUMENT ıND INPUT SIGNALS	CHAPTER	FIGURES
)elayed time-base time :oefficients		Check that the centre 8 cycles have a tota width of 8 div.	'ime-marker generator, pulse ɘpetition rate:	5.5.7.4.	
		MTB TIME/DIV. DTB TIME/DIV.			
		0.1 µs 0.05 µs	0.05 µs		
		0.2 µs 0.1 µs	0.1 µs		
		0.5 µs 0.2 µs	0.2 µs		
		1 µs 0.5 µs	0.5 µs		
	R349	2 µs 1 µs	1 µs		5.1.
		5 P 2 µs	2 µs		
		10 µs 5 µs	5 P		
		20 µs 10 µs	0 µs		
		50 µs 20 µs	0 µs		
		0.1 ms 50 µs	0 µs		
	R35	0.2 ms 0.1 ms	0.1 ms		5.1.
		0.5 ms 0.2 ms	0.2 ms		
		1 ms 0.5 ms	0.5 ms		
		2 ms 1 ms	1 ms		
		Continuous control range **of** R9 must be between 1 : 2.6 and 1 : 3			
)elay time multiplier	R268	Start of DTB trace on the second time-marker pulse when DELAY TIME control is set to 0.1	'ime-marker generator ıulse repetition rate 0.1 ms.	5.5.7.5.	5.1.
	R262	Start of DTB trace on the tenth time-marker pulse when DELAY TIME control is set to 9.0	'ime-marker generator ıulse repetition rate 0.1 ms	5.5.7.5.	5.1.
K-DEFLECTION _ine mode via **X** DEFL	R891	Trace width must be 8 div.		5.5.8.1	5.2.
CAL VOLTAGE	R1549	Output voltage 1.2 Volt (± 0.7%)	Accurate measuring oscilloscope	5.5.9.	5.1

5.5. ADJUSTING PROCEDURE

The adjusting elements are indicated in fig. 5.1., 5.2. and 5.3. for respectively top, bottom and right-hand side of the instrument.

5.5.1. Power supply

- Check that the voltage selector (S25) has been set to the local mains voltage.
- Connect the instrument to the mains voltage or to a 24V battery supply.
- Switch on the oscilloscope and check that the pilot lamp B5 lights up.
- Check that the power consumption (with graticule illumination on) does not exceeed 45W from AC and 37W from a battery supply.

5.5.1.1. Supply voltage adjustment

- Check at nominal mains voltage or battery supply voltage that the voltage on pin 3 of X858 (see fig. 5.2.) is –7.5V + or –3^{o}/oo; if necessary readjust **R1474** (fig. 5.3.).

5.5.1.2. Current sensing

- Connect a resistor of 130Ω (1.5W) across pin 2 (+14V) and pin 1 (⊥) of X858 (fig. 5.2.).
- Adjust the maximum current by means of **R1476** (fig. 5.3.), so that the current limit point is just not reached.
- Remove the resistor.

5.5.1.3. –1500V supply voltage

- Check the –1500V supply voltage on pins 7 and 14 of the c.r.t. socket.
  This –1500V must be + or –3^{o}/oo; if necessary readjust **R1471** (fig. 5.3.).

5.5.2. CRT display adjustments

5.5.2.1. Intensity

- Set the controls as indicated in fig. 4.1.
- Turn R401 (fig. 5.1.) fully to the left.
- Depress X DEFL of S2.
- Set the displayed point in the vertical and horizontal centre of the screen by means of the Y position R1 and the X pos. R5 controls.
- Depress 0 if S17.
- Turn the INTENS control R12 30^{o} from the left hand stop.
- Check that the point is just visible; if necessary readjust **R1504** (fig. 5.1.).

5.5.2.2. Intens ratio

- Depress MTB of S2.
- Depress DC of S17.
- Set the MTB TIME/DIV switch S15 to 5µs.
- Set the DTB TIME/DIV switch S13 to 1µs.
- Set the DELAY TIME control R3 to 5.0.
- Set the INTENS control R12 so that the MTB trace is barely visible over the entire screen.
- Check that the intensified part (DTB part) is more brillant and can be well distinguished from the MTB trace; if necessary readjust R401 (fig. 5.1.).
- Set the DTB TIME/DIV S13 to OFF.
- If necessary readjust intensity adjustment R1504 (see chapter 5.5.2.1.).

5.5.2.3. Trace rotation

- Set the MTB TIME/DIV S15 to 0.1ms.
- Set the trace in the vertical centre of the screen by means of the POSITION control R1.
- Check that the trace runs exactly in parallel with the horizontal graticule line; if necessary readjust TRACE ROTATION R14 (front panel).

***NOTE: If the adjustment range is not sufficient enough, remove connector X1502 (FINAL X/Z AMPLIFIER Unit 5), turn it 180^{o} and reconnect it.
After that, repeat the procedure described above.***

5.5.2.4. Focus and astigmatism

- Set the AMPL/DIV switch S9 to 0.1V.
- Depress 0 of S18.
- Set the MTB TIME/DIV switch S15 to 20µs.
- Depress ALT of S1.
- Set the trace of channel B in the vertical centre of the screen by means of the POSITION control R2.
- Set the FOCUS control R13 135° from its left hand stop.
- Apply a sine-wave signal, frequency 10kHz, 6 div, trace height to input A.
- Check that the traces are as sharp as possible; if necessary optimise with the aid of **R1473** and small readjustments of R13 (fig. 5.3.).

5.5.2.5. Geometry (barrel and pin-cushion distortion)

- Depress A of S1.
- Set the AMPL/DIV switches S9 and S11 to 0.1V.
- Apply a sine-wave signal, frequency 100kHz, amplitude ≈ 800mVp-p to input A.
- Adjust the trace height to 7.4 div. with R7.
- Set the MTB TIME/DIV switch S15 to 50µs.
- Apply a sine-wave signal, frequency ≈ 50Hz/amplitude ≈ 1Vp-p to input B.
- Depress X DEFL of S2.
- Depress B of S23.
- Adjust the horizontal deflection to 9.4 div. by means of the continuous control R8.
- Check that the displayed vertical and horizontal lines are as straight as possible and check that the signal falls between the hatched area shown in fig. 5.4.; if necessary readjust **R1472** (fig. 5.3.).
- Remove the input signals.

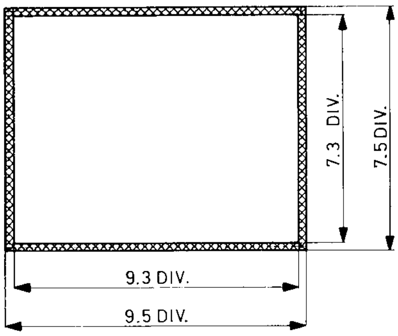


***Fig.** 5.4. Geometry check*

5.5.3. Balance adjustments

The balance adjustments of channels A and B are identical.
The knobs, sockets and adjustments of channel B are shown in brackets behind those of channel A.

5.5.3.1. Attenuator AMPL/DIV balance channel A (B)

- Set the controls as indicated in fig. 4.1.
- Depress A (B) of S1.
- Depress 0 of S17 and S18.
- Depress A (B) of S23.
- Set the trace in the vertical centre of the screen by means of POSITION control R1 (R2).
- Switch the AMPL/DIV control S9 (S11) between the positions 2mV and 5mV.
- Adjust R547 (R747) for minimal trace jump, fig. 5.2.
- Switch the AMPL/DIV control S9 (S11) between the positions 10mV and 20mV.
- Adjust R571 (R771) for minimal trace jump, fig. 5.2.

5.5.3.2. Normal-Invert balance channel A (B)

- Depress A (B) of S1.
- Put the AMPL/DIV control S9 (S11) in position 2mV.
- Set the trace in the vertical centre of the screen by means of POSITION control R1 (R2).
- Pull and push the normal-invert switch S4 (S5).
- Adjust R604 (R804) for minimal trace jump, fig. 5.2.

5.5.3.3. Final Y amplifier balance

- Interconnect both inputs of the delay line.
- Adjust R1213 (fig. 5.2.) on the final Y amplifier unit so that the trace is just in the vertical mid of the screen. Disconnect both inputs of the delay-line.
- Depress 0 of S17 and S18.
- Put the AMPL/DIV switches in position 20mV/div.
- Turn the channel A position control R1 fully counter clockwise.
- Turn the channel B position control R2 fully clockwise.
- Depress ADD of S1.
- Position the trace in the vertical mid of the screen by means of R660 (fig. 5.2.).
- Depress ALT of S1.
- Position the channel A and B traces in the vertical mid of the screen by means of R1 and R2.
- Depress ADD of S1 and read out the vertical distance between the trace and the vertical mid of the screen.
- Depress B of S1 and adjust R660 (fig. 5.2.) so that a vertical distance is obtained equal to the one measured in the previous step.
- Check the adjustment as follows: depress ALT of S1 and position the channel A and B traces in the vertical mid of the screen.
- Depress ADD and check if the trace is still in the vertical mid of the screen.

5.5.4. **LF** corrections and sensitivities

The LF corrections and sensitivity adjustments of channel A and B are identical.
The knobs, sockets and adjustments for channel B are shown in brackets behind those of channel A.

5.5.4.1. Continuous control of channel A (B)

- Depress A (B) of S1.
- Depress A (B) of S23.
- Set the AMPL/DIV switch S9 (S11) to 20mV.
- Apply a square-wave signal, freq. 10kHz, ampl. 100mV approx. to input A (B), giving 5 div. deflection on screen.
- Turn the continuous control CAL R7 (R8) 15^{o} counter clockwise out of its CAL position.
- Check that the continuous attenuation starts at this position of the continuous control; if necessary readjust R622 **(R822)**, fig. 5.2.
- Turn the continuous control CAL R7 (R8) fully counter clockwise.
- Check that the trace height is $\leqslant$ 2 div., if necessary readjust R617 **(R817)**, fig. 5.2.

5.5.4.2. LF correction of channel A (B)

- Set the controls as indicated in fig. 4.1.
- Set the MTB TIME/DIV switch S15 to 20ms.
- Set the AMPL/DIV switch S9 (S11) to 20mV.
- Apply a square-wave signal, frequency 100Hz, ampl. 100mV to input A (B).
- Check that the pulse top is as straight as possible; if necessary readjust R538 **(R738)**, fig. 5.2.

NOTE: *Check if the AMPL/DIV balance, the **normal/invert** balance and the final Y amplifier balance are still within tolerance. If not repeat paragraphs 5.5.3.1., 5.5.3.2. and 5.5.3.3.*

5.5.4.3. Gain XI (sensitivity) channel A (B)

- Set the MTB TIME/DIV switch to 0.2ms.
- Apply a square-wave signal, freq. 10kHz, ampl. 100mV to input A (B).
- Set the AMPL/DIV switch S9 (S11) to 20mV.
- Depress A (B) of S1.
- Depress A (B) of S23.
- Check that the trace height is 5 div. + or – 3%; if necessary readjust **R1256 (R779)**, fig. 5.1. (fig. 5.2.).

5.5.4.4. Gain X10 (sensitivity) channel A (B)

- Depress A (B) of S1.
- Depress A (B) of S23.
- Set the AMPL/DIV switch S9 (S11) to 2mV.
- Apply a square-wave signal, freq. 10kHz, ampl. 10mV to input A (B).
- Check that the trace height is 5 div. + or – 3%; if necessary readjust **R586 (R786)**, fig. 5.2.

5.5.4.5. Trigger view sensitivity via EXT and A and B

- Set the controls as indicated in fig. 4.1.
- Put the MTB TIME/DIV (S15) in position 0.5ms.
- Set the AMPL/DIV switch S9 (S11) to 0.2mV.
- Apply a square-wave signal, freq. 10kHz, ampl. exactly 0.8V to input EXT (X5) and A and B.
- Apply a square-wave signal, freq. 10kHz, ampl. exactly 2V to input EXT (X5) and A and B.
- Depress TRIG VIEW of S1.
- Depress TRIG and AUTO PP of S3.
- Set the trace in the vertical centre by means of the LEVEL control R6,
- Depress EXT of S23,
- Check that the trace height is 4 div.; if necessary readjust R1104, fig. 5.2.
- Depress A of S23.
- Check that the trace height is exactly 4 div.; if necessary readjust R958, fig. 5.2.
- Depress B of S23.
- Check that the trace height is exactly 4 div.; if necessary readjust R961, fig. 5.2.

5.5.5. Square-wave response and bandwidth

The adjustments of channel A and B are identical.
The item numbers of the knobs, sockets and adjustments of channel B are shown in brackets behind those of channel A.

5.5.5.1. Attenuator square-wave response, channel A (B)

- Set the controls as indicated in fig. 4.1.
- Set the MTB TIME/DIV switch S15 to 20μs.
- Apply a square-wave signal freq. 10kHz, rise time ⩽ 100ns to input A (B).
- Depress A (B) of S1.
- Depress A (B) of S23.
- Check the trace height of the displayed signal (indicated in the table below).
- Check the square-wave response; check that the pulse-top errors do not exceed + or –1% ; if necessary readjust as indicated in the table below.

Channel A (B) AMPL/DIV S9 (S11)	Amplitude of input signal A (B)	Adjusting element channel A (B)	Trace height + or –1%
2 mV	12 mV		6 div.
5 mV	30 mV		6 div.
10 mV	60 mV		6 div.
20 mV	120 mV	C509 (C709)	6 div.
50 mV	300 mV		6 div.
0.1 V	600 mV		6 div.
0.2 V	1.2 V	C511 (C711)	6 div.
0.5 V	3 V		6 div.
1 V	6 V		6 div.
2 V	12 V	C503 (C703)	6 div.
5 V	15 V		3 div.
10 V	30 V		3 div.
		see fig. 5.2.	

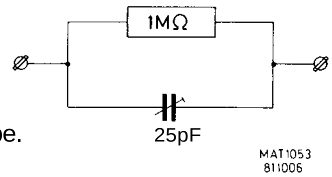
- Remove the input signal

5.5.5.2. *Input capacitance, channel A (B)*

- Apply via a dummy probe (fig. 5.5.) a square-wave signal, freq. 10kHz, rise-time ⩽ 100ns to input A (B).
- Check the square-wave response; check that the pulse top errors do not exceed + or – 1% ; if necessary

Channel A (B) AMPL/DIV S9 (S11)	Amplitude of input signal A (B)	Adjusting element channel A (B)	Trace height + or –1%
2 mV	24 mV	–	6 div.
5 mV	60 mV	–	6 div.
10 mV	120mV	–	6 div.
20 mV	240 mV	Adjust Cd (dummy)	6 div.
50 mV	600 mV	–	6 div.
0.1 V	1.2 V	–	6 div.
0.2 V	2.4 V	C512 (C712)	6 div.
0.5 V	6 V	–	6 div.
1 V	12 V	–	6 div.
2 v	24 V	C504 (C704)	6 div.
5 v	30 V		3 div.
10 V	30 V		1.5 div.

Fig. 5.5. Dummy probe 2 : 1



- Remove input signal and dummy probe.

All HF square-wave adjustments must be carried out with a resistor of 215 kΩ switched in parallel with R1229 via contact bridge X1205 on the final Y amplifier (unit 9).
This compensates for HF square-wave response changes at high ambient temperatures

5.5.5.3. *HF square-wave response channel A*

- Set the controls as indicated in fig. 4.1.
- Set the AMPL/DIV switch S9 to 20mV.
- Apply to X2 (A) a square-wave signal at 120mV, frequency 1MHz and with a rise-time ⩽ Ins.
- Set the TIME/DIV switch S15 to 0.2µs.
- Using C1211 and C1244 (fig. 5.2.) adjust the square-wave response as straight as possible (see fig. 5.6.).

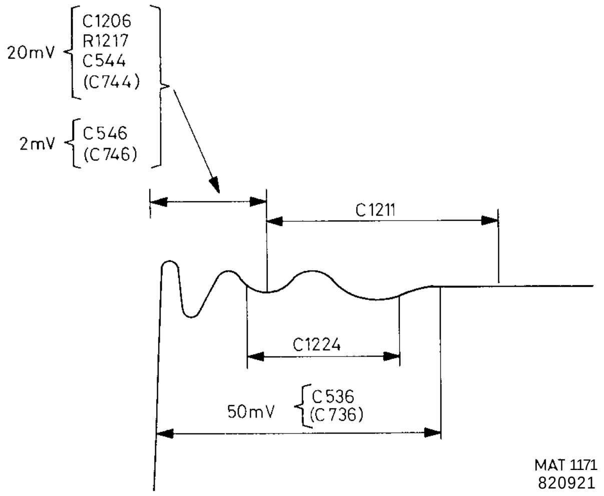


Fig. 5.6. Adjustment of HF square-wave response

- Set the TIME/DIV switch S15 to 0.1µs.
- Using C1206, R1217 and C544 (fig. 5.2.) adjust the square-wave response as straight as possible (fig. 5.6.).
- Set the AMPL/DIV switch S9 to 50mV.
- Apply to X2 (A) a square-wave signal of 300mV, frequency 1MHz and with a rise-time ⩽ 1ns.
- Using C536 (fig. 5.2.) adjust the square-wave response as straight as possible (see fig. 5.6.).
- Set the AMPL/DIV switch S9 to 2mV.
- Apply (via a 20dB attenuator, if generator output voltage is too high) to X2 (A) a square-wave signal of 12mV, frequency 1MHz and with a rise-time ⩽ 1ns.
- Using C546 (fig. 5.2.) adjust the square-wave response as straight as possible (fig. 5.6.)
- Check the bandwidth according to paragraph 5.5.5.8.

5.5.5.4, HF square-wave response channel B

- Set the controls as indicated in fig. 4.1.
- Set the AMPL/DIV switch S11 to 20mV.
- Apply to X4 (B) a square-wave signal of 120mV, frequency 1MHz and with a rise-time ⩽ 1ns.
- Set the TIME/DIV switch S15 to 0.1µs.
- Using C744 (fig. 5.2.) adjust the square-wave response as straight as possible (fig. 5.6.)
- Set the AMPL/DIV switch S11 to 50mV.
- Apply to X4 (B) a square-wave signal of 300mV, frequency 1MHz and with a rise-time ⩽ 1ns.
- Using C736 (fig. 5.2.) adjust the square-wave response as straight as possible (see fig. 5.6.).
- Set the AMPL/DIV switch S11 to 2mV.
- Apply to X4 (B) a square-wave signal of 12mV, frequency 1MHz and with a rise-time ⩽ Ins (via a 20dB attenuator, if generator output voltage is too high).
- Adjust with C746 (fig. 5.2.) the square-wave response as straight as possible (fig. 5.6.).
- Check the bandwidth according to paragraph 5.5.5.8.

5.5.5.5. Square-wave response channel A (B) invert

- Depress A (B) of S1.
- Depress A (B) of S23.
- Pull the NORMAL-INVERT switch S4 (S5).
- Apply a square-wave signal, frequency 1MHz, rise-time ⩽ 1ns to input A (B).
- Check the square-wave response of the inverted signal; if necessary readjust for an optimal result between NORMAL square-wave and INVERTed square-wave by means of the procedure given in section 5.5.5.3. and 5.5.5.4.

5.5.5.6. Square-wave response trigger view via channel A and B and external trigger input

- Depress TRIGGER VIEW of S1.
- Depress AUTO of S3.
- Put MTB TIME/DIV switch S15 in position 0.05µs/div.
- Put the AMPL/DIV switches S9 and S11 in position 10 mV/div.

NOTE: This part of the procedure describes the square-wave adjustment via channel A and B. The procedure steps of channel B are mentioned between brackets behind those of channel A: first the steps for channel A must be carried out.

- Depress pushbutton A (B) of S23.
- Apply a square-wave signal of 1MHz/rise-time ⩽ 1ns giving a vertical deflection of 6 div. to the channel A (B) input socket X2 (X4).
- Position the signal in the vertical mid of the screen by means of MTB LEVEL control R6.
- Adjust the square-wave response as flat as possible by means of trimming capacitor C895 (C896).

- Depress EXT of S23.
- Put MTB TIME/DIV switch S15 in position 0.2ms/div.
- Apply a square-wave signal of 2kHz/1,2 Volt to the external trigger input socket X5.
- Adjust the square-wave response as flat as possible with C1112.
- Apply a square-wave signal of 1MHz/rise-time ⩽ 1ns/1,2 Volt to the external trigger input socket X5.
- Put MTB TIME/DIV switch S15 in position 0.05 µ5/div.
- Adjust the square-wave response as flat as possible with C1102.

NOTE: Disconnect the contact bridge X1205 on unit 9.

5.5.5.7. Chopper cross-talk from channel A to B

- Set the controls as indicated in fig. 4.1.
- Depress CHOP pushbutton of S1.
- Set the AMPL/DIV switches S9 and S11 to 20mV.
- Apply to X2 (A) a square-wave signal of 120mV, frequency 10kHz and with a rise-time ⩽ 1ns.
- Put the TIME/DIV switch S15 to 0.1ms.
- Check that the cross-talk from channel A to B does not exceed 1.5% (0.1 div.).

5.5.5.8. Bandwidth check channel A (B)

- Depress the X MAGN switch S7 (X1).
- Set the MTB TIME/DIV switch S15 to 5μs.
- Apply a sine-wave signal, freq. 50kHz, constant amplitude of 12mV to input A (B).
- Depress A (B) of S1.
- Depress A (B) of S23.
- Set the AMPL/DIV switch S9 (S11) to 2mV.
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal from 50kHz to 80MHz (constant amplitude 12mV).
- Check that the trace height is ⩾ 4.2 div. over the whole freq. range.
- Set the AMPL/DIV switch S9 (S11) to 20mV.
- Apply a sine-wave signal, freq. 50kHz, constant amplitude of 120mV to input A (B).
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal from 50kHz to 100MHz (constant amplitude 120mV).
- Check that the trace height is ⩾ 4.2 div. over the whole freq. range.
- If the specifications mentioned above are not met, readjust the instrument according to chapter 5.5.5.3. and 5.5.5.4.

5.5.5.9. Bandwidth check trigger view via channel A (B)

- Set the AMPL/DIV switch S9 (S11) to 2mV.
- Apply a square-wave signal, frequency 50kHz, constant amplitude of 12mV to input A (B).
- Depress A (B) of S23.
- Depress TRIG VIEW of S1.
- Set the trace in the vertical centre of the screen by means of the LEVEL control R6.
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal from 50kHz to 60MHz (constant amplitude 12mV).
- Check that the trace height is ⩾ 4.2 div.

5.5.5.10. Bandwidth check trigger view via EXT

- Depress EXT of S29.
- Apply a sine-wave signal, freq. 50kHz, constant amplitude 0.8V to input EXT (X5).
- Check that the trace height is exactly 4 div.
- Increase with frequency of the input signal to 70MHz (constant amplitude 0.8V).
- Check that the trace height is ⩾ 2.8 div.
- Remove the input signal.
- If the specification mentioned above is not met readjust the instrument according to chapter 5.5.5.6.

5.5.6. Triggering

5.5.6.1. Trigger symmetry

- Set the controls as indicated in fig. 4.1.
- Set **S15** to **50µs.**
- Set **S9** to **.2V.**
- Apply a sine-wave signal 1.6V p-p frequency 10kHz to input A.
- Adjust the generator to a trace height of 8 div.
- Push the SLOPE switch S8 for positive triggering.
- Set R6 fully clockwise.
- Note the starting-point of the trace.
- Pull the SLOPE switch S8 for negative triggering.
- Set R6 fully counter-clockwise.
- Note the starting-point of the trace.
- Check that in both situations described above, the distances between the trigger points and the top respectively the bottom of the sine-wave signal are equal; if necessary readjust **R1054** (fig. 5.2.) for an optimal result.
- Remove the input signal.

5.5.6.2. Trigger sensitivity

- Set the controls as indicated in fig. 4.1.
- Set S9 and S11 to .2V.
- Apply a sine-wave signal 80mV, frequency 10kHz to the input A.
- Pull and push the SLOPE switch S8.
- Check that the trace is well triggered; if necessary readjust **R388** (fig. **5.1**.).

5.5.6.3. Trigger balance channel A, B and EXT

- Depress TRIG VIEW of S1.
- Depress AUTO PP and TRIG of S3.
- Depress 0 of S17 and S18.
- Depress LF of S20 and A of S23.
- Set the trace in the vertical centre of the screen by means of the LEVEL control R6.
- Depress DC of S20.
- Check that the trace is in the vertical centre of the screen; if necessary readjust **R959** (see fig. 5.2.).
- Depress B of S23.
- Check that the trace is in the vertical centre of the screen; if necessary readjust **R962** (see fig. 5.2.).
- Depress EXT of S23.
- Check that the trace is in the vertical centre of the screen; if necessary readjust **R1103** (see fig. **5.2.).**

5.5.6.4. Composite balance

- Depress A of S1.
- Depress A of S23.
- Depress AUTO (AUTO PP and TRIG) of S3.
- Put AMPL/DIV in position 0.2V.
- Release all the pushbuttons of S20.
- Depress DC of S17.
- Apply a sine-wave signal, frequency 10kHz to input X2 (A).
- Set the trace-height to 4 div.
- Set S15 to 10µs.
- Depress A and B (COMP) of S23.
- Adjust R964 (fig. **5.2.) so** that the starting point of the trace does not shift when switching to position DC of S20.

5.5.6.5. Trigger view balance

- Depress TRIG VIEW of S1.
- Depress 0 of **S17.**
- Depress AUTO PP of **S3.**
- Depress DC of S20.
- Depress A of S23.
- Check that the trace is in the vertical centre of the screen; if necessary readjust **R841** (see fig. 5.2.).

5.5.6.6. Trigger balance, DTB, via chennel A and B

- Depress A of S1.
- Set S9 and S11 to 0.2V.
- Set **S13** and S15 to 50µs.
- Depress A of S22.
- Set the DELAY TIME control **R3** fully counter-clockwise (to 0.0).
- Depress DTB of S2.
- Depress DC of S17 and S18.
- Apply a sine-wave signal, frequency 10kHz, amplitude 1.2V to input X2 (A).
- Release all switches of S19.
- Set the trace in the vertical centre of the screen by means of R1.
- Set the start of the trace on the vertical centre line of the screen by means of R4 (LEVEL DTB).
- Depress DC of S19.
- Check that the start of the trace is on the vertical centre line of the screen; if necessary readjust **R887** (fig. 5.2.).
- Depress B of S1.
- Depress B of S22.
- Depress B of S23.
- Apply a sine-wave signal, frequency 10kHz, amplitude 1.2V to input X4 (B).
- Set the trace in the vertical centre of the screen by means of R2.
- Release all switches of S19.
- Set the start of the trace on the vertical centre line of the screen by means of R4.
- Depress DC of S19.
- Check that the start of the trace is on the vertical centre line of the screen; if necessary readjust **R889** (see fig. 5.2.).
- Remove the input signal.

5.5.7. Time-base generators

NOTE: Before starting the adjustment of the time-base generators and the delay time multiplier add a 1.8MΩ resistor ford. nr. 4822 110 63194) across R371 on the time-base (unit 2). This compensates for sweep time inaccuracies at high ambient temperatures.

5.5.7.1. Main time-base time coefficients

- Set the controls as indicated in fig. 4.1.
- Set the AMPL/DIV switch S9 to 0.5V.
- Set the MTB TIME/DIV switch S15 to 1µs.
- Apply a time-marker signal of ≈ 2V, pulse repetition rate 1µs to input X2 (A).
- Check that the centre 8 cycles have a total width of 8 div; if necessary readjust **R1384** (fig. 5.1 .).
- Pull the X MAGN switch S7 (X10).
- Check if the MAGN led B2 lights up.
- Apply a time-marker signal, pulse repetition rate 0.1µs to input X2 (A).
- Check that the centre 8 cycles have a total width of 8 div; if necessary readjust **R1381** (fig. 5.1 .).
- Push the X MAGN switch S7.
- Set the MTB TIME/DIV switch S15 to 0.1ms.
- Apply a time-marker signal, pulse repetition rate 0.1ms, to input X2 (A).
- Check that the centre 8 cycles have a total width of 8 div; if necessary readjust **R348** (fig. 5.1.).
- Set the MTB TIME/DIV switch S15 to 10ms.
- Apply a time-marker signal, pulse repetition rate 10ms, to input X2 (A).
- Check that the centre 8 cycles have a total width of 8 div; if necessary readjust **R347** (fig.5.1.).
- Check the other positions of the TIME/DIV switch S15, using the appropriate input signals, tolerances +/– 3%.
- Check that the trace-length in all TIME/DIV positions is >10 div.
- Set the TIME/DIV switch S15 to 1µs.
- Apply a time-marker signal, pulse repetition rate 1µs to input X2 (A).
- Check that the control range of the continuous control R10 lies between 1:2.6 and 1:3.
- Check that the UNCAL led lights up when the continuous control R10 is not in CAL position.
- Set the continuous control R10 in CAL position.

5.5.7.2. X position range

- Set the MTB TIME/DIV switch S15 to Ims.
- Apply a time-marker signal, pulse repetition rate 10ms, to input A.
- Check that the two displayed marker pulses can be horizontally shifted over a range of 10 div.
- Pull the X MAGN control S7 (X10).
- Check that the two time-marker pulses can be horizontally shifted over a range of 100 div.
- Depress the X MAGN control S7.

5.5.7.3. Hold off

- Set the MTB TIME/DIV switch S15 to 0.1µs.
- Apply a time-marker signal, pulse repetition rate 10µs, to input X2 (A).
- Turn the HOLD OFF control R11 counter clockwise.
- Check if the intensity of the displayed signal suddenly decreases.
- Set the TIME/DIV swith S15 to 10µs.
- Apply a time-marker signal, pulse repetition rate 0.1 ms, to input X2 (A).
- Turn the HOLD OFF control control R11 counter clockwise.
- Check if the intensity of the displayed signal suddenly decreases.
- Set the TIME/DIV switch S15 to 5ms.
- Apply a time-marker signal, pulse repetition rate 0.1 sec, to input X2 (A).
- Turn the HOLD OFF control R11 counter clockwise.
- Check if the number of sweeps suddenly decreases (longer HOLD OFF time).
- Set the HOLD OFF control R11 fully clockwise.

5.5.7.4. *Delayed time-base time coefficients*

- Set the controls as indicated in fig. 4.1.
- Depress A of S22.
- Set the DELAY TIME control R3 to 0.
- Set the MTB TIME/DIV switch S15 to 2µs.
- Set the DTB TIME/DIV switch S13 to 1µs.
- Apply a time-marker signal, pulse repetition rate 1µs, to input X2 (A).
- Depress DTB of S2.
- Check that the centre *8* cycles have a total width of *8* div; if necessary readjust **R349** (fig. 5.1.).
- Set the MTB TIME/DIV switch to 0.2ms.
- Set the DTB TIME/DIV switch to 0.1ms.
- Apply a time-marker signal, pulse repetition rate 0.1 ms, to input A.
- Check that the centr *8* cycles have a total width of *8* div; if necessary readjust **R351** (fig. 5.1.).
- Check the other positions of the DTB TIME/DIV switch S13 (keep the MTB TIME/DIV switch S15 one position slower than the DTB TIME/DIV switch) using the appropriate input signals, tolerances + or – 3% – 1 subdiv.).
- Set the MTB TIME/DIV switch S15 to 5µs.
- Set the DTB TIME/DIV switch S13 to 1µs.
- Apply a time-marker signal, pulse repetition rate 1µs, to input A.
- Check that the control range of the continuous control R9 lies between 1:2,6 and 1:3.
- Check that the UNCAL LED B4 lights up when the continuous control R9 is not in the CAL position.
- Set the continuous control R9 in CAL position.
- Remove the input signal.

5.5.7.5. *Delay time multiplier*

- Depress MTB of S2.
- Depress MTB of S22.
- Set the DELAY TIME control R3 to 1.0.
- Set the start of the trace exactly on the first vertical graticule line by means of the X POS control R5.
- Set the MTB TIME/DIV switch (S15) to 0.1 ms.
- Set the DTB TIME/DIV switch (S13) to 0.1µs.
- Apply a time-marker signal, pulse repetition rate 0.1 ms to input A.
- Check that the intensified part on the trace coincides with the starting point of the second time-marker pulse if necessary readjust **R268** (fig. 5.1).
- Set the DELAY TIME control to 9.0.
- Check that the intensified part on the trace coincides with the starting point of the tenth time-marker pulse; if necessary readjust **R262** (fig. 5.1.).
- Both adjustments are a little bit interdependent, so the procedure described above must be repeated until both conditions are fulfilled.
- Set the DELAY TIME control R3 to 0.

5.5.7.6. *Checking the delay time jitter*

- Set the MTB TIME/DIV switch S15 to 1ms.
- Set the DTB TIME/DIV switch S13 to 0.5µs.
- Apply a sine-wave signal, frequency 1MHz to input X2 (A).
- Set the trace height to 6 div.
- Set the DELAY TIME control to 9.0.
- Depress DTB of S2.
- Check that the jitter of the DTB trace is ⩽ 1 div.

NOTE: Remove the 1.8MΩ resistor again.

5.5.8. X Deflection

5.5.8.1. *Adjusting the LINE mode via X DEFL*

- Connect the instrument to a mains voltage with a mains frequency of 50 or 60 Hz.
- Depress B and EXT (LINE) of S23.
- Check that the trace width is *8* div; if necessary readjust **R891** (fig. 5.2.).

5.5.9. Calibration voltage

- Check if the output voltage on CAL output socket X1 has a frequency of 2kHz (± 10%) and a duty cycle between 45 and 55%.
- Check the output voltage on X1 with a well calibrated oscilloscope. Amplitude must be 1.2 Volt ± 0.7%. If incorrect readjust R1549 on unit 5.

5.6. ADJUSTMENT INTERACTIONS

This table shows you what adjustment points are affected (see horizontal row) after readjustment of a certain adjustment point in the vertical row.
The adjustment points that are affected may also need readjustment.

ADJUSTMENT MADE / ADJUSTMENTS AFFECTED	POWER SUPPLY Output voltage - R1474	Current sens. - R1476	−1500V - R1471	CRT SECTION Intensity - R1504	Intens ratio - R401	Trace rotation - R14	Astigmatism - R1473	Geometry - R1472	BALANCE ADJUSTMENTS LF correction - R538/R738	Atten. bal. - R547/R747	X1/X10 bal. - R571/R771	Norm./inv. - R604/R804	Add. bal. - R660	Final Y bal. - R1213	LF CORRECTIONS AND SENSITIVITIES Cont. control - R622/R822	Cont. control - R617/R817	Cont. control R1256	Gain X1 - R779	Gain X10 - R586/R786	Trig. view sens. R1104, R958, R961	VERTICAL CHANNELS Sq. wave 20mV - C509/C709	Sq. wave 0.2V - C511/C711	Sq. wave 2V - C503/C783	Input cap. 0.2V - C512/C712	Input cap. 2V - C504/C704	Sq. wave 20mV - C1211, C1224,	C1206, R1217, C544/C744	Sq. wave 50mV - C536/C736	Sq. wave 2mV - C546/C746	Tr. view sq. w. - C1112, C1102	TRIGGERING Trig. symm. - R1054	Trig. sens. - R388	Trig. bal. MTB - R959,	R962, R964, R1103	Trig. view bal. - R841	Trig. bal. DTB - R887, R889	TIME BASE GENERATORS MTB - R1384, R1381, R348,	R347	DTB - R349, R351	Delay time - R268, R262	X-DEFLECTION Line via X-defl. - R891
POWER SUPPLY																																									
Output voltage - R1474	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X		X	X		X	X	X		X	X	X		X	X	X
Current sens. - R1476		X																																							
−1500V - R1471			X	X			X	X									X									X		X	X								X				
CRT SECTION																																									
Intensity - R1504				X																																					
Intens ratio - R401					X																																				
Trace rotate - R14						X																																			
Astigmatism - R1473							X																																		
Geometry. R1472								X																																	
BALANCE ADJUSTMENTS																																									
LF correction - R538/R738									X	X	X	X	X																				X		X	X					
Atten. bal. - R547/R747										X	X	X	X																				X		X	X					
X1/X10 bal. - R571/R771											X	X	X																				X		X	X					
Norm./inv. - R604/R804												X																													
Add. bal. - R660													X																												
Final Y bal. - R1213														X																											
LF CORRECTIONS AND SENSITIVITIE																																									
Cont. control R622/R822															X																										
Cont. control R617/R817																X																									
Cont control R1256																	X	X								X															
Gain X1 R779																		X	X	X						X		X	X												
Gain X10 - R586/R786																			X									X													
Trig. view sens. - R1104																				X													X								
R958, R961																				X																					
VERTICAL CHANNELS																																									
sq. wave 20mV - C509/709																					X																				
Sq. wave 0.2V - C511/C711																						X																			
Sq. wave 2V - C503/C703																							X																		
Input cap. 0.2V - C512/C712																								X																	
Input cap. 2V - C504/C704																									X																
Sq. wave 20mV C1211, C1224,																										X															
C1206, R1217, C544/C744																											X														
Sq. wave 50mV - C536/C736																												X													
Sq. wave 2mV - C546/C746																													X												
Trig. view sq. wave - C1112, C1102																														X											
TRIGGERING																																									
Trig. symm. - R1054																															X	X									
Trig. sens. - R388																																X									
Trig. bal. MTB - R959,																																	X								
R962, R964, R1103																																		X							
Trig. view bal. - R841																																			X						
Trig. bal DTB - R887, R889																																				X					
TIME BASE GENERATORS																																									
MTB - R1384, R1381, R348																																					X		X		
R347																																						X			
DTB - R349, R351																																							X		
Delay-time - R268, R262																																								X	
X-DEFLECTION																																									
Line via X-defl R891																																									

6. CORRECTIVE MAINTENANCE

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.

6.1. IMPORTANT NOTES

Damage may result if the instrument is switched on when a printed circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.
How to open the instrument is outlined in chapter 3. "Dismantling the instrument".

WARNING: The EHT-cable is unbreakely connected to the EHT multiplier unit. The cable can be disconnected from the CRT. When the EHT-cable is disconnected from the CRT the end of the cable must be discharged immediately by shorting it to the instruments earth.

6.2. REPLACEMENTS

6.2.1. Standard parts

Electrical and mechanical part replacements 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 the instrument's performance.***

6.2.2. 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.

6.2.3. Transistors and integrated circuits

6.2.3.1. General

Transistors and IC'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.
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.

WARNING: Silicone grease is used to facilitate the conduction of heat between power transistors and their heatsink (for instance on the power supply unit). Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

6.2.3.2. *Static sensitive components (V501 and V701)*

This instrument contains electrical components (MOS devices) that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

6.2.3.3. *Handling MOS devices*

Though all our MOS devices incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the following precautions are recommended.

CAUTION: Testing or handling and mounting call for special attention to personal safety.
Personnel handling **MOS** devices should normally be connected to ground via a resistor.

Storage and transport:

Store and transport the circuits in their original packing.
Alternatively, use may be made of a conductive material or a special IC carrier that either short-circuits all leads or insulates them from external contact.

Testing or handling:

Work on a conductive surface (e.g. metal table top) when testing the circuits or transfering them from one carrier to another. Electrically connect the person doing the testing or handling to the conductive surface, for example by a metal bracelet and a conductive cord to a chain. Connect all testing and handling equipment to the same surface. Signals should not be applied to the inputs while the device power supply is off.
All unused input leads should be connected either to the supply voltage or to ground.

Mounting:

Mount MOS devices on printed circuit boards after all other components have been mounted. Take care that the circuits themselves, metal parts of the board, mounting tools, and the person doing the mounting are kept at the same electric (ground) potential.
If it is impossible to ground the printed-circuit board, the person mounting the circuits should touch the board before bringing the MOS circuits into contact with it.

Soldering:

Soldering iron tips, including those of low voltage irons, or soldering baths should also be kept at the same potential as the MOS circuits and the board.

Static charges:

Dress personnel in clothing of non-electrostatic material (no wool, silk or synthetic fibres). After the MOS circuits have been mounted on the proper handling precautions should still be observed.
Until the sub-assemblies are inserted into the complete system in which the proper voltages are supplied, the board is no more than an extension of the leads of the devices mounted on the board. To prevent static charges from being transmitted through the board wiring to the device it is recommended that conductive clips or conductive tape is put on the circuit board terminals.

Transient voltages:

To prevent permanent damage due to transient voltages, do not insert or remove MOS devices, or printed circuit boards with MOS devices, from test sockets or systems with power on.

Voltages surges:

Beware of voltage surges due to switching electrical equipment ON or OFF, relays and d.c. lines.

6.2.4. Replacing knobs (see fig. **6.1.)**

Single knobs and delay time multiplier knob

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

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.
When fitting the delay-time multiplier knob, turn the spindle of the potentiometer fully anti-clockwise, **so** that **it** occupies the "0" position. Adjust the knob **so** that its dial also occupies the "0" position and slide **it** on the potentiometer shaft: when doing this, take care that the stud of the knob fits correctly in the hole that is present in the front panel. After this screw B can be tightened again.

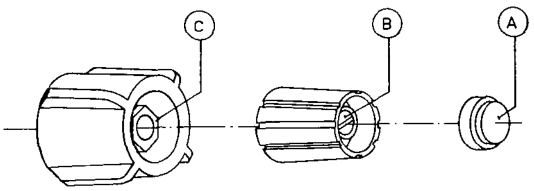


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Fig. 6.7. Removing the knobs.

6.2.5. Removing the carrying handle

- Prise off the centre knobs from each pivot, using a screwdriver (Fig. 6.2. 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.

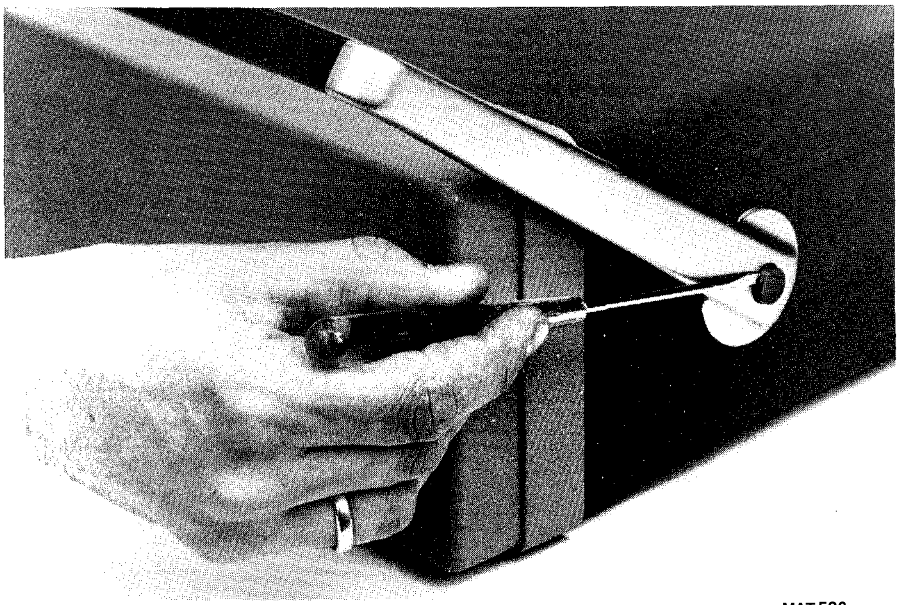

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Fig. 6.2. Removal of centre knobs from carrying handle

6.2.6. Replacing the cathode ray tube (CRT)

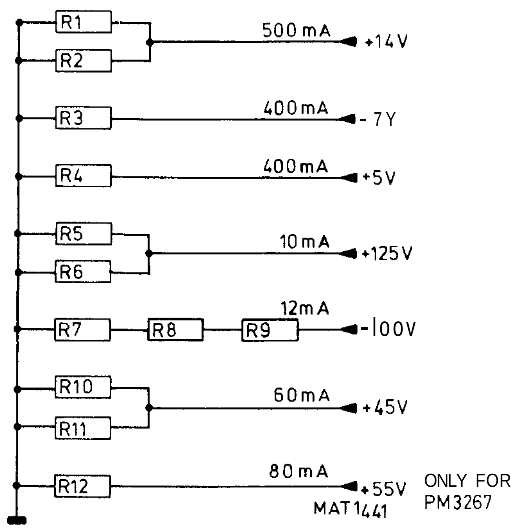
WARNING: Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode. In particular be very careful with the side connections of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.

- Remove the five side connections from the CRT.
- Unscrew the bracelet that secures the CRT in its rubber socket.
- Unplug the EHT-cable from the CRT.

WARNING: The EHT-cable is unbreakely connected to the EHT multiplier unit. The cable can be disconnected from the CRT. When the EHT-cable is disconnected from the CRT the end of the cable must be discharged immediately by shorting it to the instruments earth.

- Unplug the trace rotation cable from the X/Z final amplifier unit (3-pole connector).
- Remove the top support of the CRT screen that carries the graticule illumination lamps.
- Remove the screen bezel and contrast filter as indicated in section 5.3. of the operating manual.
- Remove the CRT socket.
- Carefully pull the CRT from the instrument through the front profiie.
- After removing the two star screws that secure the rubber CRT support to the rear panel, remove the CRT shield.

IMPORTANT: When remounting the CRT shield, the rubber CRT support or the CRT itself follow the procedure in reversed sequence and take care that the CRT is pushed properly against the contrast filter in the front profile before fixing the bracelet.



Components:

R1 and R2	56Ω	4w	WR0617	4822 112 21074
R3	18Ω	4w	WR0617	4822 112 21061
R4	12Ω	4w	WR0617	4822 112 21056
R5 and R6	27K	1,15W	CR68	4822 110 23145
R7	1K8	4w	WR0617	4822 11221114
R8 and R9	3K3	4w	WR0617	4822 11221121
R10 and R11	1K5	4w		4822 11221112
R12	680Ω	7w	WR0825	4822 11241103

Fig. 6.2a. Dummy load for power supply.

6.2.7. Removing the printed circuit boards

6.2.7.1. Removing the trigger source unit (see fig. 6.5.A)

- Remove 2 screws in the unit.
- Remove 1 screw that secures the unit to the right chassis plate.
- Unplug 1 multipole connector.
- Unplug 2 coaxial connectors.
- Unplug one single pole connector.
- Slide the unit out of the front panel.

6.2.7.2. Removal of pre-amplifier and trigger unit

- Remove the trigger source unit as indicated in chapter 6.2.7.1. (see also fig. 6.5.A).
- Unplug the inputs of the delay-line cable and unscrew the attachment bracket.
- Unplug 3 coaxial connectors.
- Unplug 3 multipole connectors. One of them is a so called bottom-entry, that is attainable via a square hole in the right-hand chassis plate.
- Slacken the 2 screws in the pushbutton switches that secure the unit to the front panel. If you remove the screws it is very difficult to install them again!
- Remove the metal screening plate from the attenuator part. This plate is attached by means of 9 selftapping screws (see also fig. 6.5.B).
- Remove the 6 fixing screws, that are equipped with washers.
- Lift the unit in the direction indicated in fig. 6.5.C.
- CHECK THAT THE CONTACTS AND THE POSITION-PINS OF THE SWITCH UNIT ARE FREE FROM THE PRE-AMPLIFIER AND TRIGGER UNIT IN ORDER TO PREVENT THAT THE CONTACTS ARE BEND IF THE UNIT IS TAKEN OUT OF THE INSTRUMENT (see fig. 6.6.).
- Take the unit out of the instrument in the direction indicated in fig. 6.5.D).

When remounting, follow the procedure above in reversed sequence and take care that the unit is correctly positioned above the position-pins before inserting the unit.

6.2.7.3. Removal of time base unit

- Remove the screening-plate.
- Unplug 5 coaxial cables.
- Unplug 2 single wire connectors (blue wire of x218, white wire of x217).
- Unplug 4 multipole connectors. One of them is a so called bottom-entry, that is attainable via a square hole in the right-hand chassis plate.
- Remove the 3 fixing screws, one of them (about in the middle of the unit) fixes also the screening-plate.
- Slacken the 4 screws in the pushbutton switches that secure the unit to the front panel. If you remove the screws it is very difficult to install them again!
- Lift the unit in the direction indicated in fig. 6.3.A.
- CHECK THAT THE CONTACTS AND THE POSITION-PINS OF THE SWITCH UNIT ARE FREE FROM THE TIME BASE UNIT IN ORDER TO PREVENT THAT THE CONTACTS ARE BEND IF THE UNIT IS TAKEN OUT OF THE INSTRUMENT (see fig. 6.4.).
- Take the unit out of the instrument in the direction indicated in fig. 6.3.B.

When remounting, follow the procedure above in reversed sequence and take care that the unit is correctly positioned above the position-pins before inserting the unit.

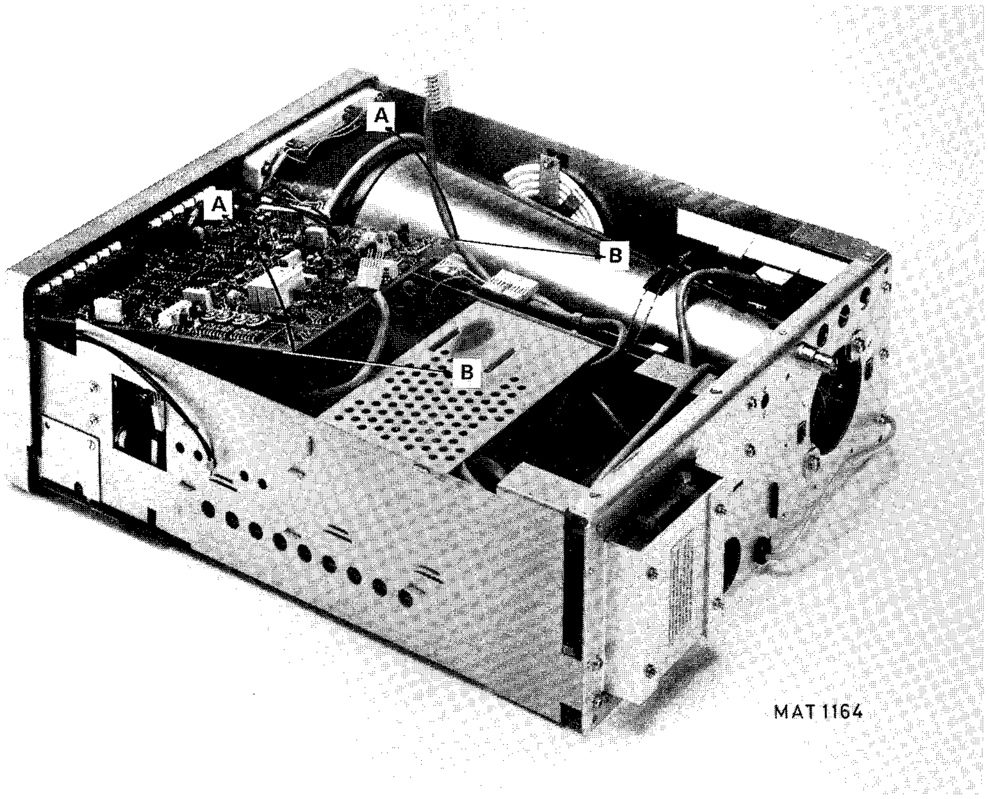


Fig. 6.3. Removal of time-base unit

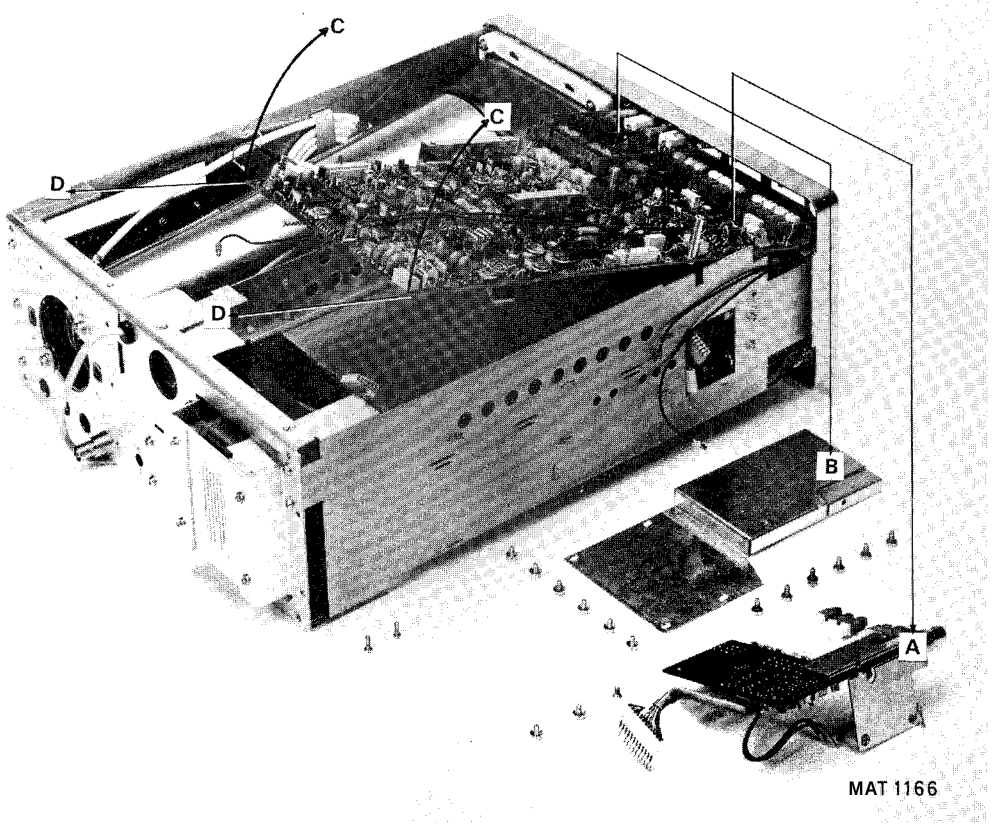


Fig. 6.5. Removal of pre-ampl. and trigger unit

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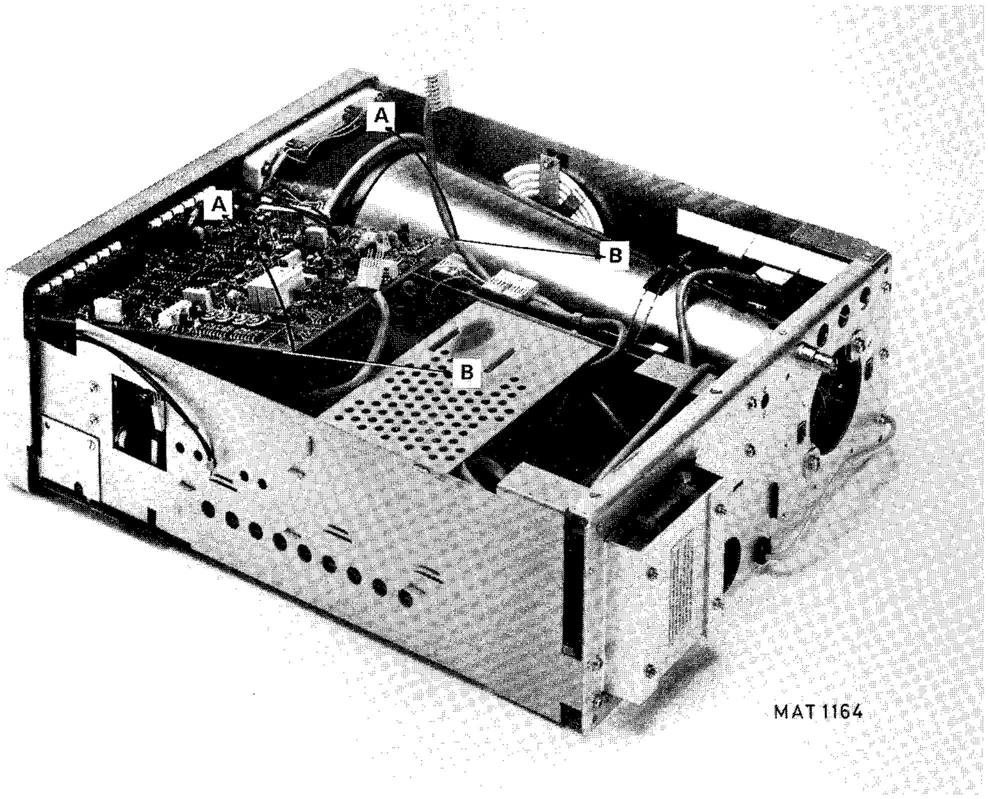

Fig. 6.3. Removal of time-base unit

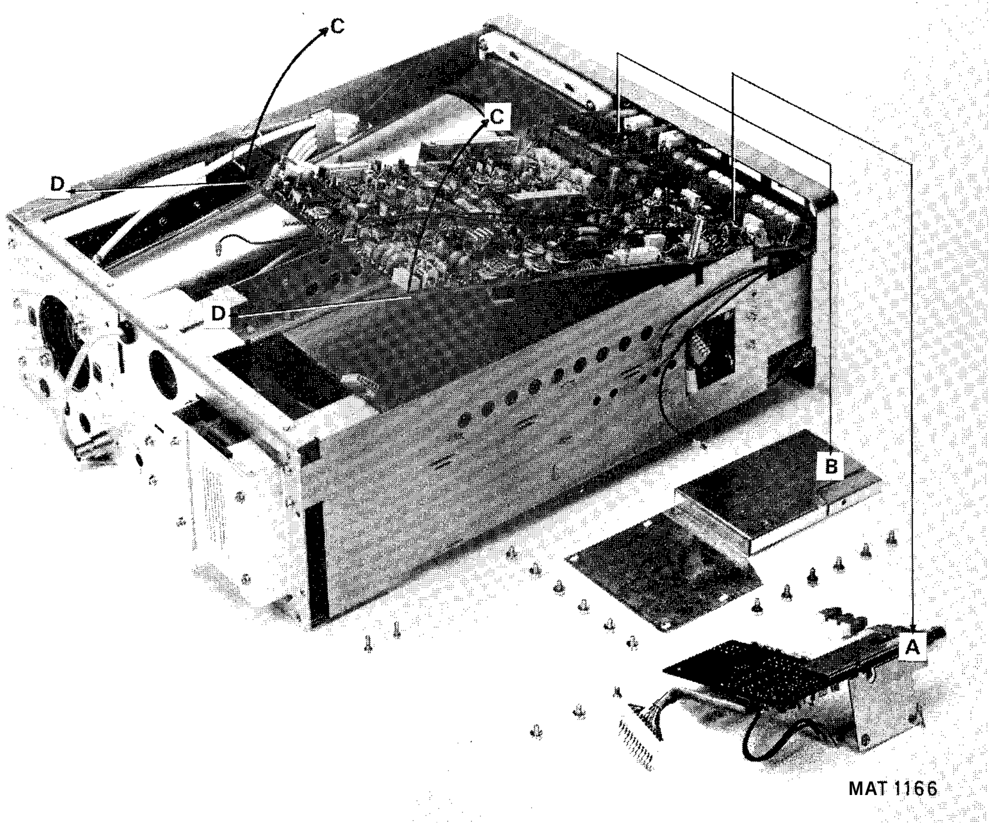

Fig. 6.5. Removal of pre-ampl. and trigger unit

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6.2.7. **Removing the**

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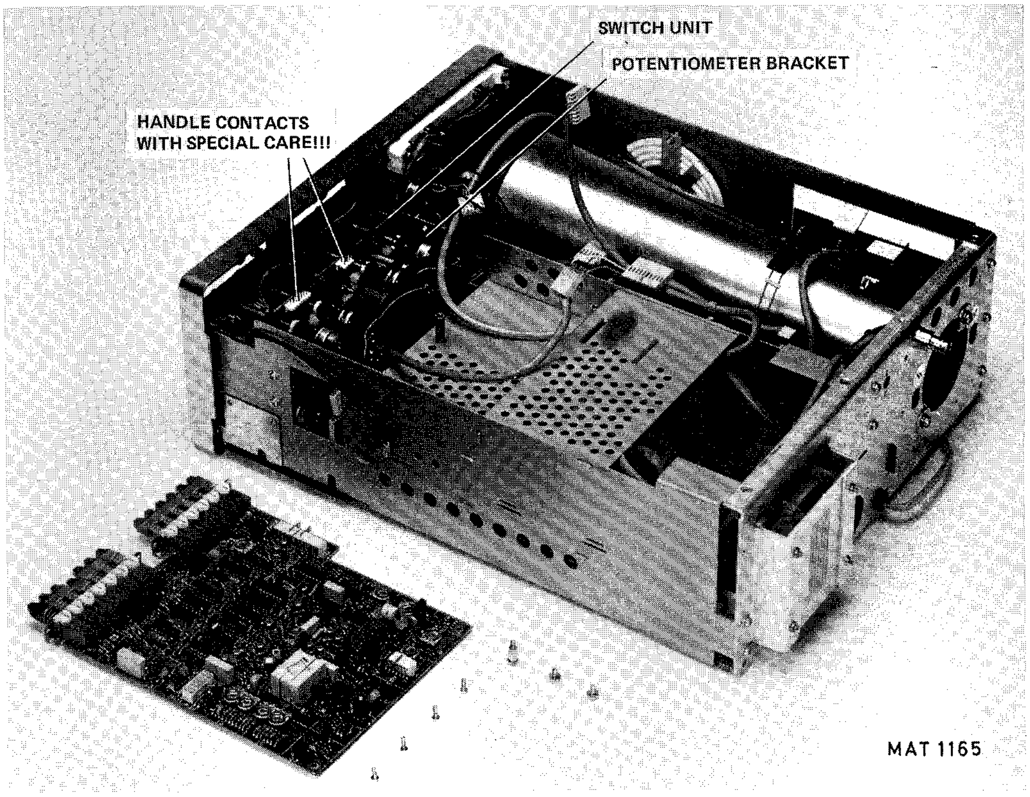

Fig. 6.4. Time-base unit removed

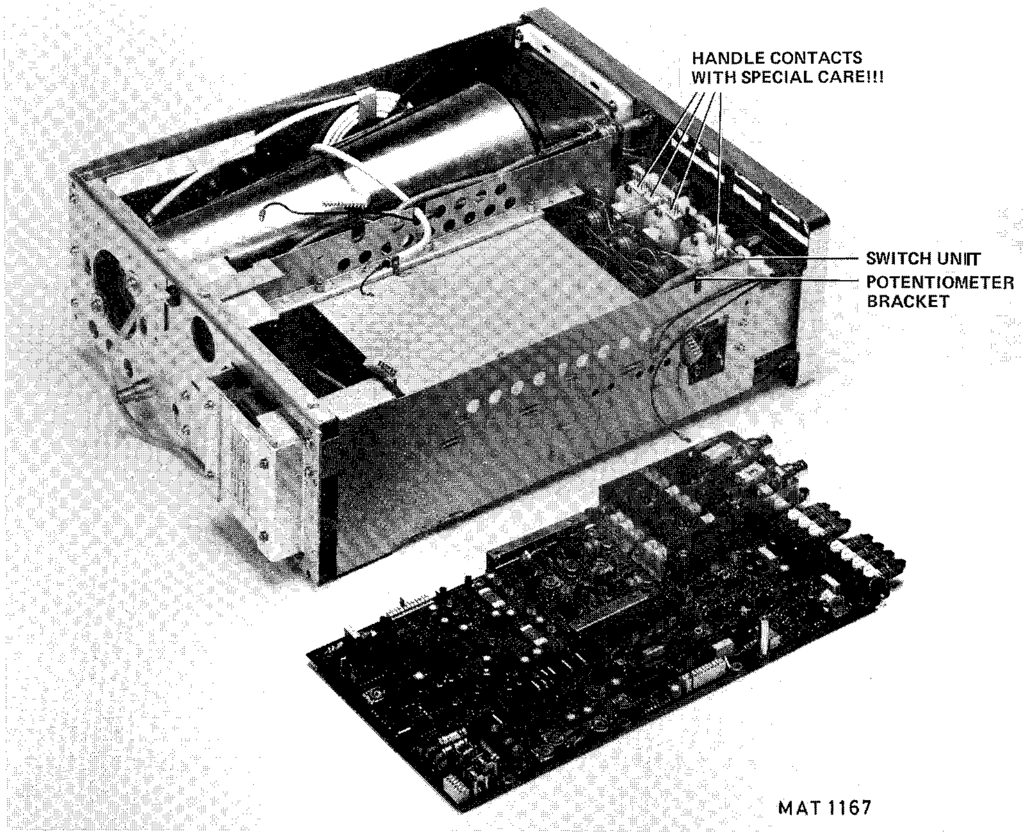

Fig. 6.6. Pre-ampl. and trigger unit removed

6.2.7.4. Removal of switch unit and potentiometer unit

- Remove the time base unit as indicated in chapter 6.2.7.3.
- Remove the trigger source unit as indicated in chapter 6.2.7.1.
- Remove the pre-amplifier and trigger unit as indicated in chapter 6.2.7.2.
- Remove one multipole connector from the final X/Z amplifier unit.
- Remove one multipole connector from the pre-amplifier and trigger unit.
- Remove all the knobs from the front panel.
- Remove 4 star-screws, that secure the switch unit and potentiometer unit to the left and right-hand chassis panel.
- Lift the units upwards out of the instrument.
- The switch board can be separated from the potentiometer unit by means of 4 star screws (one of them is only attainable with a small screwdriver).

IMPORTANT: Repair of parts on the switch unit is not recommended because special tools are required for assembling. As a result the unit is only available as a complete spare part.

6.2.7.5. Removal of power supply EHT unit and mains transformer

- Unplug one four pole connector from the power supply. This connector is attached to a cable that comes from the rear plate.
- Unplug one coaxial lead on the time-base. This lead is from the BNC socket on the rear panel.
- Remove the two star screws that secure the rubber CRT socket to the rear plate (the CRT remains in position by means of its supports at the screen side).
- Remove six screws that secure the top and bottom of the rear plate to the chassis.
- Remove seven screws that secure the rear plate to the chassis. The rear plate can now be taken off.
- Remove the four star screws that secure the mains transformer to the rear plate.
- Remove - if necessary - the star screw that secures the power supply to its compartment. This screw is accessible via a hole in the pre-amplifier and trigger unit.

NOTE: This screw earths the power supply. When remounting the supply, fix this screw as tighty as possible.

- Slide the unit gently out of is compartment and remove - if necessary - the two wires from the EHT multiplier unit.
- To remove the EHT unit, snap it out of the two slots of the power supply compartment. To remove the post-accelerator connection cable first remove the time-base unit according chapter 6.2.7.3.

WARNING: The EHT is unbreakely connected to the EHT multiplier unit. The cable can be disconnected from the CRT. When the EHT-cable is disconnected from the CRT the end of the cable must be discharged immediately by shorting it to the instruments earth.

Fig. 6.2a. shows you a dummy load for the power supply.

6.2.7.6. Replacement of thermal fuse in mains transformer

The double isolation of the instrument is achieved by the isolation properties of the mains transformer. If the mains transformer should become too hot (for instance due to a secondary short-circuit) the isolation layer can be damaged. In order to prevent this, a thermal fuse is incorporated in the mains transformer. If the temperature of the transformer becomes too high, the fuse blows and the mains voltage is interrupted.
The blown fuse can be replaced by a new one, if you are sure that the isolation layer of the transformer is not damaged.
For this proceed as follows: Remove the rear plate with the mains transformer. Desolder the two wires of the fuse and slide it out of its compartment within the transformer. Slide the new fuse into the compartment and solder the wires on to the soldering tags of the transformer.

6.2.7.7. Removal of final X/Z amplifier unit

- Unplug 6 multipole connectors.
- Unplug 1 coaxial cable.
- Unplug 2 single-wire connectors from the time-base.
- Remove very carefully the 2 side connections of the CRT

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.

- Remove 3 fixing screws.
- Lift the unit a little out of its bottom fixing points.
- Unplug 2 wires, that originate from the CRT socket.

CAUTION: These wires carry the **–1500 Volt** life voltages for the CRT; they may neither be touched nor be short-circuited to earth if the instrument is working.

- Unplug 2 wires, that originate from the CAL output socket on the front panel.
- Take the unit out of the instrument.

When remounting follow the procedure above in reversed sequence.

6.2.7.8. Removing the final vertical amplifier unit

- Unplug one multipole connector from the conductor side at the unit.
- Remove very carefully the two side connections of the Y-deflection plates from the CRT. It is also possible to unsolder the two connection wires on the unit.

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.

- Remove the two screws that secure the unit to the left-hand chassis plate.
- Remove the two "star" screws in the heat-sink of the OM518 resistance network that secure the unit to the left-hand chassis plate.
- Unplug the two connections of the delay line from the conductor side of the unit.
- Remove one "star" screw that secures the delay line to the conductor side of the unit.

6.2.7.9. Removal of potentiometer from potentiometer unit

- For R7, R8, R9, R10 and R11: remove the pre-amplifier and trigger unit according to chapter 6.2.7.2. For R1, R2, R3, R4, R5 and R6: remove the time base unit according to chapter 6.2.7.3.
- Remove the fixing nut of the potentiometer.
- Unsolder the wires of the potentiometer and take it out of the coupling piece and the potentiometer unit.
- Remove the coupling-disc by pulling it of the potentiometer shaft. Bear in mind that the coupling discs of the potentiometers with a push-pull function are secured with a fixing-washer.

6.2.7.10. Removal of coupling piece

- Remove the potentiometer according to chapter 6.2.7.9.
- Pull the plastic fixing spring out of the coupling piece.
- Remove the coupling piece from the plastic shaft.
- Remove the knob from the plastic shaft; remove the plastic cap from the knob, remove the screw inside the knob and pull the knob off.
- Slide the plastic shaft backwards out of the instrument.

IMPORTANT: When rearranging the coupling piece take care that the flat side at the ends of the plastic shaft and the potentiometer shaft fits correctly in the hole of the coupling discs.

6.2.8. Soldering techniques

Ordinary 60/40 solder and a 35 ... 40 Watt pencil type soldering iron can be used for 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 base material.

6.3. 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 circuits.
Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done on the power supply.
For more detailed information see the interaction table (section 5.6).

6.4. INSTRUMENT REPACKING

If the instrument is to be shipped to a Service Centre for service or repair, attach a tag showing owner (with address) and the name of an individual at your firm who 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 danger occurs during transport.

6.5. TROUBLE-SHOOTING

6.5.1. Introduction

The following information is provided to facilitate 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.

6.5.2. 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 (0.7 Volt approx. in conductive state) and the voltage between collector and emitter (0,2 Volt 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 circuits. In circuit testing cab be done with an oscilloscope or voltmeter. A good knowlegde of the circuit par under test is essential. Therefore first read the circuit discription 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 6.2. (replacement).*
After replacement of a component the calibration of the instrument may be affected due to component tolerances. If necessary do the required adjustments.

6.5.3. Checks after repair and maintenance.

6.5.3.1. Checking the protective lead in instruments with a three-wire mains cable

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.

6.5.3.2. Checking the insulating resistance.

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

6.6. OPTIONAL MTB GATE OUTPUT, DTB GATE OUTPUT, MTB SWEEP OUTPUT AND TTL OR ECL TRIGGERING

6.6.1. **MTB** and **DTB** gate

For these options it is only necessary to install BNC sockets at the rear panel and to add coaxial cables between these sockets and respectively socket X209 (MTB gate) and socket X211 (DTB gate) on the time base unit.
For ordering numbers of BNC sockets and coaxial cables see the parts list in chapter 7.

MTB gate: install R270 (33E2, 5322 116 50527).
DTB gate: close soldering bridge between D208 and R273.

6.6.2. **MTB sweep** out

For this option it is necessary to install a number of components in tne way indicated on the time base p.c.b. lay-out (see fig. 8.8).

R352	1K/M R25	5322 116 54549
R353	1K27/M R25	5322 116 50555
R354	5E11/M R25	5322 116 54192
V267	BC548C	482213044196
C252	15UF/40 V	482212420709
C266	10NF	4822 121 41134
X218	Coax socket, outer part	532226824116
	Coax socket, contact pin	532226814141

Mount a BNC socket on the rear panel and add a coaxial cable between the BNC socket and socket X218 on the time base unit. For ordering numbers of BNC socket and coaxial cable refer to the parts list in chapter 7.

6.7. ACCESSORY INFORMATION

6.7.1. Adjustments

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to the CAL socket of the oscilloscope.
A trimmer C2 (Fig. 6.13.) can be adjusted through a hole in the compensation box to obtain optimum square-wave response. See Fig. 6.7.. 6.8. and 6.9.

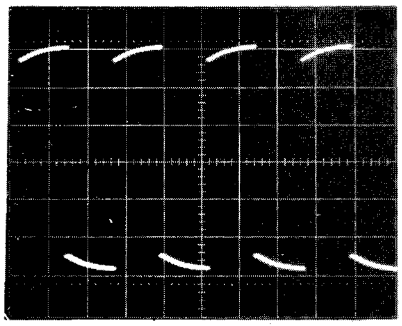

Fig. 6.7. Over compensation (adjustment C2)

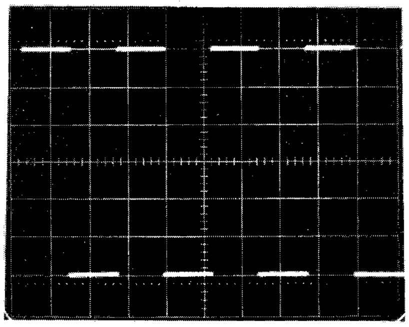

Fig. 6.8. Correct compensation (adjustment C2)

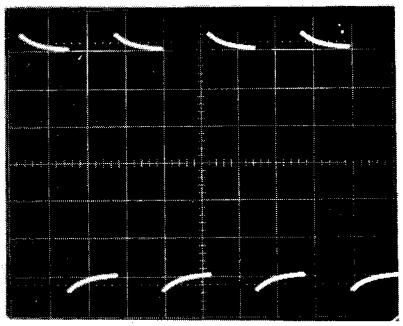

Fig. 6.9. Under-compensation (adjustment C2)

Adjusting the h.f. step response

The h.f. step response correction network has been adjusted by the manufacturer to match the oscilloscope input. For optimum pulse response, for separate delivered probes, the probe can be adjusted to match your particular oscilloscope. Later readjustment is only necessary if the probe is to be used with a different type of oscilloscope, or after replacement of an electrical component.
For the adjustment, proceed as follows:
Connect the probe to a fast pulse generator (rise-time not exceeding Ins) which is terminated by its characteristic impedance. Dismantle the compensation box. Set the generator to 100kHz. Adjust R2 and R3 alternatively to obtain a display as shown in Fig. 6.10.
It is important that the leading edge is as steep, and the top is as flat, as possible. Incorrect settings of R2 and R3 give rise to pulse distortions as shown in Fig. 6.1 1. and 6.12.

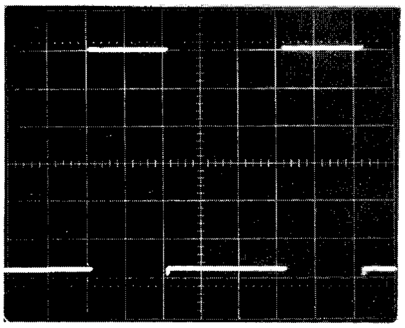

Fig. 6.10. Preset potentiometers (correctly adjusted)

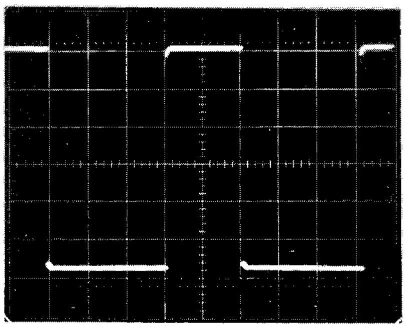

Fig. 6.11. Rounding due to incorrectly adjusted potentiometers

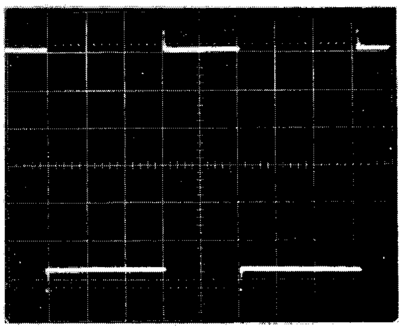

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Fig. 6.12. Overshoot due to incorrectly (adjusted potentiometers)

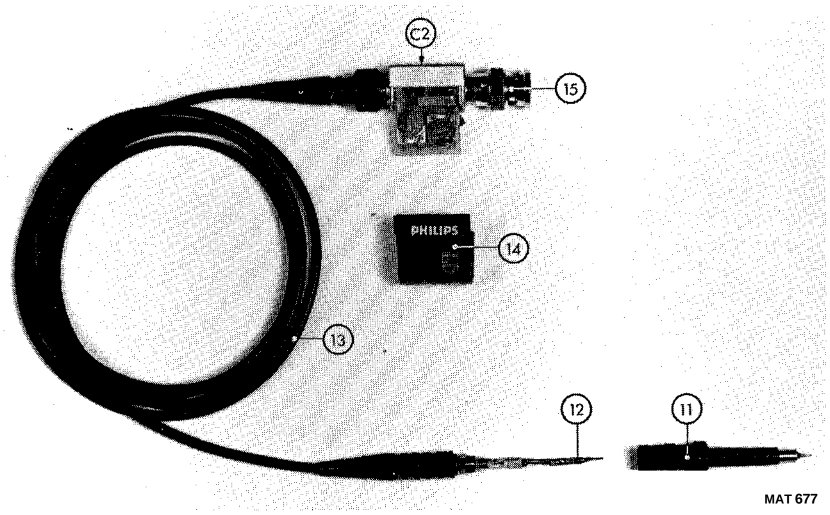
6.7.2. Dismantling

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 of the printed-wiring board are then accessible.



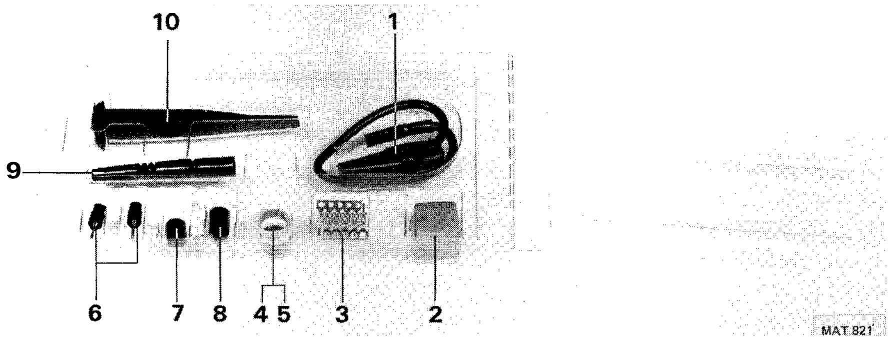


Fig. 6.13. Mechanical parts

6.7.3. 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 the 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.

6.7.4. Replacing the **BNC**

Dismantle the compensation box.
Unsolder the connection to the printed-wiring board. Hold the frame of the compensation box firmly and loosen the BNC with a 3/8 inch spanner. Replace the BNC and fit it, working in the reverse order.

Replace the probe tip

The damaged tip can be pulled out by means of a pair of pliers. A new tip must be firmly pushed in.

6.7.4. Parts List

Mechanical parts (see Fig. 6.13 and 6.14.)

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

item	Ordering number	Qty	Description
1	5322 321 20223	1	Earth cable
2	5322 256 94136	1	Probe holder
3	532225544026	0	Soldering terminals which may be incorporated in circuits as routine test points
4	532253264223	2	Marking ring red
5	532253264224	2	Marking ring white
5	532253264225	2	Marking ring blue (not shown)
6	532226814017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	532246244318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	532226424018	1	Wrap pin adaptor
10	532226424019	1	Spring-loaded test clip
11	532226424021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network
13	532232014063	1	Cable assembly
14	5322 447 64016	1	Cap
15	532226844019	1	BNC connector

Electrical parts

Item	Ordering number	Description
C1	–	Part of RC network (not supplied separately
c2	532212554003	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	532210010112	Potmeter 1 kΩ, 20 %, 0.5 W

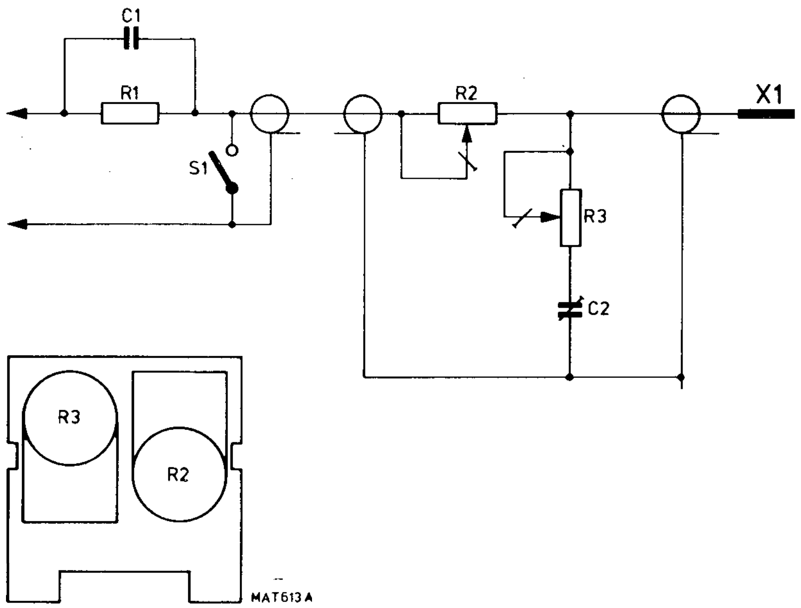


Fig. 6.14. Electrical parts

7. PARTS LIST

Subject to alteration without notice

7.1. PARTS INDICATED IN FIG. 7.1. ... 7.6.

Item	Ord. number	Description
Fig. 7.1.		
1.	532241430004	Ten turn knob (used for "delay time")
2.	532241420034	Pushbutton brown/green (31 pcs./instrument).
3.	532241420033	Pushbutton brown (used for "single").
4.	532244790372	Instrument cover (without handle and feet).
5.	5322 414 70016	Cover, brown with line.
	532241430044	Knob, dia 10mm.
6.	532241470018	Cover, blue with line.
	532250280006	Screw, selftapping
	532241430059	Knob, dia 1Omm.
	532241430045	Knob, dia 19mm.
7.	532241430047	Knob (used for "hold off').
	532249264337	Fixing spring for this knob.
8.	532226710004	BNC input socket (used for A, B and EXT).
9.	532226814052	Calibration terminal.
	532232580243	Grommet for calibration terminal.
10.	532244790322	Front cover
11.	532246244297	Rubber foot (of instrument cover).
12.	532244790305	Cast alluminum front frame.
13.	532245920271	Screen bezel.
14.	532248034074	Contrast filter blue.
	532248034046	Contrast filter grey
15.	532241470016	Cover, brown with line.
	532241430046	Knob, dia 1Omm.
	532249264337	Clamping spring for knob.
	532245581017	Text plate
16.	5322 455 81018	Text plate PM3267U (USA version)
	5322 455 81019	Sticker TTL (optional)
	5322 455 81021	Sticker ECL (optional)
Fig. 7.2.		
20.	532249854077	Grip of carrying handle.
	532249854072	Bracket of carrying handle.
	532241430043	Pushbutton knob.
	482250230004	Selftapping screw.
	4822 532 10582	Washer
	532252014267	Bearing bush, plastic.
	532253084075	Spring.
	532252834128	Ratchet.
21.	532246490096	Cast alluminium rear frame.
22.	532244790405	Plastic rear panel.
23.	532253220749	BNC socket 2-Mod.
24.	532250014228	Coin slot screw for rear panel.
	532253070324	Circlip for coin slot screw.
25.	532246244298	Foot (of rear panel).
	482250230096	Selftapping screw of rear panel foot.
26.	532232564083	Line cable cleat, European type.
	5322 325 50101	Line cable cleat, USA type.
27.	4822321 10084	Line cable, European type.
	4822321 10092	Line cable, USA type
28.	532226340045	Mains voltage adaptor.

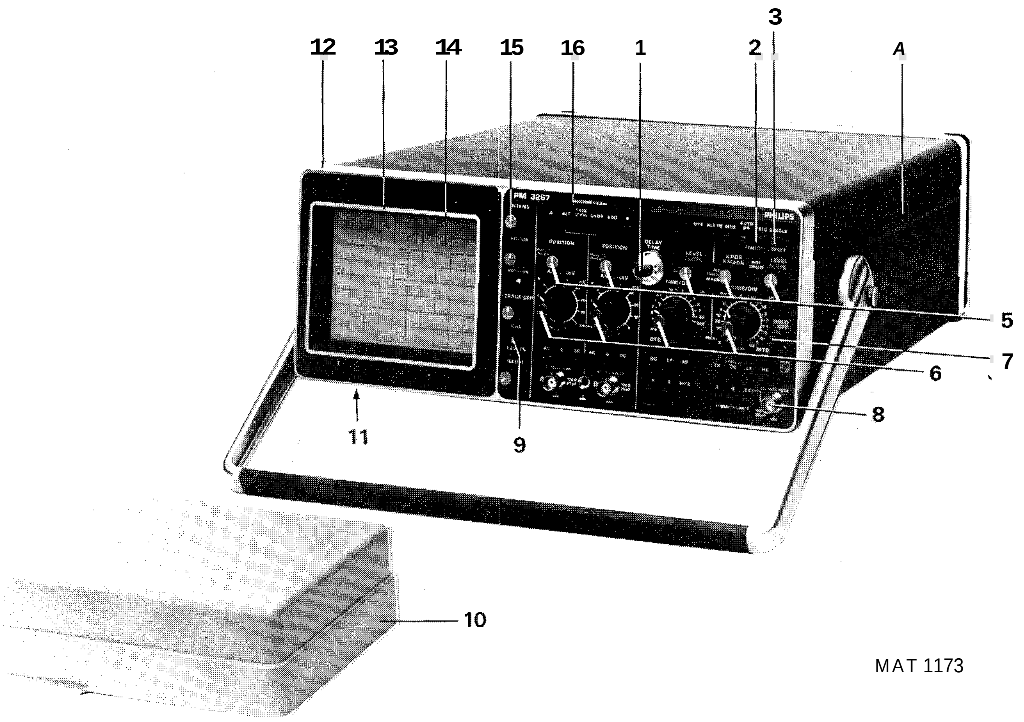


Fig. 7.1. Mechanical parts, rear view

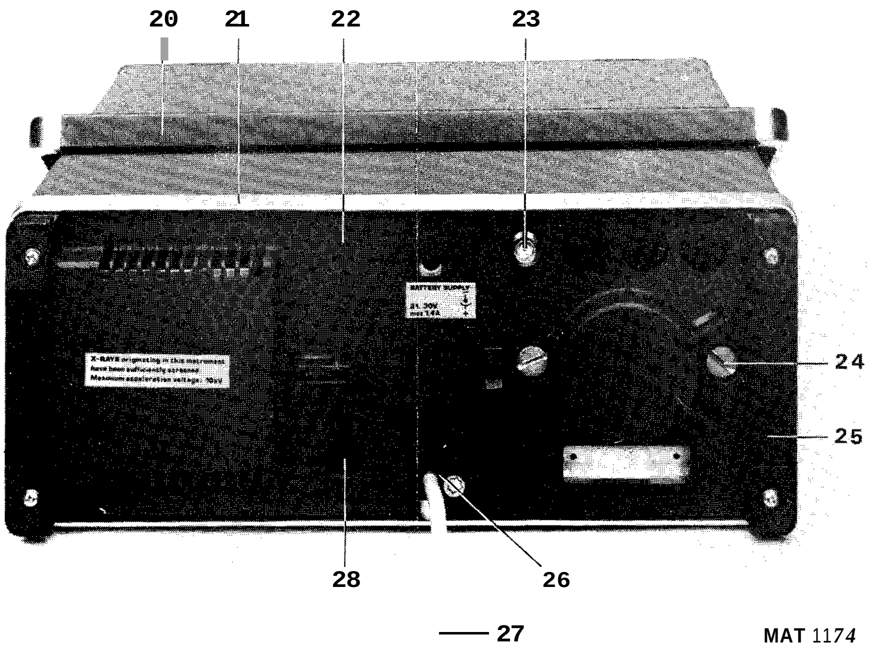


Fig. 7.2. Mechanical parts, rear view

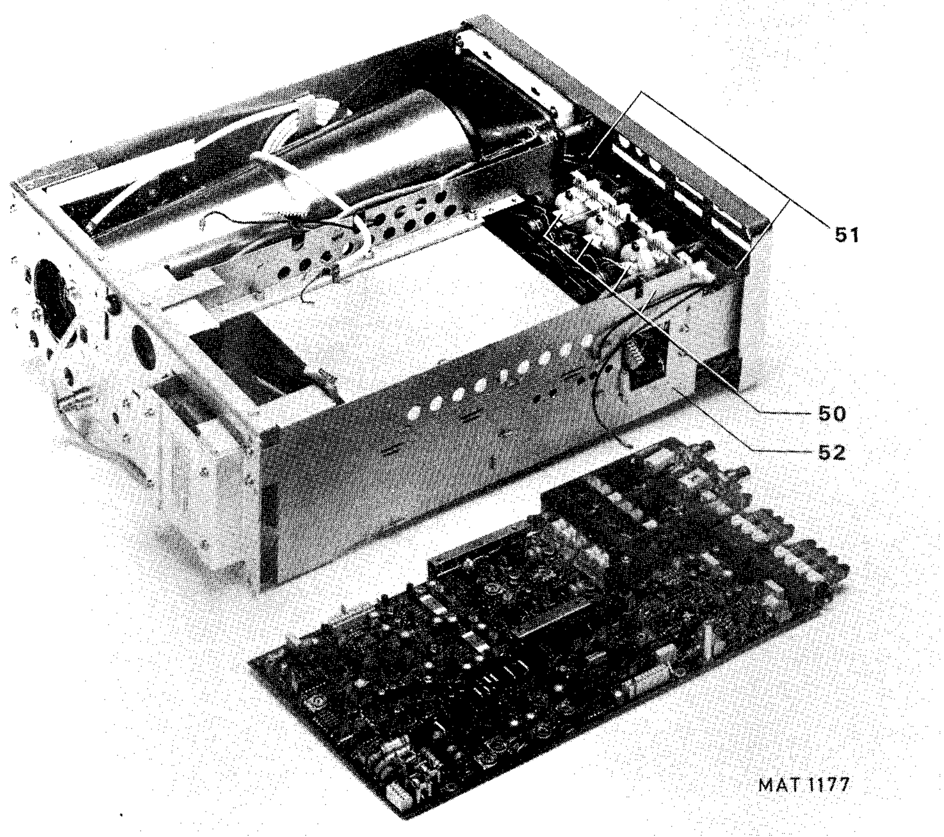


Fig. 7.5. Mechanical parts, unit 3 and 4 removed

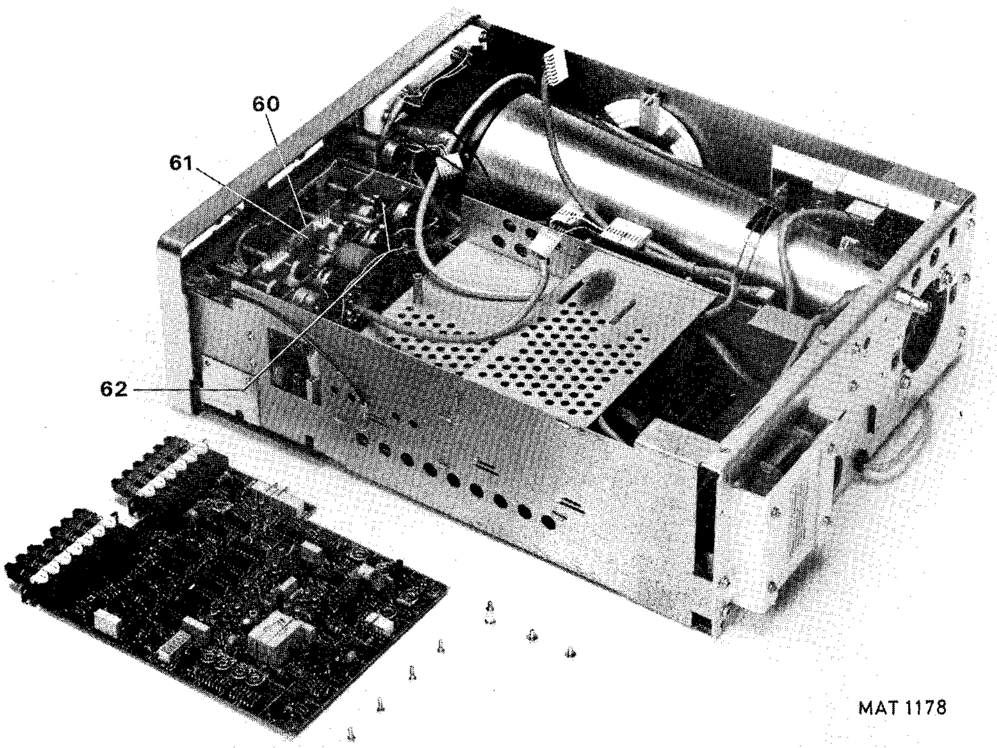


Fig. 7.6. Mechanical parts, unit 2 removed

7.2. PARTS NOT INDICATED WITH ITEM-NUMBERS IN THE FIGURES

Ordering nu

Ordering number	Description
532227660208	Pushbutton switch S1 (on time base unit)
532227670075	Pushbutton switch S2 and S3 (on time base unit)
532227680237	Pushbutton switch S17 ... S20 (on pre-ampl. +trigger unit)
5322 276 60209	Pushbutton switch S22, S23 (on trigger unit)
532226824116	Coaxial socket (p.c.b. type)
532226814141	Contact pin for coaxial socket.
5322 320 14102	Coaxial cable set. This is a universal cable set. Always use the cable out of this set with a length that comes close to the length of the cable that must be replaced.
5322 320 10003	Coaxial cable per metre (without sockets)
532226554006	20 pole CIS-connector, female p.c.b. type. This connector must be sawn to the required size for: X807, X852, X858, X1406, X1501, X1502, X1512, X1513, X1503, X1401 and X1407
532226750343	Double 4-pole CIS-connector! female p.c.b. "bottom entry" type. Used for X204 (unit 2), X501, X502, X651 and X867 (unit 3).
532226750341	Double 7-pole CIS-connector, female p.c.b. "bottm entry" type. Used for X213 (unit 2)
532226764031	8-pole CIS-connector, female p.c.b. type. This connector must be sawn to the required size. Used for: X214 and X851.
5322267 64027	8-pole CIS-connector, female p.c.b. type. This connector must be sawn to the required size. Used for: X201, X202, X203 and X1506.
532226764007	20-pin CIS-contact block without pins. This block must be sawn to the required size for: X201, X202, X203, X214, X807, X851, X852, X858, X1401, X1406, X1407, X1501, X1502, X1503, X1506, X1512 and X1513.
532226764007	20 pin CIS-contact block without pins. This connector must be sawn on the required size for: X201, X202, X203, X214, X807, X851, X852, X858, X1401, X1406, X1407, X1501, X1502, X1503, X1506.
532226540186	Double 4 pin CIS-contact block (male header) X204, X501, X502, X651, X867 (switch unit).
532226540187	Double 7 pin CIS-contact block (male header) X213 (switch unit).
5322 268 14105	Contact pin, long type for bottom entry: X214, X851.
5322 268 14013	Contact pin, short type: all connectors except X214 and X851.

7.3. ELECTRICAL PARTS

IMPORTANT: Because of problems in the computer program in sorting out the component numbers in the correct sequence, the computer parts lists are somewhat confusing. However all the components are listed.

LIST OF POTENTIOMETER / SWITCH COMBINATIONS

Item nr.	Function	Service ordering code
R 1/S4	Positionlpull to invert A.	5322 101 40097
R2/S5	Positionlpull to invert B.	5322 101 40097
R3	Delay time	532210350002
R4/S6	Level/slope DTB	5322 101 40097
R5/S7	X pos. /X magn.	532210240062
R6/S8	Level/slope MTB	5322 101 40097
R7/S10	Continuelcal A	5322 101 40096
R8/S12	Continue/cal B	5322 101 40096
R9/S14	Continue/cal DTB	532210140096
R10/S16	Continue/cal MTB	5322101 40096
R11	Hold off	5322 101 40096
R12	Intensity	5322 101 20691
R13	Focus	5322 101 20692
R14	Trace rotation	4822 101 20417
R15	Trace separation	5322 101 20693
R16/S21	Illumination/power on	5322 101 40107

LIST OF MODIFIED COMPONENTS THAT ARE NOT PRESENT IN THE COMPUTER PARTS LIST

Capacitors:

C276	33µF/10 V	482212420945
C521, C721	1,8 pF	4822 122 31034
C540, C740	5,6 pF	4822 122 31047
C554, c754	6,8µF/25 V	5322 124 14081
C721	1,8 pF	4822 122 31034
c754	6,8 µF/25 V	532212414081
C860	33µF/16 V	482212420688
C940	330 pF	4822 122 31353
C946	4.7 pF	4822 122 31045
c1210	22 pF	4822 122 31063

Integrated circuits:

D504, D704	OQ 0049	532220910414

Coils:

L502, L702	Bead	5322 526 10247

Resistors:

R296	1, 78 KΩ	5322 116 50515
R333	4,64 KΩ	5322 116 50484
R334	3,83 KΩ	5322 116 54589
R411	28,7 KΩ	532211654653
R517	31,6 Ω	532211654034
R521, R721	14,7 KΩ	532211654632
R607	7,5 KΩ	532211654608
R717	31,6 Ω	532211654034
R807	7,5 KΩ	532211654608
R870	1 KΩ	4822 116 51235
R869	42,2 Ω	532211651052
R930	422 Ω	5322 116 50459
R931	619 Ω	4822 116 51232
R960	100 Ω	5322 116 55549
R987	261 Ω	5322 116 54502
R1006	316 KΩ	5322 116 55268
R1205	100 KΩ	4822 116 51268
R1210	133 Ω	532211654482
R1218	464 Ω	532211650536
R1229	121 KΩ	532211654704
R1232	42,2 KΩ	5322 11650474
R1233	110 KΩ	5322 116 54701
R1308	1,62 KΩ	532211654565
F1321, R1327	7,5 KΩ	532211654608
R1331	133 KΩ	5322 116 54708
R1360	31,6 KΩ	5322 116 54657
R1423	10 KΩ	4822 116 51253

Semiconductors:

V230, V253, V296, V297	BAT 83	5322 130 32103
V260	BZX79-C6V8	4822 130 34278
V303, V304, V305, V306	BAW62	4822 130 30613
V515, V715	BZX79-C6V8	4822 130 34278
V856	BC558B	4822 130 44197
V867, V868	BAT 83	5322 130 32103

POSNR	DESCRIPTION				ORDERING CODE
C 230	CAPACITOR,CERAM	18PF			4822 122 31061
C 788	CAP,ELEC.TANTAL	6,8 UF 25 V			5322 124 14081
C 863	CAPACITORICERAM	15 PF			4822 122 31058
C 869	CAPACITORPCERAM	3,3 PF			4822 122 31041
C 879	CAPACITOR,CERAM	15 PF			4822 122 31058
C 881	CAPACITOR,CERAM	27 PF			4822 122 30045
C 882	CAPACITOR,CERAM	0,68 PF			4822 122 31215
C 894	CAPACITOR,CERAM	12 PF			4822 122 31056
C 895	CAPACITOR,TRIMM	3,5 PF TRIMCAP			5322 125 50048
C 896	CAPACITOR,CERAM	4,7 PF			4822 122 31045
C 896	CAPACITOR,TRIMM	10 PF TRIMCAP			5322 125 50049
C 901	CAPACITORPCERAM	12 PF			4822 122 31056
C 907	CAPACITORPCERAM	12 PF			4822 122 31056
C 910	CAPACITOR,CERAM	100 PF			4822 122 31316
C 915	CAP,ELEC.TANTAL	6,8U 25V			5322 124 14081
C 921	CAPACITOR,CERAM	2,7 PF			4822 122 31038
C 923	CAPACITORICERAM	2,7 PF			4822 122 31038
C 924	CAPACITOR,CERAM	2,7 PF			4822 122 31038
C 926	CAPACITORPCERAM	2,7 PF			4822 122 31038
C 927	CAPACITOR,CERAM	2,7 PF			4822 122 31038
C 928	CAPACITOR,CERAM	2,7 PF			4822 122 31038
C 940	CAPACITORtCERAM	330 PF			4822 122 31353
C 1102	CAPACITOR,TRIMM	27PF			5322 125 50164
C 1103	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1104	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1105	CAPACITORPCERAM	6,8NF-20+50		100	4822 122 31429
C 1106	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1107	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1108	CAPACITOR,CERAM	3,9PF	0,25PF	100	5322 122 34107
C 1109	CAPACITORtCERAM	4,7NF	10	100	4822 122 30128
C 1112	CAPACITOR,TRIMM	27PF			5322 125 50164
C 1113	CAPACITOR,CERAM	10PF	2	500	4822 122 31195
C 1114	CAPACITOR,CERAM	15PF	2	500	4822 122 31197
C 1201	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1202	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 1203	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1204	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 1206	CAPACITOR,TRIMM	27PF			4822 125 50088
C 1211	CAPACITOR,TRIMM	27PF			4822 125 50088
C 1214	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 1216	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1217	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1218	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 1219	CAPACITOR,CERAM	2,2PF	0,25PF	100	4822 122 31036
C 1221	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 1222	CAPACITOR,CERAM	2,2PF	0,25PF	100	4822 122 31036
C 1223	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1224	CAPACITOR,TRIMM	2,0-18P TRIM			5322 125 50051
C 1226	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1227	CAPACITORtCERAM	22PF	2	100	4822 122 31063
C 1228	CAPACITORtCERAM	100PF	2	100	4822 122 31316
C 1229	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 1231	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 1232	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 1300	CAPACITOR,CERAM	330PF	2	100	4822 122 31353
C 1301	CAPACITOR,FOIL	68NF	10%	250V	5322 121 44137
C 1302	CAPACITOR,FOIL	68NF	10%	250V	5322 121 44137
C 1303	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1304	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 1305	CAPACITOR,CERAM	330PF	2	100	4822 122 31353
C 1306	CAPACITORICERAM	1NF	10	500	4822 122 31175
C 1307	CAPACITOR,CERAM	1NF	10	500	4822 122 31175
C 1308	CAPACITOR,CERAM	8,2PF	0,25PF	100	4822 122 31052
C 1309	CAPACITOR,CERAM	8,2PF	0,25PF	100	4822 122 31052

POSNR	DESCRIPTION			ORDERING CODE
C 1310	CAPACITOR,CERAM	390PF 2	100	4822 122 31426
C 1311	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1314	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1315	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1316	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1317	CAPACITOR,CERAM	1ONF-20+50	100	4822 122 31414
C 1318	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1319	CAPACITOR, FOIL	68NF 10%	250V	5322 121 44137
C 1320	CAPACITOR,CERAM	390PF 2	100	4822 122 31426
C 1321	CAPACITOR, FOIL	68NF 10%	250V	5322 121 44137
C 1322	CAPACITOR,FOIL	68NF 10%	250V	5322 121 44137
C 1323	CAP ,ELECTROLYT.	22UF 40%	10V	4822 124 20943
C 1326	CAP,ELECTROLYT.	4,7UF-10+50	63	4822 124 20726
C 1327	CAP.ELECTROLYT.	4,7UF-10+50	63	4822 124 20726
C 1372	CAPACITOR, CERAM	10NF-20+50	100	4822 122 31414
C 1373	CAP,ELEC.TANTAL	220NF 20%	35v	5322 124 14074
C 1401	CAP,ELECTROLYT.	150UF-10+50	25	4822 124 20703
C 1402	CAPPELECTROLYT.	330UF-10+50	10	4822 124 20684
C 1403	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 1404	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 1406	CAP,ELEC.TANTAL	10UF 50%	16V	5322 124 14066
C 1407	CAPACITOR,CERAM	2,7NF 10	100	4822 122 30057
C 1408	CAPACITOR,HT	13NF 5%	2KV	5322 121 41466
C 1409	CAPACITOR,HT	13NF 5%	2KV	5322 121 41466
C 1411	CAPPELECTROLYT.	330UF-10+50	10	4822 124 20684
C 1412	CAPPELECTROLYT.	220UF-10+50	25	5322 124 24139
C 1413	CAP,ELECTROLYT.	22UF-10+50	63	5322 124 24146
C 1414	CAPACITOR,FOIL	IOONF 10%	IOOV	5322 121 40323
C 1415	CAPACITOR, FOIL	1,5UF 10%	IOOV	4822 121 40452
C 1416	CAPACITOR,PAPER	47NF 10%	250V	5322 121 44138
C 1417	CAPACITOR, FOIL	220NF 10%	IOOV	4822 121 40232
C 1419	CAP,ELECTROLYT.	220UF-10+50	25	5322 124 24139
C 1421	CAP,ELECTROLYT.	10UF-10+50	160	4822 124 21129
C 1422	CAPPELECTROLYT.	47UF-10+50	63	5322 124 21182
C 1423	CAP, ELECTROLYT.	330UF-10+50	10	5322 124 21181
C 1424	CAPPELECTROLYT.	330UF-10+50	10	5322 124 21181
C 1426	CAPPELECTROLYT.	330UF-10+50	10	5322 124 21181
C 1427	CAP,ELECTROLYT.	330UF-10+50	10	5322 124 21181
C 1428	CAP,ELECTROLYT.	68UF-10+50	63	4822 124 20734
C 1430	CAPACITOR,FOIL	22 NF		5322 121 40308
C 1431	CAPACITOR, FOIL	IOONF 10%	630V	4822 121 40145
C 1432	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1433	CAPPELECTROLYT.	10UF-10+50	160	4822 124 21129
C 1434	CAPACITOR,FOIL	IOONF 10%	630V	4822 121 40145
C 1436	CAPACITOR, FOIL	22NF 10%	400V	5322 121 40308
C 1437	CAP,ELECTROLYT.	10UF-10+50	160	4822 124 21129
C 1438	CAP, ELECTROLYT.	10UF-10+50	160	4822 124 21129
C 1439	CAPACITOR, FOIL	100NF 10%	630V	4822 121 40145
C 1441	CAP, ELECTROLYT.	47UF-10+50	63	5322 124 21182
C 1442	CAP, ELECTROLYT.	100UF-10+50	10	4822 124 20679
C 1443	CAP,ELEC.TANTAL	6,8UF 20%	25V	5322 124 14081
C 1444	CAP,ELEC.TANTAL	10UF 50%	16V	5322 124 14066
C 1445	CAPACITOR,CERAM	4,7NF 10	100	4822 122 30128
C 1446	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1447	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 1448	CAPACITOR, FOIL	2NF 1%	250V	4822 121 50568
C 1449	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1450	CAPACITOR,CERAM	150 PF		4822 122 31413
C 1451	CAPACITOR,FOIL	IOONF 10%	IOOV	5322 121 40323
C 1452	CAP,ELEC.TANTAL	4700UF-10+30	40	4822 124 70326
C 1453	CAPACITOR,PAPER	220NF 10%	250V	5322 121 44142
C 1501	CAPACITOR,FOIL	68NF 10%	250V	5322 121 44137
C 1502	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1503	CAPACITORpCERAM	10NF-20+50	100	4822 122 31414
C 1504	CAPPELECTROLYT.	22UF 40%	10V	4822 124 20943

POSNR	DESCRIPTION			ORDERING CODE
C 1506	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 1507	CAPACITORSCERAM	0,82PF 0,25PF	100	4822 122 31214
C 1508	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1509	CAPACITOR,CERAM	4,7NF 10	100	4822 122 30128
C 1510	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 1511	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1512	CAPACITOR, FOIL	1,5NF 10%	1600V	4822 121 40354
C 1513	CAPACITOR, FOIL	1,5NF 10%	1600V	4822 121 40354
C 1514	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 1516	CAP, ELECTROLYT.	10UF-10+50	63	4822 124 20728
C 1517	CAPACITOR,CERAM	4,7NF 10	100	4822 122 30128
C 1518	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1519	CAP,ELEC.TANTAL	4,7UF 20%	25V	5322 124 14064
C 1521	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1522	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 1523	CAP,ELECTROLYT.	22 UF		5322 124 21462
C 1524	CAP,ELECTROLYT.	10UF-10+50	63	5322 124 24016
C 1526	CAP, ELECTROLYT.	15UF-20+20	10	5322 124 24008
C 201	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 202	CAP, ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 204	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 206	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 207	CAP,ELEC.TANTAL	6,8UF 20%	25V	5322 124 14081
C 208	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 209	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 211	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 212	CAPACITOR,CERAM	1NF-20+50	100	4822 122 30027
C 213	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 216	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 218	CAPACITOR,PAPER	47NF 10%	250V	5322 121 44138
C 219	CAPACITOR, FOIL			5322 121 54229
C 221	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 222	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 223	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 224	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 226	CAPACITOR, FOIL			5322 121 54229
C 227	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 232	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 234	CAPACITOR,PAPER	47NF 10%	250V	5322 121 44138
C 236	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 238	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 239	CAPACITORSCERAM	10NF-20+50	100	4822 122 31414
C 240	CAP, ELECTROLYT.	15UF-10+50	40	4822 124 20709
C 241	CAPACITOR,FOIL	1.5UF 10%	IOOV	5322 121 40227
C 242	CAPACITOR,FOIL	1.5UF 10%	IOOV	5322 121 40227
C 243	CAPACITOR, FOIL	1.5UF 10%	IOOV	5322 121 40227
C 244	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 245	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 246	CAPACITOR,CERAM	1NF-20+50	100	4822 122 30027
C 247	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 248	CAP, ELECTROLYT-	15UF 10%	16V	4822 124 20977
C 249	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 250	CAPACITOR,CERAM	220PF 2	100	4822 122 31222
C 251	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 253	CAPACITORSCERAM	10NF-20+50	100	4822 122 31414
C 254	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 255	CAPACITOR,FOIL	330NF 10%	IOOV	4822 121 40257
C 256	CAP,ELECTROLYT.	15UF-10+50	40	4822 124 20709
C 257	CAP,ELECTROLYT.	15UF-10+50	40	4822 124 20709
C 258	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 259	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 260	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 261	CAPACITOR,CERAM	120PF 2	100	4822 122 30093
C 262	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103

POSNR	DESCRIPTION				ORDERING CODE
C 263	CAPACITORtCERAM	470PF	10	100	4822 122 30034
C 264	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 265	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 267	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 268	CAPACITOR,FOIL	470NF	10%	100V	5322 121 40175
C 269	CAPACITORtCERAM	27PF	2	100	4822 122 30045
C 270	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 271	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 272	CAPACITOR,CERAM	3,9PF	0,25PF	100	5322 122 34107
C 273	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 274	CAPACITOR,CERAM	4,7PF	0,25PF	100	4822 122 31045
C 275	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 277	CAPACITOR,CERAM	27PF	2	100	4822 122 30045
C 278	CAPACITORtCERAM	4,7PF	0,25PF	100	4822 122 31045
C 279	CAPACITORtCERAM	3,9PF	0,25PF	100	5322 122 34107
C 280	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 282	CAPACITOR,FOIL	220NF	10%	100V	4822 121 40232
C 283	CAP,ELECTROLYT.	15UF	10%	16V	4822 124 20977
C 284	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 285	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 286	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 287	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 288	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 289	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 291	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 292	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 501	CAPACITOR,CERAM	2,7NF	10	500	4822 122 31174
C 502	CAPACITOR,FOIL	100NF	10%	400V	4822 121 40012
C 503	CAPACITORtTRIMM	3PF			5322 125 54026
C 504	CAPACITOR,TRIMM	5,5PF			5322 125 54027
C 505	CAPACITOR,CERAM	3,3PF	0,25PF	100	4822 122 31041
C 506	CAPACITORtCERAM	3,3PF	0,25PF	500	4822 122 31188
C 507	CAP,FEEDTROUGH	300PF	10	300	5322 123 10168
C 508	CAPACITOR,CERAM	68PF	2	500	4822 122 31207
C 509	CAPACITORtTRIMM	5,5PF			5322 125 54027
C 510	CAPACITORPCERAM	680PF	10	100	4822 122 30053
C 511	CAPACITORtTRIMM	3PF			5322 125 54026
C 512	CAPACITOR,TRIMM	5,5PF			5322 125 54027
C 513	CAPACITORtCERAM	3,3PF	0,25PF	500	4822 122 31188
C 514	CAP,FEEDTROUGH	30PF	10	300	5322 123 34001
C 522	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 523	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 524	CAPACITORtCERAM	4,7NF	10	100	4822 122 30128
C 526	CAPACITORtCERAM	4,7NF	10	100	4822 122 30128
C 527	CAPACITORtCERAM	2,7NF	10	100	4822 122 30057
C 528	CAPACITORtCERAM	100PF	2	100	4822 122 31316
C 529	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 531	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 536	CAPACITOR,TRIMM	3,5PF			5322 125 50048
C 537	CAPACITOR,CERAM	12PF	2	100	4822 122 31056
C 538	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 539	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 541	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 542	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 543	CAPACITORPCERAM	39PF	2	100	4822 122 31069
C 544	CAPACITOR,TRIMM	2,0-18P	TRIM		5322 125 50051
C 546	CAPACITOR,TRIMM	2,0-18P	TRIM		5322 125 50051
C 551	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 552	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 553	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 556	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 561	CAP,ELEC.TANTAL	10UF	50%	16V	5322 124 14066
C 563	CAP,ELECTROLYT.	33UF	40%	10V	4822 124 20945
C 564	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 566	CAP,ELECTROLYT.	33UF	40%	10V	4822 124 20945

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C 568	CAPPELECTROLYT.	33UF	40%	10V	4822 124 20945
C 569	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 572	CAP,ELEC.TANTAL	10UF	50%	16V	5322 124 14066
C 573	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 574	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 576	CAP,ELECTROLYT.	33UF	40%	10V	4822 124 20945
C 631	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 632	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 633	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 634	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 636	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 637	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 638	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 639	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 641	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 642	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 643	CAPACITOR,CERAM	820PF	10	100	4822 122 30135
C 644	CAPACITOR,CERAM	10PF	2	100	4822 122 31054
C 646	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 647	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 648	CAPACITOR,CERAM	2,2PF	0,25PF	100	4822 122 31036
C 649	CAPACITORICERAM	2,2PF	0,25PF	100	4822 122 31036
C 651	CAPACITORICERAM	10NF-20+50		100	4822 122 31414
C 653	CAPACITOR,CERAM	22PF	2	100	4822 122 31063
C 654	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 656	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 657	CAPACITOR,CERAM	2,7NF	10	500	4822 122 31174
C 701	CAPACITOR,CERAM	2,7NF	10	500	4822 122 31174
C 702	CAPACITOR,FOIL	100NF	10%	400V	4822 121 40012
C 703	CAPACITORPTRIMM	3PF			5322 125 54026
C 704	CAPACITOR,TRIMM	5,5PF			5322 125 54027
C 705	CAPACITOR,CERAM	3,3PF	0,25PF	100	4822 122 31041
C 706	CAPACITORPCERAM	3,3PF	0,25PF	500	4822 122 31188
C 707	CAP,FEEDTROUGH	300PF	10	300	5322 123 10168
C 708	CAPACITORPCERAM	68PF	2	500	4822 122 31207
C 709	CAPACITOR,TRIMM	5,5PF			5322 125 54027
C 710	CAPACITOR,CERAM	680PF	10	100	4822 122 30053
C 711	CAPACITOR,TRIMM	3PF			5322 125 54026
C 712	CAPACITOR,TRIMM	5,5PF			5322 125 54027
C 713	CAPACITOR,CERAM	3,3PF	0,25PF	500	4822 122 31188
C 714	CAP,FEEDTROUGH	30PF	10	300	5322 123 34001
C 716	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 717	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 722	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 723	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 724	CAPACITORPCERAM	4,7NF	10	100	4822 122 30128
C 726	CAPACITOR,CERAM	4,7NF	10	100	4822 122 30128
C 727	CAPACITORPCERAM	2,7NF	10	100	4822 122 30057
C 728	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 729	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 731	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 736	CAPACITOR,TRIMM	3,5PF			5322 125 50048
C 737	CAPACITORPCERAM	12PF	2	100	4822 122 31056
C 738	CAPACITORICERAM	10NF-20+50		100	4822 122 31414
C 739	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 741	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 742	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 743	CAPACITORPCERAM	39PF	2	100	4822 122 31069
C 744	CAPACITOR,TRIMM	2,0-18P	TRIM		5322 125 50051
C 746	CAPACITOR,TRIMM	2,0-18P	TRIM		5322 125 50051
C 751	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 752	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 753	CAPACITOR,CERAM	100PF	2	100	4822 122 31316
C 756	CAPACITOR,CERAM	10NF-20+50		100	4822 122 31414
C 760	CAP,ELECTROLYT.	220UF-10+50		10	4822 124 20681

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C 761	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 762	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 763	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 764	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 766	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 767	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 768	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 771	CAPACITOR,FOIL	100NF 10%	100V	5322 121 40323
C 772	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 773	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 780	CAP,ELECTROLYT.	150UF-10+50	16	4822 124 20586
C 781	CAP,ELEC.TANTAL	6,8UF 20%	25V	5322 124 14081
C 782	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 783	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 784	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 786	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 787	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 800	CAP,ELECTROLYT.	220UF-10+50	10	4822 124 20681
C 801	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 802	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 803	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 804	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 806	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 807	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 808	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 831	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 852	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 853	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 854	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 856	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 857	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 858	CAPACITOR,CERAM	680PF 10	100	4822 122 30053
C 866	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 867	CAP,ELECTROLYT.	33UF 40%	10V	4822 124 20945
C 868	CAPACITOR,FOIL	220NF 10%	100V	4822 121 40232
C 870	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 872	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 873	CAPACITORPCERAM	10NF-20+50	100	4822 122 31414
C 874	CAPACITOR,CERAM	3,3PF 0,25PF	100	4822 122 31041
C 878	CAPACITOR,CERAM	3,3PF 0,25PF	100	4822 122 31041
C 884	CAPACITOR,CERAM	12PF 2	100	4822 122 31056
C 885	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 888	CAP,ELEC.TANTAL	6,8UF 20%	25V	5322 124 14081
C 889	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 890	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 893	CAPACITOR,FOIL	220NF 10%	100V	4822 121 40232
C 897	CAPACITOR,CERAM	4,7PF 0,25PF	100	4822 122 31045
C 898	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 899	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 900	CAPACITOR,CERAM	10PF 2	100	4822 122 31054
C 902	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 903	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 904	CAPACITOR,FOIL	22NF 10%	400V	5322 121 40308
C 905	CAPACITOR,CERAM	100PF 2	100	4822 122 31316
C 906	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 908	CAPACITOR,CERAM	10NF-20+50	100	4922 122 31414
C 909	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 913	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 914	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 916	CAPACITOR,CERAM	3,9NF 10	100	4822 122 30098
C 917	CAPACITOR,CERAM	4,7NF 10	100	4822 122 30128
C 918	CAPACITOR,CERAM	4,7NF 10	100	4822 122 30128
C 919	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 920	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414
C 922	CAPACITOR,CERAM	10NF-20+50	100	4822 122 31414

POSNR	DESCRIPTION				ORDERING CODE
C 925	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 929	CAPACITORPCERAM	680PF	10	100	4822 122 30053
C 931	CAPACITOR,FOIL	220NF	10%	100V	4822 121 40232
C 932	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 933	CAPACITORPCERAM	100PF	2	100	4822 122 31316
C 934	CAPACITORPCERAM	1PF	0,25PF	100	4822 122 30104
C 935	CAPACITOR,CERAM	33PF	2	100	4822 122 31067
C 936	CAPACITOR,CERAM	1PF	0,25PF	100	4822 122 30104
C 937	CAPACITOR,CERAM	33PF	2	100	4822 122 31067
C 938	CAPACITOR,CERAM	15PF	2	100	4822 122 31058
C 939	CAPACITORtCERAM	10NF-20+50		100	4822 122 31414
C 942	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 944	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
C 945	CAPACITORPCERAM	10NF-20+50		100	4822 122 31414
D 216	INTEGR.CIRCUIT	LM308AN			5322 209 86056
D 1201	PRINTED CIRCUIT	OM504			5322 216 54192
D 1202	HEATSINK	HIC-P5185	PH		5322 255 44246
D 1203	RESISTOR				5322 116 90118
D 1204	RESISTOR				5322 116 90118
D 1401	INTEGR.CIRCUIT	UA741CN	SC		4822 209 80617
D 1402	INTEGR.CIRCUIT	TDA1060	PH		5322 209 85662
D 1403	UNIT,ELECTRICAL	R			5322 218 61003
D 1501	INTEGR.CIRCUIT	UA741CN	SC		4822 209 80617
D 201	INTEGR.CIRCUIT	UA741CN	SC		4822 209 80617
D 202	INTEGR.CIRCUIT	TCA240	PH		4822 209 80629
D 203	INTEGR.CIRCUIT	SN74S132N-00	T		5322 209 85267
D 204	INTEGR.CIRCUIT	N74LS02N	SC		5322 209 85312
D 206	INTEGR.CIRCUIT	N74LS00N	SC		5322 209 84823
D 207	INTEGR.CIRCUIT	74F74PC	FA		5322 209 81474
D 208	INTEGR.CIRCUIT	N74LS02N	SC		5322 209 85312
D 209	INTEGR.CIRCUIT	N74S02N	SC		5322 209 85407
D 211	INTEGR.CIRCUIT	N74LS10N	SC		5322 209 84996
D 212	INTEGR.CIRCUIT	74F74PC	FA		5322 209 81474
D 213	INTEGR.CIRCUIT	SN74LS122N-00	T		5322 209 85563
D 214	INTEGR.CIRCUIT	SN74S132N-00	T		5322 209 85267
D 216	INTEGR.CIRCUIT	LM308AN	SC		5322 209 86056
D 217	INTEGR.CIRCUIT	N74S32N	SC		5322 209 85679
D 218	INTEGR.CIRCUIT	N74S10N	SC		5322 209 84954
D 501	INTEGR.CIRCUIT	UA714HC	FA		5322 209 86169
D 502	INTEGR.CIRCUIT	UA714HC	FA		5322 209 86169
D 503	INTEGR.CIRCUIT	SD5000N	SC		5322 209 85748
D 631	INTEGR.CIRCUIT	PLIFIER			5322 209 80991
D 632	INTEGR.CIRCUIT	N74LS08N	SC		5322 209 84995
D 633	INTEGR.CIRCUIT	N74LS132N	SC		5322 209 85201
D 634	INTEGR.CIRCUIT	N74LS112N	SC		5322 209 85741
D 636	INTEGR.CIRCUIT	UA741CN	SC		4822 209 80617
D 637	INTEGR.CIRCUIT	LM79L05ACZ	NS		5322 209 86434
D 701	INTEGR.CIRCUIT	UA714HC	FA		5322 209 86169
D 702	INTEGR.CIRCUIT	UA714HC	FA		5322 209 86169
D 703	INTEGR.CIRCUIT	SD5000N	SC		5322 209 85748
D 831	INTEGR.CIRCUIT	PLIFIER			5322 209 80991
D 851	INTEGR.CIRCUIT	HEF4052BP	PH		4822 209 10263
D 852	INTEGR.CIRCUIT	TL082CP	T		5322 209 86064
D 853	INTEGR.CIRCUIT	ARRAY 0Q 0127			5322 209 80992
D 854	INTEGR.CIRCUIT	ARRAY 0Q 0127			5322 209 80992
E 1	LAMP	LAMP 28V 80 MA			5322 134 40534
E 2	LAMP	LAMP 28V 80 MA			5322 134 40534
F 1401	FUSE	T2A			4822 253 30025
F 1402	FUSE	500 MAT			4822 253 30017
K 1371	RELAY,REED				5322 280 20099
K 501	RELAY,REED				5322 280 20101
K 502	RELAY,REED				5322 280 20099
K 503	RELAY,REED				5322 280 20101
K 504	RELAY,REED				5322 280 20099
K 506	RELAY,REED				5322 280 20101

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K 507	RELAY,REED				5322 280 20099
K 701	RELAY,REED				5322 280 20101
K 702	RELAY,REED				5322 280 20099
K 703	RELAY,REED				5322 280 20101
K 704	RELAY,REED				5322 280 20099
K 706	RELAY,REED				5322 280 20101
K 707	RELAY,REED				5322 280 20099
K 851	RELAY,REED				5322 280 20099
L 1401	COIL	COIL			5322 156 44014
L 1402	COIL	COIL			5322 281 64154
L 1403	COIL	COIL			5322 156 44014
L 1404	COIL	COIL			5322 156 44014
L 4	COIL	SPOEL			5322 157 51614
L 501	COIL	ASSY COIL			5322 158 30199
L 701	COIL	ASSY COIL			5322 158 30199
L 801	COIL	COIL			5322 156 44014
L 802	COIL	COIL			5322 156 44014
L 803	COIL	COIL			5322 156 44014
R 113	RESISTOR,M.FILM	962 K			5322 116 52091
R 116	RESISTOR,M.FILM	385 K			5322 116 52092
R 373	RESISTOR,M.FILM	68,1 K			4822 116 51266
R 374	RESISTOR,M.FILM	56,2 K			4822 116 51264
R 376	RESISTOR,M.FILM	68,1 K			4822 116 51266
R 377	RESISTOR,M.FILM	51,1 K			5322 116 50672
R 382	RESISTOR,M.FILM	86,6 K			5322 116 54692
R 383	RESISTOR,M.FILM	53,6 K			5322 116 54674
R 573	RESISTOR,M.FILM	5,11 K			5322 116 54595
R 588	RESISTOR,M.FILM	1,78 K			5322 116 50515
R 589	RESISTOR,M.FILM	1,78 K			5322 116 50515
R 592	RESISTOR,M.FILM	348 K			5322 116 55499
R 598	RESISTOR,M.FILM	1,21 K			5322 116 54557
R 599	RESISTOR,M.FILM	1,21 K			5322 116 54557
R 601	RESISTOR,M.FILM	316 E			5322 116 54511
R 602	RESISTOR,M.FILM	178 E			5322 116 54492
R 603	RESISTOR,M.FILM	178 E			5322 116 54492
R 633	RESISTOR,M.FILM	1,15 K			5322 116 50415
R 642	RESISTOR,M.FILM	1,15 K			5322 116 50415
R 773	RESISTOR,M.FILM	5,11 K			5322 116 54595
R 788	RESISTOR,M.FILM	lr78 K			5322 116 50515
R 789	RESISTOR,M.FILM	1,78 K			5322 116 50515
R 792	RESISTOR,M.FILM	348 K			5322 116 55499
R 798	RESISTOR,M.FILM	1,21 K			5322 116 54557
R 799	RESISTOR,M.FILM	1,21 K			5322 116 54557
R 801	RESISTOR,M.FILM	316 E			5322 116 54511
R 802	RESISTOR,M.FILM	178 E			5322 116 54492
R 803	RESISTOR,M.FILM	178 E			5322 116 54492
R 922	RESISTOR,M.FILM	10 E			5322 116 50452
R 923	RESISTOR,M.FILM	10 E			5322 116 50452
R 938	RESISTOR,M.FILM	133 E			5322 116 54482
R 942	RESISTOR,M.FILM	1 E			4822 116 51179
R 991	RESISTOR,M.FILM	261 E			5322 116 54502
R 1000	RESISTOR,M.FILM	17,8	1	MR25	5322 116 50418
R 1001	RESISTOR,M.FILM	287	1	MR25	5322 116 54506
R 1002	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1003	RESISTOR,M.FILM	14,7 E			5322 116 50412
R 1004	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1005	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1007	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1008	RESISTOR,M.FILM	1,15K	1	MR25	5322 116 50415
R 101	RESISTOR,M.FILM	191K	0,5	MR25	5322 116 55363
R 1011	RESISTOR,M.FILM	5,9K	1	MR25	5322 116 50583

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R 1013	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1014	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1016	RESISTOR,M.FILM	3901K	1	MR25	4822 116 51246
R 1017	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1019	RESISTOR,M.FILM	274	1	MR25	5322 116 54504
R 102	RESISTOR,M.FILM	113	0,5	MR25	5322 116 54019
R 1021	RESISTOR,M.FILM	274	1	MR25	5322 116 54504
R 1022	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1023	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1024	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1026	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1027	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1028	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1029	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 103	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 1031	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1032	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1033	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1034	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1036	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1037	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1038	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1039	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 104	RESISTOR,M.FILM	2,94K	0,5	MR25	5322 116 51396
R 1041	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1042	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1043	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1044	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1045	RESISTOR,M.FILM	274	1	MR25	5322 116 54504
R 1046	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1047	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1048	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1049	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1051	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1054	POTM,TRIMMING	1K	20	0.75W	5322 100 10143
R 1056	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1057	RESISTOR,M.FILM	9,53K	1	MR25	5322 116 54617
R 1058	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1059	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 106	RESISTOR,M.FILM	8,66K	1	MR25	5322 116 54613
R 1060	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1061	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1062	RESISTOR,M.FILM	14,7 E			5322 116 50412
R 1063	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1064	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 1065	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1066	RESISTOR,M.FILM	866	1	MR25	5322 116 54543
R 1067	RESISTOR,M.FILM	51,1K	1	MR25	5322 116 50672
R 1068	RESISTOR,M. FILM	10K	1	MR25	4822 116 51253
R 1069	RESISTOR,M.FILM	196K	1	MR25	5322 116 55364
R 107	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 1071	RESISTOR,M.FILM	866K	1	MR25	5322 116 51395
R 1072	RESISTOR,M.FILM	402K	1	MR25	5322 116 55283
R 1073	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1076	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1077	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1078	RESISTOR,M.FILM	38,3	1	MR25	5322 116 50954
R 1079	RESISTOR,M.FILM	38,3	1	MR25	5322 116 50954
R 108	RESISTOR,M.FILM	95,3K	1	MR25	5322 116 50567
R 1081	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1082	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1083	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1084	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1085	RESISTOR,M.FILM	51,1K	1	MR25	5322 116 50672
R 1086	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904

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R 1087	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 1088	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 1089	RESISTOR,M.FILM	2,49K	1	MR25	5322 116 50581
R 109	RESISTOR,M.FILM	113	0,5	MR25	5322 116 54019
R 1090	RESISTOR,M.FILM	100	1	MR16	5322 116 55392
R 1091	RESISTOR,M.FILM	196	1	MR25	5322 116 55273
R 1092	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 1093	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 1094	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 1095	RESISTOR,M.FILM	100	1	MR16	5322 116 55392
R 1096	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 1097	RESISTOR,M.FILM	1,87K	1	MR25	5322 116 52123
R 1098	RESISTOR,M.FILM	100	1	MR16	5322 116 55392
R 1099	RESISTOR,M.FILM	100	1	MR16	5322 116 55392
R 1101	RESISTOR,M.FILM	178	1	MR25	5322 116 54492
R 1102	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1103	POTM,TRIMMING	220	20	0,5W	5322 101 14009
R 1104	POTM,TRIMMING	220	20	0,5W	5322 101 14009
R 1105	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 1106	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1107	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 1108	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 1109	RESISTOR,M.FILM	178	1	MR25	5322 116 54492
R 111	RESISTOR,M.FILM	2,94K	0,5	MR25	5322 116 51396
R 1110	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1111	RESISTOR,M.FILM	22,6K	1	MR25	5322 116 50481
R 1113	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1114	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1115	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 1116	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 1117	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1118	RESISTOR,M.FILM	24,9	1	MR25	5322 116 50903
R 1119	RESISTOR,M.FILM	24,9	1	MR25	5322 116 50903
R 112	RESISTOR,M.FILM	37,4K	0,5	MR25	5322 116 51397
R 1121	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1122	RESISTOR,HT	5,6M	5	VR25	4822 110 72207
R 1123	RESISTOR,HT	5,6M	5	VR25	4822 110 72207
R 1124	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1126	RESISTOR,M.FILM	750K	0,5	MR30	5322 116 51706
R 1127	RESISTOR,M.FILM	249K	1	MR25	5322 116 54734
R 1129	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 1131	RESISTOR,M.FILM	205	1	MR25	5322 116 55365
R 114	RESISTOR,M.FILM	18,2K	0,1	MR24E	5322 116 51403
R 117	RESISTOR,M.FILM	191K	0,5	MR25	5322 116 55363
R 118	RESISTOR,M.FILM	95,3K	1	MR25	5322 116 50567
R 119	RESISTOR,M.FILM	37,4K	0,5	MR25	5322 116 51397
R 1201	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 1202	RESISTOR,M.FILM	2,15	1	MR25	5322 116 55536
R 1203	RESISTOR,M.FILM	2,15	1	MR25	5322 116 55536
R 1206	RESISTOR,M.FILM	147	1	MR25	5322 116 50766
R 1207	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 1208	RESISTOR,M.FILM	2,61K	1	MR25	5322 116 50671
R 1209	RESISTOR,M.FILM	147	1	MR25	5322 116 50766
R 121	RESISTOR,M.FILM	18,2K	0,1	MR24E	5322 116 51403
R 1211	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 1212	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 1213	POTM,TRIMMING	1K	20	0.75W	5322 100 10143
R 1214	RESISTOR,M.FILM	121	1	MR25	5322 116 54426
R 1216	RESISTOR,M.FILM	121	1	MR25	5322 116 54426
R 1217	POTM,TRIMMING	220	20	0.75W	5322 100 10133
R 1219	RESISTOR,M.FILM	383	1	MR25	5322 116 55368

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R 122	RESISTOR,M.FILM	8,66K	1	MR25	5322 116 54613
R 1221	RESISTOR,M.FILM	1,47K	1	MR25	5322 116 50635
R 1227	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1228	RESISTOR,NTC	100K	5	0.5W	5322 116 30236
R 1234	RESISTOR,M.FILM	316	1	MR25	5322 116 54511
R 1235	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 1236	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1237	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1238	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1239	RESISTOR,M.FILM	422	1	MR25	5322 116 50459
R 1240	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 1241	RESISTOR,M.FILM	316	1	MR25	5322 116 54511
R 1242	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1243	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1244	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1246	RESISTOR,M.FILM	422	1	MR25	5322 116 50459
R 1247	RESISTOR,M.FILM	237	1	MR25	5322 116 50679
R 1248	RESISTOR,M.FILM	16,2	1	MR25	5322 116 54431
R 1249	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 1251	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 1252	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 1253	RESISTOR,M.FILM	1,47K	1	MR25	5322 116 50635
R 1254	RESISTOR,M.FILM	316	1	MR25	5322 116 54511
R 1256	POTM,TRIMMING	1K	20	0.75W	5322 100 10143
R 1257	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 1258	RESISTOR,M.FILM	3,83K	1	MR25	5322 116 54589
R 1259	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 1261	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 1262	RESISTOR,M.FILM	237	1	MR25	5322 116 50679
R 1263	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1264	RESISTOR,M.FILM	178	1	MR25	5322 116 54492
R 1266	RESISTOR,M.FILM	237	1	MR25	5322 116 50679
R 1267	RESISTOR,M.FILM	178	1	MR25	5322 116 54492
R 1268	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1269	RESISTOR,M.FILM	100	1	MR30	5322 116 54852
R 1300	RESISTOR,M.FILM	19,6K	1	MR25	5322 116 54641
R 1301	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1302	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 1303	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 1304	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1305	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 1306	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1307	RESISTOR,M.FILM	681 E			4822 116 51233
R 1309	RESISTOR,M.FILM	2,61K	1	MR25	5322 116 50671
R 1310	RESISTOR,M.FILM	19,6K	1	MR25	5322 116 54641
R 1311	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 1312	RESISTOR,M.FILM	140K	1	MR25	5322 116 54259
R 1313	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 1314	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1315	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 1316	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1317	RESISTOR,M.FILM	3,32K	1	MR25	4822 116 51247
R 1318	RESISTOR,M.FILM	301	1	MR25	5322 116 55366
R 1319	RESISTOR,M.FILM	301	1	MR25	5322 116 55366
R 1320	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 1322	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1323	RESISTOR,M.FILM	46,4K	1	MR25	5322 116 50557
R 1324	RESISTOR,M.FILM	46,4K	1	MR25	5322 116 50557
R 1325	RESISTOR,M.FILM	147	1	MR25	5322 116 50766
R 1326	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 1328	RESISTOR,M.FILM	86,6K	1	MR25	5322 116 54692
R 1329	RESISTOR,M.FILM	71,5K	1	MR25	5322 116 54685
R 1330	RESISTOR,M.FILM	147	1	MR25	5322 116 50766

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R 1332	RESISTOR,M.FILM	16,2K	1	MR25	5322 116 55361
R 1333	RESISTOR,M.FILM	4,64K	1	MR25	5322 116 50484
R 1334	RESISTOR,M.FILM	953	1	MR25	5322 116 54547
R 1336	RESISTOR,M.FILM	402K	1	MR25	5322 116 55283
R 1337	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 1338	RESISTOR,M.FILM	953	1	MR25	5322 116 54547
R 1339	RESISTOR,M.FILM	402K	1	MR25	5322 116 55283
R 1347	RESISTOR,M.FILM	1	1	MU25	4822 116 51179
R 1361	RESISTOR,M.FILM	18,7K	1	MR25	5322 116 55362
R 1362	RESISTOR,M.FILM	511K	1	MR25	5322 116 55258
R 1363	RESISTOR,M.FILM	13,3K	1	MR25	5322 116 55276
R 1370	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 1371	RESISTOR,M.FILM	26,1K	1	MR25	5322 116 54651
R 1372	RESISTOR,M.FILM	9,53K	1	MR25	5322 116 54617
R 1373	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 1374	RESISTOR,M.FILM	1,54K	1	MR25	5322 116 50586
R 1376	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 1377	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1378	RESISTOR,M.FILM	154	1	MR25	5322 116 50506
R 1381	POTM,TRIMMING	100	20	0,5W	5322 101 14011
R 1383	RESISTOR,M.FILM	1,54K	1	MR25	5322 116 50586
R 1384	POTM,TRIMMING	10K	20	0,5W	5322 100 10113
R 1388	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 1389	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 1392	RESISTOR,M.FILM	953	1	MR25	5322 116 54547
R 1401	RESISTOR,M.FILM	40,2K	1	MR25	5322 116 54665
R 1402	RESISTOR,M.FILM	1,27	1	MR25	5322 116 51393
R 1403	RESISTOR,M.FILM	1,27	1	MR25	5322 116 51393
R 1404	RESISTOR,M.FILM	1,27	1	MR25	5322 116 51393
R 1406	RESISTOR,M.FILM	24,9K	1	MR25	5322 116 54648
R 1407	RESISTOR,HT	2,2M	5	VR37	4822 110 42196
R 1408	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1409	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 1411	RESISTOR,HT	1,2M	5	VR37	4822 110 42189
R 1412	RESISTOR,HT	5,6M	5	VR37	4822 110 42207
R 1413	RESISTOR,HT	10M	1	VR37	4822 110 42214
R 1414	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1416	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1417	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1418	RESISTOR,M.FILM	14,7 E			5322 116 50412
R 1419	RESISTOR,M.FILM	90,9K	1	MR25	5322 116 54694
R 1420	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 1421	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1422	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1424	RESISTOR,M.FILM	196	1	MR25	5322 116 55273
R 1426	RESISTOR,M.FILM	6,81K	1	MR25	4822 116 51252
R 1428	RESISTOR,M.FILM	21,5K	1	MR25	5322 116 50451
R 1429	RESISTOR,M.FILM	3,16K	1	MR25	5322 116 50579
R 1430	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1431	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 1432	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 1433	RESISTOR,M.FILM	13K	1	MR25	5322 116 50522
R 1434	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1435	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1436	RESISTOR,M.FILM	78,7K	1	MR25	5322 116 50533
R 1437	RESISTOR,M.FILM	13,3K	1	MR25	5322 116 55276
R 1438	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1439	RESISTOR,M.FILM	3,83K	1	MR25	5322 116 54589
R 1440	RESISTOR,M.FILM	11	1	MR25	5322 116 54059
R 1441	RESISTOR,M.FILM	19,6	1	MR25	5322 116 50473
R 1442	RESISTOR,M.FILM	6,19K	1	MU25	5322 116 55426
R 1443	RESISTOR,M.FILM	261	1	MR25	5322 116 54502
R 1444	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1446	RESISTOR,M.FILM	2,49K	1	MR25	5322 116 50581

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R 1447	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1448	RESISTOR,M.FILM	5,9K	1	MR25	5322 116 50583
R 1449	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1451	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1452	RESISTOR,M.FILM	4,64K	1	MR25	5322 116 50484
R 1453	RESISTOR,M.FILM	30,1K	1	MR25	5322 116 54655
R 1456	RESISTOR,M.FILM	14,7K	1	MR25	5322 116 54632
R 1457	RESISTOR,M.FILM	1,54K	1	MR25	5322 116 50586
R 1458	RESISTOR,M.FILM	1,27K	1	MR25	5322 116 50555
R 1459	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1460	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 1461	RESISTOR,M.FILM	24,9K	1	MR25	5322 116 54648
R 1462	RESISTOR,M.FILM	4,64K	1	MR25	5322 116 50484
R 1463	RESISTOR,M.FILM	226	1	MR25	5322 116 54497
R 1464	RESISTOR,M.FILM	8,25K	1	MR25	5322 116 54558
R 1466	RESISTOR,M.FILM	23,7K	1	MR25	5322 116 54646
R 1467	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 1468	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 1469	RESISTOR,M.FILM	20,5K	1	MR25	5322 116 55419
R 1470	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1471	POTM,TRIMMING	100K	20	0.5W	5322 101 10312
R 1472	POTM,TRIMMING	1M	20	0.5W	5322 101 10314
R 1473	POTM,TRIMMING	220K	20	0.5W	5322 101 10315
R 1474	POTM,TRIMMING	22K	20	0.5W	5322 101 10311
R 1476	POTM,TRIMMING	330	20	0.515	5322 101 10313
R 1501	RESISTOR,M. FILM	5,11	1	MR25	5322 116 54192
R 1502	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1503	RESISTOR,M.FILM	24,9K	1	MR25	5322 116 54648
R 1504	POTM,TRIMMING	22K	20	0.5W	5322 100 10118
R 1505	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 1506	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 1507	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1508	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 1509	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1511	RESISTOR,M.FILM	40,2K	1	MR25	5322 116 54665
R 1512	RESISTOR,M.FILM	348K	1	MR25	5322 116 55499
R 1513	RESISTOR,M.FILM	8,66K	1	MR25	5322 116 54613
R 1514	RESISTOR,M.FILM	1,87K	1	MR25	5322 116 52123
R 1516	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 1517	RESISTOR,M.FILM	36,5K	1	MR25	5322 116 50726
R 1519	RESISTOR,M.FILM	249	1	MR25	5322 116 54499
R 1520	RESISTOR,M.FILM	7,5K	1	MR25	5322 116 54608
R 1521	RESISTOR,M.FILM	7,5K	1	MR25	5322 116 54608
R 1522	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 1523	RESISTOR,M.FILM	909	1	MR25	5322 116 55278
R 1524	RESISTOR,M.FILM	23,7K	1	MR25	5322 116 54646
R 1526	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 1527	RESISTOR,SAFETY	7,87K	1	MR25	5322 116 50458
R 1528	RESISTOR,M.FILM	20,5K	1	MR25	5322 116 55419
R 1529	RESISTOR,M.FILM	12,1K	1	MR25	5322 116 50572
R 1532	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1533	RESISTOR,M.FILM	46,4K	1	MR25	5322 116 50557
R 1536	RESISTORIN·FILM	100	1	MR25	5322 116 55549
R 1537	RESISTOR,M.FILM	383K	1	MR25	5322 116 55335
R 1538	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 1539	RESISTOR,M.FILM	511K	1	MR25	5322 116 55258
R 1541	RESISTOR,M.FILM	78,7K	1	MR25	5322 116 50533
R 1542	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1543	RESISTOR,M.FILM	59K	1	MR25	5322 116 54678
R 1544	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1546	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1547	RESISTOR,M.FILM	6,81K	0,1	MR24E	5322 116 54165
R 1548	RESISTOR,M.FILM	909	1	MR25	5322 116 55278
R 1549	RESISTOR,M.FILM	1,47K	0,1	MR24E	5322 116 54187

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R 1551	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 1552	RESISTOR,M.FILM	133	1	MR25	5322 116 54482
R 1553	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 17	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 201	RESISTOR,M.FILM	12,1K	1	MR25	5322 116 50572
R 202	RESISTOR,M.FILM	2,05K	1	MR25	5322 116 50664
R 204	RESISTOR,M.FILM	2,15K	1	MR25	5322 116 50767
R 205	RESISTOR,M.FILM	511K	1	MR25	5322 116 55258
R 206	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 207	RESISTOR,M.FILM	2,15K	1	MR25	5322 116 50767
R 208	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 209	RESISTOR,M.FILM	9,09K	1	MR25	4822 116 51284
R 211	RESISTOR,M.FILM	9,53K	1	MR25	5322 116 54617
R 212	RESISTOR,M.FILM	2,37K	1	MR25	5322 116 54576
R 214	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 216	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 217	RESISTOR,M.FILM	237	1	MR25	5322 116 50679
R 218	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 219	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 220	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 221	RESISTOR,M.FILM	1,54K	1	MR25	5322 116 50586
R 222	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 223	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 224	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 226	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 227	RESISTOR,M.FILM	17,8K	1	MR25	5322 116 54637
R 228	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 229	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 230	RESISTOR,M.FILM	15,4K	1	MR25	5322 116 55459
R 231	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 232	RESISTOR,M.FILM	1,69K	1	MR25	5322 116 54567
R 233	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 234	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 236	RESISTOR,M.FILM	464	1	MR25	5322 116 50536
R 237	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 238	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 239	RESISTOR,M.FILM	715	1	MR25	5322 116 50571
R 240	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 241	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 242	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 243	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 244	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 246	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 247	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 248	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 249	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 250	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 251	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 252	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 253	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 254	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 255	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 256	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 257	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 258	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 259	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 260	RESISTOR,M.FILM	6,81K	1	MR25	4822 116 51252
R 261	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 262	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 263	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 264	RESISTOR,M.FILM	6,81K	1	MR25	4822 116 51252
R 265	RESISTOR,M.FILM	1,87K	1	MR25	5322 116 52123
R 266	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426

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R 267	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 268	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 269	RESISTOR,M.FILM	154	1	MR25	5322 116 50506
R 271	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 272	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 273	RESISTOR,CARBON	33	5	CR16	4822 111 30067
R 274	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 275	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 276	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 277	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 278	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 279	RESISTOR,M.FILM	7,5	1	MR25	5322 116 54417
R 280	RESISTOR,CARBON	33	5	CR16	4822 111 30067
R 281	RESISTOR,CARBON	33	5	CR16	4822 111 30067
R 282	RESISTOR,M.FILM	562	1	MR25	4822 116 51231
R 283	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 284	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 285	RESISTOR,M.FILM	7,5	1	MR25	5322 116 54417
R 286	RESISTOR,M.FILM	562	1	MR25	4822 116 51231
R 287	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 288	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 289	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 290	RESISTOR,M.FILM	6,81K	1	MR25	4822 116 51252
R 291	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 292	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 293	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 294	RESISTOR,M.FILM	1,87K	1	MR25	5322 116 52123
R 297	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 298	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 299	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 301	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 306	RESISTOR,M.FILM	154K	1	MR25	5322 116 54714
R 307	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 308	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 309	RESISTOR,M.FILM	1,27K	1	MR25	5322 116 50555
R 311	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 312	RESISTOR,M.FILM	5911	1	MR25	5322 116 54192
R 317	RESISTOR,M.FILM	154K	1	MR25	5322 116 54714
R 318	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 319	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 321	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 322	RESISTOR,M.FILM	154K	1	MR25	5322 116 54714
R 323	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 324	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 325	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 326	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 327	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 328	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 329	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 331	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 332	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 336	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 337	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 338	RESISTOR,M.FILM	30,1K	1	MU25	5322 116 54655
R 339	RESISTOR,M.FILM	1,21K	1	MR25	5322 116 54557
R 341	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 342	RESISTOR,M.FILM	590	1	MR25	5322 116 50561
R 343	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 344	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 345	RESISTOR,HT	10M	5	VR25	4822 110 72214
R 346	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 347	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 348	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 349	POTM,TRIMMING	22K	20	0.5W	5322 101 14069

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R 351	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 355	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 356	RESISTOR,M.FILM	1,87K	1	MR25	5322 116 52123
R 357	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 358	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 359	RESISTOR,M.FILM	30,1	1	MR25	5322 116 50904
R 360	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 361	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 362	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 363	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 364	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 365	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 366	RESISTOR,M.FILM	1,15K	1	MR25	5322 116 50415
R 367	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 368	RESISTOR,M.FILM	4,64K	1	MR25	5322 116 50484
R 369	RESISTOR,SAFETY	7,87K	1	MR25	5322 116 50458
R 370	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 371	RESISTOR,M.FILM	27,4K	1	MR25	5322 116 50559
R 372	RESISTOR,M.FILM	19,6K	1	MR25	5322 116 54641
R 375	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 378	RESISTOR,M.FILM	78,7K	1	MR25	5322 116 50533
R 379	RESISTOR,M.FILM	19,6K	1	MR25	5322 116 54641
R 381	RESISTOR,M.FILM	28,7K	1	MR25	5322 116 54653
R 384	RESISTOR,M.FILM	909	1	MR25	5322 116 55278
R 385	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 386	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 387	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 388	POTM,TRIMMING	22K	20	0.75W	5322 101 14042
R 389	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 390	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 391	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 392	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 393	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 394	RESISTOR,M.FILM	536	1	MR25	5322 116 50621
R 395	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 396	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 397	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 398	RESISTOR,M.FILM	1,69K	1	MR25	5322 116 54567
R 399	RESISTOR,M.FILM	1,69K	1	MR25	5322 116 54567
R 400	RESISTOR,M.FILM	1,15K	1	MR25	5322 116 50415
R 401	POTM,TRIMMING	2,2K	20	0.5W	5322 101 14008
R 402	RESISTOR,M.FILM	1,15K	1	MR25	5322 116 50415
R 403	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 404	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 405	RESISTOR,M.FILM	1,69K	1	MR25	5322 116 54567
R 406	RESISTOR,M.FILM	562	1	MR25	4822 116 51231
R 407	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 410	RESISTOR,M.FILM	3,16K	1	MR25	5322 116 50579
R 501	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 502	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 503	RESISTOR,M.FILM	348	1	MR25	5322 116 54515
R 504	RESISTOR,M.FILM	75	1	MR25	5322 116 54459
R 505	RESISTOR,M.FILM	90,9	1	MR25	5322 116 54466
R 506	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 508	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 509	RESISTOR,M.FILM	988K	0,5	MR30	5322 116 51401
R 511	RESISTOR,M.FILM	8,35K	0,1	MR24E	5322 116 55148
R 512	RESISTOR,M.FILM	23,7	1	MR25	5322 116 54014
R 513	RESISTOR,M.FILM	172K	0,5	MR30	5322 116 51399
R 514	RESISTOR,M.FILM	920K	0,5	MR30	5322 116 55218
R 516	RESISTOR,M.FILM	92K	0,1	MR24E	5322 116 54875
R 518	RESISTOR,M.FILM	825K	1	MR25	5322 116 51398
R 519	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192

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R 522	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 523	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 524	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 526	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 527	RESISTOR,M.FILM	1,96K	1	MR25	5322 116 54571
R 528	RESISTOR,M.FILM	31,6	1	MR25	5322 116 54034
R 529	RESISTOR,M.FILM	110	1	MR25	5322 116 54474
R 531	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 532	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 533	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 534	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 536	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 537	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 539	RESISTOR,SAFETY	7,87K	1	MR25	5322 116 50458
R 541	RESISTOR,M.FILM	22,6K	1	MR25	5322 116 50481
R 542	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 543	RESISTOR,M.FILM	825K	1	MR25	5322 116 51398
R 544	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 546	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 547	POTM,TRIMMING	1K	20	0,5W	5322 100 10112
R 548	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 549	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 551	RESISTOR,M.FILM	137	0,1	MR24E	5322 116 51402
R 552	RESISTOR,M.FILM	205	0,1	MR24E	5322 116 51404
R 553	RESISTOR,M.FILM	53,6	0,1	MR24E	5322 116 54997
R 554	RESISTOR,M.FILM	82,5	0,1	MR24E	5322 116 51405
R 555	RESISTOR,M.FILM	464	1	MR25	5322 116 50536
R 554	RESISTOR,M.FILM	82,5	0,1	MR24E	5322 116 51405
R 557	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 558	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 559	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 560	RESISTOR,M.FILM	68,1	1	MR25	5322 116 54455
R 561	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 562	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 563	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 564	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 566	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 567	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 568	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 569	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 571	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 572	RESISTOR,M.FILM	42,2K	1	MR25	5322 116 50474
R 574	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 576	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 577	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 578	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 582	RESISTOR,M.FILM	2,61K	1	MR25	5322 116 50671
R 583	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 584	RESISTOR,M.FILM	82,5	1	MR25	5322 116 54462
R 586	POTM,TRIMMING	1K	20	0.75W	5322 100 10143
R 587	RESISTOR,M.FILM	121	1	MR25	5322 116 54426
R 591	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 593	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 594	RESISTOR,M.FILM	14K	1	MR25	5322 116 55571
R 596	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 597	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 604	POTM,TRIMMING	220	20	0.75W	5322 100 10133
R 606	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 608	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 609	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 611	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 612	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 613	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552

POSNR	DESCRIPTION				ORDERING CODE
R 614	RESISTOR,M.FILM	365K	1	MR25	5322 116 55641
R 616	RESISTOR,M.FILM	348K	1	MR25	5322 116 55499
R 617	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 618	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 619	RESISTOR,M.FILM	68,1K	1	MR25	4822 116 51266
R 621	RESISTOR,M.FILM	115K	1	MR25	5322 116 54279
R 622	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 623	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 624	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 626	RESISTOR,M.FILM	2,49	1	MR25	5322 116 51394
R 627	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 631	RESISTOR,M.FILM	18,7K	1	MR25	5322 116 55362
R 632	RESISTOR,M.FILM	64,9K	1	MR25	5322 116 50514
R 634	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 636	RESISTOR,M.FILM	3,32K	1	MR25	4822 116 51247
R 637	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 638	RESISTOR,M.FILM	3,32K	1	MR25	4822 116 51247
R 639	RESISTOR,M.FILM	75K	1	MR25	4822 116 51267
R 641	RESISTOR,M.FILM	18,7K	1	MR25	5322 116 55362
R 643	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 644	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 646	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 647	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 648	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 649	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 651	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 652	RESISTOR,M.FILM	64,9	1	MR25	5322 116 54453
R 653	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 654	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 656	RESISTOR,M.FILM	2,21K	1	MR25	4822 116 51245
R 657	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 658	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 659	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 660	POTMtTRIMMING	47K	20	0.75W	5322 101 14056
R 661	RESISTOR,M.FILM	75	1	MR25	5322 116 54459
R 662	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 663	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 664	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 666	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 668	RESISTOR,M.FILM	237	1	MR25	5322 116 50679
R 669	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 671	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 672	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 673	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 674	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 676	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 677	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 678	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 679	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 681	RESISTOR,M.FILM	68,1	1	MR25	5322 116 54455
R 682	RESISTOR,M.FILM	6891	1	MR25	5322 116 54455
R 683	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 684	RESISTOR,M.FILM	348	1	MR25	5322 116 54515
R 686	RESISTOR,M.FILM	348	1	MR25	5322 116 54515
R 687	RESISTOR,M.FILM	68,1	1	MR25	5322 116 54455
R 688	RESISTOR,M.FILM	68,1	1	MR25	5322 116 54455
R 689	RESISTOR,M.FILM	261	1	MR25	5322 116 54502
R 691	RESISTOR,M.FILM	6,81K	1	MR25	4822 116 51252
R 692	RESISTOR,M.FILM	12,1K	1	MR25	5322 116 50572
R 693	RESISTOR,M.FILM	14,7K	1	MR25	5322 116 54632
R 694	RESISTOR,M.FILM	110	1	MR25	5322 116 54474
R 701	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 702	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 703	RESISTOR,M.FILM	348	1	MR25	5322 116 54515

POSNR	DESCRIPTION				ORDERING CODE
R 704	RESISTOR,M.FILM	75	1	MR25	5322 116 54459
R 705	RESISTOR,M.FILM	90,9	1	MR25	5322 116 54466
R 706	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 708	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 709	RESISTOR,M.FILM	988K	0,5	MR30	5322 116 51401
R 711	RESISTOR,M.FILM	8,35K	011	MR24E	5322 116 55148
R 712	RESISTOR,M.FILM	23,7	1	MR25	5322 116 54014
R 713	RESISTOR,M.FILM	172K	0,5	MR30	5322 116 51399
R 714	RESISTOR,M.FILM	920K	0,5	MR30	5322 116 55218
R 716	RESISTOR,M.FILM	92K	0,1	MR24E	5322 116 54875
R 718	RESISTOR,M.FILM	825K	1	MR25	5322 116 51398
R 719	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 722	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 723	RESISTOR,M.FILM	5,11	1	MR25	5322 116 54192
R 724	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 726	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 727	RESISTOR,M.FILM	1,96K	1	MR25	5322 116 54571
R 728	RESISTOR,M.FILM	3116	1	MR25	5322 116 54034
R 729	RESISTOR,M.FILM	110	1	MR25	5322 116 54474
R 731	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 732	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 733	RESISTOR,M.FILM	162	1	MR25	5322 116 50417
R 734	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 736	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 737	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 739	RESISTOR,SAFETY	7,87K	1	MR25	5322 116 50458
R 741	RESISTOR,M.FILM	22,6K	1	MR25	5322 116 50481
R 742	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 743	RESISTOR,M.FILM	825K	1	MR25	5322 116 51398
R 744	RESISTOR,M.FILM	11,5	1	MR25	5322 116 50838
R 746	RESISTOR,M.FILM	11,5	1	MR25	5322 116 50838
R 747	POTM,TRIMMING	1K	20	0,5W	5322 100 10112
R 748	RESISTOR,M.FILM	8,66K	1	MR25	5322 116 54613
R 749	RESISTOR,M.FILM	12,1K	1	MR25	5322 116 50572
R 751	RESISTOR,M.FILM	137	011	MR24E	5322 116 51402
R 752	RESISTOR,M.FILM	205	0,1	MR24E	5322 116 51404
R 753	RESISTOR,M.FILM	53,6	0,1	MR24E	5322 116 54997
R 754	RESISTOR,M.FILM	82,5	011	MR24E	5322 116 51405
R 755	RESISTOR,M.FILM	464	1	MR25	5322 116 50536
R 756	RESISTOR,M.FILM	82,5	0,1	MR24E	5322 116 51405
R 757	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 758	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 759	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 760	RESISTOR,M.FILM	68,1	1	MR25	5322 116 54455
R 761	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 762	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 763	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 764	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 766	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 767	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 768	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 769	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R 771	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 772	RESISTOR,M.FILM	42,2K	1	MR25	5322 116 50474
R 774	RESISTOR,M.FILM	2,87K	1	MR25	5322 116 55279
R 776	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 777	RESISTOR,M.FILM	90,9	1	MR25	5322 116 54466
R 778	RESISTOR,M.FILM	90,9	1	MR25	5322 116 54466
R 779	POTM,TRIMMING	470	20	0.75W	5322 100 10135
R 781	RESISTOR,M.FILM	196	1	MR25	5322 116 55273
R 782	RESISTOR,M.FILM	2,61K	1	MR25	5322 116 50671
R 783	RESISTOR,M.FILM	10	1	MR25	5322 116 50452
R 784	RESISTOR,M.FILM	82,5	1	MR25	5322 116 54462
R 786	POTM,TRIMMING	1K	20	0.75W	5322 100 10143

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R 787	RESISTOR,M.FILM	121	1	MR25	5322 116 54426
R 791	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 793	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 794	RESISTOR,M.FILM	14K	1	MR25	5322 116 55571
R 796	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 797	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 804	POTM,TRIMMING	220	20	0.75W	5322 100 10133
R 806	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 808	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 809	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 811	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 812	RESISTOR,M.FILM	1,33K	1	MR25	5322 116 55422
R 813	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 814	RESISTOR,M.FILM	365K	1	MR25	5322 116 55641
R 816	RESISTOR,M.FILM	348K	1	MR25	5322 116 55499
R 817	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 818	RESISTOR,M.FILM	2,26K	1	MR25	5322 116 50675
R 819	RESISTOR,M.FILM	68,1K	1	MR25	4822 116 51266
R 821	RESISTOR,M.FILM	115K	1	MR25	5322 116 54279
R 822	POTM,TRIMMING	10K	20	0.75W	5322 100 10141
R 823	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 824	RESISTOR,M.FILM	649	1	MR25	5322 116 54532
R 826	RESISTOR,NTC	3,3K	5	0.5W	5322 116 30234
R 827	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 828	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 831	RESISTOR,M.FILM	42,2	1	MR25	5322 116 51052
R 832	RESISTOR,M.FILM	42,2	1	MR25	5322 116 51052
R 833	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 834	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 836	RESISTOR,M.FILM	215	1	MR25	5322 116 55274
R 837	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 838	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 839	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 841	POTM,TRIMMING	22K	20	0.5W	5322 101 14069
R 842	RESISTOR,M.FILM	8,25K	1	MR25	5322 116 54558
R 843	RESISTOR,M.FILM	274	1	MR25	5322 116 54504
R 844	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 846	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 847	RESISTOR,M.FILM	348	1	MR25	5322 116 54515
R 848	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 849	RESISTOR,M.FILM	51,1	1	MR25	5322 116 54442
R 868	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 871	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 872	RESISTOR,M.FILM	9,53K	1	MR25	5322 116 54617
R 873	RESISTOR,M.FILM	536	1	MR25	5322 116 50621
R 875	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 876	RESISTOR,M.FILM	422	1	MR25	5322 116 50459
R 877	RESISTOR,M.FILM	464	1	MR25	5322 116 50536
R 878	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 879	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 880	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 881	RESISTOR,M.FILM	2,49K	1	MR25	5322 116 50581
R 882	RESISTOR,M.FILM	1,05K	1	MR25	5322 116 54552
R 883	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 884	RESISTOR,M.FILM	7,15K	1	MR25	5322 116 54606
R 886	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 887	POTM,TRIMMING	100	20	0,5W	5322 101 14011
R 888	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 889	POTM,TRIMMING	100	20	0.75W	5322 100 10138
R 891	POTM,TRIMMING	10K	20	0,5W	5322 100 10113
R 892	RESISTOR,M.FILM	909	1	MR25	5322 116 55278
R 893	RESISTOR,M.FILM	1	1	MR25	4822 116 51179
R 894	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 896	RESISTOR,M.FILM	422	1	MR25	5322 116 50459

POSNR	DESCRIPTION				ORDERING CODE
R 897	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 898	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 899	RESISTOR,M.FILM	40,2	1	MR25	5322 116 50926
R 901	RESISTOR,M.FILM	619	1	MR25	4822 116 51232
R 902	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 903	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 904	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 906	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 907	POTM,TRIMMING	4,7K	20	0.75W	5322 100 10139
R 910	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 911	RESISTOR,M.FILM	90,9K	1	MR25	5322 116 54694
R 912	RESISTOR,HT	10M	5	VR25	4822 110 72214
R 913	RESISTOR,HT	10M	5	VR25	4322 110 72214
R 914	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 917	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 918	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 919	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 921	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 924	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 927	RESISTOR,M.FILM	750	1	MR25	4822 116 51234
R 928	RESISTOR,M.FILM	59	1	MR25	5322 116 54448
R 929	RESISTOR,M.FILM	2,49	1	MR25	5322 116 51394
R 932	RESISTOR,M.FILM	402K	1	MR25	5322 116 55283
R 933	RESISTOR,M.FILM	536	1	MU25	5322 116 50621
R 936	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 937	RESISTOR,M.FILM	287	1	MR25	5322 116 54506
R 939	RESISTOR,M.FILM	464	1	MR25	5322 116 50536
R 940	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 941	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 943	RESISTOR,M.FILM	562	1	MR25	4822 116 51231
R 944	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 945	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 946	RESISTOR,M.FILM	1,69K	1	MR25	5322 116 54567
R 947	RESISTOR,M.FILM	1,27K	1	MR25	5322 116 50555
R 948	RESISTOR,M.FILM	487	1	MR25	5322 116 55451
R 949	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 950	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 951	RESISTOR,M.FILM	2,49K	1	MR25	5322 116 50581
R 952	RESISTOR,M.FILM	7,15K	1	MR25	5322 116 54606
R 953	RESISTOR,M.FILM	105K	1	MR25	5322 116 55356
R 954	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 955	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
R 956	RESISTOR,M.FILM	12,7K	1	MR25	5322 116 50443
R 957	RESISTOR,M.FILM	8,25K	1	MR25	5322 116 54558
R 958	POTM,TRIMMING	220	20	0.75W	5322 100 10133
R 959	POTM,TRIMMING	220	20	0,5W	5322 101 14009
R 961	POTM,TRIMMING	220	20	0.75W	5322 100 10133
R 962	POTM,TRIMMING	220	20	0,5W	5322 101 14009
R 963	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 964	POTM,TRIMMING	100	20	0,5W	5322 101 14011
R 965	RESISTOR,M.FILM	21,5	1	MR25	5322 116 50677
R 966	RESISTOR,M.FILM	100	1	MU25	5322 116 55549
R 967	RESISTOR,M.FILM	2,49	1	MU25	5322 116 51394
R 968	RESISTOR,M.FILM	48,7	1	MR25	5322 116 50511
R 969	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 970	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 971	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 973	RESISTOR,M.FILM	562	1	MR25	4822 116 51231
R 974	RESISTOR,M.FILM	51,1K	1	MR25	5322 116 50672
R 975	RESISTOR,M.FILM	21,5	1	MR25	5322 116 50677
R 976	RESISTOR,M.FILM	866	1	MR25	5322 116 54543
R 977	RESISTOR,M.FILM	4,02K	1	MR25	5322 116 55448
R 978	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 979	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235

POSNR		DESCRIPTION				ORDERING CODE
R	980	RESISTOR,M.FILM	51,1K	1	MR25	5322 116 50672
R	981	RESISTOR,M.FILM	1,78K	1	MR25	5322 116 50515
R	982	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R	983	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R	984	RESISTOR,HT	2,2M	5	VR25	4822 110 72196
R	986	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R	987	RESISTOR,M.FILM	316	1	MR25	5322 116 54511
R	988	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R	989	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R	992	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R	993	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R	994	RESISTOR,M.FILM	26,1K	1	MR25	5322 116 54651
R	995	RESISTOR,M.FILM	26,1K	1	MR25	5322 116 54651
R	996	RESISTOR,M.FILM	287	1	YR25	5322 116 54506
R'	997	RESISTOR,M.FILM	511	1	MR25	4822 116 51282
R	998	RESISTOR,M.FILM	56,2	1	MR25	5322 116 54446
R	999	RESISTOR,M.FILM	14,7	1	MR25	5322 116 50412
S	25	ADAPTER,VOLTAGE				5322 263 40045
T	1401	TRANSF,PULS				5322 142 60329
T	1402	TRANSFORMER				5322 148 80046
T	1403	TRANSFORMER				5322 142 70065
T	1404	TRANSFORMER				5322 158 40085
T	1406	TRANSFORMER				5322 146 30434
T	801	TRANSFORMER	TRANSFORMER ASSY			5322 142 50147
V	302	TRANSISTOR	BC 548 C			4822 130 44196
V	307	DIODE	BAW 62			4822 130 30613
V	310	DIODE	BAS 45			5322 130 32256
V	311	DIODE,REFERENCE	BZV46-C1V5			5322 130 34865
V	505	DIODE	BAV 45			5322 130 34037
V	510	DIODE	BAV 45			5322 130 34037
V	514	DIODE	BAW 62			4822 130 30613
V	705	DIODE	BAV 45			5322 130 34037
V	705	DIODE	BAV 45			5322 130 34037
V	710	DIODE	BAV 45			5322 130 34037
V	714	DIODE	BAW 62			4822 130 30613
V	852	TRANSISTOR	BF 324			4822 130 41448
V	853	TRANSISTOR	BF 324			4822 130 41448
V	861	TRANSISTOR	BFQ 22S			5322 130 42031
V	862	TRANSISTOR	BFQ 22S			5322 130 42031
V	921	TRANSISTOR	BF 324			4822 130 41448
V	922	TRANSISTOR	BF 324			4822 130 41448
V	1	TUBE,PICTURE	D14-125GH/117			5322 131 20093
V	1101	TRANSISTOR	BC548C	PH		4822 130 44196
V	1102	TRANSISTOR	BF199	PH		4822 130 44154
V	1103	TRANSISTOR	BF199	PH		4822 130 44154
V	1104	TRANSISTOR, FET	BFS21A	PH		5322 130 40709
V	1106	DIODE	BAV45	PH		5322 130 34037
V	1203	TRANSISTOR	BC558B	PH		4822 130 44197
V	1204	TRANSISTOR	BFQ24	PH		5322 130 41664
V	1206	TRANSISTOR	BFQ24	PH		5322 130 41664
V	1207	DIODE	BB405B	PH		5322 130 34953
V	1208	DIODE	BB405B	PH		5322 130 34953
V	1209	TRANSISTOR	BFQ24	PH		5322 130 41664
V	1211	TRANSISTOR	BFQ24	PH		5322 130 41664
V	1212	TRANSISTOR	BC548C	PH		4822 130 44196
V	1213	TRANSISTOR	BFQ22S	PH		5322 130 42031
V	1214	TRANSISTOR	BFQ22S	PH		5322 130 42031
V	1302	TRANSISTOR	BF422	PH		4822 130 41782
V	1303	TRANSISTOR	BF423	PH		4822 130 41646
V	1306	TRANSISTOR	BFQ24	PH		5322 130 41664
V	1307	TRANSISTOR	BFQ22	PH		5322 130 41709
V	1308	DIODE	BAW62	PH		4822 130 30613
V	1309	DIODE	BAW62	PH		4822 130 30613
V	1311	TRANSISTOR	BF423	PH		4822 130 41646
V	1312	TRANSISTOR	BF422	PH		4822 130 41782

POSNR	DESCRIPTION			ORDERING CODE
V 1313	TRANSISTOR	BF422	PH	4822 130 41782
V 1314	TRANSISTOR	BF423	PH	4822 130 41646
V 1316	TRANSISTOR	BF423	PH	4822 130 41646
V 1317	TRANSISTOR	BF422	PH	4822 130 41782
V 1318	DIODE	BAW62	PH	4822 130 30613
V 1319	DIODE	BAW62	PH	4822 130 30613
V 1371	TRANSISTOR	BF324	PH	4822 130 41448
V 1372	TRANSISTOR	BF324	PH	4822 130 41448
V 1373	TRANSISTOR	BC558B	PH	4822 130 44197
V 1374	TRANSISTOR	BC548C	PH	4822 130 44196
V 1401	TRANSISTOR	BSW68A	PH	5322 130 44788
V 1402	DIODE	BAX12A	PH	5322 130 34605
V 1403	DIODE	BY476	PH	5322 130 34668
V 1404	TRANSISTOR	BC547B	PH	4822 130 40959
V 1405	DIODE	BAW62	PH	4822 130 30613
V 1406	TRANSISTOR	BC547B	PH	4822 130 40959
V 1407	DIODE	BASll	PH	4822 130 41273
V 1408	DIODE,REFERENCE	BZV10	PH	5322 130 34439
V 1409	DIODE	BYW29-150	PH	5322 130 34711
V 1410	DIODE	BAW62	PH	4822 130 30613
V 1411	DIODE	BASll	PH	4822 130 41273
V 1412	DIODE	BYW29-150	PH	5322 130 34711
V 1413	TRANSISTOR	BDY90	PH	5322 130 44243
V 1414	DIODE	BYW29-150	PH	5322 130 34711
V 1415	DIODE	BASll	PH	4822 130 41273
V 1416	DIODE	BASll	PH	4822 130 41273
V 1417	DIODE	BASll	PH	4822 130 41273
V 1418	DIODE	BASll	PH	4822 130 41273
V 1419	DIODE	BASll	PH	4822 130 41273
V 1421	DIODE	BAW62	PH	4822 130 30613
V 1422	DIODE,REFERENCE	BZX79-C10	PH	4822 130 34297
V 1423	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
V 1424	DIODE	BZX79-C12	PH	4822 130 34197
V 1426	DIODE	BAW62	PH	4822 130 30613
V 1427	DIODE	BAW62	PH	4822 130 30613
V 1428	TRANSISTOR	BC547B	PH	4822 130 40959
V 1629	TRANSISTOR	BC547B	PH	4822 130 40959
V 1432	DIODE	BAW62	PH	4822 130 30613
V 1433	TRANSISTOR	BC547B	PH	4822 130 40959
V 1434	DIODE	BAW62	PH	4822 130 30613
V 1436	DIODE	BYW29-150	PH	5322 130 34711
V 1437	DIODE	BAX12A	PH	5322 130 34605
V 1438	TRANSISTOR	2N4033	PH	5322 130 41708
V 1439	DIODE	BYW29-150	PH	5322 130 34711
V 1441	DIODE	BYW29-150	PH	5322 130 34711
V 1442	DIODE	BYW29-150	PH	5322 130 34711
V 1501	TRANSISTOR	BC548C	PH	4822 130 44196
V 1502	TRANSISTOR	BC558B	PH	4822 130 44197
V 1503	TRANSISTOR	BSX20	PH	4822 130 41705
V 1504	TRANSISTOR	BC558B	PH	4822 130 44197
V 1507	DIODE	BAV21	PH	4822 130 30842
V 1508	THYRISTOR	BSS68	PH	5322 130 44247
V 1509	TRANSISTOR	BC548C	PH	4822 130 44196
V 1511	TRANSISTOR	BF450	PH	4822 130 44237
V 1512	TRANSISTOR	BC548C	PH	4822 130 44196
V 1513	TRANSISTOR	BF199	PH	4822 130 44154
V 1514	DIODE	BAV21	PH	4822 130 30842
V 1516	TRANSISTOR	BC548C	PH	4822 130 44196
V 2	TRANSISTOR	BD938	PH	5322 130 42029
V 200	TRANSISTOR	BC558B	PH	4822 130 44197
V 202	DIODE,REFERENCE	BZX79-C3V0	PH	4822 130 31251
V 203	TRANSISTOR	BC558B	PH	4822 130 44197
V 204	TRANSISTOR	BC558B	PH	4822 130 44197
V 205	DIODE	BAW62	PH	4822 130 30613
V 206	DIODE	BAW62	PH	4822 130 30613

POSNR	DESCRIPTION			ORDERING CODE
V 207	TRANSISTOR	BC548C	PH	4822 130 44196
V 208	TRANSISTOR	BC558B	PH	4822 130 44197
V 209	TRANSISTOR	BC548C	PH	4822 130 44196
V 211	DIODE	BAN62	PH	4822 130 30613
V 212	TRANSISTOR	BFQ24	PH	5322 130 41664
V 213	TRANSISTOR	BC558B	PH	4822 130 44197
V 214	DIODE	BAW62	PH	4822 130 30613
V 216	DIODE	BAW62	PH	4822 130 30613
V 217	DIODE	BAW62	PH	4822 130 30613
V 218	DIODE	BAW62	PH	4822 130 30613
V 219	TRANSISTOR	BC548C	PH	4822 130 44196
V 220	DIODE	BAN62	PH	4822 130 30613
V 221	TRANSISTOR	BC548C	PH	4822 130 44196
V 222	DIODE	BAW62	PH	4822 130 30613
V 223	TRANSISTOR	BC558B	PH	4822 130 44197
V 224	TRANSISTOR	BC558B	PH	4822 130 44197
V 225	TRANSISTOR	BF324	PH	4822 130 41448
V 226	TRANSISTOR	BF324	PH	4822 130 41448
V 227	TRANSISTOR	BSX20	PH	4822 130 41705
V 228	TRANSISTOR	BSX20	PH	4822 130 41705
V 229	TRANSISTOR	BC558B	PH	4822 130 44197
V 231	TRANSISTOR	BC548C	PH	4822 130 44196
V 232	DIODE	BAW62	PH	4822 130 30613
V 233	TRANSISTOR	BSX20	PH	4822 130 41705
V 234	TRANSISTOR	BSX20	PH	4822 130 41705
V 235	TRANSISTOR	BC548C	PH	4822 130 44196
V 236	TRANSISTOR	BC558B	PH	4822 130 44197
V 237	TRANSISTOR	BC548C	PH	4822 130 44196
V 238	TRANSISTOR	BC548C	PH	4822 130 44196
V 239	DIODE	BAW62	PH	4822 130 30613
V 240	DIODE	BAW62	PH	4822 130 30613
V 241	DIODE	BAW62	PH	4822 130 30613
V 242	DIODE	BAW62	PH	4822 130 30613
V 243	DIODE	BAW62	PH	4822 130 30613
V 244	DIODE	BAW62	PH	4822 130 30613
V 245	DIODE	BAW62	PH	4822 130 30613
V 246	TRANSISTOR	BC548C	PH	4822 130 44196
V 247	TRANSISTOR	BC548C	PH	4822 130 44196
V 248	TRANSISTOR	BC548C	PH	4822 130 44196
V 249	DIODE	BAW62	PH	4822 130 30613
V 250	DIODE	BAW62	PH	4822 130 30613
V 251	DIODE	BAW62	PH	4822 130 30613
V 252	DIODE	BAW62	PH	4822 130 30613
V 254	DIODE	BAW62	PH	4822 130 30613
V 255	DIODE	BAW62	PH	4822 130 30613
V 256	TRANSISTOR	BC548C	PH	4822 130 44196
V 257	TRANSISTOR	BC548C	PH	4822 130 44196
V 258	TRANSISTOR	BC548C	PH	4822 130 44196
V 259	TRANSISTOR	BC548C	PH	4822 130 44196
V 261	TRANSISTOR	BC558B	PH	4822 130 44197
V 262	DIODE	BAW62	PH	4822 130 30613
V 263	DIODE	BAW62	Pti	4822 130 30613
V 264	TRANSISTOR	BC558B	PH	4822 130 44197
V 265	DIODE	BAW62	PH	4822 130 30613
V 266	DIODE,REFERENCE	BZV46-C1V5	PH	5322 130 34865
V 268	TRANSISTOR	BC548C	PH	4822 130 44196
V 269	TRANSISTOR	BC548C	PH	4822 130 44196
V 271	TRANSISTOR	BSX20	PH	4822 130 41705
V 272	TRANSISTOR	BC548C	PH	4822 130 44196
V 273	TRANSISTOR	BC548C	PH	4822 130 44196
V 274	DIODE	BAW62	PH	4822 130 30613
V 276	DIODE	BAN62	PH	4822 130 30613
V 277	DIODE	BAW62	PH	4822 130 30613
V 278	DIODE	BAW62	PH	4822 130 30613
V 279	DIODE	BAW62	PH	4822 130 30613

POSNR	DESCRIPTION			ORDERING CODE
V 281	DIODE	BAW62	PH	4822 130 30613
V 282	DIODE	BAW62	PH	4822 130 30613
V 283	DIODE	BAW62	PH	4822 130 30613
V 284	TRANSISTOR	BC548C	PH	4822 130 44196
V 285	TRANSISTOR	BC548C	PH	4822 130 44196
V 286	TRANSISTOR	BC548C	PH	4822 130 44196
V 287	TRANSISTOR	BC548C	PH	4822 130 44196
V 288	TRANSISTOR	BFY90	PH	4822 130 40493
V 289	TRANSISTOR	BFY90	PH	4822 130 40493
V 291	TRANSISTOR	BF324	PH	4822 130 41448
V 292	TRANSISTOR	BFQ24	PH	5322 130 41664
V 293	TRANSISTOR	BF324	PH	4822 130 41448
V 294	DIODE	BAW62	PH	4822 130 30613
V 295	DIODE	BAW62	PH	4822 130 30613
V 298	DIODE	BAW62	PH	4822 130 30613
V 299	DIODE	BAW62	PH	4822 130 30613
V 300	DIODE	BAW62	PH	4822 130 30613
V 301	DIODE	BAW62	PH	4822 130 30613
V 501	TRANSISTOR,FET	ON905	PH	5322 130 41904
V 502	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
V 503	TRANSISTOR	BF324	PH	4822 130 41448
V 504	TRANSISTOR	BFW30	PH	5322 130 40379
V 506	TRANSISTOR	BC558B	PH	4822 130 44197
V 507	TRANSISTOR	BF199	PH	4822 130 44154
V 508	TRANSISTOR	BF199	PH	4822 130 44154
V 509	TRANSISTOR	BC548C	PH	4822 130 44196
V 511	TRANSISTOR	BC548C	PH	4822 130 44196
V 512	DIODE,REFERENCE	BZX79-B6V8	PH	4822 130 34278
V 513	TRANSISTOR	BC558B	PH	4822 130 44197
V 516	TRANSISTOR	24		5322 130 41993
V 518	DIODE	BAW62	PH	4822 130 30613
V 519	TRAHSISTOR	BF450	PH	4822 130 44237
V 521	TRANSISTOR	BC548C	PH	4822 130 44196
V 631	TRANSISTOR	BC548C	PH	4822 130 44196
V 632	TRANSISTOR	BSX20	PH	4822 130 41705
V 633	TRANSISTOR	BFQ24	PH	5322 130 41664
V 634	TRANSISTOR	BFQ24	PH	5322 130 41664
V 636	TRANSISTOR	BFQ22S	PH	5322 130 42031
V 637	TRANSISTOR	BFQ22S	PH	5322 130 42031
V 701	TRANSISTOR,FET	ON905	PH	5322 130 41904
V 702	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
V 703	TRANSISTOR	BF324	PH	4822 130 41448
V 704	TRANSISTOR	BFU30	PH	5322 130 40379
V 706	TRANSISTOR	BC558B	PH	4822 130 44197
V 707	TRANSISTOR	BF199	PH	4822 130 44154
V 708	TRANSISTOR	BF199	PH	4822 130 44154
V 709	TRANSISTOR	BC548C	PH	4822 130 44196
V 711	TRANSISTOR	BC548C	PH	4822 130 44196
V 712	DIODE,REFERENCE	BZX79-B6V8	PH	4822 130 34278
V 713	TRANSISTOR	BC558B	PH	4822 130 44197
V 716	TRANSISTOR	24		5322 130 41993
V 718	DIODE	BAW62	PH	4822 130 30613
V 719	TRANSISTOR	BF450	PH	4822 130 44237
V 721	TRANSISTOR	BC548C	Pti	4822 130 44196
V 722	TRANSISTOR	BC548C	PH	4622 130 44196
V 831	TRANSISTOR	BF324	PH	4822 130 41448
V 832	TRANSISTOR	BF324	PH	4822 130 41448
V 833	TRANSISTOR	BFQ22S	PH	5322 130 42031
V 834	TRANSISTOR	BFQ22S	PH	5322 130 42031
V 851	TRANSISTOR	BFQ24	PH	5322 130 41664
V 854	TRANSISTOR	BFQ24	PH	5322 130 41664
V 857	DIODE	BAW62	PH	4822 130 30613
V 858	DIODE	BAW62	PH	4822 130 30613
V 859	TRANSISTOR	BC548C	PH	4822 130 44196
V 860	DIODE	BAW62	PH	4822 130 30613

POSNR	DESCRIPTION			ORDERING CODE
V 863	TRANSISTOR	BC558B	PH	4822 130 44197
V 864	TRANSISTOR	BC548C	PH	4822 130 44196
V 865	TRANSISTOR	BF199	PH	4822 130 44154
V 866	TRANSISTOR	BC548C	PH	4822 130 44196
V 869	TRANSISTOR	BF199	PH	4822 130 44154
V 870	TRANSISTOR	BC548C	PH	4822 130 44196
V 871	TRANSISTOR	BC548C	PH	4822 130 44196
V 872	TRANSISTOR	BF199	PH	4822 130 44154
V 873	TRANSISTOR	BF199	PH	4822 130 44154
V 874	TRANSISTOR	BF199	PH	4822 130 44154
V 875	TRANSISTOR	BC548C	PH	4822 130 44196
V 876	TRANSISTOR	BF199	PH	4822 130 44154
V 877	DIODE,REFERENCE	BZX79-C4V7	PH	4822 130 34174
V 878	TRANSISTOR	BF199	PH	4822 130 44154
V 879	TRANSISTOR	BF199	PH	4822 130 44154
V 880	TRANSISTOR	BC548C	PH	4822 130 44196
V 881	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
V 882	TRANSISTOR	BF199	PH	4822 130 44154
V 883	TRANSISTOR	BF199	PH	4822 130 44154
V 884	DIODE	BAW62	PH	4822 130 30613
V 885	DIODE,REFERENCE	BZX79-C4V7	PH	4822 130 34174
V 887	TRANSISTOR,FET	BFS21A	PH	5322 130 40709
V 888	DIODE	BAW62	PH	4822 130 30613
V 889	DIODE	BAW62	PH	4822 130 30613
V 890	DIODEPREFERENCE	BZX79-C6V8	PH	4822 130 34278
V 891	DIODE	BAW62	PH	4822 130 30613
V 892	DIODE	BAW62	PH	4822 130 30613
V 893	TRANSISTOR	BC548C	PH	4822 130 44196
V 894	DIODE	BAW62	PH	4822 130 30613
V 895	TRANSISTOR	BF199	PH	4822 130 44154
V 896	TRANSISTOR	BC548C	PH	4822 130 44196
V 897	TRANSISTOR	BC548C	PH	4822 130 44196
V 898	TRANSISTOR	BC548C	PH	4822 130 44196
V 899	TRANSISTOR	BC548C	PH	4822 130 44196
V 901	DIODE	BAW62	PH	4822 130 30613
V 902	DIODE	BAW62	PH	4822 130 30613
V 903	DIODE	BAW62	PH	4822 130 30613
V 904	DIODE	BAW62	PH	4822 130 30613
V 906	DIODE	BAW62	PH	4822 130 30613
V 907	TRANSISTOR	BC548C	PH	4822 130 44196
V 908	TRANSISTOR	BC558B	PH	4822 130 44197
V 909	TRANSISTOR	BC548C	PH	4822 130 44196
V 910	DIODE	BAW62	PH	4822 130 30613
V 912	TRANSISTOR	BF450	PH	4822 130 44237
V 913	TRANSISTOR	BF450	PH	4822 130 44237
V 914	TRANSISTOR	BF450	PH	4822 130 44237
V 916	TRANSISTOR	BF450	PH	4822 130 44237
V 917	TRANSISTOR	BF450	PH	4822 130 44237
V 918	TRANSISTOR	BF450	PH	4822 130 44237
V 919	TRANSISTOR,FET	BFS21A	PH	5322 130 40709
V 923	TRANSISTOR	BFQ24	PH	5322 130 41664
V 924	TRANSISTOR	BFQ24	PH	5322 130 41664

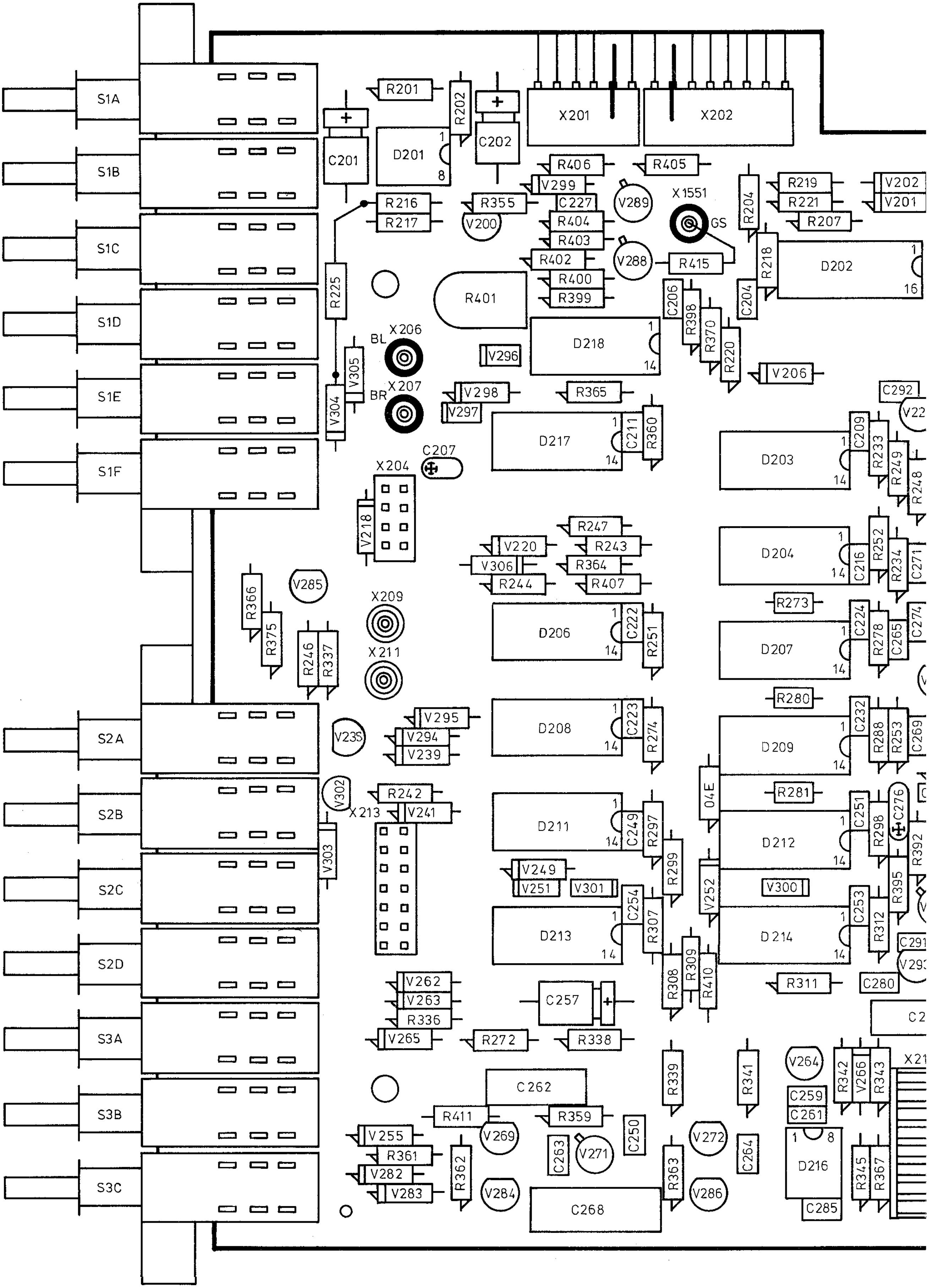
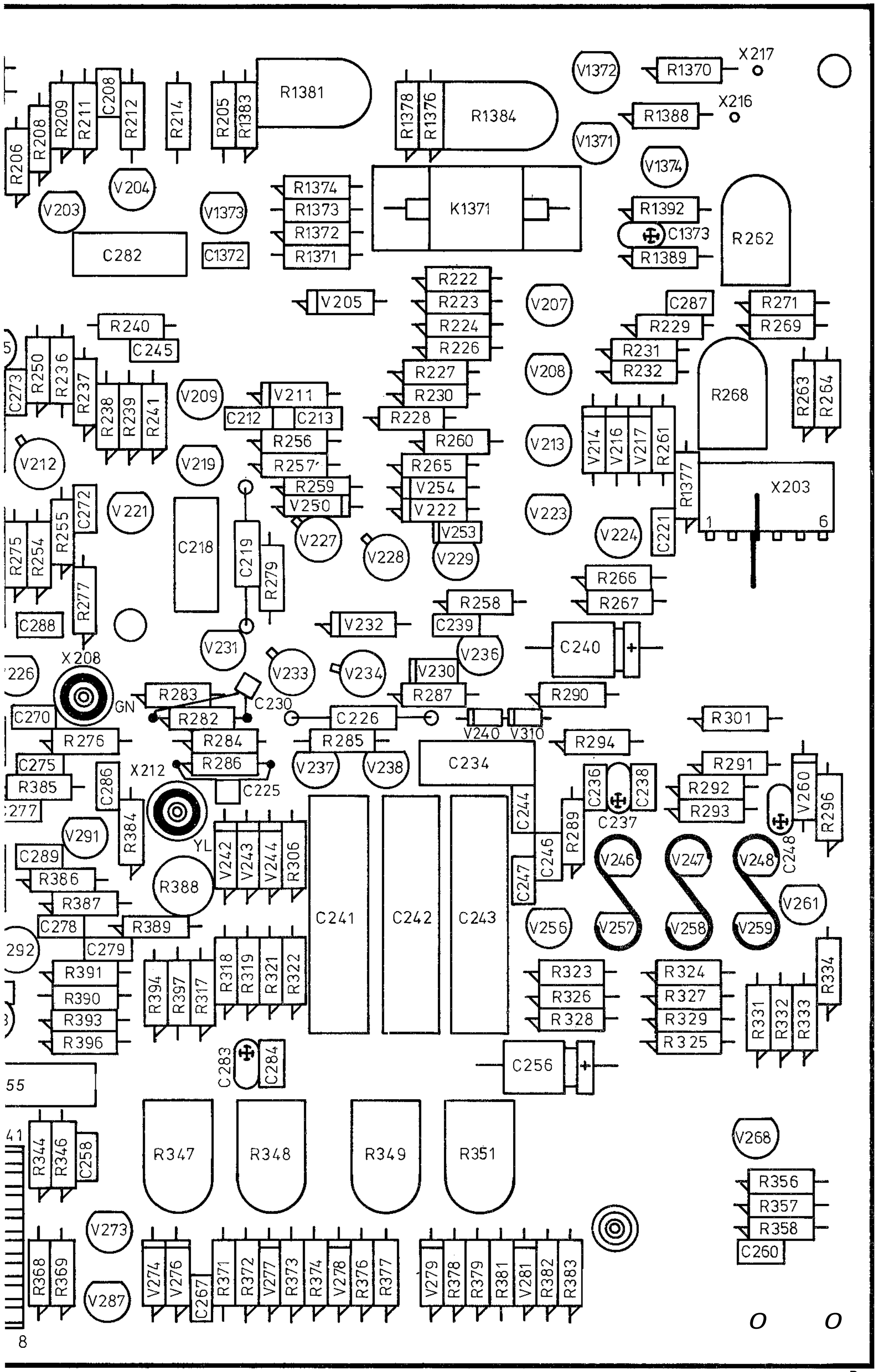


Fig. 7.7. Time-base unit p.c.b. with component location raster



MAT 1179B

Capacitors	
C201	A11
C202	A11
C203	A12
C204	B13
C206	B13
C207	C12
C208	B15
C209	C14
C211	B13/C1
C212	C15
C213	C15
C216	C14
C218	C15
C219	C15
C221	C17
C222	D13/C1
C223	D13
C224	D14/C1
C225	D15
C226	D15/D1
C227	A12
C230	D15
C232	D14
C234	D16
C236	D16
C237	D16
C238	D17/D1
C240	C17
C241	D16/E1
C242	D16/E1
C243	D16/E1
C244	D16
C246	D16
C247	D16/E1
C248	D17
C249	D13/E1
C250	F13
C251	D14
C252	F17
C253	E14
C254	E13
C255	E14
C256	E16
C257	E12
C258	F14
C259	F13
C260	F17
C261	F13
C263	F12
C264	F13
C265	D14/C1
C266	F17
C267	F15
C268	F12/F1
C269	D14
C270	D14

7.4. LOCATION LIST OF PARTS SITUATED ON THE TIME-BASE UNIT A2 (see Fig. 7.7)

C271	C14
C272	C14
C273	C14
C274	C14/D14
C275	D14
C276	D14
C277	D14
C278	E14
C279	E14
C280	E14
C282	B15/B14
C283	E14
C284	E14
C286	D14
C287	B17
C288	D14
C289	D14
C291	E14
C292	B14
C1372	B15
C1373	B16

Integrated circuits

D201	A11/A12
D202	B14/B13
D203	C13
D204	C13
D206	D12/C12
D207	D13/C13
D208	D12
D209	D13
D211	D12/E12
D212	D13/E13
D213	E12
D214	E13
D216	F13
D217	C12/B12
D218	B12/B13

Relay

K1371	B16

Resistors

R201	A11
R202	A12
R204	A13
R206	B14
R207	A13/B13
R208	B14
R209	A14/B14
R211	A14/B14
R212	A14/B14
R214	A15/B15
R216	A11
R217	A11/B11
R218	B13
R219	A13
R220	B13
R221	A13
R222	B16
R223	B16
R224	B16
R225	B11
R226	B16
R227	C16
R228	C16
R229	B17
R230	C16
R231	B16/B17
R232	C16/C17
R233	C14
R234	C14
R236	B14/C14
R237	C14
R238	C14
R239	C14
R241	C15
R242	F12
R243	C12/C13
R244	c12
R246	D11
R247	c12
R248	c14
R249	c14
R250	B14/C14
R251	D13/C13
R252	C14
R253	D14
R254	C14
R255	C14
R256	C15
R257	C15
R258	C16
R259	C15
R260	C16 (TS)
R261	C17
R262	B17
R263	C17
R264	C17
R265	C16 (TS)
R266	C16
R267	C16
R268	C17
R269	B17
R271	B17
R272	E12
R274	D13
R275	C14
R276	D14
R277	D14/C14
R278	D14/C14
R279	C15
R282	D15
R283	D15
R284	D15
R285	D15
R286	D15
R287	D16
R288	D14
R289	D16
R290	D16 (TS)
R291	D17
R292	D17
R293	D17
R294	D17 and D16 (TS)
R296	D17
R297	D13/E13
R298	D14/E14
R299	E13
R300	E12
R301	D17
R306	D15/E12
R307	E13
R308	E13
R309	E13
R311	E13
R312	E14
R317	E15
R318	E15
R319	E15
R321	E15
R322	E15
R323	E16
R324	E17
R325	E17
R326	E16
R327	E17
R328	E16
R329	E17
R331	E17
R332	E17
R333	E17
R334	E17
R336	E11/E12
R337	D11
R338	E12
R339	F13
R341	F13
R342	F14
R343	F14
R344	F14
R345	F14
R346	F14

(TS) = located on track side

R347	F15	R404	B12/A12	V236	D16
R348	F15	R405	A13	V237	D15
R349	F16/F15	R406	A12	V238	D15/D16
R351	F16	R407	C12/C13	V239	D11/D12
R352	F16	R410	E13	V240	D16 (TS)
R353	F16	R411	F12	V241	D11/D12
R354	F16	R415	B13	V242	D15/E15
R355	A12	R1370	A17	V243	D15/E15
R356	F17	R1371	B15	V244	D15/E15
R357	F17	R1372	B15	V246	D16
R358	F17	R1373	B15	V247	D17
R359	F12	R1374	B15	V248	D17
R360	C13/B13	R1376	A16/B16	V249	E12
R361	F11	R1377	C17	V250	C15 (TS)
R362	F12	R1378	A16/B16	V251	E12
R363	F13	R1381	A15/B15	V252	E13
R364	C12	R1383	A15/B15	V253	C16 (TS)
R365	B12	R1384	A16/B16	V254	C16 (TS)
R366	C11	R1388	A17/B17	V255	F11
R367	F14	R1389	B17	V256	E16
R368	F14	R1392	B17	V257	E16
R369	F14	V200	B12/A12	V258	E17
R370	B13	V201	A14	V259	E17
R371	F15	V202	A14	V260	D17
R372	F15	V203	B14	V261	E17
R373	F15	V204	B14	V262	E11/E12
R374	F15	V205	B14	V263	E11/E12
R375	C11	V206	B13	V264	F13
R376	F15	V207	B16	V265	E11
R377	F16/F15	V208	C16	V266	F14
R378	F16	V209	C15	V267	F17
F379	F16	V211	C15	V268	F17
R381	F16	V212	C14	V269	F12
R382	F16	V213	C16	V271	F12
R383	F16	V214	C16	V272	F13
R384	D14	V216	C16	V273	F14
R385	D14	V217	C16/C17	V274	F15
R386	E14	V218	C11	V276	F15
R387	E14	V219	C15	V277	F15
R388	D15/E15	V220	C12	V278	F15
R389	E14/E15	V221	C14	V279	F16
R390	E14	V222	C16	V281	F16
R391	E14	V223	C16	V282	F11
R392	E14/D14	V224	C16	V283	F11
R393	E14	V225	B14	V284	F12
R394	E15/E14	V226	D14	V285	C11
R395	E14	V227	C15	V286	F13
R396	E14	V228	C15/C16	V287	F14
R397	E15	V229	C16	V288	B13/B12
R398	B13	V230	D16 (TS)	V289	A13/A12
R399	B12	V231	D15	V291	D14
R400	B12	V232	D16	V292	E14
R401	B12	V233	D15	V293	E14
R402	B12	V234	D16	V294	D11/D12
R403	B12	V235	D11	V295	D12
				V296	B12
				V297	B12
				V298	B12
				V299	A12

V300	E13
V301	E12
V302	D11
V303	E11
V304	B11
V305	B11
V306	C12
V310	D16
V1371	B16
V1372	A16
V1373	B15
V1374	B17

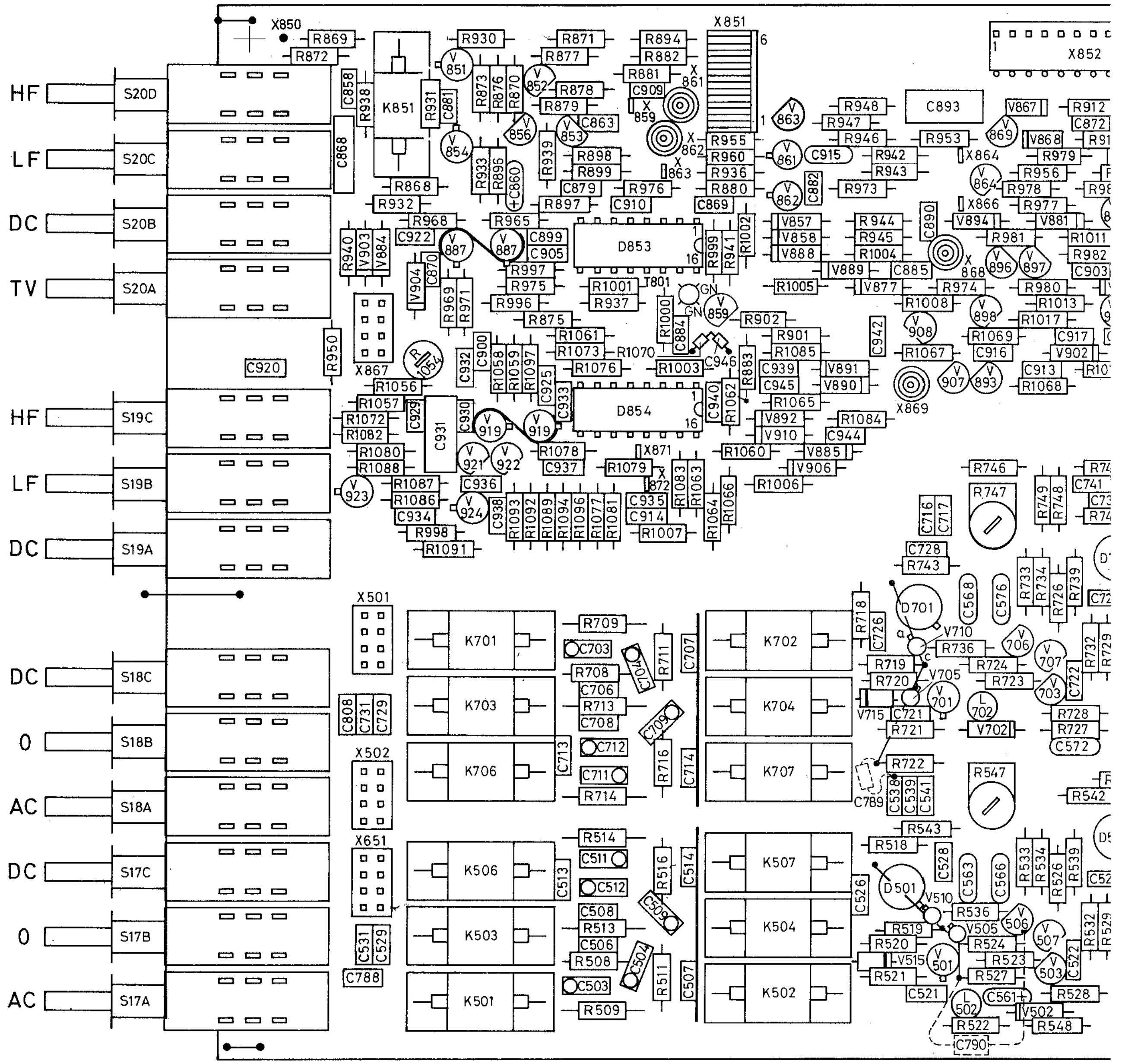
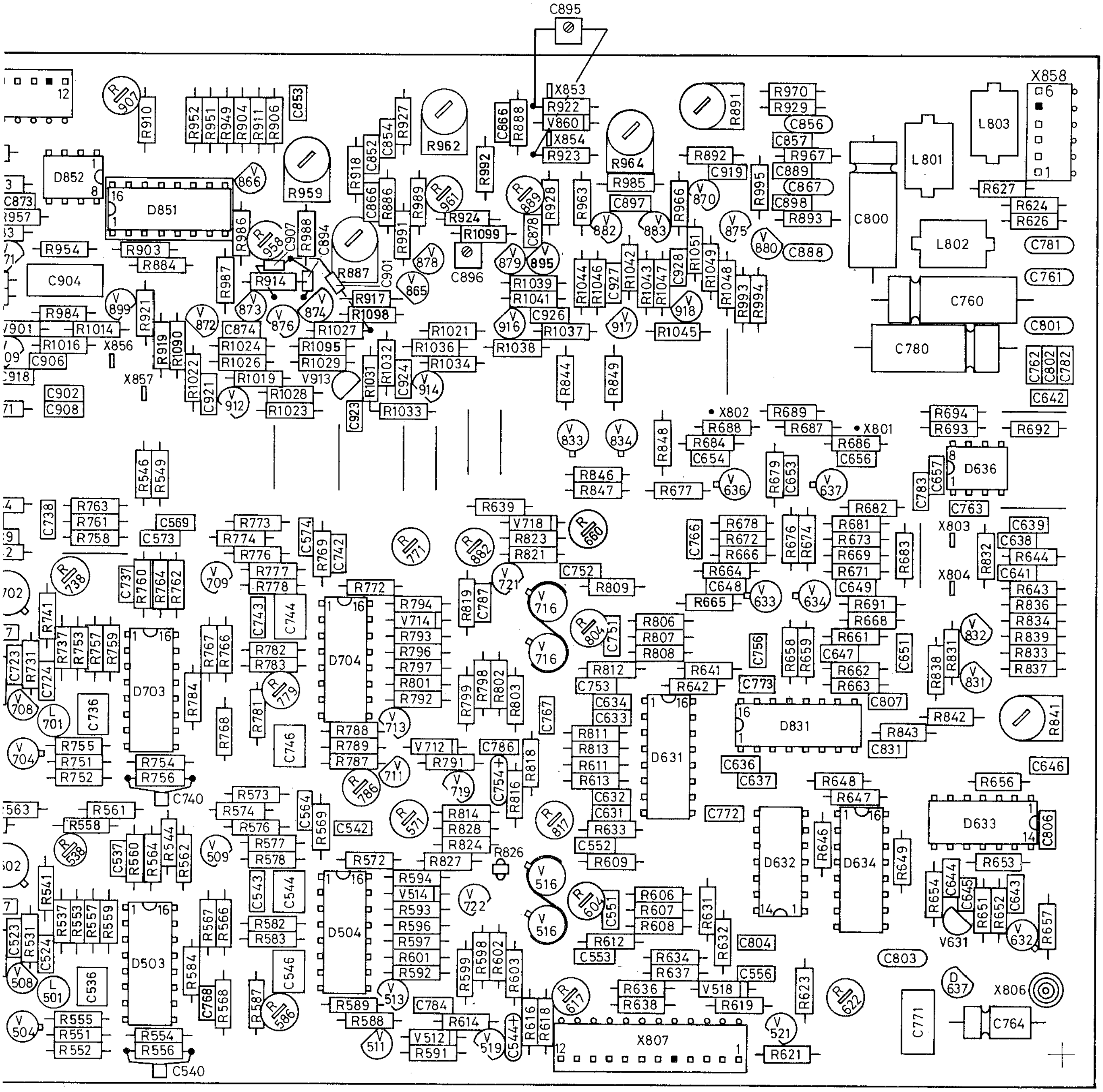


Fig. 7.8. Pre-amplifier and trigger unit p.c.b. with component location raster



MAT 1180 A

7.5. LOCATION LIST OF PARTS SITUATED ON THE PRE-AMPLIFIER AND TRIGGER UNIT 3 (see Fig. 7.8).

Capacitors

C501	F1	C573	C6	C729	D1
C502	F1	C574	C6	C731	D1
C503	F2	C576	D4	C736	D6
C504	F3	C631	E8	C737	D6
C506	F2	C632	E8	C738	C5
C507	F3	C633	D8	C739	C5
C508	F2	C634	D8	C740	E6
C509	F3	C636	E9	C741	C5
C511	E2	C637	E9	C742	C7
C513	E2	C638	C10	C743	D6
C514	E3	C639	C10	C744	D6
C521	F4	C641	C10	C746	D6, E6
C522	F5	C642	B10	C751	D8
C523	F5	C643	E10	C753	D8
C526	E4, F4	C644	E10	C754	E7
C527	E5	C645	E10	C756	D8
C528	E4	C646	E10	C760	B10
C529	F1	C647	D9	C761	B10
C531	F1	C648	D9	C762	B10
C536	F6	C649	D9	C763	C10
C537	E6	C651	D10	C764	F10
C538	E4	C653	C9	C766	C8
C539	E4	C654	C8, C9	C767	D8
C540	F6	C656	C9	C768	F6
C541	E4	C657	C10	C771	F10
C542	E7	C702	E1	C772	E9
C543	E6	C703	D2	C773	D9
C544	E6	C704	D3	C780	B10
C546	F6	C706	D2	C781	B10
C551	E8	C707	D3	C782	B10
C552	E8	C708	E2	C783	C10
C553	F8	C709	E3	C784	F7
C554	F8	C711	E2	C786	D7, D8
C556	F9	C712	E2	C787	D7
C561	F5	C713	E2	C788	F1
C563	E4	C714	E3	C789	E4
C564	E6	C716	C4	C790	F4
C566	E4	C717	C4	C800	A9
C568	D4	C721	D4	C801	B10
C569	C6	C722	D5	C802	B10
C572	E5	C723	D5	C803	F10
		C726	D4	C804	F9
		C727	D5	C806	E10
		C728	D4	C807	D9
				C808	D1

C831	D9
C851	A2
C851	A2
C852	A7
C853	A7
C854	A7
C856	A9
C857	A9
C858	A1
C860	A2/B2
C861	A2
C862	A2
C863	A2
C864	A2
C866	A7
C867	A9
C868	A1
C869	B3
C870	B2
C872	A5
C873	A5
C874	B6
C878	A8/B8
C879	A2
C881	A1
C884	B3
C885	B4
C888	B9
C889	A9
C890	B4
C893	A4
C894	B6
C895	A8
C896	B7
C897	A8
C898	A9
C899	B2
C900	B2
C901	B7
C902	B5, C5
C903	B5
C904	B5
C905	B2
C906	B5
C907	B6
C908	C5
C909	A3
C910	B2, B3
C911	A3
C913	C5
C914	C3
C915	A3
C916	B4, C4
C917	B5

C918	B5
C919	A8, A9
C920	C1
C921	B6, C6
C922	B1
C923	B7
C924	B7
C925	C2
C926	B8
C927	B8
C928	B8
C929	C1
C930	C2
C931	C1, C2
C932	C2
C933	C2
C934	C1
C935	C3
C936	C2
C938	C2
C939	C3
C940	C3
C942	B4
C944	C3, C4
C945	C3
C946	B3

Integrated circuit

D501	E4, F4
D502	E5
D503	F6
D504	E7, F7
D631	D8, E8
D632	E9
D633	E10
D634	E9
D636	C10
D701	D4
D702	D5
D703	D6
D704	D7
D831	D9
D851	A6
D852	A5
D853	B2, B3
D854	C2, C3

Resistors

R501	F1
R502	F1
R503	F1
R504	F1
R506	F1

R508	F2
R509	F2
R511	F3
R512	F4
R513	F2
R514	E2
R516	E3
R517	E4, F4
R518	E4
R519	F4
R520	F4
R521	F4
R522	F4
R523	F4
R524	F4
R526	E5
R527	F4
R528	F5
R529	F5
R531	F5
R532	F5
R533	E5
R534	E5
R536	E4
R537	F5
R538	E6, E5
R539	E5
R541	E5
R543	E4
R544	E6
R546	C6
R547	E4
R548	F5
R549	C6
R551	F5
R552	F5
F553	F5
R554	F6
R555	F6
R556	F6
F557	F5
R558	E5, F6
R559	F6
R560	E6
R561	E6
R562	E6
R564	E6
R566	F6
R567	F6
R569	E7
R571	E7
R572	E7

R573	E6	R646	E9	R716	E3
R574	E6	R647	E9	R717	E4
R576	E6	R648	E9	R718	D4
R577	E6	R649	E10	R719	D4
R578	E6	R651	E10	R720	D4
R582	F6	R652	E10	R722	E4
R583	F6	R653	E10	R723	D4
R584	F6	R654	E10	R724	D4
R586	F6	R656	E10	R726	D5
R587	F6	R657	F10	R727	E5
R588	F7	R658	D9	R729	D5
R589	F7	R659	D9	R732	D5
R591	F7	R660	D9	R733	D5
R592	F7	R661	D9	R734	D5
R593	E7	R662	D9	R736	D4
R594	E7	R663	D9	R737	D5
R596	F7	R664	C9	R738	D5
R597	F7	R666	C9	R739	D5
R598	F7	R668	D9	R741	D5
R599	F7	R669	C9	R742	C5
R601	F7	R671	C9	R743	D4
R602	F7	R672	C9	R744	C5
R603	F8	R673	C9	R746	C4
R604	E8	R674	C9	R747	C4
R606	E8	R676	C9	R748	C5
R607	E8	R678	C9	R749	C5
R608	E8	R679	C9	R751	E5
R609	E8	R681	C9	R752	E5
R611	E8	R682	C9	R753	D5
R612	F8	R683	C10	R754	E6
R613	E8	R684	C8	R755	D6
R614	F7	R686	C9	R756	E6
R616	F8	R687	C9	R757	D5
R617	F8	R688	C9	R758	C5
R618	F8	R689	C9	R759	D6
R619	F9	R691	D9	R760	D6
R621	F9	R692	C10	R761	C5
R622	F9	R693	C10	R762	D6
R623	F9	R694	C10	R763	C5
R624	A10	R701	E1	R764	D6
R626	A10	R702	E1	R766	D6
R627	A10	R703	E1	R767	D6
R632	F9	R704	E1	R768	D6
R633	E8	R706	D1	R769	C7
R634	F8	R708	D2	R771	C7
R636	F8	R709	D2	R773	C6
R637	F8	R711	D3	R774	C6
R638	F8	R712	D4	R776	C6
R639	C7	R713	D2	R777	C6, D6
R641	D8	R714	E2	R778	D6
R642	D8			R779	D6
R643	D10			R781	D6
R644	C10			R782	D6

R783	D6
R784	D6
R786	E7
R787	E7
R788	D7
R789	D7
R791	E7
R792	D7
R793	D7
R794	D7
R796	D7
R797	D7
R798	D7
R799	D7
R801	D7
R802	D7
R803	D8
R804	D8
R806	D8
R807	D8
R808	D8
R809	D8
R811	D8
R812	D8
R813	D8
R814	E7
R816	E8
R817	E8
R818	E8
R819	D7
R821	C8
R823	C8
R824	E7
R826	E7
R827	E7
R828	E7
R831	D10
R832	C10
R833	D10
R834	D10
R836	D10
R837	D10
R838	D10
R839	D10
R841	D10
R842	D10
R843	D10
R844	B8
R846	C8
R847	C8
R848	C8
R849	B8
R868	A1
R869	A1

R870	A2
R871	A2
R872	A1
R873	A2
R874	A2
R875	B2
R876	A2
R877	A2
R878	A2
R879	A2
R880	A3, B3
R881	A3
R882	A3
R883	B3
R884	B6
R886	A7
R887	B7
R888	A7, A8
R889	A7, A8
R891	A8, A9
R893	A9
R894	A3
R896	A2
R898	A2
R899	A2
R901	B3
R902	B3
R903	B6
R912	A5
R913	A5
R914	B6
R917	B7
R918	A7
R919	B6
R921	B6
R922	A8
R923	A8
R927	A7
R928	A8
R929	A9
R930	A2
R931	A2
R932	B1
R933	A2
R934	A2
R936	A3
R937	B2
R938	A1
R939	A2
R940	B1
R941	B3
R942	A4
R943	A4
R944	B4
R945	B4

R946	A4
R947	A3, A4
R948	A4
R953	A4
R954	B5
R955	A3
R956	A5
R957	A5
R958	B6
R959	A6
R960	A3
R961	A7
R962	A7
R963	A8
R964	A8
R965	B2
R966	A8
R967	A9
R968	B1
R969	B2
R970	A9
R971	B2
R972	B3, B4
R973	A4
R974	B4
R975	B2
R976	A3
R977	B5
R979	B5
R980	B5
R982	B5
R984	B5
R985	A8
R986	A6, B6
R987	B6
R988	B6
R991	A7
R992	A7
R993	B9
R994	B9
R995	A9
R996	B2
R997	B2
R998	C2
R999	B3
R1000	B3
R1001	B2
R1002	B3
R1004	B4
R1005	B4
R1006	C3
R1007	C3
R1008	B4
R1011	B5
R1013	B5
R1014	B5

R1016	B5
R1017	B5
R1019	B6
R1021	B7
R1022	B6
R1023	C6
R1024	B6
R1026	B6
R1027	B7
R1028	B6, C6
R1029	B7
R1031	B7
R1032	B7
R1033	C7
R1034	B7
R1036	B7
R1037	B8
R1038	B8
R1039	B8
R1041	B8
R1042	B8
R1043	B8
R1044	B8
R1045	B8
R1046	B8
R1047	B8
R1048	B9
R1049	B8
R1051	B8
R1056	C1
R1057	C1
R1058	C2
R1059	C2
R1060	C3
R1061	B2
R1062	C3
R1063	C3
R1064	C3
R1065	C3
R1066	C3
R1067	B4
R1068	C5
R1069	B4
R1070	B3
R1071	C5
R1072	C1
R1073	B2
R1076	C2
R1077	C2
R1079	C2
R1080	C1
R1081	C2
R1082	C1
R1083	C3
R1084	C4
R1085	B3
R1086	C1
R1087	C1
R1088	C1
R1089	C2
R1090	B6
R1092	C2
R1093	C2
R1094	C2
R1095	B7
R1096	C2
R1097	C2
R1098	B7
R1099	B8

Reed Relays

K501	F2
K502	F3
K503	F2
K504	F3
K506	E2
K507	E3
K701	D2
K702	D3
K703	D2
K704	D3
K706	E2
K707	E3
K851	A1, A2

Coils

L502	F4
L701	D5
L702	D4
L801	A10
L802	B10
L803	A10

Transformer

T801	B3

Semiconductors

V501	F4
V502	F5
V503	F5
V504	F5
V505	F4
V506	F5
V507	F5
V508	F5
V509	E6
V510	E4/F4
V511	F7
V512	F7
F513	F7
V514	E7
V515	F4
V516	E8, F8
V518	F9
V519	F7
V521	F9
V631	E10
V632	F10
V633	D9
V634	D9
V636	C9
V637	C9
V701	D4
V702	E4
V703	D5
V705	D4
V706	D4, D5
V707	D5
V708	D5
V709	D6
V710	D4
V711	E7
V712	D7
V713	D7
V714	D7
V715	D4
V716	D8
V718	C8
V719	E7
V721	D8
V722	E7
V831	D10
V832	D10
V833	C8
V834	C8
V851	A2
V852	A2
V853	A2
V854	A2
V856	A2
V857	B3
V858	B3
V860	A8
V861	A3
V862	B3
V863	A3
V864	A4
V865	B7
V867	A4, A5
V868	A5
V869	A4
V870	A8
V871	B5
V872	B6
V873	B6
V874	B7
V875	A8
V876	B6

V877	B4
V878	B7
V879	B7, B8
V880	B9
V881	B4
V882	A8
V883	A8
V884	B1
V885	C3
V887	B2
V888	B3
V889	B4
V890	C3
V891	C3
V892	C3
V893	C4
V895	B8
V896	B4
V897	B5
V898	B4
V899	B6
V901	B5
V902	B5
V903	B1
V904	B1
V907	C4
V908	B4
V909	B5
V910	C3
V912	C6
V913	B7
V914	B7
V916	B8
V917	B8
V918	B8
V919	C2
V921	C2
V922	C2
V923	C1
V924	C2

8. DIAGRAMS AND PRINT LAY-OUTS

8.1. LOCATION OF ELECTRICAL PARTS

Item numbers of C ..., R ..., V ... and K ... have been divided in groups which relate to the circuit, the unit and the circuit diagram, according the following table.

Itemnumber	Location	Unit	Figure
1 ... 99	Potentiometer unit, front and rear side	103	8.17.
100 ... 199	Switch unit	102	8.16.
200 ... 499 1370 ... 1399	Time base unit	2	8.8.18.10.
500 ... 1099	Preamplifier and trigger unit	3	8.1/8.3.
1100 ... 1199	Trigger selection unit	4	8.7.
1200 ... 1299	Final Y amplifier	9	8.2.
1300 ... 1369 1500 ... 1599	Final X/Z amplifier	5	8.12.
1400 ... 1499	Power supply	6	8.14

NOTE: The components on the time base unit (unit 2) and the preamplifier and trigger unit (unit 3) can be found with the location lists in chapter 7.4. and 7.5.

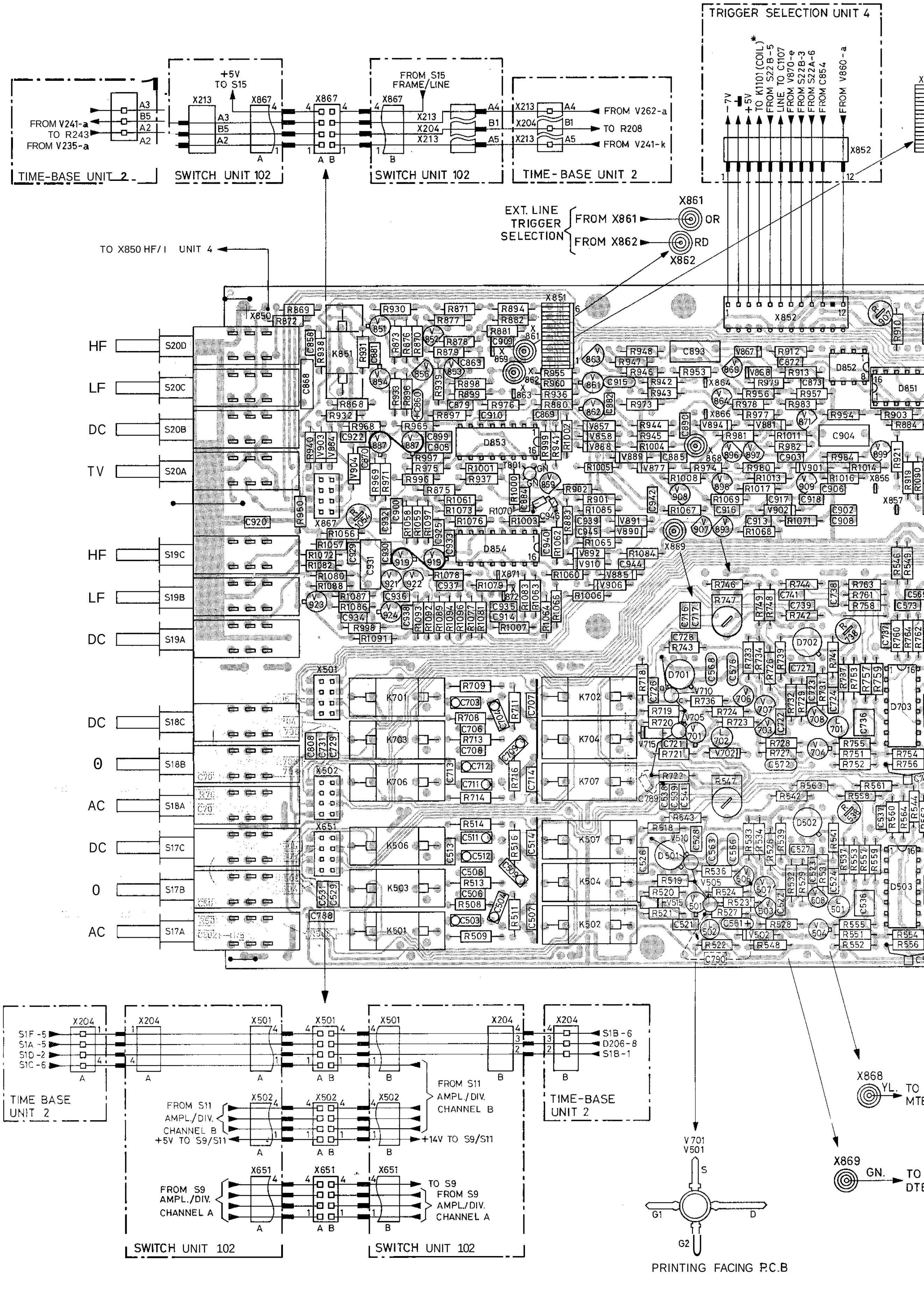
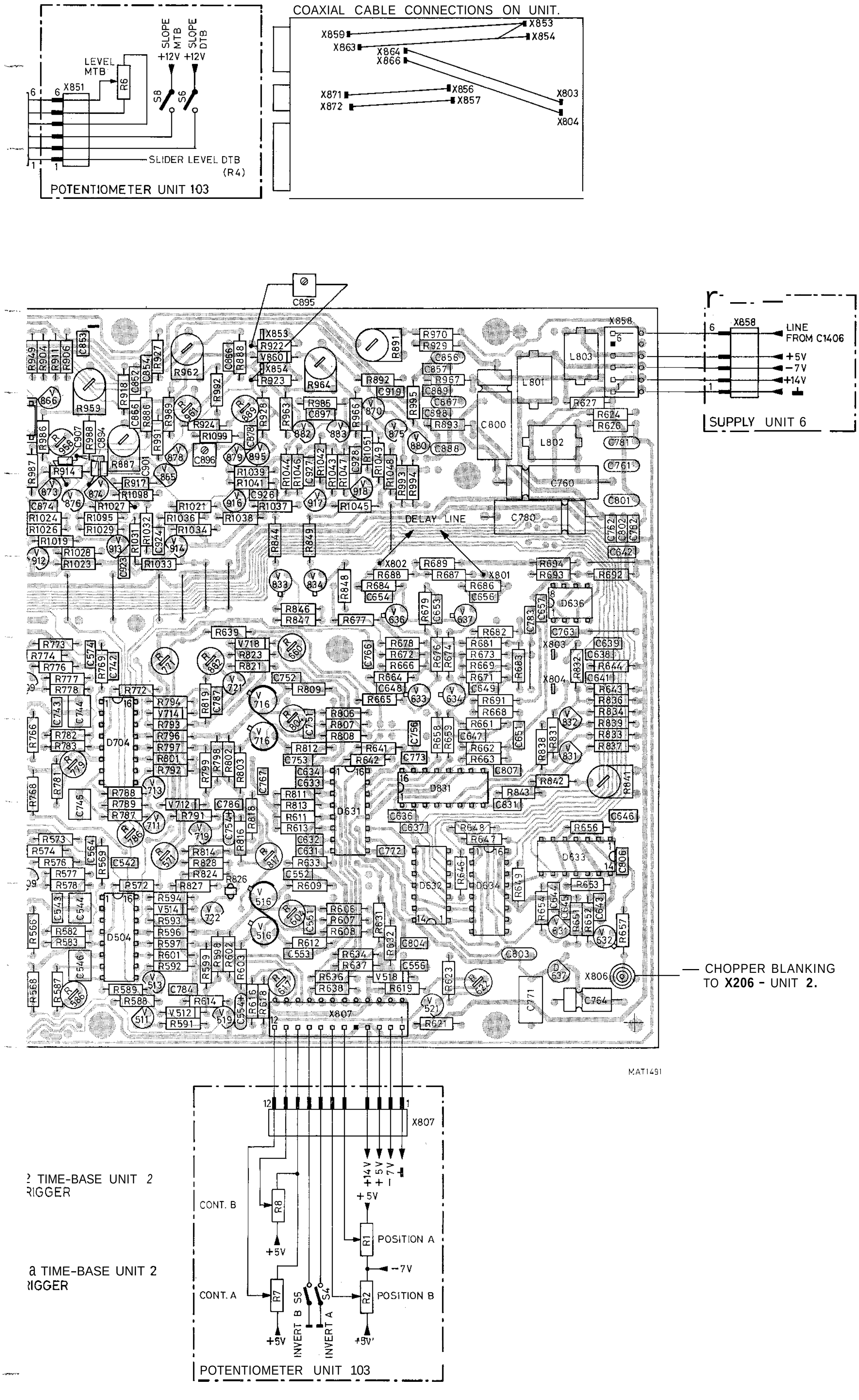


Fig. **8.1.** Pre-amplifier and trigger-unit (unit 3), p.c.b. lay-out



COAXIAL CABLE CONNECTIONS ON UNIT.
LEVEL MTB
SLOPE MTB
SLOPE DTB
+12V
SLIDER LEVEL DTB (R4)
POTENTIOMETER UNIT 103
LINE FROM C1406
+5V
−7V
+14V
SUPPLY UNIT 6
DELAY LINE
CHOPPER BLANKING TO X206 - UNIT 2.
MAT1491
CONT. B
CONT. A
POSITION A
POSITION B
INVERT B
INVERT A
POTENTIOMETER UNIT 103

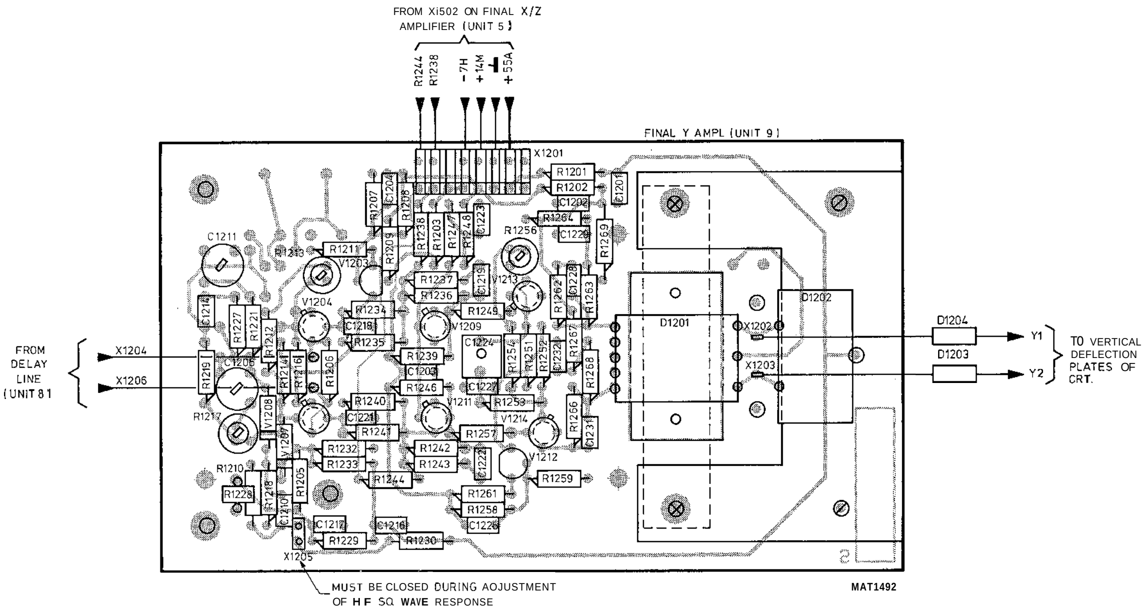
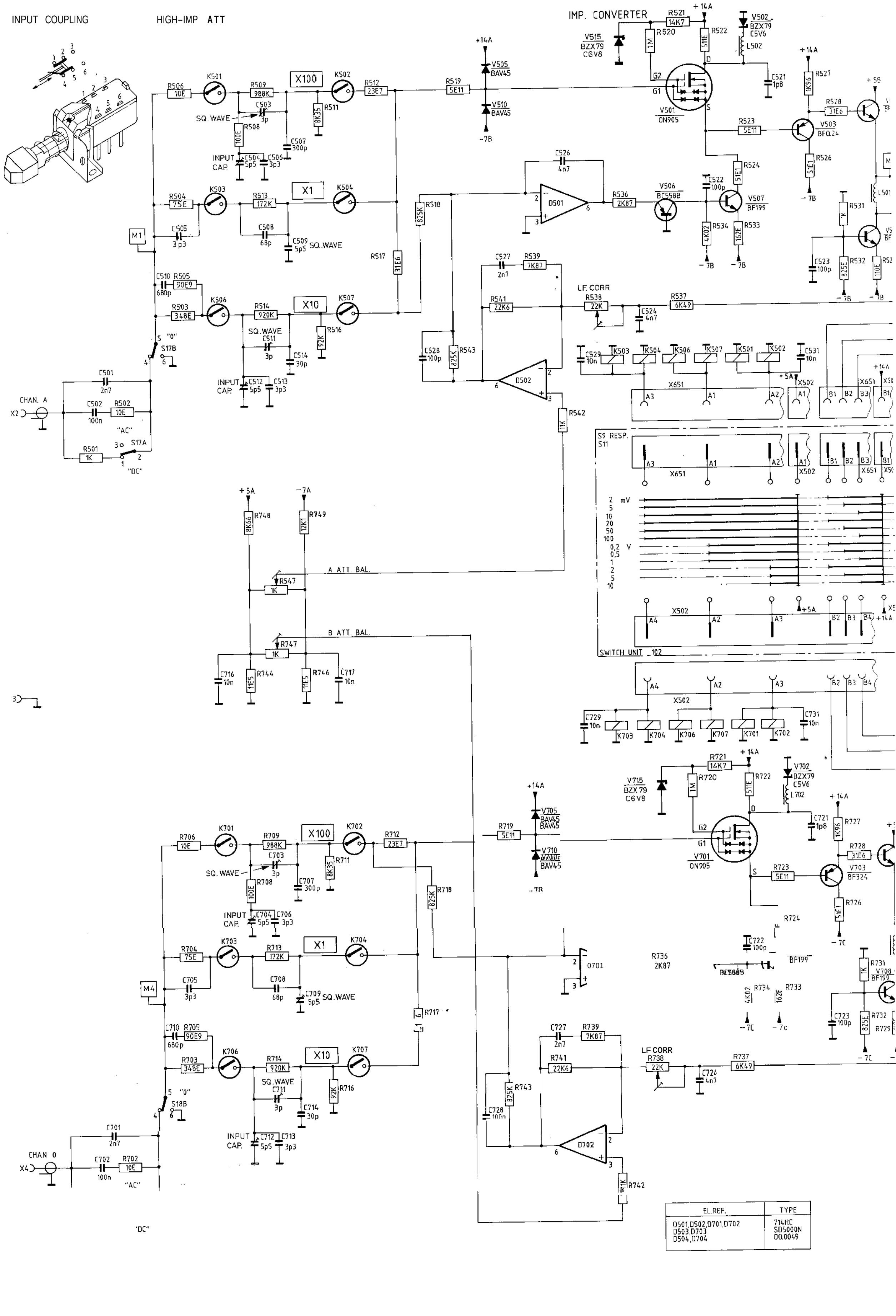
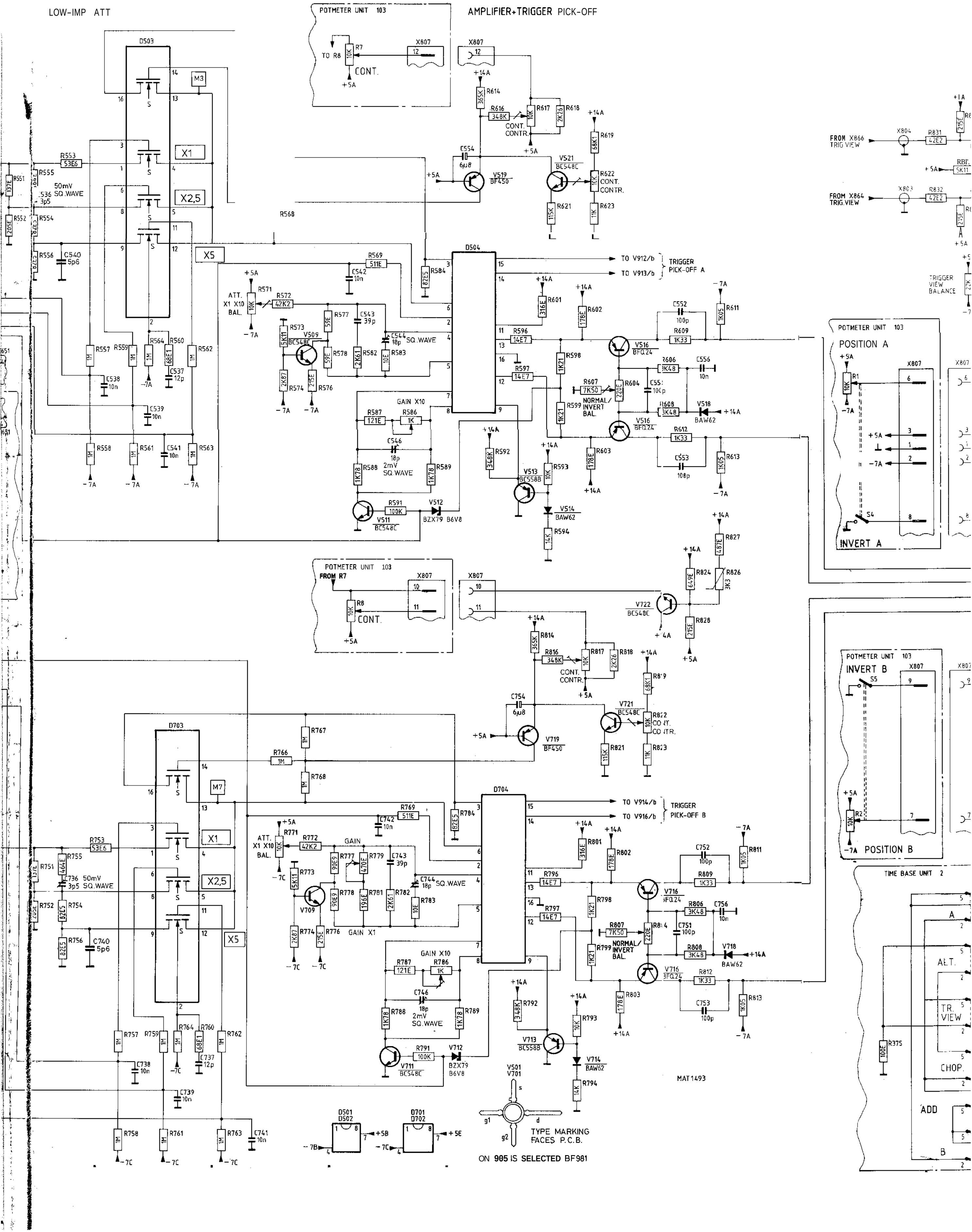


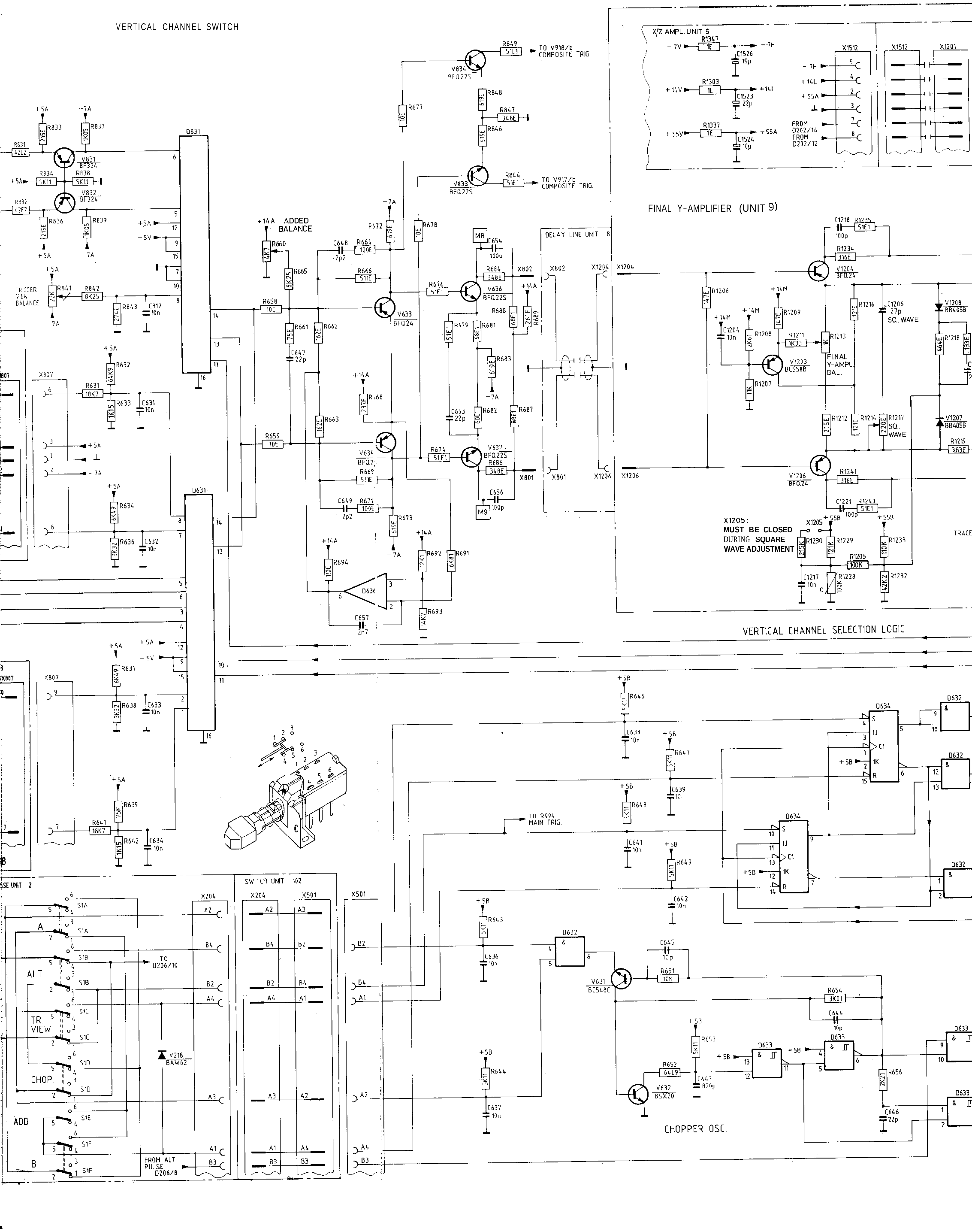
Fig. 8.2. *Final* ***Y-amplifier*** *(unit* ***9), p.c.b.*** *lay-out*

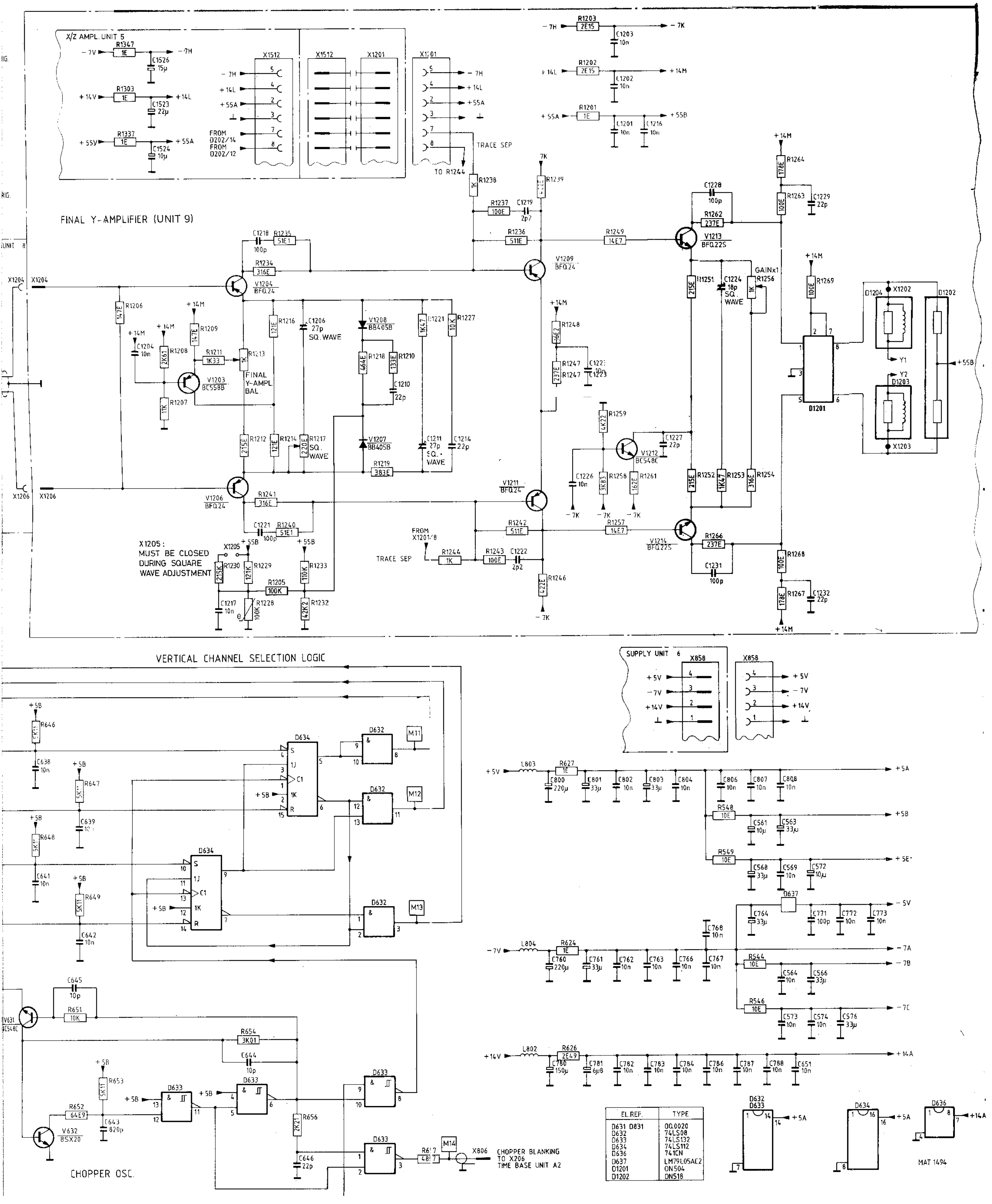
8-7

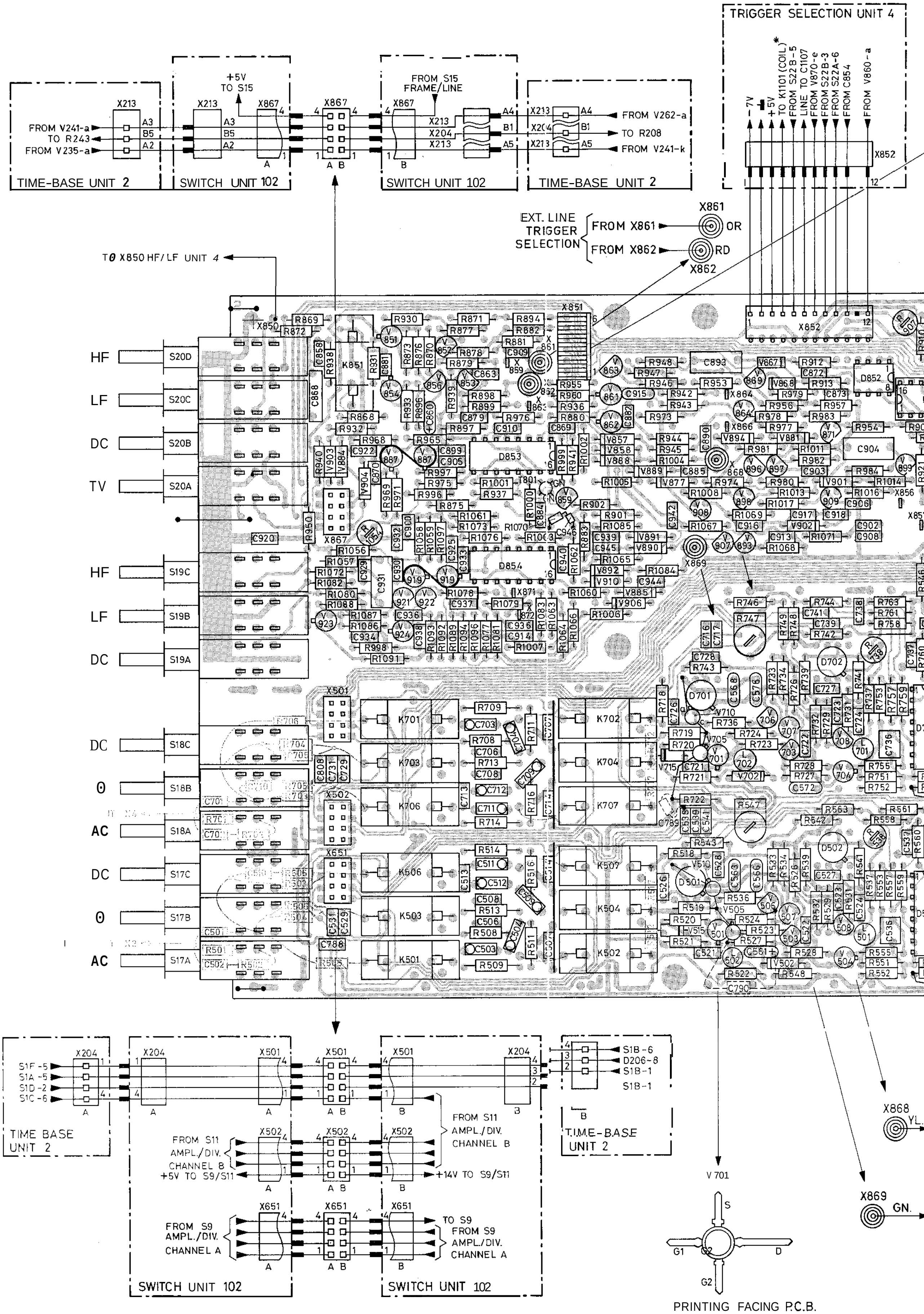


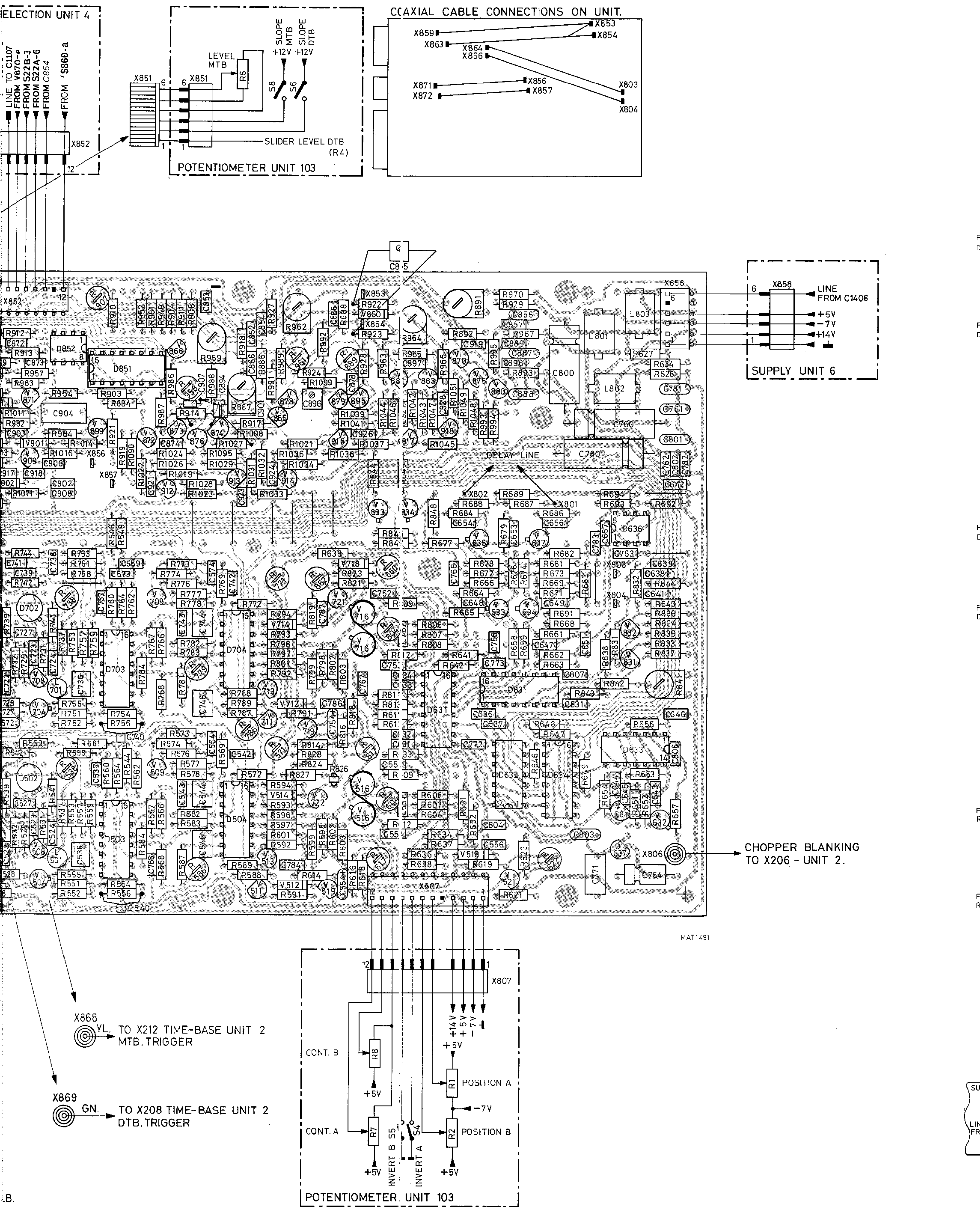
INPUT COUPLING
HIGH-IMP ATT
IMP. CONVERTER
CHAN. A
CHAN 0
"AC"
"DC"
SQ. WAVE
INPUT CAP.
X100
X1
X10
LF CORR.
A ATT. BAL.
B ATT. BAL.
S9 RESP.
S11
SWITCH UNIT 102
EL.REF. | TYPE
D501,D502,D701,D702 | 714HC
D503,D703 | SD5000N
D504,D704 | OQ0049


LOW-IMP ATT
POTMETER UNIT 103
AMPLIFIER+TRIGGER PICK-OFF
TO V912/b
TO V913/b
TRIGGER PICK-OFF A
TO V914/b
TO V916/b
TRIGGER PICK-OFF B
FROM X866 TRIG VIEW
FROM X864 TRIG.VIEW
TRIGGER VIEW BALANCE
POSITION A
INVERT A
INVERT B
POSITION B
TIME BASE UNIT 2
ALT.
TR. VIEW
CHOP.
ADD
NORMAL/ INVERT BAL.
GAIN X10
GAIN X1
2mV SQ.WAVE
50mV SQ.WAVE
TYPE MARKING FACES P.C.B.
ON 905 IS SELECTED BF981
MAT1493


VERTICAL CHANNEL SWITCH
X/Z AMPL. UNIT 5
FINAL Y-AMPLIFIER (UNIT 9)
DELAY LINE UNIT 8
ADDED BALANCE
TRIGGER VIEW BALANCE
TO V918/b COMPOSITE TRIG.
TO V917/b COMPOSITE TRIG.
FINAL Y-AMPL. BAL.
SQ. WAVE
X1205: MUST BE CLOSED DURING SQUARE WAVE ADJUSTMENT
VERTICAL CHANNEL SELECTION LOGIC
TO R994 MAIN TRIG.
SWITCH UNIT 102
CHOPPER OSC.
FROM ALT PULSE D206/8
TO D206/10
ALT.
TR. VIEW
CHOP.
ADD
TRACE


X/Z AMPL. UNIT 5
FINAL Y-AMPLIFIER (UNIT 9)
X1205 : MUST BE CLOSED DURING SQUARE WAVE ADJUSTMENT
FINAL Y-AMPL BAL
TRACE SEP
TO R1244
FROM X1201/8
GAINx1
SQ. WAVE
VERTICAL CHANNEL SELECTION LOGIC
SUPPLY UNIT 6
CHOPPER OSC.
CHOPPER BLANKING TO X206 TIME BASE UNIT A2
EL.REF. TYPE
D631 D831 OQ0020
D632 74LS08
D633 74LS132
D634 74LS112
D636 741CN
D637 LM79L05AC2
D1201 ON504
D1202 ON518
MAT 1494


TRIGGER SELECTION UNIT 4
-7V
+5V
TO K1101 (COIL)*
FROM S22B-5
LINE TO C1107
FROM V870-e
FROM S22B-3
FROM S22A-6
FROM C854
FROM V860-a
X852
+5V
TO S15
FROM S15
FRAME/LINE
X213
X867
FROM V241-a
TO R243
FROM V235-a
TIME-BASE UNIT 2
SWITCH UNIT 102
SWITCH UNIT 102
TIME-BASE UNIT 2
FROM V262-a
TO R208
FROM V241-k
EXT. LINE
TRIGGER
SELECTION
FROM X861
FROM X862
X861
OR
RD
X862
TO X850 HF/LF UNIT 4
HF
LF
DC
TV
HF
LF
DC
DC
0
AC
DC
0
AC
S20D
S20C
S20B
S20A
S19C
S19B
S19A
S18C
S18B
S18A
S17C
S17B
S17A
X204
S1F-5
S1A-5
S1D-2
S1C-6
TIME BASE
UNIT 2
X501
S1B-6
D206-8
S1B-1
S1B-1
TIME-BASE
UNIT 2
FROM S11
AMPL./DIV.
CHANNEL B
X502
FROM S11
AMPL./DIV.
CHANNEL B
+5V TO S9/S11
+14V TO S9/S11
X651
FROM S9
AMPL./DIV.
CHANNEL A
TO S9
FROM S9
AMPL./DIV.
CHANNEL A
SWITCH UNIT 102
SWITCH UNIT 102
X868
YL
X869
GN.
V 701
S
G1
G2
D
G2
PRINTING FACING P.C.B.


SELECTION UNIT 4
POTENTIOMETER UNIT 103
COAXIAL CABLE CONNECTIONS ON UNIT.
SUPPLY UNIT 6
DELAY LINE
CHOPPER BLANKING TO X206 - UNIT 2.
MAT1491
TO X212 TIME-BASE UNIT 2 MTB. TRIGGER
TO X208 TIME-BASE UNIT 2 DTB. TRIGGER
POTENTIOMETER UNIT 103

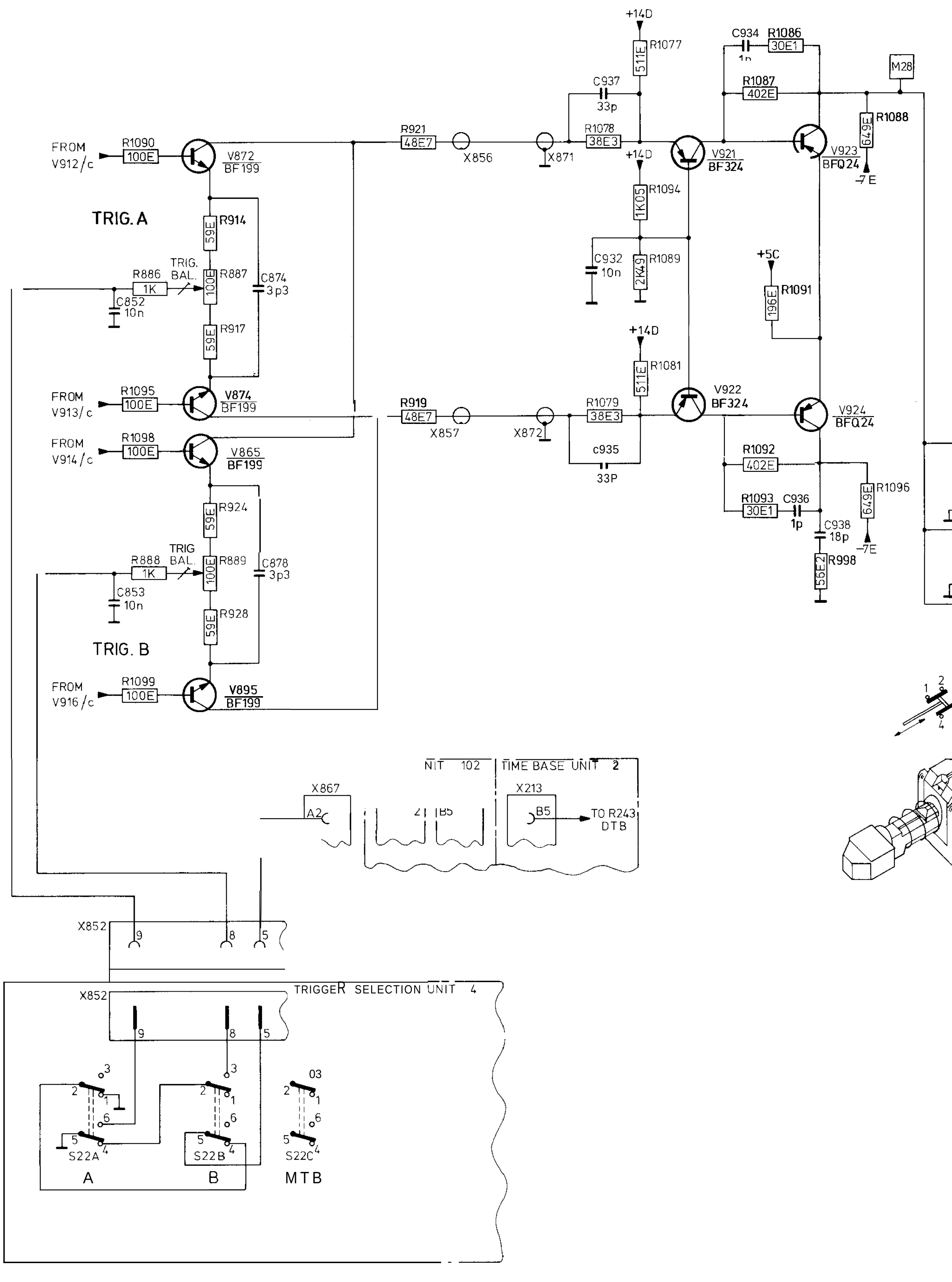
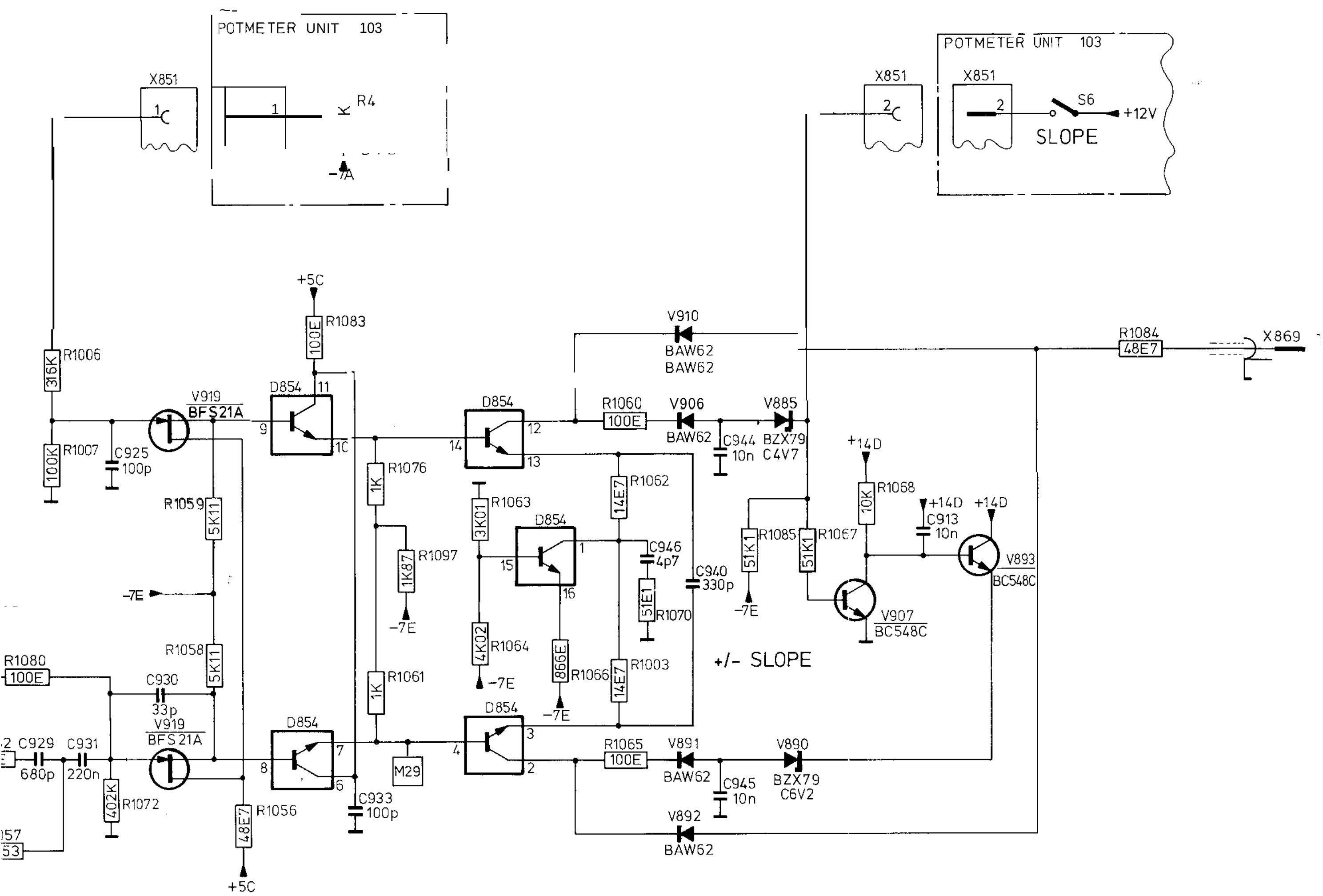
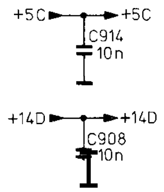


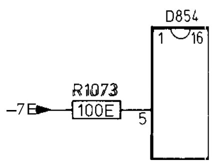
Fig. 8.6. Circuit diagram delayed time-base triggering (unit 3)



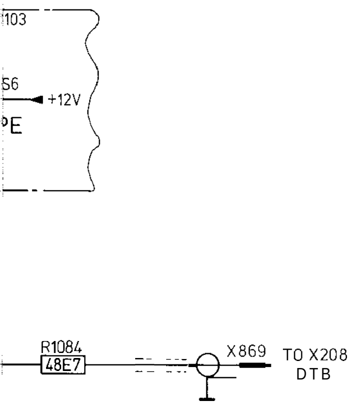
3



EL REF	TYPE
D854	OQ00127



MAT 1496



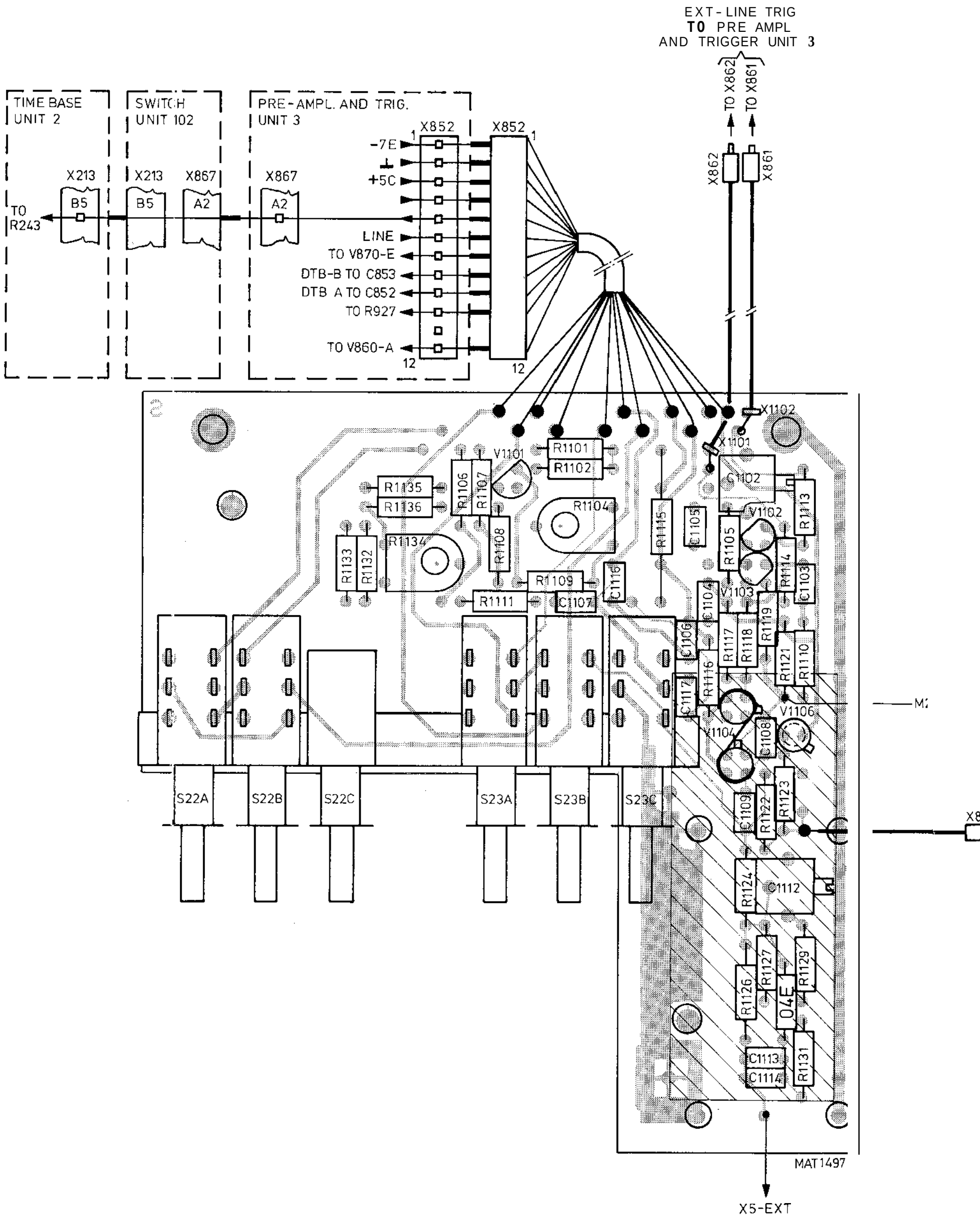
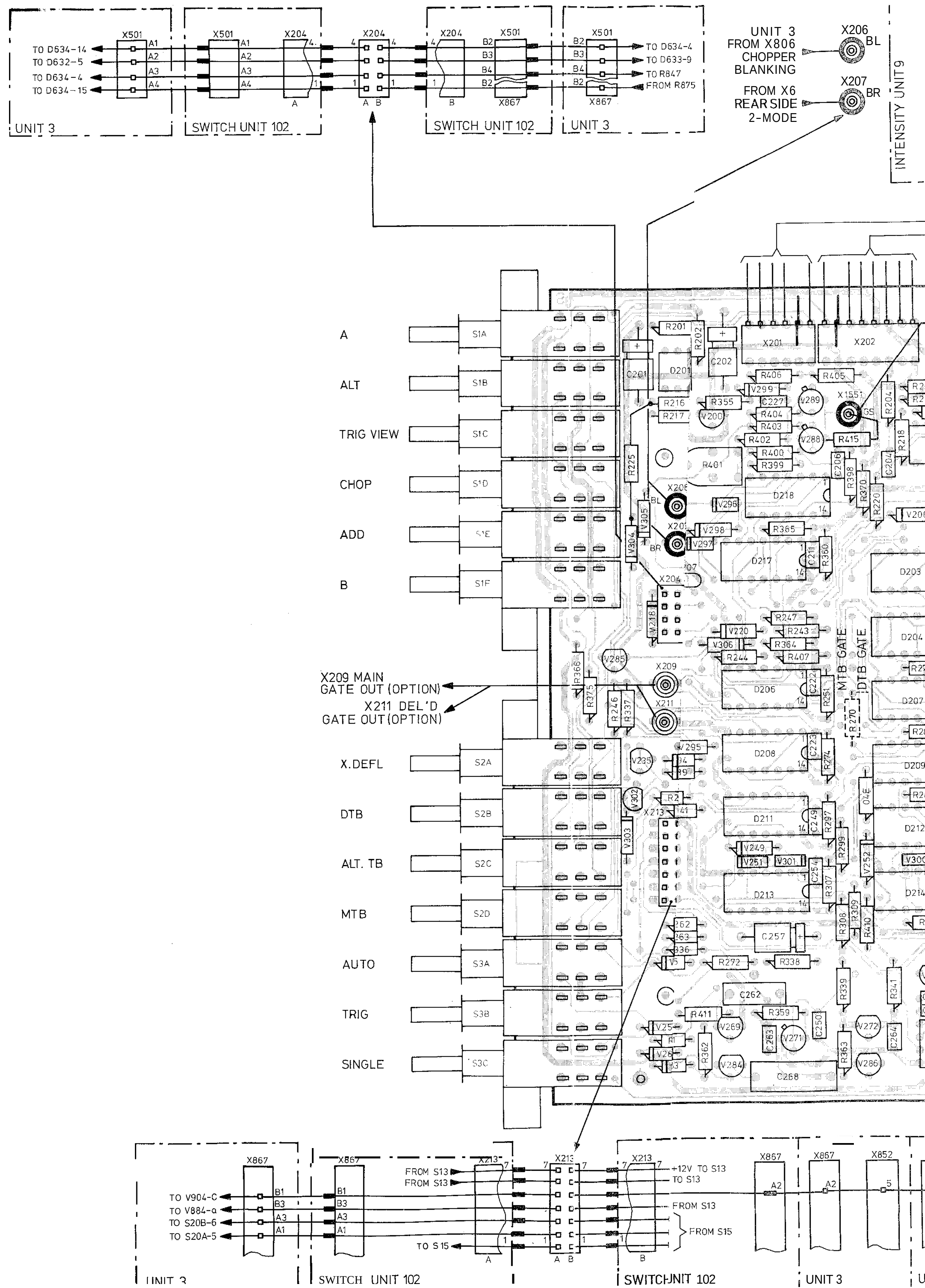
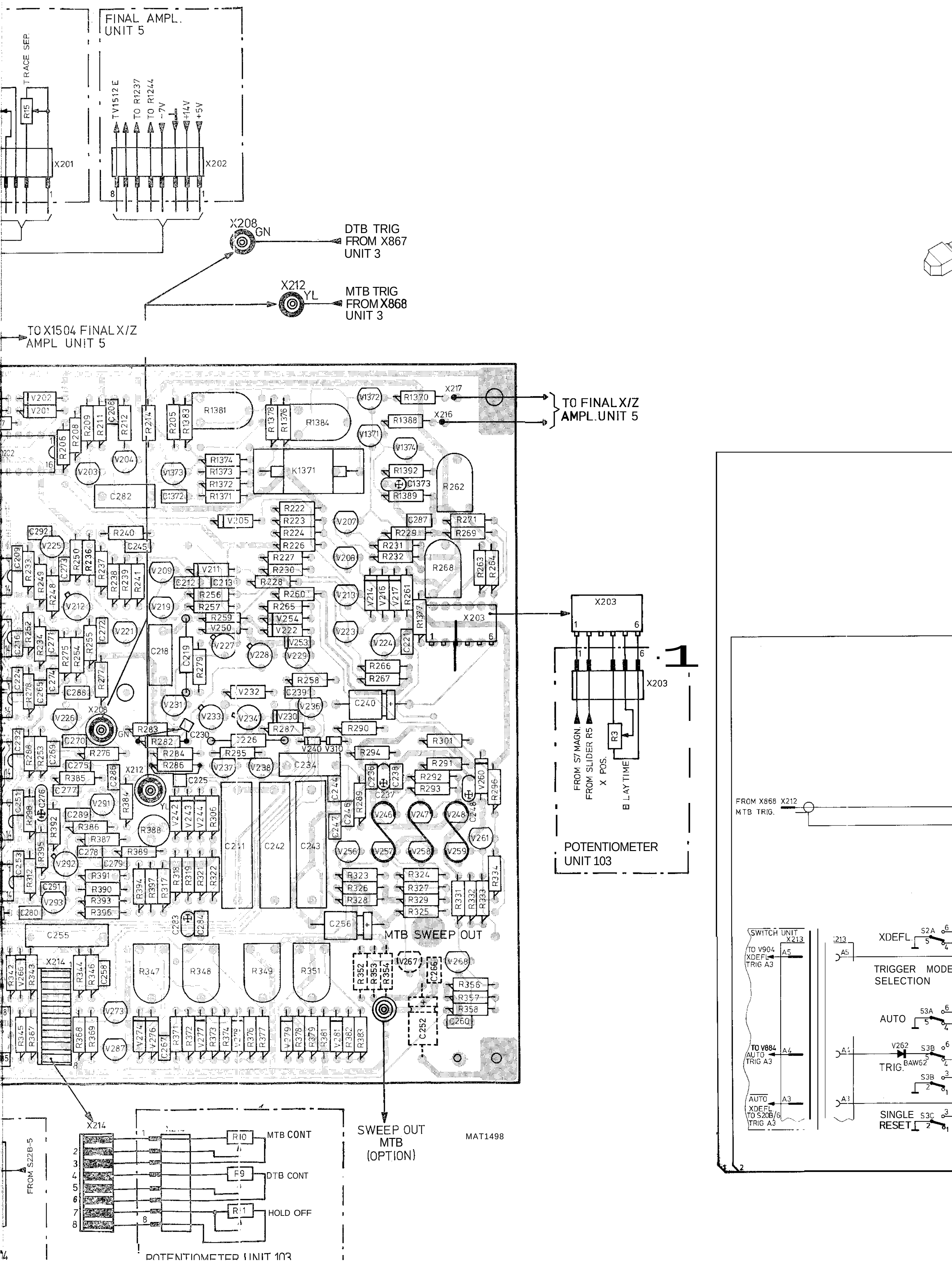


Fig. 8.7. ***Trigger selection unit (unit 4), p.c.b.*** *lay-out*

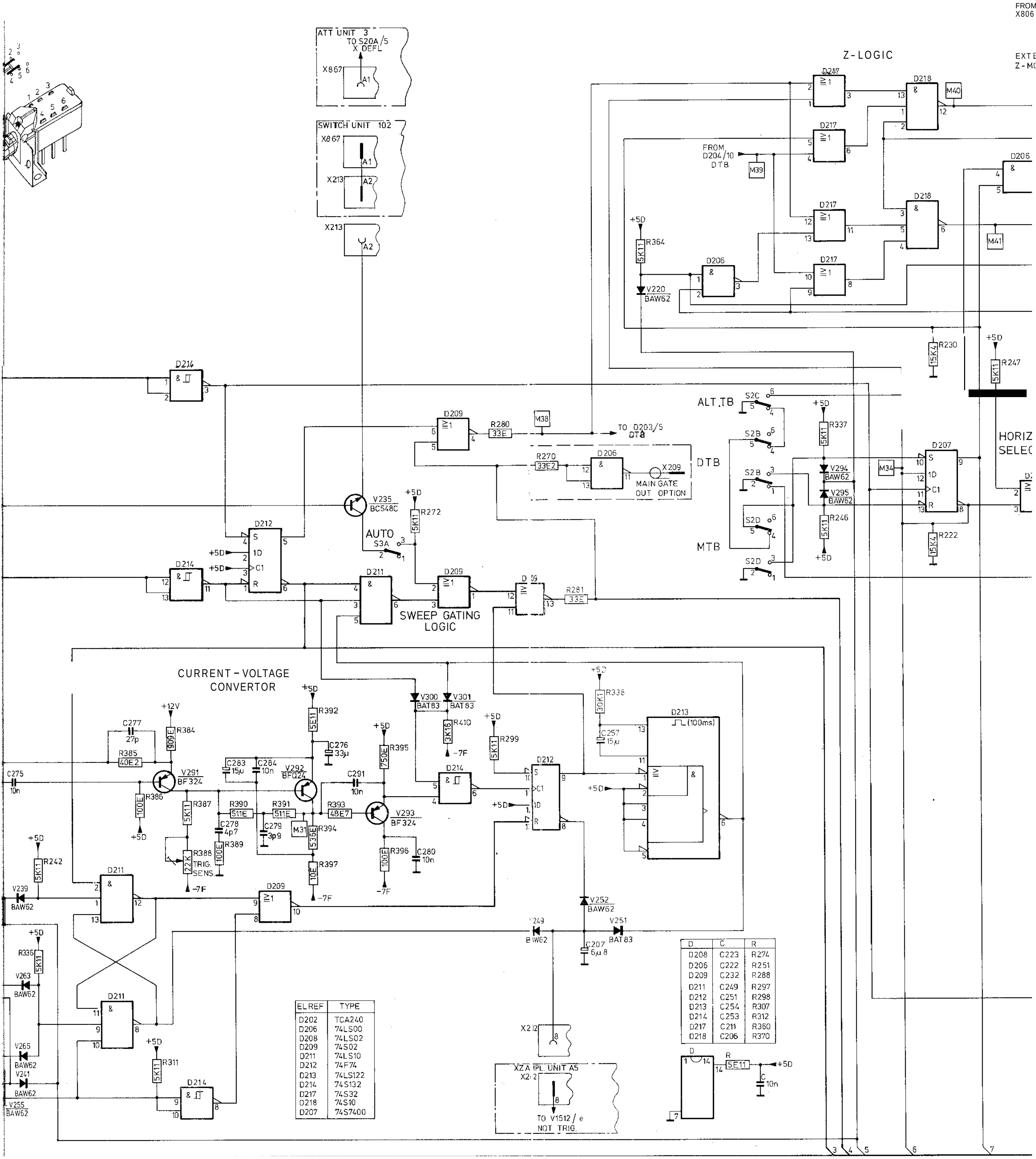
MAT *1496*



UNIT 3
SWITCH UNIT 102
X501
X204
TO D634-14
TO D632-5
TO D634-4
TO D634-15
TO D634-4
TO D633-9
TO R847
FROM R875
X867
UNIT 3 FROM X806 CHOPPER BLANKING
FROM X6 REAR SIDE 2-MODE
X206 BL
X207 BR
INTENSITY UNIT9
A
ALT
TRIG VIEW
CHOP
ADD
B
X209 MAIN GATE OUT (OPTION)
X211 DEL'D GATE OUT (OPTION)
X.DEFL
DTB
ALT. TB
MTB
AUTO
TRIG
SINGLE
MTB GATE
DTB GATE
TO V904-C
TO V884-a
TO S20B-6
TO S20A-5
FROM S13
FROM S13
TO S15
+12V TO S13
TO S13
FROM S13
FROM S15
X213
X852
SWITCH UNIT 102


FINAL AMPL. UNIT 5
TRACE SEP.
X201
X202
X208 GN
DTB TRIG FROM X867 UNIT 3
X212 YL
MTB TRIG FROM X868 UNIT 3
TO X1504 FINAL X/Z AMPL UNIT 5
TO FINAL X/Z AMPL. UNIT 5
X203
FROM S7 MAGN.
FROM SLIDER R5
X POS.
B LAYTIME
POTENTIOMETER UNIT 103
MTB SWEEP OUT
X214
MTB CONT
DTB CONT
HOLD OFF
SWEEP OUT MTB (OPTION)
MAT1498
FROM X868 X212 MTB TRIG.
SWITCH UNIT X213
XDEFL
TRIGGER MODE SELECTION
AUTO
TRIG.
SINGLE RESET

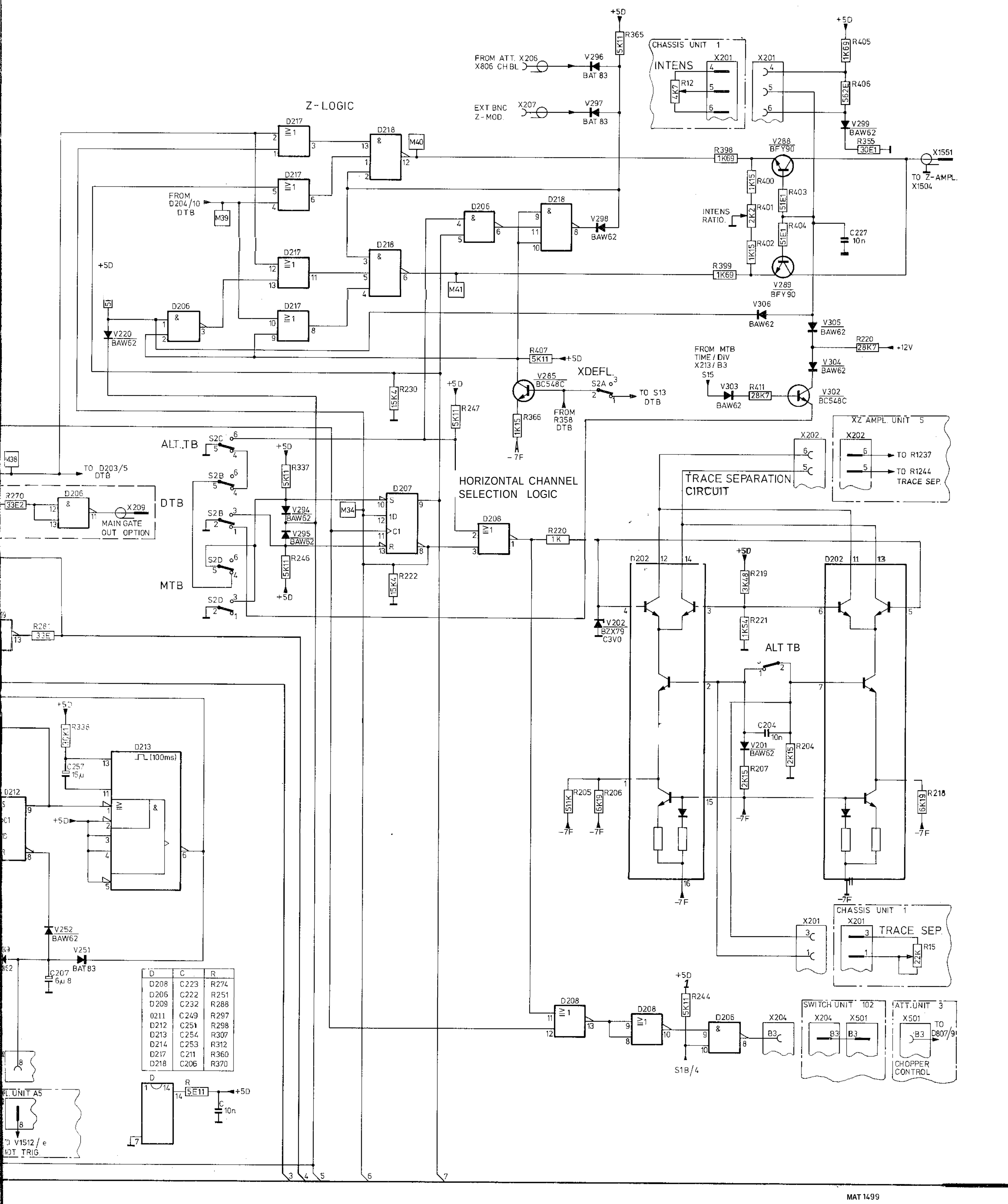
8821



EL.REF	TYPE
D202	TCA240
D206	74LS00
D208	74LS02
D209	74S02
D211	74LS10
D212	74F74
D213	74LS122
D214	74S132
D217	74S32
D218	74S10
D207	74S7400

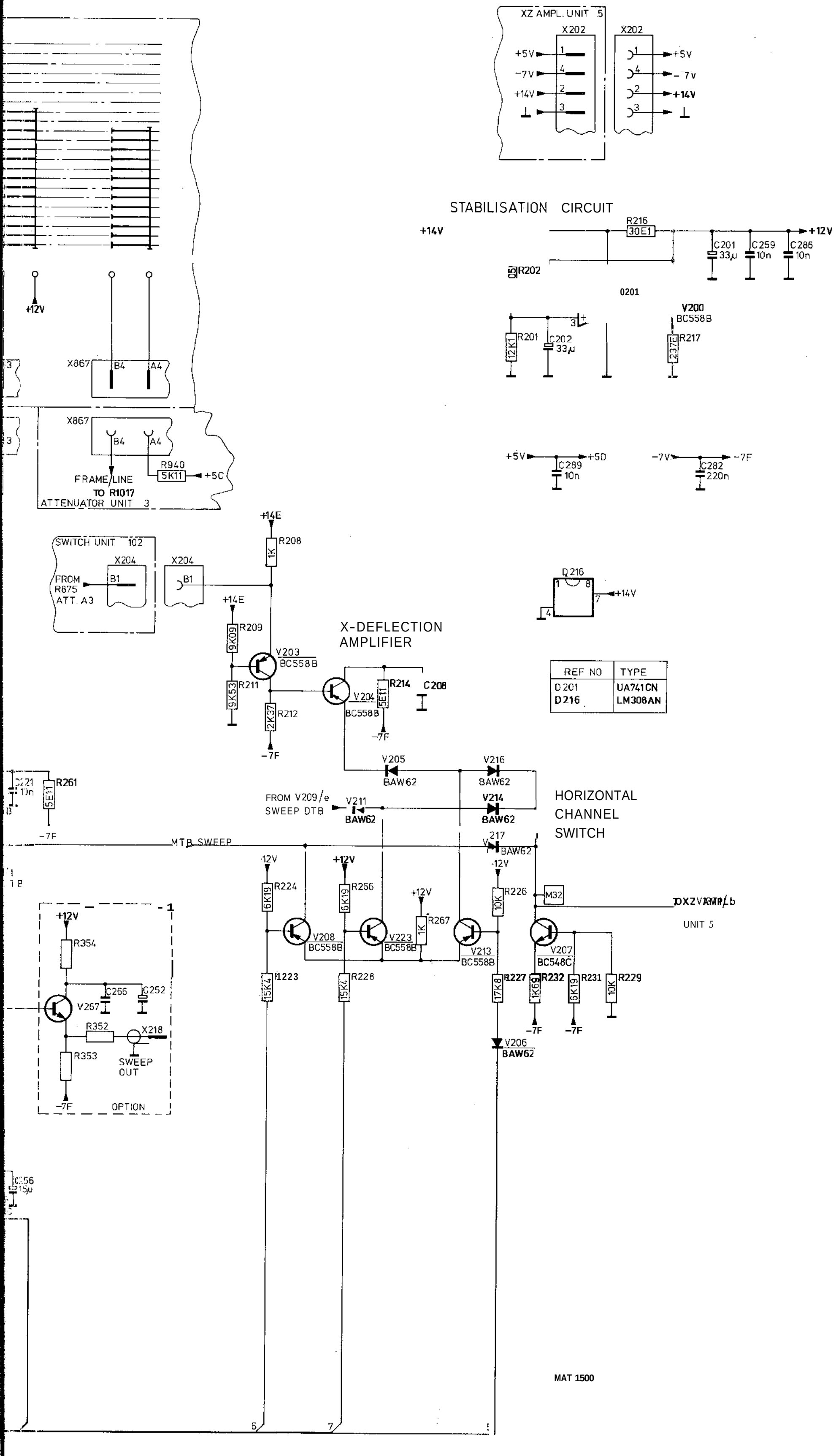
D	C	R
D208	C223	R274
D206	C222	R251
D209	C232	R288
D211	C249	R297
D212	C251	R298
D213	C254	R307
D214	C253	R312
D217	C211	R360
D218	C206	R370

Fig. 8.9. Circuit diagram main time-base (unit 2)



D	C	R
D208	C223	R274
D206	C222	R251
D209	C232	R288
D211	C249	R297
D212	C251	R298
D213	C254	R307
D214	C253	R312
D217	C211	R360
D218	C206	R370

Fig. 8.9. Circuit diagram main time-base (unit 2)



REF NO	TYPE
D 201	UA741CN
D 216	LM308AN

MAT 1500

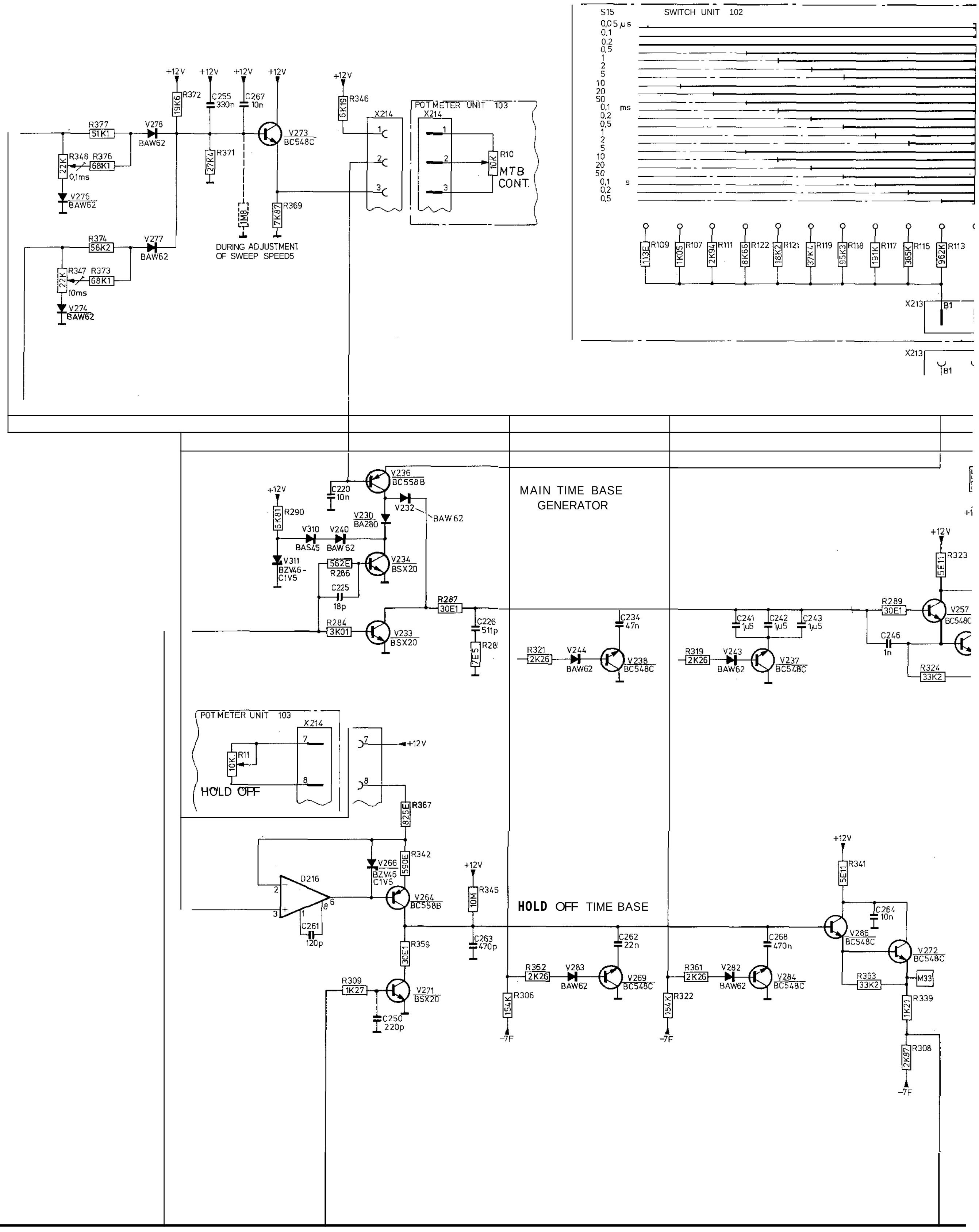
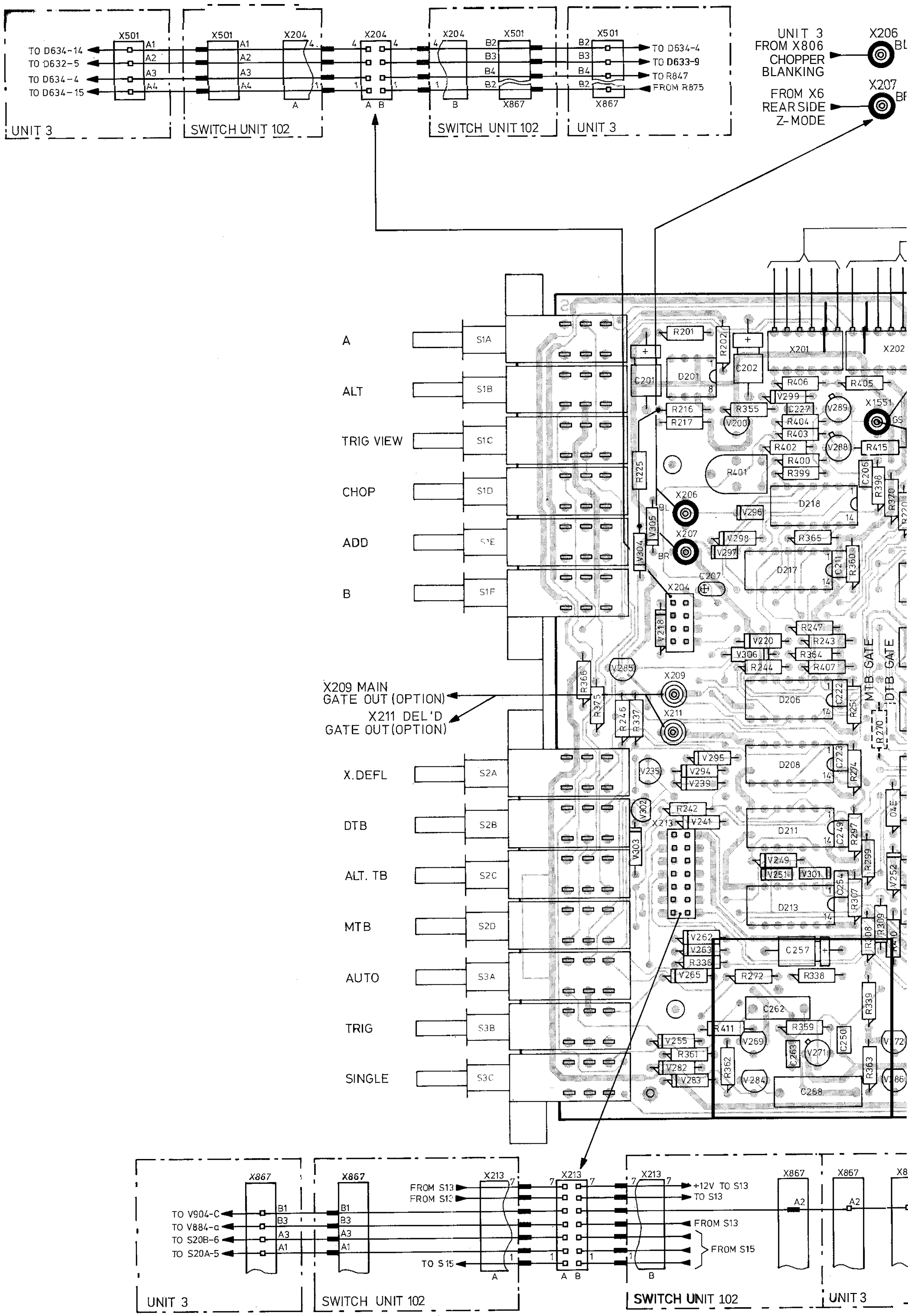


Fig. 8.9, Circuit diagram main time-base (unit 2)



X501
TO D634-14
TO D632-5
TO D634-4
TO D634-15
UNIT 3
X501
X204
SWITCH UNIT 102
X204
X204
X501
X867
SWITCH UNIT 102
X501
TO D634-4
TO D633-9
TO R847
FROM R875
X867
UNIT 3
UNIT 3
FROM X806
CHOPPER
BLANKING
X206
FROM X6
REAR SIDE
Z-MODE
X207
A
ALT
TRIG VIEW
CHOP
ADD
B
X209 MAIN
GATE OUT (OPTION)
X211 DEL'D
GATE OUT (OPTION)
X.DEFL
DTB
ALT. TB
MTB
AUTO
TRIG
SINGLE
MTB GATE
DTB GATE
X867
TO V904-C
TO V884-a
TO S20B-6
TO S20A-5
UNIT 3
X867
SWITCH UNIT 102
FROM S13
FROM S13
X213
TO S15
X213
X213
+12V TO S13
TO S13
FROM S13
FROM S15
SWITCH UNIT 102
X867
X867
UNIT 3

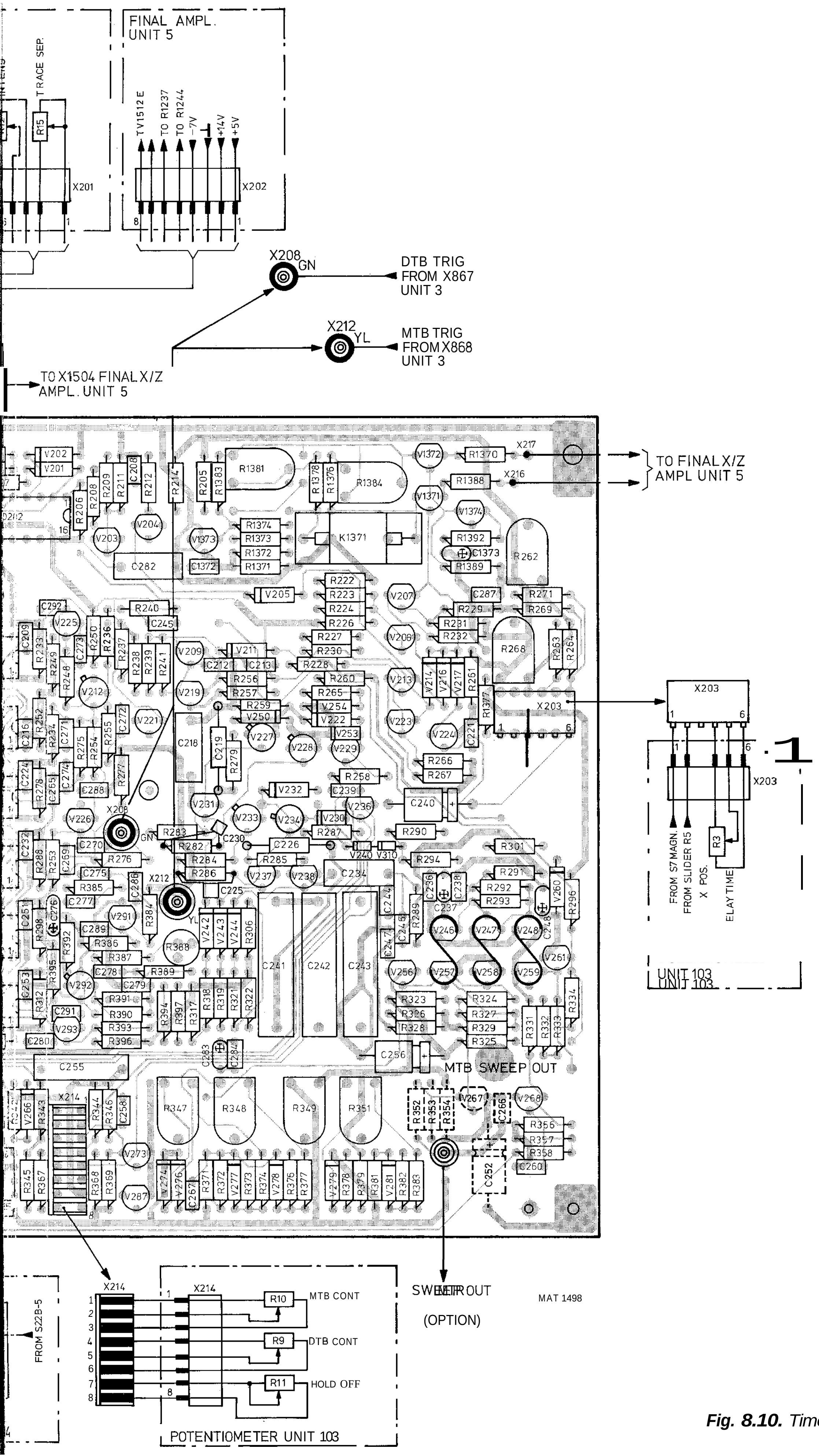
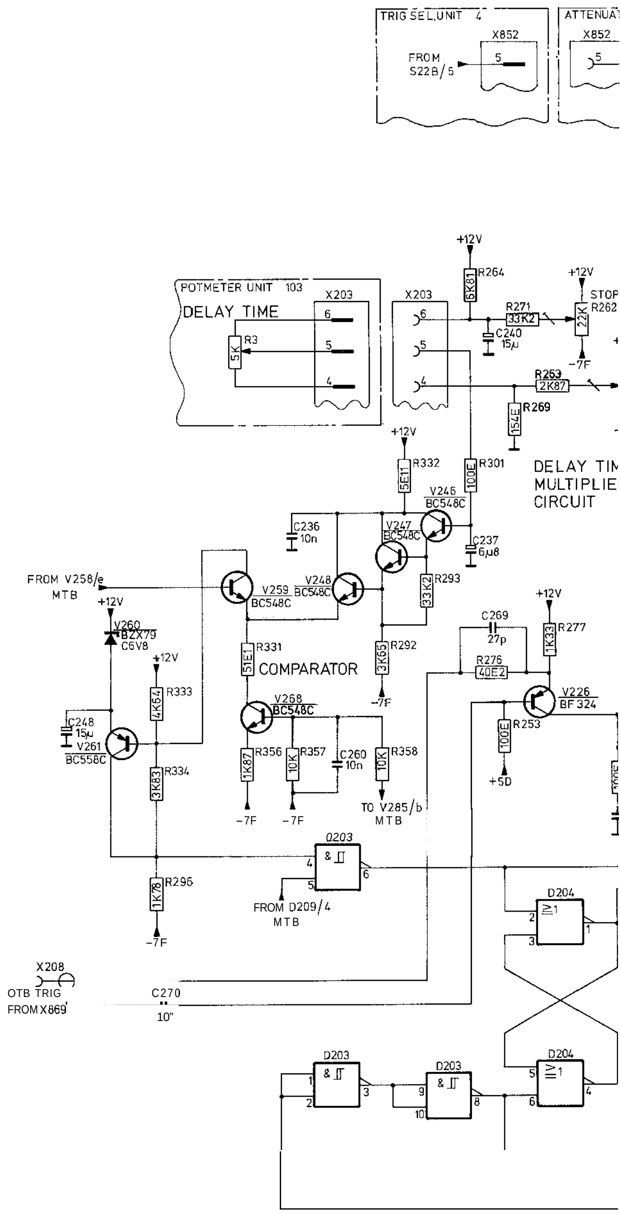


Fig. 8.10. Time-base unit (unit 2), p.c.b. lay-out



D	C	R
D203	C209	R233
D204	C216	R252
D207	C224	R278

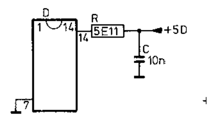
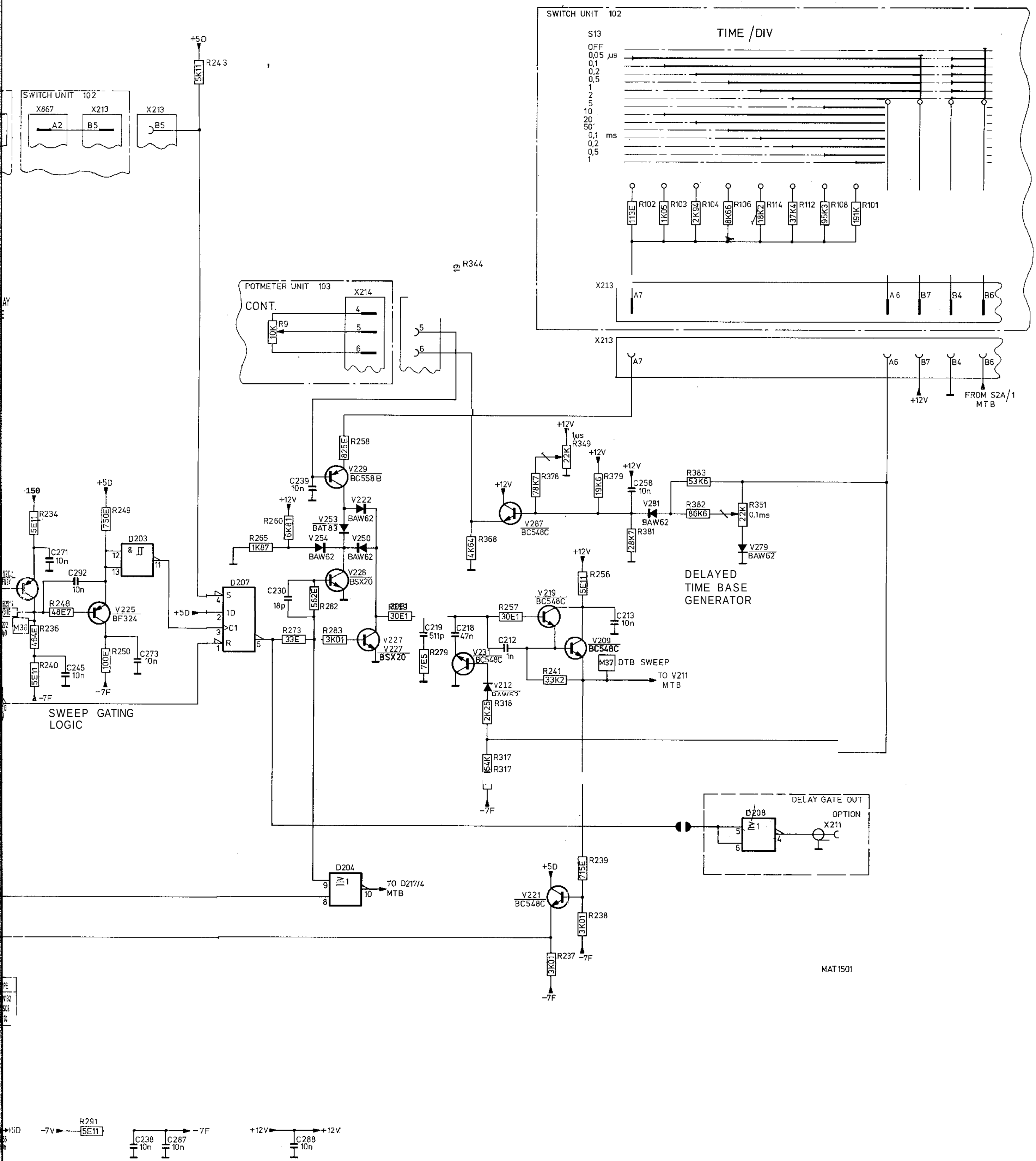
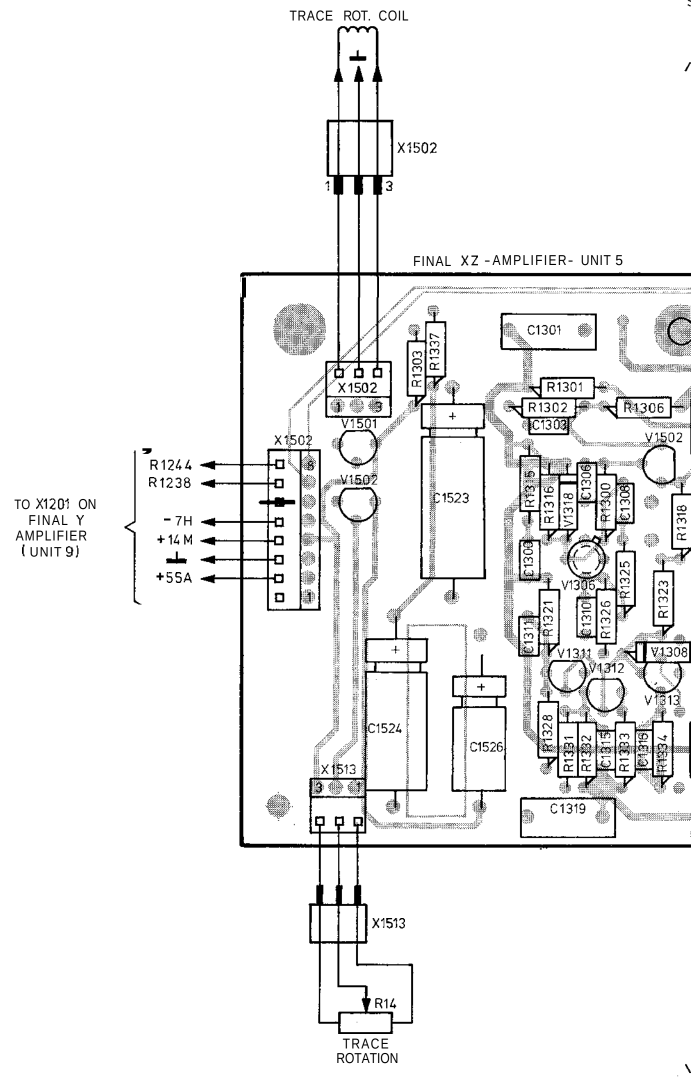


Fig. 8.11. Circuit diagram delayed time-base (unit 2)


SWITCH UNIT 102
TIME /DIV
S13
OFF
0,05 µs
0,1
0,2
0,5
1
2
5
10
20
50
0,1 ms
0,2
0,5
1
R102 113E
R103 1K05
R104 2K94
R106 8K66
R114 18K2
R112 37K4
R108 95K3
R101 191K
X213
A7
A6
B7
B4
B6
+12V
FROM S2A/1 MTB
R344
POTMETER UNIT 103
CONT.
X214
R9 10K
SWITCH UNIT 102
X867
A2
X213
B5
+5D
R243 5K11
R258 825E
V229 BC558B
C239 10n
V222 BAW62
R260 6K81
V253 BAT83
V254 BAW62
V250 BAW62
R265 1K87
V228 BSX20
C230 18p
R282 562E
D207
S
1D
C1
R
R273 33E
R283 3K01
V227 BSX20
R269 30E1
C219 511p
R279 7E5
C218 47n
V231 BC548C
C212 1n
R257 30E1
V219 BC548C
V209 BC548C
C213 10n
R256 5E11
M37 DTB SWEEP
R241 33K2
TO V211 MTB
V212 BAW62
R318 2K26
R317 64K
-7F
R349 22K 1µs
R378 78K7
V287 BC548C
R368 4K64
R379 19K6
C258 10n
R381 28K7
V281 BAW62
R383 53K6
R382 86K6
R351 22K 0,1ms
V279 BAW62
DELAYED
TIME BASE
GENERATOR
DELAY GATE OUT
OPTION
D208
≥1
X211
R239 715E
V221 BC548C
R238 3K01
R237 3K01
D204
≥1
TO D217/4 MTB
-150
R234 5E11
C271 10n
C292 10n
R249 750E
D203
R248 48E7
V225 BF324
R236 464E
M36
R240 5E11
C245 10n
R250 100E
C273 10n
SWEEP GATING
LOGIC
R291 5E11
C236 10n
C287 10n
C288 10n
+12V
-7V
-7F
MAT 1501


TRACE ROT. COIL
X1502
FINAL XZ -AMPLIFIER- UNIT 5
C1301
R1303
R1337
X1502
R1301
R1302
R1306
C1303
V1501
V1502
X1502
R1244
R1238
TO X1201 ON FINAL Y AMPLIFIER (UNIT 9)
-7H
+14M
+55A
C1523
C1524
C1526
X1513
C1319
X1513
R14
TRACE ROTATION

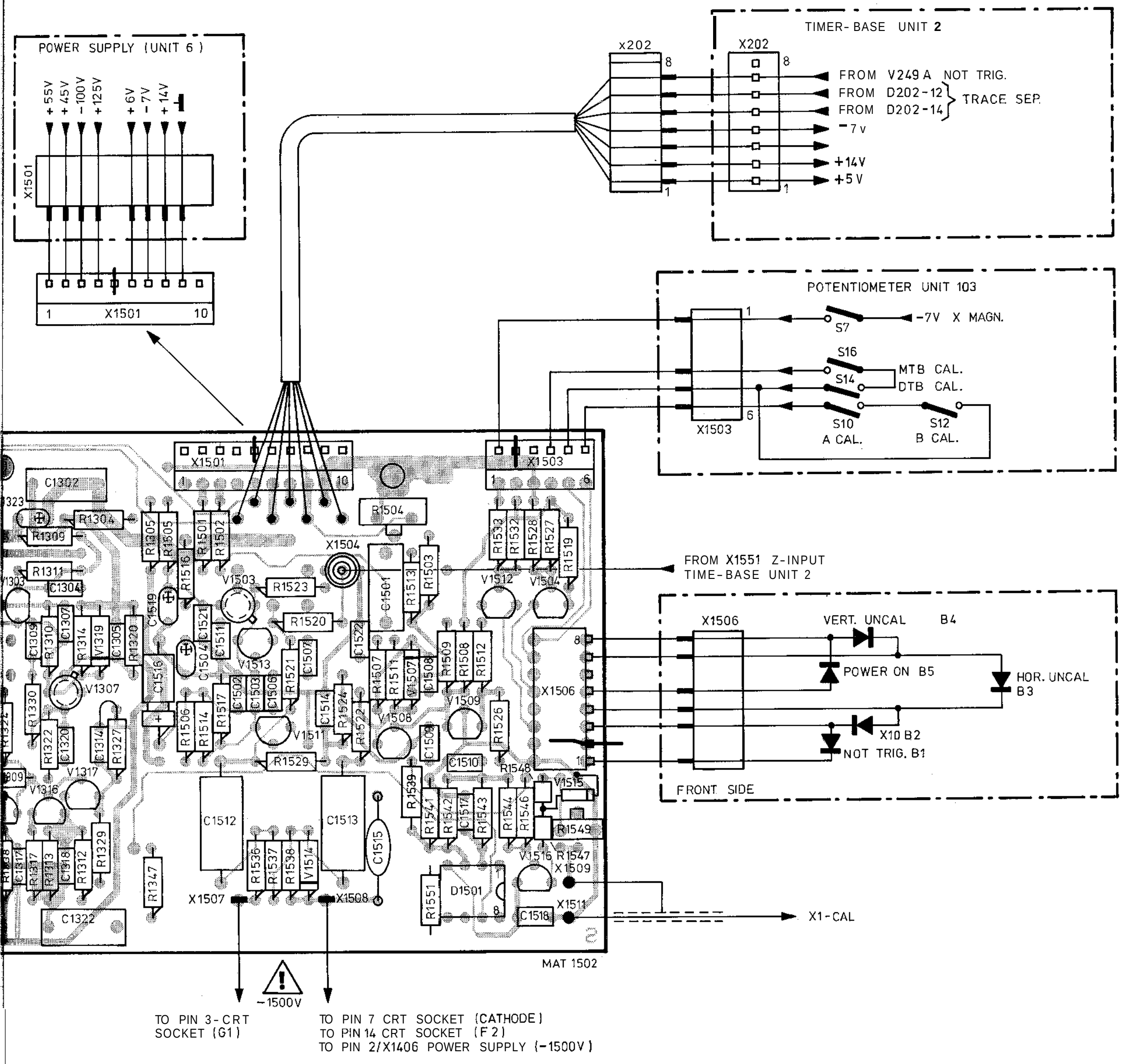


Fig. 8.12. Final X/Z amplifier unit (unit 5), p.c.b. lay-out

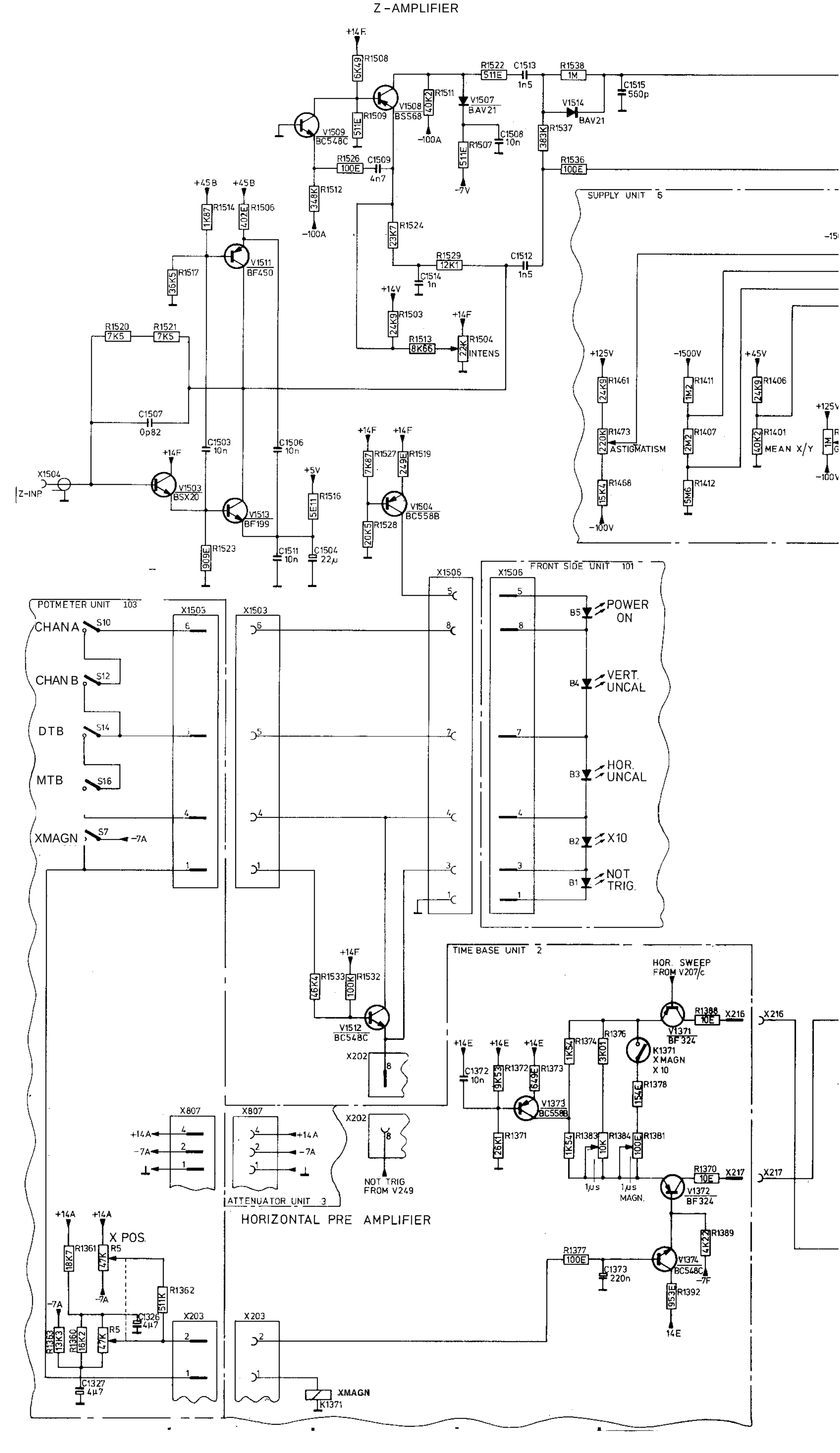
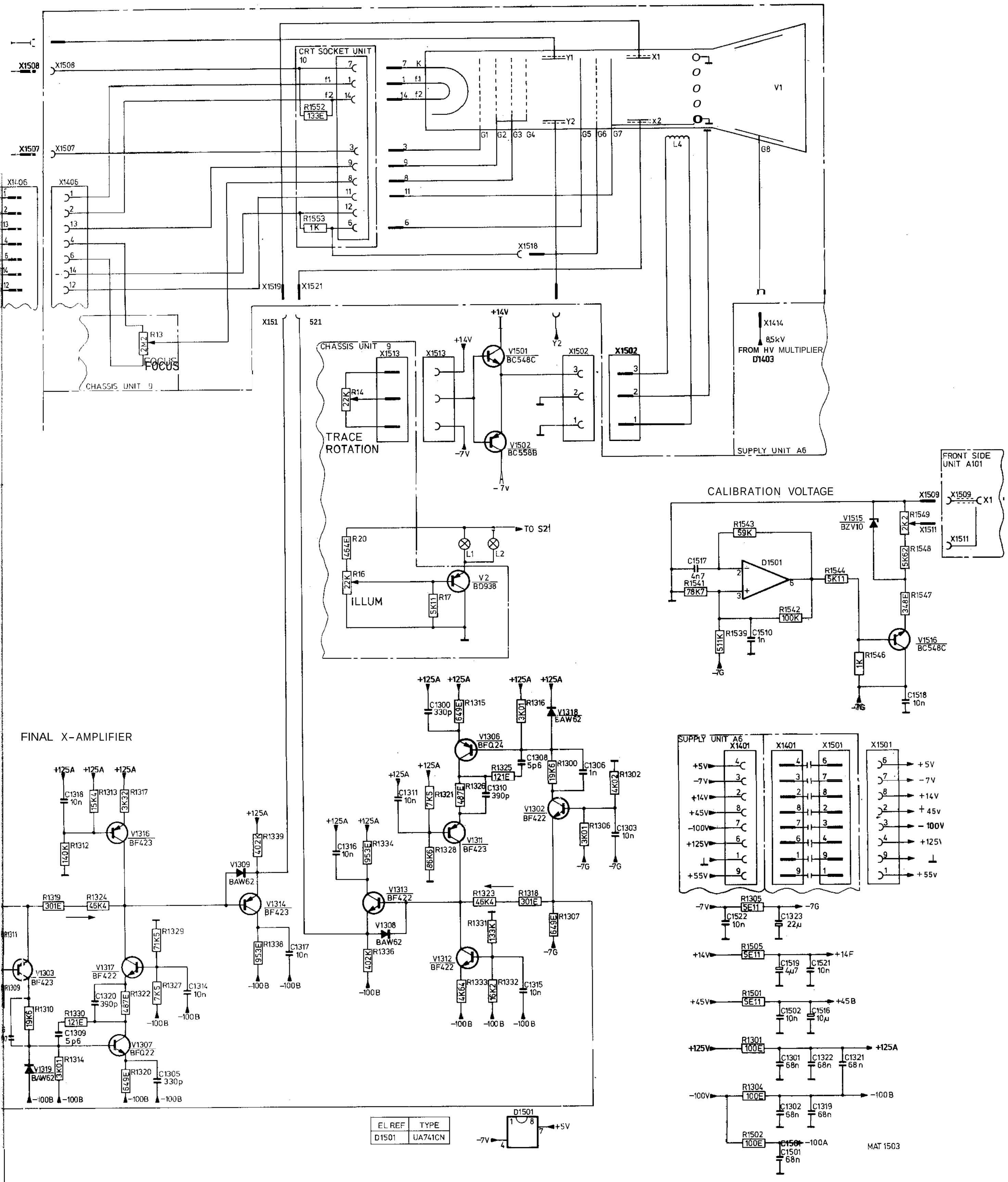
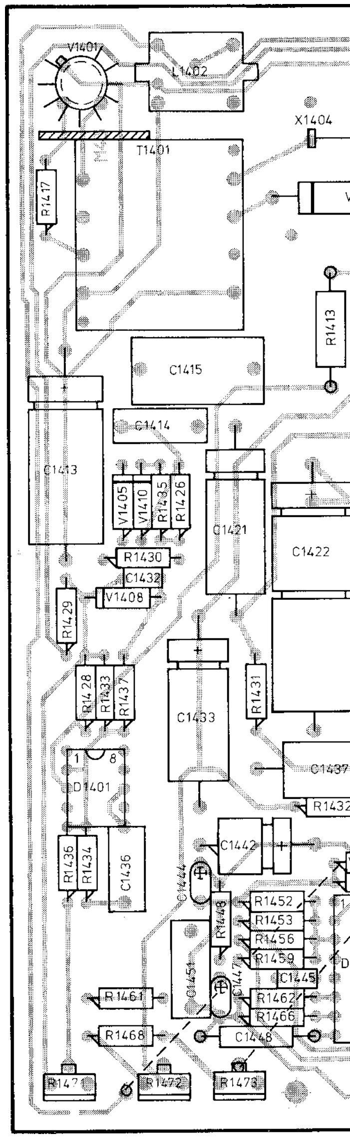


Fig. 8.13. Circuit diagram final X-amplifier, calibration unit and display section



EL REF	TYPE
D1501	UA741CN


V1401
L1402
X1404
T1401
R1417
R1413
C1415
C1414
C1413
V1405
V1410
R1435
R1426
C1421
C1422
R1430
C1432
V1408
R1429
R1428
R1433
R1437
C1433
R1431
D1401
C1437
R1432
R1436
R1434
C1436
C1442
C1444
R1448
R1452
R1453
R1456
R1459
C1445
C1451
C1447
R1462
R1466
R1461
R1468
C1448
R1471
R1472
R1473

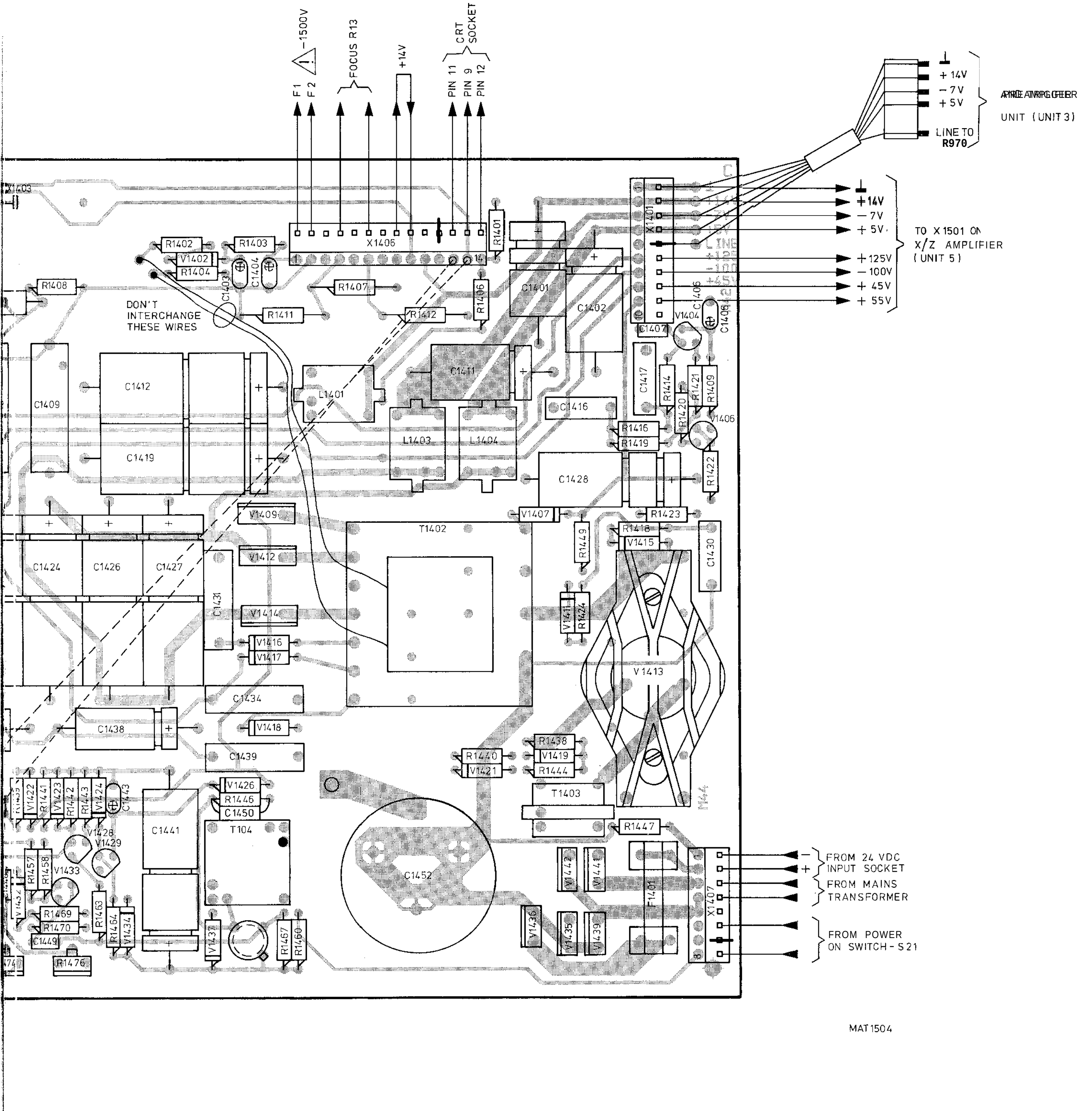
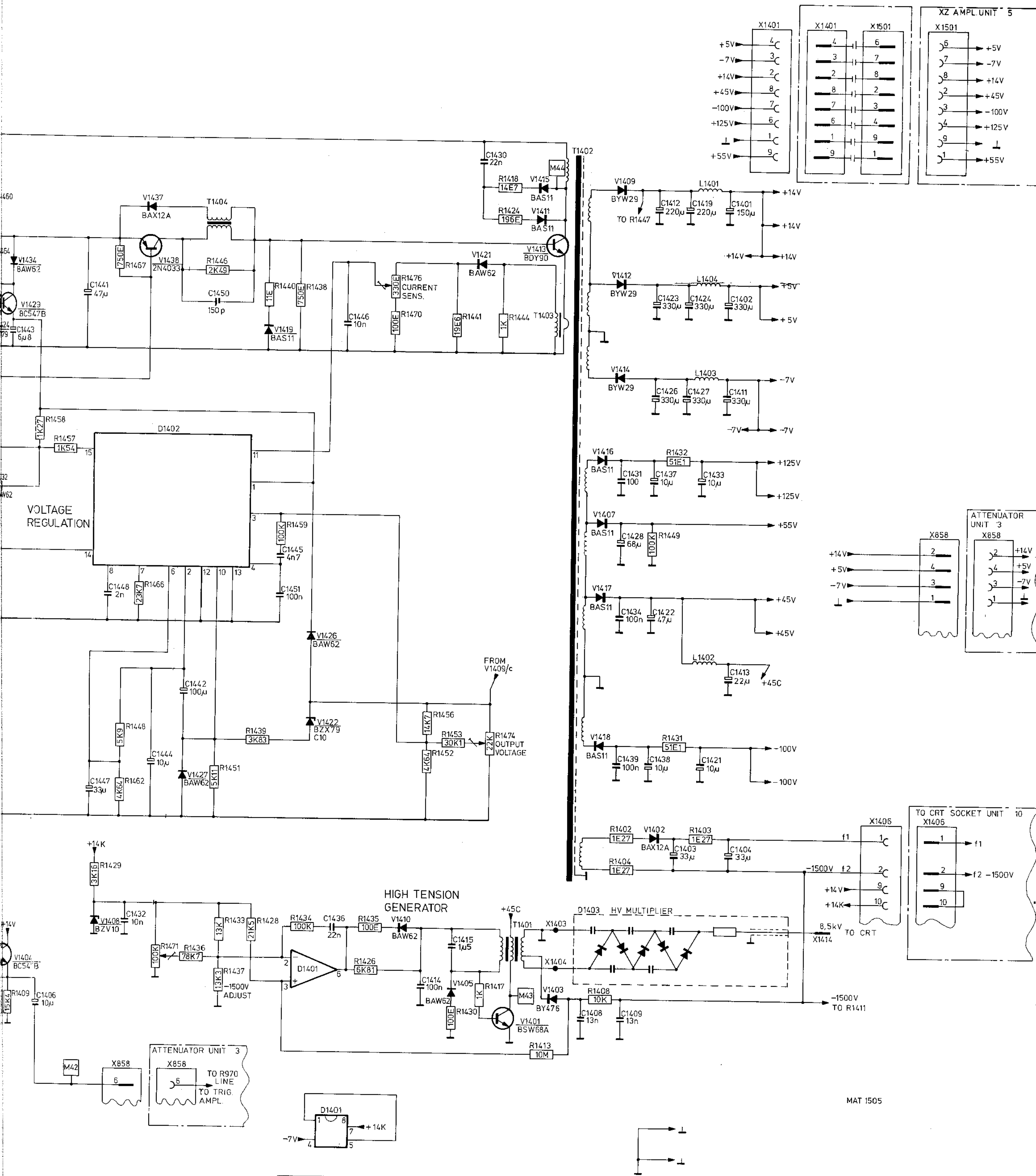
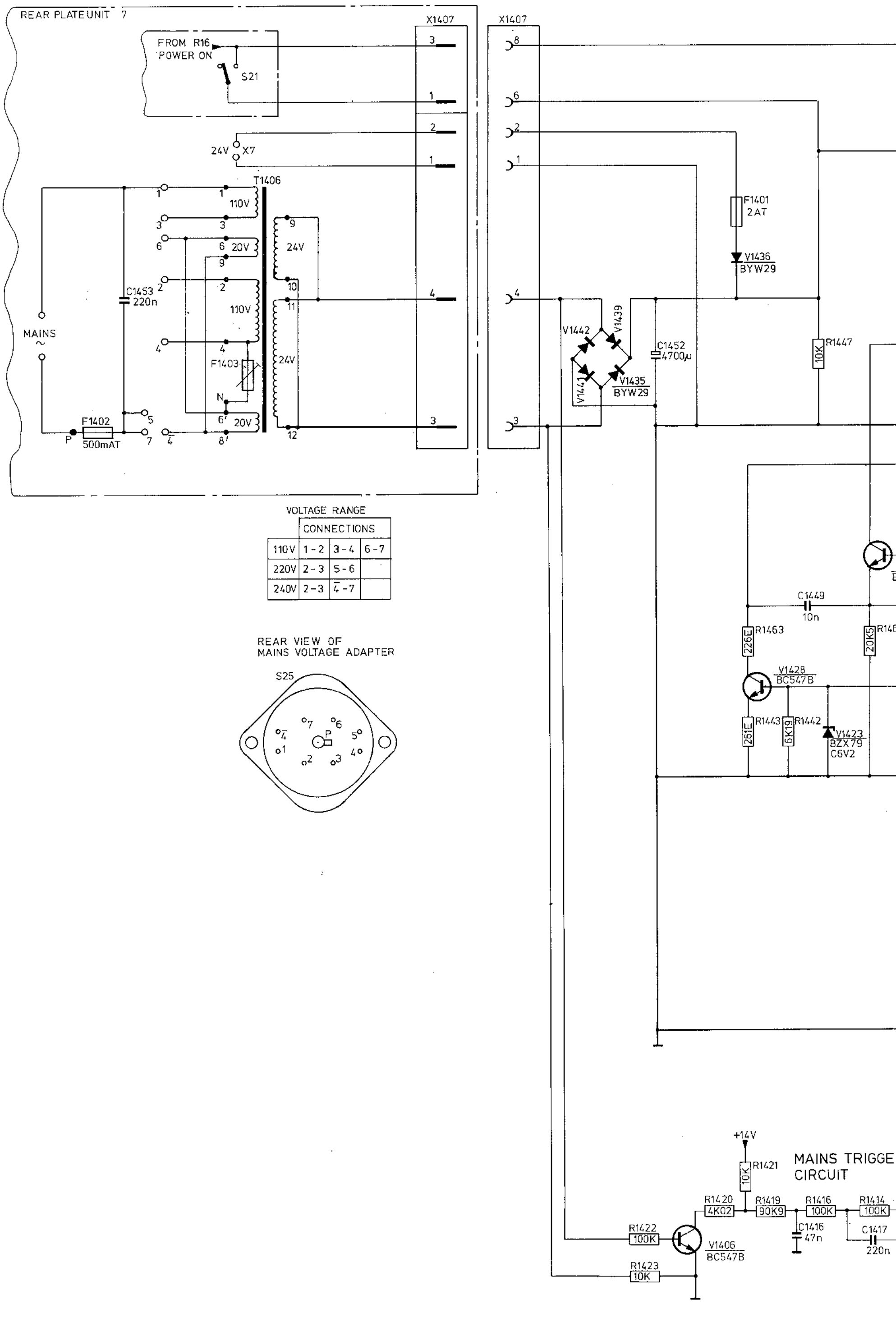


Fig. 8.14. **Power supply** *unit (unit 6), p.c.b.* **lay-out**



REF NO	TYPE
D1401	UA741CN
D1402	TDA1060



VOLTAGE RANGE

	CONNECTIONS		
110V	1-2	3-4	6-7
220V	2-3	5-6	
240V	2-3	$\bar{4}$-7	

Fig. 8.15. Circuit diagram of power supply and H.V. generator

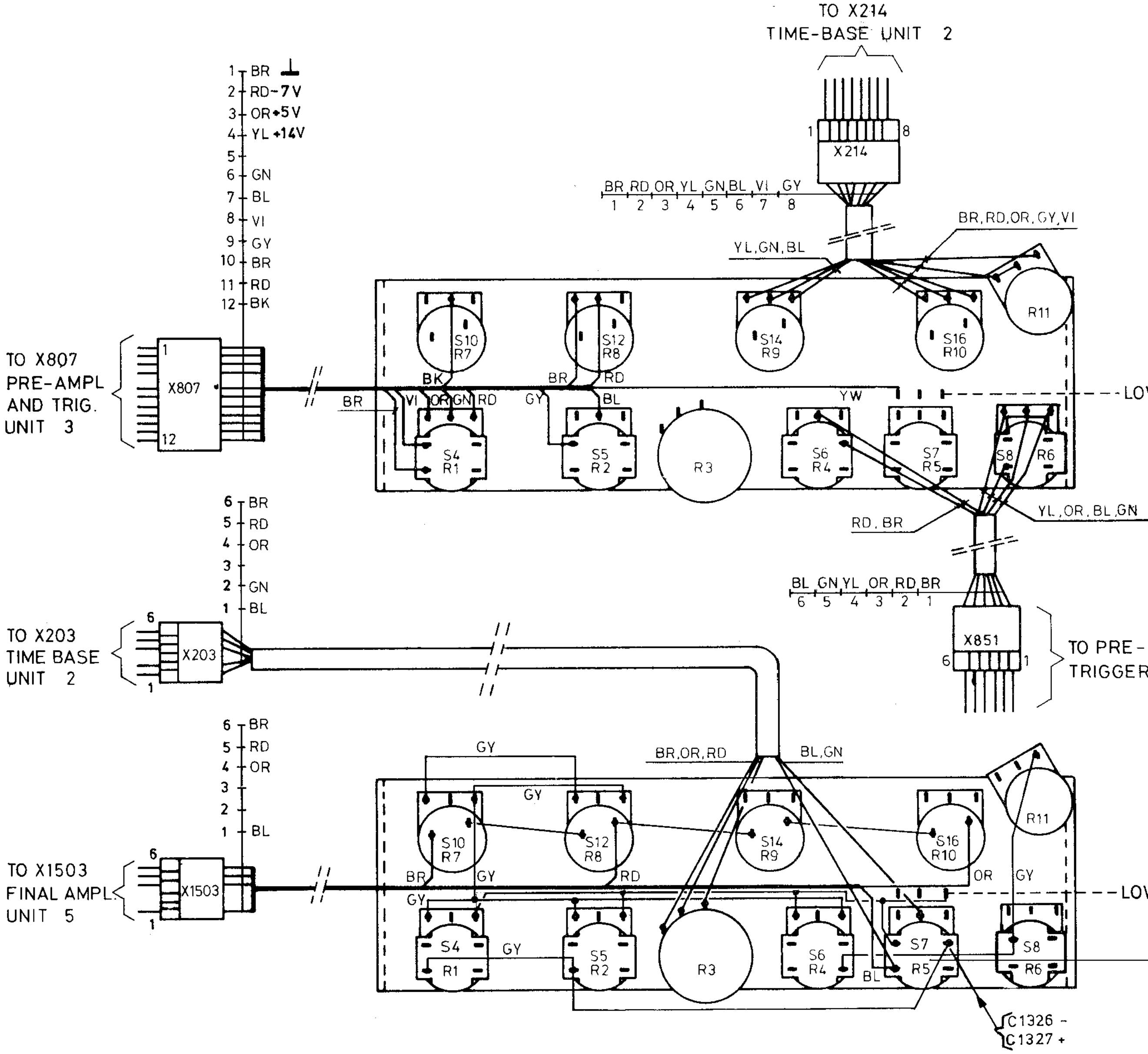
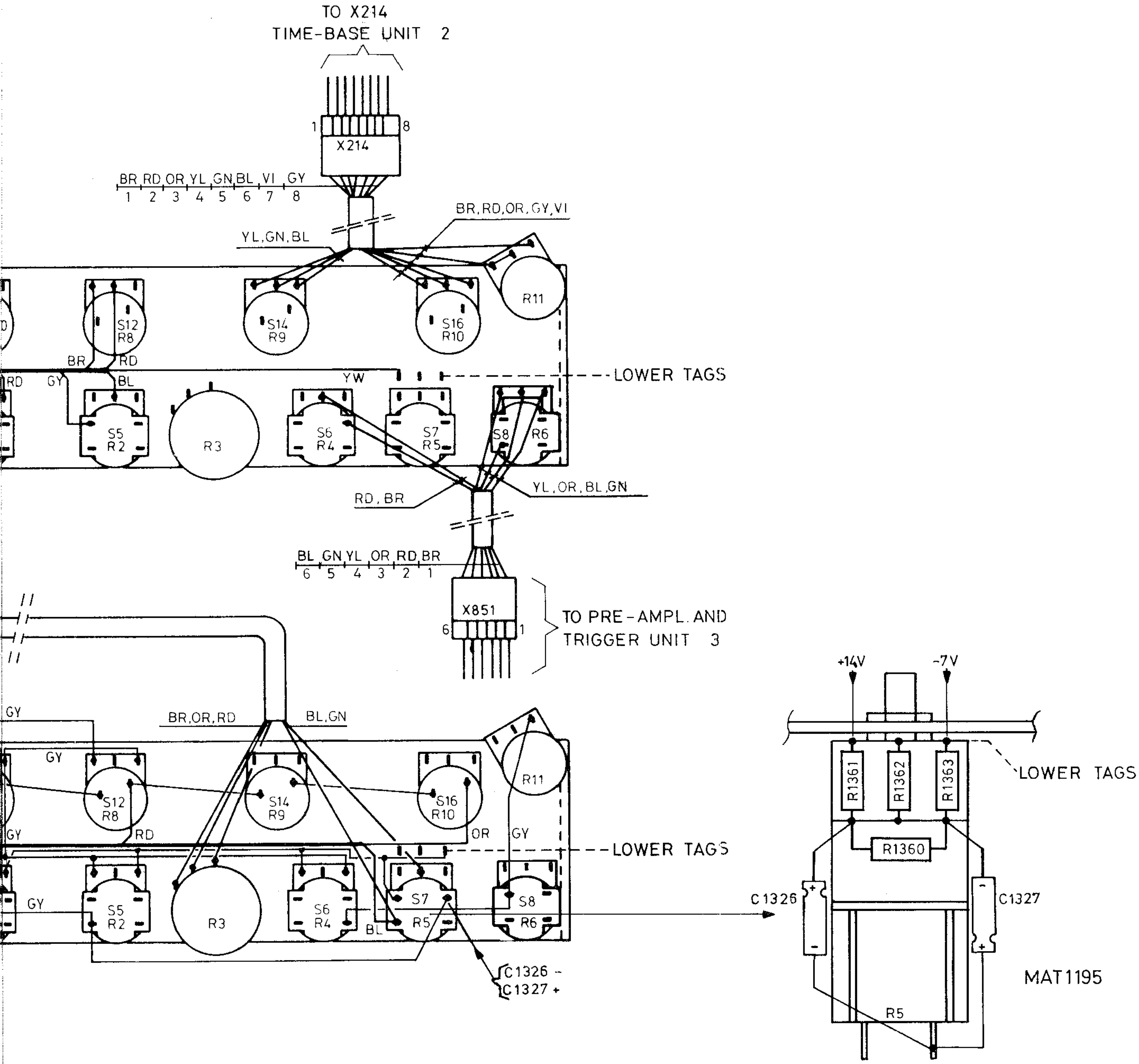


Fig. 8.17. Potentiometer unit (unit 103), wiring lay-out


TO X214
TIME-BASE UNIT 2
X214
BR RD OR YL GN BL VI GY
1 2 3 4 5 6 7 8
BR, RD, OR, GY, VI
YL, GN, BL
R11
S12 R8
S14 R9
S16 R10
BR
RD
GY
BL
YW
LOWER TAGS
S5 R2
R3
S6 R4
S7 R5
S8
R6
RD, BR
YL, OR, BL, GN
BL GN YL OR RD BR
6 5 4 3 2 1
X851
TO PRE-AMPL. AND
TRIGGER UNIT 3
BR, OR, RD
BL, GN
OR
LOWER TAGS
C1326 -
C1327 +
+14V
-7V
R1361
R1362
R1363
R1360
C1326
C1327
R5
MAT1195

-out

9. VOLTAGE WAVEFORMS IN THE INSTRUMENT

9.1. INTRODUCTION

The waveforms given in this chapter are typical values and represent an average instrument.
So the waveforms measured in your "oscilloscope under test" can differ somewhat from the values given in this manual. The waveforms are listed in 3 chapters:
9.2. Vertical deflection and triggering
9.3. Horizontal deflection
9.4. Power supply
The measurement can be started at every desired point because settings of "measuring oscilloscope" and "oscilloscope under test" that differ from the "standard" settings are indicated beside the waveforms.
The test points are marked on the units.

The required test equipment consists of an oscilloscope of 100 MHz (e.g. Philips PM 3262) with a suitable 10:1 attenuator probe.
The input square wave signal for the "oscilloscope under test" can be obtained from a function generator (e.g. Philips PM 5127).

Standard-settings for the "oscilloscope under test"

- Depress the Y-position controls to the non-inverted position (S4 and S5).
- Push the channel A and B signal coupling switches in the AC position (S17 and S18).
- Depress pushbutton A (or B) of the vertical display mode selector S1.
- Set the channel A and B AMPL/DIV controls in the 1 V/div. position and their verniers to CAL.
- Depress pushbutton MTB of the horizontal display mode selector (S2).
- Depress the time base magnifier X MAGN (S7).
- Depress pushbutton AUTO PP of trigger mode selector (S3).
- Set the MTB in the 0.1 ms/div. position and its vernier to CAL.
- Set the DTB TIME/DIV switch in the OFF position and its vernier to CAL.
- Depress pushbutton DC of the MTB and DTB trigger coupling controls (S20 and S19).
- Depress pushbutton A (or B) of the MTB trigger source selector (S23).
- Depress pushbutton MTB of the DT8 trigger source selector (S22).
- Apply a square-wave signal on 6 Vp-p/10 kHz to the input sockets A, B and EXT.
- Set the signal in the middle of the screen by means of the channel A (or B) position controls (R1 and R2).
- Set the HOLD OFF control in the CAL position.
- Adjust the DELAY TIME control to 5,00.

Standard-settings of the "measuring oscilloscope"

- The waveforms are measured on channel A, the required AMPL/DIV position is indicated beside every waveform.
- The vertical position of the main time base line without input signal is indicated beside every waveform with a "0".
- The instrument is triggered on channel A.
- Only the MTB is used and the required TIME/DIV position is indicated beside every waveform.
- The MTB trigger coupling control occupies the DC position.

The units on which voltage waveforms can be measured are:

Unit 2: Time base unit

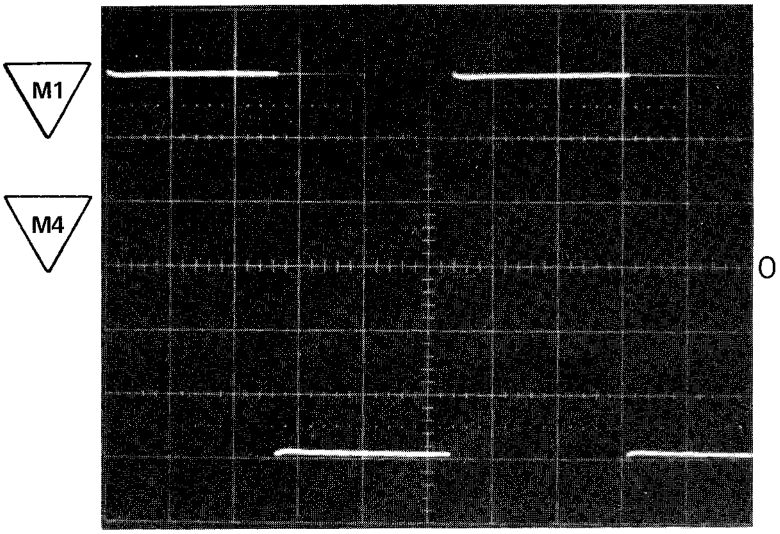
Unit 3: Preamplifier and trigger unit; for measurements on test points M23 ... M29, the trigger source selection unit must be lifted.

Unit 4: Trigger selection unit, the test point on this unit (M27) is not indicated. For the location of M27 refer to the p.c.b. lay-out of the unit.

Unit 6: Power supply.

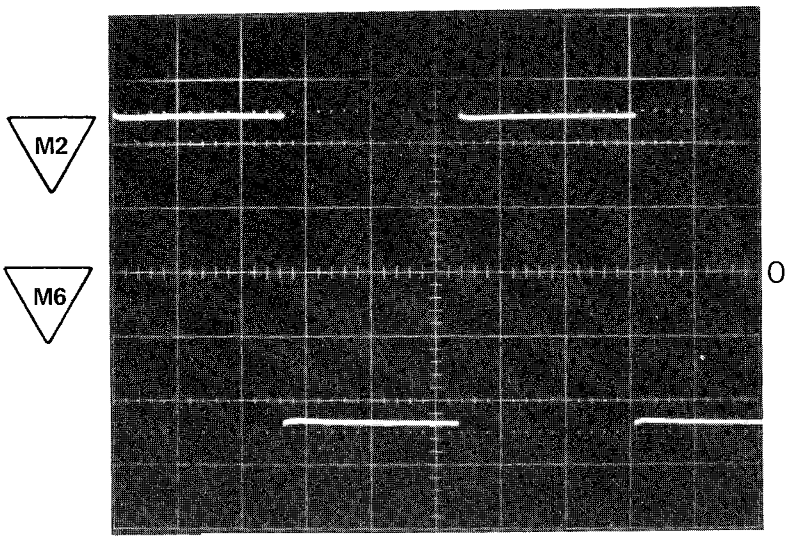
9.2 VERTICAL DEFLECTION AND TRIGGERING

Unit **3**



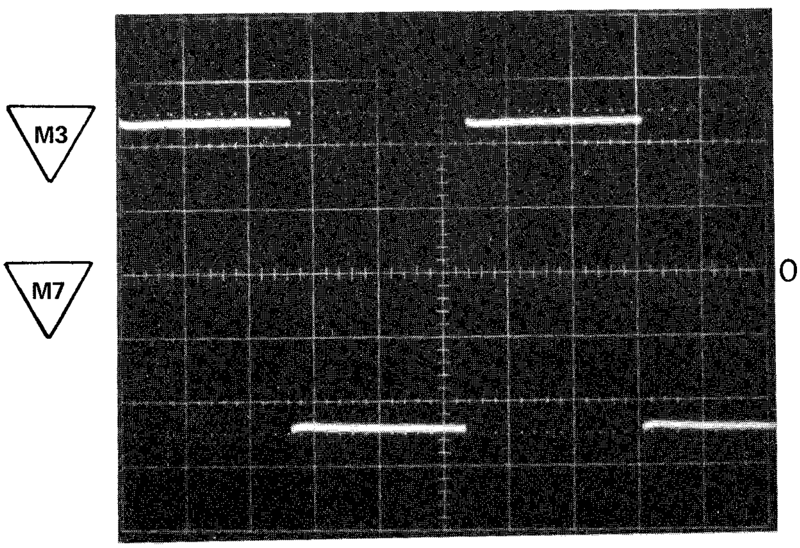
Measuring oscilloscope:
0.1 V/div.
20 μs/div.
DC input coupling

Oscilloscope under test:
M I = channel A
M4 = channel **B**



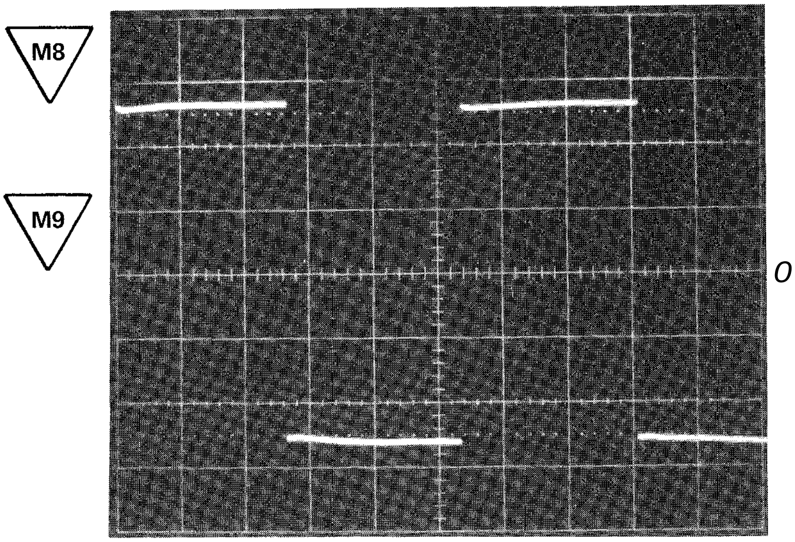
Measuring oscilloscope:
10 mV/div.
20 μs/div.
DC input coupling

Oscilloscope under test:
M2 = channel A
M6 = channel B



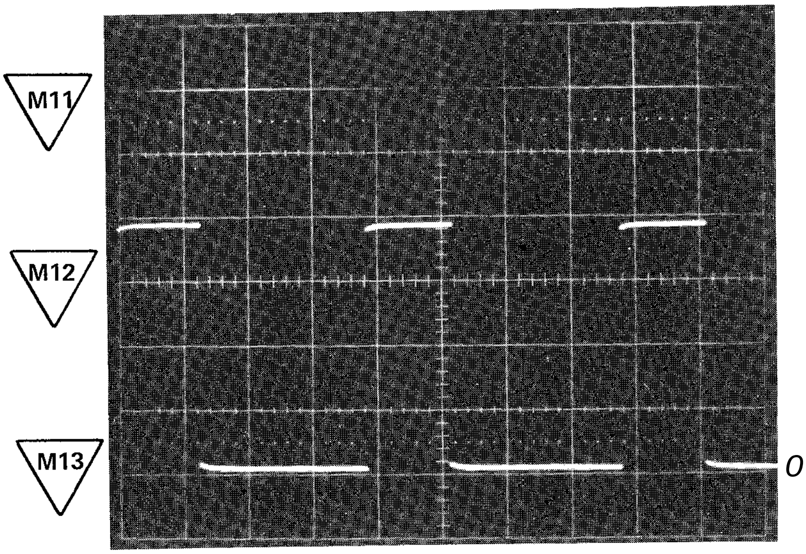
Measuring oscilloscope:
2 mV/div.
20 μs/div.
DC input coupling

Oscilloscope under test:
M3 = channel A
M7 = channel B



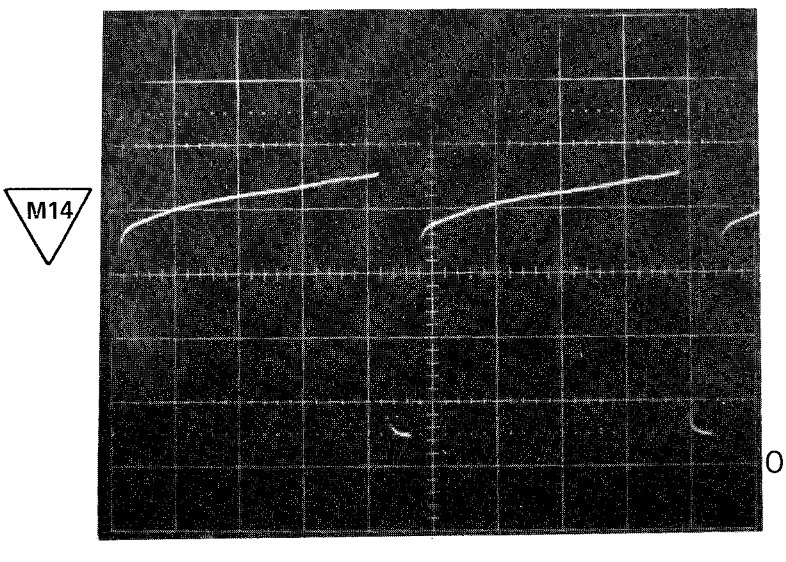
Measuring oscilloscope:
5 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
Select vertical display (S1)
via channel A and B.



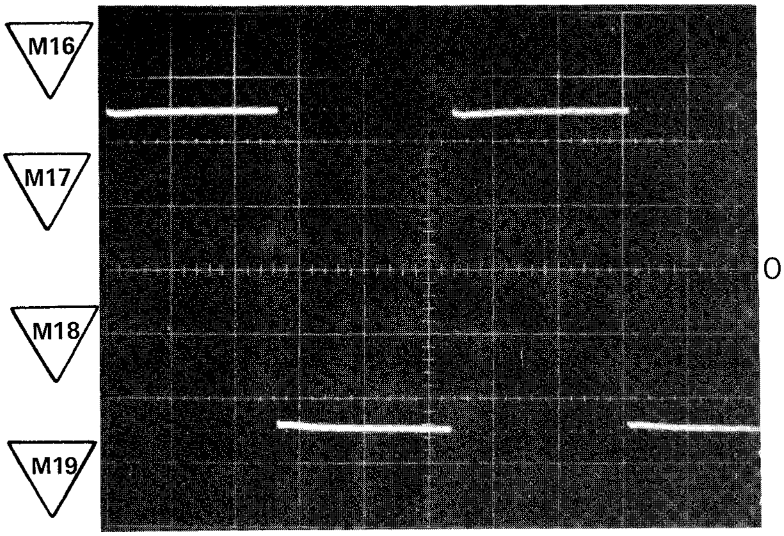
Measuring oscilloscope:
0.1 V/div.
1 ms/div.
DC input coupling

Oscilloscope under test:
Select vertical display mode
(S1) ALT combined with
TRIG VIEW



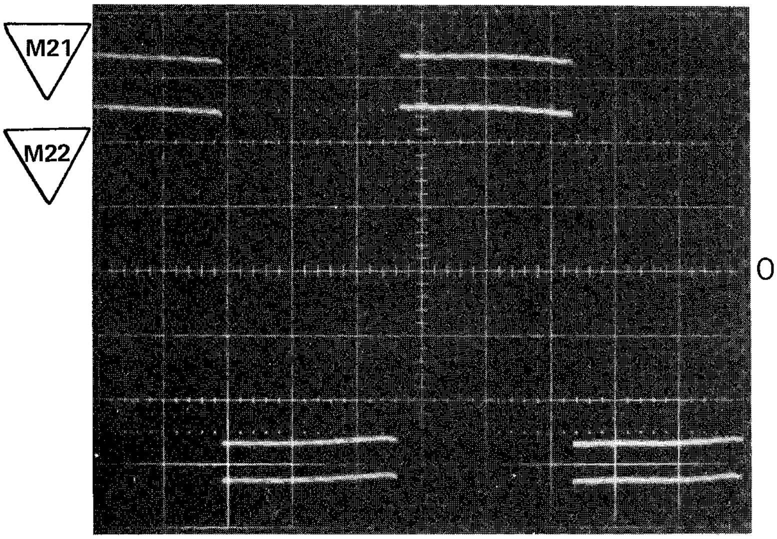
Measuring oscilloscope:
0.1 V/div.
0.2 μs/div.
DC input coupling

Oscilloscope under test:
Select vertical display mode
(S1) CHOP



Measuring oscilloscope:
5 mV/div.
20 μs/div.
AC input coupling

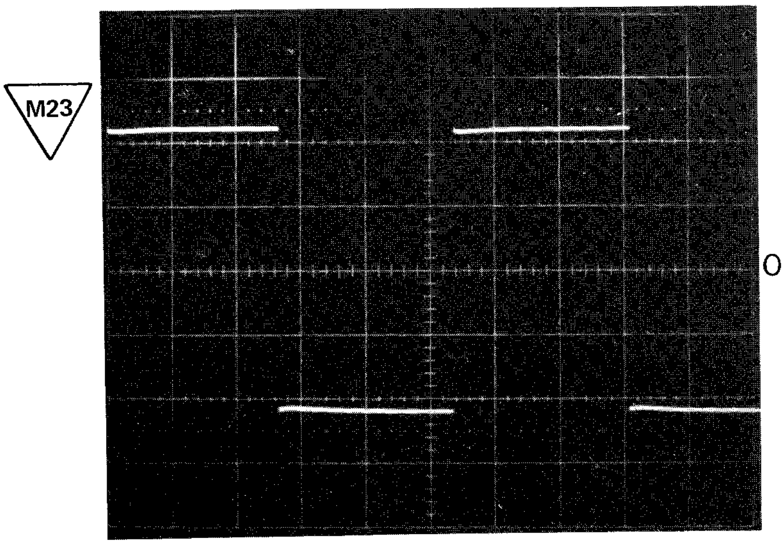
Oscilloscope under test:
M16/M17: MTB triggering on channel A.
M18/M19: MTB triggering on channel B.



Measuring oscilloscope:
5 mV/div.
20 μs/div.
AC input coupling

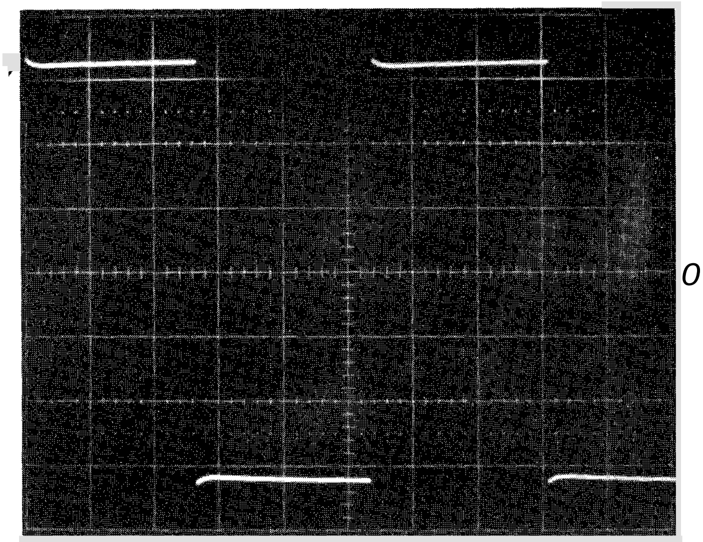
Oscilloscope under test:
MTB triggering via COMP.
Waveform depends on channel A and B position control.
Depress ALT of S1

NOTE: *For the following measurements the Trigger selection unit must be lifted.*



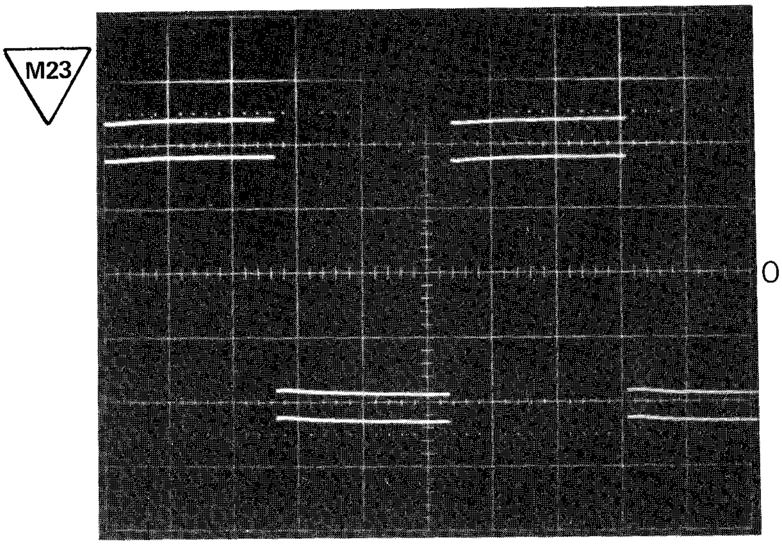
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
Select MTB triggering via channel A and B.



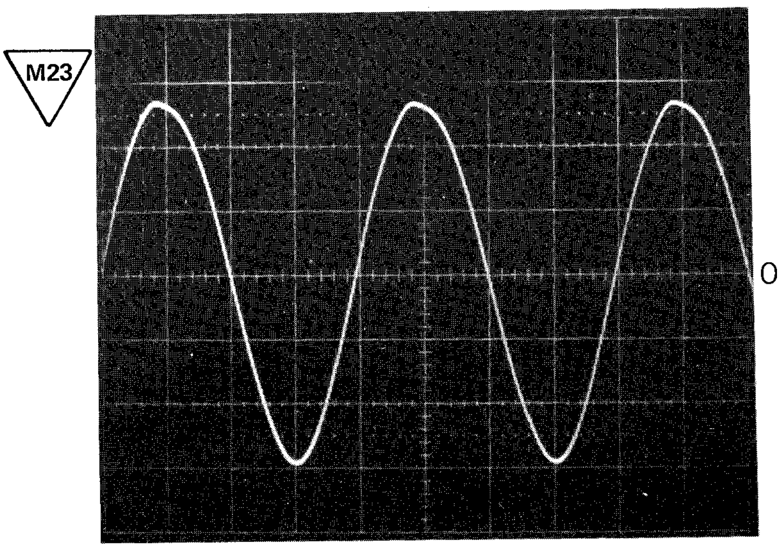
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
Select MTB triggering via the EXT input. Apply the channel A/B input signal to EXT input socket.



Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

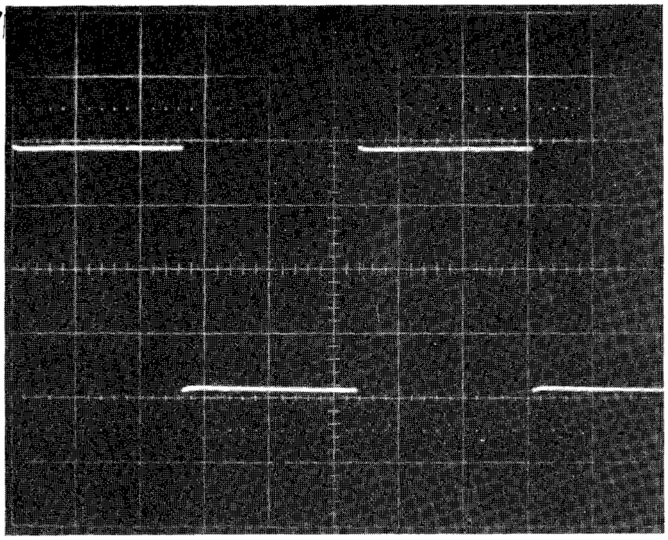
Oscilloscope under test:
Select MTB triggering via COMP. Waveform depends on channel A and B position controls.



Measuring oscilloscope:
20 mV/div.
5ms/div.
AC input coupling

Oscilloscope under test:
Select MTB triggering via LINE.

M24

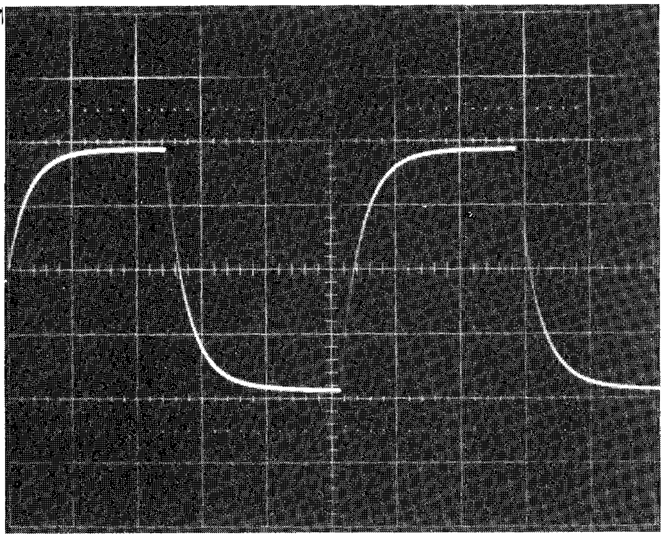


0

Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
DC trigger coupling of MTB.

M24

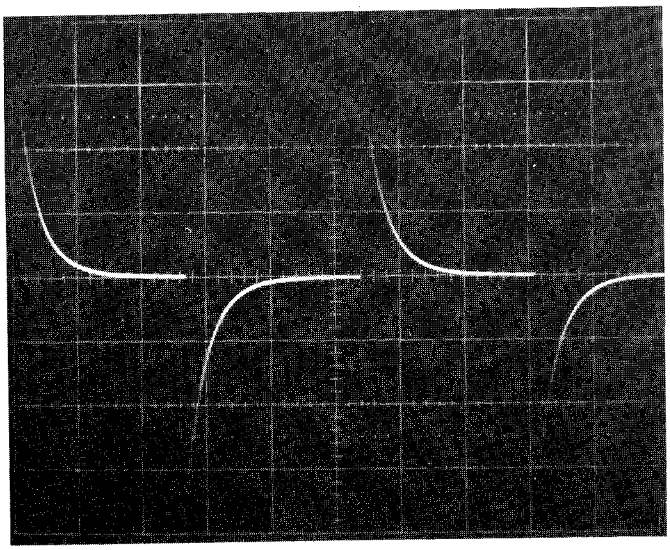


0

Measuring oscilloscope:
20 mV/div
20 μs/div.
AC input coupling

Oscilloscope under test:
LF trigger coupling of MTB.

M24



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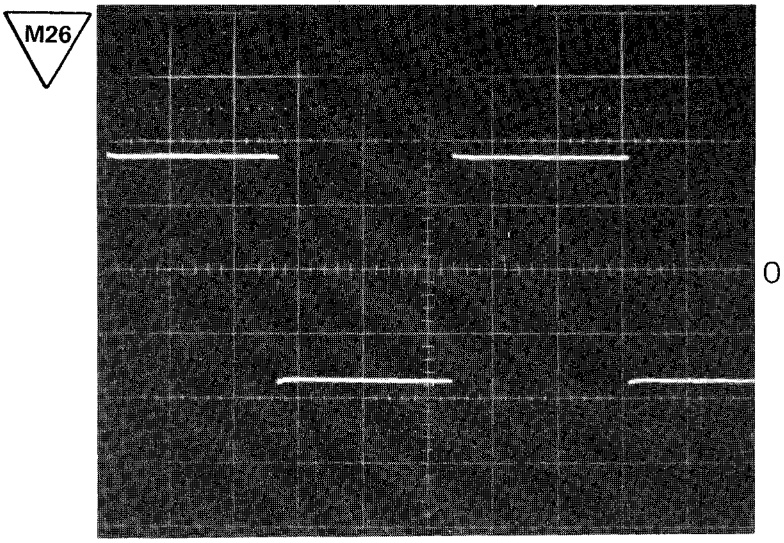
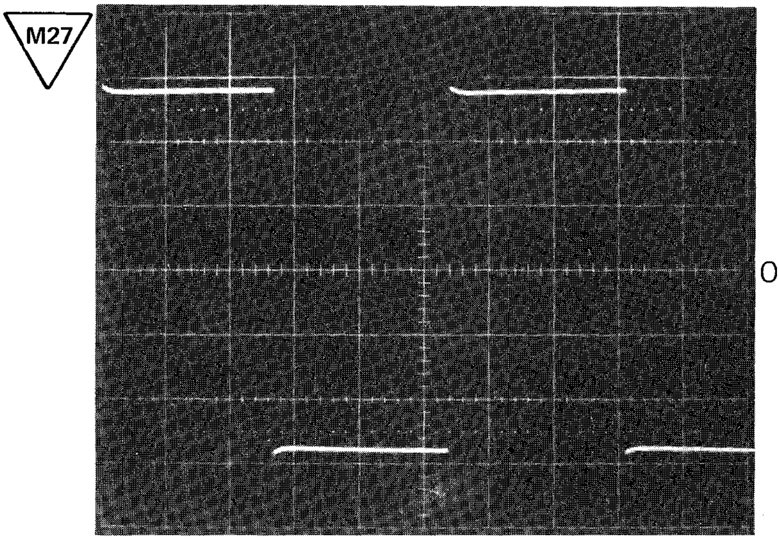
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
HF trigger coupling of MTB.

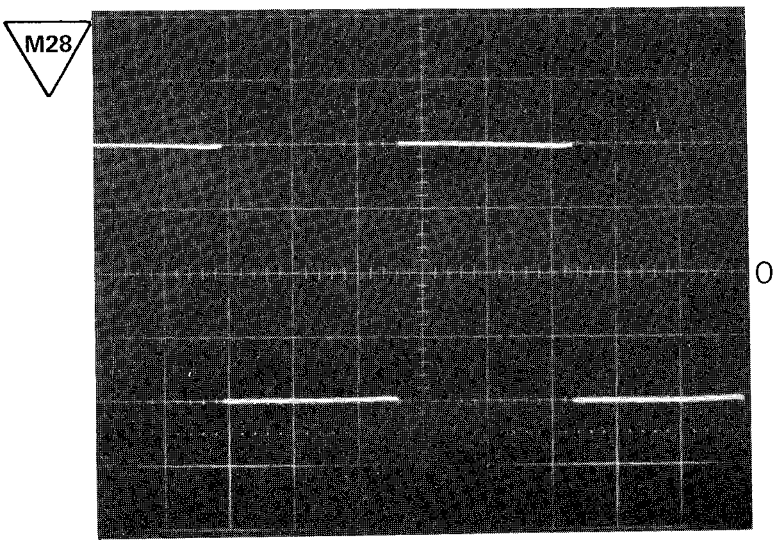


Measuring oscilloscope:
50 mV/div.
20 μs/div.
AC input coupling



Measuring oscilloscope:
10 mV/div.
20 μs/div.
AC input coupling

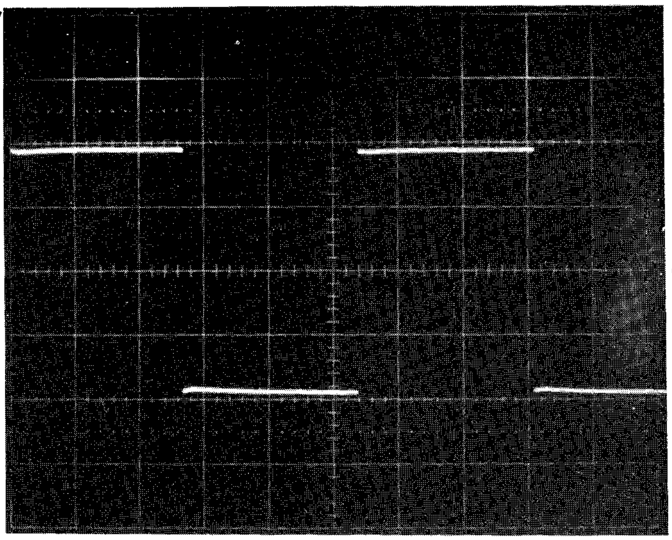
Oscilloscope under test:
This test point is located on the trigger selection unit.
Select MTB triggering via the EXT input. Apply the channel A/B input signal to the EXT input socket.



Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
Select DTB triggering on channel A and B

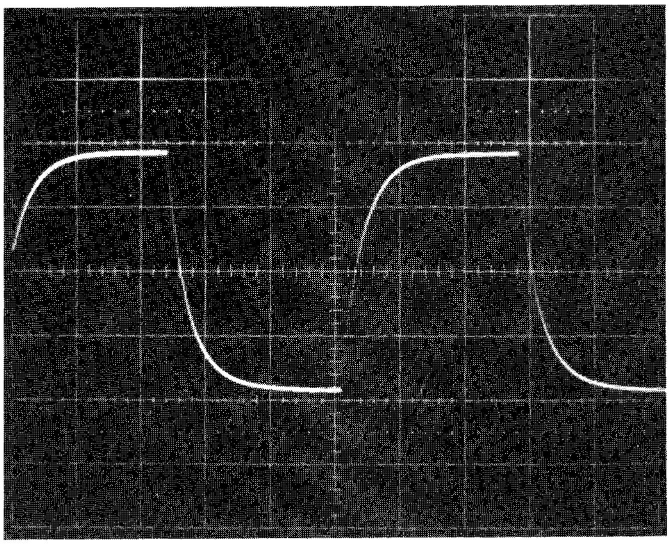
M29



(3

Measuring oscilloscope:
20 mV/div.
20 µs/div.
AC input coupling

M29

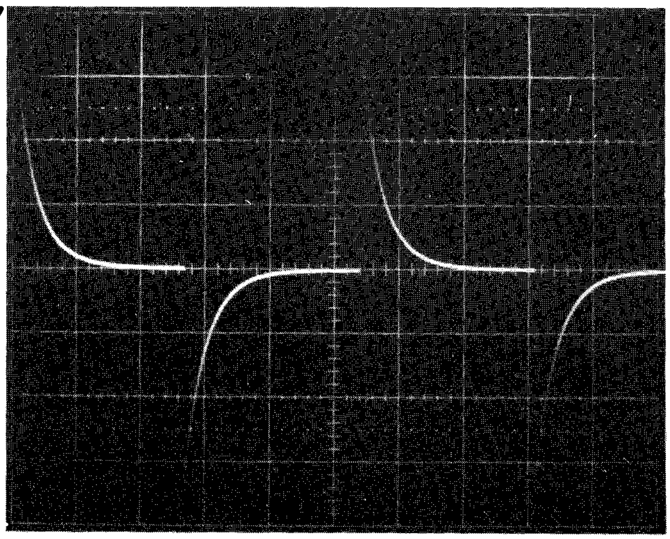


0

Measuring oscilloscope:
20 mV/div.
20 µs/div.
AC input coupling.

Oscilloscope under test:
LF trigger coupling of DTB.

M29



0

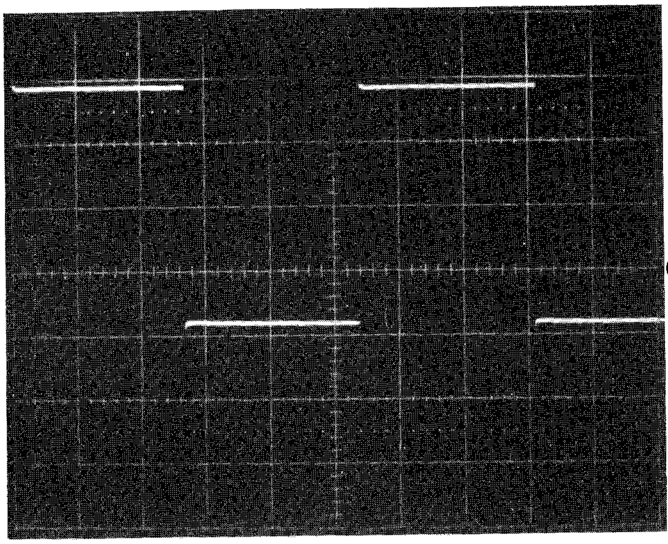
Measuring oscilloscope:
20 mV/div.
20 µs/div.
AC input coupling

Oscilloscope under test:
HF trigger coupling of DTB.

9.3 HORIZONTAL DEFLECTION

Unit 2

M31



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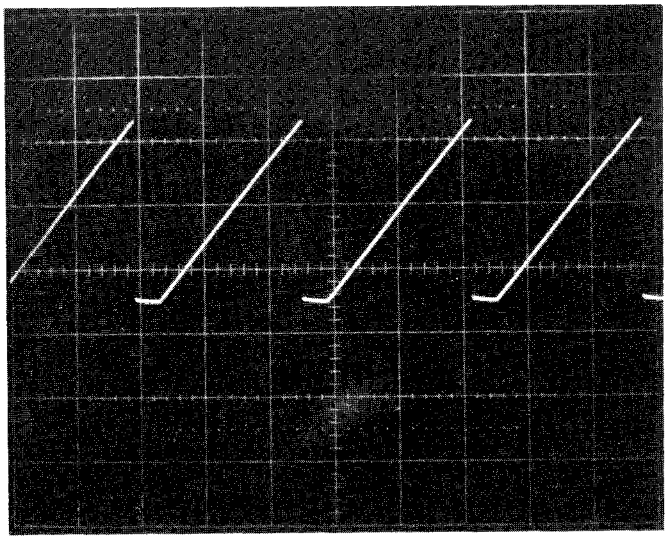
Measuring oscilloscope:
0.1 V/div.
20 μs/div.
DC input coupling

M32



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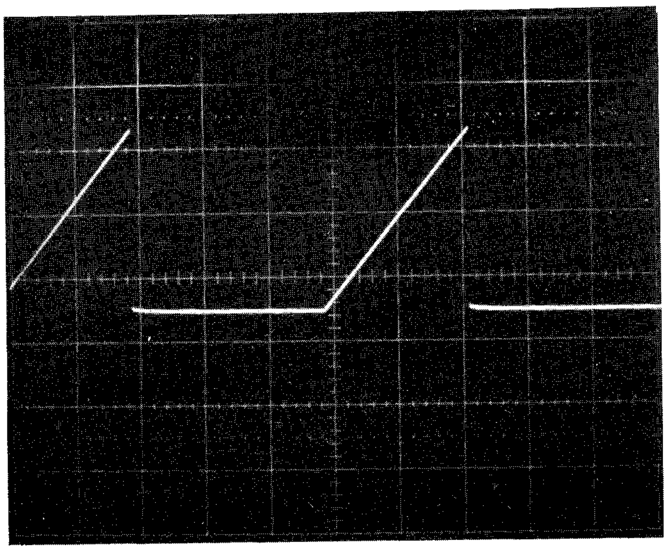
Measuring oscilloscope:
0.2 V/div.
0.5 msldiv.
DC input coupling

M32

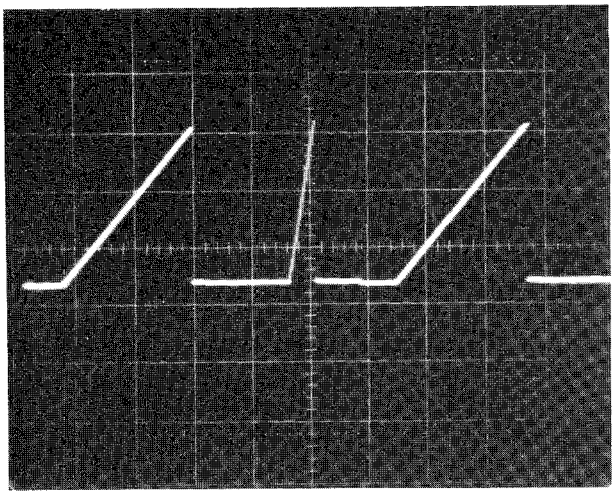


0

Measuring oscilloscope:
0.2 V/div.
0.5 msldiv.
DC input coupling

Oscilloscope under test:
Turn the HOLD OFF control fully anti-clockwise.

M32



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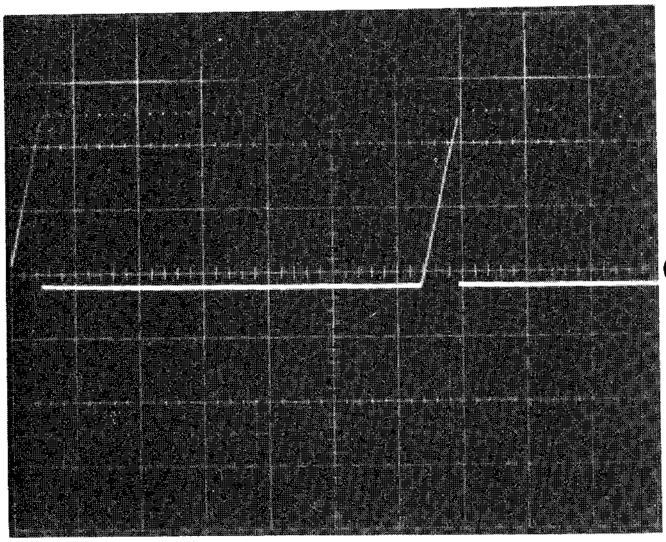
Measuring oscilloscope:
0.2 Vldiv.
0.5 msldiv.
DC input coupling.
Oscilloscope under test:
Select ALT TB mode (S2).
Adjust the DTB to **20μs/div.**
Operate the HOLD **OFF** control to avoid "double" triggering.

M33



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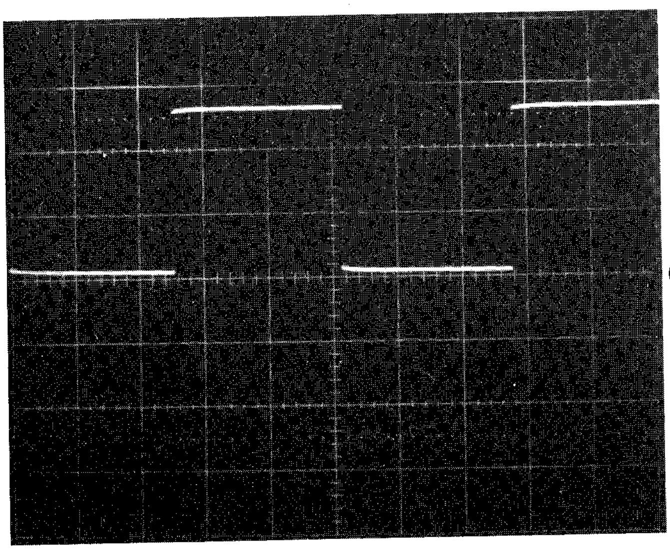
Measuring oscilloscope:
0.2 V/div.
0.2 msldiv.
DC input coupling.

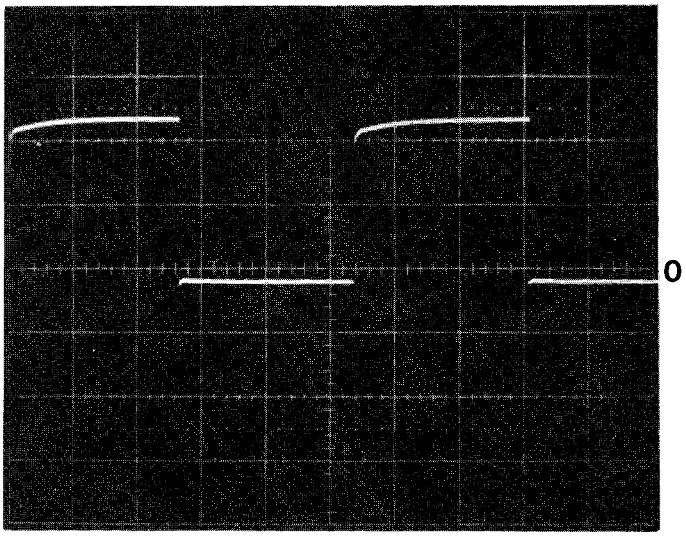
M34



0

Measuring oscilloscope:
0.2 V/div.
0.5 msldiv.
DC input coupling.
Oscilloscope under test:
Select ALT TB mode (S2).
Adjust the DTB to ***20*** μs/div.

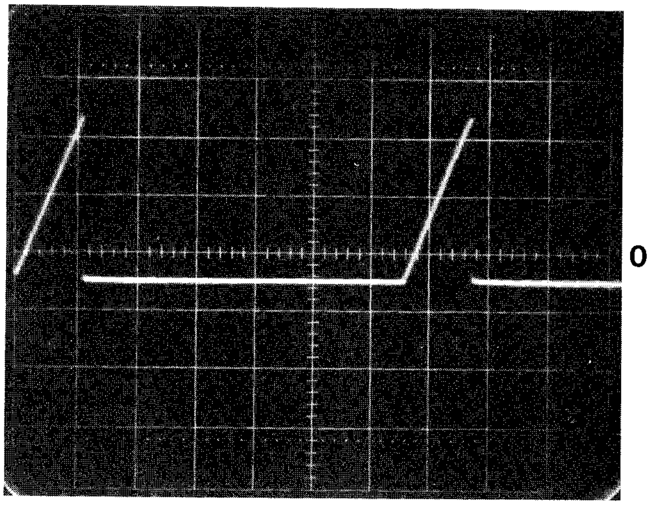
M36



Measuring oscilloscope:
0.1 V/div.
20 μs/div.
DC input coupling

Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select ALT TB mode (S2).
Depress A of S22

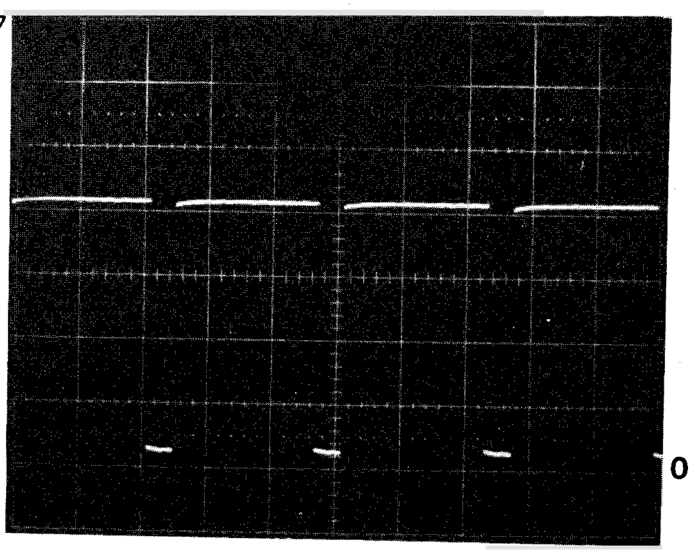
M37



Measuring oscilloscope:
0.2 V/div.
0.2 ms/div.
DC input coupling.

Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select DTB mode (S2).

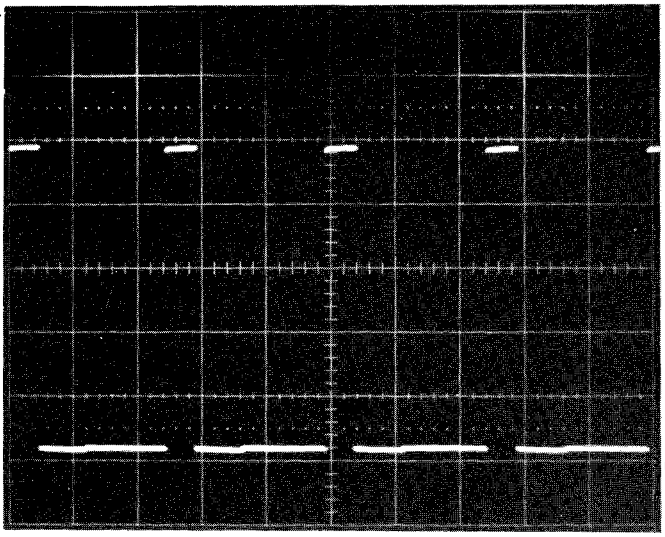
M38



Measuring oscilloscope:
0.1 V/div.
0.5 ms/div.
DC input coupling.

Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select DTB mode (S2).

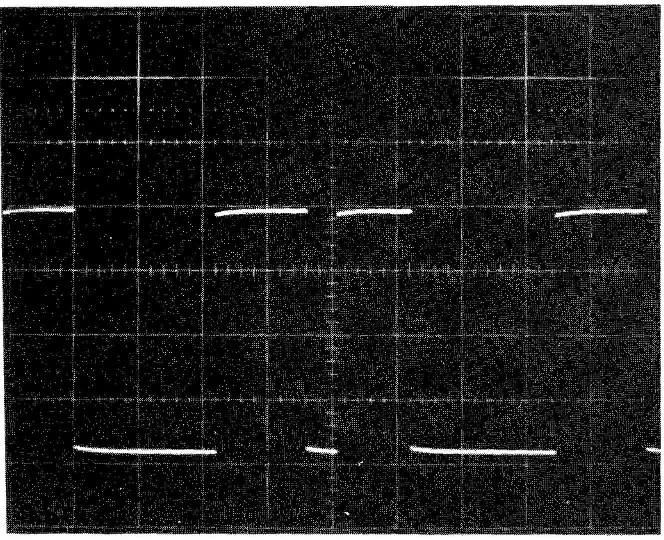
M39



Measuring oscilloscope:
0.1 V/div.
0.5 ms/div.
DC input coupling

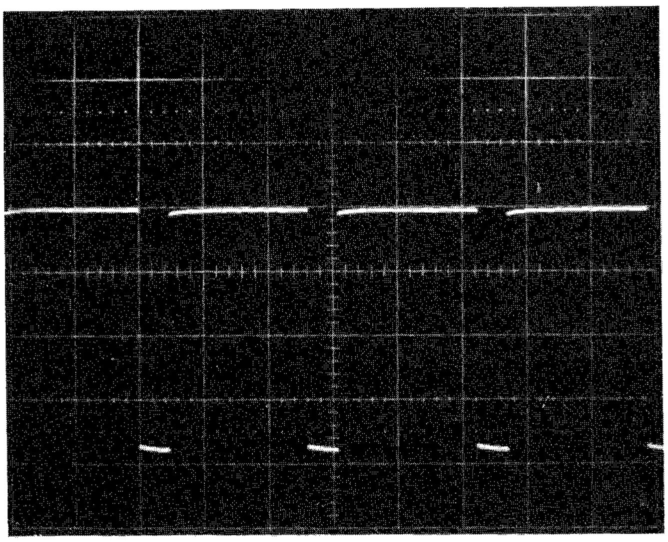
Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select DTB mode (S2).

M40



Measuring oscilloscope:
0.1 V/div.
0.5 ms/div.
DC input coupling.
Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select ALT TB mode (S2).
Operate the HOLD OFF control to avoid “double” triggering.

M41



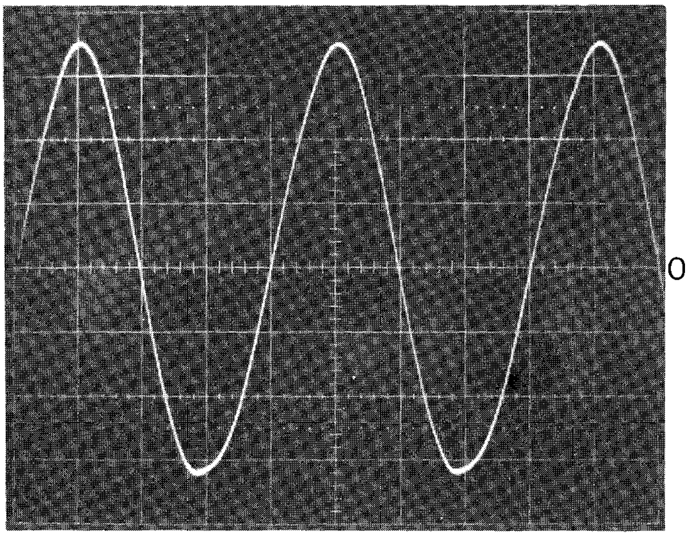
Measuring oscilloscope:
0.1 V/div.
0.5 ms/div.
DC input coupling

Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select ALT TB mode (S2).

9.4. POWER SUPPLY

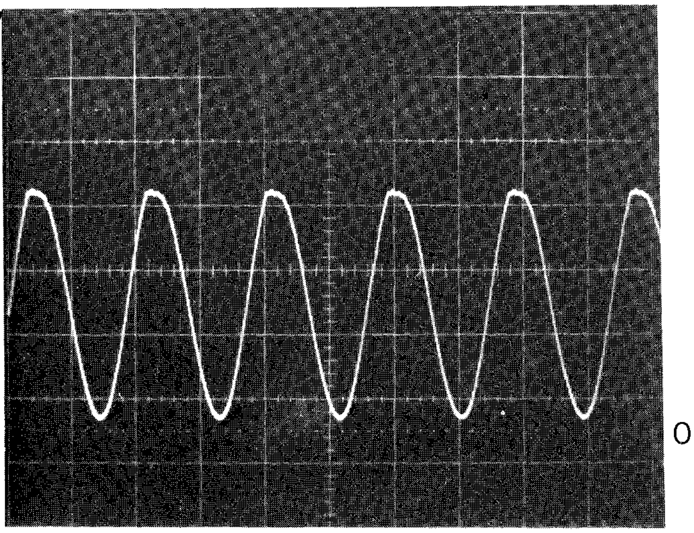
Unit 6

M42



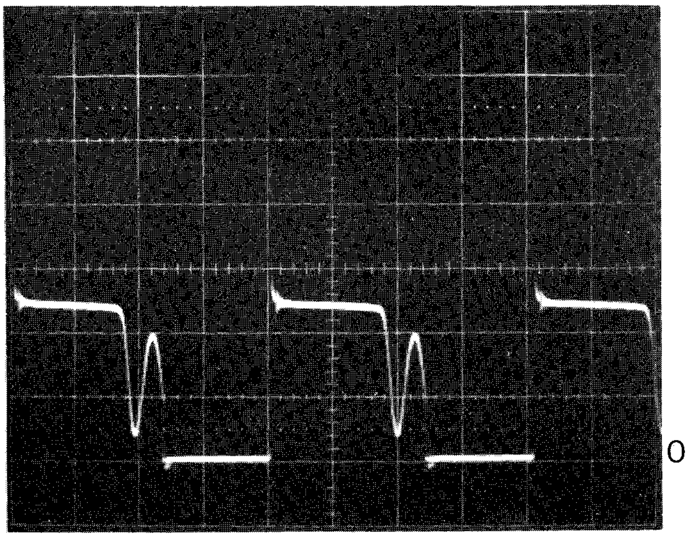
Measuring oscilloscope:
0.1 Vfdiv.
5 msfdiv.
DC input coupling

M43



Measuring oscilloscope:
2 Vfdiv.
20 μs/div.
DC input coupling

M44



Measuring oscilloscope:
2 Vfdiv.
10 μs/div.
DC input coupling

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

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

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

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

CODED FAILURE DESCRIPTION ⑥

⑤ ***Nature of call***

- [ ] Installation
- [ ] Pre sale repair
- [ ] Preventive maintenance
- [x] Corrective maintenance
- [ ] Other

Location	Component/sequence no.	Category
	T S 0 6 0 7	5
	R 0 0 6 3 1	2
0 0 2 1	9 9 0 0 0 1	4

⑦ ***Job completed*** [x]

Working time ⑧ 1 2 Hrs

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

①Country: 3 2 = Switzerland

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

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

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

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

⑥Coded failure description

Location

☐☐☐☐

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

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

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

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

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

B. Parts not identified in the circuit diagram:

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

Category

☐

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

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

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

1 2 = 1.2 working hours (1 h 12 min.)

Sales and service all over the world

Alger: Bureau de Liaison Philipr.
24 bis, Rue Bougainville,
El Mouradia. Alger; tel.: 565612

Argentina: Philipr Argentina S.A.,
Cassila de Correo 3479, (Central), 1430 Buenos Aires;
tei. 542-2411/51 and 41-4071/78

Australia: Philipr Scientific & Industrial
Equipment Division, Centre Court,
25 - 27 Paul Street. P.O. Box 119,
North Ryde/NSW 2113; tel. 1218888222

Bangla Desh: Philips Bangla Desh Ltd.,
P.D. Box 62; Ramna Dacca, tel. 234280

België/Belgique: Philips & MBLE associated S.A..
Scientific and Industr al Equipment Division,
80 Rue des Deux Gares 1010 Bruxelles;
tel. (2) 523.00.00

Bolivia: Indurtriar Bolivianas Philipr S.A..
Cajón Postal 2964. La Par;
tel.: 351581

Brasil: Philips do Brasil Ltda,
Avenida 9 de Julho 5229, Caixa Portal 8681
CEP 01401 - Sao Paulo (S.P.);
tel. 2821611
Service Centre.
Sistemas Profissionais
Rua Amador Bueno, 474,
Caixa Portal 3159 - S. Amaro,
CEP 04752 - Sto Amaro (S.P.);
tel. (11) 2476522

Canada: Philips Test and Measuring Instruments Inc.,
2315 Steeles Avenue West, Unit 126.
Downsview (Ontario) M3J-3A8;
tel. (416) 665 8410

Chile: Philips Chiléna S.A.,
Division Professional. Avda. Santa Maria 0760,
Casilla Postal 2661, Santiago de Chile: tel 77003

Colombia. Indurtriar Philips de Columbia S.A.,
Calle 13 no. 51–39. Apa tado Aereo 4282,
Bogota; tel. *2600600*

Danmark: Philips Elektronik-Systemer A/S,
Afd. for Industri og Forskning, Strandlodsvej 4,
P.O. Box 1919, 2300 København S;
tel. (1) 572222

Deutschland (Bundesrepublik): Philips GmbH
Unternehmensbereich Elektronik für
Wissenschaft und Industrie, Miramstrasse 87,
Postfach 310 320, 35 Kassel-Bettenhausen;
tei. (561) 5010

Ecuador: Philips Ecuador S.A..
Casilla 4601, Quito; tel. 396100

Egypt: Resident Delegate Office of Phiiipr Industries.
5 Sherif Street. Corner Eloui, PO. Box 1687, Cairo.
tel. 154038'154257

Eire: Philipr Electrical (Ireland) Ltd.,
Newstead, Clonskeagh, Dublin 14; tel (1) 193355

España: Philips Ibérica S.A.E.,
Dptc Aparatos de Medida, Martinez Villergas 2,
Apartado 2065, Madrid 27;
tel (1) 4042200
Service Centre:
Dpto Tec. de Instrumentación,
Calle de Albasanz 75, Madrid 17;
tel. (1) 2047100

Ethiopia: Philips Ethiopia (Priv. Ltd. Co.),
Ras Abebe Areguay Avenue,
P.O.B. 2565.
Addir Ababa; tel. 448300

Finland: See Suomi

France: S.A Philips Industrielle et Commerciale.
Science et Industrie,
105 Rue de Paris, 93 002 Bobigny;
tel. (1) 8301111

Great Britain: Pye Unicam Ltd., York Street,
Cambridge CB1-2PX; tel. (223) 358866
Service Centre
Beddington Lane, Croydon, Surrey CR9-4EN;
tel. (1) 6843670

Greece: See Hellas

Hellas: Philips S.A. Hellénique,
54 Avenue Syngrou, P.O. Box 153,
Athens 403; tel. (1) 9215311

Hong Kong: Philips Hong Kong Ltd.
Hopewell Centre. 27-29th floor.
No. 17, Kennedy Road. P.D. Box 2108,
Wanchai, Hong Kong:
tel. (5) 283298
Service Centre:
Hopewell Centre, 16th floor.
tel. (5) 283575

India: Philips India, Peico Electronics & Electrical Ltd
S&I Equipment. Shivsagar Estate,
Block "A". Dr. Annie Besant Road,
P.O.B. 6598. Worli, Bombay 400 018 (WB);
tel. 391431

Indonesia: P.T. Philips Development Corporation,
Department for Science and Industry Wisma PeDe

Iran: Philips Iran Ltd., P.O.B. 1297, Teheran:
tel. 31208115

Iraq: Philip Iraq W.L.L., Munir Abbar Building.
4th floor, South Gate. P.O.Box 5749, Baghdad:
tel. 8880409

Island: Heimilisteaki SF, Saetúr 8, Reykjavik;
tel. 24000

Islas Canarias: Philips Ibérica S.A.E.,
Triana 132, Las Palmas, Casilla 39-41.
Santa Cruz de Tenerife

Italia: Philipr S.p.A., Sezione S&I/T&M,
Viale Elvezia 2,20052 Monza; tel. (39) 36351

Jamaica: Philipr (Jamaica) Ltd..
Savannah Av. & Washington Blvd.,
P.O. Box 61, Kingston - 6;
tel. 92 - 53041

Japan: See Nippon

Jordan: Philips Delegate Offic
P.O. Box 35268, Amman, tel. 43998

Kenya. Philips (Kenya) Lfd..
01 Kalou Road. Industrial Area,
P.O.B. 30554. Nairobi tel. 557999

Kuwait: Delegate Office of Philips Industries,
P.O. Box 3801, Safat, Kuwait; tel. 428678

Lebanon: Philipr Middle East S A.P L.,
P.O. Box 11670, Beirut; tel. 285748/9

Malaysia: Philips Malaysia Snd Bhd.,
Professional Division.
Lot 2, Jalan 222, Section 14,
P.O Box 2163, Petaling Jaya,
Selangor; tei. 774411/562144

México: Philips Mexicana S.A. de C.V.,
Div. Cientifico Industrial, Calle Durango 161,
Apartado Postal 24–328, Mexico 1(D.F.);
tel. 544-91-99/525-15-40

Morocw: S.A.M.T.E.L., Casa Bandoeng,
B.P. 10896, Casablanca05; tel. 3031921302992

Nederland: Philipr Nederland.
Hoofdgroep PPS, Boschdijk 525. Gebouw VB,
5600 PB Eindhoven; tel. 193333
Service centre;
Technische Service Prof. Activiteiten,
Hurksestraat 42, Gebouw HBK.
5652 AI Eindhoven; tel. 723094/722295

Ned. Antillen: Philips Antillana N V..
Postbus 523, Willemstad, Curaçao,
tel 414071/74

New Zealand: Philips Electrical Industries of N.Z. Ltd..
Scientific and Industrial Equipment Division.
68-86 Jervois Quay. P.G Box 2097,
Wellington C1; tel. 735735

Nigaria: Associated Electroric Products (Nigeria) Ltd..
Ikorodu Road, P.O.B. 1921, Lagos; tel. 900160161

Nippon: NF Trading Co. Ltd..
Kirimoto Bldg. 11-2,
Tsunashima Higashi 1 - Chome, Kohoku-ku,
Yokohama

Norge: Norsk A.S. Philips.
Cept. Industry and Telecommunication
Postboks 1, Manglerud, Oslo 6; tel. [illegible] 680200

Oesterreich: Oesterreichische Philips Industrie GmbH,
Abteilung Industrie Elektronik,
Parttartgasse 34, A-1230 Wien;
tel (222)-841611/15.

Pakistan: Philipr Electrical Co. of Pakistan Ltd.,
El-Markz, M.A. Jinnach Road, P.O.B. 7101.
Karachi 3; tel. 70071

Paraguay: Philipidel Paraguay S.A.,
Av. Artigas 1497,
Casilla de Correo 605, Asunción;
tei. 291924

Perú: Philipr Peruana S.A..
Av. Alfonso Ugarte 1268,
Apartado Aereo 1841, Lima 100; tel. 326070

Philippines Philips Industrial Development Inc.,
2246 Pasong Tamo, Q.O.R.M.C.C. 811.
Makati, Metro, Manila: tel. 868951/868959

Portugal: Philips Portuguesa S.A R L.,
Av. Eng.° Duarte Pacheco 6, Apartado 1331, Lisboa 1000;
tel. (19) 683121
Service Centre:
Servicos Técnicos Profissionais, Outurela,
2795 Linda-a-Velha; tei. (19) 683121

Saoudi Arabia: Delegate Office Philips Industries,
Sabreen Bldg., Airport Road, P.O. Box 9844,
Riyadh. tel. 4777808/4778463

Schweiz-Suisse-Svizzera: Philip: A.G.,
Allmendstrasse 140, Postfach, CH-8027 Zurich;
tel. (1) 4882211/4882629

Singapore: Philipr Singapore Private Ltd.,
Lorong 1, Tao Payoh, 1st floor,
P.O. Box 340, Toa Payoh Central Post Office

South Africa: South African Philips (Pty) Ltd.,
2 Herb Street, New Doornfontein, P.O.B. 7703.
Johannesburg 2000; tel. (11) 6140411

South-Korea: Philips Electronics (Korea) Ltd..
G.P.O. Box 3680, Seoul; tel. 794 5011/5

Suomi: Oy Philips AB.,
Kaivokatu 8,
P.O. Box 10255,
SF-00101 Helsinki 10; tel. 17271
Service Centre:
P.O. Box 11, SF-02631 Espoo 63:
tel. (0) 523122

Sverige: Philips Försäljning AB,
Div. Industrielektronik, Lidingövägen 50,
Fack, S11584 Stockholm: tel. (8) 635000

Syria: Philips Moyen-Orient S.A.R.L., Rue Fardoss 79,
Immeuble Kassas and Sadate, B.P. 2442, Damas;
tel. 118605/221650

Taiwan: Philips Taiwan Ltd.,
San Min Building, 57-1 Chung Shan North Rd., Sec. 2,
P.O. Box 22978, Taipei;
tel. 12) 5631717

Tanzania: Philipr (Tanzania) Ltd.,
P.O. Box. 20104. Dar es Salaam: tel. 29571

Thailand: Philips Electrical Co. of Thailand Ltd..
283 Silom Road. P.D. Box 961, Bangkok 5;
tel. 233-6330/9

Tunisia: S.T.I.E.T.. 32 bir. Rue Ben Ghedhahem,
Tunis; tel. 244268

Türkiye: Turk Philips Ticaret AS.,
Posta Kutusu 504, Beyoglu,
Istanbul 1; tel. 435910

United Arab Emirates: Philip, Middle East B.V.,
Dubai International Trade Centre. Level 11.
P.O. Box 2969, Dubai; tel. 475267

Uruguay: Indurtriar Philips del Uruguay S.A..
Avda Uruguay 1287, Casilla de Correo 294,
Montevideo: tel. 915641

U.S.A.:
Philips Test and Measuring Instruments Inc.,
California, Garden Grave 92645
12882 Valley View Street. Suite 9:
tel.: (213) 594-8741/(714) 898-5000
California. Milpitas 95035
489 Valley Way:
tel. 14081946-6722
Florida. Winter Park 32789
1850 Lee Road. Suite 229;
tel. (305) 628-1711
Georgia, Norcross 30071
1094 Peachtree Industrial Blvd.. Suite 220;
tel. (404) 5860238
Illinois. Itasca 60143
500 Park Blvd., Suite 1170;
tel. 131217730616
Massachusetts, Woburn 01801
21 Olympia Avenue;
tel. (617) 935-3912
Minnesota, Minneapolis 55420
7801 Metro Parkway, Suite 109;
tel. (612) 854-2426
New Jersey, Mahwah 07430
85 McKee Drive:
tel. (201) 529-3800. Toll-free (800) 631.7112

Venezuela: Industrias Venezolanas Philips S.A..
Av. Ppal de los Ruices,
Apartado Aereo 1167, Caracas 107;
tel. (2) 393811/353533

Zaire: S.A.M.E./S.Z.A.R.L., B.P. 16636, Kinshasa:
tel. 31693

Zambia: Philips Electrical Zambia Ltd..
Mwenbeshi Road. P.O.B. 31878, Lusaka;
tel.218511

Zimbabwe: Philips Electrical (PVT) Ltd..
62 Umtali Road, P.O. Box 994. Beverley/Harare;
tel. 47211

For information on **change of address:**
Philipr Export B.V..
Scientific and Industrial Equipment Division.
Test and Measuring Instruments, Building TO III-4, P.O. Box 218,
5600 MD Eindhoven - The Netherlands

For **countries not listed here:**
Philips Export B.V., S&I Export,
Test and Measuring Instruments. Building TQIII-3, P.O. Box 218,
5600 MD Eindhoven - The Netherlands;
Tel. (40) 782285