75 MHz Portable Dual-Channel Oscilloscope

PM3256/PM3256U

Service Manual

4822 872 05307
851215/1/06

I&E

Industrial & Electro-acoustic Systems Division

PHILIPS

Industrial &
Electro-acoustic Systems

PHILIPS

75 MHz Portable Dual-Channel Oscilloscope

PM3256/PM3256U

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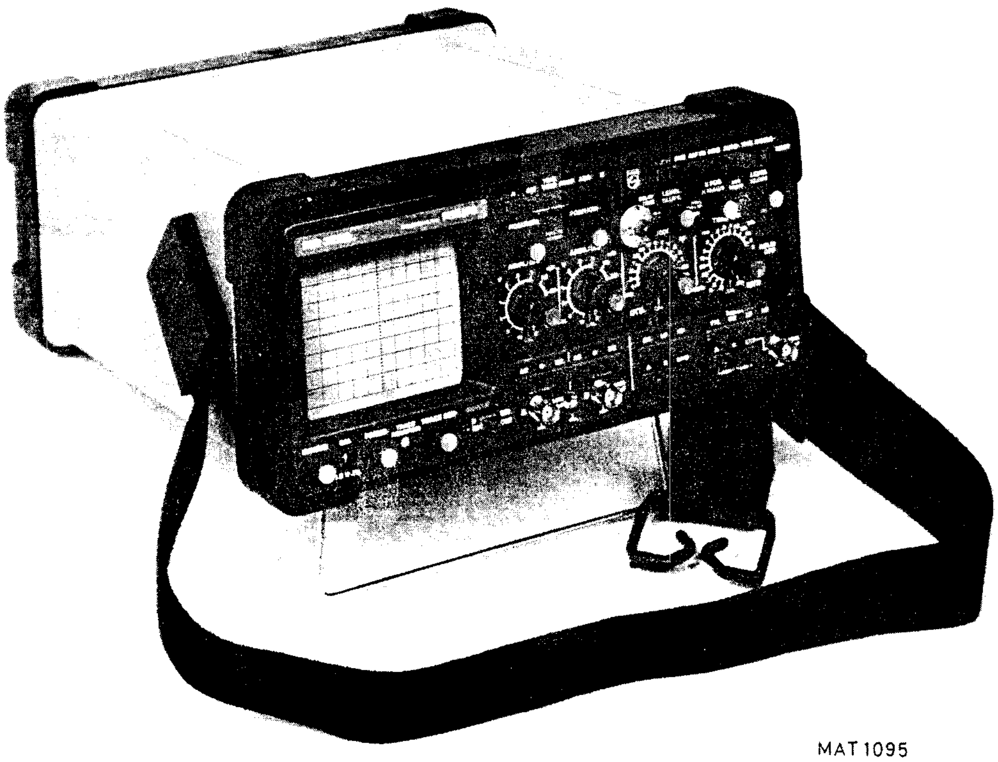

MAT 1095

Also published: Operating Manual PM3256

WARNING: These servicing instructions are for use by qualified personal only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the Operating Instructions unless you are fully qualified to do so.

PHILIPS

IMPORTANT

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

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

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0. SAFETY INSTRUCTIONS

Read these pages carefully before installation and use of the instrument.

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition.
Adjustment, maintenance and repair of the instrument shall be carried out only by qualified personnel.

0.1. SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual.
Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

0.2. CAUTION AND WARNING STATEMENTS

CAUTION: **is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.**

WARNING: **calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.**

0.3. SYMBOLS

	High voltage $\geqslant$ 1000V	(red)
	Life part	(black/yellow)
	Read the operating instructions	(black/yellow)
	Protective earth (grounding) terminal	(black)

0.4. IMPAIRED SAFETY-PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians.
Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

0.5. GENERAL CLAUSES

0.5.1. 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 accessible terminals which can be dangerous to live.**

0.5.2. The instrument shall be disconnected from all voltage sources before it is opened.

0.5.3. Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

0.5.4. WARNING: (only PM3256U) Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous.
Intentional interruption is prohibited.

WARNING: (only PM3256) It must be born in mind that in all measurements the frame ground of the oscilloscope is raised to the same potential as that of the measuring ground probe connection.
Neither the probe's ground lead nor the frame ground shall be connected to live potentials.

0.5.5. Components which are important for the safety of the instrument may only be renewed by components obtained through your local Philips organisation. (See also section 6).

0.5.6. After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in Section 6 have to be performed.

1. CHARACTERISTICS

A. Performance Characteristics

- Properties expressed in numerical values with stated tolerance are guaranteed by PHILIPS.
  Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).

B. Safety Characteristics

This appartus has been designed and tested in accordance with:

PM3256U : Safety Class I requirements of IEC Publication 348 Safety Requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B for "U" instruments.

PM3256 : Safety Class II requirements of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus for "Double Insulated" instruments.

The instrument has been supplied in a safe condition.

C. Initial Characteristics

- Overall dimensions:
  - Height : 143mm
  - Width : 305mm
  - Depth : 418mm incl. cover and feet
- Maximum Weight (Mass) : 90N (≈ 9 kg)
- Operation position:
  a) Horizontally on bottom feet
  b) Vertically on rear feet
  c) With the tilting bracket folded down (sloping position)

1.1. CATHODE RAY TUBE

C.R.T. type	Rectangular tube face, mesh type, post-accelerator, metal-backed phosphor
Total acceleration	10 kV
Graticule	Internal 8 x 10 div. each equals 8 mm, dotted lines on 1,5 and 6,5 div. from the top of the graticule, for rise-time measurements
Trace rotation	Screwdriver adjustment (front panel)

1.2. VERTICAL OR Y-AXIS

Display modes	– Two identical channels – Channel A only – Channel B only – Trigger view only – Channels A and B chopped – Channels A and B and trigger view chopped – Channels A and B and trigger view alternated – Channels A and B alternated – Channels A and B added
Polarity inversion	Channels A and B can be inverted
Chopping frequency	≈ 500 kHz
CMRR	40 dB at 1 MHz after adjustment at low frequency
Dynamic range 10 MHz 75 MHz	24 div. 7 div.
Bandwidth	DC: 0 ... ⩾ 75MHz* AC: 2Hz ... ⩾ 75MHz* * 2, 5, 10mV: DC: 0 ... ⩾ 70MHz AC: 2Hz ... ⩾ 70MHz
Rise time	⩽ 4,7ns (in settings 2, 5, 10mV: ⩽ 5ns)
Pulse aberrations, input rise time ⩽ 1ns, + and –2,5 div. from screen centre settings: 20 mV/div ... 10 V/div 2 mV/div ... 10 mV/div	 ⩽ 3 % (⩽ 4 % p-p) } In INVERT mode additional 1% ⩽ 4 % (⩽ 5 % p-p) }
Deflection coefficients	2 mV...10 V/div calibrated in 1-2-5 steps.
Non-calibrated continuous control	1 : > 2,5
Vert. positioning	+ or –8 div. from screen centre
Input impedance	1 MΩ (± 1 %) in parallel with 25 pF (± 2.5 pF). Input capacitanes are adjusted in such a way that 10 : 1 attenuator probe after being adjusted at one channel can be applied to the second channel or ext. trig. input without readjustment.
Input coupling	AC, 0, DC
Max. rated input voltage	400V (d.c. + a.c. peak) Test voltage for 1 min. 570V (a.c./r.m.s.) 50Hz
Deflection accuracy	± 3 %
Trace jump: continuous control	⩽ 0,2 div.
attenuator control	⩽ 0,2 div; except for 10 mV/div. → 20 mV/div.: ⩽ 0,4 div.
normal/invert control	⩽ 0,5 div. (only in settings 20 mV/div...10 V/div)
Cross talk	40 dB at 10 MHz
Visible signal delay	Built-in delay-line permits viewing at leading edge of input signal

1.3. TRIGGER VIEW

Bandwidth	50 MHz (INT.) 60 MHZ (EXT.)
Sensitivity A or B	Settings of AMPL./DIV switches.
Sensitivity EXT. :	200 mV/div. + or –3 %
EXT. TTL :	200 mV/div. + or –3 %
EXT. TV (TV option) :	200 mV/div. + or –3 %
Pulse aberrations via EXT.	≤ 6 % (≤ 8 % p-p)
Time delay between vertical input displayed via A or B and external input displayed via trigger view	≤ 10 ns
Time delay between vertical input displayed via A or B and trigger view of A or B	≤ 15 ns

1.4. HORIZONTAL OR X-AXIS

Display	– Main time-base – Main time-base intensified – Delayed time-base – Alternated between main time-base intensified and delayed time base – X-Y operation
Trace separation adjustment in alternate time-base mode	MTB: between 0 and +2 div. and DTB: between 0 and –2 div.
Horizontal positioning range	+ or –5 div.
Intensified ratio	Internal adjustable

1.4.1. Triggering of the main time-base

Source	Y_A, Y_B, composite, external and line
Coupling	DC, LF, HF, TTL Optional TV or ECL instead of TTL
Mode	Automatic, normal
Trigger bandwidth in normal mode DC:	0 ... 100 MHz
LF:	2 Hz ... 25 kHz
HF:	25 kHz ... 100 MHz
Trigger sensitivity: Internal	0,5 div. } ≤ 10 MHz
External	100 mV } ≤ 10 MHz
Internal	1,2 div. } ≤ 100 MHz
External	300 mV } ≤ 100 MHz
Internal TTL	TTL level in 2 V/div.
External TTL	TTL level with 10 : 1 probe connected
Level range	
In normal internal mode	+ or –8 div
In normal external mode	+ or –1,6 V
In auto mode	Related to peak-to-peak value of the trigger signal
In TTL mode and in optional TV and ECL mode	Fixed level
Triggering slope	+ or –
External input impedance	1 MΩ ± 1 % in parallel with 25 pF ± 2,5 pF (See also for additional information the channel input impedance)
Max. rated input voltage	400V (d.c. + a.c. peak) Test voltage for 1 min. 570V (a.c./r.m.s.) 50Hz.

1.4.2. Main time-base

Time coefficients		0,5 s/div ... 50 ns/div 22 calibrated steps in 1-2-5 sequence
Continuous non-calibrated control		1 : > 2,5
Magnifier		x10 calibrated
Coefficients error		⩽ 3 % (⩽ 5 % including magn.)
Mode		AUTO, TRIG., SINGLE
Variable hold-off time		The sweep hold-off time can be varied by a factor of 10
Not trig'd LED		LAMP is on when there is no trigger signal. In single shot mode LAMP is on when sweep is waiting for trigger signal.

1.4.3. Triggering of the delayed time-base

Source		Y_A, Y_B
Coupling		DC, LF, HF
Trigger bandwidth	DC: LF: HF:	0 ... 100MHz 2Hz ... 25kHz 25kHz ... 100MHz
Trigger sensitivity		0.5 div ⩽ 10MHz 1,3 div. ⩽ 100MHz
Level range		+ or –8 div
Triggering slope		+ or –

1.4.4. Delayed time-base

Operation	Delayed time-base starts either immediately after delay time or is triggerable after the delay time
Time coefficients	1 ms/div ... 50 ns/div 14 calibrated steps in 1-2-5 sequence
Continuous non-calibrated control	1 : > 2,5
Coefficients error	⩽ 3 % (⩽ 5 % including magn.)
Delay time	Variable between 0,00 and 10,00 div. of the main time base with a minimum of 60ns
Incremental delay time error	0,5% (measured at 15°C - 25°C)
Delay time jitter	1 : > 20.000

1.5. X-Y-OPERATIONS

Mode		Y_A, Y_B, External, Line
Deflection coefficients		In channel A or B mode as selected by A or B AMPL./div ± 10 % In external mode 0,2 V/div. ± 10 % In line mode 8 div. at 50 Hz
Bandwidth starting at 8 div at 1 kHz	DC: LF: HF:	DC ... 100kHz (-0,5 dB) 2 Hz ... 25 kHz 25 kHz ... 100 kHz
Phase shift between X and Y ampl.		⩽ 3° at 100 kHz in DC mode
Dynamic range		20 div at 100 kHz

1.6. CALIBRATION UNIT

Amplitude	1,2 $V_{p\text{-}p}$ ± 1 %
Frequency	approx. 2 kHz square-wave, output is short-circuit protected

1.7. POWER SUPPLY

Mains voltage ranges	a.c.:	110 V + 20 %, –10 % 220V, 240 V ± 10 %
	battery supply :	20 V...28 V
Mains frequency		50 Hz...400 Hz ± 10 %
Power consumption		38 W from a.c. 30 W from battery supply, 1,5 A max.

1.8. Z-MOD.

TTL compatible
"1" is normal intensity
"0" is blanked

1.9. OPTIONS

Automatic TV trigger
Automatic ECL trigger
Sweep out MTB
Gate out MTB
Gate out DTB

1.10. ENVIRONMENTAL CHARACTERISTICS

The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.
Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO–ACOUSTIC SYSTEMS DIVISION, 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 IEC 68 Db
Bump	30 g half sine, 11 ms duration, 3 shocks per direction with a total of 18
Vibration	15 minutes in each of 3 directions, 5-55 Hz; 0,7 $mm_{p\text{-}p}$ and 4 g max. acceleration

Altitude

Limit range of operation	5000 m (in open air)
Limit range of transport	15000 m (in open air)
Recovery time	30 minutes if amb. temp. is raised from –10 °C to + 20 °C at 60 % relative humidity
Electromagnetic interference	Meets VDE 0871 and VDE 0875 grenzwertklasse B

* When operated with pouch:
Ambient temperature
Rated range of use 0 °C ... +30 °C
Limit range of operation –10 °C ... +45 °C

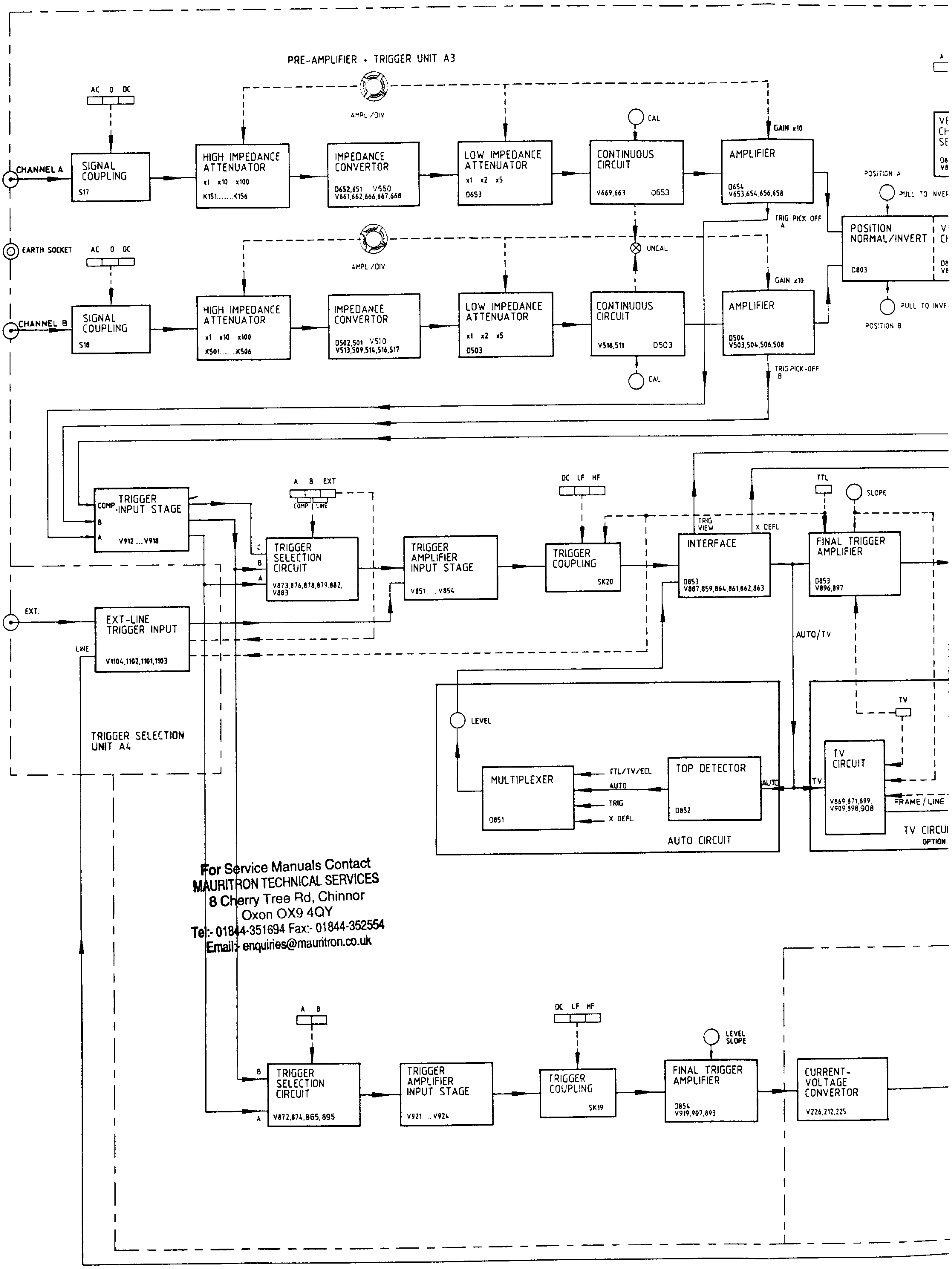
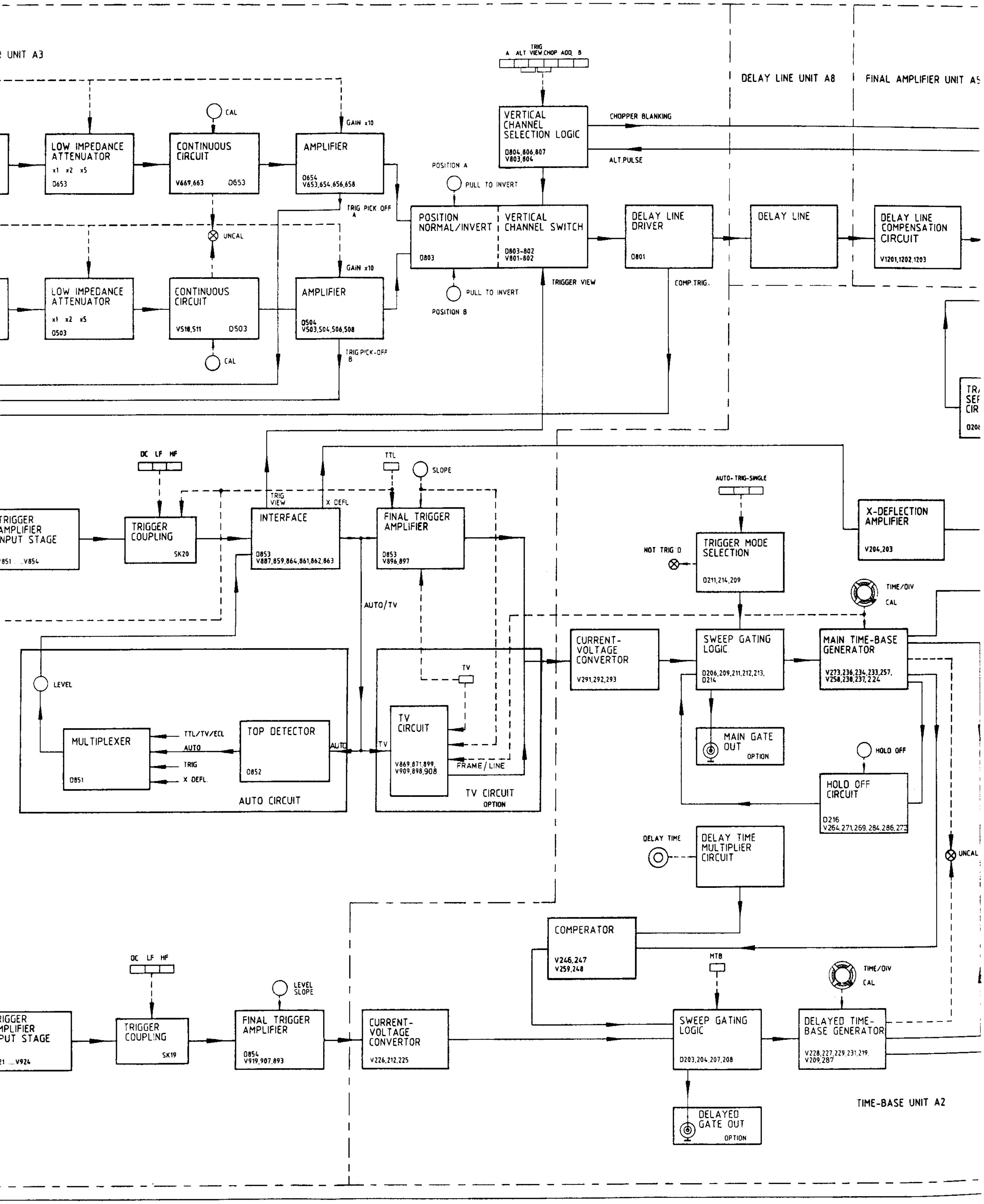
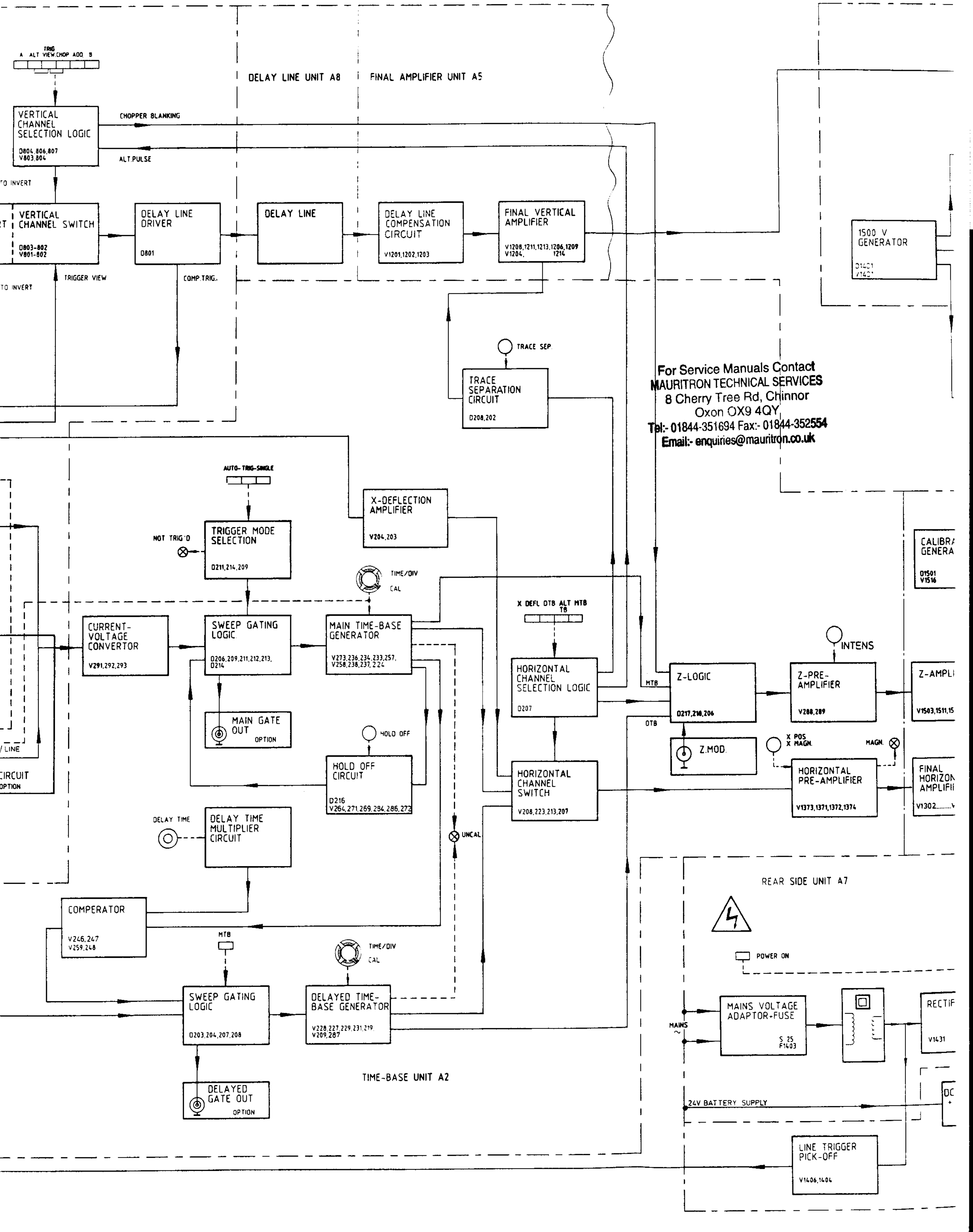
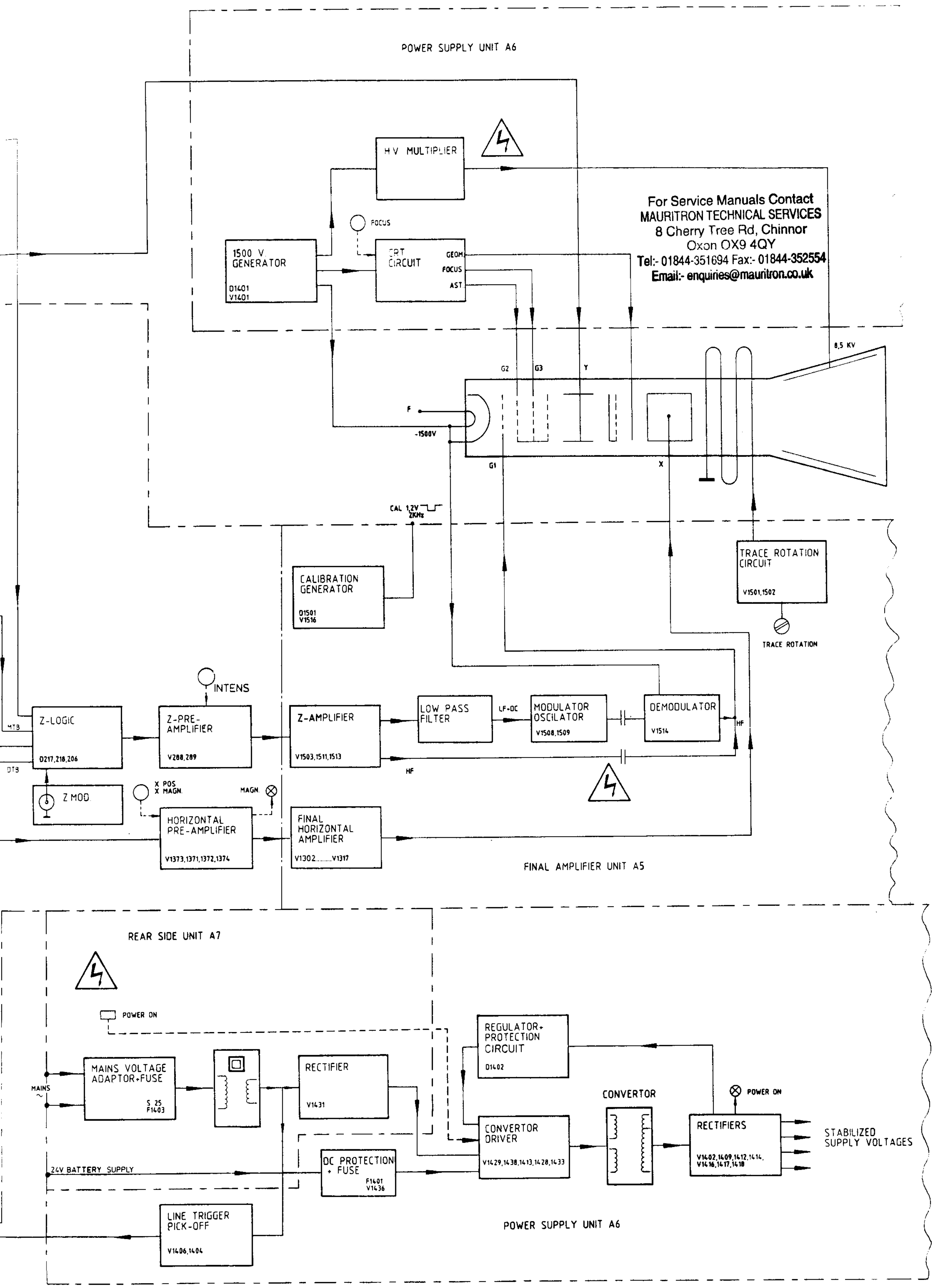


Fig. 2.1 Blockdiagram.



UNIT A3
DELAY LINE UNIT A8
FINAL AMPLIFIER UNIT A9
TRIG A ALT VIEW CHOP ADD B
VERTICAL CHANNEL SELECTION LOGIC
D804,806,807 V803,804
CHOPPER BLANKING
ALT.PULSE
LOW IMPEDANCE ATTENUATOR
x1 x2 x5
D653
CONTINUOUS CIRCUIT
V669,663 D653
CAL
AMPLIFIER
GAIN x10
D654 V653,654,656,658
TRIG PICK OFF A
UNCAL
POSITION A
PULL TO INVERT
POSITION NORMAL/INVERT
D803
VERTICAL CHANNEL SWITCH
D803-802 V801-802
DELAY LINE DRIVER
D801
DELAY LINE
DELAY LINE COMPENSATION CIRCUIT
V1201,1202,1203
LOW IMPEDANCE ATTENUATOR
x1 x2 x5
D503
CONTINUOUS CIRCUIT
V518,511 D503
AMPLIFIER
D504 V503,504,506,508
POSITION B
TRIGGER VIEW
COMP.TRIG.
TRIG PICK-OFF B
DC LF HF
TRIGGER AMPLIFIER INPUT STAGE
V851 ... V854
TRIGGER COUPLING
SK20
TRIG VIEW
X DEFL
INTERFACE
D853 V887,859,864,861,862,863
TTL
SLOPE
FINAL TRIGGER AMPLIFIER
D853 V896,897
AUTO-TRIG-SINGLE
X-DEFLECTION AMPLIFIER
V204,203
NOT TRIG'D
TRIGGER MODE SELECTION
D211,214,209
TIME/DIV
CAL
AUTO/TV
CURRENT-VOLTAGE CONVERTOR
V291,292,293
SWEEP GATING LOGIC
D206,209,211,212,213, D214
MAIN TIME-BASE GENERATOR
V273,236,234,233,257, V258,238,237,224
LEVEL
TV
MULTIPLEXER
D851
TTL/TV/ECL
AUTO
TRIG
X DEFL.
TOP DETECTOR
D852
AUTO CIRCUIT
TV CIRCUIT
V869,871,899, V909,898,908
FRAME/LINE
TV CIRCUIT OPTION
MAIN GATE OUT OPTION
HOLD OFF
HOLD OFF CIRCUIT
D216 V264,271,269,284,286,273
DELAY TIME
DELAY TIME MULTIPLIER CIRCUIT
UNCAL
COMPERATOR
V246,247 V259,248
MTB
DC LF HF
TRIGGER AMPLIFIER INPUT STAGE
V921 ... V924
TRIGGER COUPLING
SK19
LEVEL SLOPE
FINAL TRIGGER AMPLIFIER
D854 V919,907,893
CURRENT-VOLTAGE CONVERTOR
V226,212,225
SWEEP GATING LOGIC
D203,204,207,208
DELAYED TIME-BASE GENERATOR
V228,227,229,231,219, V209,287
TIME-BASE UNIT A2
DELAYED GATE OUT OPTION


DELAY LINE UNIT A8
FINAL AMPLIFIER UNIT A5
TRIG A ALT VIEW CHOP ADD B
VERTICAL CHANNEL SELECTION LOGIC
D804,806,807
V803,804
CHOPPER BLANKING
ALT.PULSE
TO INVERT
VERTICAL CHANNEL SWITCH
D803-802
V801-802
DELAY LINE DRIVER
D801
DELAY LINE
DELAY LINE COMPENSATION CIRCUIT
V1201,1202,1203
FINAL VERTICAL AMPLIFIER
V1208,1211,1213,1206,1209
V1204, 1214
TRIGGER VIEW
COMP.TRIG.
1500 V GENERATOR
TRACE SEP.
TRACE SEPARATION CIRCUIT
D208,202
AUTO-TRIG-SINGLE
X-DEFLECTION AMPLIFIER
V204,203
NOT TRIG'D
TRIGGER MODE SELECTION
D211,214,209
TIME/DIV
CAL
CURRENT-VOLTAGE CONVERTOR
V291,292,293
SWEEP GATING LOGIC
D206,209,211,212,213,
D214
MAIN TIME-BASE GENERATOR
V273,236,234,233,257,
V258,238,237,224
X DEFL DTB ALT MTB TB
HORIZONTAL CHANNEL SELECTION LOGIC
D207
MTB
DTB
Z-LOGIC
D217,218,206
INTENS
Z-PRE-AMPLIFIER
V288,289
Z-AMPL
V1503,1511,15
CALIBRA GENERA
D1501
V1516
MAIN GATE OUT
OPTION
HOLD OFF
HOLD OFF CIRCUIT
D216
V264,271,269,284,286,272
HORIZONTAL CHANNEL SWITCH
V208,223,213,207
Z.MOD.
X POS
X MAGN.
MAGN.
HORIZONTAL PRE-AMPLIFIER
V1373,1371,1372,1374
FINAL HORIZON AMPLIFI
V1302
LINE
CIRCUIT
OPTION
DELAY TIME
DELAY TIME MULTIPLIER CIRCUIT
UNCAL
COMPERATOR
V246,247
V259,248
REAR SIDE UNIT A7
MTB
POWER ON
SWEEP GATING LOGIC
D203,204,207,208
DELAYED TIME-BASE GENERATOR
V228,227,229,231,219
V209,287
MAINS
MAINS VOLTAGE ADAPTOR-FUSE
S 25
F1403
RECTIF
V1431
DELAYED GATE OUT
OPTION
TIME-BASE UNIT A2
24V BATTERY SUPPLY
DC
LINE TRIGGER PICK-OFF
V1406,1404


POWER SUPPLY UNIT A6
HV MULTIPLIER
FOCUS
1500 V. GENERATOR
D1401
V1401
CRT CIRCUIT
GEOM
FOCUS
AST
8,5 KV
G2
G3
Y
F
-1500V
G1
X
CAL 1,2V
2KHz
CALIBRATION GENERATOR
D1501
V1516
TRACE ROTATION CIRCUIT
V1501,1502
TRACE ROTATION
INTENS
MTB
Z-LOGIC
D217,218,206
DTB
Z-PRE-AMPLIFIER
V288,289
Z-AMPLIFIER
V1503,1511,1513
LOW PASS FILTER
LF+DC
MODULATOR OSCILATOR
V1508,1509
DEMODULATOR
V1514
HF
HF
Z MOD.
X POS
X MAGN.
MAGN.
HORIZONTAL PRE-AMPLIFIER
V1373,1371,1372,1374
FINAL HORIZONTAL AMPLIFIER
V1302.........V1317
FINAL AMPLIFIER UNIT A5
REAR SIDE UNIT A7
POWER ON
MAINS
MAINS VOLTAGE ADAPTOR+FUSE
S 25
F1403
RECTIFIER
V1431
REGULATOR+ PROTECTION CIRCUIT
D1402
CONVERTOR
POWER ON
CONVERTOR DRIVER
V1429,1438,1413,1428,1433
RECTIFIERS
V1402,1409,1412,1414,
V1416,1417,1418
STABILIZED SUPPLY VOLTAGES
24V BATTERY SUPPLY
DC PROTECTION + FUSE
F1401
V1436
LINE TRIGGER PICK-OFF
V1406,1404
POWER SUPPLY UNIT A6

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 A3, DELAY LINE UNIT A8 and FINAL AMPLIFIER UNIT A5.
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 CIRCUIT, 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 swiching 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 A3. Both the main time-base and the delayed time-base are located on the TIME–BASE UNIT A2.
The FINAL HORIZONTAL AMPLIFIER and the Z-AMPLIFIER are situated on the FINAL AMPLIFIER UNIT A5.

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 AMPLIFIER INPUT STAGE 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:

TTL	: ± 0,7 divisions
AUTO	: determined by TOP DETECTOR
TRIG	: ± 8 divisions
X DEFL	: 0 divisions (LEVEL inoperative)

If the instrument is provided with the TV option, the TTL pushbutton will function as the TV 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 DEFLECTION 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 A2.
The Z-AMPLIFIER, CALIBRATION GENERATOR and TRACE ROTATION CIRCUIT are located on the FINAL AMPLIFIER UNIT A5. The supply voltages for the c.r.t. are derived from the POWER SUPPLY UNIT A6.

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 Z-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 G1 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 DEMODULATOR stage to retrieve the original signal.
The original h.f. and d.c. + l.f. signals are recombined on the grid G1

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 +14 V 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. 8.2)

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 (C694) is inserted in the signal path R758// C695-C694-R755-R728 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.
The HF part of the input signal is applied to the attenuator via C697.

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 via R758, R760 and R728. Thus the full bandwidth of the oscilloscope is available. In this mode the HF part of the input signal is applied to the attenuator via C697.

If the 0 pushbutton is depressed, the input signal is isolated from the attenuator and the attenuator input is earthed via R728 and S17B points 5 and 6, as a reference for calibration or trace centreing, etc.
Blocking capacitor C694 is discharged via R757, R728 and S17B points 5 and 6 when 0 is selected.

2.2.2. Attenuator and Impedance Converter (see Fig. 2.2. and 8.2)

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.
Reed relay K653 is activated in the AMPL/DIV (S9) positions 2 mV/DIV...100 mV/DIV (x1 stage).
In the 0,2 V/DIV...1 V/DIV positions of S9, reed relays K651, K652 are activated. The input signal is x10 attenuated by voltage divider R674, R704.
When positions 2 V/DIV...10 V/DIV are selected, reed relays K654, K656 are activated, and the input signal is x100 attenuated by voltage divider R759, R732.

The low-impedance attenuator reduces the gain by x1, x2 and x5, using voltage dividers R723, R764, R763, R767 and R766, selected by FET switches D653
In the x1 positions the FET switch D653 (9, 11, 12) is conductive (x5 attenuation).
In the x2 positions D653 (1, 3, 4) conducts (x1 attenuation) and in the x5 positions, D653 (5, 6, 8) (x 2,5 attenuation).
The AMPL/DIV switch S9 controls the FET switches via resistors R721, R722 and R684. These resistors have high-ohmic values to eliminate parasitic capacitances on the FET gates, to prevent loss of bandwidth. Trimmers C686 and C662 are adjustable to obtain constant input capacitance in all attenuator settings.
The high-impedance attenuator sections are made independent of input frequency (i.e. the capacitive attenuation for a.c. signals is adjusted to the resistive attenuator for d.c. signals) with trimmers C687, C676 and C663.

Impedance convertor (see Fig. 2.2 and 8.2)

The input signal is fed via FET V661 (in source-follower configuration), transistors V666, V667 and V668 to the low-impedance attenuator.
The special type FET V661, 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 R710.
The input signal is applied to the other gate.
The diodes inside this FET protect the input source follower of the impedance convertor against excessive voltage swings.
The l.f. part of the signal is fed to the inverting input, pin 2, of D652 via the LF gain potentiometer R719.
This l.f. signal is compared with a d.c. voltage on pin 3 of D652 that is adjustable with R653 (attenuator balance).
The output of D652 (frequencies up to 300 Hz, determined by R683 and C661) is routed to the voltage divider R676, R678.
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 D651.
To reduce distortion originated in the current source V662, transistor V660 is mounted between the low-ohmic output of D651 and the base of V662.
The collector of V660 is high-ohmic, so the distortion on the base and on the emitter of V662 is equal and in antiphase, so it is eliminated.
If the feedback l.f. signal is, for example, too small, the correction amplifier will drive transistor V662 so that the amplitude of the l.f. part of the input signal is compensated.
Potentiometer R719 permits adjustment of the l.f. feedback gain.
The d.c. offset of the operational amplifiers D652, D651 can be compensated by preset R653 (A ATT. BAL.).

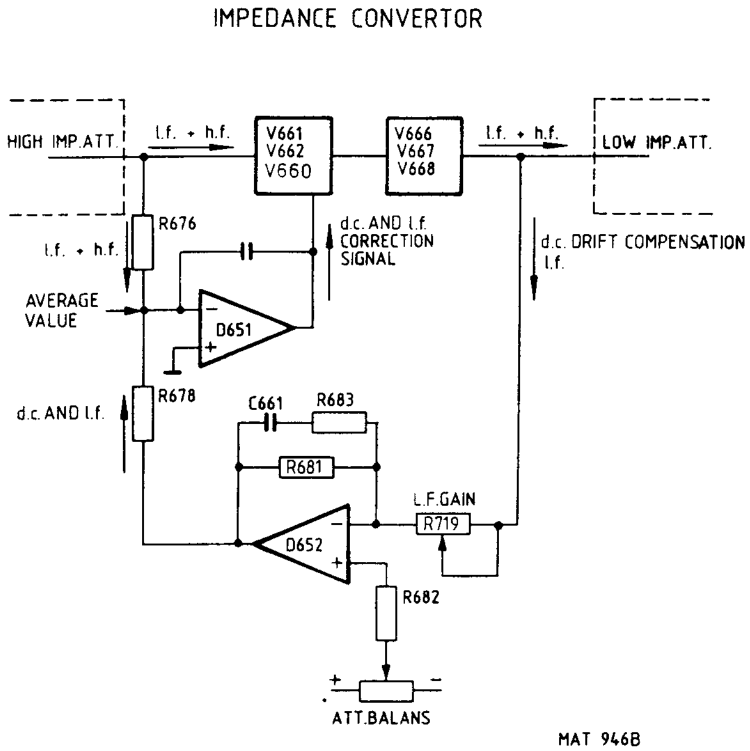


Fig. 2.2 Impedance convertor.

Continuous Control Circuit (see Fig. 2.3 and 8.2)

The output signal of the low-impedance attenuator is fed to the integrated circuit D654 (3,6) via the continuous circuit comprising FET D653 (13, 14, 16).
This FET is located between the signal path, pin 6 of D654 and earth, via resistor R686, This resistor compensates the output impedance of the low-impedance attenuator (50 Ω) and the impedance of the selected FET switch (30 Ω), as shown in Fig. 2.3.
This compensation is necessary to obtain an equal bias current for the inputs (6,3) of integrated circuit D654. The continuous control R7 drives the FET (pin 14) more, or less conductive via transistor V669 and resistors R724, R688, R687.
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 V655, 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 increases 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 D654.
The CAL position of the CONT. control can be adjusted with the CAL CONT. potentiometer R743 that controls the current I through transistor V663. The CONT. control range can be adjusted with potentiometer R750.

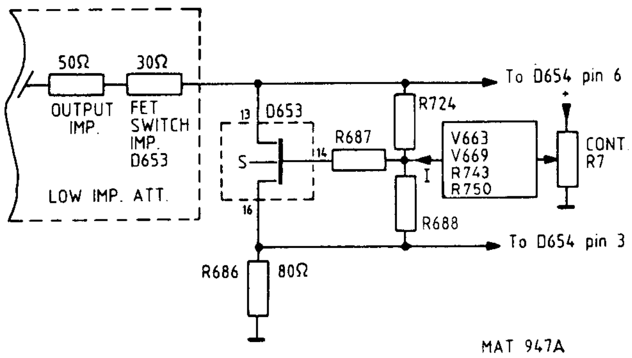


Fig. 2.3. Continuous control circuit

2.2.3. Amplifier

The channel A trigger signals for both time-bases are picked-off from pins 14 and 15 of integrated circuit D654.
The circuit of D654 (known as a Cherry-stage) converts the voltage input signal into a current output signal (pins 12 and 13). Transistor V653 serves as a current source for D654.
In the three most sensitive AMPL/DIV positions (2,5,10 mV/DIV) the amplifier has a gain of ten, controlled via D654, pin 2, from the AMPL/DIV switch.
Potentiometer R672 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 R727.
The supply voltage of D654 is applied to pin 9 via transistor V654.
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 R578 to equalise the x1 gain of both vertical channels.
From the amplifier D654 (pins 12 and 13) the output current signal is routed to the vertical channel switch via transistors V656 and V658. These transistors function as a current mirror and also compensate for trace shift when the signal is inverted (POSITION control pulled). Potentiometer R701 (NORMAL/INVERT BAL) provides the shift compensation.

VERTICAL DISPLAY MODE SWITCH	X501						D806				A D804	B D804	TRIG VIEW
S1	B4	A1	A3	A4	B2	A2	P5	P6	P7	P9	P8	P11	P3
A	*	*	0	1	0	1	1	0	0	1	$\boxed{1}$	0	0
B	0	1	1	0	0	1	0	1	0	1	0	$\boxed{1}$	0
TRIG VIEW	1	0	1	0	0	1	0	1	1	0	0	0	$\boxed{1}$
CHOP	0	1	1	1	1	1	1→0 0→1	0→1 1→0	0	1	1→0 0→1	0→1 1→0	0 0
ALT	0	1	1	1	0	0	1→0 0→1	0→1 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	$\boxed{1}$	$\boxed{1}$	0
CHOP + TRIG VIEW	1	1	1	1	1	1	1 0 0	0 1 1	1 1 0	0 0 1	$\boxed{1}$ 0 0	0 0 $\boxed{1}$	0 $\boxed{1}$ 0
ALT + TRIG VIEW	1	1	1	1	0	0	1 0 0	0 1 1	1 1 0	0 0 1	$\boxed{1}$ 0 0	0 0 $\boxed{1}$	0 $\boxed{1}$ 0

* = don't care
$\boxed{1}$ = vertical channel is selected

Fig. 2.4 Vertical channel selection logic

2.2.4. Vertical Channel Selection Logic

Vertical channel switches D802 and D803 are controlled by the vertical channel selection logic (D804, D806, D807) 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 D804 is H in this mode, opening the signal path for channel A in integrated circuit D803.
Signals on D803 pins 5 and 6 are routed to output pins 13, 14 of D803.

B depressed: Pin 11 of D804 is at H level in this mode,opening the signal path for channel B in integrated circuit D803.
Signals on D803 pins 3 and 4 are routed to the output (pins 13,14) of D803.

TRIG VIEW depressed: Pin 3 of D804 is H in this mode, opening the path for trigger view signals in integrated circuit D802.
The trigger view signal from the INTERFACE of the trigger amplifier (V861, V862) is routed to D802, pins 5 and 6, via transistors V801, V802.
In this mode, the TRIG VIEW signal is fed to the DELAY LINE DRIVER via the outputs (13,14) of D802.

CHOP depressed: Pins 8 and 11 of D804 are alternately H and L at a fixed frequency of 500 kHz approx., generated by the chopper oscillator, consisting of transistor V804 and two NAND gates of D807 (11,12,13)(4,5,6) and capacitor C832.
If D804-6 is at H level, transistor V803 starts the chopper oscillator. Transistor V804 is blocked and C832 charges via R861.
If pins 12 and 13 of D807 are both H, its output goes to an L level, giving an H on pin 6 of D807. This H signal is fed back to the base of V804, which conducts and discharges C832 to give an L on D807-12.
Pin 6 of D807 goes L and blocks transistor V804, etc.
The chopper signal is applied to the clock inputs of the flip-flops D806 via D807, pins 10 and 8. The alternate pulse applied at D807-9 is overruled.
The J and K inputs (pins 2 and 3) and the preset and clear inputs (pins 4 and 15) of D806 are at level H, so this flip-flop switches on the chopper frequency applied to the clock input.
The input pin 10 of D806 is L and pin 14 is H, so output pin 7 is L in this mode, resulting in a level L on D804-3 (TRIG VIEW is off).

ALT depressed: In the ALT mode, the chopper oscillator is switched off (D804-6 = L).
However, D807-10 is H, which means that the alternate pulses from the HORIZONTAL CHANNEL SELECTION LOGIC are applied to the clock inputs of flip-flops D806 (pins 1 and 13), which make the D804 outputs (pins 8 and 11) alternately H and L.

ADD depressed: With ADD selected, D804 outputs 8 and 11 are both at H level.
Channel A and B signals are selected via pins 10 and 11 of D803, and are added in integrated circuit D803.

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 chopper frequency is applied to the clock inputs of flip-flops D806 (pins 1 and 13).
The outputs of D804 (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 D807-10 is at level H.
The alternate pulses are applied to the clock inputs of flip-flop D806, 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 D802 and D803 (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 0Q0020 is controlled by the outputs of D804 (pins 8,11,3) as follows:

0Q0020 pins 10	11	OUTPUT pins 13 and 14
0	0	NO
0	1	A
1	0	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 D803. 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 D802 (pins 5 and 6) via transistors V801, V802, which adapt the trigger view signal to the input level of the channel switch D802.
The balance of the symmetrical TRIG VIEW signal is adjustable with R808. The trigger view signal is controlled by the signal applied to D802-11.
If this input is H, it opens the trigger view signal path to the DELAY LINE DRIVER (D801).

2.2.6. Delay-Line Driver

In the DELAY-LINE DRIVER the input current signals are converted to voltage signals. This consists of a Hooper stage, using transistors D801 (3,4,5)(1,2,3).
For optimal common mode suppression the voltage level on the emitters of the Hooper stage D801 pin 3 must be constant. If the current on the input of this stage changes the currents of the two current sources V807 and V808 must be adapted to keep the voltage level on the emitters D801 pin 3 constant.
This current regulation is achieved by transistor D801 (12, 13, 14).
In this way the common mode signals are optimal suppressed so that only the differential signals are applied to the DELAY LINE.
The composite trigger signals (COMP TRIG) are picked-off from the collectors of D801-8 and D801-11 and fed symmetrically to the bases of V917 and V918 located on the TRIGGER INPUT STAGE.
The output of the DELAY-LINE DRIVER is applied to the FINAL VERTICAL AMPLIFIER via the DELAY LINE. The characteristic impedance of this cable-type delay line is 140 ohms.

2.2.7. Final Vertical Amplifier

The DELAY LINE is terminated in the DELAY-LINE COMPENSATION CIRCUIT by the resistor R1216. Compensation is achieved by transistors V1201, V1202, V1203 and RC network.
Transistors V1201, V1202 form a Cherry stage. Distortion originating in the delay line is corrected by the frequency-dependent impedance of the RC network between the emitters of V1201, V1202.
This frequency-dependent network consists of:

a)	R1203/C1207 C1203	: For optimal square-wave response by adjusting the pulse-roundings.
b)	R1201-L1201-L1202	: To reduce pulse aberrations.
c)	R1202	: To reduce chopper cross-talk.
d)	V1205-V1210	: Temperature compensation for optimal square-wave response at high input frequencies.

The varicap diodes V1205 and V1210 are driven by a d.c. voltage controlled by the temperature dependent resistor R 1235

The Cherry stage converts the input voltage signal to a current signal.
Transistor V1203 functions as a current source for this stage.

Any unbalance in the Y deflection plates of the c.r.t. can be corrected with the position-balance potentiometer R1205 that controls the emitter currents of V1201, V1202.
The output currents of the Cherry stage feed the Hooper stage V1208, V1211, which converts the input current signals into voltage form. It also contains the TRACE SEPARATION facility for the ALT TB mode. The TRACE SEPARATION CIRCUIT located on the TIME-BASE UNIT controls the current that is drawn from V1208, V1211, and thus controls the output voltage of the stage. Adjusting the TRACE SEP results in the MTB signal being shifted upwards and the DTB signal downwards.
The output voltage of the Hooper stage is applied to another Cherry stage V1206, V1209 where it is converted again to a current signal. The common-emitter circuit includes the gain adjustment R1239 of the FINAL VERTICAL AMPLIFIER to adjust for different c.r.t. sensitivities. By means of the RC combination R1250/C1223 the rise time of the square-wave signal can be optimised. The current source for the Cherry stage is transistor V1213. The output currents of this stage are fed via transistors V1204 and V1214 to the Y-deflection plates of the c.r.t. In the interest of low output capacitance, these drive transistors are mounted in common-base configuration.

2.3. CIRCUIT DESCRIPTION OF THE HORIZONTAL SECTION

2.3.1. Main Time-base Triggering (see Fig. 8.4)

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 the DELAY-LINE DRIVER D801 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 D806-10 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, 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 mode, the trigger signal is a.c.-coupled (K851 is open).
Only in the external X deflection mode together with AUTO 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 (if option is available in the oscilloscope) 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 and is routed via shunt feedback amplifier V863 to the TOP DETECTOR and the TV CIRCUIT (when available).

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 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 (Optional)

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 D851 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:

TTL/ECL/TV 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 TTL, ECL or TV mode (depending on user's instrument), 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 for TTL, ECL or TV 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. 8.5)

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. 8.8)

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 therefore 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 MTB sawtooth voltage is also routed via voltage divider R327, R329 and emitter-follower V256 to the input of Schmitt trigger D214 (1,2,3), the end-of-sweep detector. It detects an H input level if the input voltage rises above +1,9 V, whereupon output D214-3 becomes L. This L level is applied to the set input, pin 4 of flip-flop D212, to make the inverting output (pin 6) logic L.
This L level is routed via NAND gate D211 (3,4,5,6) and NOR gate D209 (2,3,1) to input pin 12 of D209. Input pin 2 is always at logic L in the AUTO mode. If no trigger signal is present, the other input, pin 11 of D209 is permanently at L. The L level on input D209-12 makes output D209-13 go to level H, which makes transistors V233 and V234 conductive. Switching transistor V233 discharges the MTB timing capacitance and V234 takes over the current from current source V236. As a result, the MTB sweep is switched off.

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.

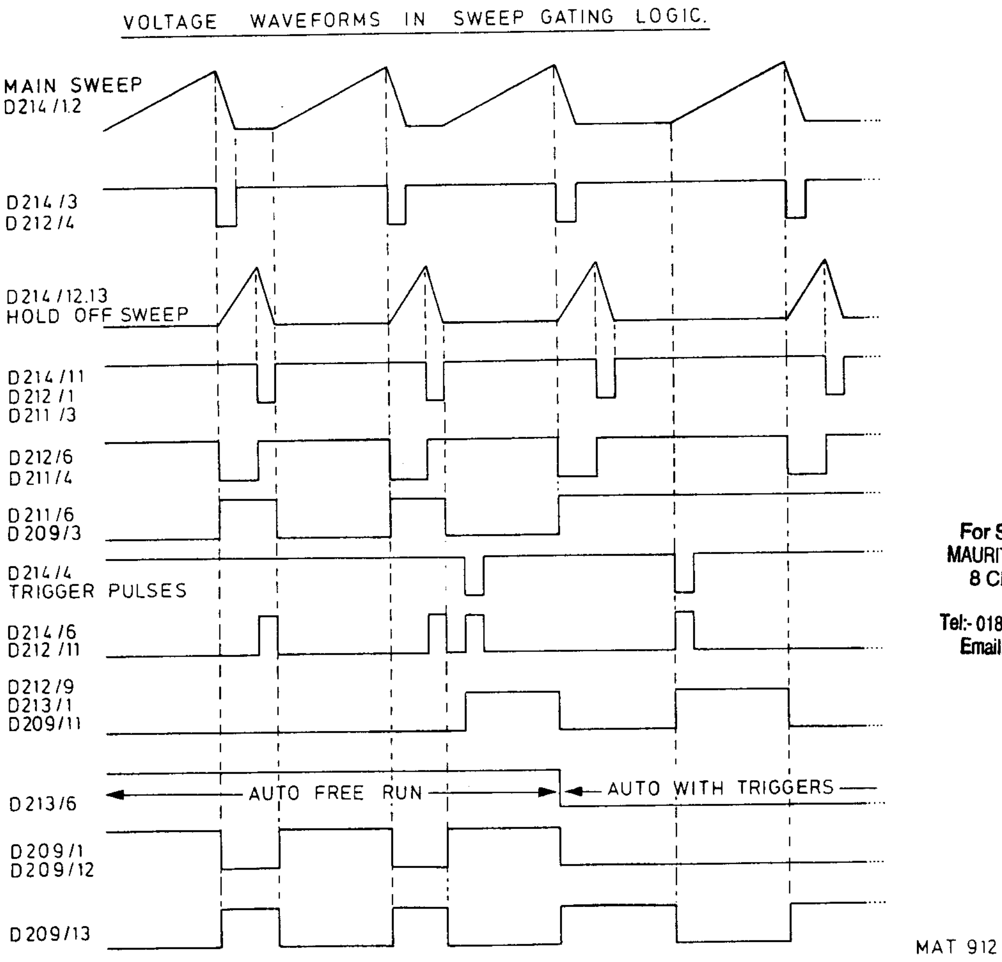


Fig. 2.5. Important voltage waveforms in the MTB control logic

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.

f) SINGLE-SHOT mode (see also AUTO and TRIGGERED modes)

In this mode, the conditions of the Set-Reset (SR) flip-flop formed by NAND gates D211 (1,2,12,13) and D211 (8,9,10,11) are important.
Before the start of the hold-off period, the following apply:

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

At the start of the hold-off period input pin 2 of D211 is made L and the flip-flop jumps to the set position (output 12 is H, output 8 is L).
This situation remains after the end of the hold-off period although input 2 is now H, because an L level from output 8 is applied to input 13 of D211. As a result of this SR flip-flop condition, the reset input pin 13 of flip-flop D212 stays at L and the time-base cannot be started by a further trigger pulse.

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 -7 V). The TRACE SEPARATION CIRCUIT receives, via two outputs, current from R1226 and R1237 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 R1226 is routed to D202-11 and via an internal transistor to the current source connected to pins 7,8. The current from R1237 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 routeing of the currents of R1226 and R1237 over both current sources are identical to the situation without ALT TB selected. Only the magnitude of the currents differs, that from R1226 being higher than that from R1237. This results in a downwards shift of the time-base line in comparison with the situation where the currents in R1226 and R1237 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 R1226 and R1237 in the FINAL VERTICAL AMPLIFIER are routed via another path in D202. The current from R1226 is routed to D202-12 and is lower than the current from R1237, 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 R1226 and R1237 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 XDEFL, 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.

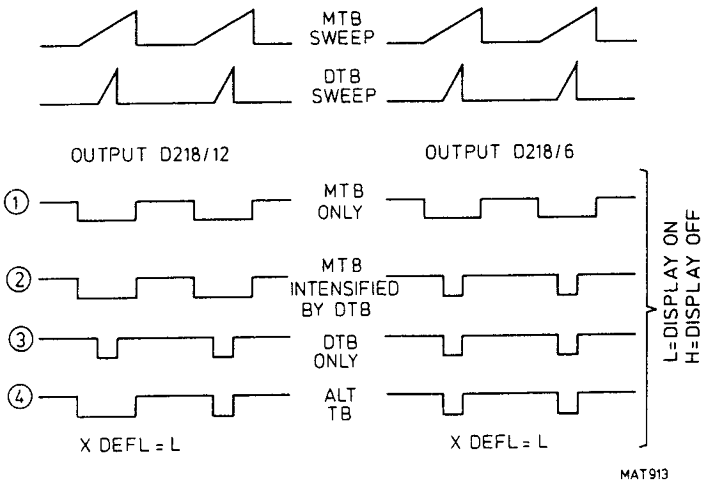


Fig. 2.6 Important voltage waveforms in the Z-modulation control logic

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 D218 (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

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 A3.
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.

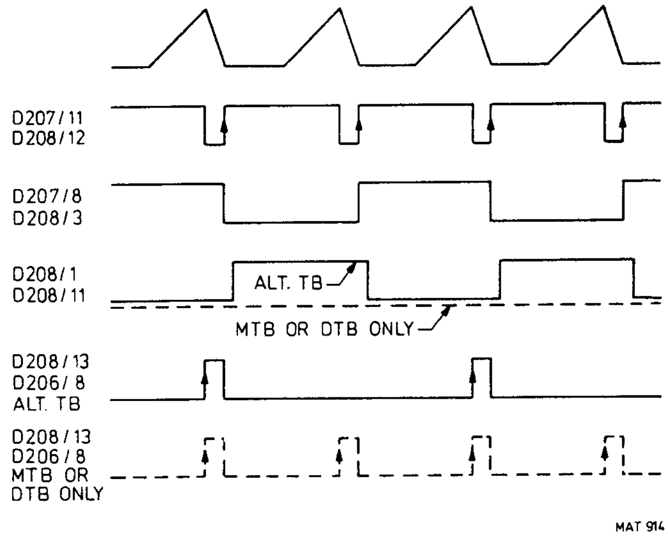


Fig. 2.7 Important voltage-waveforms in the alternate mode control logic

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. 8.10)

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

The time-base is switched on and off by means of the switching transistors V228 and V227. At the end of the DTB sweep V228 conducts and takes over the current from current source V229; V227 conducts at the start of the hold-off period in order to discharge the timing capacitance.
The DTB sawtooth is taken off by Darlington pair V219/V209 and routed to diode V211 in the X deflection selector. The sawtooth is also routed via emitter-follower V221 to the input of the end-of-sweep detector D203 (1,2,3).

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 D207 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.

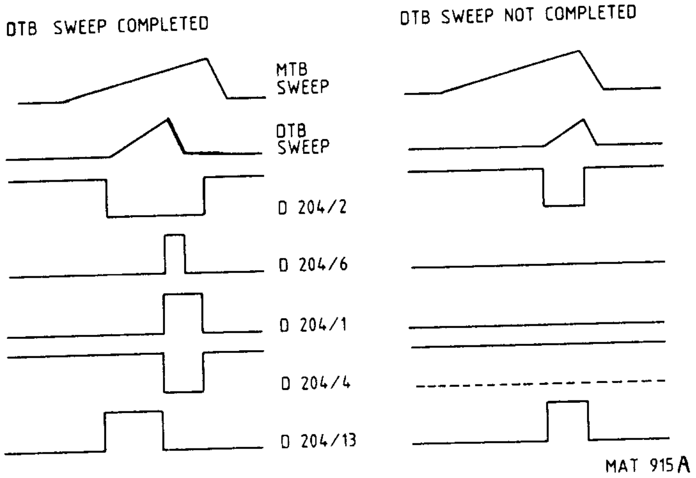


Fig. 2.8 Important voltage-waveforms in the DTB control logic

2.3.5. Final X Amplifier (see Fig. 8.12)

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. 8.12)

a) Z-Amplifier

The signal from the Z-LOGIC on the time-base unit A2 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., l.f. and h.f. components to be applied to the Wehnelt cylinder G1 of the c.r.t. Since G1 is at a cathode potential of -1500 V, blocking capacitors are required between G1 and the Z amplifier output.
The h.f. component is routed via blocking capacitor C1512 to G1.
However, the d.c. and l.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 l.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 l.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 R1547, R1548, R1549 in the output circuit are high-precision types.

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 in C1441 at switching-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 I1 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 T1.

The current I2 is flowing via the primary winding of T1404 to the base of transistor V1413 (I3)
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 I6 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 (I 5). This is realised by the negative current I 5 during period T3. After ≈ 40µs, 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.

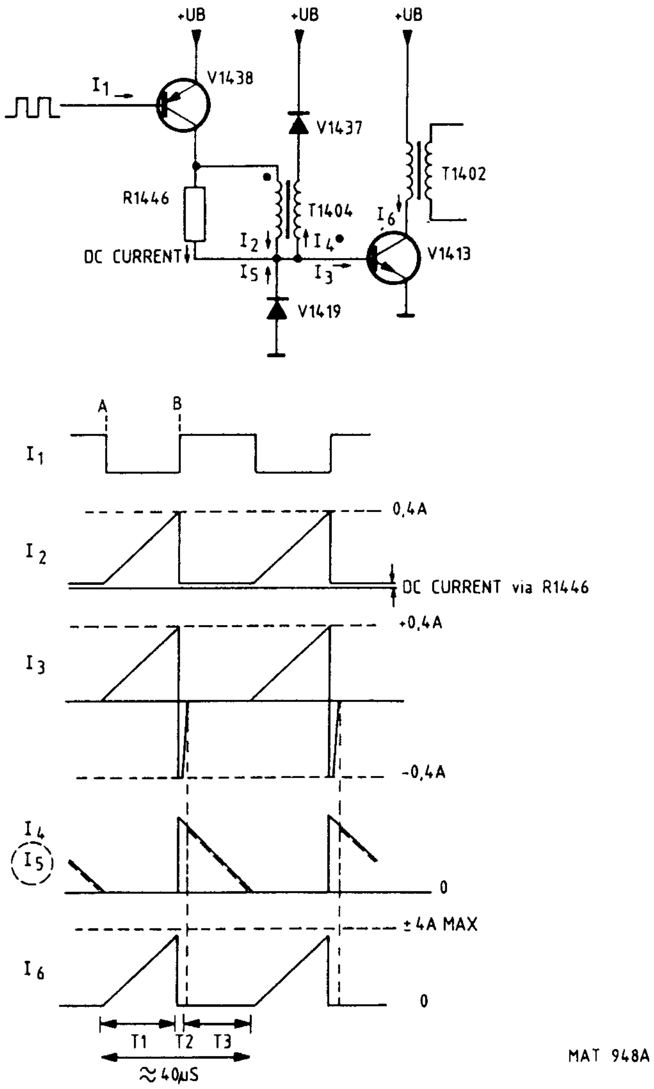


Fig. 2.9 The converter-driver

– *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 I6 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 approximately every 40µs.

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

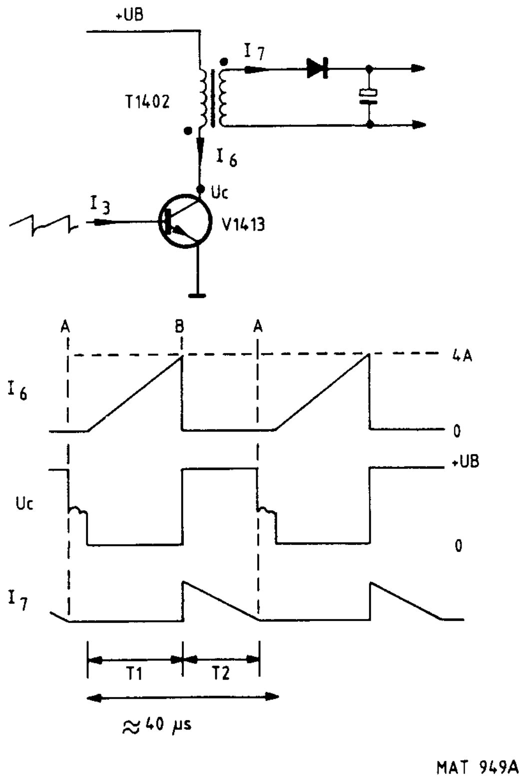


Fig. 2.10 The fly-back converter

2.5.3. The Regulator and Protection Circuit (see Fig. 8.14)

The regulator circuit D1402, via transistors V1433 and V1428, controls the pulse-width of the square-wave current applied to the base of V1438.
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 +14V supply via diode V1423.

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 R1474 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.

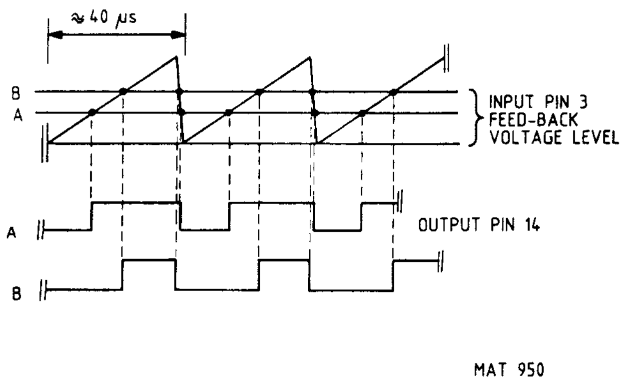


Fig. 2.11 Pulse-width modulation

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. 8.14)

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. 8.14)

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. 8.14)

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

– *Shunt feedback amplifier*

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

– *Series feedback amplifier followed by a shunt feedback amplifier*

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

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

– *Emitter-follower*

The emitter-follower is used as an impedance converter.
The input 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 inout 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 cutput becomes L and the inverting output H.
  If J = H and K = H: the outputs switch to the opposite state.

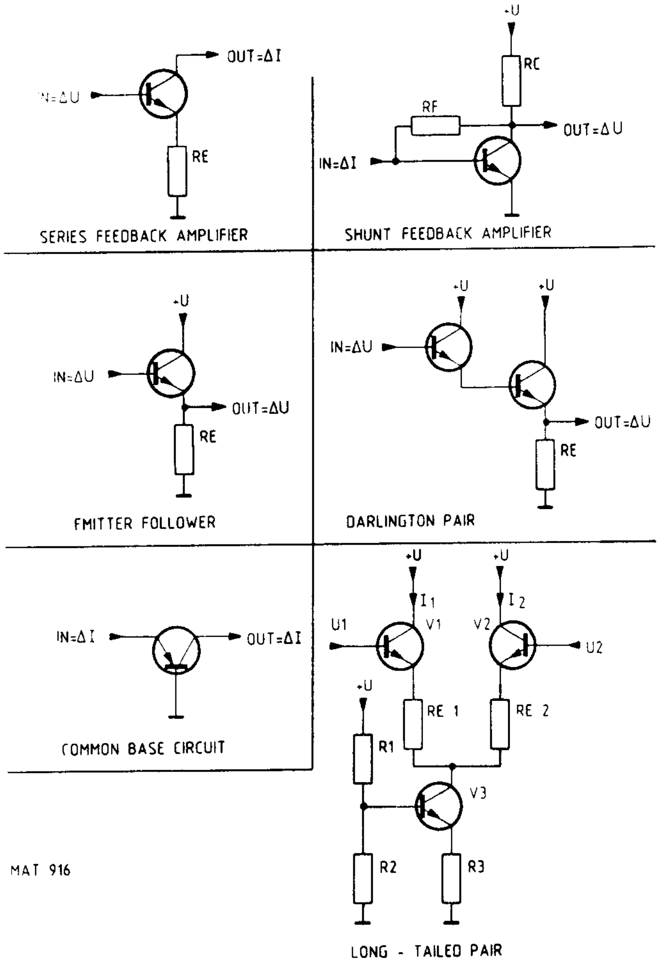


Fig. 2.12 Basic analog circuits

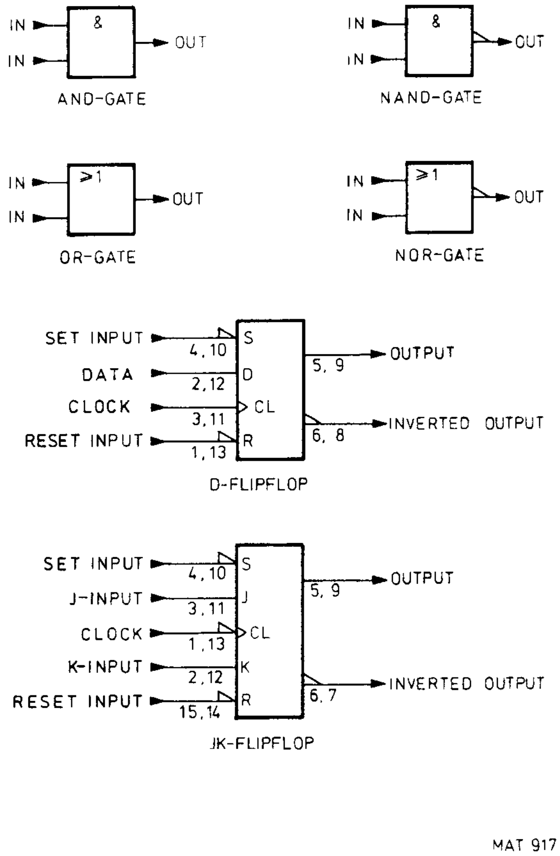


Fig. 2.13 Basic digital circuits

3. DISMANTLING THE INSTRUMENT

3.1. GENERAL INFORMATION

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 a careful note must be made of all disconnected leads that they can be reconnected to their correct terminals during assembly.

CAUTION: **Damage may result if:**

- **The instrument is switched on when a circuit board has been removed.**
- **A circuit board is removed within one minute after switching-off the instrument.**

3.2. REMOVAL OF TOP AND BOTTOM COVER

- Remove the two locking-brackets situated on the right- and left-hand side of the instrument.
- Pull the rubber band off the rear side of the instrument as indicated in Fig. 3.1./A.
- Remove 4 "cross-head" screws in the rear panel as indicated in Fig. 3.1./B.
- Bend the top and bottom cover of the instrument in the directions indicated in Fig. 3.2./A.
- Remove the shoulder strap as indicated in Fig. 3.2./B.
- Take the top and bottom cover out of the rubber band at the front side of the instrument as indicated in Fig. 3.2./C.
- If necessary the rubber band can be pulled off the front side of the instrument in the direction indicated in Fig. 3.2./D.

When remounting the top and bottom cover, take care that the strap-clasp is on the right-hand side of the instrument (the side where the mains transformer is situated).

When remounting the rubber bands

- The front and the rear bands are different.
  The rear band incorporates small rubber feet, that permit air circulation if the instrument is standing on its rear panel. The front band is equipped with studs that fit in slits of the front panel. Due to the asymmetrical position of two studs that fit in the left- and right-hand side of the front panel, only one position of the rubber band is correct.
- If the mounting of the rubber bands and the top and bottom cover gives problems, industrial talcum powder can be used to facilitate this procedure.
  Take care that no talcum powder falls in the instrument.

3.3 ACCESS TO PARTS FOR CHECKING AND ADJUSTING PROCEDURES

All the adjustment points can be reached after removal of the top and bottom cover of the instruments (see section 3.2.).
Five adjustment points on the power supply unit can be reached via holes in the right-hand chassis plate of the instrument.

Note: For adjustment, always use an insulated adjustment tool.

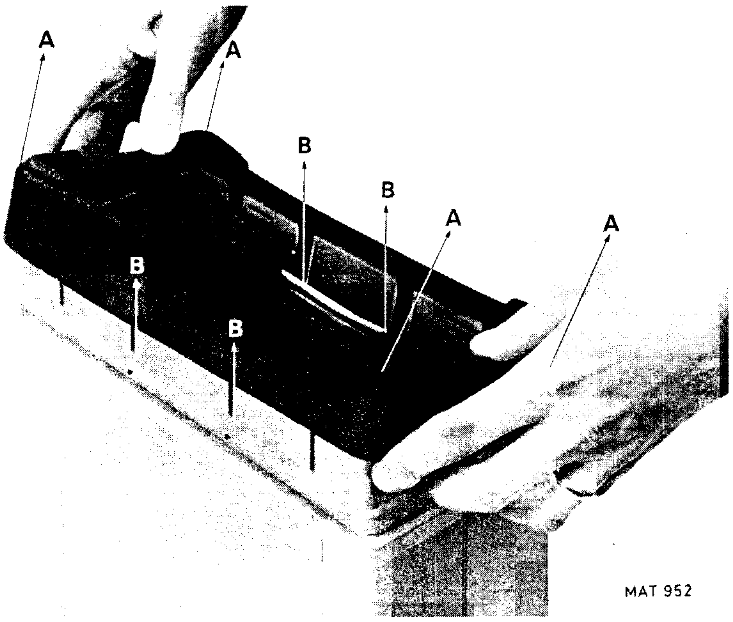


Fig. 3.1 Removal of rubber band of rear panel

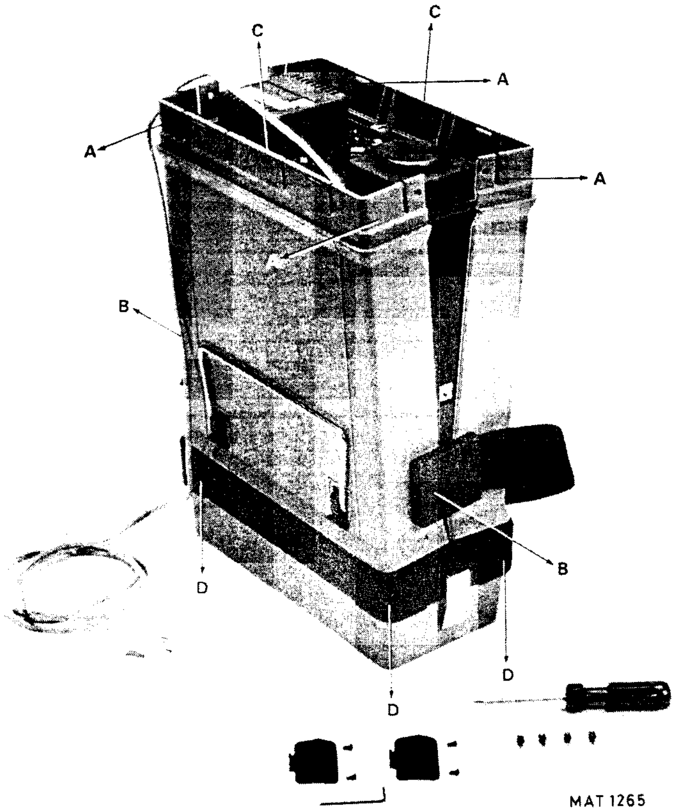


Fig. 3.2 Removal of shoulder strap, top and bottom cover

4. PERFORMANCE CHECK

4.1. GENERAL INFORMATION

WARNING: **Before switching-on, ensure that the instrument has been installed in accordance with the Installation Instructions outlined in Section 3 of the Operating Manual.**

This procedure is intended to:
- Check the instruments' specification.
- Be used for incoming inspection to determine the acceptability of newly purchased instruments and/or recently recalibrated instruments.
- Check the necessity of recalibration after the specified recalibration intervals.

NOTE: *The procedure does not check every facet of the instruments calibration; rather, it is concerned primarily with those parts of the instrument which are essential to measurement accuracy and correct operation. Removing the instruments covers is not necessary to perform this procedure. All checks are made from the outside of the instrument.*

If the test is started within a short period after switching-on, bear in mind that steps may be out of specification, due to insufficient 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.*

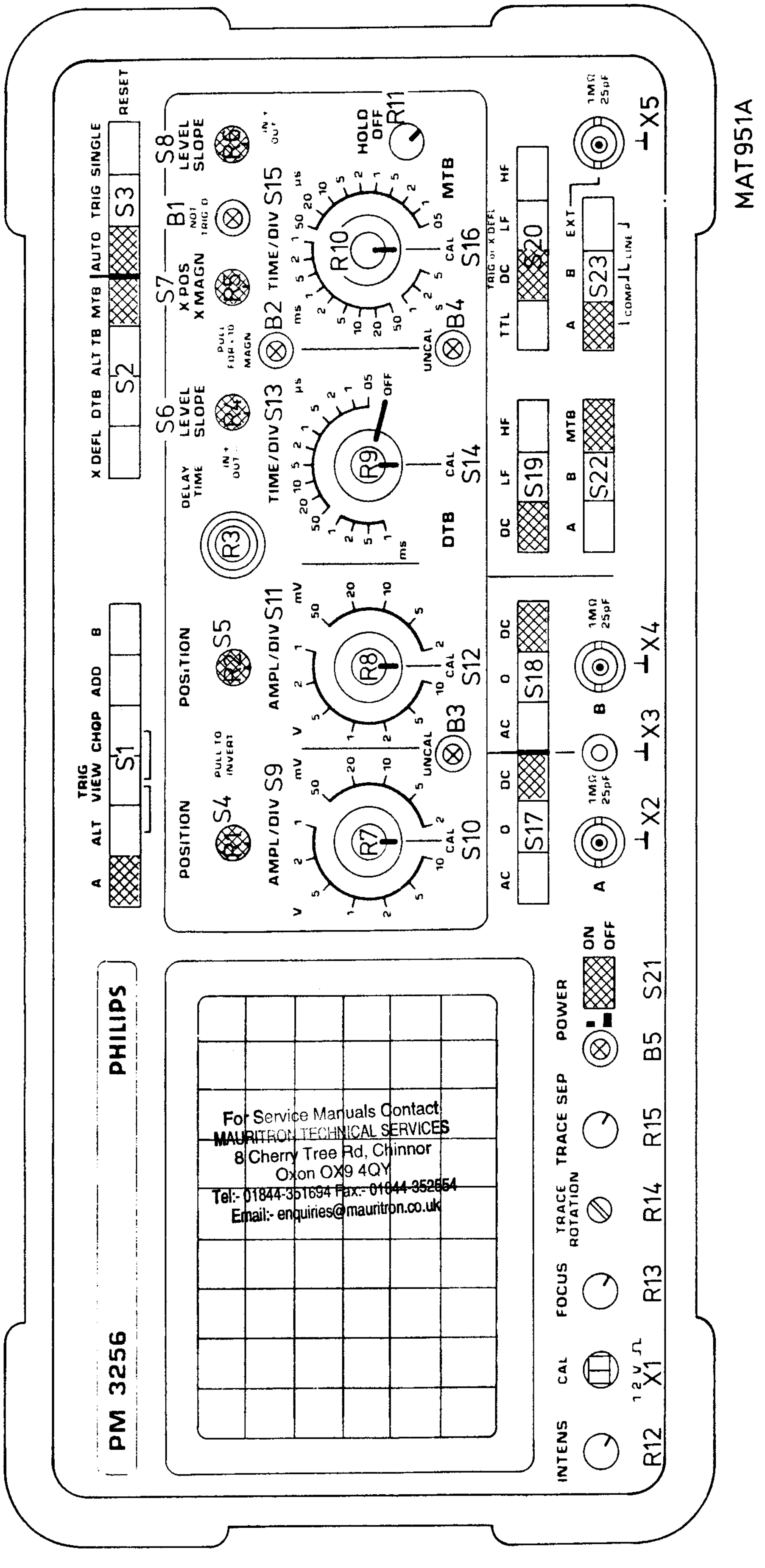


Fig. 4.1 Preliminary settings

4.2. PRELIMINARY SETTINGS OF THE CONTROLS

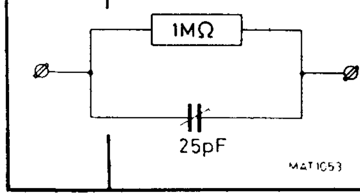
- Start this check procedure with **NO** input signals connected, **ALL** pushbuttons released and **ALL** switches in the CAL position.
- Depress the controls as indicated in figure 4.1.

4.3. RECOMMENDED TEST EQUIPMENT

Type of instrument	Required specification	Example of recommended instrument
Function generator	Freq.: 1 mHz... 10 MHz Sine-wave/Square-wave Ampl. 0... 20 Vpp DC offset 0 ... ± 5 V Rise-time < 30 ns Duty cycle 50 %	Philips PM 5134
Constant amplitude sine-wave generator	Freq.: 100 kHz ... 100 MHz Constant ampl. of 120 mVpp and 3 Vpp	Tektronix SG 503
Square-wave calibration generator	For ampl. calibration: Freq.: 1 kHz Ampl.: 10 mV ... 50 V For rise-time measurements: Freq.: 1 MHz Ampl.: 10 mV ... 500 mV Rise-time: ≤ 1 ns	Tektronix PG 506
Time-marker generator	Repetition rate: 0,5 s ... 0,05 μs	Tektronix TG 501
Variable mains transformer	Well-insulated output voltage 90 ... 264 Vac	Philips ord. number 2422 529 00005
DC power supply	Adjustable output: 20 ... 28 V Current: 1,5 A	Philips PE1540
Moving-iron meter		
Dummy probe 2 : 1	1 MΩ ± 0,1 %//25 pF	
Cables, T-piece, terminations 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 50 Hz - 400 Hz ± 10 %	– Depress pushbutton POWER ON	S21	– Starts at selected mains voltage ± 10 % (for 110 V: +20 % –10 %) – Pilot lamp B5 lights up.	
4.1.2a	Power consumption				38 W from ac	
4.1.1b	Start POWER SUPPLY	24 V (x7 - rear side)	– Depress pushbutton POWER ON	S21	– Starts at dc supply voltages between 20 V and 28 V – Pilot lamp B5 lights up.	
4.1.2b	Power consumption				30 W from dc (1.5 A max.)	
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 1 kHz ampl. 100 mV to A input	– Depress A – Ampl/div. to 20 mV	S1	Square-wave 1 kHz 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 1 kHz, ampl. 200 mV to A and B input	– Depress ADD – AMPL/DIV switches to 50 mV	S1	Square-wave signal 1 kHz, trace height 8 div. visible	
4.3.2.	Polarity inversion	Square-wave signal to A input (B)	Pull switch S4 (S5) – Depress A (B) of S1		Square-wave signal is inverted.	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.3.3.	Vertical deflection coefficients	Square-wave signal 1 kHz to A input (B) AMPL 10 mV (p-p) 20 mV (p-p) 50 mV (p-p) 100 mV (p-p) 200 mV (p-p) 500 mV (p-p) 1 V (p-p) 2 V (p-p) 5 V (p-p) 10 V (p-p) 20 V (p-p) 50 V (p-p)	– Depress A (B) of S1 – Depress A (B) of S23 AMPL/DIV S9 (S11) 2 mV 5 mV 10 mV 20 mV 50 mV 0,1 V 0,2 V 0,5 V 1 V 2 V 5 V 10 V	 Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 4 DIV., + or –3 % (± 0,12 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 4 DIV., + or –3 % (± 0,12 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 4 DIV., + or –3 % (± 0,12 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.) Trace height 4 DIV., + or –3 % (± 0,12 div.) Trace height 5 DIV., + or –3 % (± 0,15 div.)	
4.3.3.1.	Continuous control	Square-wave signal 1 kHz to A input (B) ampl. 100 mV (p-p)	– AMPL/DIV to 20 mV – Continuous control R7 (R8)	– Continuous range 1 : > 2,5 (< 2 div.) – **UNCAL led B3 lights up**	
4.3.4.	Vertical positioning	Sine-wave signal 10 kHz to input A Amplitude 160 mVp-p	– AMPL/DIV to 20 mV – Set signal in vertical centre by means of position R1 – Set AMPL./DIV. to 10 mV – Position control R1 fully – Position control R1 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 1 kHz to A input via dummy (B) AMPL. 20 mV (p-p) 50 mV (p-p) 100 mV (p-p) 200 mV (p-p) 500 mV (p-p) 1 V (p-p)	– Depress A (B) of S1 – Depress A (B) of S23 AMPL/DIV S9 (S11) 2 mV 5 mV 10 mV 20 mV 50 mV 0,1 V	 Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
		AMPL. 2 V (p-p) 5 V (p-p) 10 V (p-p) 20 V (p-p) 50 V (p-p) 50 V (p-p)	0,2 V 0,5 V 1 V 2 V 5 V 10 V	Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 5 div., + or –3 % (± 0,15 div.) Trace height 2.5 div., + or – 3 %	
4.3.6.	Input coupling	Sine-wave signal 2 kHz + 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 100 kHz ampl. 0,48 V to A and B input Sine-wave signal 1 MHz, ampl. 0,48 V to A and B input	– AMPL/DIV switches to 0,1 V. – Pull N/I switch S5. – Depress ADD of S1 – AMPL/DIV switches to 20 mV – Set the continuous controls for minimum trace height difference	Rejection 40 dB ⟶ trace height ⩽ 0,24 div.	
4.3.8.	Dynamic range	Sine-wave signal 10 MHz, ampl. 2,4 V to input A (B) Sine-wave signal 75 MHz, ampl. 1 V to input A (B)	– Depress A (B) of S1 – Depress AC of S17 (S18) – AMPL/DIV to 0,1 V – Shift trace with POSITION control R1 (R2) – AMPL/DIV to 0,1 V	24 div. trace height distortion-free visible on screen 7 div. trace height distortion-free visible on screen	
4.3.9.	Cross talk	Sine-wave signal 10 MHz to A input ampl. 120 mV	– AMPL/DIV switches S9 and S11 to 20 mV – Depress B of S1	Cross talk from A to B ⩽ 0,06 div. (40 dB)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.3.10.	Pulse aberration	Square-wave signal 1 MHz, rise-time ⩽ 1 ns, ampl. 10 mV to A input (B)	– AMPL/DIV to 2 mV – Position controls R1 (R2)	– Trace height 5 div., + and –2,5 div. from screen centre – Pulse aberrations ⩽ 4 % (⩽ 5%p-p) – In invert mode additional 1 %	
		Square-wave signal 1 MHz, rise-time ⩽ 1 ns, ampl. 0,5 V to input A (B)	– AMPL/DIV to 0,1 V – Position controls R1 (R2)	– Trace height 5 div., + and –2,5 div. from screen centre – Pulse aberrations ⩽ 3 % (⩽ 4 %p-p) – In invert mode additional 1 %	
4.3.11.	Rise time	Square-wave signal 1 MHz, rise-time ⩽ 1 ns, ampl. 50 mV to input A (B) (pos. slope)	– AMPL/DIV to 10 mV – Set signal between dotted lines – Pull S8 (neg. triggering) – Set second pos. slope in the horizontal centre by X POS R5	– Trace height 5 div. – Rise-time measured between 10 % and 90 % (4 div.) must be ⩽ 4,7 ns (second pos. slope)	
4.3.12.	Trace jump a) attenuator		– Depress 0 of S17 (S18) – Set trace in the centre of the screen – Switch AMPL/DIV switch between 2 mV and 5 mV – Switch AMPL/DIV switch between 10 mV and 20 mV	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)	Trace jump ⩽ 0,5 div. (only in AMPL./DIV. settings : 20 mV/div. ... 10 V/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 ⩽ 0,2 div.	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.3.13.	Bandwidth channel A (B)	Sine-wave signal 500 kHz, ampl. 120 mV to input A (B)	– TIME/DIV switch S15 to 5 μs – AMPL/DIV switch to 20 mV – Adjust ampl. of input signal to trace height 6 div.		
		Sine-wave signal 500 kHz-75 MHz, ampl. 120 mV to input A (B)		Trace height must be ⩾ 4,2 div.	
4.4.	**Trigger view**				
4.4.1.	Sensitivity A (B)	Square-wave signal 1 kHz to A input (B)	– Depress A (B) of S23 – Depress TRIG VIEW S1. – AMPL/DIV switch S9 (S11) to		
		Ampl. 10 mV (p-p)	2 mV	Trace height 5 div.	
		20 mV (p-p)	5 mV	Trace height 4 div.	
		50 mV (p-p)	10 mV	Trace height 5 div.	
		100 mV (p-p)	20 mV	Trace height 5 div.	
		200 mV (p-p)	50 mV	Trace height 4 div.	
		500 mV (p-p)	0,1 V	Trace height 5 div.	
		1 V (p-p)	0,2 V	Trace height 5 div.	
		2 V (p-p)	0,5 V	Trace height 4 div.	
		5 V (p-p)	1 V	Trace height 5 div.	
		10 V (p-p)	2 V	Trace height 5 div.	
		20 V (p-p)	5 V	Trace height 4 div.	
		50 V (p-p)	10 V	Trace height 5 div.	
4.4.2.	Sensitivity EXT	Sine-wave signal 1 kHz to EXT input X5 Ampl. 1,2 V	– Depress EXT of S23 – Depress TRIG VIEW of S1 – Depress AUTO+TRIG of S3	Trace height 6 div. ± 3 % (± 0,18 div.)	
		Square-wave signal 1 kHz, ampl. 1,2 V to EXT input X5	– Depress EXT of S23 – Depress TRIG VIEW of S1 – Depress TTL of S20	Trace height 6 div. ± 3 % (± 0,18 div)	
4.4.3.	Pulse aberrations via EXT.	Square-wave signal 1 MHz, ampl. 3 V, rise time ⩽ 1 ns, to input EXT X5 (TEK 106)	– Depress TRIG VIEW S1 – Depress EXT of S23	Trace height 6 div. Pulse aberrations ⩽ 6 % (⩽ 8 %p-p)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.4.5.	Time delay between vertical input displayed via A or B and external input displayed via trigger view	Square-wave signal 1 MHz, ampl. 0,5 V, rise-time 1 ns to A (B) input and to EXT input	– AMPL/DIV to 0,1 V/DIV – Depress ALT and TRIG VIEW of S1 – TIME/DIV switch S15 to 0.05 μs – Pull X MAGN S7 – Depress EXT of S23	– Time delay between A (B) signal and EXT (via TRIG VIEW) signal must be $\leqslant$ 10 ns ($\leqslant$ 2 div.)	
	Time delay between A or B and trigger view A or B		– Depress A (B) of S23 – Depress alternately A (B) and TRIG VIEW of S1	– Time delay between A (B) signal and trigger view signal of A (B) must be $\leqslant$ 15 ns ($\leqslant$ 3 div.)	
4.4.6.	Bandwidth INT	Sine-wave signal 500 kHz, ampl. 120 mV to input A	– Depress TRIG VIEW S1 – AMPL/DIV to 20 mV – Adjust the ampl. of the input signal to 6 div. trace height		
		Sine-wave signal 500 kHz-50 MHz, ampl. 120 mV to input A		Trace height must be $\geqslant$ 4,2 div.	
	Bandwidth EXT	Sine-wave signal 500 kHz, ampl. 3 V to EXT input X5	– Depress TRIG VIEW S1 – Depress EXT of S23 – Adjust the ampl. of the input signal to trace height 6 div.		
		Sine-wave signal 500 kHz - 60 MHz, ampl. 3 V to EXT input X5		Trace height must be $\geqslant$ 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 2 kHz, ampl. 120 mV to input A	– AMPL/DIV to 50 mV – TIME/DIV MTB (S15) to 0,2 ns – Depress MTB of S2 – TIME/DIV DTB (S13) to 50 μs – 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 – Horizontal deflection is determined by the input signal A (2,4 div.)	
4.5.2.	Trace separation		– TIME/DIV MTB S15 to 0,2 ms – TIME/DIV DTB S13 to 50 μs – Depress ALT TB of S2 – Set trace in the centre of the screen R1 – TRACE SEP R15 – TRACE SEP R15	– Both time-base lines cover each (one line) – MTB trace (with intensified part) 2 div. upwards – DTB trace 2 div. downwards	
4.5.3.	Horizontal positioning range	Time marker signal to input A	– Set marker on first and last vertical graticule line – X POS control R5 – X POS control R5 – Pull X MAGN S7 – X POS R5 – X POS R5	First marker to horizontal centre of the screen Last marker to horizontal centre of the screen First marker visible on screen Last marker visible on screen	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
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 2 kHz ampl. 300 mV to input A	– AMPL/DIV switch (S9) to 50 mV	Well triggered display	
			– Depress LF of S20 – Depress TRIG VIEW of S1	Square-wave signal visible with roundings (LF filter)	
			– Depress HF of S20 – Depress B of S1	Differentiated square-wave visible	
		Square-wave signal 2 kHz, 500 mV to input B and EXT (X5)	– AMPL/DIV (S11) to 0,1 V – Depress DC of S20 – Depress B of S23	Well triggered display	
			– Depress EXT of S23	Well triggered display	
		TTL compatible square-wave signal to input A (B)	– Depress TTL of S20 – Depress A (B) of S23 – Depress A (B) of S1	Well triggered display	
		Sine-wave signal 10 kHz, ampl. 120 mV to input A and CAL signal via 10:1 probe to input B	– AMPL/DIV to 50 mV – 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, equal to mains freq., ampl. 120 mV to input A (B)	– Depress A (B) of S1 – Depress B and EXT (LINE) of S23	Well triggered display	
4.6.2.	Trigger sensitivity INTERNAL	Sine-wave signal freq. ⩽ 10 MHz, ampl. 120 mVpp to input A	– AMPL/DIV to 0,2 V – Decrease trace height by R7	Signal triggers at trace height of ⩾ 0,5 div.	
		Sine-wave signal freq. ⩽ 100 MHz, 1,2 div. trace height to input A	– AMPL/DIV to 0,1 V – Decrease trace height by R7	Signal triggers at trace height of ⩾ 1 div.	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.6.3.	Trigger sensitivity TTL	TTL compatible signal, 1 kHz to input A and EXT	– AMPL/DIV to 2 V – Depress TTL of S20 – Pull slope S8 – Depress EXT S23 – Push slope S8	– Well triggered display – Well triggered display – Well triggered display – Well triggered display	
4.6.4.	Trigger sensitivity EXTERNAL	Sine-wave signal, freq. ≤ 10 MHz, ampl. 100 mVpp to EXT (X5) Sine-wave signal, freq. ≤ 100 MHz, ampl. 300 mV to EXT (X5)	– Depress TRIG VIEW of S1 – Depress EXT of S23	Signal is well triggered Signal is well triggered	
4.6.5.	Level range and triggering slope	Sine-wave signal, ampl. 160 mV, freq. 1 kHz to input A	– AMPL/DIV to 10 mV – Depress TRIG of S3 – Depress TRIG VIEW of S1 – LEVEL R6 – Pull SLOPE S8 – AMPL/DIV to 20 mV – Depress AUTO of S3 – LEVEL R6	Trace is triggered over ± 8 div., trigger point on positive slope Trigger point on negative slope Triggered signal over the complete LEVEL range	
		Sine-wave signal 1 kHz, ampl. 3,2 V to EXT input X5	– Depress EXT of S23 – Depress TRIG of S3 – LEVEL R6	Trigger point adjustable over the complete amplitude (+ or –1,6 V)	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.6.6.	Trigger bandwidth	Sine-wave signal 25 kHz, ampl. 300 mV to input A	– Depress DC of S20 – Depress TRIG of S3 – AMPL/DIV to 50 mV – Depress TRIG VIEW – Set trace in the centre by means of R6	Trace must be triggered	
			– Decrease freq. of input signal to ≈ 1 Hz (trace height 6 div.)	Trace must be triggered	
			– Increase freq. of input signal to 100 MHz	Trace must be triggered	
		Sine-wave signal, 25 kHz to input A	– Depress DC of S20 – Adjust ampl. of input signal so that trace height is 6 div.		
			– Depress LF of S20	Trace height ⩾ 4,2 div.	
			– Decrease freq. of input signal to 2 Hz	Trace height increases and signal must be triggered	
			– Depress HF of S20		
			– Freq. of input signal 25 kHz	Trace height ⩾ 4,2 div.	
			– Increase freq. of input signal to 100 MHz	Trace height increases and signal must be triggered	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.7.	**Main time-base**				
4.7.1.	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 %	
		0,5 ms	0,5 ms	Coefficient error ⩽ 3 %	
		1 ms	1 ms	Coefficient error ⩽ 3 %	
		2 ms	2 ms	Coefficient error ⩽ 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	Coefficient error ⩽ 3 %	
4.7.2.	Magnifier	Square-wave signal repetition time 0,1 µs to input A	– TIME/DIV to 1 µs – Pull X MAGN. S7 – X pos R5	– MAGN. led B2 lights up – Coefficient error ⩽ 5 % – Trace adjustable over 100 div.	
4.7.3.	Continuous control	As 4.7.2.	– TIME/DIV to 0,1 µs – Continuous control CAL R10	– UNCAL led B4 lights up. – Continuous range 1 : > 2,5	

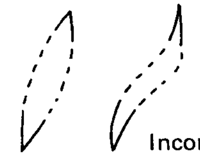
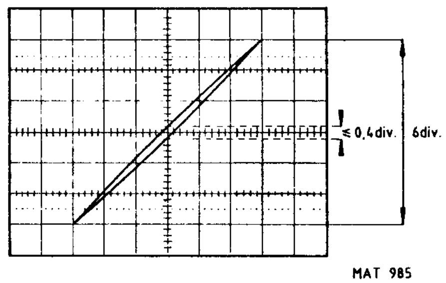
STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.7.4.	Single shot	Square-wave signal 10 kHz to input A	– TIME/DIV to 0,1 ms – Depress SINGLE of S3	– Trace once visible – During SINGLE shot action NOT TRIG'D led B1 lights up	
4.7.5.	Hold off	Square-wave signal repetition time 10 μs to input A	– TIME/DIV to 2 μs – HOLD OFF R11	– Sweep HOLD OFF time can be varied by a factor of 10 → trace intensity decreases	
4.8.	**Triggering of the delayed time-base**				
4.8.1.	Trigger source, trigger coupling and trigger bandwidth	Sine-wave signal 2 kHz ampl. 300 mV to input A	– AMPL/DIV to 0,1 V – TIME/DIV MTB (S15) to 0,5 ms – TIME/DIV DTB (S13) to 50 μs	– 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 100 MHz.	– Trace must be well triggered	
			– Depress HF of S19 – Decrease freq. of input signal to 25 kHz.	– Trace must be well triggered	
			– Depress LF of S19 – Decrease freq. of input signal to 2 Hz.	– Trace must be well triggered	
		Sine-wave signal 2 kHz ampl. 300 mV 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 – Depress MTB of S22	– Well triggered intensified part – Intensified part well triggered independent of R4	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.8.2.	Trigger sensitivity	Sine-wave signal freq. $\leqslant$ 10 MHz, ampl. 300 mVpp to input A	– AMPL/DIV to 0,2 V – TIME/DIV MTB (S15) to 0,05 μsec – TIME/DIV DTB (S13) to 0,05 μsec – Depress A of S22 – Depress DTB of S22 – Adjust LEVEL R4 – Decrease trace height by R7	Signal triggers at trace height of $\geqslant$ 0,5 div.	
		Sine-wave signal freq. $\leqslant$ 100 MHz ampl. 300 mVpp to input A	– Adjust LEVEL R4 – Decrease trace height by R7	Signal triggers at trace height of $\geqslant$ 1,3 div.	
4.8.3.	Level range and triggering slope	Sine-wave signal 1 kHz ampl. 160 mV to input A (B)	– AMPL/DIV to 10 mV – TIME/DIV MTB (S15) to 0,5 ms – TIME/DIV DTB (S13) to 0,1 ms – 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
4.9.	**Delayed time-base**				
4.9.1.	Time coefficients	Time-marker signal repetition time:	– Depress DTB of S2 – MTB TIME/DIV S15 / DTB TIME/DIV S13		
		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 μs / 2 μs	Coefficient error ⩽ 3 %	
		5 μs	10 μs / 5 μs	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 ⩽ 3 %	
		1 ms	2 ms / 1 ms	Coefficient error ⩽ 3 %	
4.9.2.	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. ⟷	
4.9.3.	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
4.9.4.	Incremental Delay Time error	Marker pulse to input A, repetition time 0,5 msec. ampl. 3 div.	MTB/TIME/DIV to 0.5 msec. DTB/TIME/DIV to 20 μsec. Depress ALT TB of S2. Depress MTB of S22. Delay Time R3 Delay Time R3	Intensified part to second marker pulse. Positive slope of DTB signal to vertical centre of the screen. Note the value of R3 in 3 digits. Intensified part to third ... tenth marker pulse. Positive slope of DTB signal to vertical centre of the screen. Note the values of R3 in 3 digits. Calculate the steps between the sequential noted values. Maximum difference between the steps is: $\leqslant$ 0,05.	
4.9.5.	Delay time jitter	Sine-wave signal 1 MHz to input A	– Set trace height to 6 div. – TIME/DIV MTB (S15) to 1 ms – TIME/DIV DTB (S13) to 0,5 μs – Delay time R3 to 10 – Depress DTB of S2	Jitter of DTB trace $\leqslant$ 1 div	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.10	**X-Y Operation**				
4.10.1.	Mode and deflection coefficients	Sine-wave signal 10 kHz 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 to the horizontal graticule line visible, trace height and trace width 6 div. ± 10 %	
		Sine-wave signal 10 kHz 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	As described above	
		Sine-wave signal 10 kHz ampl. 1 V to EXT input X5	– Depress EXT of S23 – Depress B and EXT (LINE) of S23	Trace width 5 div. ± 10 % Trace width 5 div. at 50 Hz mains frequency	
4.10.2.	Bandwidth via A	Sine-wave signal 1 kHz to input A	– Depress A of S23 – Depress HF of S20 – Depress X DEFL of S2 – Depress B of S1 – Adjust ampl. of input signal for horizontal deflection 8 div.	Horizontal deflection 8 div.	
			– Increase freq. of input signal to 100 kHz	Horizontal deflection ⩾ 7,8 div. (0,5 dB)	
		Sine-wave signal 1 kHz to input A	– Depress LF of S20 – Adjust ampl. of input signal for horizontal deflection 8 div. – Increase freq. of input signal to 20 kHz (ampl. same as above)	**Horizontal deflection decreases**	
			– Depress HF of S20 – Increase freq. of input signal to 100 kHz	**Horizontal deflection decreases** **Horizontal deflection increases**	
	Bandwidth via EXT. input (X5)	Sine-wave signal 1 kHz to input EXT (ampl. 4 V)	– Depress EXT of S23 – Horizontal deflection 8 div. – Increase freq. of input signal to 100 kHz	**Trace width ⩾ 7,8 div.**	

STEP	OBJECTIVE	INPUT VOLTAGE	SETTINGS	REQUIREMENTS	MEASURING RESULTS
4.10.3.	Dynamic range	Sine-wave signal 100 kHz to input A	– Set AMPL/DIV to 0,2 V – Adjust ampl. of input signal to 5 div. trace height. – Set AMPL/DIV to 50 mV – Depress X DEFL of S2 – Adjust R1 and R5 to check the complete signal shape.	– Check that the displayed signal is distortion free (see the Fig.)  Correct Incorrect	
4.10.4	Phase shift between X and Y anpl.	Sine-wave signal 2 kHz, ampl. 120 mV 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 100 kHz	A line under an angle of 45° with respect to the horizontal graticule line visible Phase shift ≤ 3°  	
4.11.	**Calibration**		CAL X1	≈ 2 kHz square-wave signal, ampl. 1,2 Vpp, 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

5.1. General Information

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

- Where possible, instrument performance is checked before an adjustment is made.
- Warming-up time under average conditions is 30 minutes.
- All limits and tolerances given in this section are calibration guides and should not be interpreted as instrument specifications unless they are also published in chapter 1. 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 (4822 112 51054)

5.3. Preliminary settings of the controls

See Fig. 4.1.

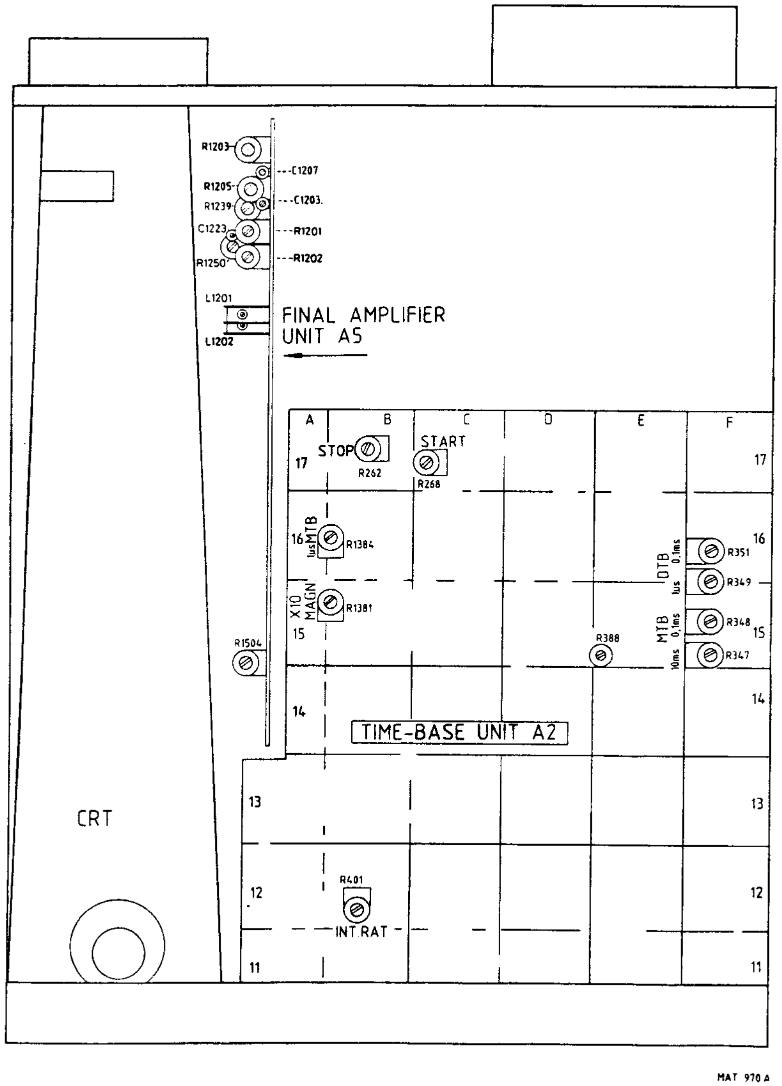


Fig. 5.1. Adjustment points top view

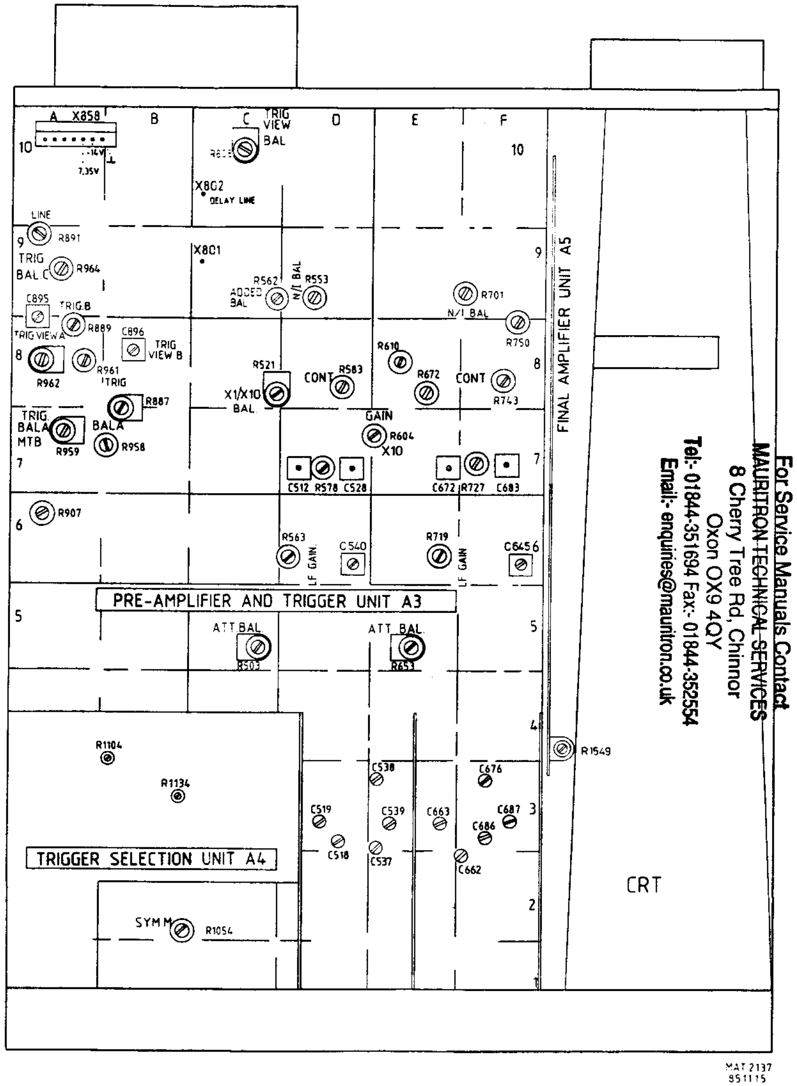


Fig. 5.2. Adjustment points bottom view

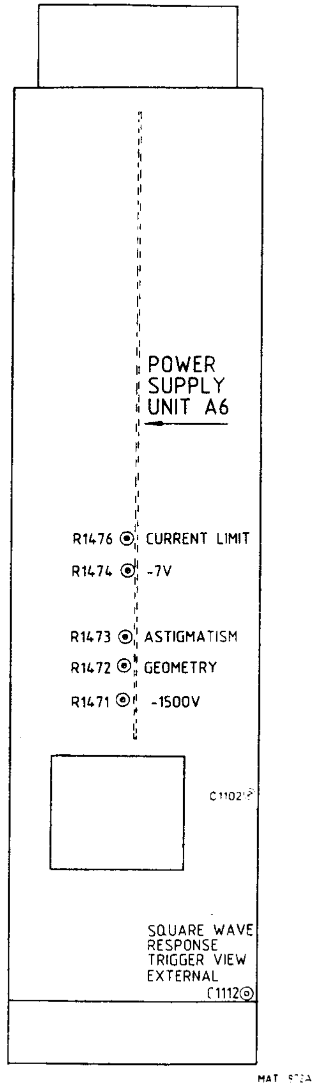


Fig. 5.3. Adjustment points right side

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	R1474		−7.35 V + or −3 $^{0}/oo$ on pin 3 of X858		Digital multimeter	5.5.1.1.	5.3.
Current sensing	R1476		Extra load between pin 2 (+14 V) and pin 1 of X858. Adjust so that current limit point is just not reached.		–	5.5.1.2.	5.3.
−1500 V supply voltage	R1471		−1500 V + or −3 $^{0}/oo$ 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	R1504		Point is just visible		–	5.5.2.1.	5.1.
Intens ratio	R401		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.
Focus and astigmatism	R1473		Trace as sharp as possible		Function generator (sine-wave signal 10 kHz)	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 100 kHz and ≈ 50 Hz)	5.5.2.5.	5.3.
BALANCE ADJUSTMENTS							
Attenuator balance channel A (B)	R653	(R503)	Trace jump ⩽ 0.2 div. (AMPL/DIV setting 2 mV and 5 mV)		–	5.5.3.1.	5.2.
	R672	(R521)	Trace jump ⩽ 0.4 div. (AMPL/DIV setting 10 mV and 20 mV)		–	5.5.3.1.	5.2.
Normal-Invert balance channel A (B)	R701	(R553)	Trace jump ⩽ 0.5 div.		–	5.5.3.2.	5.2.
Final Y-amplifier balance	R1205		Top and bottom levels of the sine-waves on the same point of the screen, with the POSITION controls R1 and R2 fully ↶ and ↷		–	5.5.3.3.	5.1.
Added balance	R562		Trace in vertical centre		–	5.5.3.4.	5.2.
LF CORRECTIONS AND SENSITIVITIES							
Continuous control of channel A (B)	R743	(R583)	Continuous attenuation starts at 15° from counter clockwise-stop of R7 (R8)		Function generator (square-wave signal 10 kHz)	5.5.4.1.	5.2.
	R750	(R610)	Trace height from 6 div. to ⩽ 2.4 div. when R7 (R8) are fully counter clockwise		Function generator (square-wave signal 10 kHz)	5.5.4.1.	5.2.
LF correction of channel A (B)	R719	(R563)	Pulse top as straight as possible		Function generator (square-wave signal 100 Hz)	5.5.4.2.	5.2.
Gain x1 channel A (B)	R1239	(R578)	Trace height 6 div. + or −3 %		Function generator (square-wave signal 1 kHz)	5.5.4.3.	5.1. and 5.2.
Gain x10 channel A (B)	R727	(R604)	Trace height 6 div. + or −3 %		Function generator (square-wave signal 1 kHz)	5.5.4.4.	5.2.
Trigger view sensitivity EXT ,A and B	R1104	R958 (A) R961 (B)	Trace height 6 div. + or −0.9 subdiv.		Function generator (square-wave signal 1 kHz)	5.5.4.5.	5.2.
VERTICAL CHANNELS							
Attenuator square-wave response channel A (B)			Pulse top errors ⩽ + or −1.5 %		Square-wave calibration generator, rise time ⩽ 100 ns freq. 10 kHz	5.5.5.1.	5.2.
			AMPL/DIV switch setting	Trace height + or −1.5 %	amplitude:		
			2-5-10 mV	6 div.	12 mV - 30 mV - 60 mV		
	C676	(C538)	20 mV	6 div.	120 mV		
			50 mV	6 div.	300 mV		
			0.1 V	6 div.	600 mV		
	C663	(C539)	0.2 V	6 div.	1.2 V		
			0.5 V	6 div.	3 V		
			1 V	6 div.	6 V		
	C687	(C519)	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 −1.5 %		Square-wave calibration generator, rise time ⩽ 100 ns, via dummy-probe 2 : 1 (fig. 5.5)	5.5.5.2.	5.2.
		AMPL/DIV setting	Trace height + or −1.5 %	Freq. 10 kHz 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		
	C662 (C537)	0.2 V	6 div.	2.4 V		
		0.5 V	6 div.	6 V		
		1 V	6 div.	12 V		
	C686 (C518)	2 V	6 div.	24 V		
		5 V	3 div.	30 V		
		10 V	1.5 div.	30 V		
HF square wave response						
Presets	C672, C683 (A)	Adjust for minimum capacity			5.5.5.3.	5.2.
	C512, C528 (B)	Adjust for minimum capacity				5.2.
	R1203 (final Y)	Fully counter clockwise				5.1.
	C1207 (final Y)	Adjust for minimum capacity				5.1.
Square-wave response channel B		AMPL/DIV setting:		Square-wave generator, rise time ⩽ 1 ns		
	R1202	20 mV, pulse top straight		120 mV/25 kHz		5.1.
	C1203, R1201	20 mV, pulse top straight		120 mV/100 kHz		5.1.
	R1250	20 mV, steep slope, no aberrations		120 mV/1 MHz		5.1.
	C1223, L1201 L1202	20 mV, pulse top straight		120 mV/1 MHz		5.1.
	C1207	20mV, pulse top straight		120 mV/1 MHz		5.1.
	C512	20 mV, slope 1/2 div overshoot		120 mV/1 MHz		5.2.
	C528	2 mV, 3/4 subdiv. overshoot		12 mV/1 MHz		5.2.
	C1223	20 mV, pulse top straight		120 mV/ 1 MHz		5.1.
	Repeat the previous two steps for optimal result.					
	C540	50 mV, pulse response equal to 20 mV/div		300 mV/1 MHz		5.2.
	C537	0.2 V, pulse response equal to 20 mV/div		1.2 V/1 MHz		5.2.
Square-wave response channel A	C683	2 mV, 3/4 subdiv. overshoot		12 mV/1MHz		5.2.
	C672	20 mV, 1/2 subdiv. overshoot		120 mV/1MHz		5.2.
	Repeat the previous two steps for optimal result					
	C645	50 mV, pulse response equal to 20 mV/div		300 mV/1MHz		5.2.
	C662	0.2 V, pulse response equal to 20 mV/div		1.2 V/1 MHz		5.2.
Square-wave response tigger view EXT	C1112	Pulse top as straight as possible		3 V/10 kHz applied to X5.	5.5.5.5.	5.3.
	C1102	Trig view signal 5% overshoot		3 V/1 MHz applied to X5		5.3.
	C895	Trig view signal A: aberrations ⩽ 8 %		1 MHz/120 mV square wave to A		5.3.
	C896	Trig view signal B: aberrations ⩽ 8 %		1 MHz/120 mV square wave to A		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, 10 kHz, ampl. 0.8 V	5.5.6.1.	5.2.
Trigger sensitivity	R388	Push and pull S8; trace must be triggered at trace height of 2 subdivisions		Sine-wave signal, 10 kHz, ampl. 0.8 V	5.5.6.2	5.1.
Trigger balance channel A, B and EXT	R959	Trace in the vertical centre		–	5.5.6.3.	5.2.
	R962	Trace in the vertical centre		–	5.5.6.3.	5.2.
	R1134	Trace in the vertical centre				
TTL level	R907	+ SLOPE } symmetrically around 0,7 div.		Sine-wave signal, 10 kHz	5.5.6.3.	5.2.
	R907	– SLOPE } symmetrically around 0,7 div.			5.5.6.4.	5.2.

ADJUSTMENT	ADJUSTING ELEMENT	ADJUSTING RESULT	RECOMMENDED INSTRUMENT AND INPUT SIGNALS	CHAPTER	FIGURES
COMP balance	R964	+ SLOPE: symmetrically around 0,7div.	Sine-wave signal, 10 kHz	5.5.6.4.	5.2.
	R964	– SLOPE: symmetrically around 0,7div.			
Trigger view balance	R808	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, 10 kHz	5.5.6.6.	5.2.
DTB via A and B	R889 (B)	Start of trace on the vertical centre line	Sine-wave signal, 10 kHz	5.5.6.6.	5.2.
Line triggering	R891	Trace must be 8 div. high	–	5.5.6.7.	5.2
TIME-BASE GENERATORS					
Main-time base time coefficients		Check that the centre 8 cycles have a total width of 8 div. MTB TIME/DIV	Time-marker generator, pulse repetition rate:	5.5.7.1.	
		0.05 μs horizont. lin. of first three cycles	0.05 μs		5.1.
	R1381	0.1 μs	0.1 μs		5.1.
		0.2 μs	0.2 μs		
		0.5 μs	0.5 μs		
	R1384	1 μs	1 μs		5.1.
		2 μs	2 μs		
		5 μs	5 μs		
		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			
Delayed time-base time coefficients		Check that the centre 8 cycles have a total width of 8 div. MTB TIME/DIV. DTB TIME/DIV.	Time-marker generator ,pulse repetition rate:	5.5.7.4	
		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 μs 2 μs	2 μs		
		10 μs 5 μs	5 μs		
		20 μs 10 μs	10 μs		
		50 μs 20 μs	20 μs		
		0,1 ms 50 μs	50 μs		
	R351	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			
Delay time multiplier	R268	Start of DTB trace on the second time marker pulse when DELAY TIME control is set to 1,0	Time-marker generator pulse 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	Time-marker generator pulse repetition rate 0,1 ms	5.5.7.5.	5.1
CALIBRATION SIGNAL					
Output voltage	R1549	2 kHz 1,2 Vpp ± 0,1%	–	5.5.10.	5.2.

5.5. CHECKING AND 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 24 V battery supply.
- Switch on the oscilloscope and check that the pilot lamp B5 lights up.
- Check that the power consumption does not exceed 38 W from AC and 30 W 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 −7.35 V + or −3 ^{o}/oo; if necessary readjust **R1474** (fig. 5.3.).

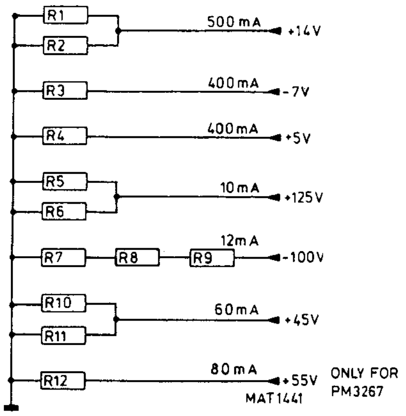
5.5.1.2. Current sensing

- Connect a resistor of 130 Ω (1.5 W) across pin 2 (+14 V) 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. −1500 V supply voltage

- Remove the cover of the c.r.t. socket (item 18 of fig. 7.2).
- Check the −1500 V supply voltage on pins 7 and 14 of the c.r.t. socket. This −1500 V must be + or −3 ^{o}/oo; if necessary readjust **R1471** (fig. 5.3.).

Dummy load for power supply.



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 112 21114
R8 and R9	3K3	4W	WR0617	4822 112 21121
R10 and R11	1K5	4W		4822 112 21112
R12	680Ω	7W	WR0825	4822 112 41103

5.5.2. CRT display adjustments

5.5.2.1. Intensity

- Set the controls as indicated in **fig. 4.1**.
- Depress X DEFL of S2.
- Set the displayed point in the vertical and horizontal centre of the screen by means of the position R1 and the X pos. R5 controls.
- Depress 0 of S17.
- Turn the INTENS control R12 ≈ 22,5° (one notch-distance) from the left hand stop.
- Check that the point is just visible; if necessary readjust **R1504** (fig. 5.1.) If after installing a new c.r.t., the adjustment range is too small, R1503 must be changed into 24,9 K Ohm (5322 116 54648) and **R1315** into 8,66 K Ohm (5322 116 54613).
- Depress DC of S17.

5.5.2.2. Intens ratio

- Depress MTB of S2.
- Set the MTB TIME/DIV switch S15 to 5 μs.
- Set the DTB TIME/DIV switch S13 to 1 μs.
- 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 brilliant and can be well distinguished from the MTB trace; if necessary readjust **R401** (fig. 5.1).
- Set the DTB TIME/DIV S13 to OFF.

5.5.2.3. Trace rotation

- Set the MTB TIME/DIV S15 to 0.1 ms.
- 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).

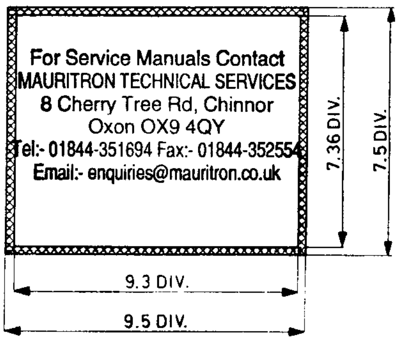
NOTE: If the adjustment range is not sufficient enough, remove connector X1502 (FINAL AMPLIFIER UNIT A5), turn it 180° and reconnect it.
After that, repeat the procedure described above.

5.5.2.4. Focus and astigmatism

- Set the AMPL/DIV switch S9 to 0.1 V.
- Depress 0 of S18.
- Set the MTB TIME/DIV switch S15 to 50 μs.
- 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 180° from its left hand stop.
- Apply a sine-wave signal, frequency 10 kHz, 6 div. trace height to input A.
- Check that the traces are as sharp as possible; if necessary optimise with the aid of **R1473** (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 50 mV.
- Apply a sine-wave signal, frequency 100 kHz, amplitude ≈ 400 mVpp to input A.
- Adjust the trace height to 7,4 div.
- Set the MTB TIME/DIV switch S15 to 50 μs.
- Apply a sine-wave signal, frequency ≈ 50 Hz 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.



MAT 981 A

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 2 mV and 5 mV.
- Check that the trace does not jump more than 0.2 div.; if necessary readjust **R653 (R503)**, fig. 5.2.
- Switch the AMPL/DIV control S9 (S11) between the positions 10 mV and 20 mV.
- Check that the trace does not jump more than 0,4 div.; if necessary readjust **R672 (R521)**, fig. 5.2.

5.5.3.2. Normal-Invert balance channel A (B)

- Put the AMPL/DIV switch in position 20 mV.
- Depress A (B) of S1.
- 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).
- Check that the trace does not jump more than 0.5 div.; if necessary readjust **R701 (R553)**, fig. 5.2.

5.5.3.3. Final Y-amplifier balance

- Apply a sine-wave signal to input A and B, amplitude 160 mV (p-p), frequency ≈ 10 kHz.
- Set the AMPL/DIV. switches S9 and S11 to 10 mV.
- Depress CHOP of S1.
- Turn the POSITION controls R1 and R2 fully counter clockwise and clockwise.
- Check that the top and bottom levels of the sine-wave signal are on the same point on the screen on both sides of the vertical centre line in the POSITION controls positions fully and : if necessary readjust **R1205**, fig. 5.1.

5.5.3.4. Added balance

- Remove the input signals of channel A and B.
- Depress ALT of S1.
- Set the AMPL/DIV switches S9 and S11 to 20 mV.
- Set the trace of channel A and B in the vertical centre of the screen.
- Depress ADD of S1.
- Check if the trace lies in the vertical centre of the screen; if necessary readjust **R562**, fig. 5.2 (the deviation of the trace from the vertical centre line must be doubled by adjusting **R562.**)
- Depress ALT of S1.
- Set the traces of both channels A and B on the vertical centre line.
- Depress ADD of S1.
- Check if the trace lies exactly on the vertical centre line; if necessary repeat the procedure above.

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 20 mV.
- Apply a square-wave signal, freq. 10 kHz, ampl. 120 mV (p-p) to input A (B).
- Turn the continuous control CAL R7 (R8) 15° counter clockwise out of its CAL position.
- Check that the continuous attenuation starts at this position of the continuous control; if necessary readjust **R743 (R583)**, fig. 5.2.
- Turn the continuous control CAL R7 (R8) fully counter clockwise.
- Check that the trace height is $\leqslant$ 2,4 div.; if necessary readjust **R750 (R610)**, 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 2 ms.
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Apply a square-wave signal, frequency 100 Hz, ampl. 120 mV to input A (B).
- Check that the pulse top is as straight as possible; if necessary readjust **R719 (R563)**, fig. 5.2.

5.5.4.3. Gain X1 (sensitivity) channel A (B)

- Set the MTB TIME/DIV switch to 0.1 ms.
- Apply a square-wave signal, freq. 1 kHz, ampl. 120 mV (from calibrated output of PG506) to input A (B).
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Depress A (B) of S1.
- Depress A (B) of S23.
- Check that the trace height is 6 div. + or –3 %; if necessary readjust **R1239 (R578)**, 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 2 mV.
- Apply a square-wave signal, freq. 1 kHz, ampl. 12 mV (from calibrated output of PG506) to input A (B).
- Check that the trace height is 6 div. + or –3 %; if necessary readjust **R727 (R604)**, 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.
- Set the MTB TIME/DIV switch S15 to 50 μs.
- Apply a square-wave signal, freq. 1 kHz, ampl. exactly 1,2 V to input EXT (X5) and A and B.
- Depress TRIG VIEW of S1.
- Depress TRIG and AUTO 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 6 div. + or –0.9 subdiv.; if necessary readjust **R1104**, fig. 5.2.
- Depress A of S23.
- Put AMPL/DIV switches S9 and S11 in position 0.2 V.
- Check that the trace height is exactly 6 div.; if necessary readjust **R958**.
- Depress B of S23.
- Check that the trace height is exactly 6 div.; if necessary readjust **R961**.

5.5.5. Vertical channels

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 20 μs.
- Apply a square-wave signal, freq. 10 kHz, rise time ⩽ 100 ns 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 –1,5 %; 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 –1.5 %
2 mV	12 mV		6 div.
5 mV	30 mV		6 div.
10 mV	60 mV		6 div.
20 mV	120 mV		6 div.
50 mV	300 mV	C676 (C538)	6 div.
0.1 V	600 mV		6 div.
0.2 V	1.2 V		6 div.
0.5 V	3 V	C663 (C539)	6 div.
1 V	6 V		6 div.
2 V	12 V		6 div.
5 V	15 V	C687 (C519)	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. 10 kHz, rise time ⩽ 100 ns to input A (B).
- Check the square-wave response; check that the pulse top errors do not exceed + or −1.5 %; if necessary readjust as indicated in the table below.
- Check the amplitude of the displayed signal.

Channel A (B) AMPL/DIV S9 (S11)	Amplitude of input signal A (B)	Adjusting element channel A (B)	Trace height + or −1.5 %
2 mV	24 mV	–	6 div.
5 mV	60 mV	–	6 div.
10 mV	120 mV	–	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	C662 (C537)	6 div.
0.5 V	6 V	–	6 div.
1 V	12 V	–	6 div.
2 V	24 V	C686 (C518)	6 div.
5 V	30 V		3 div.
10 V	30 V		1.5 div.

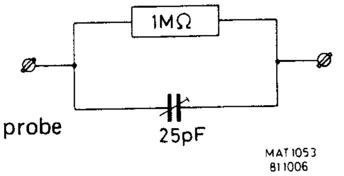


Fig. 5.5. Dummy probe 2:1

- Remove input signal and dummy probe

5.5.5.3. *HF square-wave response channel B (A)*

- Set the controls as indicated in fig. 4.1.
- Depress B of S1.
- Depress B of S23.
- Apply a square-wave signal to input B, frequency as given in the table below, rise time ⩽ 1 ns.
- Adjust the trace height to exactly 6 div. (AMPL/div to 20mV).
- Set by means of the POSITION control R2 the top of the square-wave signal on the second division from the top of the graticule.
- Preset the following adjustment points:
  Preamplifier and trigger unit:
  CHANNEL A: C672 and C683 minimum capacity.
  CHANNEL B: C512 and C528 minimum capacity.
  Final Y-amplifier:
  R1203 maximum (fully counter clockwise)
  R1207 minimum capcity.
- Adjust according the table below:

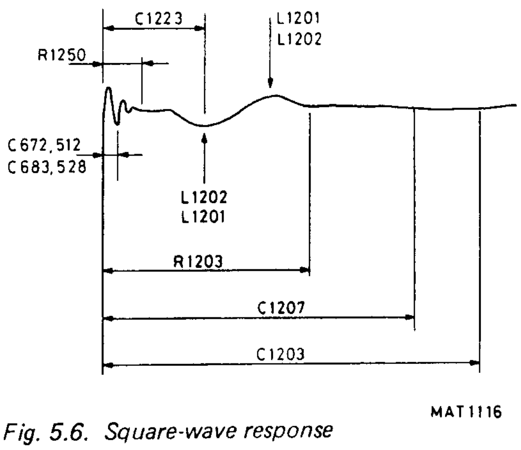


Fig. 5.6. Square-wave response

ADJUST-MENT SEQUENCE	S11 AMPL/DIV	FREQ. OF INPUT SIGNAL	S15 TIME/DIV	ADJUST-MENT POINT	ADJUSTING RESULT (see also fig. 5.6.)
1	20 mV	25 kHz	10 µs	R1202	top as straight as possible
2	20 mV	100 kHz	1 µs	C1203 R1201	top as straight as possible
3	20 mV	1 MHz	50 ns	R1250	slope as steep as possible without aberrations
4	20 mV	1MHz	50 ns	C1223 L1201 L1202	top as straight as possible
5	20 mV	1 MHz	50 ns	C1207	top as straight as possible
5a	20 mV	1 MHz	50 ns	C 512	slope 1/2 subdivision overshoot.
6	2 mV	1 MHz	50 ns	C528	slope 3/4 subdivision overshoot.
7	20 mV	1 MHz	50 ns	C1223	top as straight as possible
8	Repeat points 6 and 7 for an optimal result.				
9	50 mV	1 MHz	50 ns	C540	pulse response equal to response in 20 mV/div. (point 7)
10	.2 V	1 MHz	50 ns	C537	
11	20 mV/div. ... 10 V/div.	1 MHz	50 ns		minimum pulse aberrations, also in invert mode
			⩽ 0,9 subdiv. (⩽ 1 subdiv. pp)		in invert additional 0,25 subdivisions
	2 mV/div ... 10 mV/div.		⩽ 1 subdiv. (⩽ 1,2 subdiv. pp)		

- Depress A of S1.
- Depress A of S23.
- Apply a square-wave signal to input A, frequency as given in the table below, rise time ⩽ 1ns.
- Adjust the trace height to exactly 6 div.
- Set by means of the POSITION control R1 the top of the square-wave signal on the second division from the top of the graticule.
- Adjust according the table below:

ADJUST-MENT SEQUENCE	S9 AMPL./DIV.	FREQ. OF INPUT SIGNAL	S15 TIME/DIV.	ADJUSTMENT POINT	ADJUSTING RESULT (see also fig. 5.6.)
12	2mV	1MHz	50ns	C683	Slope 3/4 subdivision overshoot.
13	20mV	1MHz	50ns	C672	Slope 1/2 subdivision overshoot.
14	Repeat points 12 and 13 for an optimal result.				
15	50mV	1MHz	50ns	C645	Pulse response equal to response in 20mV/div. (point 13).
16	.2 V	1MHz	50ns	C662	
17	20 mV/div. ... 10 V/div.	1MHz	50ns		Minimum pulse aberrations, also in invert mode.
			⩽ 0.9 subdiv. (⩽ 1 subdiv. PP) ⩽ 1 subdiv. (⩽ 1.2 subdiv. PP)		In invert mode additional 0.25 subdiv.
	2 mV/div. ... 10 mV/div.				

5.5.5.4. Vertical shift influence on the input signal

- Set the AMPL/DIV switch S9 to 20 mV.
- Apply a square-wave signal to input A, trace height exactly 5 div., rise time ⩽ 1 ns.
- Set by means of the POSITION control R1 the top of the square-wave signal 2,5 div. above the vertical centre line.
- Shift the bottom of the square-wave signal by means of R1 5,5 div. upwards and check that the aberrations on the bottom of the square-wave signal are ⩽ 0,25 div.
- Set the square-wave signal in the centre of the screen.
- Shift the top of the square-wave signal 5,5 div. downwards and check that the aberrations are ⩽ 0,25 div.

5.5.5.5. Square-wave response Trigger view EXT.-channel A (B)

- Set the MTB TIME/DIV switch S15 to 20 μs.
- Depress TRIG VIEW of S1.
- Apply a square-wave signal, freq. 10 kHz, amplitude 1,2 V to input EXT (X5).
- Depress EXT of S23.
- Depress TRIG of S3.
- Set the trace in the vertical centre of the screen by means of the LEVEL control R6.
- Check that the pulse top is as straight as possible; if necessary readjust **C1112** (fig. 5.3) (overshoot < 1.8 subdiv.).
- Increase the frequency of the input signal to 1 MHz, rise time ⩽ 1 ns, amplitude 1,2 V.
- Set the MTB TIME/DIV switch S15 to 0.2 μs.
- Check that the trigger view signal is as straight as possible; if necessary readjust **C1102** (see fig. 5.3.).
- Remove the input signal.
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Depress A of S23.
- Apply a square-wave signal, freq. 1 MHz, rise-time ⩽ 1 ns, amplitude 120 mV to input A.
- Set the trace in the vertical centre of the screen by means of the LEVEL control R6.
- Check that the pulse-aberrations and overshoot are ⩽ 8 % (2,4 subdiv.); if necessary readjust **C895.**
- Apply the square wave signal to input B.
- Depress B of S23.
- Set the trace in the vertical centre of the screen by means of the LEVEL control R6.
- Check that the pulse response is as straight as possible and that the pulse aberrations and overshoot are ⩽ 8 % (2,4 subdiv.); if necessary readjust **R896.**

5.5.6. Triggering

5.5.6.1. Trigger symmetry

- Set the controls as indicated in fig. 4.1.
- Set S15 to 50 μs.
- Set S9 to .2 V.
- Apply a sine-wave signal, frequency 10 kHz to input A.
- Set the trace-height to exactly 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** 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, frequency 10 kHz to the input A, trace height 2 subdivisions.
- Pull and push the SLOPE switch S8.
- Check that the trace is well triggered over the complete level range; if necessary readjust **R388** (fig. 5.1.).

NOTE: Section 5.5.6.3. and 5.5.6.4. and 5.5.6.5. must always be adjusted together in the sequence as given below

5.5.6.3. Trigger balance channel A, B and EXT

- Depress A of S23.
- Depress TRIG VIEW of S1.
- Depress AUTO and TRIG of S3.
- Depress 0 of S17 and S18.
- Depress LF of S20.
- 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 **R1134** (see fig. 5.2.).

5.5.6.4. TTL level and COMP balance

- Depress A of S1.
- Depress A of S23.
- Set the trace in the vertical centre of the screen by means of R1.
- Depress DC of S17.
- Apply a sine-wave signal, frequency 10 kHz to input A.
- Set the trace-height to 4 div.
- Set S15 to 10 μs.
- Depress TTL of S20.
- Push the switch S8 for positive triggering and pull S8 for negative triggering.
- Check that the starting points of the trace lies symmetrically around 0.7 div. above the vertical centre of the screen; if necessary readjust **R907** (see fig. 5.2.).
- Depress A and B (COMP) of S23.
- Push the SLOPE switch S8 for positive triggering and pull S8 for negative triggering.
- Check that the trace starts symmetrically around 0.7 div. above the vertical centre of the screen; if necessary readjust **R964** (fig. 5.2.).

5.5.6.5. Trigger view balance

- Depress TRIG VIEW of S1.
- Depress 0 of S17.
- Depress AUTO 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 **R808** (see fig. 5.2).

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

- Depress A of S1.
- Set S9 and S11 to 0.2V.
- Set S13 and S15 to 50 μs.
- 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 10 kHz, amplitude 1.2 V to input A (X2).
- 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 10 kHz, amplitude 1.2 V to input B (X4).
- 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.

5.5.6.7. Line triggering.

- Depress TRIG VIEW of S1.
- Set MTB switch S15 to 10 ms/div.
- Depress AUTO and TRIG of S3 (auto triggering without peak-peak level range).
- Depress LINE of S23.
- Check if the displayed line signal is 8 div. high; if necessary readjust **R891** (fig. 5.2.).

5.5.6.8. Trigger slope and level of the main time-base

- Apply a sine-wave signal, freq. 10 kHz, amplitude 160 mV to input A (B).
- Depress A (B) of S1.
- Depress A (B) of S23.
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Set the MTB TIME/DIV switch S15 to 50μs.
- Depress TRIG of S3.
- Adjust the LEVEL control R6 for a well triggered display.
- Check that the signal is triggered on the positive going slope.
- Check that the signal is not triggered when the LEVEL control is set fully counter-clockwise and fully clockwise.
- Depress AUTO of S3.
- Check that the signal is triggered over the whole LEVEL range (R6).
- Set the AMPL/DIV switch S9 (S11) to 10 mV.
- Depress TRIG of S3.
- Check that the trace is triggered over + and –8 div.
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Pull the SLOPE switch S8.
- Check that the signal is triggered on the negative going slope.
- Push the SLOPE switch S8.
- Remove the input signal.
- Depress EXT of S23.
- Apply a sine-wave signal, freq. 1 kHz, amplitude 3,2 V to input EXT (X5).
- Depress TRIG VIEW of S1.
- Check that the trigger point can be shifted over $\geqslant \pm$ 1,6 ($\geqslant$ 8 div.) by means of the LEVEL control R6.
- Remove the input signal.

5.5.6.9. Trigger sensitivity check of the main time-base via channel A (B) and EXT

- Depress DC of S20.
- Apply a sine-wave signal, frequency as given in the table below to input A (B) (EXT).
- Set the AMPL/DIV switch S9 (S11) to 0.2 V.
- Adapt the setting of the MTB TIME/DIV switch to the frequency of the input signal.
- Decrease the amplitude of the displayed signal by means of the continuous control R7 (R8).
- Check that the signal is triggered at trace heights given in the table below.

TRIGGER SENSITIVITY MAIN TIME-BASE					
Input	**S1**	**S23**	**Frequency of the sine wave signal**	**S3**	**Trace height**
A	A	A	10 Hz	TRIG	⩽ 0.4 div.
A	A	A	100 Hz	AUTO	⩽ 0.4 div.
A	A	A	10 kHz	AUTO	⩽ 0.4 div.
A	A	A	75 MHz	AUTO	⩽ 0.6 div.
A	A	A	100 MHz	AUTO	⩽ 1,2 div.
B	B	B	100 Hz	AUTO	⩽ 0.4 div.
B	B	B	75 MHz	AUTO	⩽ 0.6 div.
B	B	B	100 MHz	AUTO	⩽ 1,2 div.
EXT	TRIG V	EXT	100 Hz	AUTO	⩽ 100 mV
EXT	TRIG V	EXT	75 MHz	AUTO	⩽ 200 mV
EXT	TRIG V	EXT	100 MHz	AUTO	⩽ 300 mV

5.5.6.10. Triggering of the main time-base in COMP mode

- Set the MTB TIME/DIV switch S15 to 0.1 ms.
- Depress A of S23.
- Depress ALT of S1.
- Depress DC of S17 and S18.
- Set the AMPL/DIV switches S9 and S11 to 20 mV.
- Apply a sine-wave signal, freq. 10 kHz, amplitude 120 mV to input A.
- Apply the CAL signal (X1) to input B via a 10:1 probe.
- Depress A and B (COMP) of S23.
- Set the POSITION controls R1 and R2 so that both traces overlap each other.
- Check that both traces are well triggered.
- Remove the input signals.

5.5.6.11. Triggerslope and level of the delayed time-base

- Depress A (B) of S1.
- Depress A (B) of S23.
- Apply a sine-wave signal, freq. 1 kHz, amplitude 160 mV to input A (B).
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Set the MTB TIME/DIV switch S15 to 0.5 ms.
- Set the DTB TIME/DIV switch S13 to 0.1 ms.
- Depress A (B) of S22.
- Depress DTB of S2.
- Adjust the LEVEL control R4 for a well triggered display.
- Check that the signal is triggered on the positive going slope.
- Set the AMPL/DIV switch to 10 mV.
- Check that the trace is triggered over + and −8 div.
- Set the AMPL/DIV switch to 20 mV.
- Pull the SLOPE switch S6.
- Check that the signal is triggered on the negative going slope.
- Push the SLOPE switch S6.

5.5.6.12. Trigger sensitivity check of the delayed time-base via the channel A (B)

- Depress AUTO of S3.
- Depress DC of S20.
- Depress DC of S19.
- Set the DELAY TIME control R3 to 0.
- Apply a sine-wave signal, frequency as given in the table below, amplitude 120 mV to input A (B).
- Set the AMPL/DIV switch S9 (S11) to 0.2 V.
- Adapt the setting of the TIME/DIV switches S15 and S13 to the frequency of the input signal.
- Set the MTB TIME/DIV switch one position lower (longer sweep time) than the DTB TIME/DIV switch.
- Decrease the amplitude of the displayed signal by means of the continuous control R7 (R8).
- Check that the signal is triggered at the trace heights given in the table below.

TRIGGER SENSITIVITY DELAYED TIME-BASE					
Input	**S1**	**S23**	**S22**	**Frequency of the sine-wave signal**	**Trace height**
A	A	A	A	100 Hz	⩽ 0.4 div.
A	A	A	A	10 kHz	⩽ 0.4 div.
A	A	A	A	75 MHz	⩽ 0.6 div.
A	A	A	A	100 MHz	⩽ 1,3 div.
B	B	B	B	100 Hz	⩽ 0.4 div.
B	B	B	B	10 kHz	⩽ 0.4 div.
B	B	B	B	75 MHz	⩽ 0.6 div.
B	B	B	B	100 MHz	⩽ 1,3 div.

- Set the DTB TIME/DIV switch S13 to OFF.
- Depress MTB of S2.
- Remove the input signal.

5.5.6.13. Filter check main time-base

- Set the MTB TIME/DIV switch to 0.2 ms.
- Apply a square-wave signal, freq. 2 kHz, amplitude 300 mV to input A.
- Set the AMPL/DIV switch S9 to 50 mV.
- Depress A of S1.
- Depress A of S23.
- Check that the signal is well triggered.
- Depress LF of S20.
- Depress TRIG VIEW of S1.
- Check that a square-wave is visible with roundings.
- Depress HF of S20.
- Check that a differentiated square-wave is visible.
- Depress DC of S20.
- Depress A of S1.

5.5.6.14. Filter check delayed time-base

- Set the DTB TIME/DIV switch S13 to 0.1 ms.
- Depress DTB of S2.
- Apply a sine-wave signal, freq. 2 kHz, amplitude 300 mV to input A.
- Set the start of the trace in the vertical centre of the screen by means of the POSITION control R1.
- Depress A of S22.
- Depress LF of S19.
- Set the start of the trace in the vertical centre by means of the LEVEL control R4.
- Depress HF of S19.
- Check that the signal is not triggered.
- Increase the frequency of the input signal to 25 kHz and higher.
- Check that the signal is well triggered.
- Depress DC of S19.

- Check that the trigger point is at the positive top of the sine-wave.
- Decrease the frequency of the input signal to 2 kHz.
- Check that the signal is well triggered.

5.5.7. Time-base generators

5.5.7.1. Main time-base time coefficients

To compensate temperature influences on the time base time coefficients, especially at high environmental temperatures, the contacts X220 (see fig. 8.7.) must be interconnected by means of a jumper or a wire during adjusting the time base coefficients.

- Set the controls as indicated in fig. 4.1.
- Set the AMPL/DIV switch S9 to 0.5 V.
- Set the MTB TIME/DIV switch S15 to 1 μs.
- Apply a time-marker signal of $\approx$ 2 V, pulse repetition rate 1 μs to input 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 0.1 μs to input A.
- Check that the centre 8 cycles have a total width of 8 div.; if necessary readjust **R1381** (fig. 5.1).
- Set the MTB TIME/DIV switch S15 to 0.05 μs.
- Apply a time-marker signal, pulse repetition rate 5 ns to input A.
- Set the X POS control R5 fully clockwise.
- Check the horizontal linearity of the first three displayed cycles of the signal.
- Check the horizontal linearity of the displayed signal when the X POS control R5 is in mid-position.
- Push the X MAGN switch S7.
- Set the MTB TIME/DIV switch S15 to 0.1 ms.
- Apply a time-marker signal, pulse repetition rate 0.1 ms, to input 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 10 ms.
- Apply a time-marker signal, pulse repetition rate 10 ms, to input 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 2.5 % (+ or −1 subdiv.).
- Check that the trace-length in all TIME/DIV positions is > 10 div.
- Set the TIME/DIV switch S15 to 1 μs.
- Apply a time-marker signal, pulse repetition rate 1 μs to input 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.
- **Remove the jumper on X220!**

5.5.7.2. X position range

- Set the MTB TIME/DIV switch S15 to 1 ms.
- Apply a time-marker signal, pulse repetition rate 10 ms, 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 0.1 µs.
- Apply a time-marker signal, pulse repetition rate 10 µs, to input A.
- Turn the HOLD OFF control R11 counter clockwise.
- Check if the intensity of the displayed signal suddenly decreases.
- Set the TIME/DIV switch S15 to 10 µs.
- Apply a time-marker signal, pulse repetition rate 0.1 ms, to input A.
- Turn the HOLD OFF control R11 counter clockwise.
- Check if the intensity of the displayed signal suddenly decreases.
- Set the TIME/DIV switch S15 to 5 ms.
- Apply a time-marker signal, pulse repetition rate 0.1 sec, to input A.
- Turn the HOLD OFF control R11 counter clockwise.
- Check if the number of sweeps sudden ly decreases (longer HOLD OFF time).
- Set the HOLD OFF control R11 fully clockwise.

5.5.7.4. Delayed time-base time coefficients

To compensate temperature influences on the time base time coefficients, especially at high environmental temperatures, the contacts X219 (see fig. 8.7.) must be interconnected by means of a jumper or a wire during adjusting the time base coefficients and the delay time multiplier.

- Set the DELAY TIME control R3 to 0.
- Set the MTB TIME/DIV switch S15 to 2 µs.
- Set the DTB TIME/DIV switch S13 to 1 µs.
- Apply a time-marker signal, pulse repetition rate 1 µs, to input 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 0.2 ms.
- Set the DTB TIME/DIV switch to 0.1 ms.
- Apply a time-marker signal, pulse repetition rate 0.1 ms, to input A.
- Check that the centre 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 2.5 % (+ or −1 subdiv.).
- Set the MTB TIME/DIV switch S15 to 5 µs.
- Set the DTB TIME/DIV switch S13 to 1 µs.
- Apply a time-marker signal, pulse repetition rate 1 µs, 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 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 1 µs.
- 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.
- **Remove the jumper on X219!**

5.5.7.6. Trace separation

- Remove the input signal.
- Depress ALT TB of S2.
- Set the MTB TIME/DIV switch S15 to 50 μs.
- Set the DTB TIME/DIV switch S13 to 20 μs.
- Set the TRACE SEP. control R15 fully clockwise.
- Check that only one line is visible.
- Set the trace in the vertical centre of the screen by means of the POSITION control R1.
- Turn the TRACE SEP control R15 fully counter clockwise.
- Check that the MTB trace shifts 2 div. upwards and the DTB trace 2 div. downwards.
- Depress MTB of S2.

5.5.7.7. Checking the delay time jitter

- Set the MTB TIME/DIV switch S15 to 1 ms.
- Set the DTB TIME/DIV switch S13 to 0.5 μs.
- Apply a sine-wave signal, frequency 1 MHz to input 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 $\leqslant$ 1 div.

5.5.8. Final checks of the vertical channels

5.5.8.1. Effective signal delay

- Depress A of S1.
- Depress A of S23.
- Apply a square-wave signal, freq. 1 MHz, rise time ⩽ 1 ns, amplitude 120 mV to input A.
- Set the AMPL/DIV switch S9 to 20 mV.
- Set the MTB TIME/DIV switch S15 to 0.05 μs.
- Turn the LEVEL control R6 counter-clockwise so that the trace is just triggered.
- Pull the X MAGN S7 (X10).
- Turn the X POS control to make the first positive slope visible.
- Check that the effective signal delay T is ⩾ 15 ns (3 div.), see Fig. 5.7.

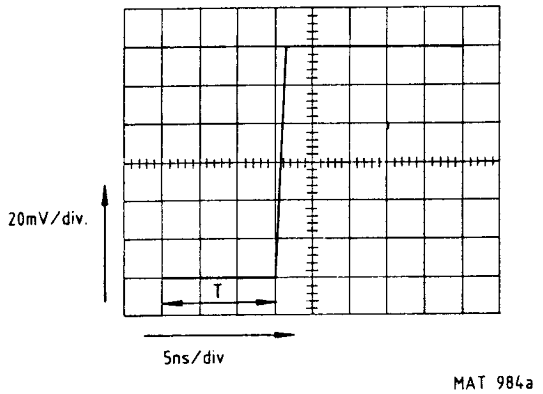


Fig. 5.7. Effective signal delay

5.5.8.2. Bandwidth check channel A (B)

- Depress the X MAGN switch S7 (X1).
- Set the MTB TIME/DIV switch S15 to 5 μs.
- Apply a sine-wave signal, freq. 500 kHz, constant amplitude of 12 mV to input A (B).
- Depress A (B) of S1.
- Depress A (B) of S23.
- Set the AMPL/DIV switch S9 (S11) to 2 mV.
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal from 500 kHz to 75 MHz (constant amplitude 12 mV).
- Check that the trace height is ⩾ 4.8 div. over the whole freq. range (oscilloscope without housing).
- If oscilloscope is provided with top and bottom cover and warmed up during 30 min. the trace height must be ⩾ 4.5 div. over the whole frequency range.
- Set the AMPL/DIV switch S9 (S11) to 20 mV.
- Apply a sine-wave signal, freq. 500 kHz, constant amplitude of 120 mV to input A (B).
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal from 500 kHz to 75 MHz (constant amplitude 120 mV).
- Check that the trace height is ⩾ 4.8 div. over the whole freq. range (oscilloscope without housing).
- If oscilloscope is provided with top and bottom cover and warmed up during 30 min. the trace height must be ⩾ 4,5 div. over the whole frequency range.

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

- Set the AMPL/DIV switch S9 (S11) to 2 mV.
- Apply a square-wave signal, frequency 500 kHz, constant amplitude of 12 mV 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 500 kHz to 60 MHz (constant amplitude 12 mV).
- Check that the trace height is ⩾ 4.2 div.

5.5.8.4. Bandwidth check trigger view via EXT

- Depress EXT of S23.
- Apply a sine-wave signal, freq. 500 kHz, constant amplitude 3 V to input EXT (X5).
- Check that the trace height is exactly 6 div.
- Increase the frequency of the input signal to 75 MHz (constant amplitude 3 V).
- Check that the trace height is ⩾ 4 div.
- Remove the input signal.

5.5.8.5. Position range, channel A (B)

- Depress A (B) of S1.
- Depress A (B) of S23.
- Apply a sine-wave signal, freq. 10 MHz, amplitude 2.4 V to input A (B).
- Set the AMPL/DIV switch S9 (S11) to 0.1 V.
- Set the MTB TIME/DIV switch to 0.05 μs.
- Check that the top and bottom parts of the sine-wave can be displayed by means of the POSITION control R1 (R2).
- Check that the displayed sine-wave signal shows no distortion over the whole position range.

5.5.8.6. Common mode rejection

- Set the AMPL/DIV switches S9 and S11 to 0.1 V.
- Apply a sine-wave signal, frequency 1 MHz, amplitude 0.48 V to inputs A and B.
- Depress ALT of S1.
- Adjust the continuous control R7 for minimum trace height difference of the channel A and B signals.
- Pull the NORMAL/INVERT switch S5.
- Depress ADD of S1.
- Set the AMPL/DIV switches S9 and S11 to 20 mV.
- Check that the displayed signal has a trace height of maximum 0.24 div.

5.5.9. X Deflection

5.5.9.1. Sensitivity via EXT

- Set the controls as indicated in fig. 4.1.
- Depress EXT of S23.
- Apply a sine-wave signal, frequency 2 kHz, amplitude 4 V to input EXT (X5).
- Depress X DEFL of S2.
- Check that the trace-width is 8 div. + or −4 subdiv.

5.5.9.2. Bandwidth check of X amplifier

- Apply a sine-wave signal, frequency 1kHz, amplitude 4V, to input EXT.
- Adjust the amplitude of the input signal for a trace-width of exactly 8 div.
- Increase the frequency of the input signal to 100kHz.
- Check that the trace-width is ⩾ 7.8 div.

5.5.9.3. Checking the LINE mode via X DEFL

- Connect the instrument to a mains voltage with a mains frequency of 50 Hz.
- Depress B and EXT (LINE) of S23.
- Check that the trace width is 8 div. (± 0,6 div.).

5.5.9.4. X DEFL sensitivity via channel A and B

- Depress A of S23.
- Depress X DEFL of S2.
- Depress B of S1.
- Apply a sine-wave signal, frequency 2 kHz, amplitude 120 mV to input A.
- Set the AMPL/DIV switch S9 to 20 mV.
- Check that the trace-width is > 5.4 div. and < 6.6 div.
- Depress B of S23.
- Depress A of S1.

- Apply a sine-wave signal, frequency 2 kHz, amplitude 120 mV to input B.
- Set the AMPL/DIV switch S11 to 20 mV.
- Check that the trace-width is $>$ 5.4 div. and $<$ 6.6 div.

5.5.9.5. Phase shift check between X and Y amplifier

- Depress A of S1.
- Depress A of S23.
- Apply a sine-wave signal, frequency 2 kHz, amplitude 120 mV to input A.
- Set the AMPL/DIV switch S9 to 20 mV.
- Check that a line, under an angle of 45^{o} with respect to the horizontal graticule line, is visible.
- Increase the frequency of the input signal to 100 kHz.
- Check that the phase shift is $< 3^{o}$ i.e. d = 2 subdiv, see Fig. 5.8.
- Depress MTB of S2.
- Remove the input signal.

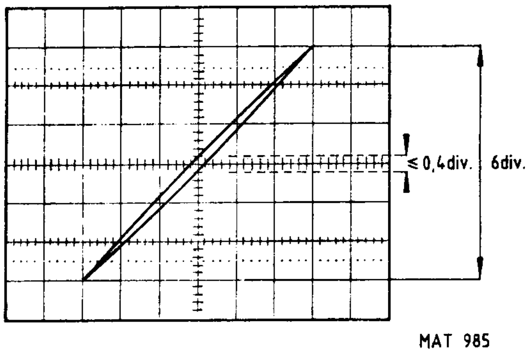


Fig. 5.8. Phase shift between X and Y amplifier

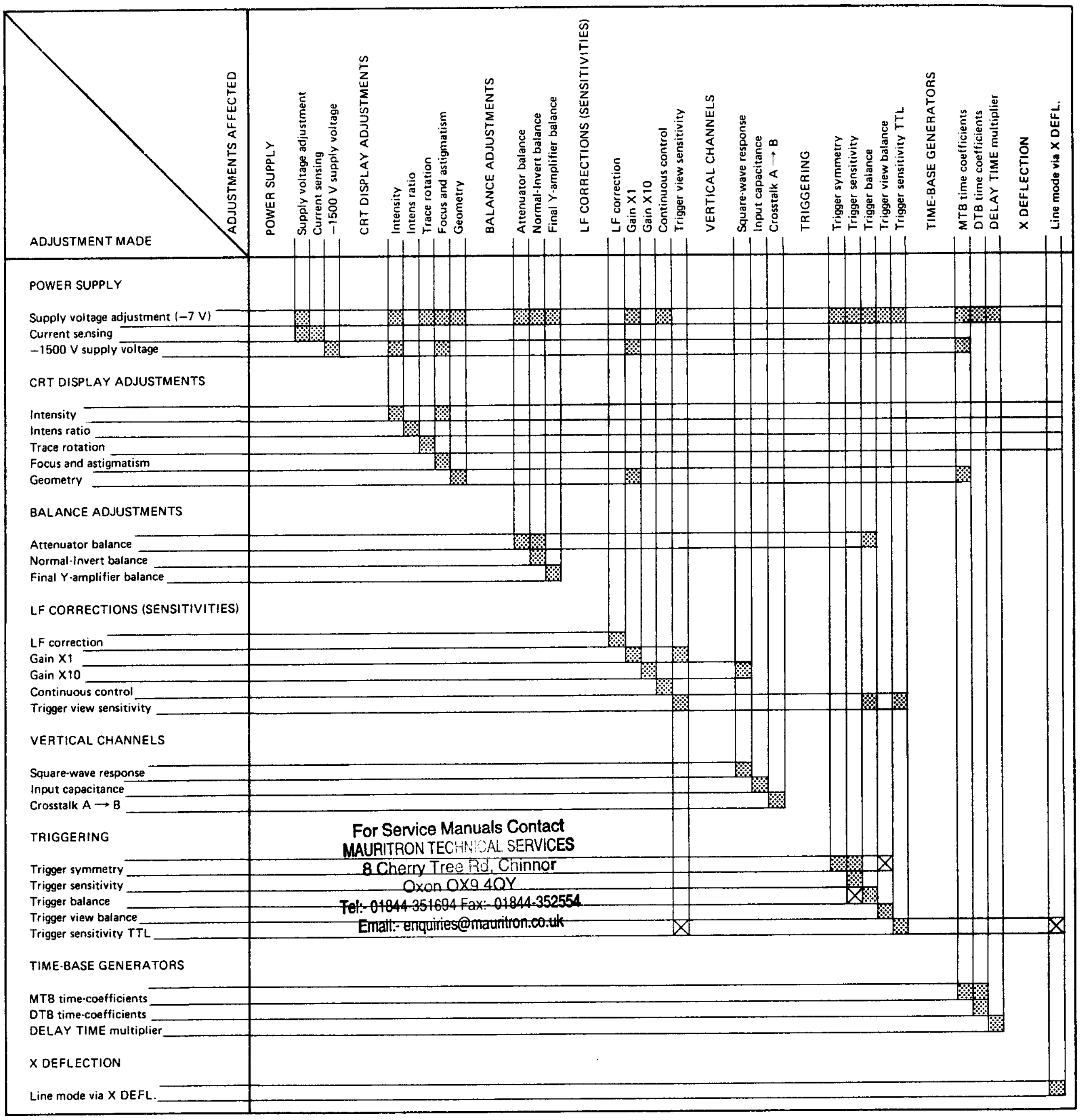
5.5.10. Calibration signal check

- Set the controls as indicated in fig. 4.1.
- Set the AMPL/DIV switch S9 to 20 mV.
- Set the MTB TIME/DIV switch to 0.1 ms.
- Apply the CAL signal via a 10:1 probe to input A.
- Check that the CAL signal has a frequency of ≈ 2 kHz with an amplitude of 1.2 Vpp (6 div.) ± 0.1 %; if necessary readjust **R1549** (unit A5).
- Adjustmentpotentiometer **R1549** can be reached at the bottom side of the oscilloscope after removing the extension shaft of the mains switch. See also fig. 5.2.

5.5.11. Checking the effect of mains voltage variations

- Set the controls as indicated in fig. 4.1.
- Depress CHOP of S1.
- Pull the X MAGN switch S7 (X10).
- Set the MTB TIME/DIV switch S15 to 0.1 ms.
- Apply the CAL signal via a 10:1 probe to input A.
- Vary the mains voltage between + and −10 % of the nominal value.
- Check that neither the trace height nor trace width changes and that the brilliance remains the same.

5.6. ADJUSTMENT INTERACTIONS



☒ If adjusting potentiometer is replaced.

6. CORRECTIVE MAINTENANCE

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 unbreakably 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 instrument's 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:
- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument.

ATTENTION: **Both type of components may only be replaced by components obtained through your local Philips organisation, or representative.**

6.2.3. Transistor, integrated circuits and mos circuits

- Return transistors and I.C.'s to their original positions, if removed during routine maintenance.
- Do not renew or switch semi-conductor devices unnecessary, as it may affect the calibration of the instrument.
- Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket or pcb-holes and cut the leads to the same length as on the component being renewed.
- When a device has been renewed, check the operation of the part of the instrument, that may be affected.
- When re-installing power-supply transistors, use silicon grease to increase the heat-transfer capabilities.

WARNING: **Handle silicon grease with care. Avoid contact with the eyes. Wash hands thoroughly after use.**

6.2.3.1. Static sensitive components (Input MOS - FET's ON905)

This instrument contains electrical components 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.

6.2.3.2. 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 insultates them from external contact.

Testing or handling.

Work on a conductive surface (e.g. metal table top) when testing the circuits or tranfering 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.

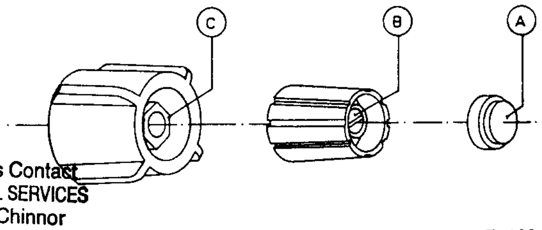
Voltage surges.

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

6.2.4. Replacing knobs

Single knobs and delay time multiplier knob

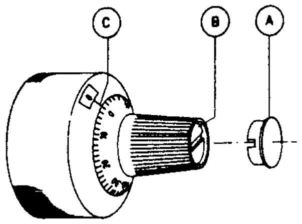
- Remove cap A
- Slacken screw (or nut) B.
- Pull the knob from the spindle.



MAT 163

Double knobs

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



MAT 1513

Fig. 6.1. Removing the knobs.

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.

6.2.5. Replacing the cathode ray tube (CRT)

- Remove the top and bottom cover as indicated in chapter 3.
- Remove the left-hand side plate by means of 4 screws.
- Remove the delay-line cable from the c.r.t. shield.
- Remove the round cover of the CRT socket from the rear panel.
- Remove very carefully the 5 side connections of the CRT.

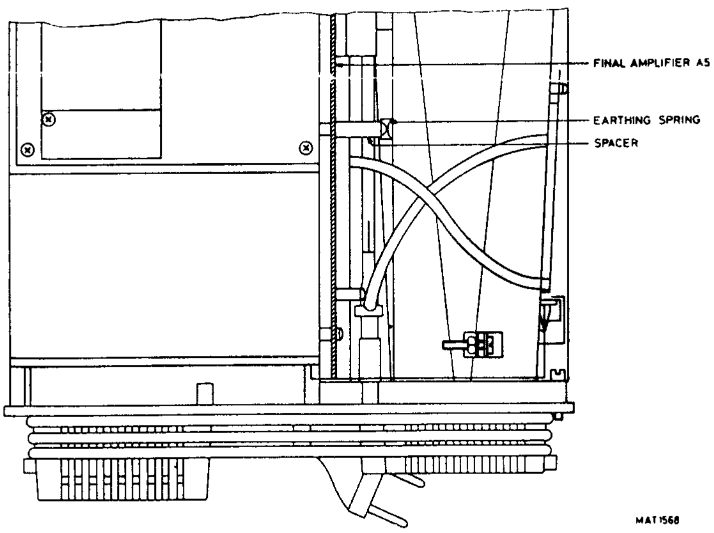
WARNING:	Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode. In particular be very careful with the side connections of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.

- Remove the extension shaft of the mains switch.
- Remove the 3-pole connector that is connected with the trace rotation coil.
- Remove the EHT connector from the CRT and discharge it to the instruments earth (see also chapter 6.1).
- Remove the screw from the bracelet round the CRT neck.
- Slacken the 4 screws that secure the rear panel to the chassis.
- Take the rear panel from the instrument, after disconnecting the supply connector.
- Take the CRT together with its shield out of the instrument after having removed the CRT-socket.
- Slide the CRT out of its shield; take care of the trace rotation coil.

When remounting the CRT and rear-side panel follow the procedure described above in reversed sequence and take care that the c.r.t. is pushed properly against the contrast filter in the front panel before fixing the bracelet round the c.r.t. neck.

6.2.5.1. Improved earthing of the c.r.t. shielding

IMPORTANT: **To prevent HF oscillations on the trace, the earthing of the c.r.t. shielding is changed during production of the PM 3256/05. The best performance is reached when the shielding of the c.r.t. is earthed as indicated in the figure below.**



Part of top view

6.2.6. Removing the printed circuit boards

6.2.6.1. Removing the trigger source unit (see fig. 6.4A)

- Remove the front rubber band (refer to chapter 3.2). Bear in mind that this rubber band is equipped with 8 studs, that must be removed from the slits in the front panel.
- 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.

6.2.6.2. Removal of pre-amplifier and trigger unit

- Remove the trigger source unit as indicated in chapter 6.2.6.1. (see also fig. 6.4.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.
- Remove the 2 screws in the pushbutton switches that secure the unit to the front panel.
- Remove the metal screening plate from the attenuator part. This plate is attached by means of 6 self-tapping screws (see also fig. 6.4.B).
- Remove the 6 fixing screws, that are equipped with isolation washers.
- Remove the intensity-unit bracket by lifting it out of the chassis.
- Lift the unit in the direction indicated in fig. 6.4.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. 6.5.).
- Take the unit out of the instrument in the direction indicated in fig. 6.4.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.

6.2.6.3. Removal of time base unit

- Remove the front rubber. Bear in mind that this rubber band is equipped with 8 studs, that must be removed from the slits in the front panel.
- Remove the screening-plate.
- Unplug 5 coaxial cables.
- Unplug 2 single wire connectors (blue wire of x216, 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 fixes also the screening-plate.
- Remove the 4 screws in the pushbutton switches that secure the unit to the front panel.
- Lift the unit in the direction indicated in fig. 6.2.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. 6.3).
- Take the unit out of the instrument in the direction indicated in fig. 6.2.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.

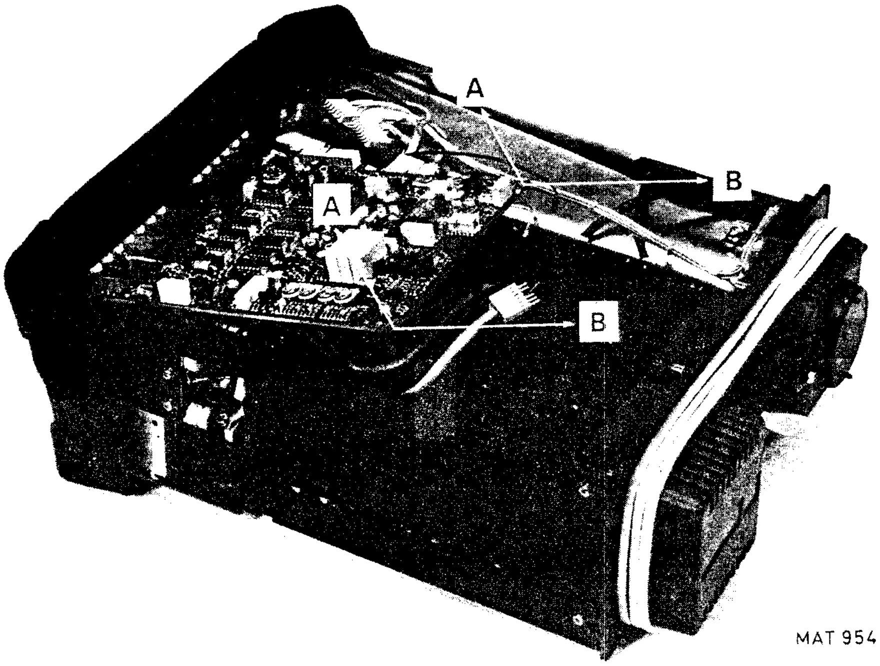


Fig. 6.2. Removal of time-base unit

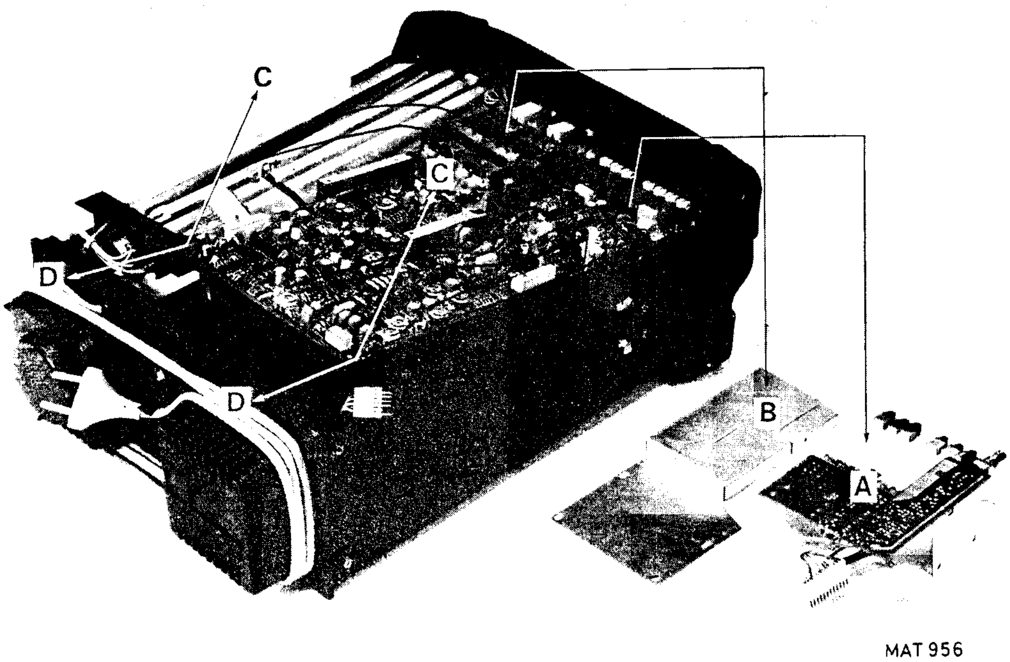


Fig. 6.4. Removal of pre-ampl. and trigger unit

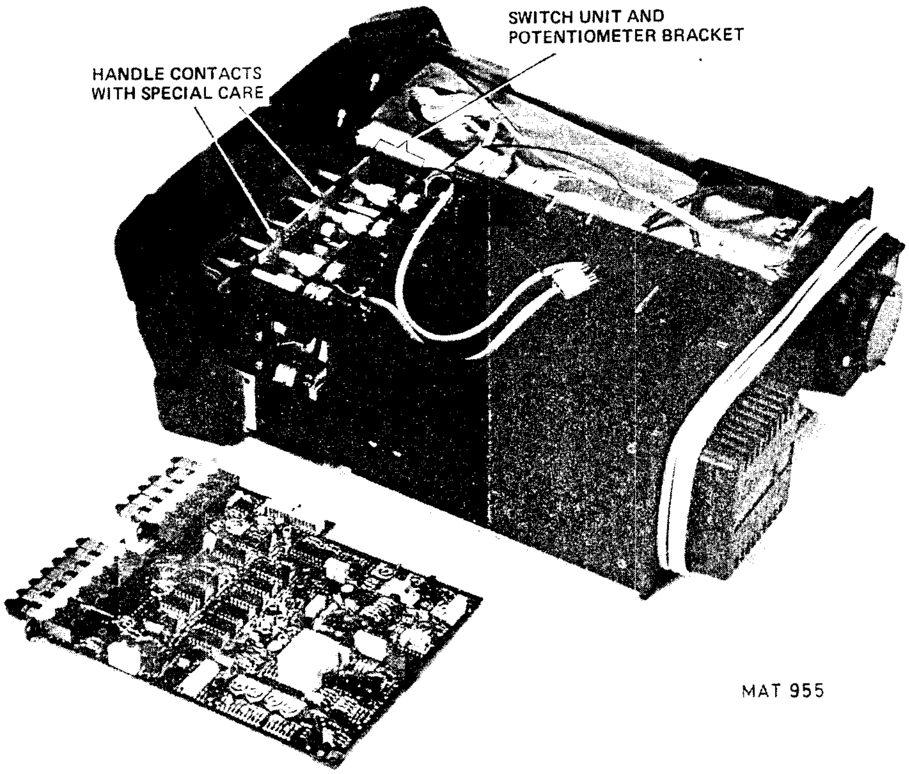


Fig. 6.3. Time-base unit removed

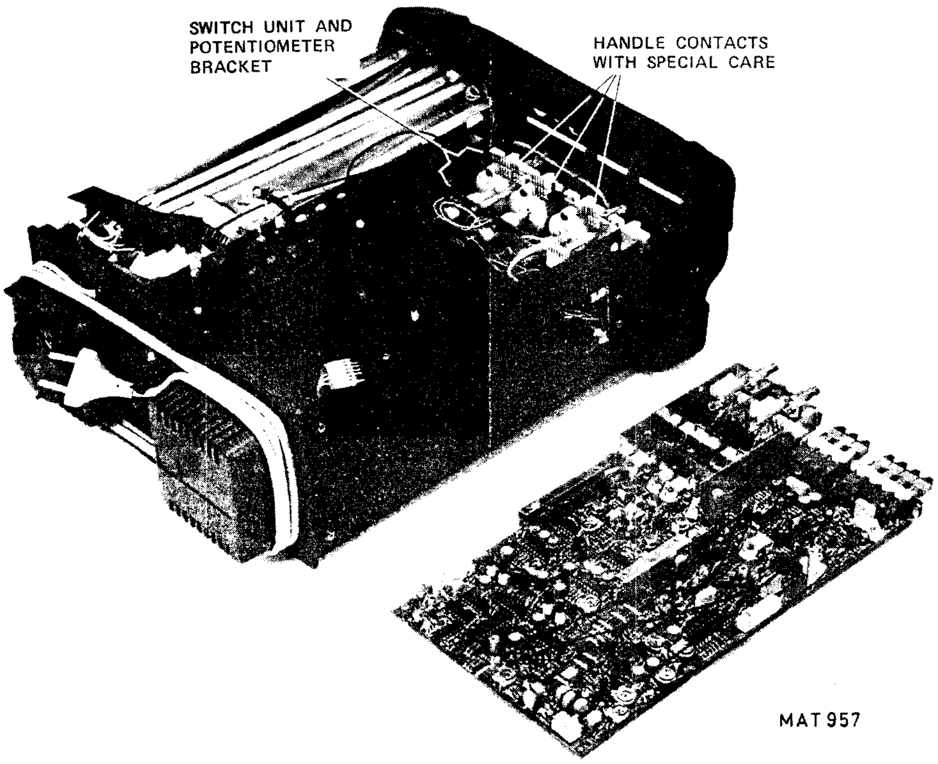


Fig. 6.5. Pre-ampl. and trigger unit removed

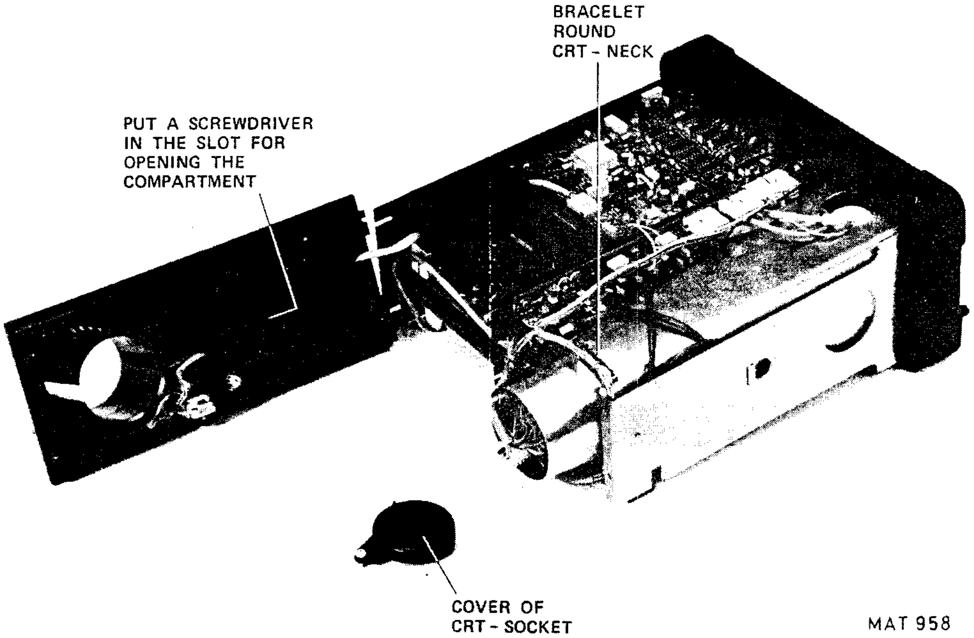


Fig. 6.6. Removal of rear panel

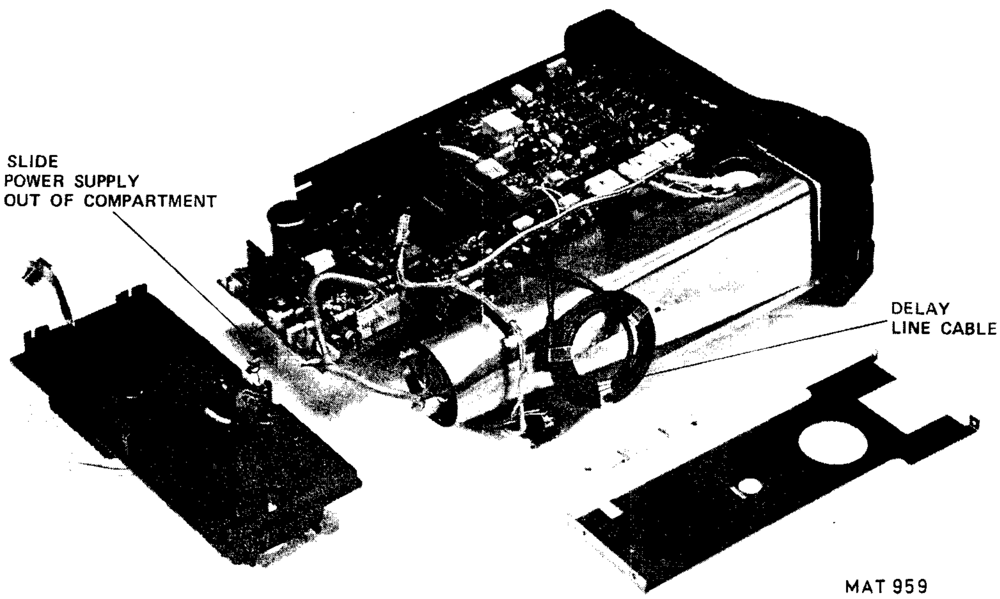


Fig. 6.7. Removal of power supply

6.2.6.4. Removal of switch unit and potentiometer unit

- Remove the time base unit as indicated in chapter 6.2.6.3.
- Remove the trigger source unit as indicated in chapter 6.2.6.1.
- Remove the pre-amplifier and trigger unit as indicated in chapter 6.2.6.2.
- Remove one multipole connector from the final amplifier 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.**

6.2.6.5. Removal of power supply and mains transformer

- For extra information refer to fig. 6.6 and 6.7.
- Remove the round cover of the CRT-socket from the rear panel.
- Remove the front rubber. Bear in mind that this rubber band is equipped with 8 studs, that must be removed from the slits in the front panel.
- Remove the left-hand metal plate by removing 4 screws.
- Remove - if required - the screw that secures the power supply to its compartment. This screw is attainable via a hole in the pre-amplifier and trigger unit.

NOTE: This screw also earthens the power supply. When remounting the supply, fix this screw as strong as possible.

- Remove the extension shaft from the mains switch.
- Remove the screw from the bracelet round the CRT-socket.
- Slacken the 4 screws that attach the rear panel to the chassis.
- Take the rear panel from the chassis, and take care that the CRT stays on its place.
- Plug the multipole connector out of the power supply that connects this unit with the rear panel.
- The mains transformer can be reached after removal of the cap of the compartment of the rear panel. This cap can be removed with a screwdriver in the slot of the cap.
- Remove one multipole connector from the pre-amplifier and trigger unit and 2 multipole connectors from the power supply.
- Remove the tyre-wrap that secures the focus cable to the H.V. multiplier cable.

IMPORTANT: **After remounting the unit, this focus cable must be secured such as in the original situation in order to prevent focus modulation.**

- Slide the unit gently out of its compartment and remove — if necessary — the two wires from the EHT multiplier unit.
- For removal of the EHT unit click it out of the two slits of the power supply compartment. For removal of the post-accelerator connection wire it is necessary to remove the time base unit according to chapter 6.2.6.3.
  After having removed the post-accelerator connection from the CRT, discharge it to the instrument's earth (see also chapter 6.1).

6.2.6.6. 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.
For this proceed as follows: Remove the mains transformer out of its compartment. 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.

6.2.6.7. Removal of final amplifier unit

- Unplug 3 multipole connectors.
- Unplug 2 single-wire connectors from the time base.
- Remove very carefully the 5 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 the outputs of the delay-line cable and unscrew the attachment bracket.
- Unplug the last multipole connector from the short side of the unit.
- 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.
- Unplug 1 coaxial cable.
- Take the unit out of the instrument.

When remounting follow the procedure above in reversed sequence.

6.2.6.8. Removal of potentiometer from potentiometer unit

- For R7, R8, R9, R10 and R11: remove the pre-amplifier and trigger unit according to chapter 6.2.6.2.
  For R1, R2, R3, R4, R5 and R6: remove the time base unit according to chapter 6.2.6.3.
- 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.

6.2.6.9. Removal of coupling piece

- Remove the potentiometer according to chapter 6.2.6.8.
- 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.

6.2.6.10. Removal of the stand-up stop-block and the stand-up

- Push by means of a pair of pliers the front side clamping lip backwards and lift the block out of the bottom cover.
- Remove both stop-blocks.
- Pull the stop-blocks from the stand-up.

For reassembling:

- Slide both stop-blocks on the stand-up.
- Push both stop-blocks first with their rear-sides in the bottom cover.
- Push by means of a screw-driver the front-sides of the stop-blocks in the bottom cover.

6.2.7. Soldering techniques

Working method:

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

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250°C. The use of solder with a low melting point is therefore recommended.
Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150°C)

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

Suitable soldering irons are:

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

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

6.3. 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 damage 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.

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

6.6.1. MTB and DTB gate

For these options it is necessary to install coax sockets X209 and X211 and 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 coax sockets and BNC sockets and coaxial cables see the parts list in chapter 7.
For MTB gate: mount coax socket X209 and resistor R270 (33,2Ω, 5322 116 50527) on the time base unit.
For DTB gate: mount coax socket X211 and close the soldering bridge inbetween D207/6 and D208/5,6 on the time base unit.

6.6.2. MTB sweep out

For this option it is necessary to install a number of components in the way indicated on the time base p.c.b. lay-out (see fig. 8.7).

R352	1K/MR25	5322 116 54549
R353	1K27/MR25	5322 116 50555
R354	5E11/MR25	5322 116 54192
V267	BC548C	4822 130 44196
C252	15UF/40 V	4822 124 20709
C266	10NF	4822 121 41134
X218	Coax socket, outer part	5322 268 24116
	Coax socket, contact pin	5322 268 14141

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.

6.6.3. TV or ECL triggering (see Fig. 8.4.)

The modifications necessary for these options are indicated in the table on the circuit diagram of the MTB triggering. The modifications must be carried out on the pre-amplifier and trigger unit. On the pre-amplifier and trigger unit p.c.b. lay-out is indicated where the modified components are located (see Fig. 8.1.).
For the TV trigger mode a number of components must be added of which the ordering number is listed below:

V869	BF199	4822 130 44154
V871	BC548C	4822 130 44196
V899	BC548C	4822 130 44196
V898	BC548C	4822 130 44196
V909	BC548C	4822 130 44196
V908	BC558B	4822 130 44197
V894	BAW62	4822 130 30613

To change the text TTL on the textplate into ECL or TV the stickers:
ECL ordering number 5322 455 81021
TV ordering number 5322 455 81022
must be used.

Specifications of TV triggering

Trigger sensitivity:

Internal TV	0,7 div. sync. pulse max. 8 div. (24 div. TV signal)
External TV	350mV sync. pulse
Frame	In 0,5s/div. - 50μs/div. main time-base settings.
Line	In 20μs/div. – 50ns/div. main time-base settings

Specifications of ECL triggering

Trigger sensitivity:

Internal ECL	ECL level in 0,5V/div.
External ECL	Not specified

6.6.3.1. Adjustment procedure ECL triggering

After the instrument is changed from TTL into ECL triggering the following must be readjusted:

a. *Trigger view sensitivity via EXT, channel A and B*
- Set the controls as indicated in fig. 4.1.
- Set the MTB TIME/DIV switch S15 to 50 μs.
- Apply a square-wave signal, freq. 10 kHz, ampl. exactly 1,2 V to input EXT (X5), A (X2) and B (X4).
- Depress TRIG VIEW of S1.
- Depress TRIG and AUTO of S3.
- Depress EXT of S23.
- Set the trace in the vertical centre by means of the LEVEL control R6.
- Check that the trace height is 6 div. + or −0.9 subdiv.; if necessary readjust **R1104** (fig. 5.2).
- Depress A of S23.
- Set the AMPL/DIV switches S9 and S11 to 0.2 V.
- Check that the trace height is exactly 6 div.; if necessary readjust **R958** (fig. 5.2.).
- Depress B of S23.
- Check that the trace height is exactly 6 div.; if necessary readjust **R961** (fig. 5.2.).

b. *Trigger sensitivity*
- Set the controls as indicated in fig. 4.1.
- Set S9 and S11 to 0.5 V.
- Depress AUTO and TRIG of S3.
- Depress ECL of S20.
- Depress A of S23.
- Set S15 to 20 μs.
- Apply a sine-wave signal, amplitude 2 V, frequency 10 kHz to the input A.
- Set the start of the trace on the vertical and horizontal centre lines of the screen by means of the controls R1 and R5.
- Pull and push the SLOPE switch S8.
- Check that the gap between the starting points of the traces is exactly 1 div.; if necessary readjust **R388** (fig. 5.1).

c. *Trigger symmetry*
- Readjust **R1054** as described in section 5.5.6.1.

d. *Trigger balance channel A, B and EXT*
- Depress TRIG VIEW of S1.
- Depress AUTO and TRIG of S3.
- Depress 0 of S17 and S18.
- Depress LF of S20.
- 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 **R1134** (see fig. 5.2).

e. ECL level and COMP balance

- Depress A of S1.
- Depress A of S23.
- Set the trace in the vertical centre of the screen by means of R1.
- Depress DC of S17.
- Apply a sine-wave signal, frequency 10 kHz to input A.
- Set the trace-height to 6 div.
- Set S15 to 10 μs.
- Depress ECL of S20.
- Depress 0 of S17.
- Set the starting point of the trace in the vertical and horizontal centre of the screen by means of the controls R1 and R5.
- Depress DC of S17.
- Push the switch S8 for positive triggering.
- Adjust starting point of trace symmetrically around –2,6 div (from mid of screen) with **R907** when operating MTB SLOPE S8.
- Depress A and B(COMP) of S23.
- Adjust starting point of trace symmetrically around –2,6 div (from mid of screen) with **R964** when operating MTB SLOPE S8.

f. Trigger view balance

- Readjust according section 5.5.6.5.

g. Trigger balance, DTB, via channel A and B

- Readjust according section 5.5.6.6.

6.6.3.2. Adjustment procedure T.V. triggering

After the instrument is changed from TTL into T.V. triggering the following must be readjusted.

a. Trigger view sensitivity via EXT, channel A and B

- Readjust according section 6.6.3.1.a. (ECL).

b. Trigger symmetry

- Readjust according section 5.5.6.1.

c. Trigger sensitivity

- Set the controls as indicated in fig. 4.1.
- Apply a sine-wave signal, frequency 10 kHz to input A (X2).
- Set the trace height to 0.4 div.
- Check that the signal is triggered; if necessary readjust **R388** (fig. 5.1).
- Pull the SLOPE switch S8 for negative triggering.
- Check that the signal is triggered; if necessary readjust **R388** (fig. 5.1).

d. Trigger balance channel A, B and EXT

- Readjust according section 6.6.3.1.d. (ECL).

e. COMP balance

- Depress A of S1.
- Depress A of S23.
- Set the trace in the vertical centre of the screen by means of R1.
- Depress DC of S17.
- Set S9 to 0.2 V.
- Apply a sine-wave signal, frequency 10 kHz to input A.
- Set the trace-height to 4 div.
- Set S15 to 10 μs.
- Depress DC of S20.
- Push SLOPE switch S8.
- Set the start of the trace on the vertical centre line by means of R6.
- Depress A and B (COMP) of S23.
- Check that the trace starts on the vertical centre line; if necessary readjust **R964** (fig. 5.2).

f. Trigger view balance

- Readjust according section 5.5.6.5.

g. Trigger balance, DTB, via channel A and B.

- Readjust according section 5.5.6.6.

6.6.3.3. Checking procedure TV triggering

- Apply a video signal to input A (B) (see table)
- Check the trigger sensitivity in accordance with the table below.

S23 TRIGGER SOURCE	S20 TRIGGER MODE	S8 SLOPE	TRACE HEIGHT	SHAPE	S15 TIME/DIV MTB
A (B)	TV	+	0,3 div. sync. pulse	+ video	50μs (FRAME)
A (B)	TV	+	0,3 div. sync. pulse	+ video	20μs (LINE)
A (B)	TV	–	0,3 div. sync. pulse	– video	
A (B)	TV	+	8 div. sync. pulse	+ video	

- Check the switching between 50μs (FRAME) and 20μs (LINE) of the TIME/DIV. switch S15.

6.7. ACCESSORY INFORMATION

6.7.1. Adjustments of the passive probes PM8927A

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. 6.14) can be adjusted through a hole in the compensation box to obtain optimum square-wave response. See Fig. 6.8, 6.9 and 6.10.

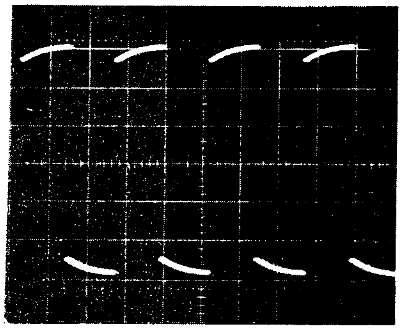


Fig. 6.8. Over-compensation (adjustment C2)

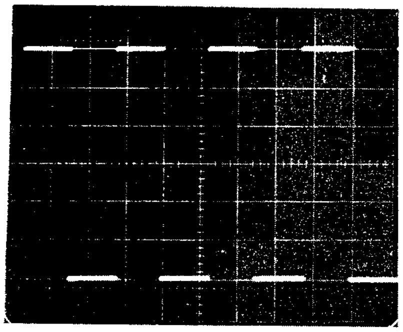


Fig. 6.9. Correct-compensation (adjustment C2)

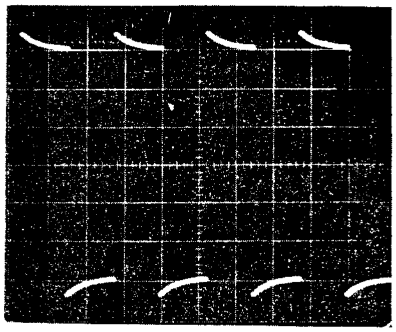


Fig. 6.10. Under-compensation (adjustment C2)

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 1 ns) which is terminated by its characteristic impedance. Dismantle the compensation box. Set the generator to 100 kHz. Adjust R2 and R3 alternatively to obtain a display as shown in Fig. 6.11.
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. 6.12 en 6.13.

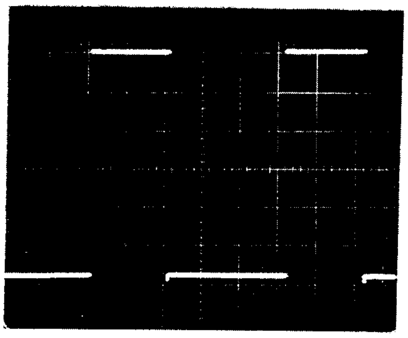


Fig. 6.11. Preset potentiometers correctly adjusted

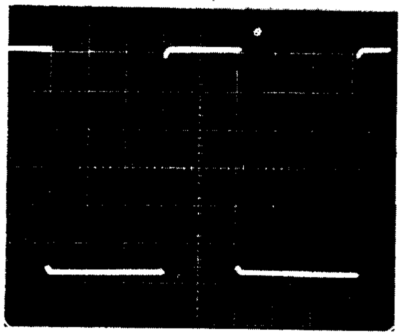


Fig. 6.12. Rounding due to incorrectly adjusted potentiometers

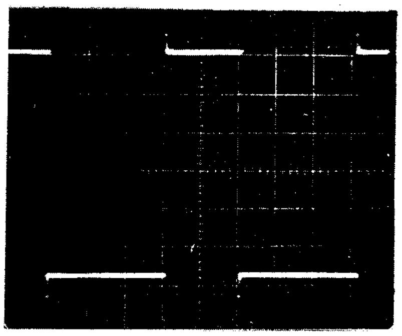


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Fig. 6.13. Overshoot due to incorrectly adjusted potentiometers

6.7.2. Dismantling

Dismantling the probe (see Fig. 6.14)

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. 6.14)

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.

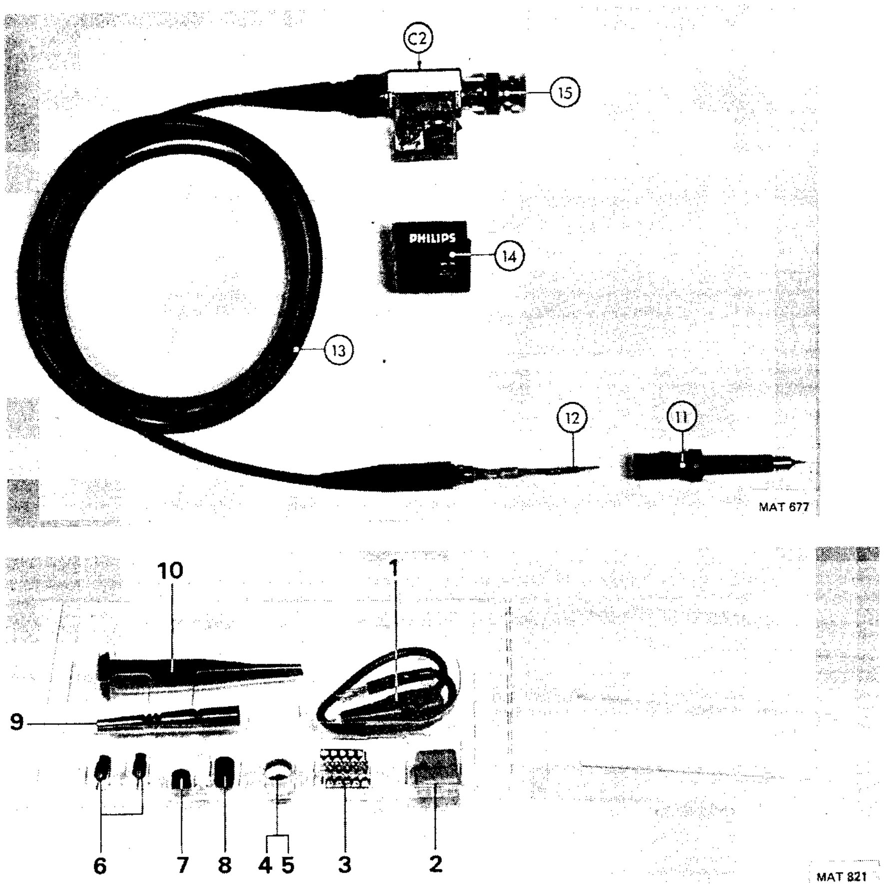

Fig. 6.14. Dismantling + accessories

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.

6.7.5. Parts lists

Mechanical parts (see Fig. 6.14 and 6.15)

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	5322 255 44026	10	Soldering terminals which may be incorporated in circuits as routine test points
4/5	5322 532 64223	6	Set marking rings
6	5322 268 14017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	5322 462 44318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	5322 264 24018	1	Wrap pin adaptor
10	5322 264 24019	1	Spring-loaded test clip
11	5322 264 24021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network
13	5322 320 14063	1	Cable assembly
14	5322 447 61006	1	Cap
15	5322 268 44019	1	BNC connector

Electrical parts

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

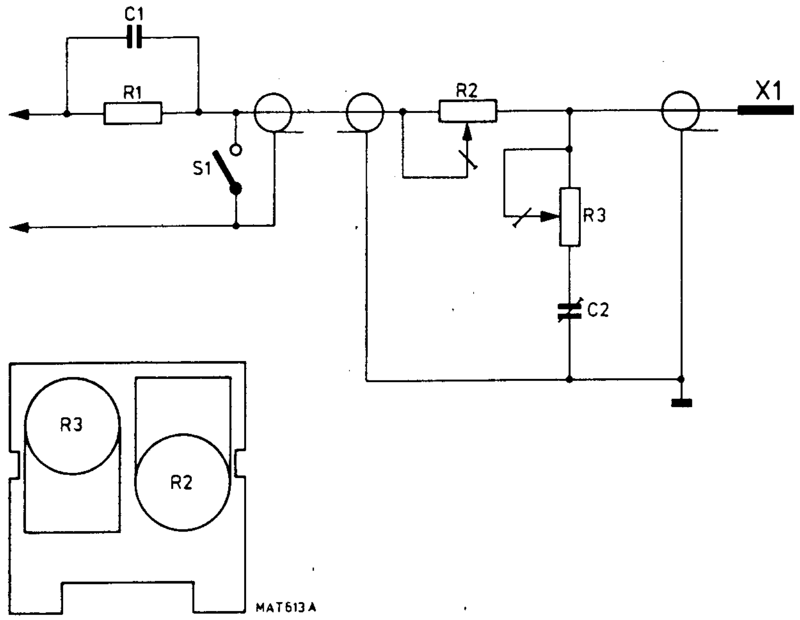

Fig. 6.15. Printed-wiring board showing adjusting elements, circuit diagram.

6.8. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

6.8.1. General directives

- Take care that the creepage distances and clearances have not been reduced.
- Before soldering, the wires should be bent through the holes of solder tags, or wrapped around the tag in the form of an open U, or, wiring ridigity shall maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

6.8.2. Safety components

Components in the primary circuit may only be renewed by components selected by Philips, see also clause 6.2.2.

6.8.3. Checking the protective earth connection (in instruments with a three-core 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/frame. The resistance shall not be more than 0,1 Ω
During measurement the mains cable should be removed.
Resistance variations indicate a defect.

6.8.4. Checking the insulation resistance

Measure the insulation resistance at U = 500V dc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2MΩ.

NOTE: 2MΩ. is a minimum requirement at 40°C and 95% Relative Humidity. Under normal conditions the insulation resistance should be much higher (10 ... 20MΩ).

6.8.5. Checking the leakage current

The leakage current shall be measured between each pole of the mains supply in turn, and all accessible conductive parts connected together (including the measuring earth terminal).
The leakage current is not excessive if the measured currents from the mentioned parts is $\leqslant$ 3,5mA rms.

(For safety class II instruments this is $\leqslant$ 0,7mA rms).

6.8.6. Voltage test

The instrument shall withstand, without electrical breakdown, the application of a test voltage between the supply circuit and accessible conductive parts that are likely to become energized.
The test potential shall be 1500V rms at supply-circuit frequency, applied for one second.
The test shall be conducted when the instrument is fully assembled, and with the primary switch in the ON position.
During the test, both sides of the primary circuit of the instrument are connected together and to one terminal of the voltage test equipment; the other voltage test equipment terminal is to be connected to the accessible conductive parts.

(For class II instruments the test potential shall be 3000V rms).

7. PARTS LIST

Subject to alteration without notice

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

Item	*Ordering number*	*Description*
Fig. 7.1.		
1	5322 414 30004	Knob with dial (used for "delay time")
2	5322 414 20034	Pushbutton brown/green (32 pcs/instr.)
3	5322 414 20033	Pushbutton brown (used for "single")
4	5322 447 90408	Top cover, brown
5	5322 498 50129	Strap, complete
	5322 498 70061	Strap fastener (to lock the strap in the rear side ventilation holes)
6	5322 447 90409	Bottom cover (without stand-up bracket), brown
7	5322 414 70016	Cap, brown with line
	5322 414 30044	Knob, dia 10 mm, brown
7A	5322 414 30047	Hold-off knob, brown
	5322 492 64337	Fixing spring for Hold-off knob
8	5322 414 70018	Cap, blue with line
	5322 502 80006	Screw, selftapping
	5322 414 30065	Knob, dia 10 mm (short), brown
	5322 414 30045	Knob, dia 19 mm, brown
9	5322 267 10004	BNC input socket (used for A, B and EXT TRIG)
10	5322 462 10207	Stand-up bracket
	5322 462 40535	Stand-up stop-block (fastening piece)
11	5322 532 20752	Screw (used for "trace rotation")
12	5322 414 74015	Cap, grey with line
	5322 502 80006	Selftapping screw
	5322 414 30065	Knob, dia 10 mm (short), brown
13	5322 480 30151	Removeable contrast filter, blue
	5322 480 30155	Yellow-green contrast filter (for PM3256-G version)
	5322 492 62993	Plastic spring for contrast filter
14	5322 447 90407	Front panel PM3256 (brown)
15	5322 466 60837	Rubber band, front
16	5322 446 60838	Rubber band, rear
Fig. 7.2.		
17	5322 263 40045	Mains voltage adapter + fuse holder (S25)
	4822 253 30017	Fuse 5 x 20 mm/500 mA
18	5322 462 40664	Cover of CRT-socket, brown
19	4822 321 10301	Mains cable
	5322 290 40196	Mains cable clamp for two-cored mains cable
	5322 290 40197	Mains cable clamp for three-cored mains cable
	5322 325 64083	Cleat for mains cable
	5322 321 20816	Mains cable PM3256P (British version)
	5322 321 10331	Mains cable PM3256U (U.S.A. version)
	5322 325 50108	Cable cleat for PM3256P and PM3256U
20	5322 267 10004	BNC socket (X6 Z-mod.)
21	4822 265 20051	24 Volt, Battery input socket
22	5322 447 90411	Rear panel, brown

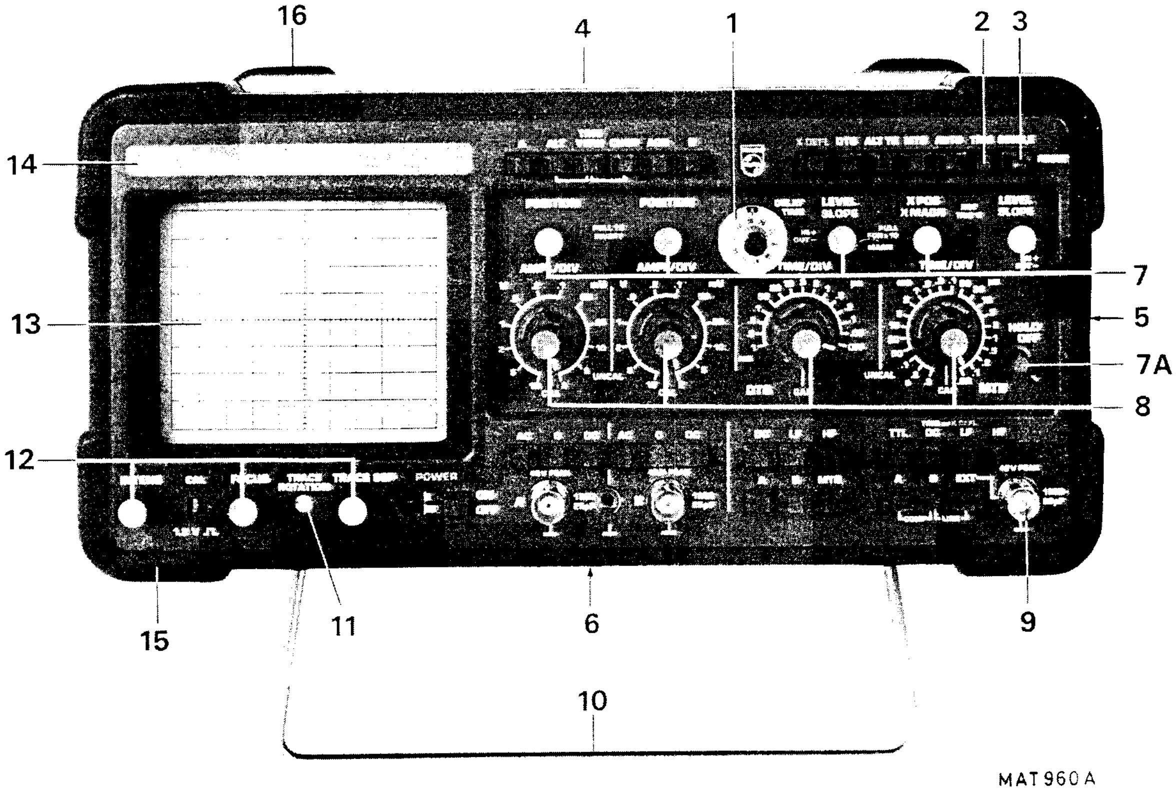

Fig. 7.1. Mechanical parts, front view

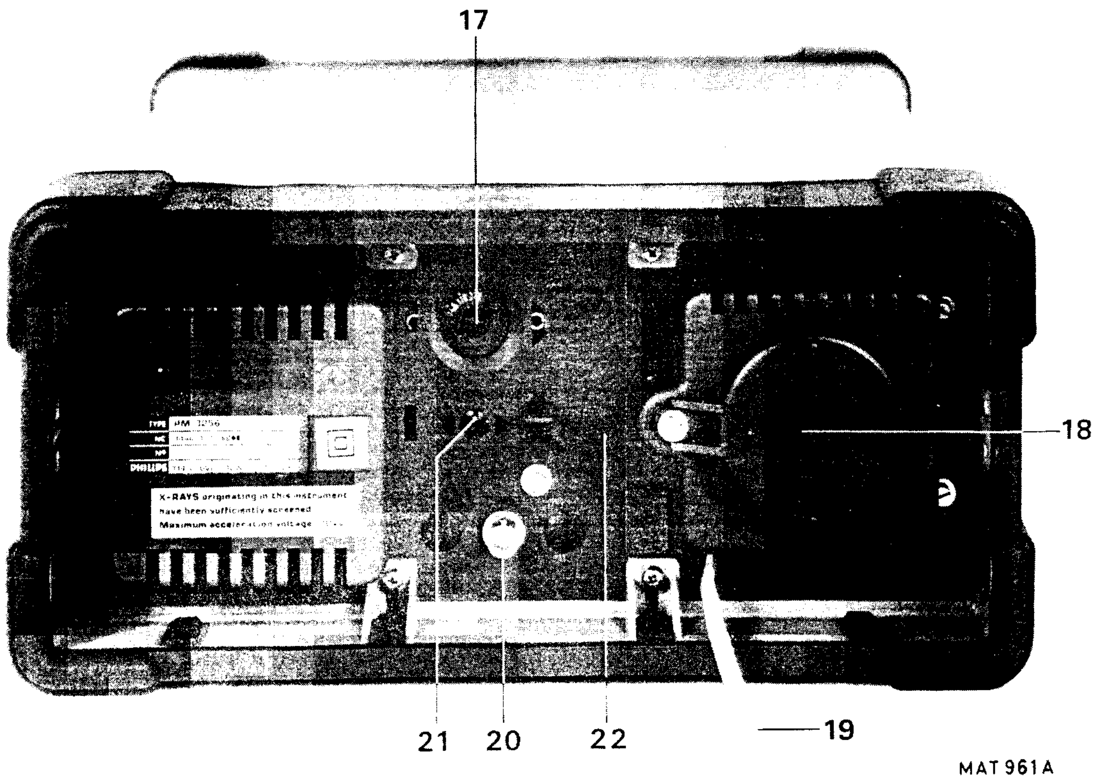

Fig. 7.2. Mechanical parts, rear view

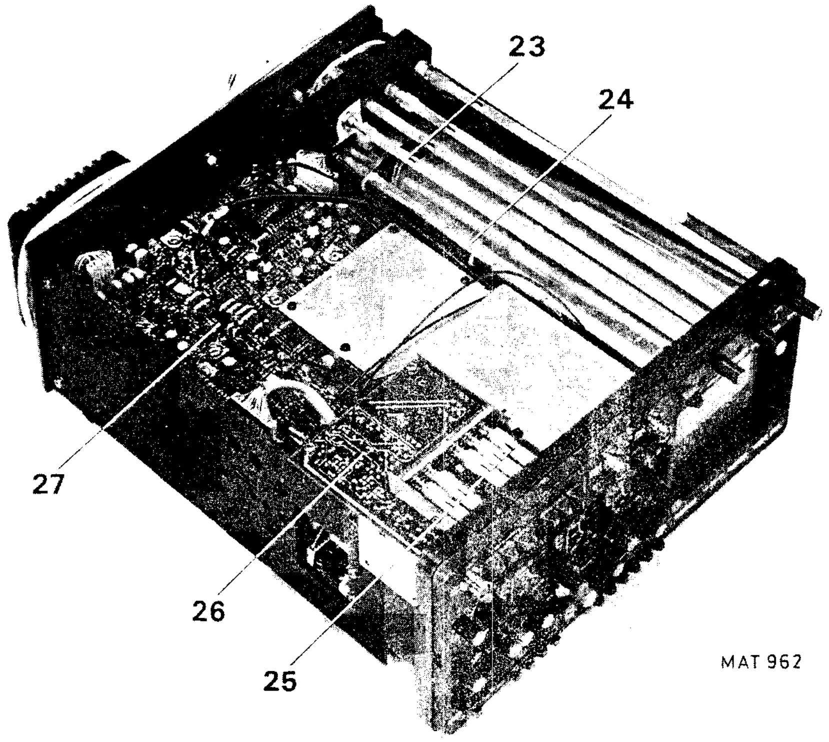

Fig. 7.3. Internal view of bottom side of instrument

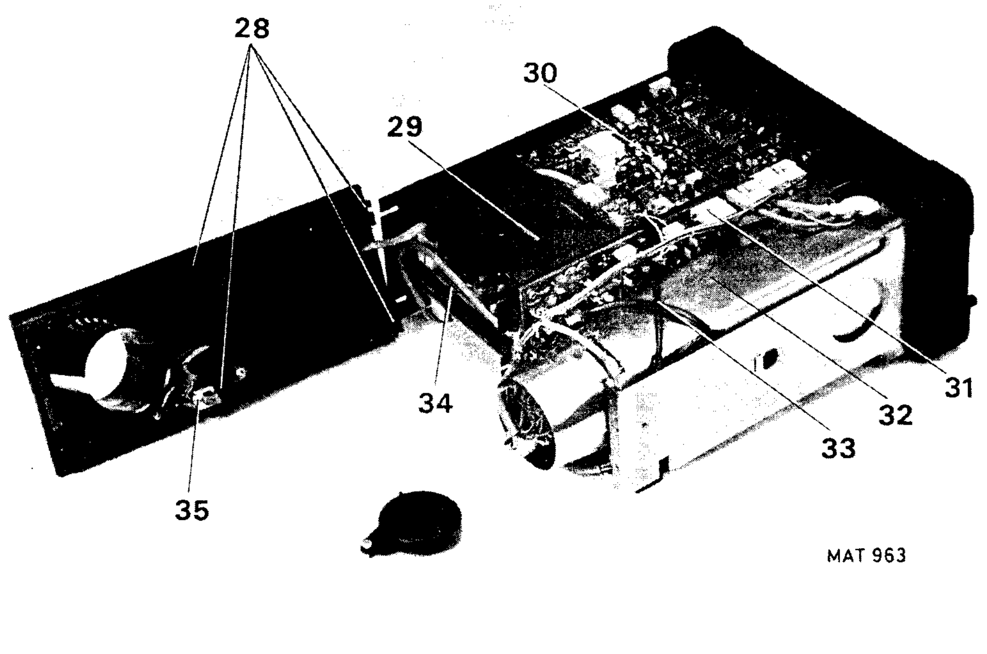

Fig. 7.4. Internal view with rear panel removed

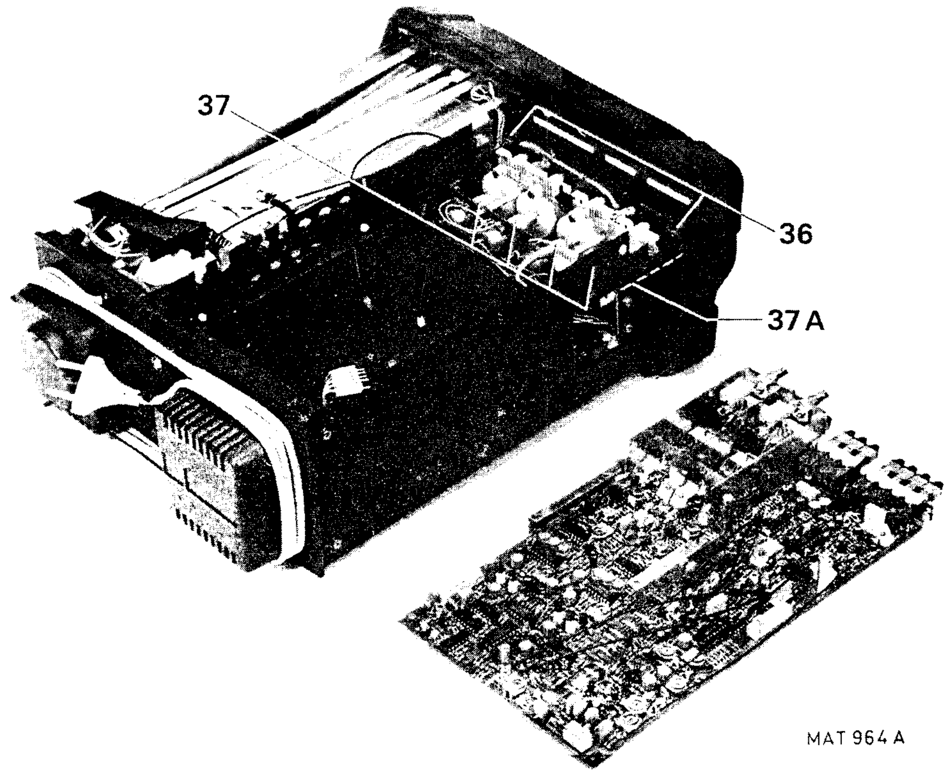

Fig. 7.5. Internal view with pre-amplifier and trigger unit removed

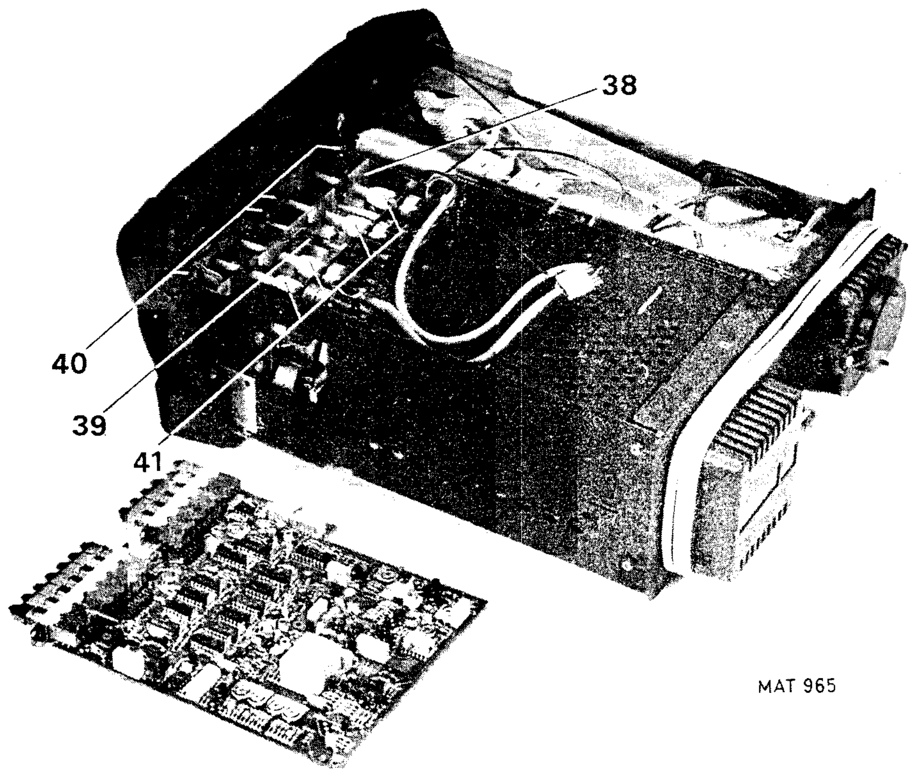

Fig. 7.6. Internal view with time-base unit removed

Item	*Ordering number*	*Description*
Fig. 7.3.		
23	5322 535 91575	Extension shaft (used for "intens, focus, trace sep").
	5322 535 94925	Extension shaft (used for "trace rotation").
24	5322 535 91233	Extension shaft (used for "power on")
25	5322 535 91232	Extension shaft (used for trigger source selection)
26	5322 216 51059	Trigger selector unit/unit A4
27	5322 216 51109	Pre-amplifier and trigger unit A3
Fig. 7.4.		
28	5322 466 80812	Plate 10x10 mm with M3-thread (fixes rear panel to chassis)
29	5322 320 20119	EHT multiplier unit
30	5322 216 51108	Time base/unit A2
31	5322 216 51027	Final amplifier/unit A5
32	5322 532 80667	CRT shield
33	5322 320 40068	Delay line cable/unit A8
34	5322 216 51028	Power supply/unit A6 (bridge-rectifier on mains transformer)
	5322 218 61013	Power supply/unit A6 (rectifier diodes on p.c.b.)
35	5322 276 10922	Mains switch (S21)
Fig. 7.5.		
36	5322 466 80812	Plate 10x10 mm with M3-thread (fixes front panel to pushbutton switch S17 ... S20)
	5322 502 21001	Special screw M3
37	5322 535 91234	Plastic shaft (continuous controls) (for short knobs)
	5322 492 62451	Fixing spring, plastic
	5322 532 60765	Coupling bush, plastic
	5322 528 20333	Coupling disc, plastic
37A	5322 535 91235	Plastic shaft (hold-off)
Fig. 7.6.		
38	5322 270 10048	Switch unit, complete (see OSC 198, 9499 448 28011)
	5322 265 40186	Pin connector, 4 double pins (X204, X867, X501, X502 and X651)
	5322 265 40187	Pin connector, 7 double pins (X213)
39	5322 528 20338	Coupling piece for delay time
40	5322 466 80812	Plate 10x10 mm with M3-thread (fixes front panel to pushbutton switch S1 ... S3)
	5322 502 21001	Special screw M3
41	5322 535 91415	Alu shaft (POSITION A and B, X MAGN, LEVEL MTB, LEVEL DTB)
	5322 492 62451	Fixing spring, plastic
	5322 532 51241	Coupling bush, plastic
	5322 528 20333	Coupling disc, plastic
	4822 530 70043	Spring washer, metal

Additional information for PM3256-G version

The PM3256-G is a normal PM3256 instrument with a special c.r.t. type D12-120GM-115.
This c.r.t. has a longer persistence time than the standard version.
Together with this c.r.t. another contrast filter (yellow/green) is installed.

Ordering numbers:	D12-120GM-115	5322 131 20112
	yellow/green contrast filter	5322 480 30155

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

Ordering number	*Description*
FRONT COVER AND FIXING MATERIALS	
5322 447 90406	Front cover box
5322 417 20115	Lock for front cover
5322 505 10698	Nut for lock and side brackets
5322 502 11524	Screw for lock
5322 502 21086	Bold headed Allen screw (for locking bracket)
5322 405 70002	Bracket for lock (right- and left handside of the oscilloscope)
CABLES AND CONNECTORS	
5322 268 24116	Coaxial socket (p.c.b. type) X206, X207, X208, X209, X211, X212, X806, X861, X862, X868, X869, X1504, X1551
5322 268 14141	Contact pin for coaxial socket, X206, X207, X208, X209, X211, X212, X806, X861, X862, X868, X869, X1504, X1551
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)
5322 265 54006	20 pole-Cis connector, female, p.c.b. type. This connector must be sawn on the required size for: X807, X852, X858, X1406, X1501, X1502, X1503, X1401 and X1407
5322 267 50343	Double 4-pole cis connector, female, p.c.b. type, bottom entry, X204 (unit A2) X501, X502, X651, X867 (unit A3)
5322 267 50341	Double 7-pole cis connector, female, p.c.b. type, bottom entry, X213 (unit A2)
5322 267 64031	8-pole cis connector, female, p.c.b. type. This connector must be sawn on the required size for: X214, X851.
5322 267 64027	8-pole cis connector, female p.c.b. type. This connector must be sawn on the required size for: X201, X202, X203 and X1506
5322 267 64007	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
5322 265 40186	Double 4 pin cis contact block (male header) X204, X501, X502, X651, X867 (switch unit)
5322 265 40187	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

CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE
C 201	33UF-10+50	16	4822 124 20688
C 202	33UF-10+50	16	4822 124 20688
C 204	10NF-20+50	100	4822 122 31414
C 206	10NF-20+50	100	4822 122 31414
C 207	6,8UF 20%	25V	5322 124 14081
C 208	10NF-20+50	100	4822 122 31414
C 209	10NF-20+50	100	4822 122 31414
C 211	10NF-20+50	100	4822 122 31414
C 212	1NF-20+50	100	4822 122 30027
C 213	10NF-20+50	100	4822 122 31414
C 216	10NF-20+50	100	4822 122 31414
C 218	47NF 10%	160V	4822 121 41676
C 219			5322 121 54229
C 220	10NF-20+50	100V	4822 122 31414
C 221	10NF-20+50	100	4822 122 31414
C 222	10NF-20+50	100	4822 122 31414
C 223	10NF-20+50	100	4822 122 31414
C 224	10NF-20+50	100	4822 122 31414
C 225	18PF		4822 122 31061
C 226			5322 121 54229
C 227	10NF-20+50	100	4822 122 31414
C 230	18PF		4822 122 31061
C 232	10NF-20+50	100	4822 122 31414
C 233	47PF		4822 122 31072
C 234	47NF 10%	160V	4822 121 41676
C 237	6,8UF 20%	25V	5322 124 14081
C 238	10NF-20+50	100	4822 122 31414
C 239	10NF-20+50	100	4822 122 31414
C 240	15UF-10+50	40	4822 124 20709
C 241	1.5UF 10%	100V	5322 121 40227
C 242	1.5UF 10%	100V	5322 121 40227
C 243	1.5UF 10%	100V	5322 121 40227
C 244	10NF-20+50	100	4822 122 31414
C 245	10NF-20+50	100	4822 122 31414
C 246	1NF-20+50	100	4822 122 30027
C 247	10NF-20+50	100	4822 122 31414
C 248	10NF		4822 122 31414
C 249	10NF-20+50	100	4822 122 31414
C 250	220PF 2	100	4822 122 30094
C 251	10NF-20+50	100	4822 122 31414
C 252	15UF MTB SWEEP-OUT		4822 124 20977
C 253	10NF-20+50	100	4822 122 31414
C 254	10NF-20+50	100	4822 122 31414
C 255	330NF 10%	100V	4822 121 40257
C 256	15UF-10+50	40	4822 124 20709
C 257	15UF-10+50	40	4822 124 20709
C 258	10NF-20+50	100	4822 122 31414
C 259	10NF-20+50	100	4822 122 31414
C 260	10NF-20+50	100	4822 122 31414
C 261	120PF 2	100	4822 122 30093
C 262	22NF-20+80	40	4822 122 30103
C 263	470PF 10	100	4822 122 30034
C 264	10NF-20+50	100	4822 122 31414
C 265	10NF-20+50	100	4822 122 31414
C 266	10NF MTB SWEEP-OUT		4822 122 31414
C 267	10NF-20+50	100	4822 122 31414
C 268	470NF 10%	100V	5322 121 40175
C 269	27PF 2	100	4822 122 30045
C 270	330PF		4822 122 31353
C 271	10NF-20+50	100	4822 122 31414

POSNR	DESCRIPTION		ORDERING CODE
C 272	2.2PF		4822 122 31036
C 273	10NF-20+50	100	4822 122 31414
C 275	330PF		4822 122 31353
C 276	33UF 10V		4822 124 20945
C 277	27PF 2	100	4822 122 30045
C 278	4,7PF 0,25PF	100	4822 122 31045
C 279	2.2PF		4822 122 31036
C 280	10NF-20+50	100	4822 122 31414
C 281	1NF		4822 122 30027
C 282	220NF 10%	100V	4822 121 40232
C 283	15UF 10%	16V	4822 124 20977
C 284	10NF-20+50	100	4822 122 31414
C 285	10NF-20+50	100	4822 122 31414
C 286	10NF-20+50	100	4822 122 31414
C 287	10NF-20+50	100	4822 122 31414
C 288	10NF-20+50	100	4822 122 31414
C 289	10NF-20+50	100	4822 122 31414
C 290	33UF		4822 124 20945
C 291	10NF		4822 122 31414
C 292	10NF		4822 122 31414
C 500	12PF 2	100	4822 122 31056
C 501	10NF-20+50	100	4822 122 31414
C 502	33UF 40%	10V	4822 124 20945
C 503	10NF-20+50	100	4822 122 31414
C 504	10NF-20+50	100	4822 122 31414
C 505	10NF-20+50	100	4822 122 31414
C 506	10NF-20+50	100	4822 122 31414
C 507	2,7NF 10	100	4822 122 30057
C 508	10NF-20+50	100	4822 122 31414
C 509	10PF 2	100	4822 122 31054
C 510	10NF-20+50	100	4822 122 31414
C 512	1.PF...10PF	300V	5322 125 50048
C 514	33UF 40%	10V	4822 124 20945
C 515	10NF-20+50	100	4822 122 31414
C 516	4,7NF 10	100	4822 122 30128
C 517	100PF 2	100	4822 122 31316
C 518	5,5PF		5322 125 54027
C 519	3PF		5322 125 54026
C 520	10NF-20+50	100	4822 122 31414
C 521	300PF 10	300	5322 123 10168
C 522	100PF 2	100	4822 122 31316
C 523	10NF-20+50	100	4822 122 31414
C 524	10NF-20+50	100	4822 122 31414
C 525	3,3PF 0,25PF	500	4822 122 31188
C 528	2,0-18P TRIM		5322 125 50051
C 529	100PF 2	100	4822 122 31316
C 530	15UF 10%	16V	4822 124 20977
C 531	33PF 2	100	5322 122 32072
C 532	68PF 2	500	4822 122 31207
C 533	4,7NF 10	100	4822 122 30128
C 534	10NF-20+50	100	4822 122 31414
C 535	3,3PF 0,25PF	500	4822 122 31188
C 536	6,8UF		5322 124 14069
C 537	5,5PF		5322 125 54027
C 538	5,5PF		5322 125 54027
C 539	5,5PF		5322 125 54027
C 540	3,5PF		5322 125 50048
C 541	30PF 10	300	5322 123 34001
C 542	100NF 10%	400V	4822 121 40012
C 543	6,8PF 0,25PF	100	4822 122 31049
C 544	2,7NF 10	500	4822 122 31174
C 545	33UF 40%	10V	4822 124 20945
C 546	4,7NF 10	100	4822 122 30128
C 547	4,7NF 10	100	4822 122 30128
C 550	47PF 2	100	4822 122 31072

POSNR		DESCRIPTION		ORDERING CODE
C	645	3,5PF		5322 125 50048
C	650	10NF-20+50	100	4822 122 31414
C	651	10NF-20+50	100	4822 122 31414
C	652	10NF-20+50	100	4822 122 31414
C	653	10NF-20+50	100	4822 122 31414
C	654	33UF 40%	10V	4822 124 20945
C	655	3,3PF 0,25PF	500	4822 122 31188
C	656	10NF-20+50	100	4822 122 31414
C	657	10NF-20+50	100	4822 122 31414
C	660	10NF-20+50	100	4822 122 31414
C	661	2,7NF 10	100	4822 122 30057
C	662	5,5PF		5322 125 54027
C	663	5,5PF		5322 125 54027
C	664	30PF 10	300	5322 123 34001
C	665	10NF-20+50	100	4822 122 31414
C	666	10NF-20+50	100	4822 122 31414
C	667	10PF 2	100	4822 122 31054
C	668	4,7NF 10	100	4822 122 30128
C	669	4,7NF 10	100	4822 122 30128
C	671	33UF 40%	10V	4822 124 20945
C	672	10PF		5322 125 50049
C	674	68PF 2	500	4822 122 31207
C	675	10NF-20+50	100	4822 122 31414
C	676	5,5PF		5322 125 54027
C	677	100PF 2	100	4822 122 31316
C	678	100PF 2	100	4822 122 31316
C	679	10NF-20+50	100	4822 122 31414
C	681	100PF 2	100	4822 122 31316
C	682	100PF 2	100	4822 122 31316
C	683	2,0-18P TRIM		5322 125 50051
C	684	10NF-20+50	100	4822 122 31414
C	685	3,3PF 0,25PF	500	4822 122 31188
C	686	5,5PF		5322 125 54027
C	687	3PF		5322 125 54026
C	688	300PF 10	300	5322 123 10168
C	689	10NF-20+50	100	4822 122 31414
C	690	33UF 40%	10V	4822 124 20945
C	691	100PF 2	100	4822 122 31316
C	692	33PF 2	100	5322 122 32072
C	693	6,8UF		5322 124 14069
C	694	100NF 10%	400V	4822 121 40012
C	695	6,8PF 0,25PF	100	4822 122 31049
C	696	15UF 10%	16V	4822 124 20977
C	697	2,7NF 10	500	4822 122 31174
C	698	4,7NF 10%	100V	4822 122 30128
C	699	4,7NF 10%	100V	4822 122 30128
C	700	12PF 2	100	4822 122 31056
C	701	10NF-20+50	100	4822 122 31414
C	705	10NF-20+50	100	4822 122 31414
C	801	6,8UF 20%	25V	5322 124 14081
C	802	33UF 40%	10V	4822 124 20945
C	803	33UF 40%	10V	4822 124 20945
C	804	10NF-20+50	100	4822 122 31414
C	805	10NF-20+50	100	4822 122 31414
C	806	10NF-20+50	100	4822 122 31414
C	807	10NF-20+50	100	4822 122 31414
C	808	10NF-20+50	100	4822 122 31414
C	809	10NF-20+50	100	4822 122 31414
C	811	10NF-20+50	100	4822 122 31414
C	812	10NF-20+50	100	4822 122 31414
C	813	18PF 2	100	4822 122 31061
C	814	18PF 2	100	4822 122 31061
C	815	10NF-20+50	100	4822 122 31414
C	816	1.5PF		5322 122 32101
C	817	1.5PF		5322 122 32101

POSNR	DESCRIPTION		ORDERING CODE
C 818	10NF-20+50	100	4822 122 31414
C 819	10NF-20+50	100	4822 122 31414
C 820	10NF-20+50	100	4822 122 31414
C 821	10NF-20+50	100	4822 122 31414
C 822	10NF-20+50	100	4822 122 31414
C 823	10NF-20+50	100	4822 122 31414
C 824	22PF 2	100	4822 122 31063
C 825	10NF-20+50	100	4822 122 31414
C 826	10NF-20+50	100	4822 122 31414
C 827	10NF-20+50	100	4822 122 31414
C 828	10NF-20+50	100	4822 122 31414
C 829	10NF-20+50	100	4822 122 31414
C 831	10PF 2	100	4822 122 31054
C 832	820PF 10	100	4822 122 30135
C 833	10NF-20+50	100	4822 122 31414
C 834	33UF 40%	10V	4822 124 20945
C 835	10PF 2	100	4822 122 31054
C 836	10NF-20+50	100	4822 122 31414
C 837	10NF-20+50	100	4822 122 31414
C 838	33UF 40%	10V	4822 124 20945
C 851	33PF 2	100	5322 122 32072
C 852	10NF-20+50	100	4822 122 31414
C 853	10NF-20+50	100	4822 122 31414
C 854	10NF-20+50	100	4822 122 31414
C 856	33UF 40%	10V	4822 124 20945
C 857	10NF-20+50	100	4822 122 31414
C 858	680PF 10	100	4822 122 30053
C 860	33UF		4822 124 20945
C 863	33PF 2	100	5322 122 32072
C 864	33PF 2	100	5322 122 32072
C 866	10NF-20+50	100	4822 122 31414
C 867	33UF 40%	10V	4822 124 20945
C 868	220NF 10%	100V	4822 121 40232
C 869	10PF		4822 122 32185
C 872	10NF-20+50	100	4822 122 31414
C 873	10NF-20+50	100	4822 122 31414
C 874	3,3PF 0,25PF	100	4822 122 31041
C 878	3,3PF 0,25PF	100	4822 122 31041
C 879	33PF 2	100	5322 122 32072
C 881	22PF 2	100	4822 122 31063
C 882	2.7PF 100V		4822 122 31038
C 883	33PF 2	100	5322 122 32072
C 884	150PF		4822 122 31413
C 885	10NF-20+50	100	4822 122 31414
C 888	6,8UF 20%	25V	5322 124 14081
C 889	10NF-20+50	100V	4822 122 31414
C 890	10NF-20+50	100	4822 122 31414
C 893	220NF 10%	100V	4822 121 40232
C 894	15PF		4822 122 31823
C 895	2PF...18PF		5322 125 50051
C 896	10PF TRIMCAP		5322 125 50049
C 897	4,7PF 0,25PF	100	4822 122 31045
C 898	10NF-20+50	100	4822 122 31414
C 899	10NF-20+50	100	4822 122 31414
C 901	12PF		4822 122 31056
C 902	10NF-20+50	100	4822 122 31414
C 903	10NF-20+50	100	4822 122 31414
C 904	22NF 10%	400V	5322 121 40308
C 905	100PF 2	100	4822 122 31316
C 906	10NF-20+50	100	4822 122 31414
C 907	15PF		4822 122 31823
C 908	10NF-20+50	100	4822 122 31414
C 909	10NF-20+50	100	4822 122 31414
C 910	22PF 2	100	4822 122 31063
C 911	10NF-20+50	100	4822 122 31414

POSNR	DESCRIPTION			ORDERING CODE
C 913	10NF-20+50		100	4822 122 31414
C 914	10NF-20+50		100	4822 122 31414
C 915	33UF 10	20%		4822 124 20945
C 916	3,9NF	10	100	4822 122 30098
C 917	4,7NF	10	100	4822 122 30128
C 918	4,7NF	10	100	4822 122 30128
C 919	10NF-20+50		100	4822 122 31414
C 920	10NF-20+50		100	4822 122 31414
C 921	1,8PF 0,25PF		100	4822 122 31034
C 922	10NF-20+50		100	4822 122 31414
C 923	1,8PF 0,25PF		100	4822 122 31034
C 924	1PF 0,25PF		100	4822 122 30104
C 926	1PF 0,25PF		100	4822 122 30104
C 927	1,8PF 0,25PF		100	4822 122 31034
C 928	1,8PF 0,25PF		100	4822 122 31034
C 929	680PF	10	100	4822 122 30053
C 930	33PF			5322 122 32072
C 931	220NF 10%		100V	4822 121 40232
C 932	10NF-20+50		100	4822 122 31414
C 933	100PF			4822 122 31316
C 934	1PF 0,25PF		100	4822 122 30104
C 935	33PF	2	100	5322 122 32072
C 936	1PF 0,25PF		100	4822 122 30104
C 937	33PF	2	100	5322 122 32072
C 938	22PF	2	100V	4822 122 31063
C 939	10NF-20+50		100	4822 122 31414
C 940	33PF			5322 122 32072
C 942	10NF-20+50		100	4822 122 31414
C 944	10NF-20+50		100	4822 122 31414
C 945	10NF-20+50		100	4822 122 31414
C 1102	1,8/27PF	250V	TRIM	5322 125 50164
C 1103	10NF-20+50		100	4822 122 31414
C 1104	10NF-20+50		100	4822 122 31414
C 1105	6.8NF			4822 122 31429
C 1106	10NF-20+50		100	4822 122 31414
C 1107	10NF-20+50		100	4822 122 31414
C 1108	3,9PF 0,25PF		100	5322 122 34107
C 1109	4,7NF	10	100	4822 122 30128
C 1112	27PF			5322 125 50164
C 1113	10PF			4822 122 31195
C 1114	10PF			4822 122 31195
C 1116	10NF 100V			4822 122 31414
C 1117	100PF 100V		2%	4822 122 31316
C 1201	10NF-20+50		100	4822 122 31414
C 1202	18PF	2	100	4822 122 31061
C 1203	27PF			5322 125 50164
C 1204	10NF-20+50		100	4822 122 31414
C 1206	68PF	2	100	4822 122 31349
C 1207	40PF			4822 125 50092
C 1208	3,3NF	10	100	4822 122 30099
C 1209	100PF	2	100	4822 122 31316
C 1211	10NF-20+50		100	4822 122 31414
C 1212	10NF-20+50		100	4822 122 31414
C 1213	100PF	2	100	4822 122 31316
C 1215	1PF 0,25PF		100	4822 122 30104
C 1218	1,2PF 0,25PF		100	4822 122 31216
C 1222	10NF-20+50		100	4822 122 31414
C 1223	27PF			5322 125 50164
C 1225	22PF	2	100	4822 122 31063
C 1226	1,2PF 0,25PF		100	4822 122 31216
C 1229	10NF-20+50		100	4822 122 31414
C 1231	1,8PF 0,25PF		100	4822 122 31034
C 1233	10NF-20+50		100	4822 122 31414
C 1234	10NF-20+50		100	4822 122 31414
C 1236	10NF-20+50		100	4822 122 31414

POSNR	DESCRIPTION		ORDERING CODE
C 1300	330PF 2	100	4822 122 31353
C 1301	68NF 10%	250V	5322 121 44137
C 1302	68NF 10%	250V	5322 121 44137
C 1303	10NF-20+50	100	4822 122 31414
C 1304	10NF-20+50	100	4822 122 31414
C 1305	330PF 2	100	4822 122 31353
C 1306	1NF 10	500	4822 122 31175
C 1307	1NF 10	500	4822 122 31175
C 1308	8,2PF 0,25PF	100	4822 122 31052
C 1309	8,2PF 0,25PF	100	4822 122 31052
C 1310	330PF 2	100	5322 122 34148
C 1311	10NF-20+50	100	4822 122 31414
C 1314	10NF-20+50	100	4822 122 31414
C 1315	10NF-20+50	100	4822 122 31414
C 1316	10NF-20+50	100	4822 122 31414
C 1317	10NF-20+50	100	4822 122 31414
C 1318	10NF-20+50	100	4822 122 31414
C 1319	68NF 10%	250V	5322 121 44137
C 1320	330PF 2	100	5322 122 34148
C 1321	68NF 10%	250V	5322 121 44137
C 1322	68NF 10%	250V	5322 121 44137
C 1323	22UF 20%	10V	4822 124 20943
C 1326	4,7UF-10+50	63	4822 124 20726
C 1327	4,7UF-10+50	63	4822 124 20726
C 1372	10NF-20+50	100	4822 122 31414
C 1373	220NF 20%	35V	5322 124 14074
C 1401	220UF		4822 124 20704
C 1402	470UF		4822 124 20684
C 1403	33UF 40%	10V	4822 124 20945
C 1404	33UF 40%	10V	4822 124 20945
C 1406	10UF 20%	16V	5322 124 14066
C 1407	2,7NF 10%	100V	4822 122 30057
C 1408	13NF 5%	2KV	5322 121 41466
C 1409	13NF 5%	2KV	5322 121 41466
C 1411	470UF		4822 124 20684
C 1412	220UF-10+50	25	5322 124 24139
C 1413	22UF-10+50	63	5322 124 24146
C 1414	100NF 10%	100V	5322 121 40323
C 1415	1500NF 10%	100V	4822 121 42031
C 1416	47NF 10%	160V	4822 121 41676
C 1417	220NF 10%	100V	4822 121 40232
C 1419	220UF-10+50	25	5322 124 24139
C 1421	10UF-10+50	160	4822 124 21129
C 1422	47UF-10+50	63	5322 124 21182
C 1423	330UF-10+50	10	5322 124 21181
C 1424	330UF-10+50	10	5322 124 21181
C 1426	330UF-10+50	10	5322 124 21181
C 1427	330UF-10+50	10	5322 124 21181
C 1428	100UF		4822 124 20735
C 1430	10NF 0	250V	5322 121 42425
C 1431	100NF 10%	630V	4822 121 40145
C 1432	10NF-20+50	100	4822 122 31414
C 1433	10UF-10+50	160	4822 124 21129
C 1434	100NF 10%	630V	4822 121 40145
C 1436	22NF 10%	400V	5322 121 40308
C 1437	10UF-10+50	160	4822 124 21129
C 1438	10UF-10+50	160	4822 124 21129
C 1439	100NF 10%	630V	4822 121 40145
C 1440	10NF		4822 122 31414
C 1441	47UF-10+50	63	5322 124 21182
C 1442	100UF-10+50	10	4822 124 20679
C 1443	6,8UF 20%	25V	5322 124 14081
C 1444	10UF 20%	16V	5322 124 14066
C 1445	4,7NF 10	100	4822 122 30128
C 1446	10NF-20+50	100	4822 122 31414

POSNR	DESCRIPTION		ORDERING CODE
C 1447	33UF 40%	10V	4822 124 20945
C 1448	2NF 1%	250V	4822 121 50568
C 1449	10NF-20+50	100	4822 122 31414
C 1450	150PF		4822 122 31413
C 1451	100NF 10%	100V	5322 121 40323
C 1452	4700UF-10+30	40	4822 124 70326
C 1453	220NF 10%	250V	5322 121 44142
C 1501	68NF 10%	250V	5322 121 44137
C 1502	10NF-20+50	100	4822 122 31414
C 1503	10NF-20+50	100	4822 122 31414
C 1504	22UF 20%	10V	4822 124 20943
C 1506	10NF-20+50	100	4822 122 31414
C 1507	0,82PF 0,25PF	100	4822 122 31214
C 1508	10NF-20+50	100	4822 122 31414
C 1509	4,7NF 10	100	4822 122 30128
C 1511	10NF-20+50	100	4822 122 31414
C 1512	1,5NF 10%	1600V	4822 121 40354
C 1513	1,5NF 10%	1600V	4822 121 40354
C 1514	1NF 10	100	4822 122 30027
C 1515	470PF H.V. CAP.		5322 122 50076
C 1516	10UF-10+50	63	4822 124 20728
C 1517	4,7NF 10	100	4822 122 30128
C 1518	10NF-20+50	100	4822 122 31414
C 1519	4,7UF 20%	25V	4822 124 10367
C 1520	1NF 10	100	4822 122 30027
C 1521	10NF-20+50	100	4822 122 31414
C 1522	10NF-20+50	100	4822 122 31414

INTEGRATED CIRCUITS

D 201	UA741CN	SC	4822 209 80617
D 202	TCA240	PH	4822 209 80629
D 203	SN74S132N-00	T	5322 209 85267
D 204	N74LS02N	SC	5322 209 85312
D 206	N74LS00N	SC	5322 209 84823
D 207	SN74F74		5322 209 81474
D 208	N74LS02N	SC	5322 209 85312
D 209	N74S02N	SC	5322 209 85407
D 211	N74LS10N	SC	5322 209 84996
D 212	SN74F74		5322 209 81474
D 213	SN74LS122N-00	T	5322 209 85563
D 214	SN74S132N-00	T	5322 209 85267
D 216	LM308AN	NS	5322 209 86056
D 217	N74S32N	SC	5322 209 85679
D 218	N74S10N	SC	5322 209 84954
D 501	LT 1012 CN8		5322 209 83584
D 502	UA714HC	FA	5322 209 86169
D 503	SD 5000N		5322 209 85748
D 504	OQ 0043		5322 209 86488
D 651	LT 1012 CN8		5322 209 83584
D 652	UA714HC	FA	5322 209 86169
D 653	SD5000N(SEMIPROCES.)		5322 209 83243
D 653	5D5000N		5322 209 85748
D 654	OQ 0043		5322 209 86488
D 801	SL3145E	PL	5322 130 34854
D 802	AMPLIFIER		5322 209 80991
D 803	AMPLIFIER		5322 209 80991
D 804	N74LS08N	SC	5322 209 84995
D 806	N74LS112N	SC	5322 209 85741
D 807	N74LS132N	SC	5322 209 85201
D 851	HEF4052BP	PH	4822 209 10263
D 852	TL082CP	T	5322 209 86064
D 853	ARRAY OQ 0127		5322 209 80992
D 854	ARRAY OQ 0127		5322 209 80992
D 1401	UA741CN	SC	4822 209 80617
D 1402	TDA1060	PH	5322 209 85662
D 1501	UA741CN	SC	4822 209 80617

POTENTIOMETERS- FRONT PANEL

POSNR		DESCRIPTION			ORDERING CODE
R	1/S4	10K	20	0.1W	5322 101 40097
R	2/S5	10K	20	0.1W	5322 101 40097
R	3	5K	10-TURN LIN		5322 103 50002
R	4/S6	10K	20	0.1W	5322 101 40097
R	5/S7	47K	20	0.1W	5322 102 40062
R	6/S8	10K	20	0.1W	5322 101 40097
R	7/S10	10K	20	0.1W	5322 101 40096
R	8/S12	10K	20	0.1W	5322 101 40096
R	9/S14	10K	20	0.1W	5322 101 40096
R	10/S16	10K	20	0.1W	5322 101 40096
R	11	10K	20	0.1W	5322 101 40096
R	12	4,7K	20	0.1W	5322 101 20618
R	13	2,2M	20	0.1W	5322 101 20621
R	14	22K	20	0.1W	5322 101 20619
R	15	22K			5322 100 20181

RESISTORS

R	101	191K	0,5	MR25	5322 116 55363
R	102	113	0,5	MR25	5322 116 54019
R	103	1,05K	1	MR25	5322 116 54552
R	104	2,94K	0,5	MR25	5322 116 51396
R	106	8,66K	1	MR25	5322 116 54613
R	107	1,05K	1	MR25	5322 116 54552
R	108	95,3K	1	MR25	5322 116 50567
R	109	113	0,5	MR25	5322 116 54019
R	111	2,94K	0,5	MR25	5322 116 51396
R	112	37,4K	0,5	MR25	5322 116 51397
R	113	962K		MPR24	5322 116 52091
R	114	18,2K	0,1	MR24E	5322 116 51403
R	116	385K		MPR24	5322 116 52092
R	117	191K	0,5	MR25	5322 116 55363
R	118	95,3K	1	MR25	5322 116 50567
R	119	37,4K	0,5	MR25	5322 116 51397
R	121	18,2K	0,1	MR24E	5322 116 51403
R	122	8,66K	1	MR25	5322 116 54613
R	201	12,1K	1	MR25	5322 116 50572
R	202	2,05K	1	MR25	5322 116 50664
R	204	2,15K	1	MR25	5322 116 50767
R	205	511K		MR25	5322 116 55258
R	206	6,19K	1	MR25	5322 116 55426
R	207	2,15K	1	MR25	5322 116 50767
R	208	1K	1	MR25	4822 116 51235
R	209	9,09K	1	MR25	4822 116 51284
R	211	9,53K	1	MR25	5322 116 55574
R	212	2,37K	1	MR25	5322 116 54576
R	214	5,11	1	MR25	4822 116 52999
R	216	30,1	1	MR25	5322 116 50904
R	217	237	1	MR25	5322 116 50679
R	218	6,19K	1	MR25	5322 116 55426
R	219	3,48K	1	MR25	5322 116 55367
R	220	1K	1	MR25	4822 116 51235
R	221	1,54K	1	MR25	5322 116 50586
R	222	15,4K	1	MR25	5322 116 55459
R	223	15,4K	1	MR25	5322 116 55459
R	224	6,19K	1	MR25	5322 116 55426
R	226	10K	1	MR25	4822 116 51253
R	227	17,8K	1	MR25	5322 116 54637
R	228	15,4K	1	MR25	5322 116 55459
R	229	10K	1	MR25	4822 116 51253
R	230	15,4K	1	MR25	5322 116 55459

POSNR		DESCRIPTION			ORDERING CODE		
R	231	6,19K	1	MR25	5322	116	55426
R	232	1,69K	1	MR25	5322	116	54567
R	233	5,11	1	MR25	4822	116	52999
R	234	5,11	1	MR25	4822	116	52999
R	236	464	1	MR25	5322	116	50536
R	237	3,01K	1	MR25	4822	116	51246
R	238	3,01K	1	MR25	4822	116	51246
R	239	715	1	MR25	5322	116	50571
R	240	169		MR25	5322	116	54489
R	241	33,2K	1	MR25	4822	116	51259
R	242	5,11K	1	MR25	5322	116	54595
R	243	5,11K	1	MR25	5322	116	54595
R	244	5,11K	1	MR25	5322	116	54595
R	246	5,11K	1	MR25	5322	116	54595
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R	248	48,7	1	MR25	5322	116	50511
R	249	750	1	MR25	4822	116	51234
R	250	100	1	MR25	5322	116	55549
R	251	5,11	1	MR25	4822	116	52999
R	252	5,11	1	MR25	4822	116	52999
R	253	100	1	MR25	5322	116	55549
R	254	511	1	MR25	4822	116	51282
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R	256	5,11	1	MR25	4822	116	52999
R	257	30,1	1	MR25	5322	116	50904
R	258	825	1	MR25	5322	116	54541
R	259	30,1	1	MR25	5322	116	50904
R	260	6,81K	1	MR25	4822	116	51252
R	261	5,11	1	MR25	4822	116	52999
R	262	22K	20	0.5W	5322	101	14069
R	263	2,87K	1	MR25	5322	116	55279
R	264	6,81K	1	MR25	4822	116	51252
R	265	1,87K	1	MR25	5322	116	52123
R	266	6,19K	1	MR25	5322	116	55426
R	267	1K	1	MR25	4822	116	51235
R	268	22K	20	0.5W	5322	101	14069
R	269	154	1	MR25	5322	116	50506
R	270	33		MRS16T	5322	116	53295
R	271	33,2K	1	MR25	4822	116	51259
R	272	5,11K	1	MR25	5322	116	54595
R	273	33	5	CR16	4822	116	52191
R	274	5,11	1	MR25	4822	116	52999
R	276	40,2	1	MR25	5322	116	50926
R	277	1,33K		MR25	5322	116	55422
R	278	5,11	1	MR25	4822	116	52999
R	279	7,5	1	MR25	5322	116	54417
R	280	33.2		MRS16T	5322	116	53296
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R	282	562	1	MR25	4822	116	51231
R	283	3,01K	1	MR25	4822	116	51246
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R	285	7,5	1	MR25	5322	116	54417
R	286	562	1	MR25	4822	116	51231
R	287	30,1	1	MR25	5322	116	50904
R	288	5,11	1	MR25	4822	116	52999
R	289	30,1	1	MR25	5322	116	50904
R	290	6,81K	1	MR25	4822	116	51252
R	291	5,11	1	MR25	4822	116	52999
R	292	3,65K	1	MR25	5322	116	54587
R	293	33,2K	1	MR25	4822	116	51259
R	296	1,78K	1	MR25	5322	116	50515
R	297	5,11	1	MR25	4822	116	52999
R	298	5,11	1	MR25	4822	116	52999
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POSNR		DESCRIPTION			ORDERING CODE
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R	306	154K	1	MR25	5322 116 54714
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R	308	2,87K	1	MR25	5322 116 55279
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R	311	5,11K	1	MR25	5322 116 54595
R	312	5,11	1	MR25	4822 116 52999
R	317	154K	1	MR25	5322 116 54714
R	318	2,26K	1	MR25	5322 116 50675
R	319	2,26K	1	MR25	5322 116 50675
R	321	2,26K	1	MR25	5322 116 50675
R	322	154K	1	MR25	5322 116 54714
R	323	5,11	1	MR25	4822 116 52999
R	324	33,2K	1	MR25	4822 116 51259
R	325	5,11	1	MR25	4822 116 52999
R	326	3,01K	1	MR25	4822 116 51246
R	327	649	1	MR25	5322 116 54532
R	328	5,11	1	MR25	4822 116 52999
R	329	3,01K	1	MR25	4822 116 51246
R	331	51,1	1	MR25	5322 116 54442
R	332	5,11	1	MR25	4822 116 52999
R	333	4,64K	1	MR25	5322 116 50484
R	334	3,83K	1	MR25	5322 116 54589
R	336	5,11K	1	MR25	5322 116 54595
R	337	5,11K	1	MR25	5322 116 54595
R	338	30,1K	1	MR25	5322 116 54655
R	339	1,21K	1	MR25	5322 116 54557
R	341	5,11	1	MR25	4822 116 52999
R	342	590	1	MR25	5322 116 50561
R	343	825	1	MR25	5322 116 54541
R	344	6,19K	1	MR25	5322 116 55426
R	345	10M	5	VR25	4822 110 72214
R	346	6,19K	1	MR25	5322 116 55426
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R	348	22K	20	0.5W	5322 101 14069
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R	351	22K	20	0.5W	5322 101 14069
R	352	1K MTB	SWEEP-OUT		4822 116 51235
R	352	1.8M		VR25	4822 110 72194
R	353	1,27K MTB	SWEEP-OUT		5322 116 50555
R	354	5,11 MTB	SWEEP-OUT		4822 116 52999
R	355	4.22K		MR25	5322 116 50729
R	356	1,87K	1	MR25	5322 116 52123
R	357	10K	1	MR25	4822 116 51253
R	358	10K	1	MR25	4822 116 51253
R	359	30,1	1	MR25	5322 116 50904
R	360	5,11	1	MR25	4822 116 52999
R	361	2,26K	1	MR25	5322 116 50675
R	362	2,26K	1	MR25	5322 116 50675
R	363	33,2K	1	MR25	4822 116 51259
R	364	5,11K	1	MR25	5322 116 54595
R	365	5,11K	1	MR25	5322 116 54595
R	366	1,15K	1	MR25	5322 116 52121
R	367	825	1	MR25	5322 116 54541
R	368	4,64K	1	MR25	5322 116 50484
R	369	7,87K	1	MR25	5322 116 50458
R	370	5,11	1	MR25	4822 116 52999
R	371	27,4K	1	MR25	5322 116 50559
R	372	19,6K	1	MR25	5322 116 54641
R	373	68,1K		MR25	4822 116 51266
R	374	56,2K		MR25	4822 116 51264
R	375	100	1	MR25	5322 116 55549
R	376	68,1K		MR25	4822 116 51266
R	377	51,1K		MR25	5322 116 50672
R	378	78,7K	1	MR25	5322 116 50533

POSNR	DESCRIPTION			ORDERING CODE
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R 380	1.8M		VR25	4822 110 72194
R 381	28,7K	1	MR25	5322 116 55462
R 382	86,6K		MR25	5322 116 54692
R 383	53,6K		MR25	5322 116 54674
R 384	909	1	MR25	5322 116 55278
R 385	40,2	1	MR25	5322 116 50926
R 386	100	1	MR25	5322 116 55549
R 387	5,11K	1	MR25	5322 116 54595
R 388	22K	20	0.75W	5322 101 14042
R 390	511	1	MR25	4822 116 51282
R 391	511	1	MR25	4822 116 51282
R 392	5,11	1	MR25	4822 116 52999
R 393	48,7	1	MR25	5322 116 50511
R 394	536	1	MR25	5322 116 50621
R 395	750	1	MR25	4822 116 51234
R 396	100	1	MR25	5322 116 55549
R 397	10	1	MR25	5322 116 50452
R 398	1,69K	1	MR25	5322 116 54567
R 399	1,69K	1	MR25	5322 116 54567
R 400	1,15K	1	MR25	5322 116 52121
R 401	2.2K			5322 101 10678
R 402	1,15K	1	MR25	5322 116 52121
R 403	51,1	1	MR25	5322 116 54442
R 404	51,1	1	MR25	5322 116 54442
R 405	1.78K		VR25	5322 116 50515
R 406	7.5K		VR25	5322 116 54608
R 408	2,15K			5322 116 50767
R 410	3,16K		MR25	5322 116 50579
R 411	28,7K	1	MR25	5322 116 55462
R 412	1.21K		MR25	5322 116 54557
R 413	2,37K		MR25	5322 116 54576
R 415	31,6E		MR16	5322 116 55392
R 500	61,9	1	MR25	5322 116 54451
R 503	1K	20	0,5W	5322 100 10112
R 504	1M	1	MR25	5322 116 55535
R 506	1M	1	MR25	5322 116 55535
R 507	1M	1	MR25	5322 116 55535
R 508	1M	1	MR25	5322 116 55535
R 509	11,5	1	MR25	5322 116 50838
R 510	68,1	1	MR25	5322 116 54455
R 511	11,5	1	MR25	5322 116 50838
R 512	287	1	MR25	5322 116 54506
R 513	5,11K	1	MR25	5322 116 54595
R 514	4,02K	1	MR25	5322 116 55448
R 516	90,9	1	MR25	5322 116 54466
R 517	90,9	1	MR25	5322 116 54466
R 518	511	1	MR25	4822 116 51282
R 519	23,7K	1	MR25	5322 116 54646
R 521	10K	20	0,5W	5322 100 10113
R 522	14K	1	MR25	5322 116 55571
R 523	3,48K	1	MR25	5322 116 55367
R 524	75K	1	MR25	4822 116 51267
R 525	562	1	MR25	4822 116 51231
R 526	8,25K		MR25	5322 116 51498
R 527	3,48K	1	MR25	5322 116 55367
R 530	10	1	MR25	5322 116 50452
R 531	10	1	MR25	5322 116 50452
R 532	825K	0,5	MR25	5322 116 51398
R 533	11K	1	MR25	5322 116 54623
R 534	22,6K	1	MR25	5322 116 50481
R 535	7,87K	1	MR25	5322 116 50458
R 537	1M	1	MR25	5322 116 55535
R 538	82,5	1	MR25	5322 116 55357
R 539	1M	1	MR25	5322 116 55535

POSNR		DESCRIPTION			ORDERING CODE
R	541	1M	1	MR25	5322 116 55535
R	542	562	1	MR25	4822 116 51231
R	543	5,11	1	MR25	4822 116 52999
R	544	5,11	1	MR25	4822 116 52999
R	545	1,33K		MR25	5322 116 55422
R	546	2,05K	1	MR25	5322 116 50664
R	547	348	1	MR25	5322 116 54515
R	548	10K	1	MR25	4822 116 51253
R	549	226		MR25	5322 116 54497
R	550	1,33K		MR25	5322 116 55422
R	551	226		MR25	5322 116 54497
R	552	1,33K		MR25	5322 116 55422
R	553	220	20	0.75W	5322 100 10133
R	554	825K	0,5	MR25	5322 116 51398
R	556	1M	1	MR25	5322 116 55535
R	557	162	1	MR25	5322 116 50417
R	558	4,02K	1	MR25	5322 116 55448
R	559	3,16K	1	MR25	5322 116 50579
R	560	383	1	MR25	5322 116 55368
R	561	2,87K	1	MR25	5322 116 55279
R	563	22K	POTM.20%		5322 101 14042
R	564	1M	1	MR25	5322 116 55535
R	565	6,49K	1	MR25	5322 116 54603
R	566	1M	1	MR25	5322 116 55535
R	567	53,6	0,1	MR24E	5322 116 54997
R	568	988K	0,5	MR30	5322 116 51401
R	569	1,96K	1	MR25	5322 116 54571
R	570	5,11	1	MR25	4822 116 52999
R	571	5,11	1	MR25	4822 116 52999
R	572	51,1	1	MR25	5322 116 54442
R	573	2,74K	1	MR25	5322 116 50636
R	574	133	1	MR25	5322 116 54482
R	575	61,9	1	MR25	5322 116 54451
R	576	1M	1	MR25	5322 116 55535
R	577	196	1	MR25	5322 116 55273
R	578	470	20	0.75W	5322 100 10135
R	579	1,62K	1	MR25	5322 116 55359
R	580	383	1	MR25	5322 116 55368
R	581	1,62K	1	MR25	5322 116 55359
R	582	115K	1	MR25	5322 116 54279
R	583	10K	20	0.75W	5322 100 10141
R	584	11K	1	MR25	5322 116 54623
R	585	2,37K	1	MR25	5322 116 54576
R	586	68,1K	1	MR25	4822 116 51266
R	588	8,35K	0,1	MR24E	5322 116 55148
R	589	10K	1	MR25	4822 116 51253
R	590	5,11	1	MR25	4822 116 52999
R	591	172K	0,5	MR30	5322 116 51399
R	592	365	1	MR25	5322 116 54516
R	593	5,11	1	MR25	4822 116 52999
R	594	5,11	1	MR25	4822 116 52999
R	595	5,11	1	MR25	4822 116 52999
R	596	205	1	MR25	5322 116 55365
R	597	31,6	1	MR25	5322 116 54034
R	598	205	0,1	MR24E	5322 116 51404
R	599	137	0,1	MR24E	5322 116 51402
R	601	82,5	0,1	MR24E	5322 116 51405
R	602	82,5	0,1	MR24E	5322 116 51405
R	603	51,1	1	MR25	5322 116 54442
R	604	1K	20	0.75W	5322 100 10143
R	605	464	1	MR25	5322 116 50536
R	606	3,3K	5	0.5W	5322 116 30234
R	607	649	1	MR25	5322 116 54532
R	608	487	1	MR25	5322 116 55451
R	609	2,26K	1	MR25	5322 116 50675

POSNR	DESCRIPTION			ORDERING CODE
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R 611	215K		MR25	5322 116 54728
R 612	215	1	MR25	5322 116 55274
R 614	59	1	MR25	5322 116 54448
R 616	92K	0,1	MR24E	5322 116 54875
R 617	5,11	1	MR25	4822 116 52999
R 618	920K	0,5	MR30	5322 116 55218
R 619	21,5	1	MR25	5322 116 50677
R 621	1M	1	MR30	4822 116 51279
R 622	42,2	1	MR25	5322 116 51052
R 623	14,7	1	MR25	5322 116 50412
R 625	1K	1	MR25	4822 116 51235
R 653	1K	20	0,5W	5322 100 10112
R 654	1M	1	MR25	5322 116 55535
R 655	68,1	1	MR25	5322 116 54455
R 656	1M	1	MR25	5322 116 55535
R 657	1M	1	MR25	5322 116 55535
R 658	1M	1	MR25	5322 116 55535
R 659	8,66K	1	MR25	5322 116 54613
R 661	12,1K	1	MR25	5322 116 50572
R 662	287	1	MR25	5322 116 54506
R 663	5,11K	1	MR25	5322 116 54595
R 664	4,02K	1	MR25	5322 116 55448
R 666	59	1	MR25	5322 116 54448
R 667	59	1	MR25	5322 116 54448
R 668	365K	1	MR25	5322 116 55641
R 669	511	1	MR25	4822 116 51282
R 671	23,7K	1	MR25	5322 116 54646
R 672	10K	20	0.75W	5322 100 10141
R 673	14K	1	MR25	5322 116 55571
R 674	920K	0,5	MR30	5322 116 55218
R 676	825K	0,5	MR25	5322 116 51398
R 678	825K	0,5	MR25	5322 116 51398
R 679	10	1	MR25	5322 116 50452
R 680	10	1	MR25	5322 116 50452
R 681	22,6K	1	MR25	5322 116 50481
R 682	11K	1	MR25	5322 116 54623
R 683	7,87K	1	MR25	5322 116 50458
R 684	1M	1	MR25	5322 116 55535
R 686	82,5	1	MR25	5322 116 55357
R 687	1M	1	MR25	5322 116 55535
R 688	1M	1	MR25	5322 116 55535
R 689	562	1	MR25	4822 116 51231
R 691	5,11	1	MR25	4822 116 52999
R 692	5,11	1	MR25	4822 116 52999
R 693	2,05K	1	MR25	5322 116 50664
R 694	348	1	MR25	5322 116 54515
R 696	10K	1	MR25	4822 116 51253
R 697	226		MR25	5322 116 54497
R 698	226		MR25	5322 116 54497
R 700	61,9	1	MR25	5322 116 54451
R 701	220	20	0.75W	5322 100 10133
R 702	8,25K	1	MR25	5322 116 51498
R 704	92K	0,1	MR24E	5322 116 54875
R 706	59	1	MR25	5322 116 54448
R 707	172K	0,5	MR30	5322 116 51399
R 708	365	1	MR25	5322 116 54516
R 709	5,11	1	MR25	4822 116 52999
R 710	1M	1	MR25	5322 116 55535
R 711	5,11	1	MR25	4822 116 52999
R 712	1,33K		MR25	5322 116 55422
R 713	162	1	MR25	5322 116 50417
R 714	4,02K	1	MR25	5322 116 55448
R 715	1,33K		MR25	5322 116 55422
R 716	2,87K	1	MR25	5322 116 55279

POSNR		DESCRIPTION			ORDERING CODE
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R	720	6,49K	1	MR25	5322 116 54603
R	721	1M	1	MR25	5322 116 55535
R	722	1M	1	MR25	5322 116 55535
R	723	53,6	0,1	MR24E	5322 116 54997
R	724	1M	1	MR25	5322 116 55535
R	725	562	1	MR25	4822 116 51231
R	726	51,1	1	MR25	5322 116 54442
R	727	1K	20	0.75W	5322 100 10143
R	728	21,5	1	MR25	5322 116 50677
R	729	464	1	MR25	5322 116 50536
R	730	10	1	MR25	5322 116 50452
R	731	10K	1	MR25	4822 116 51253
R	732	8,35K	0,1	MR24E	5322 116 55148
R	733	5,11	1	MR25	4822 116 52999
R	734	1,96K	1	MR25	5322 116 54571
R	735	61,9	1	MR25	5322 116 54451
R	736	5,11	1	MR25	4822 116 52999
R	737	51,1	1	MR25	5322 116 54442
R	737	348	1	MR25	5322 116 54515
R	738	2,74K	1	MR25	5322 116 50636
R	739	133	1	MR25	5322 116 54482
R	740	5,11	1	MR25	4822 116 52999
R	741	1,62K	1	MR25	5322 116 55359
R	742	1,62K	1	MR25	5322 116 55359
R	743	10K	20	0.75W	5322 100 10141
R	744	115K	1	MR25	5322 116 54279
R	745	10	1	MR25	5322 116 50452
R	748	11K	1	MR25	5322 116 54623
R	749	68,1K	1	MR25	4822 116 51266
R	750	10K	20	0.75W	5322 100 10141
R	751	215K		MR25	5322 116 54728
R	752	2,26K	1	MR25	5322 116 50675
R	754	3,48K	1	MR25	5322 116 55367
R	755	14,7	1	MR25	5322 116 50412
R	756	3,48K	1	MR25	5322 116 55367
R	757	1M	1	MR30	4822 116 51279
R	758	42,2	1	MR25	5322 116 51052
R	759	988K	0,5	MR30	5322 116 51401
R	760	1K	1	MR25	4822 116 51235
R	761	205	1	MR25	5322 116 55365
R	762	31,6	1	MR25	5322 116 54034
R	763	205	0,1	MR24E	5322 116 51404
R	764	137	0,1	MR24E	5322 116 51402
R	766	82,5	0,1	MR24E	5322 116 51405
R	767	82,5	0,1	MR24E	5322 116 51405
R	768	365K	1	MR25	5322 116 55641
R	801	1	1	MR25	4822 116 51179
R	802	2,49	1	MR25	5322 116 51394
R	803	1	1	MR25	4822 116 51179
R	804	5,11K	1	MR25	5322 116 54595
R	806	5,11K	1	MR25	5322 116 54595
R	807	8,25K	1	MR25	5322 116 51498
R	808	22K	20	0.5W	5322 101 14069
R	809	1,33K	1	MR25	5322 116 55422
R	810	51,1	1	MR25	5322 116 54442
R	811	61,9	1	MR25	5322 116 54451
R	812	619	1	MR25	4822 116 51232
R	813	619	1	MR25	4822 116 51232
R	814	511	1	MR25	4822 116 51282
R	815	51,1	1	MR25	5322 116 54442
R	816	61,9	1	MR25	5322 116 54451
R	817	348	1	MR25	5322 116 54515
R	818	42,2	1	MR25	5322 116 51052

POSNR	DESCRIPTION			ORDERING CODE
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R 821	100		MR25	5322 116 55549
R 822	1,54K	1	MR25	5322 116 50586
R 824	1,54K	1	MR25	5322 116 50586
R 826	100		MR25	5322 116 55549
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R 828	5,11K	1	MR25	5322 116 54595
R 829	215	1	MR25	5322 116 55274
R 830	7,5K	1	MR25	5322 116 54608
R 831	215	1	MR25	5322 116 55274
R 832	511	1	MR25	4822 116 51282
R 833	18,7K	1	MR25	5322 116 55362
R 834	3,32K	1	MR25	4822 116 51247
R 835	5,11K	1	MR25	5322 116 54595
R 836	287	1	MR25	5322 116 54506
R 838	274	1	MR25	5322 116 54504
R 839	1,05K	1	MR25	5322 116 54552
R 841	1,05K	1	MR25	5322 116 54552
R 842	1K		MR25	4822 116 51235
R 843	1K		MR25	4822 116 51235
R 844	1K		MR25	4822 116 51235
R 846	1K		MR25	4822 116 51235
R 847	5,11K	1	MR25	5322 116 54595
R 848	5,11K	1	MR25	5322 116 54595
R 849	2.21K		MR25	4822 116 51245
R 852	3,32K	1	MR25	4822 116 51247
R 853	1,33K		MR25	5322 116 55422
R 854	18,7K	1	MR25	5322 116 55362
R 856	64,9K	1	MR25	5322 116 50514
R 857	5,11K	1	MR25	5322 116 54595
R 858	5,11K	1	MR25	5322 116 54595
R 859	3,01K	1	MR25	4822 116 51246
R 860	13,3	1	MR25	5322 116 51047
R 861	5,11K	1	MR25	5322 116 54595
R 862	10K	1	MR25	4822 116 51253
R 863	51,1	1	MR25	5322 116 54442
R 864	48,7	1	MR25	5322 116 50511
R 866	6,49K	1	MR25	5322 116 54603
R 867	6,49K	1	MR25	5322 116 54603
R 868	100	1	MR25	5322 116 55549
R 869	100	1	MR25	5322 116 55549
R 870	1K		MR25	4822 116 51235
R 871	100K	1	MR25	4822 116 51268
R 872	9,53K	1	MR25	5322 116 55574
R 873	536	1	MR25	5322 116 50621
R 875	100	1	MR25	5322 116 55549
R 876	422	1	MR25	5322 116 50459
R 877	464	1	MR25	5322 116 50536
R 878	40,2	1	MR25	5322 116 50926
R 879	40,2	1	MR25	5322 116 50926
R 880	100	1	MR25	5322 116 55549
R 881	2,49K	1	MR25	5322 116 50581
R 882	1,05K	1	MR25	5322 116 54552
R 883	3,01K	1	MR25	4822 116 51246
R 884	7,15K	1	MR25	5322 116 54606
R 886	1K	1	MR25	4822 116 51235
R 887	100	20	0,5W	5322 101 14011
R 888	1K	1	MR25	4822 116 51235
R 889	100	20	0.75W	5322 100 10138
R 891	10K	POTM	0.75W	5322 100 10141
R 892	909	1	MR25	5322 116 55278
R 893	1	1	MR25	4822 116 51179
R 894	100K	1	MR25	4822 116 51268
R 896	422	1	MR25	5322 116 50459
R 897	100	1	MR25	5322 116 55549

POSNR		DESCRIPTION			ORDERING CODE
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R	899	40,2	1	MR25	5322 116 50926
R	901	619	1	MR25	4822 116 51232
R	902	4,02K	1	MR25	5322 116 55448
R	903	5,11K	1	MR25	5322 116 54595
R	904	100K	1	MR25	4822 116 51268
R	906	100K	1	MR25	4822 116 51268
R	907	4,7K	20	0.75W	5322 100 10139
R	908	14,7K		MR25	5322 116 54632
R	909	51,1K	1	MR25	5322 116 50672
R	910	100	1	MR25	5322 116 55549
R	911	90,9K	1	MR25	5322 116 54694
R	912	10M	5	VR25	4822 110 72214
R	913	10M	5	VR25	4822 110 72214
R	914	59	1	MR25	5322 116 54448
R	917	59	1	MR25	5322 116 54448
R	918	750	1	MR25	4822 116 51234
R	919	48,7	1	MR25	5322 116 50511
R	921	48,7	1	MR25	5322 116 50511
R	922	48,7	1	MR25	5322 116 50511
R	923	48,7	1	MR25	5322 116 50511
R	924	59	1	MR25	5322 116 54448
R	925	1.1K			4822 116 51236
R	927	750	1	MR25	4822 116 51234
R	928	59	1	MR25	5322 116 54448
R	929	2,49	1	MR25	5322 116 51394
R	930	422		MR25	5322 116 50459
R	931	619		MR25	4822 116 51232
R	932	402K	1	MR25	5322 116 55283
R	933	536	1	MR25	5322 116 50621
R	936	100	1	MR25	5322 116 55549
R	937	287	1	MR25	5322 116 54506
R	938	31.6		MR25	5322 116 54034
R	939	464	1	MR25	5322 116 50536
R	940	5,11K	1	MR25	5322 116 54595
R	941	14,7	1	MR25	5322 116 50412
R	942	48,7	1	MR25	5322 116 50511
R	943	487	1	MR25	5322 116 55451
R	944	48,7	1	MR25	5322 116 50511
R	945	100	1	MR25	5322 116 55549
R	946	1,69K	1	MR25	5322 116 54567
R	947	1,27K	1	MR25	5322 116 50555
R	948	487	1	MR25	5322 116 55451
R	949	100K	1	MR25	4822 116 51268
R	950	1K	1	MR25	4822 116 51235
R	951	2,49K	1	MR25	5322 116 50581
R	952	7,15K	1	MR25	5322 116 54606
R	953	105K	1	MR25	5322 116 55356
R	954	4,22K	1	MR25	5322 116 50729
R	955	14,7	1	MR25	5322 116 50412
R	956	12,7K	1	MR25	5322 116 50443
R	957	8,25K	1	MR25	5322 116 51498
R	958	220	20	0.75W	5322 100 10133
R	959	220	20	0,5W	5322 101 14009
R	960	90.9		MR25	5322 116 54466
R	961	220	20	0.75W	5322 100 10133
R	962	220	20	0,5W	5322 101 14009
R	963	100	1	MR25	5322 116 55549
R	964	100	20	0,5W	5322 101 14011
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R	969	5,11K	1	MR25	5322 116 54595
R	970	100K	1	MR25	4822 116 51268

POSNR	DESCRIPTION			ORDERING CODE
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R 973	487	1	MR25	5322 116 55451
R 974	51,1K	1	MR25	5322 116 50672
R 975	21,5	1	MR25	5322 116 50677
R 976	866	1	MR25	5322 116 54543
R 977	4,02K	1	MR25	5322 116 55448
R 978	3,01K	1	MR25	4822 116 51246
R 979	1K	1	MR25	4822 116 51235
R 980	51,1K	1	MR25	5322 116 50672
R 981	1,78K	1	MR25	5322 116 50515
R 982	10K	1	MR25	4822 116 51253
R 983	5,11K	1	MR25	5322 116 54595
R 984	2,2M	5	VR25	4822 110 72196
R 986	511	1	MR25	4822 116 51282
R 987	316	1	MR25	5322 116 54511
R 988	511	1	MR25	4822 116 51282
R 989	511	1	MR25	4822 116 51282
R 991	316	1	MR25	5322 116 54511
R 992	511	1	MR25	4822 116 51282
R 993	100K	1	MR25	4822 116 51268
R 994	26,1K	1	MR25	5322 116 54651
R 995	26,1K	1	MR25	5322 116 54651
R 996	287	1	MR25	5322 116 54506
R 997	511	1	MR25	4822 116 51282
R 999	14,7	1	MR25	5322 116 50412
R 1000	100		MR25	5322 116 55549
R 1001	287	1	MR25	5322 116 54506
R 1002	100	1	MR25	5322 116 55549
R 1003	14.7		MR25	5322 116 50412
R 1004	48,7	1	MR25	5322 116 50511
R 1005	100	1	MR25	5322 116 55549
R 1006	365K	1	MR25	5322 116 55641
R 1007	100K	1	MR25	4822 116 51268
R 1008	1,15K	1	MR25	5322 116 52121
R 1011	5,9K	1	MR25	5322 116 50583
R 1013	100K	1	MR25	4822 116 51268
R 1014	10K	1	MR25	4822 116 51253
R 1016	3,01K	1	MR25	4822 116 51246
R 1017	5,11K	1	MR25	5322 116 54595
R 1019	274	1	MR25	5322 116 54504
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R 1022	1K	1	MR25	4822 116 51235
R 1023	487	1	MR25	5322 116 55451
R 1024	750	1	MR25	4822 116 51234
R 1026	30,1	1	MR25	5322 116 50904
R 1027	1K	1	MR25	4822 116 51235
R 1028	487	1	MR25	5322 116 55451
R 1029	750	1	MR25	4822 116 51234
R 1031	30,1	1	MR25	5322 116 50904
R 1032	1K	1	MR25	4822 116 51235
R 1033	487	1	MR25	5322 116 55451
R 1034	750	1	MR25	4822 116 51234
R 1036	30,1	1	MR25	5322 116 50904
R 1037	1K	1	MR25	4822 116 51235
R 1038	487	1	MR25	5322 116 55451
R 1039	750	1	MR25	4822 116 51234
R 1041	30,1	1	MR25	5322 116 50904
R 1042	1K	1	MR25	4822 116 51235
R 1043	487	1	MR25	5322 116 55451
R 1044	750	1	MR25	4822 116 51234
R 1045	274	1	MR25	5322 116 54504
R 1046	30,1	1	MR25	5322 116 50904
R 1047	1K	1	MR25	4822 116 51235
R 1048	487	1	MR25	5322 116 55451
R 1049	750	1	MR25	4822 116 51234

POSNR	DESCRIPTION			ORDERING CODE
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R 1054	1K	20	0.75W	5322 100 10143
R 1056	48,7	1	MR25	5322 116 50511
R 1057	9,53K	1	MR25	5322 116 55574
R 1058	5,11K	1	MR25	5322 116 54595
R 1059	5,11K	1	MR25	5322 116 54595
R 1060	100	1	MR25	5322 116 55549
R 1061	1K	1	MR25	4822 116 51235
R 1062	14.7		MR25	5322 116 50412
R 1063	3,01K	1	MR25	4822 116 51246
R 1064	4,02K	1	MR25	5322 116 55448
R 1065	100	1	MR25	5322 116 55549
R 1066	866	1	MR25	5322 116 54543
R 1067	51,1K	1	MR25	5322 116 50672
R 1068	10K	1	MR25	4822 116 51253
R 1069	196K	1	MR25	5322 116 55364
R 1071	866K	1	MR25	5322 116 51395
R 1072	402K	1	MR25	5322 116 55283
R 1073	100	1	MR25	5322 116 55549
R 1076	1K	1	MR25	4822 116 51235
R 1077	511	1	MR25	4822 116 51282
R 1078	38,3	1	MR25	5322 116 50954
R 1079	38,3	1	MR25	5322 116 50954
R 1080	100	1	MR25	5322 116 55549
R 1081	511	1	MR25	4822 116 51282
R 1082	100	1	MR25	5322 116 55549
R 1083	100	1	MR25	5322 116 55549
R 1084	48,7	1	MR25	5322 116 50511
R 1085	51,1K	1	MR25	5322 116 50672
R 1086	30,1	1	MR25	5322 116 50904
R 1087	402	1	MR25	5322 116 54519
R 1088	649	1	MR25	5322 116 54532
R 1089	2,49K	1	MR25	5322 116 50581
R 1090	100	1	MR16	5322 116 55392
R 1091	196	1	MR25	5322 116 55273
R 1092	402	1	MR25	5322 116 54519
R 1093	30,1	1	MR25	5322 116 50904
R 1094	1,05K	1	MR25	5322 116 54552
R 1095	100	1	MR16	5322 116 55392
R 1096	649	1	MR25	5322 116 54532
R 1097	1,87K	1	MR25	5322 116 52123
R 1098	100	1	MR16	5322 116 55392
R 1099	100	1	MR16	5322 116 55392
R 1101	287		MR25	5322 116 54506
R 1102	100	1	MR25	5322 116 55549
R 1104	220	20	0,5W	5322 101 14009
R 1105	100		MR25	5322 116 55549
R 1106	3,01K	1	MR25	4822 116 51246
R 1107	4,02K	1	MR25	5322 116 55448
R 1108	402	1	MR25	5322 116 54519
R 1109	287		MR25	5322 116 54506
R 1110	100	1	MR25	5322 116 55549
R 1111	10M	5%	VR25	4822 110 72214
R 1113	48,7	1	MR25	5322 116 50511
R 1114	48,7	1	MR25	5322 116 50511
R 1115	4.22K		MR25	5322 116 50729
R 1116	48,7	1	MR25	5322 116 50511
R 1117	5,11K	1	MR25	5322 116 54595
R 1118	24,9	1	MR25	5322 116 50903
R 1119	24,9	1	MR25	5322 116 50903
R 1121	5,11K	1	MR25	5322 116 54595
R 1122	5,6M	5	VR25	4822 110 72207
R 1123	5,6M	5	VR25	4822 110 72207
R 1124	100	1	MR25	5322 116 55549
R 1126	750K		MR30	5322 116 51706

POSNR	DESCRIPTION			ORDERING CODE
R 1127	249K		MR25	5322 116 54734
R 1129	162	1	MR25	5322 116 50417
R 1131	205	1	MR25	5322 116 55365
R 1132	147K		MR25	5322 116 54712
R 1133	10K		MR25	4822 116 51253
R 1134	100K	POTM.	20%	5322 101 14071
R 1135	10K		MR25	4822 116 51253
R 1136	196K		MR25	5322 116 55364
R 1201	4,7K	20	0.5W	5322 101 14067
R 1202	22K	20	0.5W	5322 100 10118
R 1203	330	20	0.5W	5322 101 14244
R 1204	5,11	1	MR25	4822 116 52999
R 1205	1K	20	0.5W	5322 101 10294
R 1206	28,7	1	MR25	5322 116 54068
R 1207	22,6K	1	MR25	5322 116 50481
R 1208	121	1	MR25	5322 116 54426
R 1209	121	1	MR25	5322 116 54426
R 1210	1,33K	1	MR25	5322 116 55422
R 1211	1,47K	1	MR25	5322 116 50635
R 1212	2,74K	1	MR25	5322 116 50636
R 1213	2,74K	1	MR25	5322 116 50636
R 1214	90,9	1	MR25	5322 116 54466
R 1215	2,74K	1	MR25	5322 116 50636
R 1216	147	1	MR25	5322 116 50766
R 1217	11,5K	1	MR25	5322 116 55358
R 1218	215	1	MR25	5322 116 55274
R 1219	215	1	MR25	5322 116 55274
R 1220	215	1	MR25	5322 116 55274
R 1221	1K	1	MR25	4822 116 51235
R 1222	169K		MR25	5322 116 54718
R 1223	42,2	1	MR25	5322 116 51052
R 1224	10K	1	MR25	4822 116 51253
R 1225	15K	10	0.5W	5322 116 30221
R 1226	1K	1	MR25	4822 116 51235
R 1228	100	1	MR25	5322 116 55549
R 1229	5,11	1	MR25	4822 116 52999
R 1230	2,61K	1	MR25	5322 116 50671
R 1231	953K		MR25	5322 116 51368
R 1232	1.2M			4822 110 72189
R 1233	46,4	1	MR25	5322 116 50492
R 1234	511	1	MR25	4822 116 51282
R 1235	2,61K	1	MR25	5322 116 50671
R 1236	100	1	MR25	5322 116 55549
R 1237	1K	1	MR25	4822 116 51235
R 1238	274	1	MR25	5322 116 54504
R 1239	220	20	0.5W	4822 100 10359
R 1242	249	1	MR25	5322 116 54499
R 1246	46,4	1	MR25	5322 116 50492
R 1247	100	1	MR25	5322 116 55549
R 1248	5,11	1	MR25	4822 116 52999
R 1250	150	20	0.5W	4822 100 10355
R 1251	511	1	MR25	4822 116 51282
R 1252	42,2	1	MR25	5322 116 51052
R 1253	274	1	MR25	5322 116 54504
R 1254	1K	1	MR25	4822 116 51235
R 1256	511	1	MR25	4822 116 51282
R 1257	38,3	1	MR25	5322 116 50954
R 1258	562	1	MR25	4822 116 51231
R 1262	1,33K MS	220N		5322 116 52721
R 1263	1,33K MS	220N		5322 116 52721

POSNR	DESCRIPTION			ORDERING CODE
R 1264	1,33K MS 220N			5322 116 52721
R 1266	1,33K MS 220N			5322 116 52721
R 1269	1,1K		MR25	4822 116 51236
R 1270	1,1K		MR25	4822 116 51236
R 1300	19,6K	1	MR25	5322 116 54641
R 1301	100	1	MR25	5322 116 55549
R 1302	4,02K	1	MR25	5322 116 55448
R 1303	5,11	1	MR25	4822 116 52999
R 1304	100	1	MR25	5322 116 55549
R 1305	5,11	1	MR25	4822 116 52999
R 1306	3,01K	1	MR25	4822 116 51246
R 1307	619	1	MR25	4822 116 51232
R 1308	1,78K	1	MR25	5322 116 50515
R 1309	2,61K	1	MR25	5322 116 50671
R 1310	19,6K	1	MR25	5322 116 54641
R 1311	4,22K	1	MR25	5322 116 50729
R 1312	140K	1	MR25	5322 116 54259
R 1313	15,4K	1	MR25	5322 116 55459
R 1314	3,01K	1	MR25	4822 116 51246
R 1315	649	1	MR25	5322 116 54532
R 1316	3,01K	1	MR25	4822 116 51246
R 1317	3,32K	1	MR25	4822 116 51247
R 1318	301	1	MR25	5322 116 55366
R 1319	301	1	MR25	5322 116 55366
R 1320	649	1	MR25	5322 116 54532
R 1321	7,5K	1	MR25	5322 116 54608
R 1322	487	1	MR25	5322 116 55451
R 1323	46,4K	1	MR25	5322 116 50557
R 1324	46,4K	1	MR25	5322 116 50557
R 1325	147	1	MR25	5322 116 50766
R 1326	487	1	MR25	5322 116 55451
R 1327	7,5K	1	MR25	5322 116 54608
R 1328	86,6K	1	MR25	5322 116 54692
R 1329	71,5K	1	MR25	5322 116 54685
R 1330	147	1	MR25	5322 116 50766
R 1331	110K	1	MR25	5322 116 54701
R 1332	16,2K	1	MR25	5322 116 55361
R 1333	4,64K	1	MR25	5322 116 50484
R 1334	953	1	MR25	5322 116 54547
R 1336	402K	1	MR25	5322 116 55283
R 1338	953	1	MR25	5322 116 54547
R 1339	402K	1	MR25	5322 116 55283
R 1346	5,11	1	MR25	4822 116 52999
R 1347	5,11	1	MR25	4822 116 52999
R 1360	31,6K	1	MR25	5322 116 54657
R 1361	18,7K	1	MR25	5322 116 55362
R 1362	511K	1	MR25	5322 116 55258
R 1363	13,3K	1	MR25	5322 116 55276
R 1370	10	1	MR25	5322 116 50452
R 1371	26,1K	1	MR25	5322 116 54651
R 1372	9,53K	1	MR25	5322 116 55574
R 1373	649	1	MR25	5322 116 54532
R 1374	1,54K	1	MR25	5322 116 50586
R 1376	3,01K	1	MR25	4822 116 51246
R 1377	100	1	MR25	5322 116 55549
R 1378	154	1	MR25	5322 116 50506
R 1381	100	20	0,5W	5322 101 14011
R 1383	1,54K	1	MR25	5322 116 50586
R 1384	10K	20	0,5W	5322 100 10113
R 1388	10	1	MR25	5322 116 50452
R 1389	4,22K	1	MR25	5322 116 50729
R 1392	953	1	MR25	5322 116 54547

POSNR	DESCRIPTION			ORDERING CODE
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R 1402	1,27	1	MR25	4822 116 52169
R 1403	1,27	1	MR25	4822 116 52169
R 1404	1,27	1	MR25	4822 116 52169
R 1406	24,9K	1	MR25	5322 116 54648
R 1407	2,2M	5	VR37	4822 110 42196
R 1408	10K	1	MR25	4822 116 51253
R 1409	15,4K	1	MR25	5322 116 55459
R 1411	1,2M	5	VR37	4822 110 42189
R 1412	5,6M	5	VR37	4822 110 42207
R 1413	10M	1	VR37	4822 110 42214
R 1414	82,5K		MR25	5322 116 55374
R 1415	7,SE		MR25	5322 116 54417
R 1415	BYV96D			4822 130 31348
R 1416	82,5K		MR25	5322 116 55374
R 1417	1K	1	MR25	4822 116 51235
R 1418	7,5E		MR25	5322 116 54417
R 1419	75K		MR25	4822 116 51267
R 1420	4,02K	1	MR25	5322 116 55448
R 1421	10K	1	MR25	4822 116 51253
R 1422	100K	1	MR25	4822 116 51268
R 1423	10K	1	MR25	4822 116 51253
R 1424	196	1	MR25	5322 116 55273
R 1426	6,81K	1	MR25	4822 116 51252
R 1428	21,5K	1	MR25	5322 116 50451
R 1429	3,16K	1	MR25	5322 116 50579
R 1430	100	1	MR25	5322 116 55549
R 1431	51,1	1	MR25	5322 116 54442
R 1432	51,1	1	MR25	5322 116 54442
R 1433	13K	1	MR25	5322 116 50522
R 1434	100K	1	MR25	4822 116 51268
R 1435	100	1	MR25	5322 116 55549
R 1436	78,7K	1	MR25	5322 116 50533
R 1437	13,3K	1	MR25	5322 116 55276
R 1438	750	1	MR25	4822 116 51234
R 1439	3,83K	1	MR25	5322 116 54589
R 1440	11	1	MR25	5322 116 54059
R 1441	19,6		MR25	5322 116 50473
R 1442	6,19K	1	MR25	5322 116 55426
R 1443	261	1	MR25	5322 116 54502
R 1444	1K	1	MR25	4822 116 51235
R 1445	16.2K		MR25	5322 116 55361
R 1446	2,49K	1	MR25	5322 116 50581
R 1447	10K	1	MR25	4822 116 51253
R 1448	5,9K	1	MR25	5322 116 50583
R 1451	5,11K	1	MR25	5322 116 54595
R 1452	4,64K	1	MR25	5322 116 50484
R 1453	30,1K	1	MR25	5322 116 54655
R 1456	14,7K	1	MR25	5322 116 54632
R 1457	1,54K	1	MR25	5322 116 50586
R 1458	1,27K	1	MR25	5322 116 50555
R 1459	100K	1	MR25	4822 116 51268
R 1460	5,11	1	MR25	4822 116 52999
R 1461	24,9K	1	MR25	5322 116 54648
R 1462	4,64K	1	MR25	5322 116 50484
R 1463	226	1	MR25	5322 116 54497
R 1464	8,25K	1	MR25	5322 116 51498
R 1466	23,7K		MR25	5322 116 54646
R 1467	750	1	MR25	4822 116 51234
R 1468	15,4K	1	MR25	5322 116 55459
R 1469	20,5K	1	MR25	5322 116 55419
R 1470	100		MR25	5322 116 55549
R 1471	100K	20	0.5W	5322 101 10312
R 1472	1M	20	0.5W	5322 101 10314
R 1473	220K	20	0.5W	5322 101 10315

POSNR	DESCRIPTION			ORDERING CODE
R 1474	22K	20	0.5W	5322 101 10311
R 1476	330	20	0.5W	5322 101 10313
R 1501	5,11	1	MR25	4822 116 52999
R 1502	100	1	MR25	5322 116 55549
R 1503	11K		MR25	5322 116 54623
R 1504	22K	20	0.5W	5322 100 10118
R 1505	5,11	1	MR25	4822 116 52999
R 1506	402	1	MR25	5322 116 54519
R 1507	511	1	MR25	4822 116 51282
R 1508	6,49K	1	MR25	5322 116 54603
R 1509	511	1	MR25	4822 116 51282
R 1511	40,2K	1	MR25	5322 116 54665
R 1512	348K	1	MR25	5322 116 55499
R 1513	15,4K		MR25	5322 116 55459
R 1514	1,87K	1	MR25	5322 116 52123
R 1516	5,11	1	MR25	4822 116 52999
R 1517	36,5K	1	MR25	5322 116 50726
R 1519	249	1	MR25	5322 116 54499
R 1520	7,5K	1	MR25	5322 116 54608
R 1521	7,5K	1	MR25	5322 116 54608
R 1522	511	1	MR25	4822 116 51282
R 1523	909	1	MR25	5322 116 55278
R 1524	23,7K	1	MR25	5322 116 54646
R 1526	100	1	MR25	5322 116 55549
R 1527	7,87K	1	MR25	5322 116 50458
R 1528	20,5K	1	MR25	5322 116 55419
R 1529	12,1K	1	MR25	5322 116 50572
R 1532	100K	1	MR25	4822 116 51268
R 1533	46,4K	1	MR25	5322 116 50557
R 1536	100	1	MR25	5322 116 55549
R 1537	383K	1	MR25	5322 116 55335
R 1538	1M	1	MR25	5322 116 55535
R 1539	511K	1	MR25	5322 116 55258
R 1541	78,7K	1	MR25	5322 116 50533
R 1542	100K	1	MR25	4822 116 51268
R 1543	51,1K	1	MR25	5322 116 50672
R 1546	1K	1	MR25	4822 116 51235
R 1547	348E		MR25	5322 116 54515
R 1548	5,11K		MR25	5322 116 54595
R 1549	2,2K POTM.			5322 100 10117
R 1551	1	1	MR25	4822 116 51179
R 1552	133	1	MR25	5322 116 54482
R 1553	1K	1	MR25	4822 116 51235

CRT

V 1	D12-120GH-115	5322 131 20092
V 1	C.R.T.D12-120GM-115	5322 131 20112

SEMI CONDUCTORS

V 200	BC558B	PH	4822 130 44197
V 202	BZX79-C3V0	PH	4822 130 31881
V 203	BC558B	PH	4822 130 44197
V 204	BC558B	PH	4822 130 44197
V 205	BAW62	PH	4822 130 30613
V 206	BAW62	PH	4822 130 30613
V 207	BC548C	PH	4822 130 44196
V 208	BC558B	PH	4822 130 44197
V 209	BC548C	PH	4822 130 44196
V 211	BAW62	PH	4822 130 30613
V 212	BFQ24	PH	5322 130 41664

POSNR		DESCRIPTION		ORDERING CODE
V	213	BC558B	PH	4822 130 44197
V	214	BAW62	PH	4822 130 30613
V	216	BAW62	PH	4822 130 30613
V	217	BAW62	PH	4822 130 30613
V	218	BAW62	PH	4822 130 30613
V	219	BC548C	PH	4822 130 44196
V	220	BAW62	PH	4822 130 30613
V	221	BC548C	PH	4822 130 44196
V	222	BAW62	PH	4822 130 30613
V	223	BC558B	PH	4822 130 44197
V	224	BC558B	PH	4822 130 44197
V	225	BF324		4822 130 41448
V	226	BF324		4822 130 41448
V	227	BSX20	PH	4822 130 41705
V	228	BSX20	PH	4822 130 41705
V	229	BC558B	PH	4822 130 44197
V	230	BAT83		5322 130 32103
V	231	BC548C	PH	4822 130 44196
V	232	BAW62	PH	4822 130 30613
V	233	BSX20	PH	4822 130 41705
V	234	BSX20	PH	4822 130 41705
V	235	BC548C	PH	4822 130 44196
V	236	BC558B	PH	4822 130 44197
V	237	BC548C	PH	4822 130 44196
V	238	BC548C	PH	4822 130 44196
V	239	BAW62	PH	4822 130 30613
V	240	BAW62	PH	4822 130 30613
V	241	BAW62	PH	4822 130 30613
V	242	BAW62	PH	4822 130 30613
V	243	BAW62	PH	4822 130 30613
V	244	BAW62	PH	4822 130 30613
V	246	BC548C	PH	4822 130 44196
V	247	BC548C	PH	4822 130 44196
V	248	BC548C	PH	4822 130 44196
V	249	BAW62	PH	4822 130 30613
V	250	BAW62	PH	4822 130 30613
V	251	BAW62	PH	4822 130 30613
V	252	BAW62	PH	4822 130 30613
V	253	BAT83		5322 130 32103
V	254	BAW62	PH	4822 130 30613
V	255	BAW62	PH	4822 130 30613
V	256	BC548C	PH	4822 130 44196
V	257	BC548C	PH	4822 130 44196
V	258	BC548C	PH	4822 130 44196
V	259	BC548C	PH	4822 130 44196
V	260	BZX79-C6V8	PH	4822 130 34278
V	261	BC558B	PH	4822 130 44197
V	262	BAW62	PH	4822 130 30613
V	263	BAW62	PH	4822 130 30613
V	264	BC558B	PH	4822 130 44197
V	265	BAW62	PH	4822 130 30613
V	266	BZV46-C1V5	PH	5322 130 34865
V	267	BC548C MTB	SWEEP-OUT	4822 130 44196
V	268	BC548C	PH	4822 130 44196
V	269	BC548C	PH	4822 130 44196
V	271	BSX20	PH	4822 130 41705
V	272	BC548C	PH	4822 130 44196
V	273	BC548C	PH	4822 130 44196
V	274	BAW62	PH	4822 130 30613
V	276	BAW62	PH	4822 130 30613
V	277	BAW62	PH	4822 130 30613
V	278	BAW62	PH	4822 130 30613
V	279	BAW62	PH	4822 130 30613
V	280	BC548C		4822 130 44196
V	281	BAW62	PH	4822 130 30613

POSNR		DESCRIPTION		ORDERING CODE
V	282	BAW62	PH	4822 130 30613
V	283	BAW62	PH	4822 130 30613
V	284	BC548C	PH	4822 130 44196
V	285	BC548C	PH	4822 130 44196
V	286	BC548C	PH	4822 130 44196
V	287	BC548C	PH	4822 130 44196
V	288	BFY90	PH	4822 130 40493
V	289	BFY90	PH	4822 130 40493
V	290	BAW62		4822 130 30613
V	291	BF324		4822 130 41448
V	292	BFQ24	PH	5322 130 41664
V	293	BF324		4822 130 41448
V	294	BAW62	PH	4822 130 30613
V	295	BAW62	PH	4822 130 30613
V	296	BAT83		5322 130 32103
V	297	BAT83		5322 130 32103
V	298	BAW62	PH	4822 130 30613
V	299	BAT 83		5322 130 32103
V	300	BAT83		5322 130 32103
V	300	BAT 83		5322 130 32103
V	302	BC548C		4822 130 44196
V	303	BAW62		4822 130 30613
V	304	BZX79 C5V6		4822 130 34173
V	305	BC558B		4822 130 44197
V	306	BAW62		4822 130 30613
V	310	BAS 45		5322 130 32256
V	311	STAB.BZV 46 C1V5		5322 130 34865
V	503	BC548C	PH	4822 130 44196
V	504	BC558B	PH	4822 130 44197
V	505	BAV45		5322 130 34037
V	506	BFQ24 SELECT		5322 130 41993
V	507	BZV46-C2V0	PH	4822 130 31248
V	508	BAV45		5322 130 34037
V	509	BF199	PH	4822 130 44154
V	510	BC558B	PH	4822 130 44197
V	511	BC548C	PH	4822 130 44196
V	512	BAW62	PH	4822 130 30613
V	513	ON905	PH	5322 130 41904
V	514	BF324	PH	4822 130 41448
V	515	BZX79-C5V6	PH	4822 130 34173
V	516	BFW30	PH	5322 130 40379
V	517	BF199	PH	4822 130 44154
V	518	BF450	PH	4822 130 44237
V	651	BAW62	PH	4822 130 30613
V	653	BC548C	PH	4822 130 44196
V	654	BC558B	PH	4822 130 44197
V	655	BC548C	PH	4822 130 44196
V	656	BFQ24 SELECT		5322 130 41993
V	657	BZV46-C2V0	PH	4822 130 31248
V	660	BC558B	PH	4822 130 44197
V	661	ON905	PH	5322 130 41904
V	662	BF199	PH	4822 130 44154
V	663	BC548C	PH	4822 130 44196
V	664	BAV45		5322 130 34037
V	665	BAV45		5322 130 34037
V	666	BF324	PH	4822 130 41448
V	667	BFW30	PH	5322 130 40379
V	668	BF199	PH	4822 130 44154
V	669	BF450	PH	4822 130 44237
V	770	BZX79-C5V6	PH	4822 130 34173
V	801	BF324	PH	4822 130 41448

POSNR		DESCRIPTION		ORDERING CODE
V	802	BF324	PH	4822 130 41448
V	803	BC548C	PH	4822 130 44196
V	804	BSX20	PH	4822 130 41705
V	806	BZV46-C1V5	PH	5322 130 34865
V	807	BC558B	PH	4822 130 44197
V	808	BC558B	PH	4822 130 44197
V	851	BFQ24	PH	5322 130 41664
V	852	BF450	PH	4822 130 44237
V	853	BF450	PH	4822 130 44237
V	854	BFQ24	PH	5322 130 41664
V	856	BC558B		4822 130 44197
V	857	BAW62	PH	4822 130 30613
V	858	BAW62	PH	4822 130 30613
V	859	BC548C	PH	4822 130 44196
V	860	BAW62	PH	4822 130 30613
V	861	BF199	PH	4822 130 44154
V	862	BF199	PH	4822 130 44154
V	863	BC558B	PH	4822 130 44197
V	864	BC548C	PH	4822 130 44196
V	865	BF199	PH	4822 130 44154
V	866	BC548C	PH	4822 130 44196
V	867	BAT83		5322 130 32103
V	868	BAT83		5322 130 32103
V	869	BF199 TV OPTION		4822 130 44154
V	870	BC548C	PH	4822 130 44196
V	871	BC548C TV OPTION		4822 130 44196
V	872	BF199	PH	4822 130 44154
V	873	BF199	PH	4822 130 44154
V	874	BF199	PH	4822 130 44154
V	875	BC548C	PH	4822 130 44196
V	876	BF199	PH	4822 130 44154
V	877	BZX79-C4V7	PH	4822 130 34174
V	878	BF199	PH	4822 130 44154
V	879	BF199	PH	4822 130 44154
V	880	BC548C	PH	4822 130 44196
V	881	BZX79-C6V2		4822 130 34167
V	882	BF199	PH	4822 130 44154
V	883	BF199	PH	4822 130 44154
V	884	BAW62	PH	4822 130 30613
V	885	BZX79-C4V7	PH	4822 130 34174
V	887	ON4057		5322 130 42366
V	888	BAW62	PH	4822 130 30613
V	889	BAW62	PH	4822 130 30613
V	890	BZX79 C6V2		4822 130 34167
V	891	BAW62	PH	4822 130 30613
V	892	BAW62	PH	4822 130 30613
V	893	BC548C	PH	4822 130 44196
V	894	BAW62 TV OPTION		4822 130 30613
V	895	BF199	PH	4822 130 44154
V	896	BC548C	PH	4822 130 44196
V	897	BC548C	PH	4822 130 44196
V	898	BC548C TV OPTION		4822 130 44196
V	899	BC548C TV OPTION		4822 130 44196
V	901	BAW62	PH	4822 130 30613
V	902	BAW62	PH	4822 130 30613
V	903	BAW62	PH	4822 130 30613
V	904	BAW62	PH	4822 130 30613
V	906	BAW62	PH	4822 130 30613
V	907	BC548C	PH	4822 130 44196
V	908	BC558B TV OPTION		4822 130 44197
V	909	BC548C TV OPTION		4822 130 44196
V	910	BAW62	PH	4822 130 30613
V	912	BF450	PH	4822 130 44237
V	913	BF450	PH	4822 130 44237
V	914	BF450	PH	4822 130 44237

POSNR	DESCRIPTION		ORDERING CODE
V 916	BF450	PH	4822 130 44237
V 917	BF450	PH	4822 130 44237
V 918	BF450	PH	4822 130 44237
V 919	0N4057		5322 130 42366
V 921	BF450	PH	4822 130 44237
V 922	BF450	PH	4822 130 44237
V 923	BFQ24	PH	5322 130 41664
V 924	BFQ24	PH	5322 130 41664
V 1101	BC548C	PH	4822 130 44196
V 1102	BF199	PH	4822 130 44154
V 1103	BF199	PH	4822 130 44154
V 1104	0N4057		5322 130 42366
V 1106	BAV45	PH	5322 130 34037
V 1201	BFQ24	PH	5322 130 41664
V 1202	BFQ24	PH	5322 130 41664
V 1203	BC558B	PH	4822 130 44197
V 1204	BFW16A	PH	5322 130 44015
V 1205	BB405B	PH	5322 130 34953
V 1206	BFW30	PH	5322 130 40379
V 1208	BFQ24	PH	5322 130 41664
V 1209	BFW30	PH	5322 130 40379
V 1210	BB405B	PH	5322 130 34953
V 1211	BFQ24	PH	5322 130 41664
V 1213	BC548C	PH	4822 130 44196
V 1214	BFW16A	PH	5322 130 44015
V 1302	BF422	PH	4822 130 41782
V 1303	BF423	PH	4822 130 41646
V 1306	BFQ24	PH	5322 130 41664
V 1307	BFQ22	PH	5322 130 41709
V 1308	BAW62	PH	4822 130 30613
V 1309	BAW62	PH	4822 130 30613
V 1311	BF423	PH	4822 130 41646
V 1312	BF422	PH	4822 130 41782
V 1313	BF422	PH	4822 130 41782
V 1314	BF423	PH	4822 130 41646
V 1316	BF423	PH	4822 130 41646
V 1317	BF422	PH	4822 130 41782
V 1318	BAW62	PH	4822 130 30613
V 1319	BAW62	PH	4822 130 30613
V 1371	BF324	PH	4822 130 41448
V 1372	BF324	PH	4822 130 41448
V 1373	BC558B	PH	4822 130 44197
V 1374	BC548C	PH	4822 130 44196
V 1401	BSW68A	PH	5322 130 44788
V 1402	BAX12A	PH	5322 130 34605
V 1403	VG10 RECT.DIODE		5322 130 33041
V 1404	BC547B	PH	4822 130 40959
V 1405	BAW62	PH	4822 130 30613
V 1406	BC547B	PH	4822 130 40959
V 1408	BZV10	PH	5322 130 34439
V 1409	BYW29-150	PH	5322 130 34711
V 1410	BAW62	PH	4822 130 30613
V 1411	BAS11	PH	4822 130 41273
V 1412	BYW29-150	PH	5322 130 34711
V 1413	BDY90	PH	5322 130 44243
V 1414	BYW29-150	PH	5322 130 34711
V 1415	BYV 96D		4822 130 31348
V 1416	BAS11	PH	4822 130 41273
V 1417	BAS11	PH	4822 130 41273
V 1418	BAS11	PH	4822 130 41273
V 1419	BAS11	PH	4822 130 41273
V 1421	BAW62	PH	4822 130 30613
V 1422	BZX79-C10	PH	4822 130 34297
V 1423	BZX79-C6V2	PH	4822 130 34167
V 1424	BZX79-C12	PH	4822 130 34197

POSNR	DESCRIPTION		ORDERING CODE
V 1426	BAW62	PH	4822 130 30613
V 1427	BAW62	PH	4822 130 30613
V 1428	BC547B	PH	4822 130 40959
V 1429	BC547B	PH	4822 130 40959
V 1431	BY225-200	PH	4822 130 50312
V 1432	BAW62	PH	4822 130 30613
V 1433	BC547B	PH	4822 130 40959
V 1434	BAW62	PH	4822 130 30613
V 1436	BYW29-150	PH	5322 130 34711
V 1437	BAX12A	PH	5322 130 34605
V 1438	2N4033	PH	5322 130 41708
V 1440	BAX12		5322 130 34605
V 1501	BC548C	PH	4822 130 44196
V 1502	BC558B	PH	4822 130 44197
V 1503	BSX20	PH	4822 130 41705
V 1504	BC558B	PH	4822 130 44197
V 1507	BAV21	PH	4822 130 30842
V 1508	BSS68	PH	5322 130 44247
V 1509	BC548C	PH	4822 130 44196
V 1511	BF450	PH	4822 130 44237
V 1512	BC548C	PH	4822 130 44196
V 1513	BF199	PH	4822 130 44154
V 1514	BAV21	PH	4822 130 30842
V 1515	BZY10		5322 130 34439
V 1516	BC548C	PH	4822 130 44196

MISCELLANEOUS

POSNR.	DESCRIPTION		ORDERING NUMBER
PUSHBUTTON SWITCHES			
	PUSHBUTTON SWITCH S1 (on time base unit)		5322 276 60208
	PUSHBUTTON SWITCH S2 AND S3 (on time base unit)		5322 276 70075
	PUSHBUTTON SWITCH S17 ... S20 (on pre-ampl. + trigger unit)		5322 276 80237
	PUSHBUTTON SWITCH S22, S23 (on trigger unit)		5322 276 60209
LED'S			
B 1	LED	CQY54A	5322 130 32188
B 2	LED	CQY54A	5322 130 32188
B 3	LED	CQY54A	5322 130 32188
B 4	LED	CQY54A	5322 130 32188
B 5	LED	CQY54A	5322 130 32188
FUSES			
	THERMAL FUSE FOR MAINS TRANSORMER		5322 252 24008
F 1401	FUSE	T2A	4822 253 30025
F 1402	FUSE	500 MA	4822 253 30017
RELAYS			
K 501	REED RELAY		5322 280 20101
K 502	REED RELAY		5322 280 20099
K 503	REED RELAY		5322 280 20101
K 504	REED RELAY		5322 280 20101
K 506	REED RELAY		5322 280 20099
K 651	REED RELAY		5322 280 20101
K 652	REED RELAY		5322 280 20099
K 653	REED RELAY		5322 280 20101
K 654	REED RELAY		5322 280 20101
K 656	REED RELAY		5322 280 20099
K 851	REED RELAY		5322 280 20099
K 852	REED RELAY		5322 280 20099
K 1101	REED RELAY		5322 280 20099
K 1371	REED RELAY		5322 280 20099
COILS			
L 1	BEAD FOR COAX CABLE FROM X806 to X206		5322 526 14019
L 2	BEAD FOR POWER SUPPLY CABLE		5322 526 14031
L 1201	COIL		5322 156 21103
L 1202	COIL		5322 156 21103
L 1401	COIL		5322 156 44014
L 1402	COIL		5322 281 64154
L 1403	COIL		5322 156 44014
L 1404	COIL		5322 156 44014

TRANSFORMERS

T 801	TRANSFORMER ASSY	5322 142 50147
T 1401	TRANSFORMER TFE25	5322 142 60329
T 1402	TRANSFORMER TFEC41	5322 148 80046
T 1403	TRANSFORMER TFU10	5322 142 70065
T 1404	TRANSFORMER TFRM6	5322 158 40085
T 1406	MAINS TRANSFORMER	5322 146 10037
	PLUG FOR 24 V BATTERY SUPPLY ACCORDING 130/10 IEC-02	4822 266 20014
	PLUG AND CABLE (length 40 cm) FOR 24 V BATTERY SUPPLY ACCORDING 130/10 IEC-02	4822 321 20125

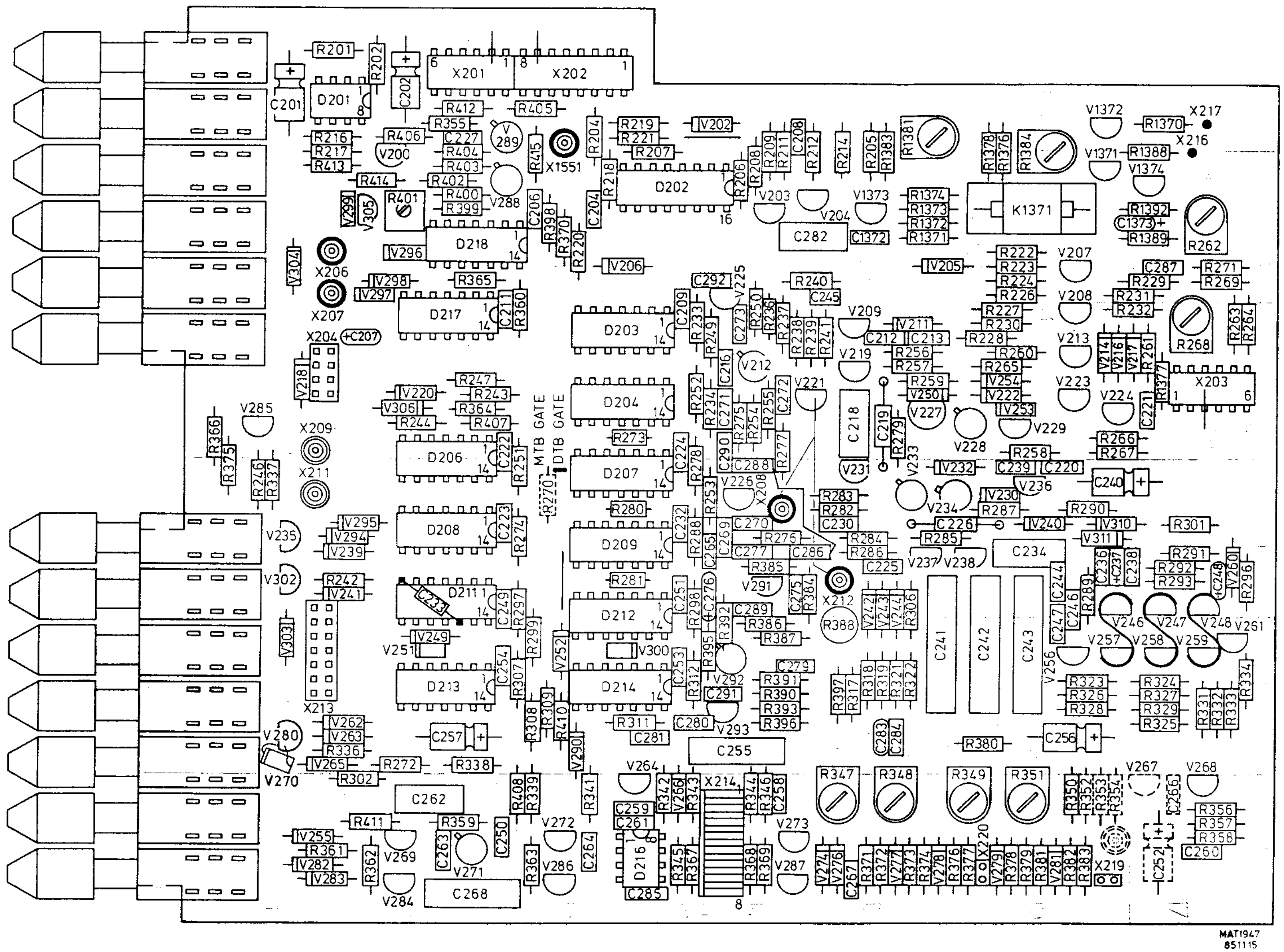


Fig. 7.7. Time-base unit p.c.b. with component location raster

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

Capacitors

C201	A11
C202	A12
C204	B13
C206	B13
C207	C12
C208	A14
C209	C14/B14
C211	B13/C13
C212	C15
C213	C15
C216	C14
C218	C15
C219	C15
C220	D16
C221	C17
C222	D13/C13
C223	D13
C224	D14/C14
C225	D15
C226	D15/D16
C227	A12
C230	D15
C232	D14
C233	D12
C234	D16
C236	D16
C237	D16
C238	D17/D16
C239	D16
C240	D16
C241	D15/E15
C242	D16/E16
C243	D16/E16
C244	D16
C245	B14
C246	D16
C247	D16/E16
C248	D17
C249	D13/E13
C250	F13
C251	D14
C252	F17
C253	E14
C254	E13
C255	E14
C256	E16
C257	E12
C258	F14
C259	F13
C260	F17
C261	F13
C262	F12
C263	F12
C264	F13
C265	D14
C266	F17
C267	F15
C268	F12/F13
C269	D14
C270	D14
C271	C14
C272	C14
C273	C14
C274	C14/D14
C275	D14
C276	D14
C277	D14
C278	E14
C279	E14
C280	E14
C281	E13/E14
C282	B15/B14
C283	E15
C284	E15
C285	F13/F14
C286	D14
C287	B17
C288	D14
C289	D14
C290	C14/D14
C291	E14
C292	B14
C1372	B15
C1373	B16/B17

Integrated circuits

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

Relay

K1371	B16

Resistors

R201	A11
R202	A12
R204	A13
R205	B14
R205	A15/B15
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	C14
R237	C14
R238	C14
R239	C14
R240	B14
R241	C15
R242	D11/D12
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
R261	C17
R262	B17
R263	C17
R264	C17
R265	C16
R266	C16
R267	C16
R268	C17
R269	B17
R270	D13
R271	B17
R272	E12
R273	C13
R274	D13
R275	C14
R276	D14
R277	D14/C14
R278	D14/C14
R279	C15
R280	D13
R281	D13
R282	D15
R283	D15
R284	D15
R285	D15
R286	D15
R287	D16
R288	D14
R289	D16
R290	D16
R291	D17
R292	D17
R293	D17
R296	D17
R297	D13/E13
R298	D14/E14
R299	E13
R301	D17
R302	E12
R306	D15/E15
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
R345	F14
R346	F14
R347	F15
R348	F15
R349	F16/F15
R350	F16
R351	F16
R352	F16
R353	F16
R354	F16
R355	A12
R356	F17
R357	F17
R358	F17
R359	F12
R360	C13/B13
R361	F11
R362	F12
R363	F13
R364	C12
R365	B12
R366	C11
R367	F14
R368	F14
R369	F14
R370	B13
R371	F15
R372	F15
R373	F15
R374	F15
R375	C11/D11
R376	F15
R377	F16/F15
R378	F16
R379	F16
R380	E16
R381	F16
R382	F16
R383	F16
R384	D14
R385	D14
R386	E14
R387	E14
R388	D15/E15
R390	E14
R391	E14
R392	E14/D14
R393	E14
R395	E14
R396	E14
R397	E15
R398	B13
R399	B12
R400	B12
R401	B12
R402	B12
R403	B12
R404	B12/A12
R405	A13
R406	A12
R407	C12/C13
R408	F13
R411	D12
R412	A12
R413	B11
R414	B12
R415	B13
R1370	A17
R1371	B15
R1372	B15
R1373	B15
R1374	B15
R1376	A16/B16
R1377	C17
R1378	A16/B16
R1379	B15
R1381	A15/B15
R1383	A15/B15
R1384	A16/B16
R1388	A17/B17
R1389	B17
R1392	B17
V200	B12/A12
V202	A14
V203	B14
V204	B14/B15
V205	B15
V206	B13
V207	B16
V208	C16
V209	C15
V211	C15
V212	C14
V213	C16
V214	C16
V216	C16
V217	C16/C17
V218	C11
V219	C15
V220	C12
V221	C14
V222	C16
V223	C16
V224	C16
V225	B14
V226	D14
V227	C15
V228	C16
V229	C16
V230	D16
V231	D15
V232	D15
V233	D15
V234	D15
V235	D11
V236	D16
V237	D15
V238	D15/D16
V239	B11/B12
V240	D16
V241	D11/D12
V242	D15/E15
V243	D15/E15
V244	D15/E15
V246	D16
V247	D17
V248	D17
V249	E12
V250	C15
V251	E12
V252	E13
V253	C16
V255	F11
V256	E16
V257	E16
V258	E17
V259	E17
V260	D17
V261	E17
V262	E11/E12
V263	E11/E12
V264	F13
V265	E11/E12
V266	F14
V267	F17

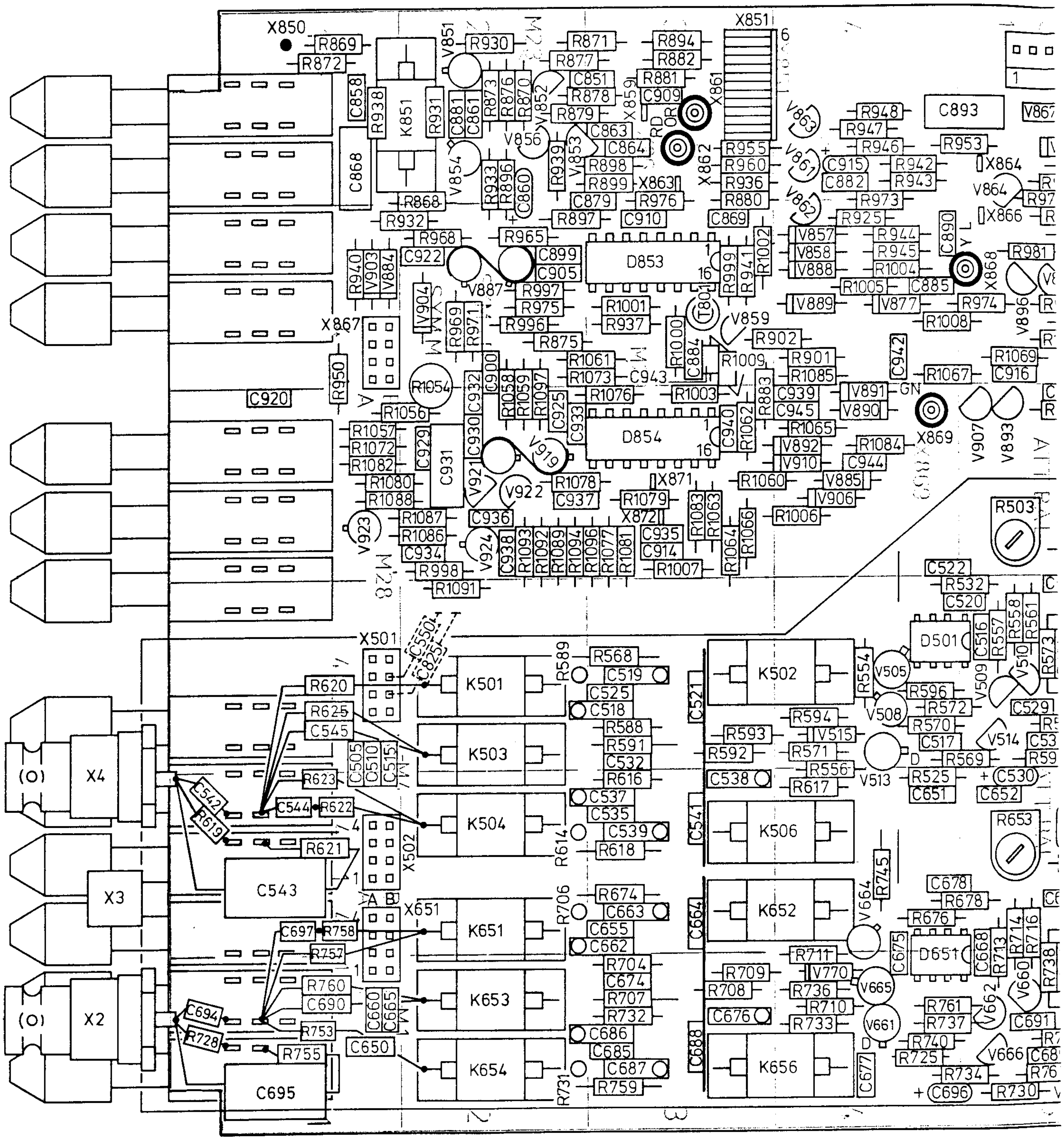
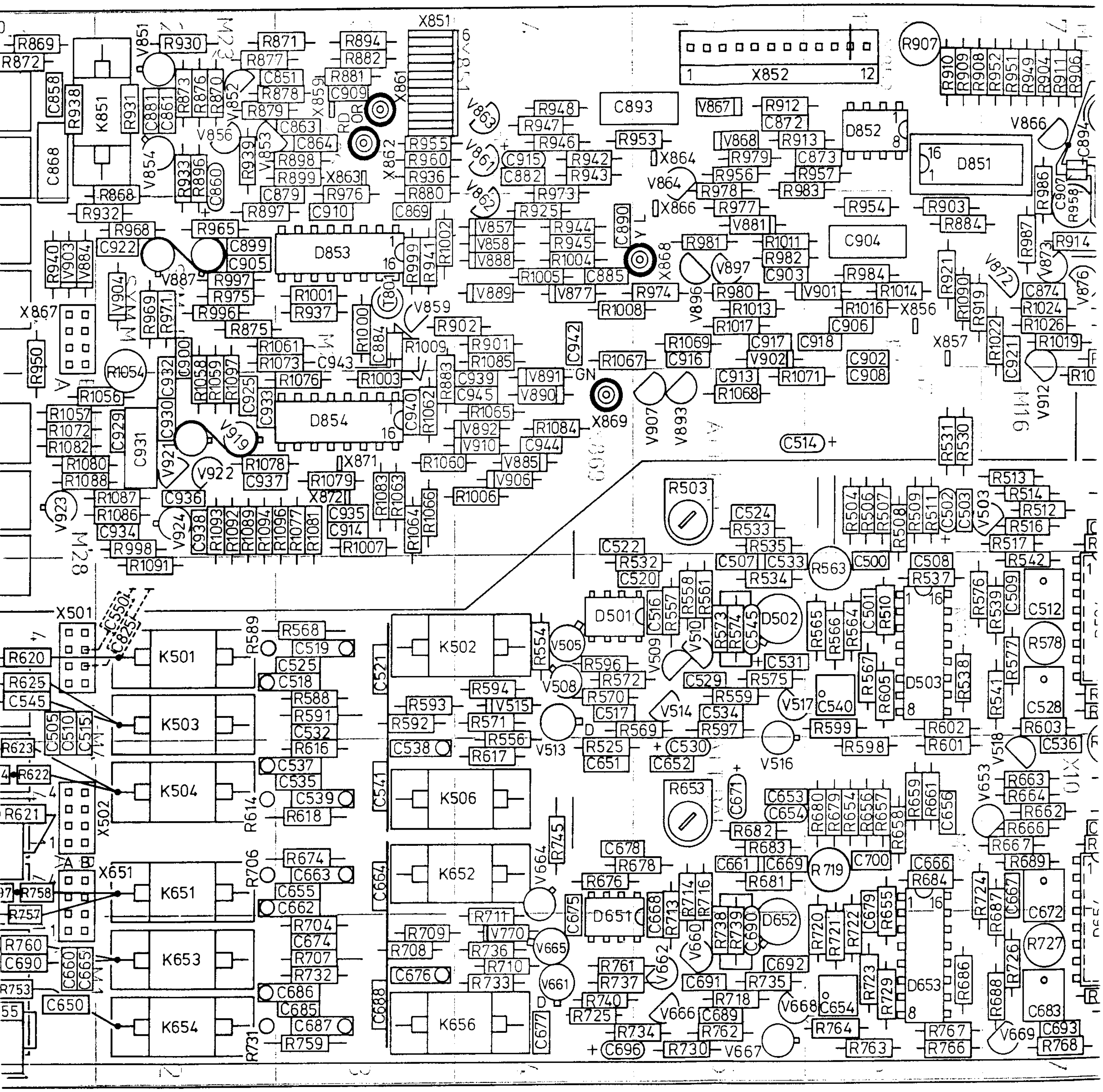
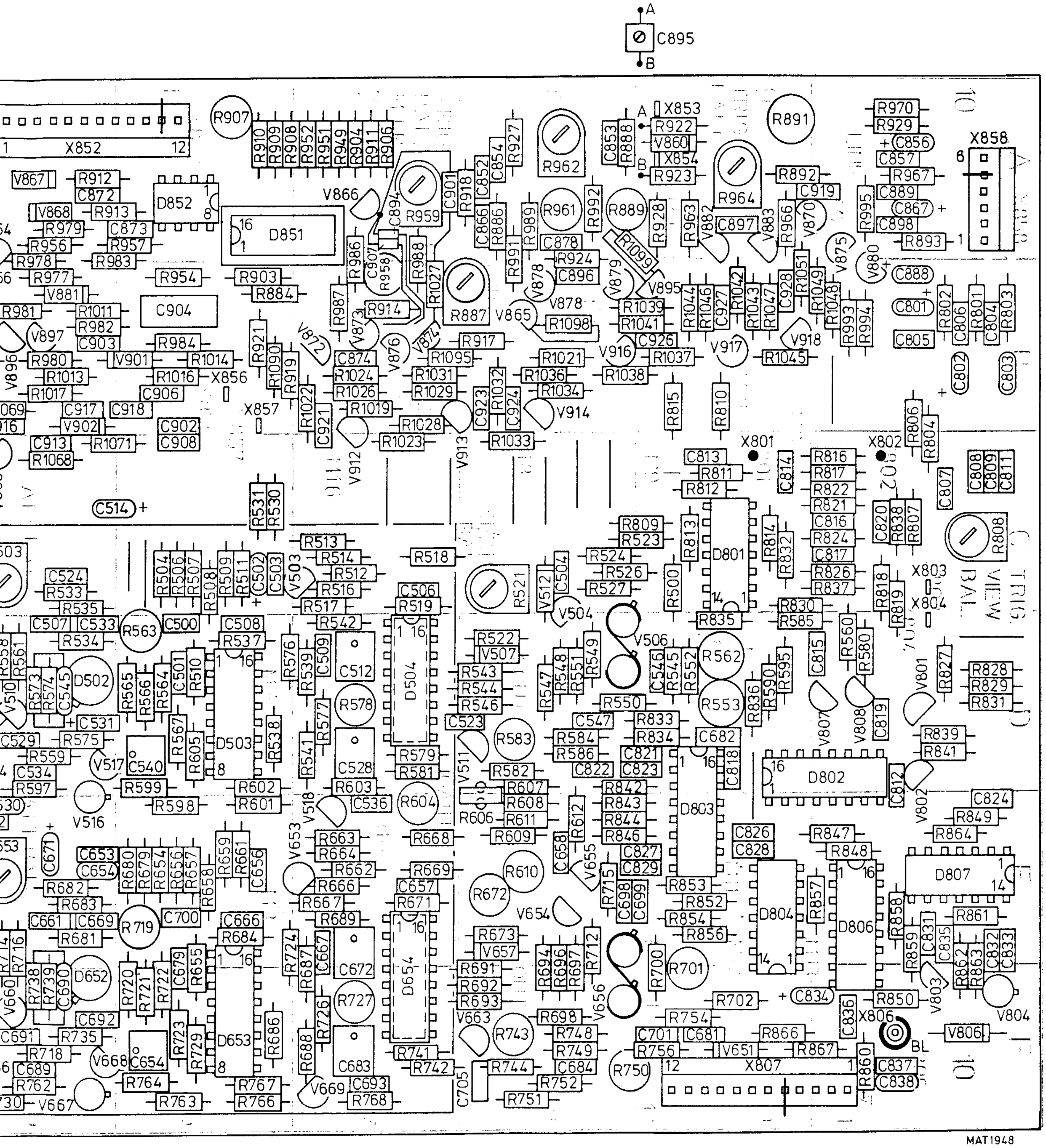


Fig. 7.8. Pre-amplifier and trigger unit p.c.b. with component location raster



: p.c.b. with component location raster



MAT1948
851108

V268	F17
V269	F12
V270	E11
V271	F12
V272	F13
V273	F14
V274	F15
V276	F15
V277	F15
V278	F15
V279	F16
V280	E11
V281	F16
V282	F11
V283	F11
V284	F12
V285	C11
V286	F13
V287	F14
V288	B13/B12
V289	A13/A12
V290	E13
V291	D14
V292	E14
V293	E14
V294	D11/D12
V295	D12
V296	B12
V297	B12
V298	B12
V299	A12
V302	D11
V303	E11
V304	B11
V306	C12
V307	D11
V310	D16
V311	D16
V1371	B16
V1372	A16
V1373	B15
V1374	B17

7.5. LOCATION LIST OF PARTS SITUATED ON THE PRE-AMPLIFIER AND TRIGGER UNIT A3 (see Fig. 7.8.)

Capacitors	
C500	D6
C501	D6
C502	C6
C503	C6
C504	C8
C505	D1
C506	C7
C507	D5
C508	D6
C509	D7
C510	D1
C512	D7
C514	C5/C6
C515	D1
C516	D5
C517	D4
C518	D3
C519	D3
C520	D4/D5
C521	D3
C522	C4/C5
C523	D7/D8
C524	C5
C525	D3
C528	D7
C529	D5
C530	E5
C531	D5
C532	D3
C533	D5
C534	D5
C535	E2
C536	E7
C537	E3
C538	E3
C539	E3
C540	D6
C541	E3
C542	E1
C543	E1/F1
C544	E1
C545	E1
C546	D9
C547	D8
C550	D2 (TS)
C645	F6
C650	F1
C651	E4
C652	E5
C653	E5
C654	E5
C655	E3
C656	E6
C657	E7
C658	E8
C660	F1
C661	E5
C662	E3
C663	E3
C664	E3
C665	F1
C666	E6
C667	E7/F7
C668	E5/F5
C669	E5
C671	E5
C672	E7/F7
C674	F3
C675	E4/F4
C676	F3
C677	F4
C678	E4/E5
C679	F6/E6
C681	F9
C682	D9
C683	F7
C684	F8
C685	F3
C686	F3
C687	F3
C688	F3
C689	F5
C690	F1
C691	F5
C692	F5
C693	F7
C694	E1
C695	F1
C696	F4/F5
C697	F1
C698	E8
C699	E9
C700	E6
C701	F9
C705	F8
C801	B10
C802	B10
C803	B10
C804	B10
C805	B10
C806	B10
C807	C10
C808	C10
C809	C10
C811	C10
C812	D10/E10
C813	C9
C814	C9
C815	D10
C816	C10
C817	C10
C818	D9
C819	D10
C820	C10
C821	D8/D9
C822	D8
C823	D8/D9
C824	E10
C825	D2 (TS)
C826	E9
C827	E8/E9
C828	E9
C829	E8/E9
C831	E10
C832	F10/E10
C833	F10/E10
C834	F9/F10
C835	E10
C836	F10
C837	F10
C838	F10
C851	A2/A3
C852	A8
C853	A8
C854	A8
C856	A10
C857	A10
C858	A1
C860	A2
C863	A3
C864	A3
C866	A8
C867	A10
C868	A1
C869	B3
C872	A5
C873	A5/A6
C874	B7
C878	A8
C879	A2/A3
C881	A2
C882	A4
C883	B3
C884	B3
C885	B4
C888	B10
C889	A10
C890	B4
C893	A4/A5
C894	A7
C896	B8
C897	A9

C898	A10
C899	B2
C900	B2/C2
C901	A7
C902	B6
C903	B5
C904	B6
C905	B2
C906	B6
C907	A7
C908	C6
C909	A3
C910	B3
C913	C5
C914	C3
C915	A4
C916	B5
C917	B5
C918	B6
C919	A10
C920	C1
C921	B7/C7
C922	B2
C923	B8
C924	B8
C925	C2
C926	B9
C927	B9
C928	B9
C929	C2
C930	C2
C931	C2/B2
C932	C2
C933	C2
C934	C2
C935	C3
C936	C2
C937	C2/C3
C938	C2
C939	C4
C940	C3
C942	B4
C943	B3
C944	C4
C945	C4

Integrated circuits

D501	D4
D502	D5
D503	D6
D504	D7
D651	E4/F4
D652	E5/F5
D653	E6/F6
D654	E7/F7
D801	C9
D802	D10/D9
D803	D9/E9
D804	E9
D806	E10/F10
D807	E10
D851	A6/A7
D852	A6
D853	B3
D854	C3

Relays

K501	D2
K502	D3/D4
K503	D2
K504	E2
K506	E3/E4
K651	E2
K652	E3/E4
K653	F2
K654	F2
K656	F3/F4
K851	A1/A2

Resistors

R500	C9
R503	C5
R504	C6
R506	C6
R507	C6
R508	C6
R509	C6
R510	D6
R511	C6
R512	C7
R513	C7
R514	C7
R516	C7
R517	C7
R518	C7
R519	C7
R521	C8
R522	C8
R523	C8/C9
R524	C8
R525	E4
R526	C8/C9
R527	C8
R530	C6
R531	C6
R532	D4/D5
R533	C5
R534	D5
R535	C5
R537	D6
R538	D6
R539	D7
R541	D7
R542	D7
R543	D8
R544	D8
R545	D9
R546	D8
R547	D8
R548	D8
R549	D8
R550	D8/D9
R551	D8
R552	D9
R553	D9
R554	D4
R556	D4/E4
R557	D5
R558	D5
R559	D5
R560	D10
R561	D6
R562	D9
R563	D6
R564	D6
R565	D6
R566	D6
R567	D6
R568	D3
R569	D4/D5
R570	D4
R571	D4
R572	D4/D5
R573	D5
R574	D5
R575	D5
R576	D6/D7
R577	D7
R578	D7
R579	D7
R580	D10
R581	D7
R582	D8
R583	D8
R584	D8
R585	D9/D10
R586	D8
R588	D3
R589	D2
R590	D9
R591	D3
R592	D3
R593	D3
R594	D4
R595	D9
R596	D4
R597	D5

R598	E6
R599	D6
R601	E6
R602	D6
R603	D7
R604	E7
R605	D6
R606	E8
R607	D8
R608	E8
R609	E8
R610	E8
R611	E8
R612	E8
R614	E2
R616	E3
R617	E4
R618	E3
R619	E1
R620	D1
R621	E1
R622	E1
R623	E1
R625	D1
R653	E5
R654	E6
R655	F6/E6
R656	E6
R657	E6
R658	E6
R659	E6
R661	E6
R662	E7
R663	E7
R664	E7
R666	E7
R667	E7
R668	E7
R669	E7
R671	E7
R672	E8
R673	E8
R674	E3
R676	E4
R678	E4/E5
R679	E6
R680	E6
R681	E5
R682	E5
R683	E5
R684	E6
R686	F6
R687	E7/F7
R688	F7
R689	E7
R691	F8
R692	F8
R693	F8
R694	E8/F8
R696	E8/F8
R697	E8/F8
R698	F8
R700	F9/E9
R701	E9/F9
R702	F9
R704	F3
R706	E2
R707	F3
R708	F3
R709	F3
R710	F4
R711	F4
R712	E8/F8
R713	E5/F5
R714	E5/F5
R715	E8
R716	E5/F5
R718	F5
R719	E6
R720	F6
R721	F6
R722	F6/E6
R723	F6
R724	E6
R725	F4
R726	F7
R727	F7
R728	F1
R729	F6
R730	F5
R731	F2
R732	F3
R733	F4
R734	F4/F5
R735	F5
R736	F4
R737	F4/F5
R738	F5
R739	F5
R740	F4
R741	F7
R742	F7
R743	F8
R744	F8
R745	E4
R748	F8
R749	F8
R750	F8/F9
R751	F8
R752	F8
R753	F1
R754	F9
R755	F1
R756	F9
R757	F1/E1
R758	E1
R759	F3
R760	F1
R761	F4/F5
R762	F5
R763	F6
R764	F6
R766	F6
R767	F6
R768	F7
R801	B10
R802	B10
R803	B10
R804	B10/C19
R806	B10/C10
R807	C10
R808	C10
R809	C8/C9
R810	B9
R811	C9
R812	C9
R813	C9
R814	C9
R815	B9
R816	C10
R817	C10
R818	C10
R819	C10/D10
R821	C10
R822	C10
R824	C10
R826	C10
R827	D10
R828	D10
R829	D10
R830	C9/C10
R831	D10
R832	C9
R833	D9
R834	D9
R835	D9
R836	D9
R837	C10
R838	D10
R839	D10
R841	D10
R842	D8/D9
R843	E8/E9
R844	E8/E9
R846	E8/E9
R847	E10

R848	E10
R849	E10
R850	F10
R852	E9
R853	E9
R854	E9
R856	E9
R857	E10
R858	E10
R859	E10/F10
R860	F10
R861	E10
R862	F10
R863	E10/F10
R864	E10
R866	F9
R867	F9/F10
R868	A2
R869	A1
R870	A2
R871	A2/A3
R872	A1
R873	A2
R874	A2
R875	B2
R876	A2
R877	A2/A3
R878	A2/A3
R879	A2/A3
R880	A3
R881	A3
R882	A3
R883	B3/C3
R884	B6
R886	A8
R887	B7/B8
R888	A8
R889	A8
R891	A9/A10
R892	A9/A10
R893	A10
R894	A3
R896	A2
R897	B2/B3
R898	A3
R899	A3
R901	B4
R902	B3/B4
R903	B6
R904	A7
R906	A7
R907	A6
R908	A6
R909	A6/A7
R910	A6
R911	A7
R912	A5
R913	A5/A6
R914	B7
R917	B8
R918	A8
R919	B6/B7
R921	B6
R922	A9
R923	A9
R924	A8/B8
R925	B4
R927	A8
R928	A9
R929	A10
R930	A2
R931	A2
R932	B1/B2
R933	A2
R934	A2
R936	A3
R937	B3
R938	A1
R939	A2
R940	B1
R941	B3
R942	A4
R943	A4
R944	B4
R945	B4
R946	A4
R947	A4
R948	A4
R949	A7
R950	B1/C1
R951	A7
R952	A7
R953	A4/A5
R954	B6
R955	A3
R956	A5
R957	A5/A6
R958	B7
R959	A7
R960	A4
R961	A8
R962	A8
R963	A9
R964	A9
R965	B2
R966	A9
R967	A10
R968	B2
R969	B2
R970	A10
R971	B2
R973	B4
R975	B2
R976	A3
R977	B5
R978	A5
R979	A5
R980	B5
R981	B5
R982	B5
R983	A5/A6
R984	B6
R986	A7/B7
R987	B7
R988	A7/B7
R989	A8
R991	A8/B8
R992	A8
R993	B10
R994	B10
R995	A10
R996	B2
R997	B2
R998	C2
R999	B3
R1000	B3
R1001	B3
R1002	B3
R1003	C3
R1004	B4
R1005	B4
R1006	C4
R1007	C3
R1008	B4/B5
R1009	B3
R1011	B5
R1013	B5
R1014	B6
R1016	B6
R1017	B5
R1019	B7
R1021	B8
R1022	B7
R1023	C7
R1024	B7
R1026	B7
R1027	B7
R1028	B7
R1029	B7
R1031	B7
R1032	B8
R1033	C8
R1034	B8
R1036	B8
R1037	B9
R1038	B8/B9
R1039	B8/B9

R1041	B8/B9
R1042	B9
R1043	B9
R1044	B9
R1045	B9
R1046	B9
R1047	B9
R1048	B10
R1049	B10
R1051	B9
R1054	B2/C2
R1056	C1/C2
R1057	C1
R1058	C2/B2
R1059	C2/B2
R1060	C4/C3
R1061	B2/B3
R1062	C3
R1063	C3
R1064	C3
R1065	C4
R1066	C3
R1067	B4/B5
R1068	C5
R1069	B5
R1071	C5/C6
R1072	C1
R1073	B2/B3
R1076	C3
R1077	C3
R1078	C2/C3
R1079	C3
R1080	C1/C2
R1081	C3
R1082	C1
R1083	C3
R1084	C4
R1085	B4
R1086	C2
R1087	C2
R1088	C2/C1
R1089	C2
R1090	B6
R1091	D2
R1092	C2
R1093	C2
R1094	C2
R1095	B7/B8
R1096	C3/C2
R1097	B2/C2
R1098	B8
R1099	B8-B9

Coil

T801	B3

Semi-conductors

V503	C7
V504	C8/D8
V505	D4
V506	D8
V507	D8
V508	D4
V509	D5
V510	D5
V511	D8
V512	C8
V513	D4
V514	D5
V515	D4
V516	D5/E5
V517	D5
V518	E7
V651	F9
V653	E6/E7
V654	E8
V655	E8
V656	E8/F8
V657	E8
V660	F5
V661	F4
V662	F5
V663	F8
V664	E4/F4
V665	F4
V666	F5
V667	F5
V668	F5
V669	F7
V770	F4
V801	D10
V802	D10
V803	F10
V804	F10
V806	F10
V807	D10
V808	D10
V851	A2
V852	A2
V853	A2/A3
V854	A2
V856	A2
V857	B4
V858	B4
V859	B3
V860	A9
V861	A4
V862	B4
V863	A4
V864	A5
V865	B8
V866	A7
V867	A5
V868	A5
V869	A5
V870	A9/A10
V871	B6
V872	B7
V873	B7
V874	B7
V875	A10
V876	B7
V877	B4
V878	B8
V879	B8
V880	B10
V881	B5
V882	A9/B9
V883	A9/B9
V884	B1
V885	C4
V887	B2
V888	B4
V889	B4
V890	C4
V891	C4
V892	C4
V893	C5
V894	B5
V895	B9
V896	B5
V897	B5
V898	B5
V899	B6
V901	B5/B6
V902	B5
V903	B1
V904	B2
V906	C4
V907	C5
V909	B6
V910	C4
V912	B7/C7
V913	B7/B8
V914	B8
V916	B8
V917	B9
V918	B9
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.

Item number	*Location*	*Figure*	*Unit*
1 ... 25	Potentiometer unit and front- and rear-side unit	8.16 and 4.1	A103
100 ... 199	Switch unit	8.15	A102
200 ... 499 1370 ... 1394	Time base unit (see location list section 7.4)	8.7	A2
500 ... 1099	Pre-amplifier and trigger unit (see location list section 7.5)	8.3	A3
1100 ... 1150	Trigger selection unit	8.6	A4
1200 ... 1599	Final amplifier unit	8.11	A5
1400 ... 1499	Power supply unit	8.13	A6

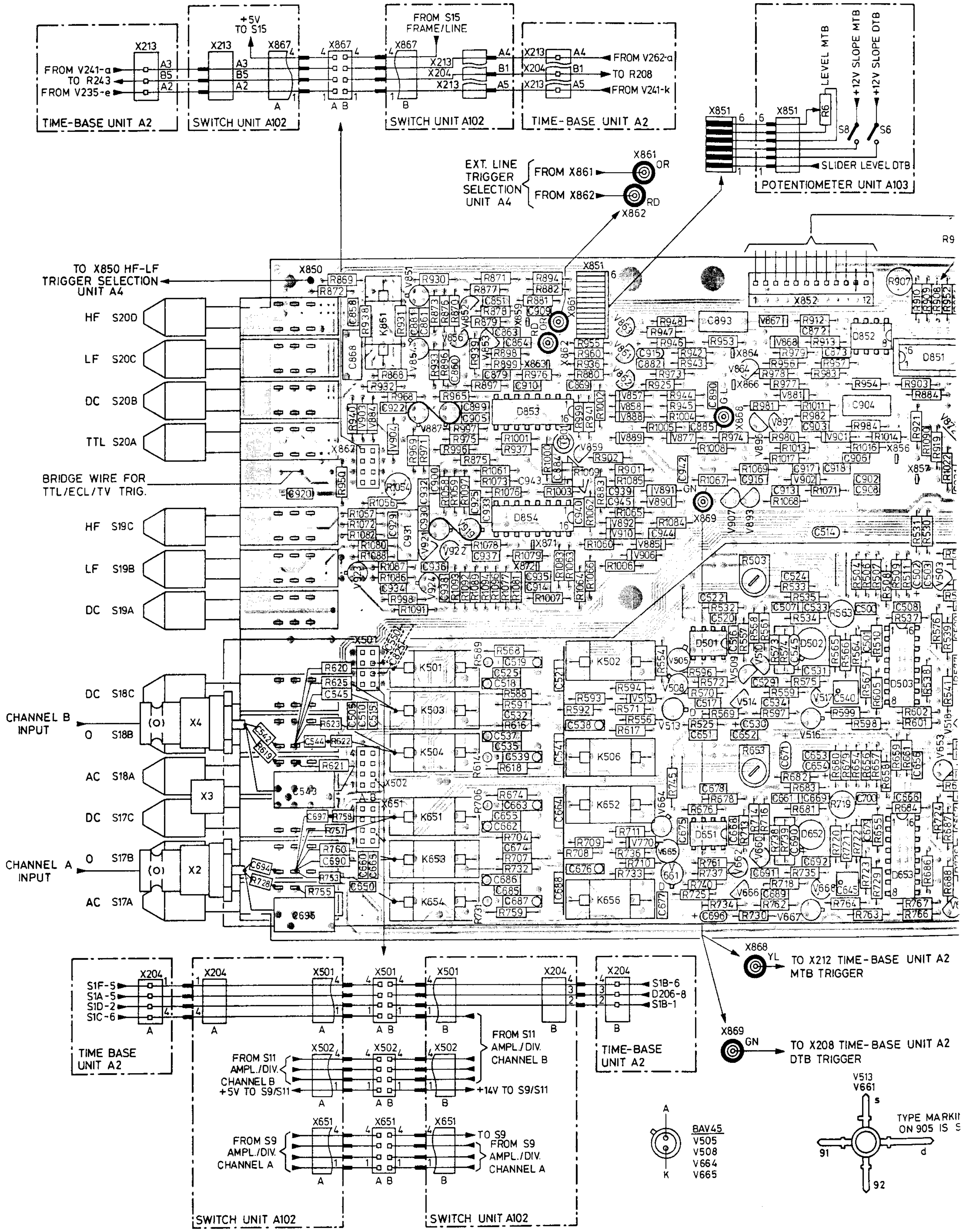
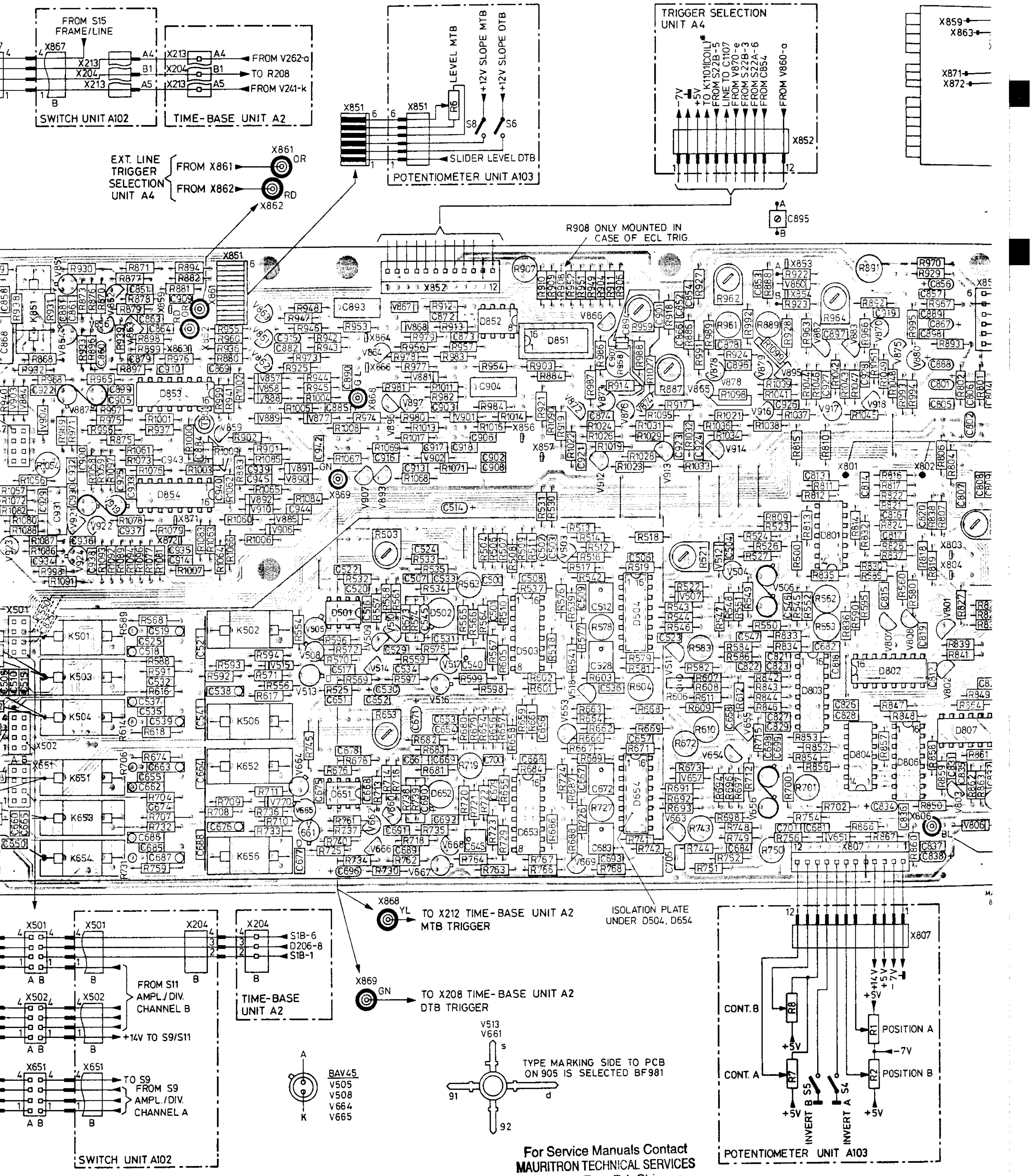
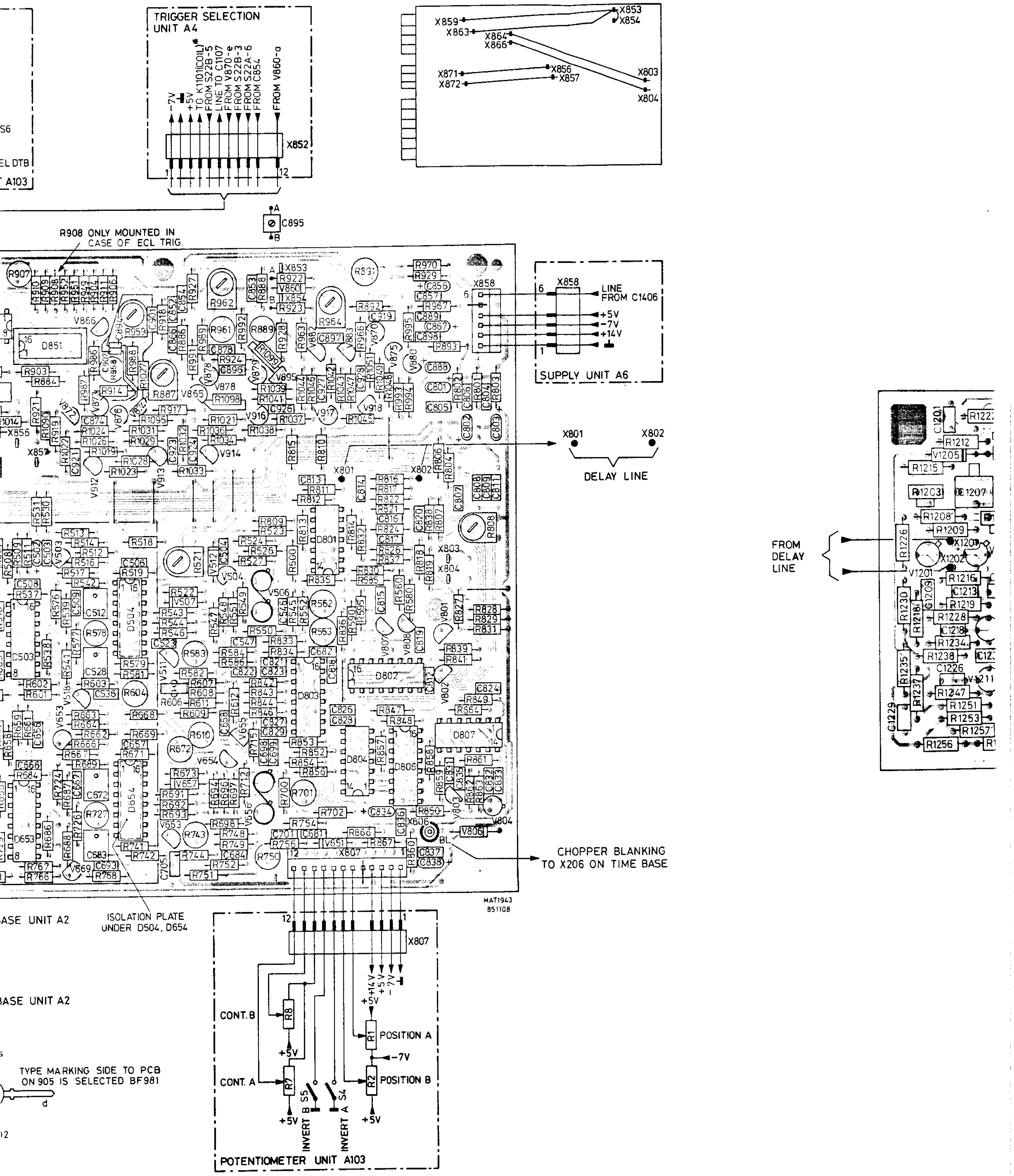


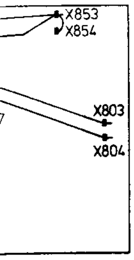
Fig. 8.1. Pre-amplifier and trigger-unit p.c.b. A3 and final Y-amplifier p.c.b. (part of unit A5)

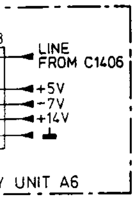

FROM S15
FRAME/LINE
SWITCH UNIT A102
TIME-BASE UNIT A2
FROM V262-a
TO R208
FROM V241-k
LEVEL MTB
+12V SLOPE MTB
+12V SLOPE DTB
SLIDER LEVEL DTB
POTENTIOMETER UNIT A103
TRIGGER SELECTION
UNIT A4
-7V
+5V
TO K1101(COIL)*
FROM S22B-5
LINE TO C1107
FROM V870-e
FROM S22B-3
FROM S22A-6
FROM C854
FROM V860-a
EXT. LINE
TRIGGER
SELECTION
UNIT A4
FROM X861
FROM X862
R908 ONLY MOUNTED IN
CASE OF ECL TRIG.
TO X212 TIME-BASE UNIT A2
MTB TRIGGER
TO X208 TIME-BASE UNIT A2
DTB TRIGGER
ISOLATION PLATE
UNDER D504, D654
FROM S11
AMPL./DIV.
CHANNEL B
+14V TO S9/S11
TO S9
FROM S9
AMPL./DIV.
CHANNEL A
TIME-BASE
UNIT A2
SWITCH UNIT A102
BAV45
V505
V508
V664
V665
V513
V661
TYPE MARKING SIDE TO PCB
ON 905 IS SELECTED BF981
CONT. B
CONT. A
POSITION A
POSITION B
INVERT B S5
INVERT A S4
POTENTIOMETER UNIT A103

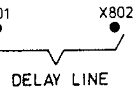
A3 and
A5)

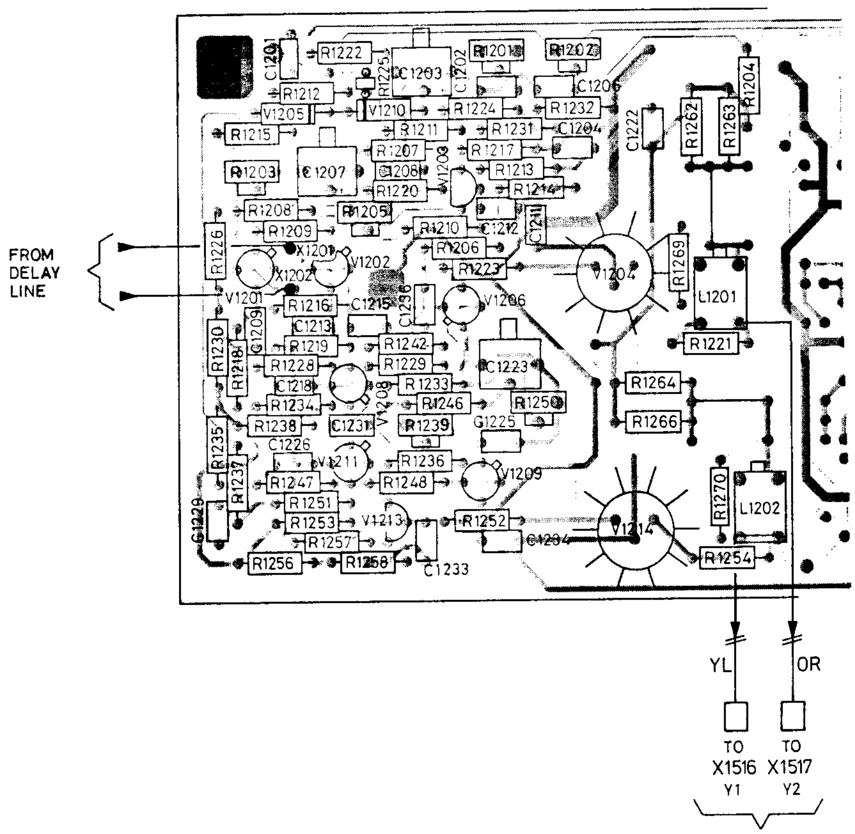


TRIGGER SELECTION UNIT A4
-7V
+5V
TO K1101(COIL)*
FROM S22B-5
LINE TO C1107
FROM V870-e
FROM S22B-3
FROM S22A-6
FROM C854
FROM V860-a
X852
R908 ONLY MOUNTED IN CASE OF ECL TRIG.
X858
LINE FROM C1406
+5V
-7V
+14V
SUPPLY UNIT A6
X801
X802
DELAY LINE
FROM DELAY LINE
CHOPPER BLANKING TO X206 ON TIME BASE
MAT1943 851108
ISOLATION PLATE UNDER D504, D654
BASE UNIT A2
TYPE MARKING SIDE TO PCB ON 905 IS SELECTED BF981
X807
+14V
+5V
-7V
CONT.B
CONT. A
POSITION A
POSITION B
INVERT B S5
INVERT A S4
POTENTIOMETER UNIT A103

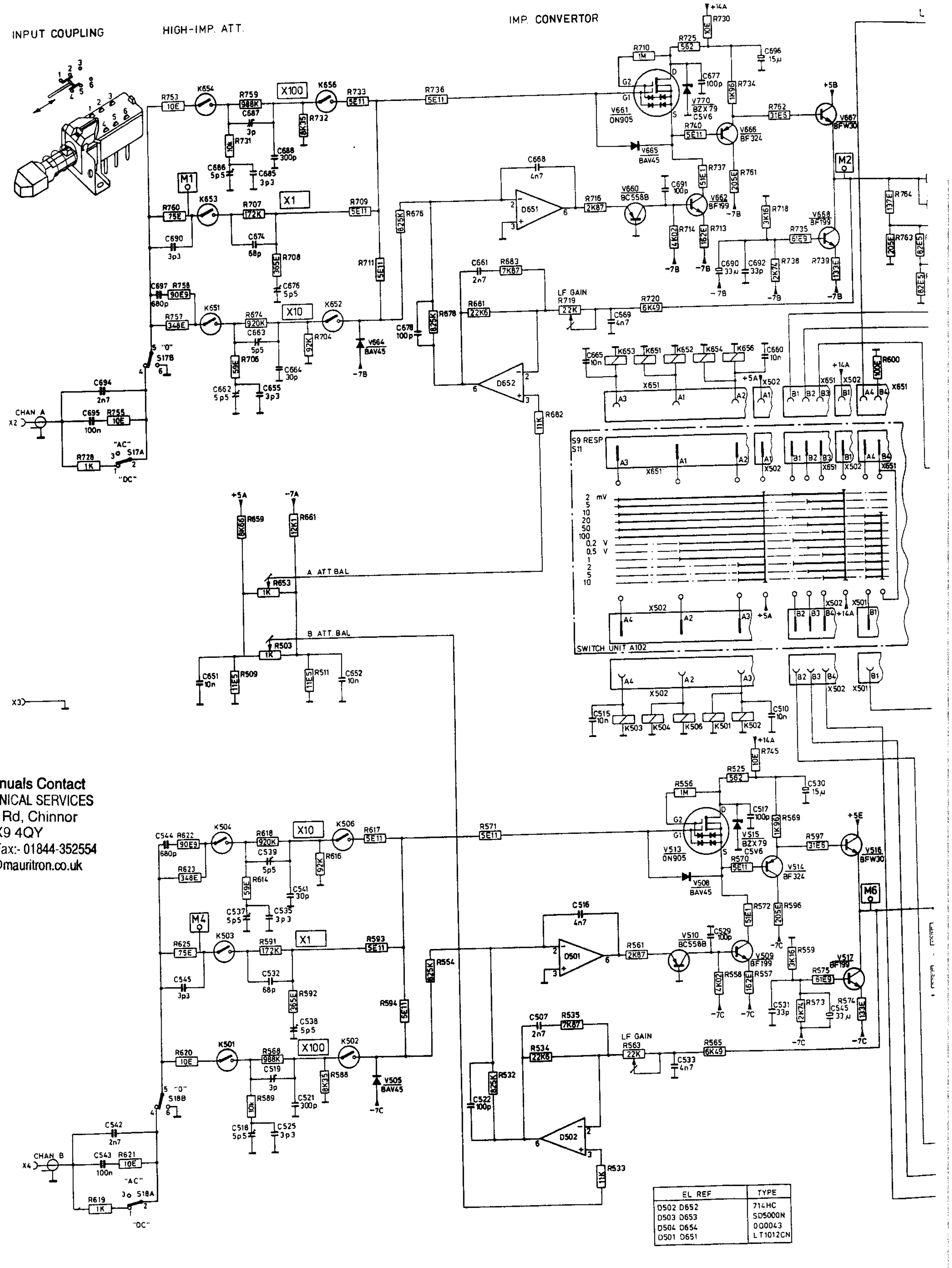




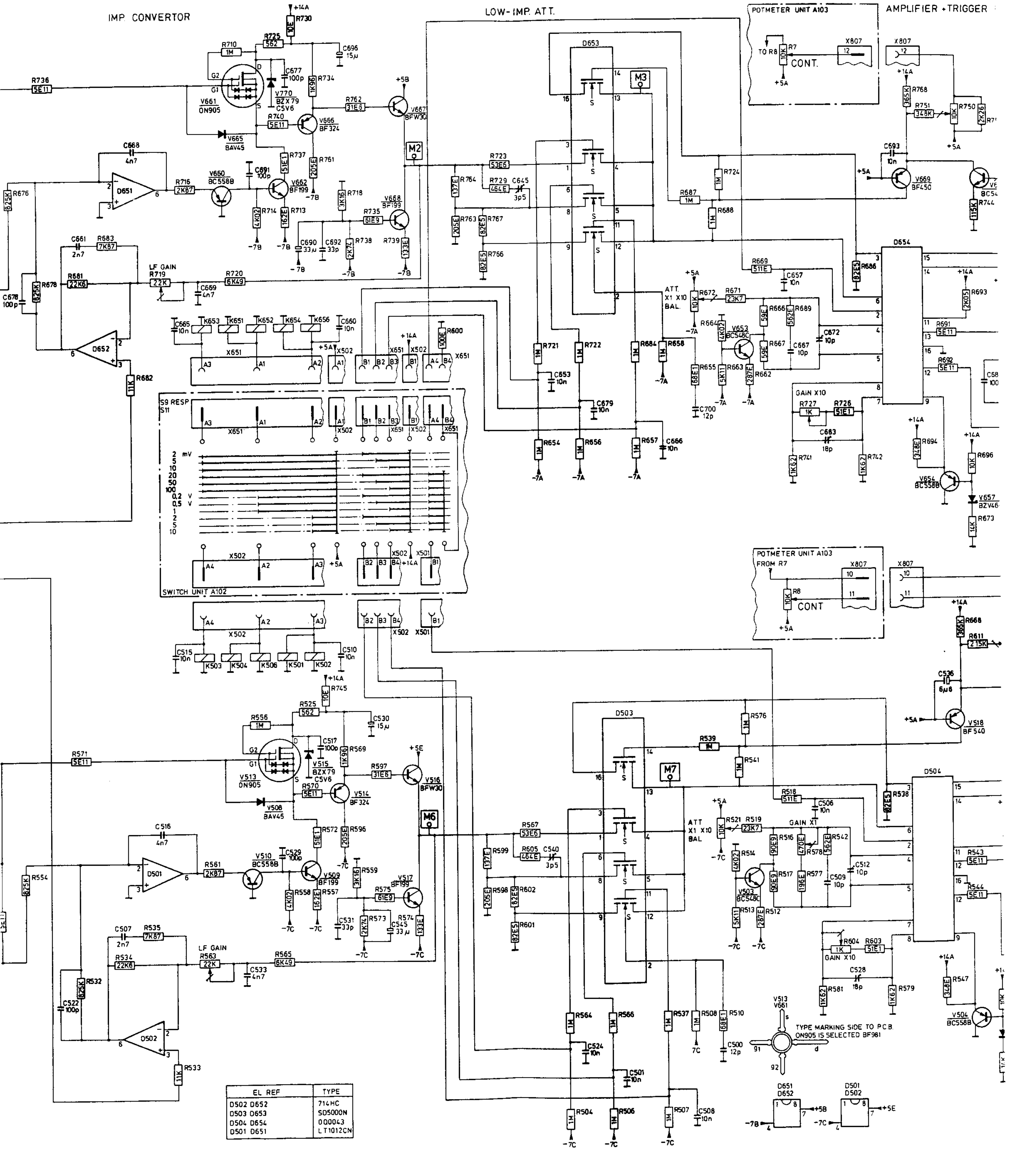




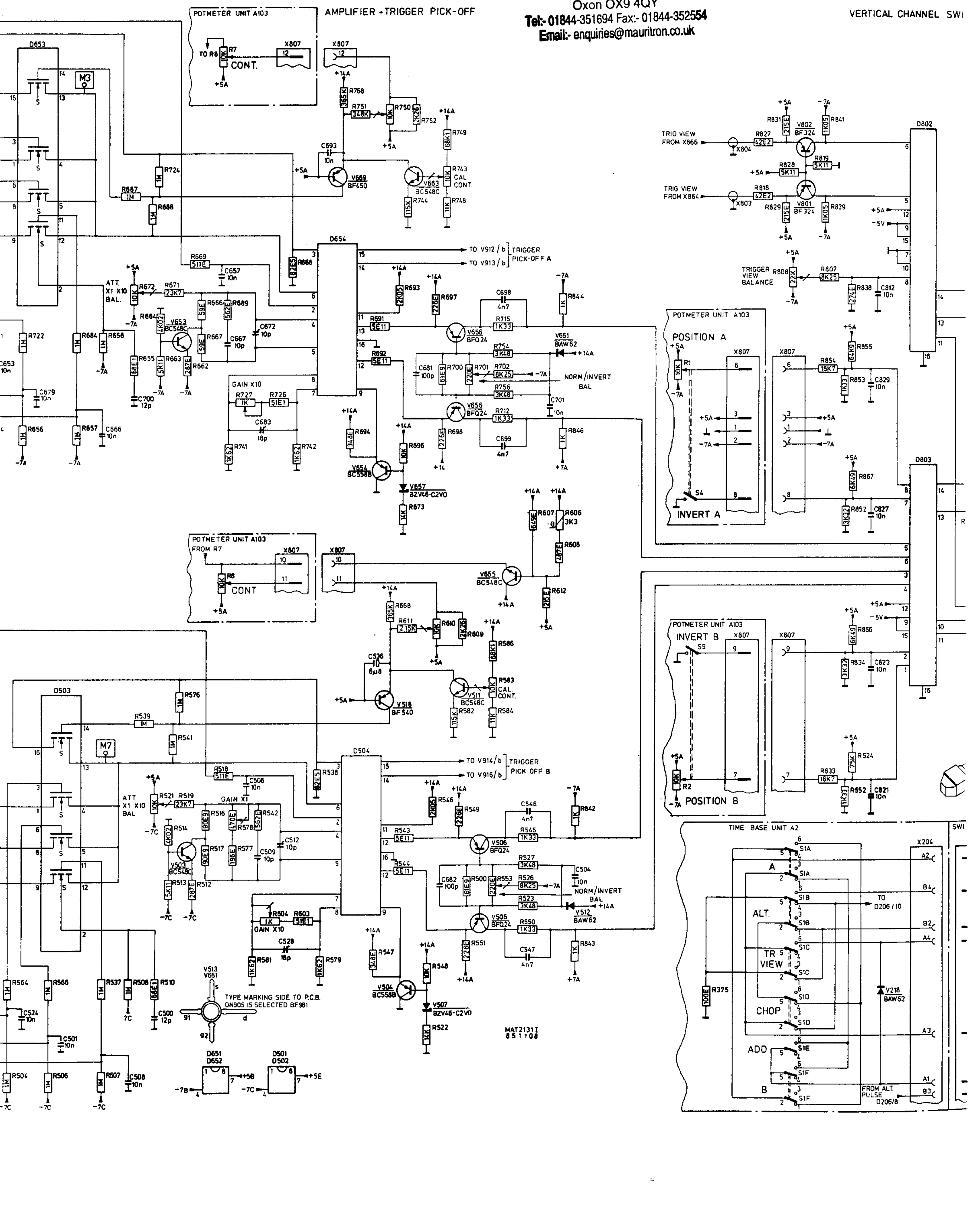
PPER BLANKING
6 ON TIME BASE

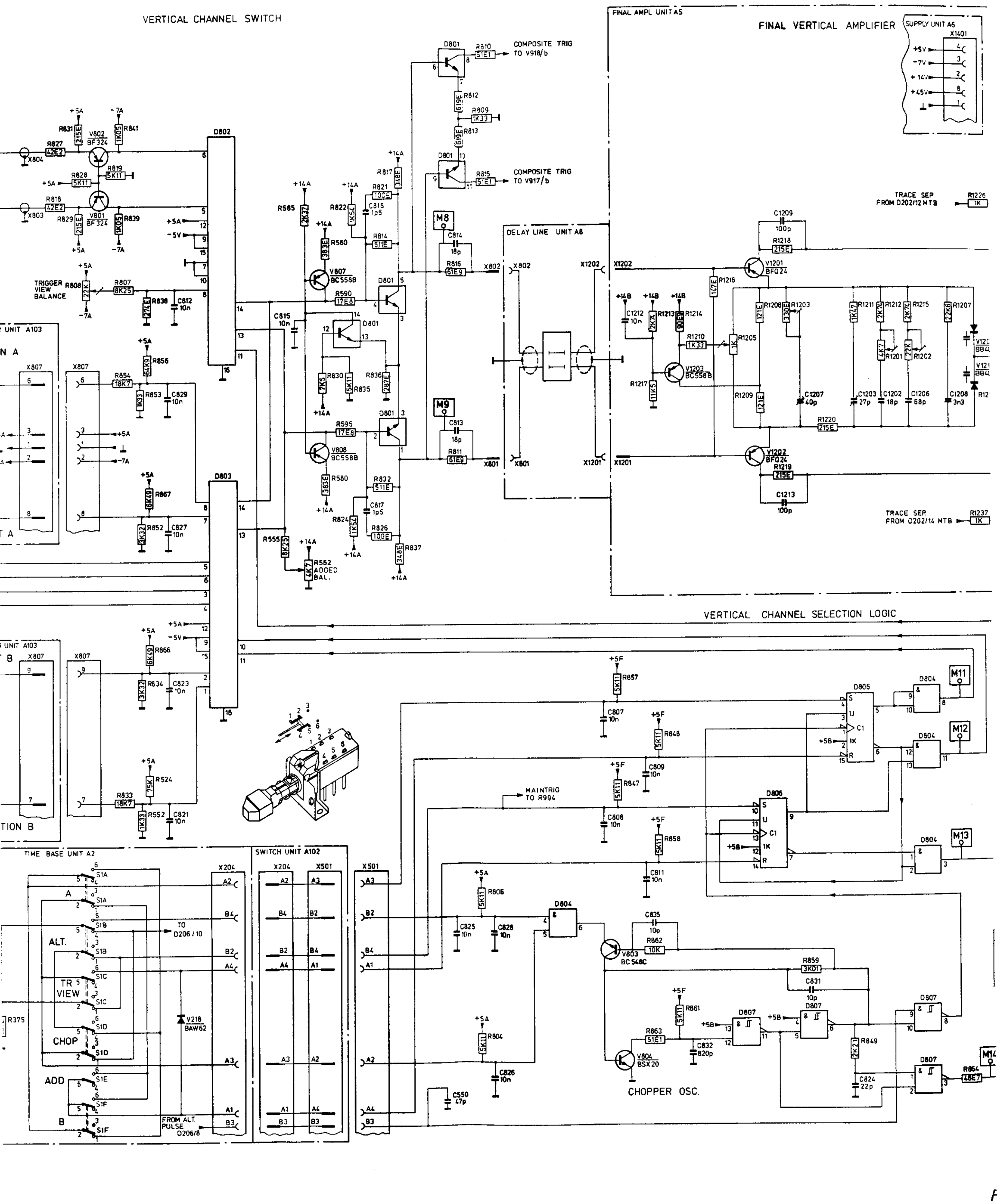


EL REF	TYPE
D502 D652	714HC
D503 D653	SD5000N
D504 D654	OQ0043
D501 D651	LT1012CN

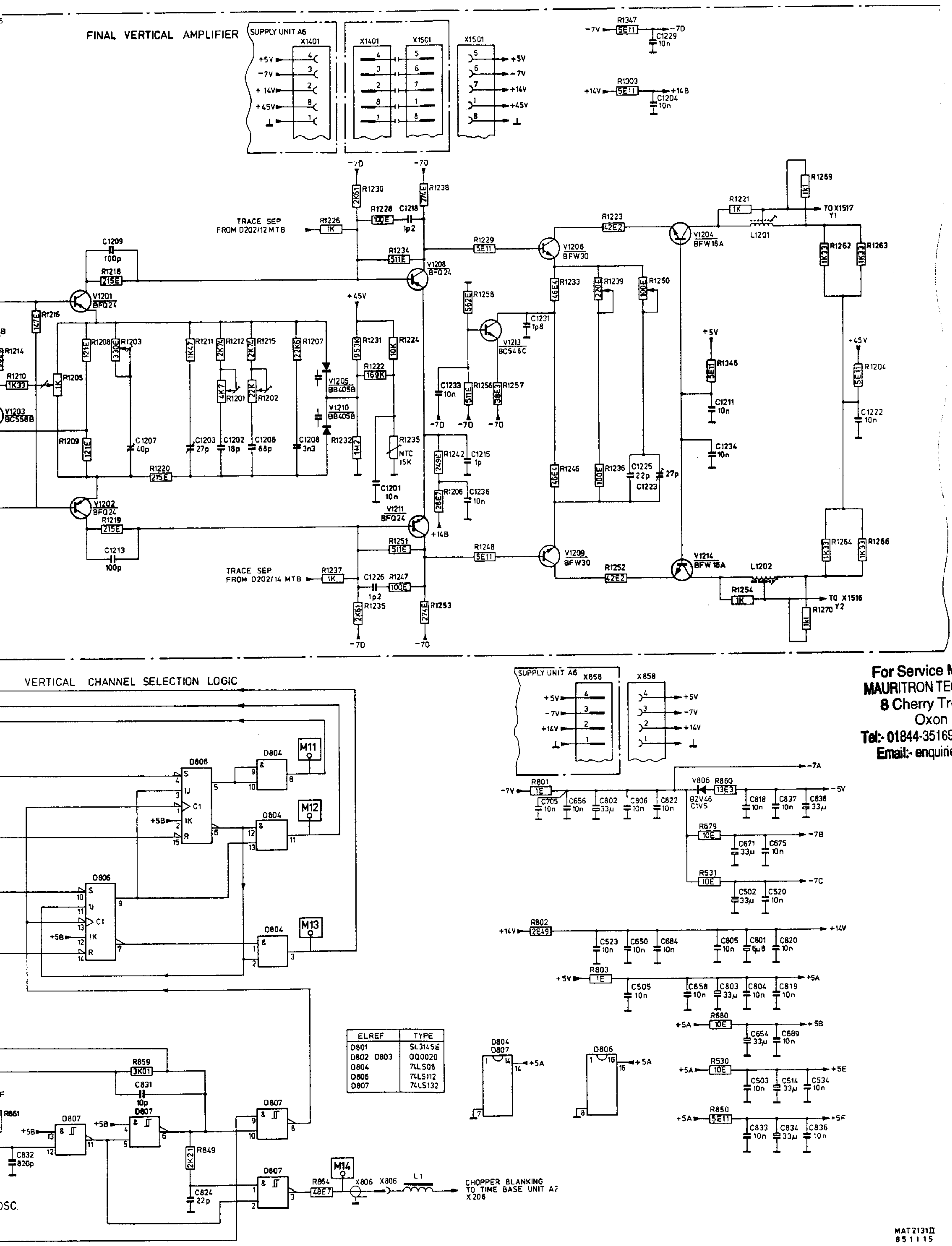


EL REF	TYPE
D502 D652	714HC
D503 D653	SD5000N
D504 D654	OQ0043
D501 D651	LT1012CN


AMPLIFIER + TRIGGER PICK-OFF
VERTICAL CHANNEL SWI
POTMETER UNIT A103
CONT.
TO V912 / b
TO V913 / b
TRIGGER PICK-OFF A
TO V914 / b
TO V916 / b
TRIGGER PICK OFF B
ATT. X1 X10 BAL.
GAIN X10
GAIN X1
NORM/INVERT BAL
CAL. CONT.
TRIG VIEW FROM X866
TRIG VIEW FROM X864
TRIGGER VIEW BALANCE
POSITION A
INVERT A
INVERT B
POSITION B
TIME BASE UNIT A2
ALT.
TR VIEW
CHOP
ADD
TO D206 / 10
FROM ALT. PULSE D206/8
TYPE MARKING SIDE TO P.C.B.
ON905 IS SELECTED BF981.
MAT2131I
851108



VERTICAL CHANNEL SWITCH
FINAL AMPL UNIT A5
FINAL VERTICAL AMPLIFIER
SUPPLY UNIT A6
COMPOSITE TRIG TO V918/b
COMPOSITE TRIG TO V917/b
DELAY LINE UNIT A8
TRIGGER VIEW BALANCE
TRACE SEP FROM D202/12 MTB
TRACE SEP FROM D202/14 MTB
R562 ADDED BAL.
VERTICAL CHANNEL SELECTION LOGIC
MAINTRIG TO R994
TIME BASE UNIT A2
SWITCH UNIT A102
TO D206/10
FROM ALT PULSE D206/8
CHOPPER OSC.
ALT.
TR VIEW
CHOP
ADD



ELREF	TYPE
D801	SL3145E
D802 D803	OQ0020
D804	74LS08
D806	74LS112
D807	74LS132

Fig. 8.2. Circuit diagram vertical deflection (attenuator, channel switch, final Y-amplifier)

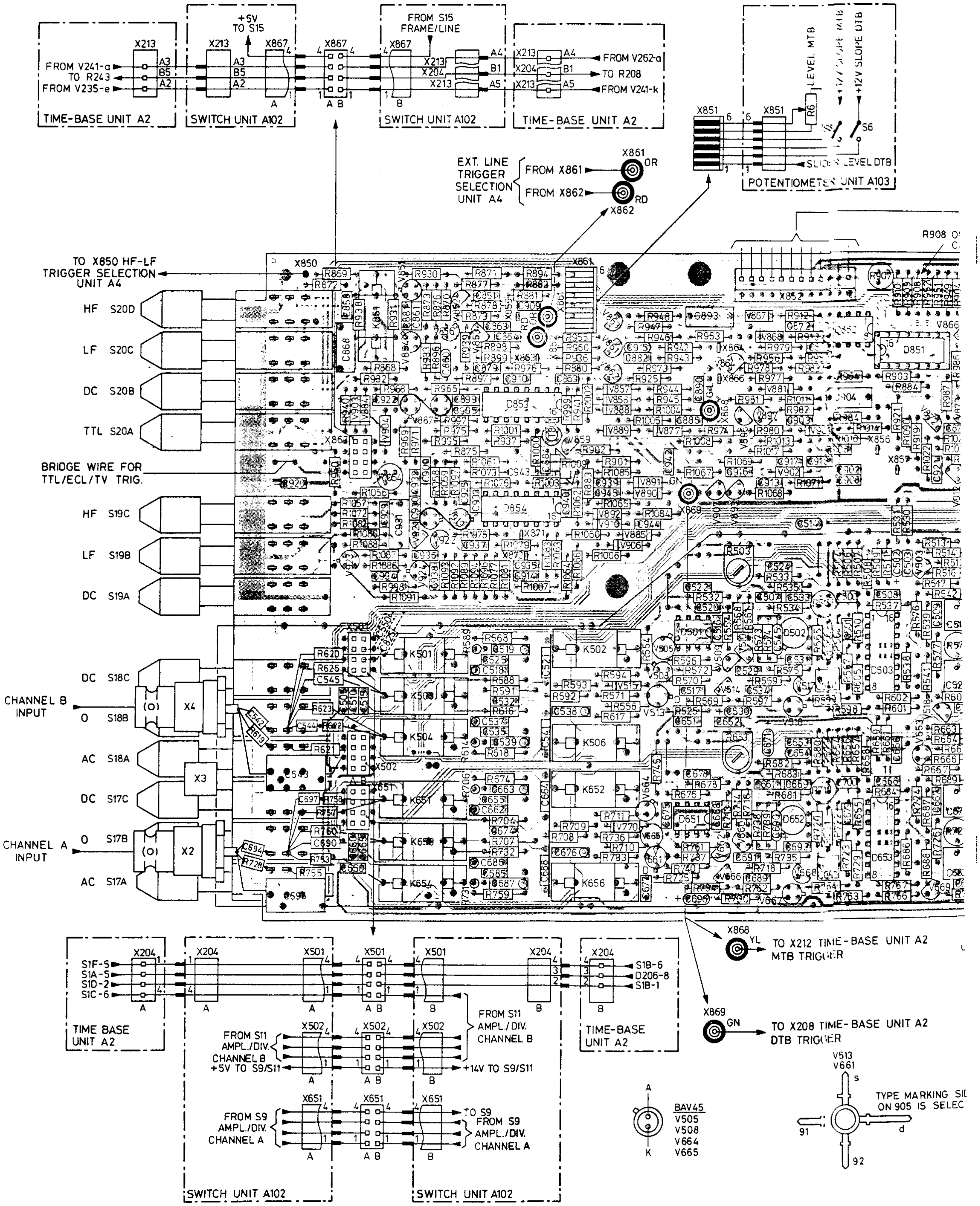
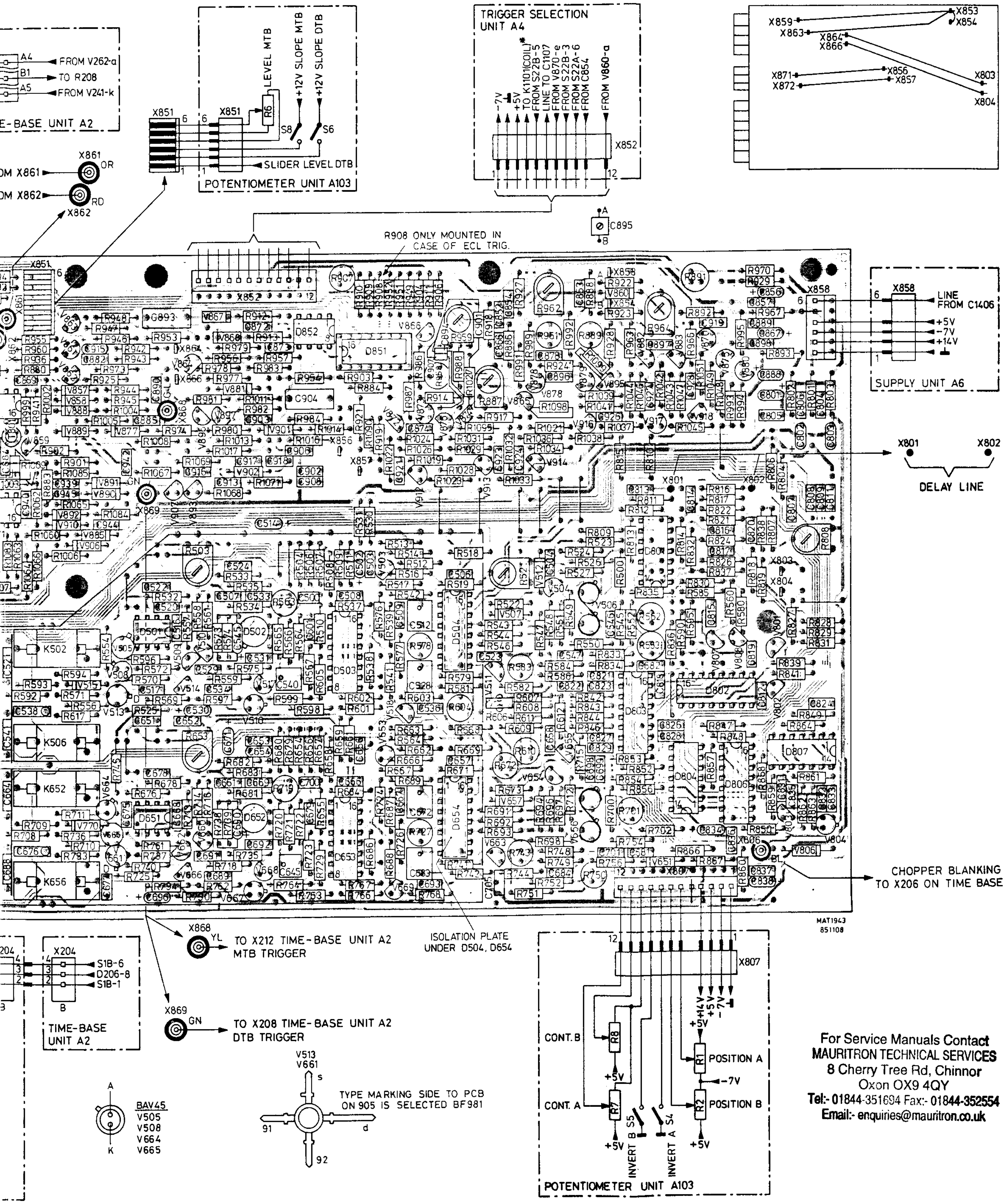
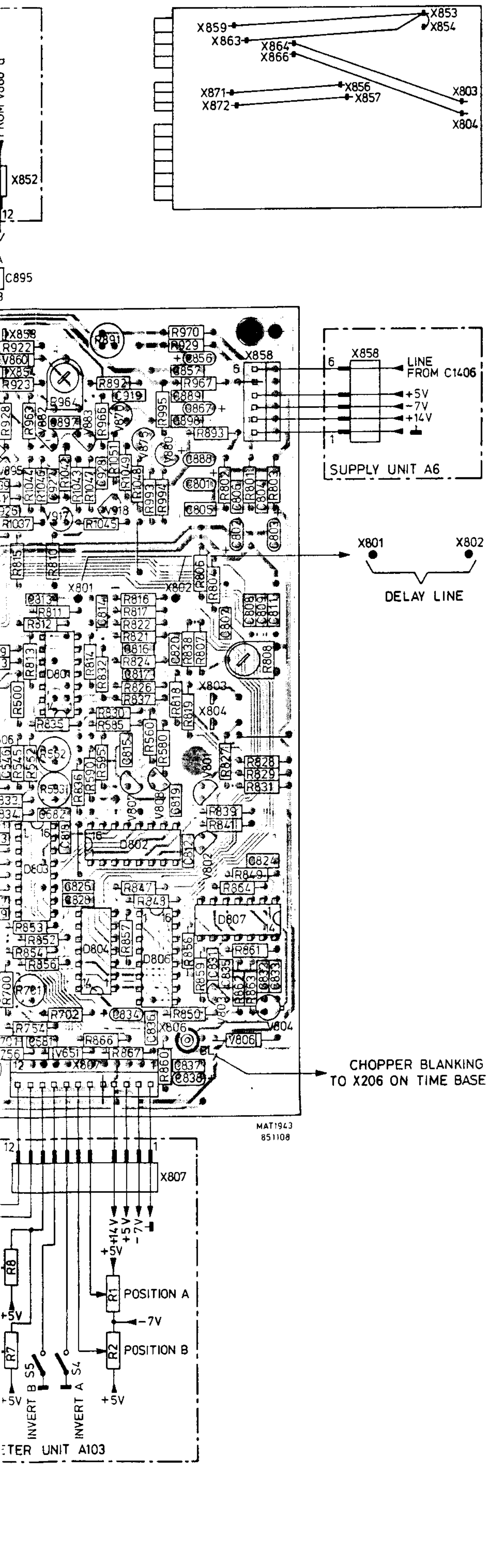


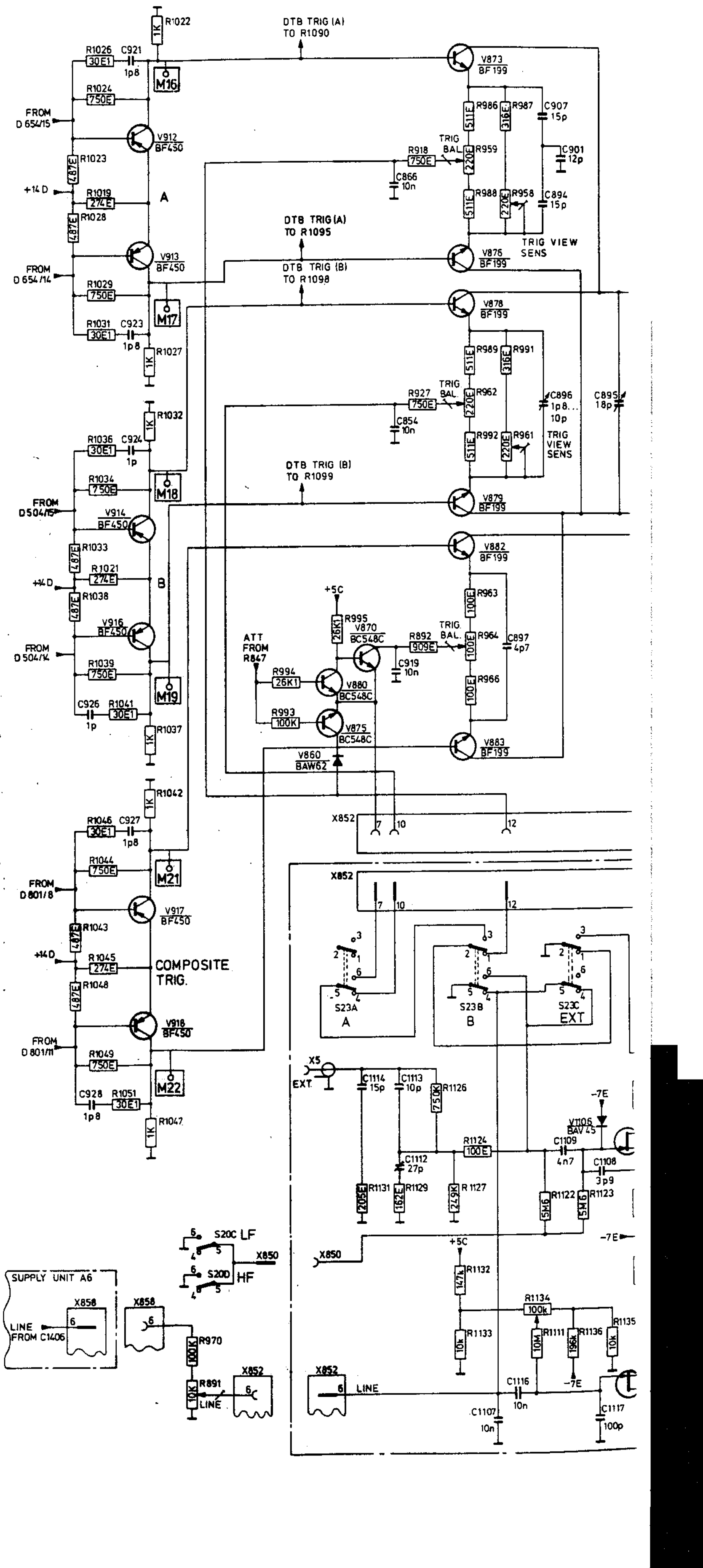
Fig. 8.3. Pre-amplifier and trigger-unit p.c.b. A3

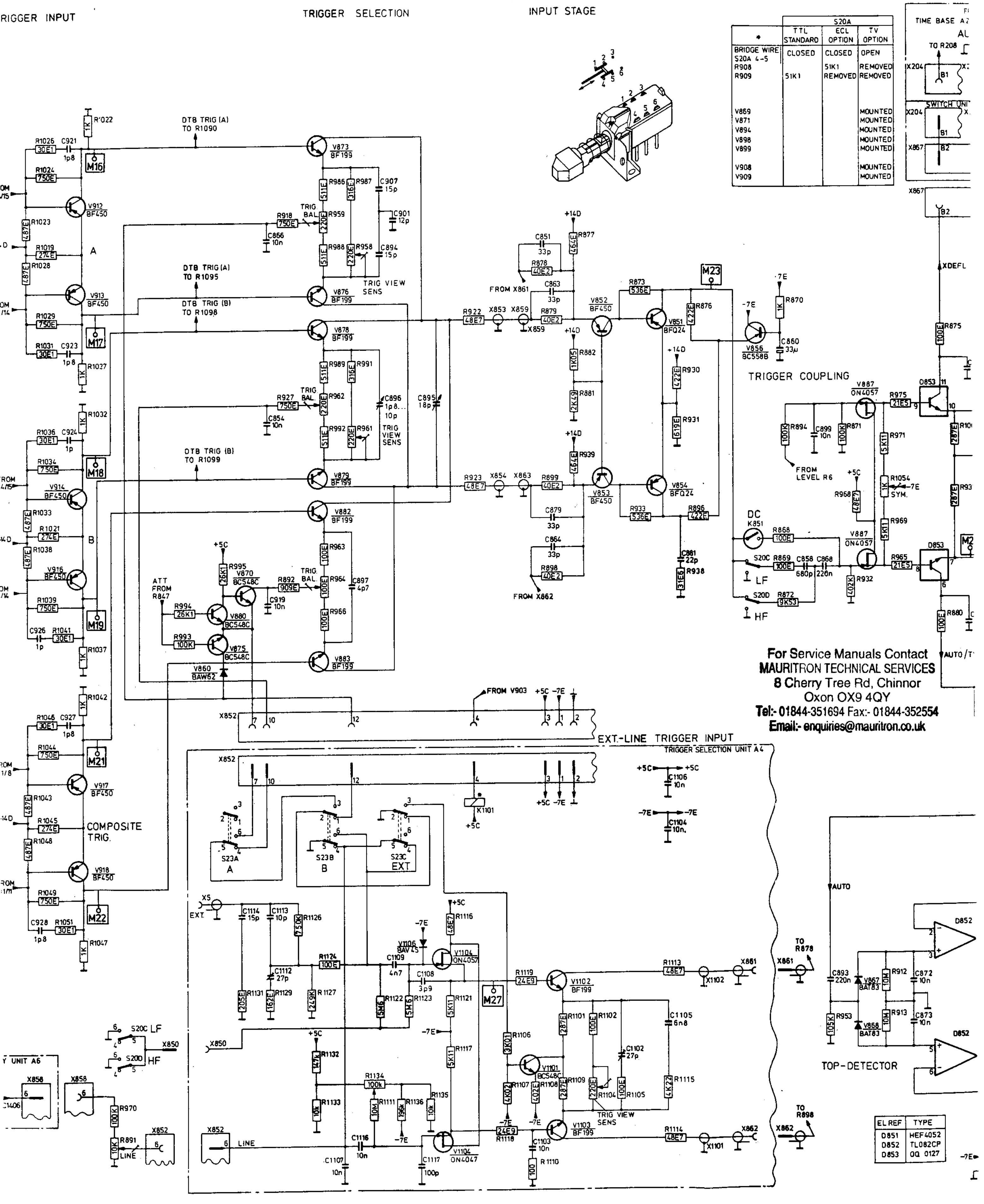

TRIGGER SELECTION
UNIT A4
POTENTIOMETER UNIT A103
SUPPLY UNIT A6
DELAY LINE
R908 ONLY MOUNTED IN
CASE OF ECL TRIG.
CHOPPER BLANKING
TO X206 ON TIME BASE
TO X212 TIME-BASE UNIT A2
MTB TRIGGER
TO X208 TIME-BASE UNIT A2
DTB TRIGGER
ISOLATION PLATE
UNDER D504, D654
TIME-BASE
UNIT A2
TYPE MARKING SIDE TO PCB
ON 905 IS SELECTED BF981
BAV45
V505
V508
V664
V665
MAT1943
851108

TRIGGER INPUT

TRIGGER SELECTION



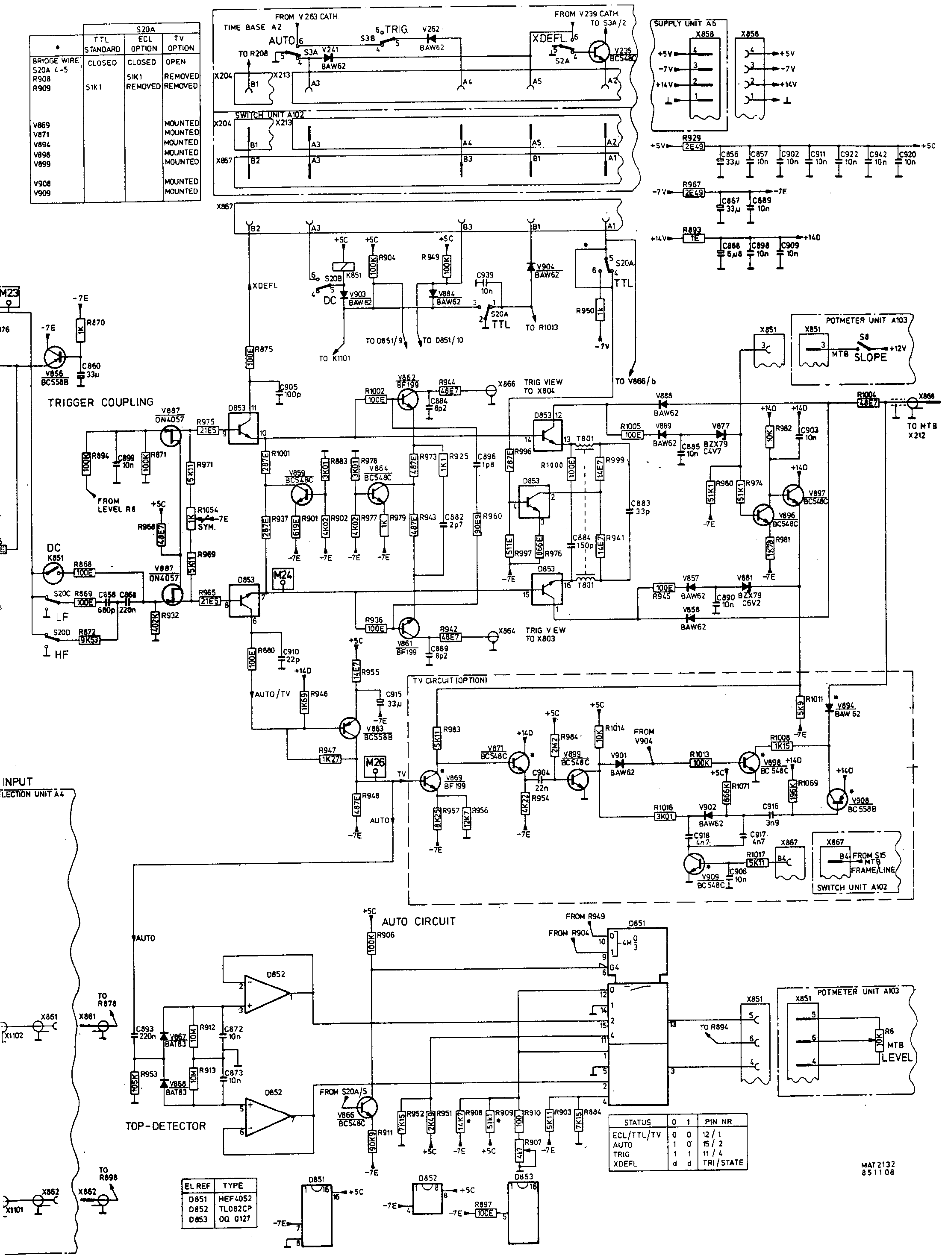




*	S20A TTL STANDARD	S20A ECL OPTION	S20A TV OPTION
BRIDGE WIRE S20A 4-5	CLOSED	CLOSED	OPEN
R908		51K1	REMOVED
R909	51K1	REMOVED	REMOVED
V869			MOUNTED
V871			MOUNTED
V894			MOUNTED
V898			MOUNTED
V899			MOUNTED
V908			MOUNTED
V909			MOUNTED

EL REF	TYPE
D851	HEF4052
D852	TL082CP
D853	OQ 0127

Fig. 8.4. Circuit diagram

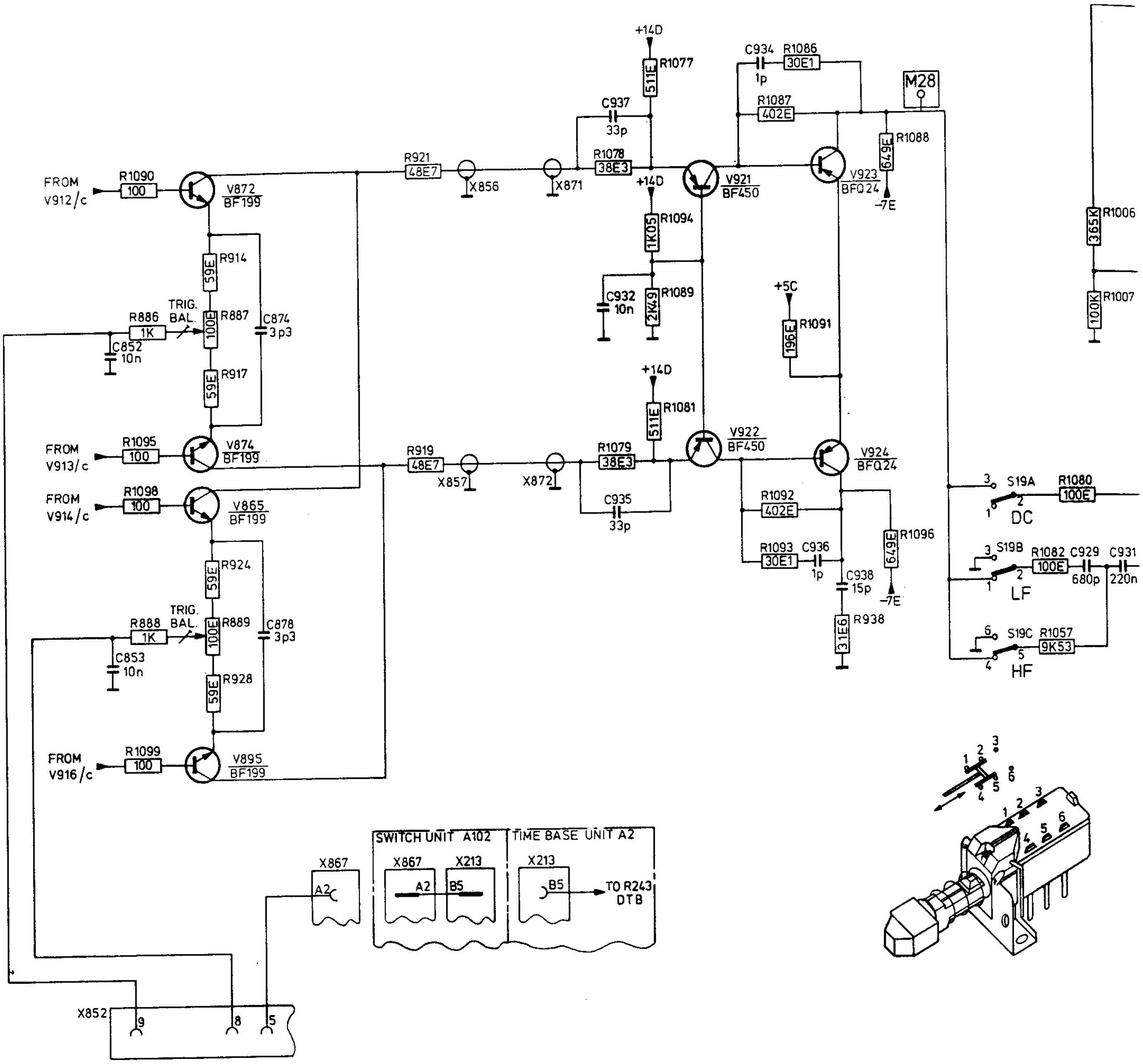


•	S20A TTL STANDARD	S20A ECL OPTION	S20A TV OPTION
BRIDGE WIRE S20A 4-5	CLOSED	CLOSED	OPEN
R908		51K1	REMOVED
R909	51K1	REMOVED	REMOVED
V869			MOUNTED
V871			MOUNTED
V894			MOUNTED
V898			MOUNTED
V899			MOUNTED
V908			MOUNTED
V909			MOUNTED

STATUS	0	1	PIN NR
ECL/TTL/TV	0	0	12/1
AUTO	1	0	15/2
TRIG	1	1	11/4
XDEFL	d	d	TRI/STATE

EL REF	TYPE
D851	HEF4052
D852	TL082CP
D853	OQ 0127

Fig. 8.4. Circuit diagram main time-base triggering (unit A3)



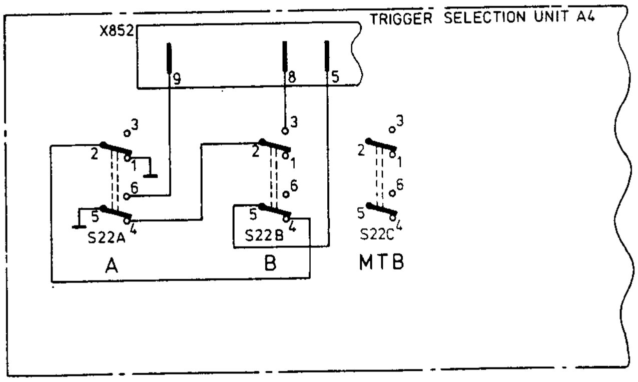
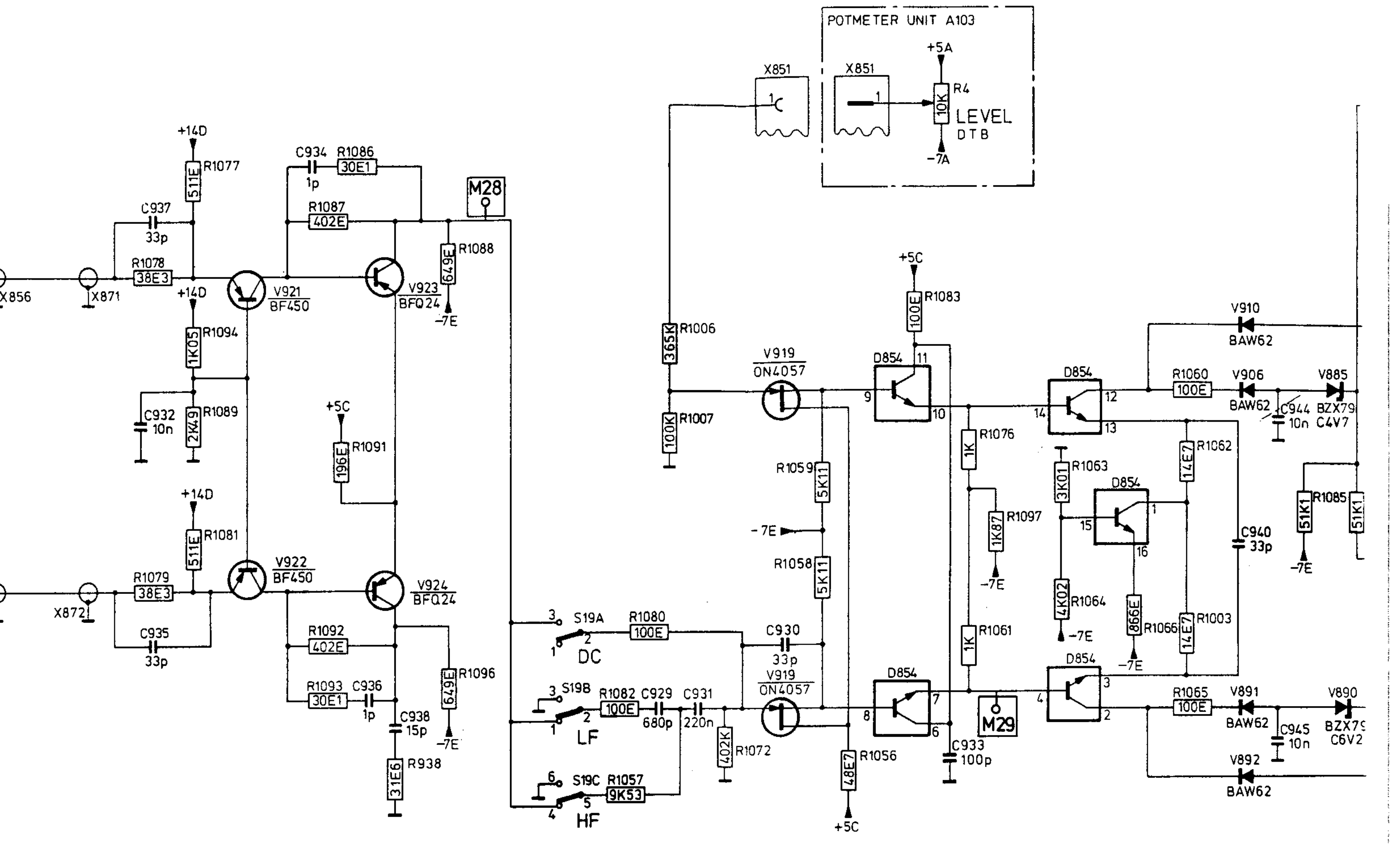
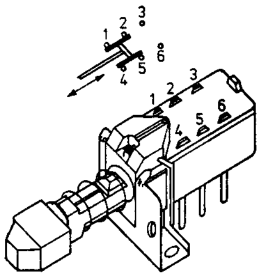
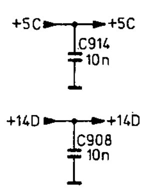


Fig. 8.5. Circuit diagram delayed time-base triggering (unit A3)

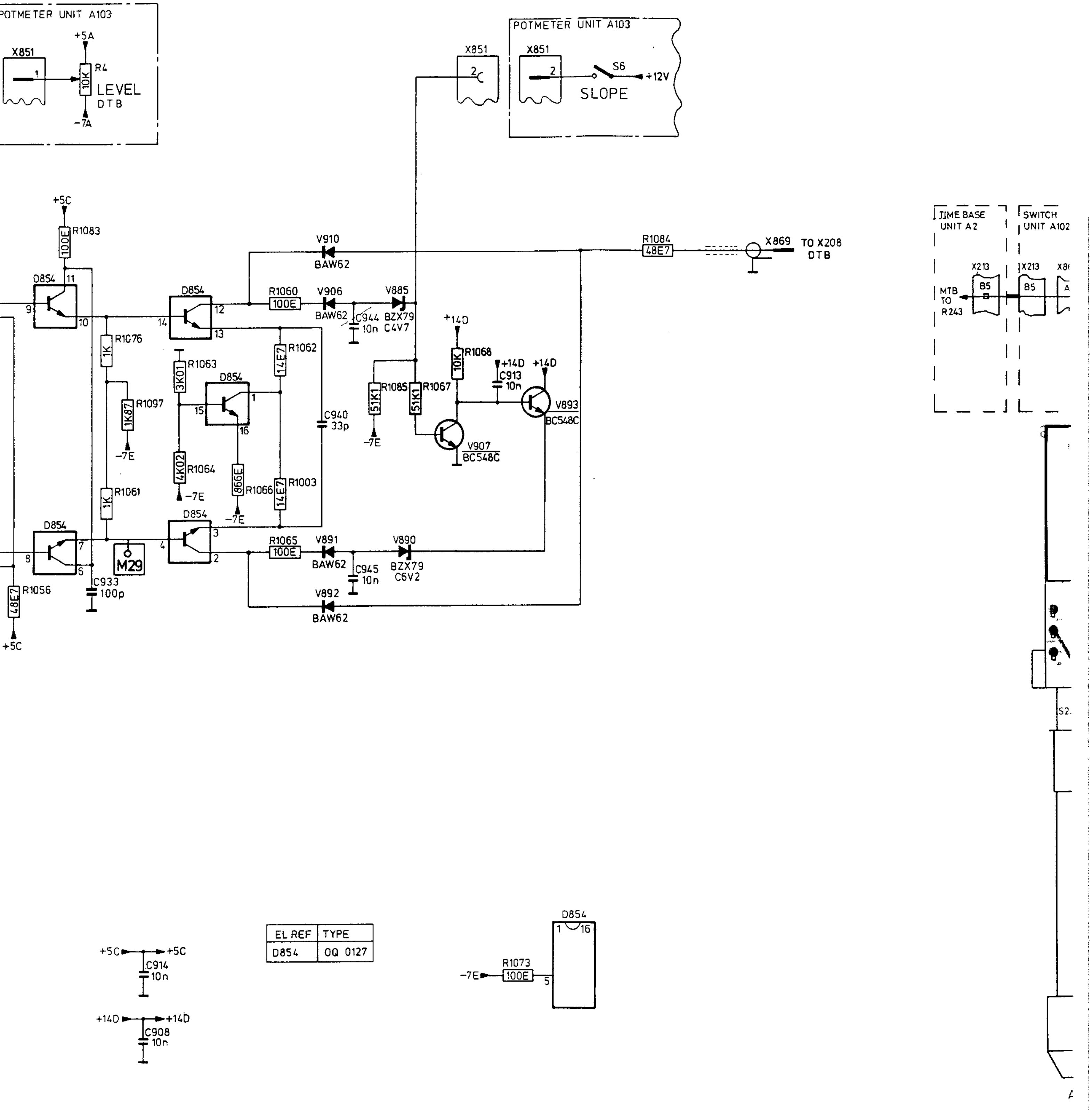






EL REF	TYPE
D854	OQ 0127

…it A3)



EL REF	TYPE
D854	OQ 0127

MAT 2146
851115

Fig.

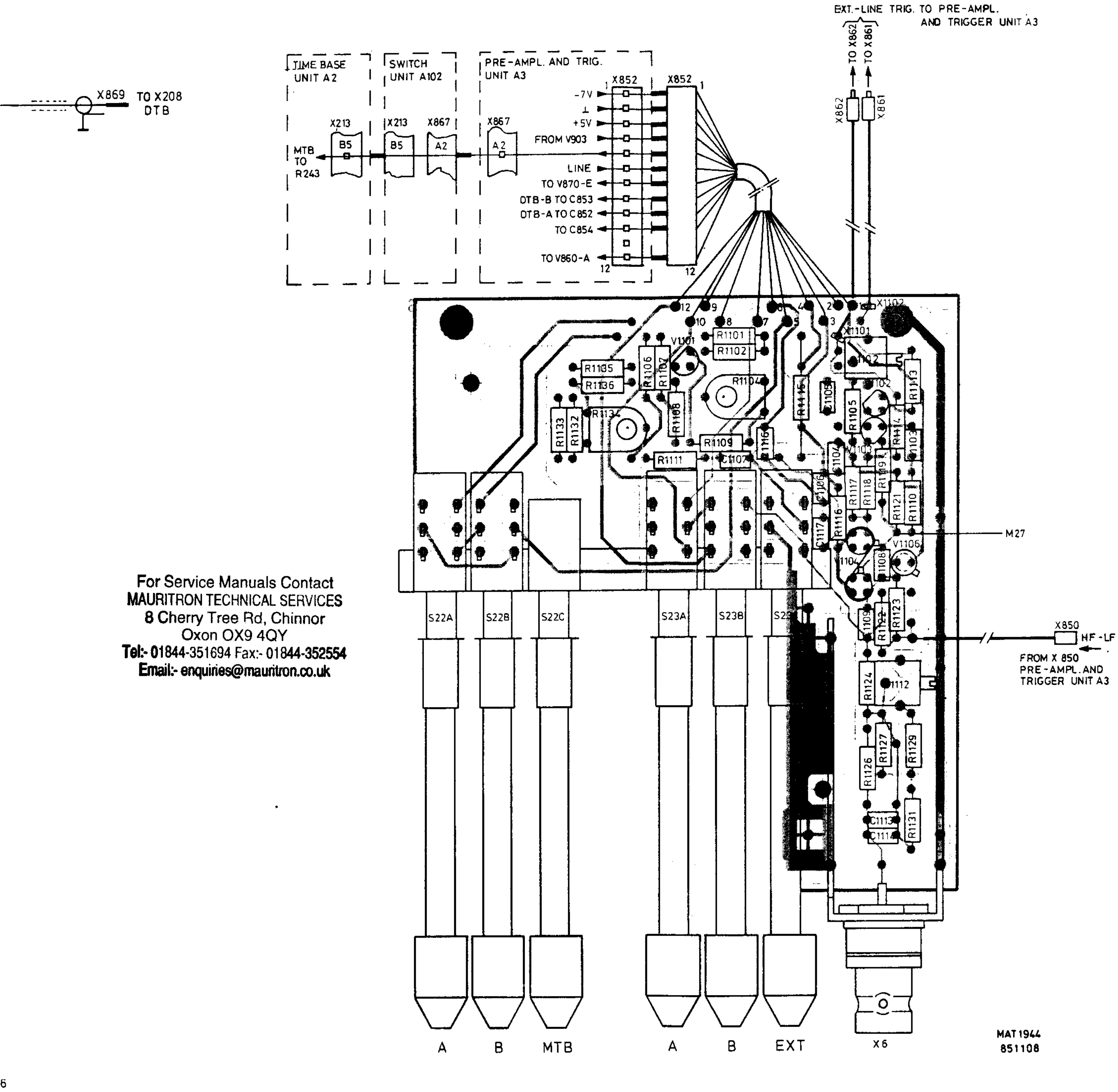
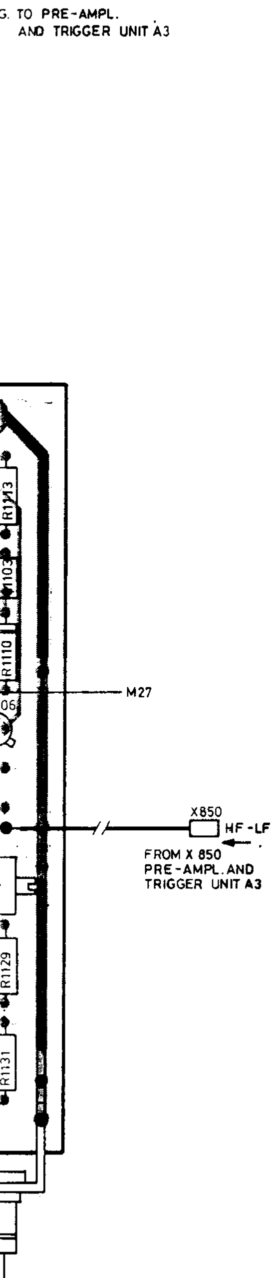


Fig. 8.6. Trigger selection unit A4, p.c.b.



MAT 1944
851108

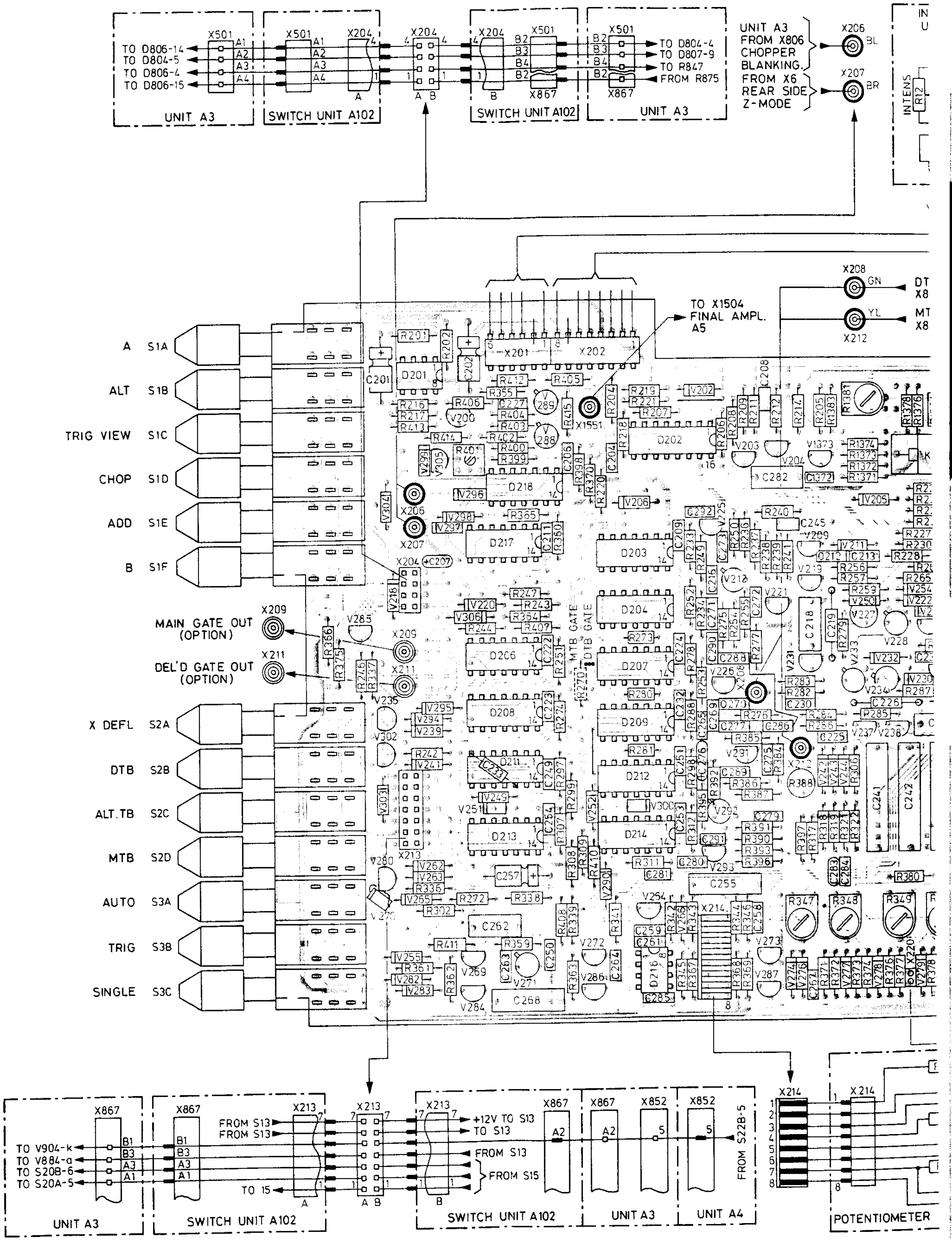
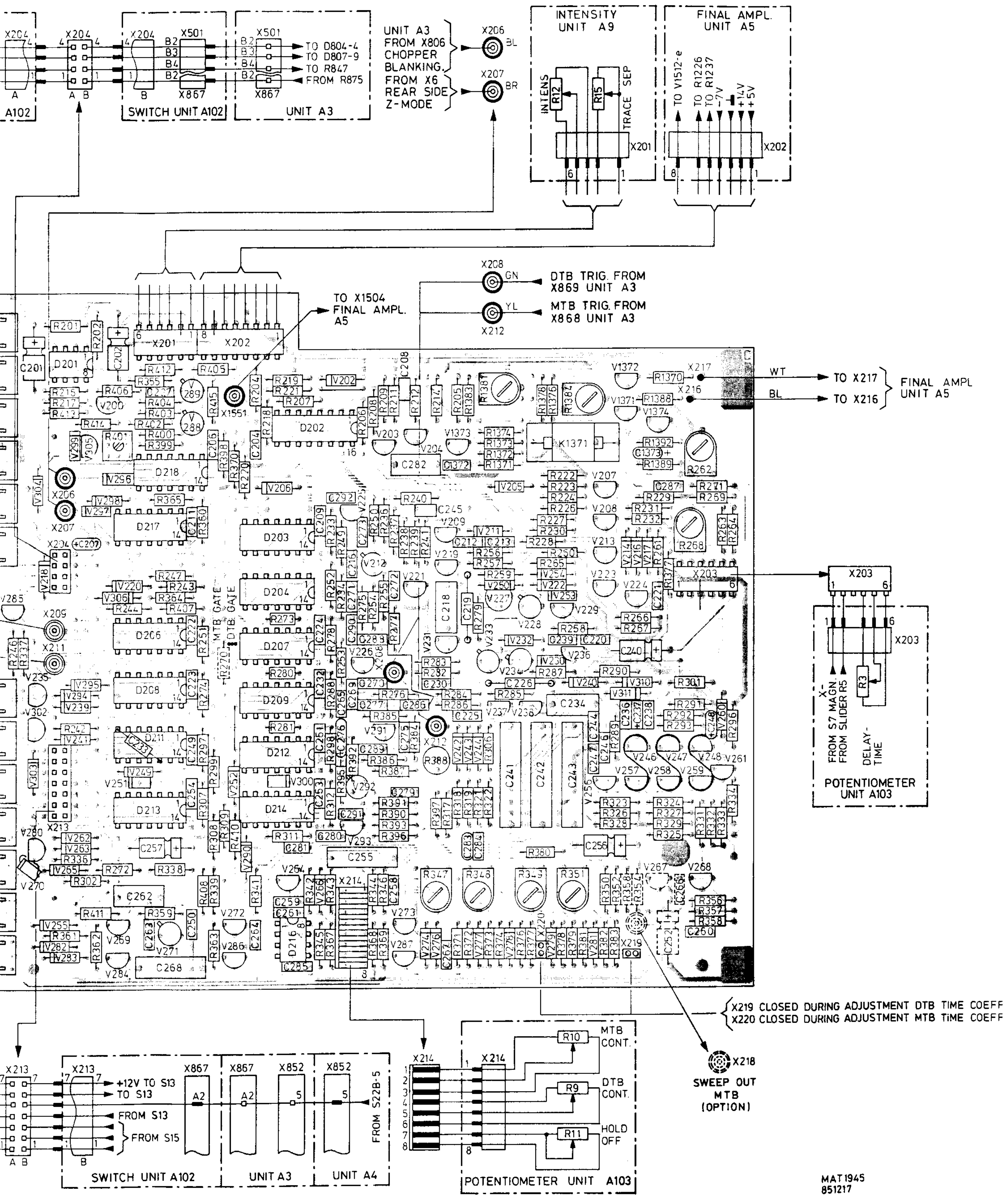
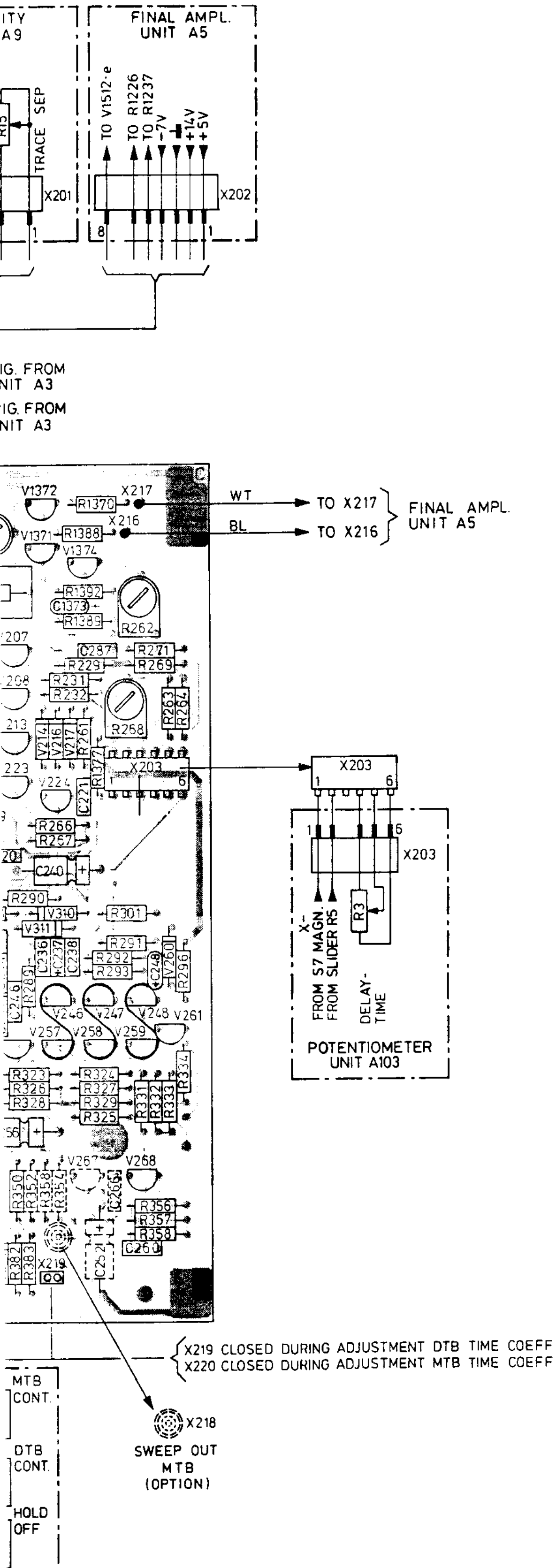


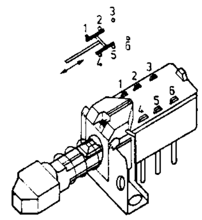
Fig. 8.7. Time-base unit p.c.b. A2

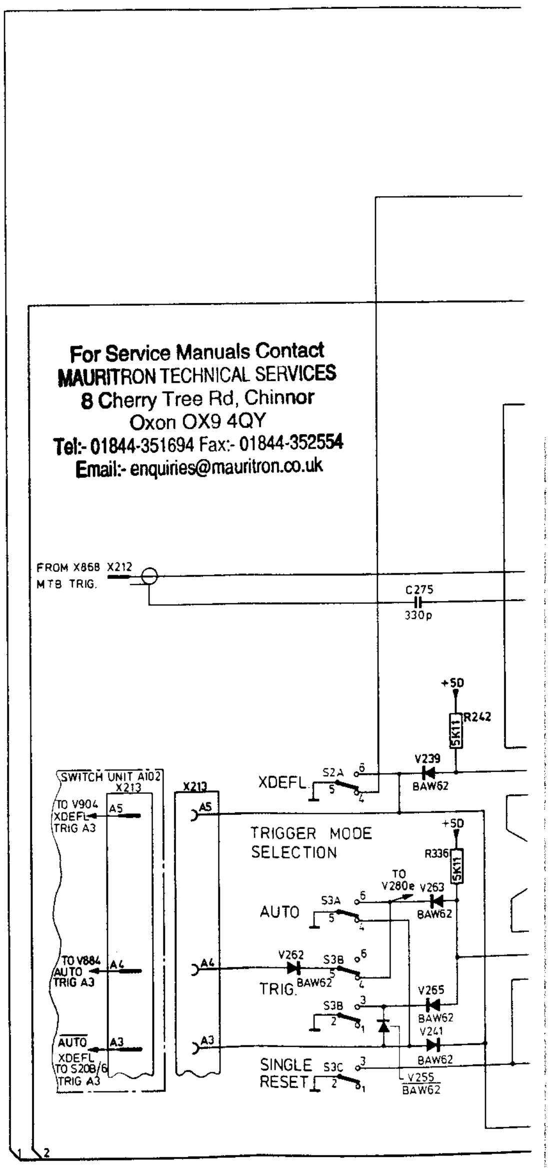


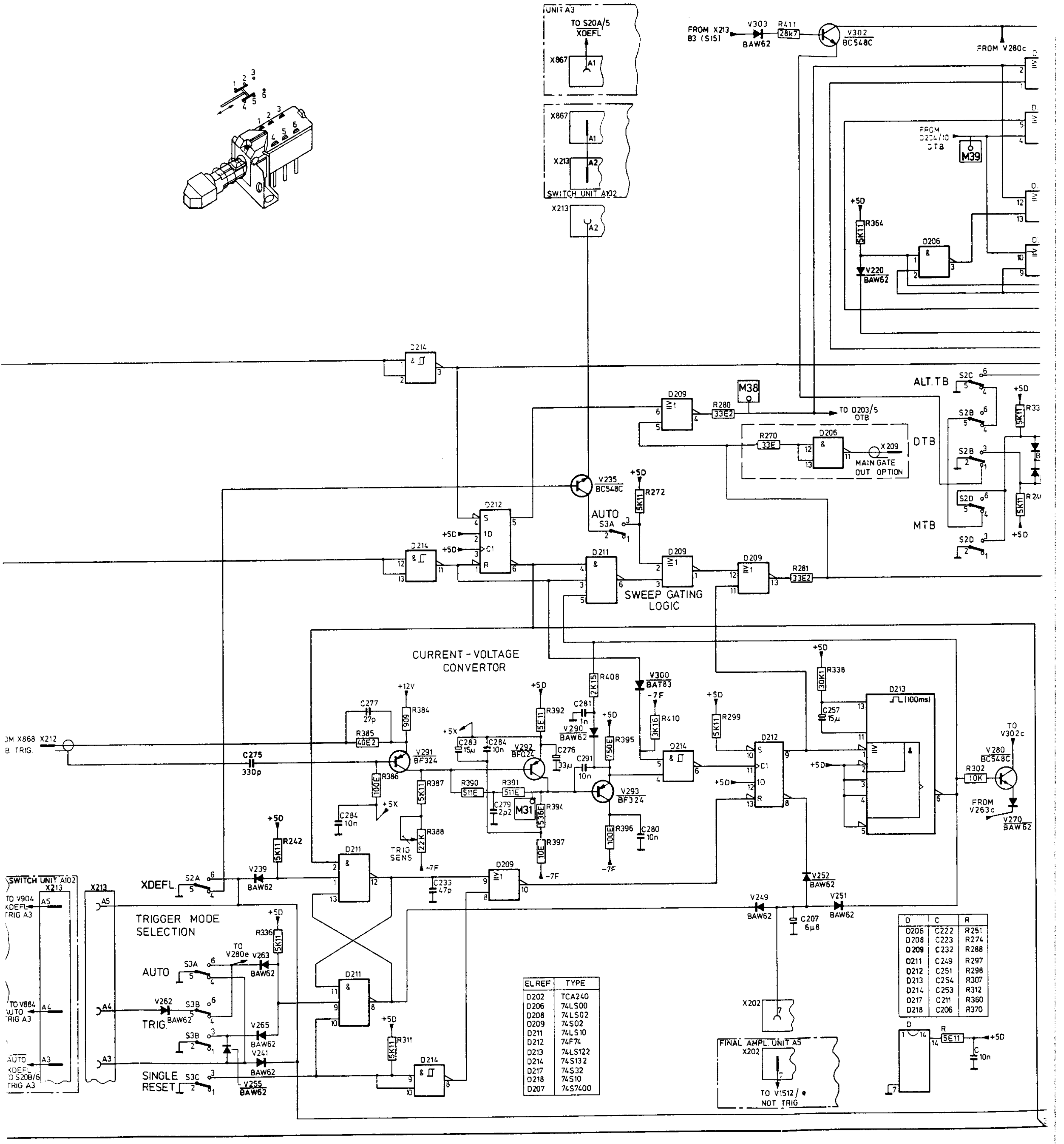
SWITCH UNIT A102
UNIT A3
UNIT A3
FROM X806
CHOPPER
BLANKING
FROM X6
REAR SIDE
Z-MODE
TO D804-4
TO D807-9
TO R847
FROM R875
INTENSITY
UNIT A9
INTENS
TRACE SEP
FINAL AMPL.
UNIT A5
TO X1504
FINAL AMPL.
A5
DTB TRIG. FROM
X869 UNIT A3
MTB TRIG. FROM
X868 UNIT A3
TO X217
TO X216
FINAL AMPL
UNIT A5
MTB GATE
DTB GATE
FROM S7 MAGN.
FROM SLIDER R5
DELAY-TIME
POTENTIOMETER
UNIT A103
X219 CLOSED DURING ADJUSTMENT DTB TIME COEFF
X220 CLOSED DURING ADJUSTMENT MTB TIME COEFF
+12V TO S13
TO S13
FROM S13
FROM S15
FROM S22B-5
SWITCH UNIT A102
UNIT A3
UNIT A4
MTB CONT.
DTB CONT.
HOLD OFF
POTENTIOMETER UNIT A103
SWEEP OUT
MTB
(OPTION)
MAT1945
851217



MAT1945
851217







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
D205	C222	R251
D208	C223	R274
D209	C232	R288
D211	C249	R297
D212	C251	R298
D213	C254	R307
D214	C253	R312
D217	C211	R360
D218	C206	R370

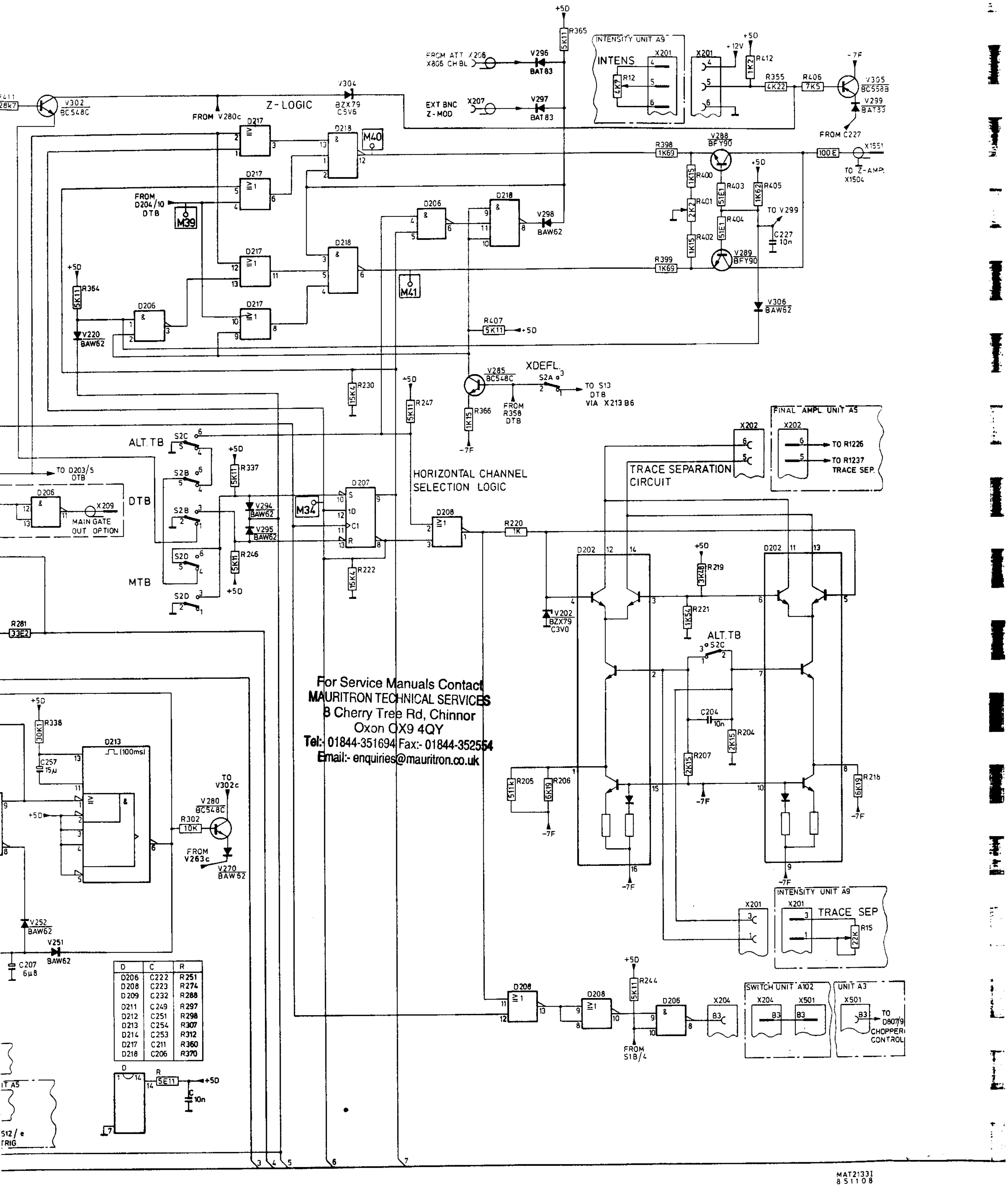
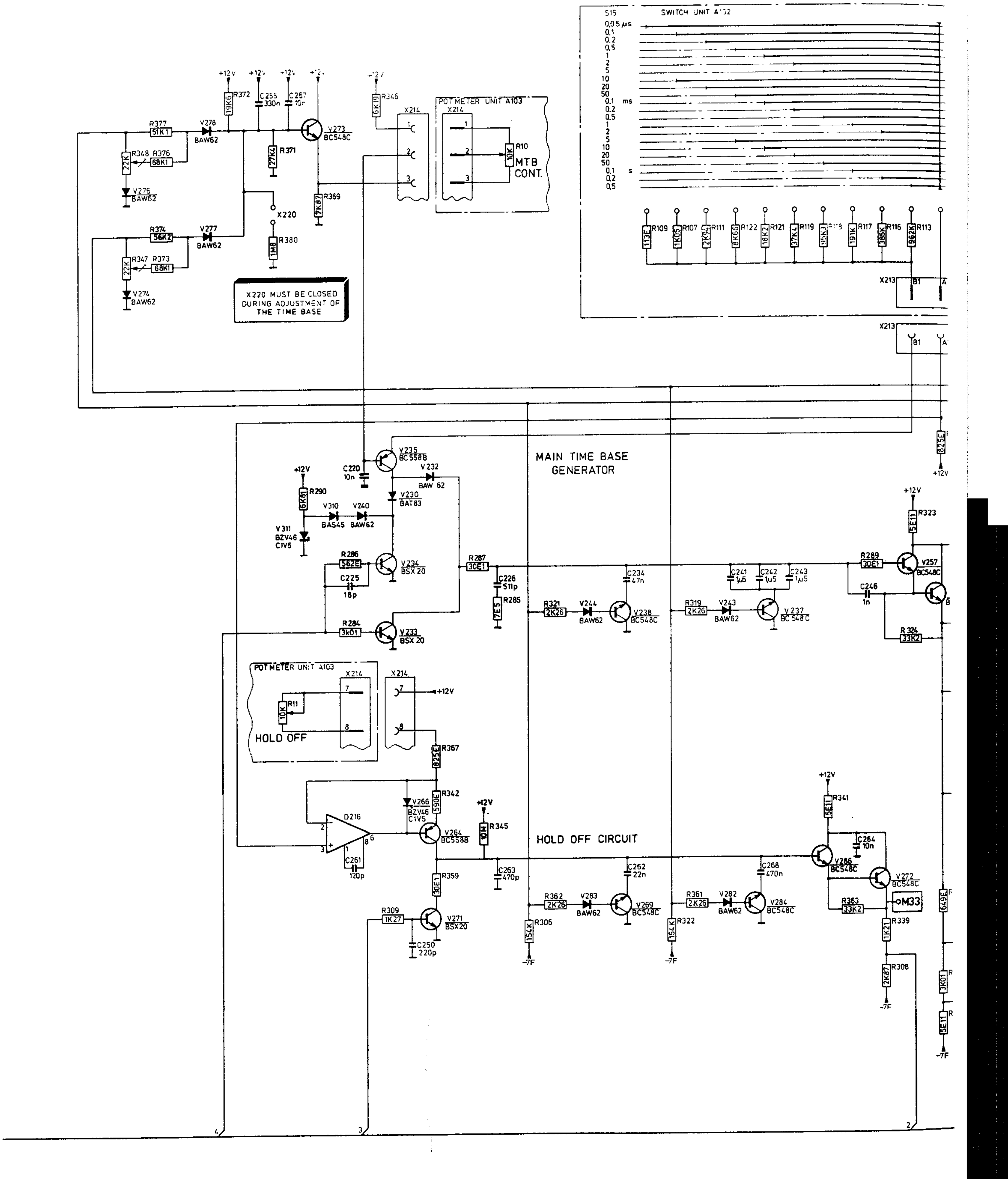
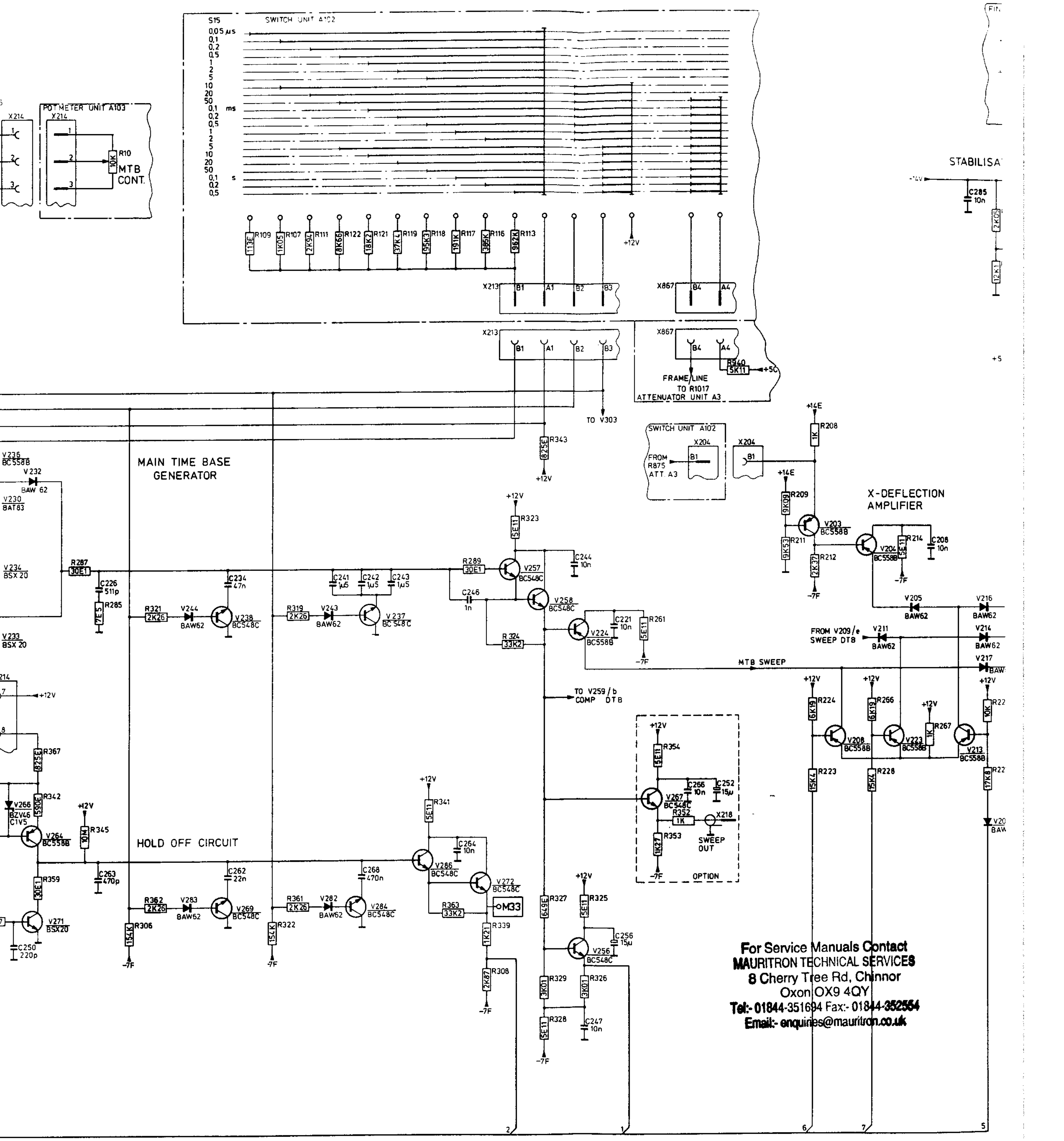


Fig. 8.8. Circuit diagram main time-base (unit A2)



SWITCH UNIT A102
POTMETER UNIT A103
MTB CONT.
X220 MUST BE CLOSED DURING ADJUSTMENT OF THE TIME BASE
MAIN TIME BASE GENERATOR
HOLD OFF
HOLD OFF CIRCUIT



SWITCH UNIT A102
POTMETER UNIT A103
MTB CONT.
STABILISA
ATTENUATOR UNIT A3
FRAME/LINE TO R1017
TO V303
MAIN TIME BASE GENERATOR
X-DEFLECTION AMPLIFIER
FROM R875 ATT A3
FROM V209/e SWEEP DTB
MTB SWEEP
TO V259/b COMP DTB
HOLD OFF CIRCUIT
SWEEP OUT
OPTION

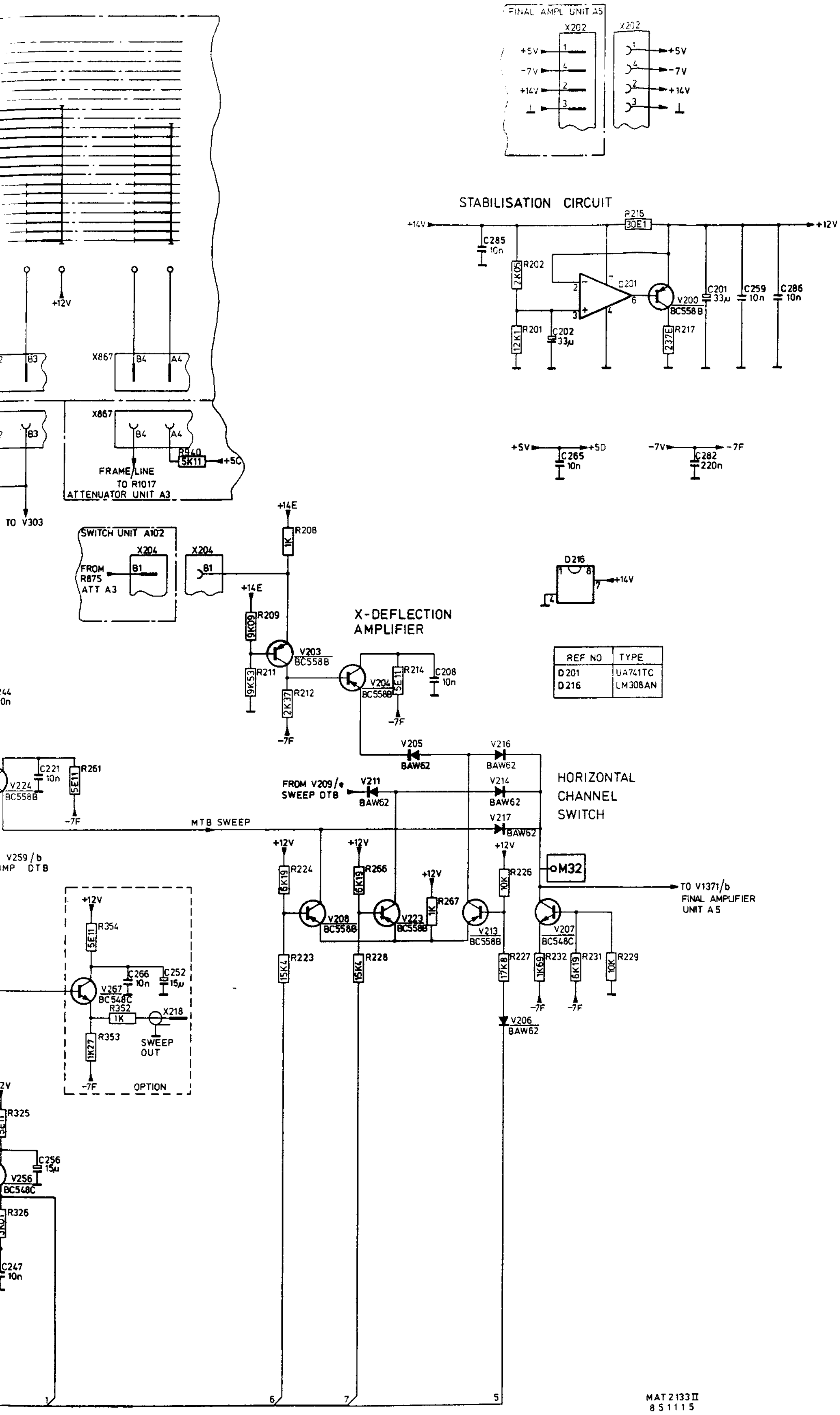
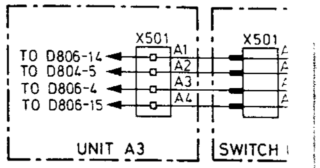
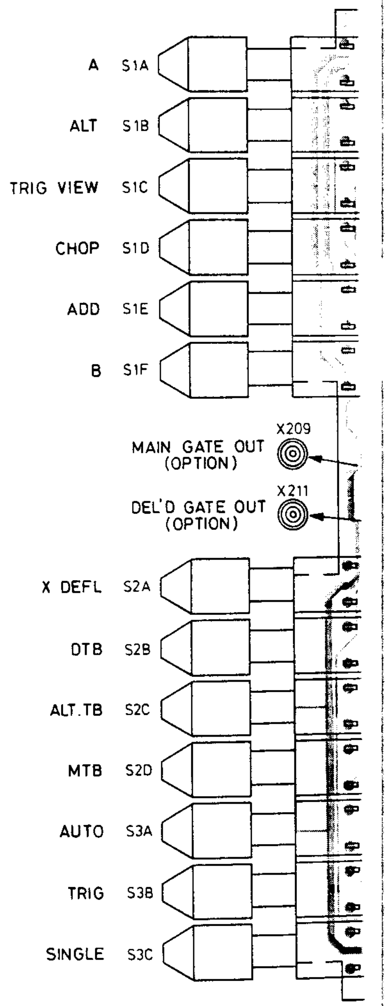
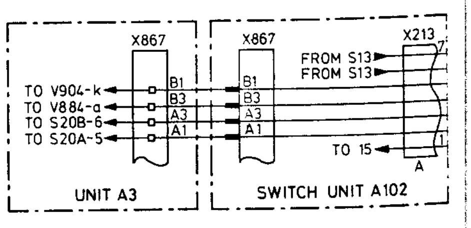


Fig. 8.8. Circuit diagram main time-base (unit A2)


X501
TO D806-14
TO D804-5
TO D806-4
TO D806-15
A1
A2
A3
A4
UNIT A3
X501
SWITCH


A S1A
ALT S1B
TRIG VIEW S1C
CHOP S1D
ADD S1E
B S1F
X209
MAIN GATE OUT
(OPTION)
X211
DEL'D GATE OUT
(OPTION)
X DEFL S2A
DTB S2B
ALT.TB S2C
MTB S2D
AUTO S3A
TRIG S3B
SINGLE S3C


X867
TO V904-k
TO V884-a
TO S20B-6
TO S20A-5
B1
B3
A3
A1
UNIT A3
X867
FROM S13
FROM S13
X213
TO 15
A
SWITCH UNIT A102

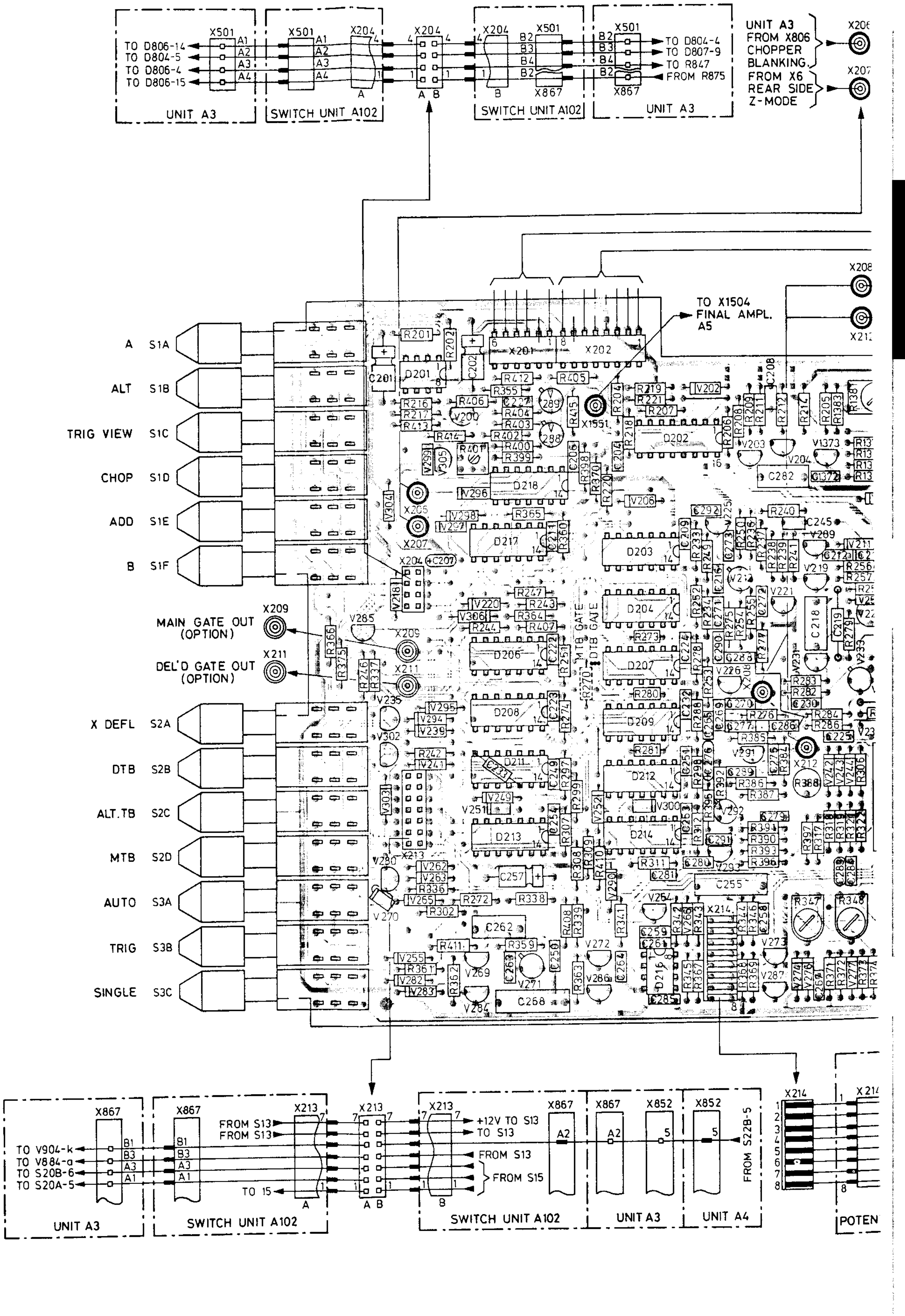


Fig. 8.9. Time-base unit p.c.b. A2

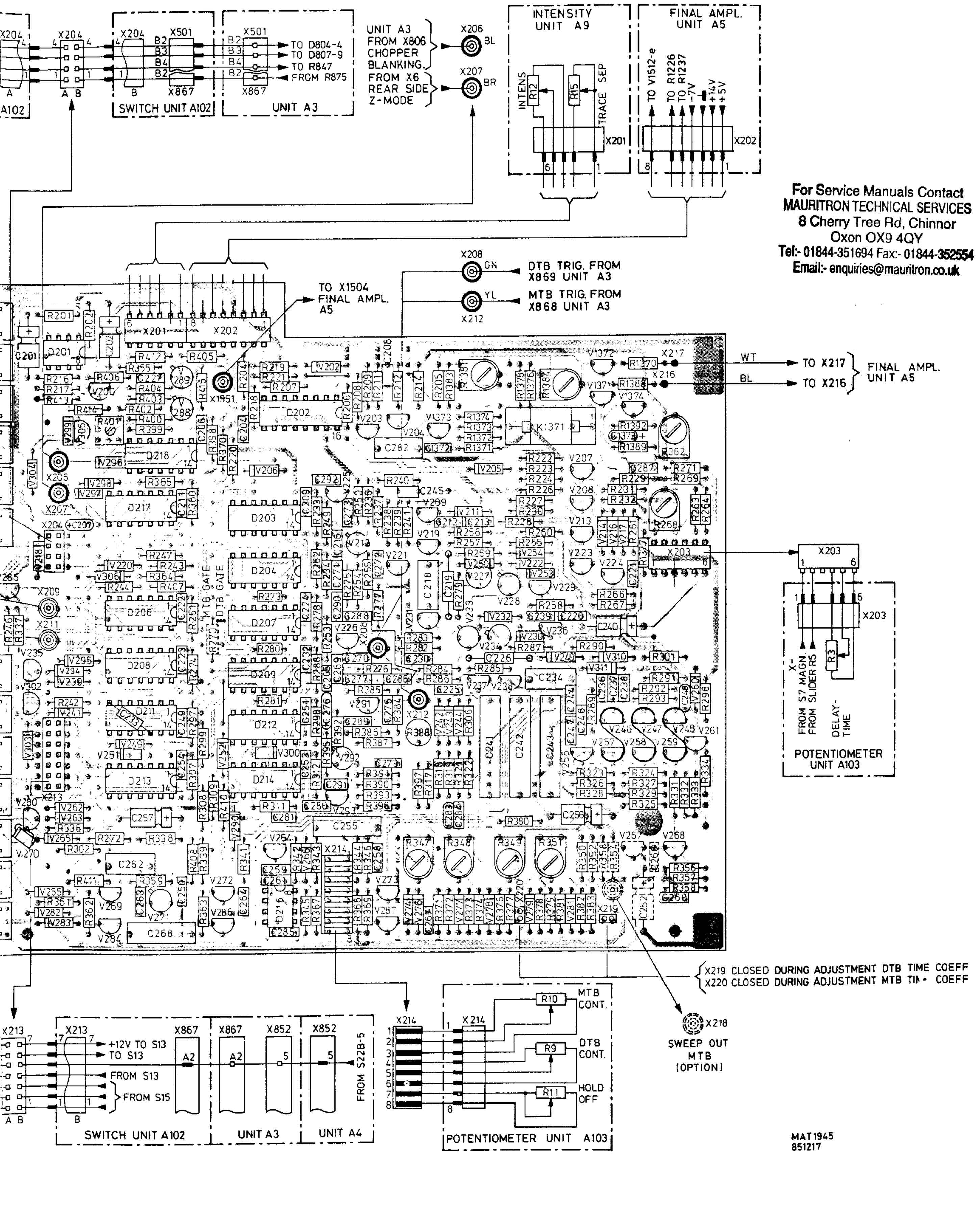
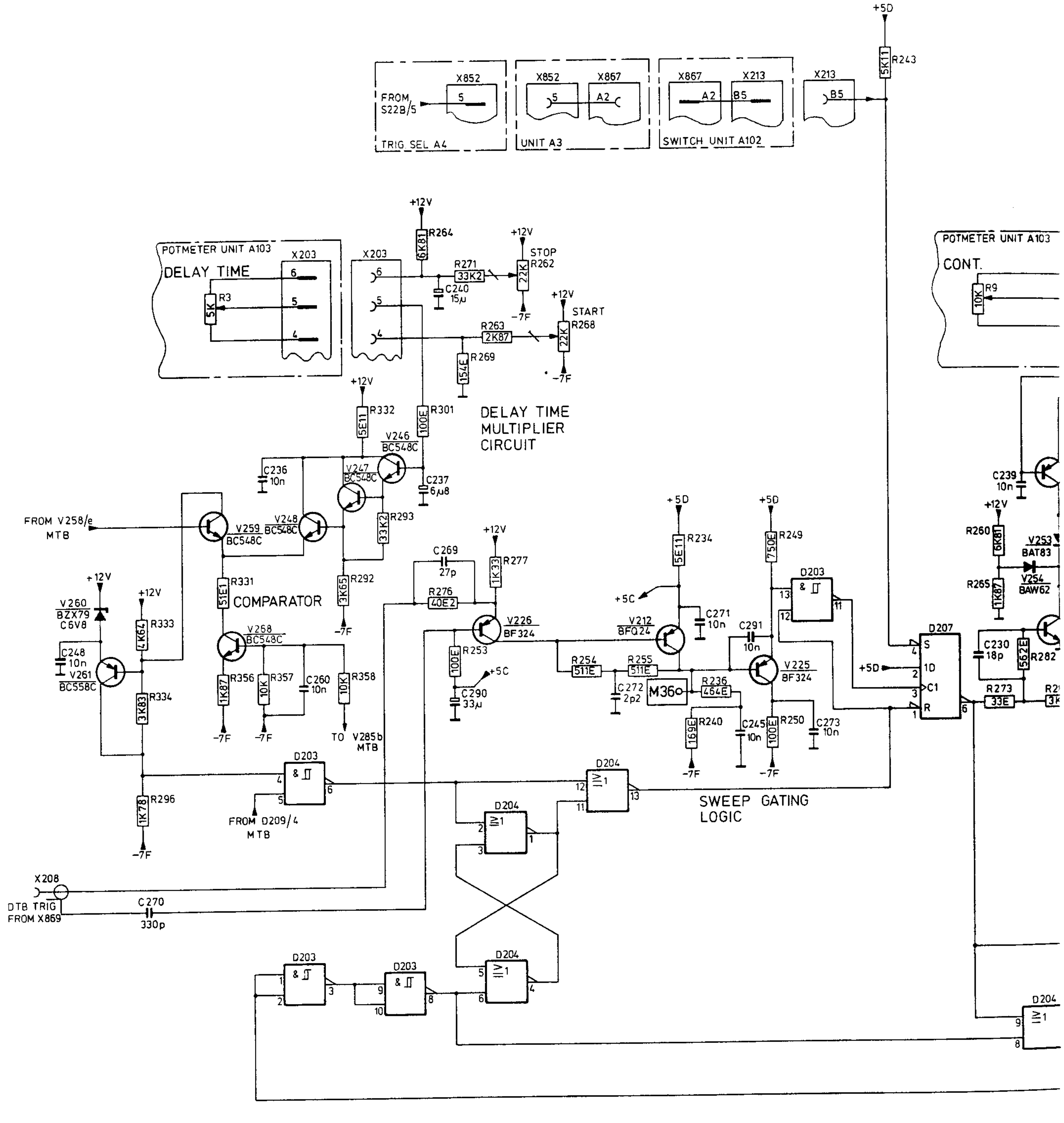


Fig. 8.9. Time-base unit p.c.b. A2



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

EL REF	TYPE
D203	74SN132
D204	74LS02
D207	74F74

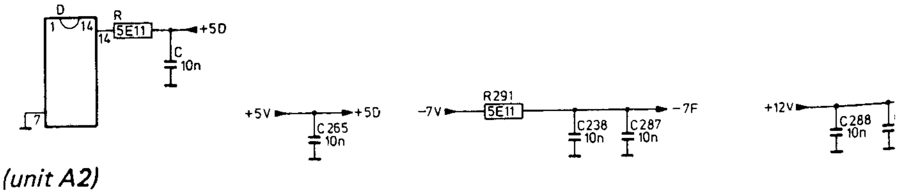
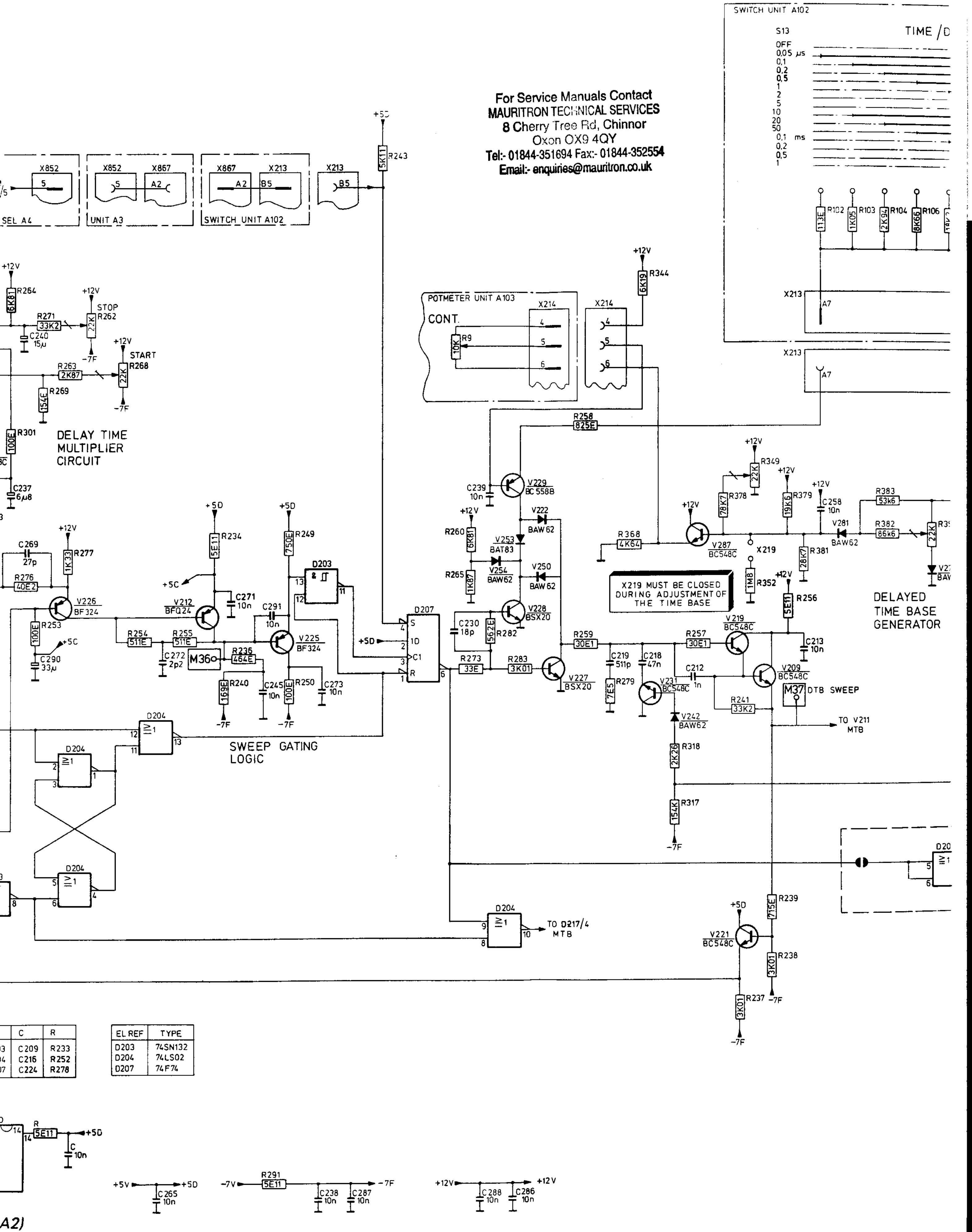
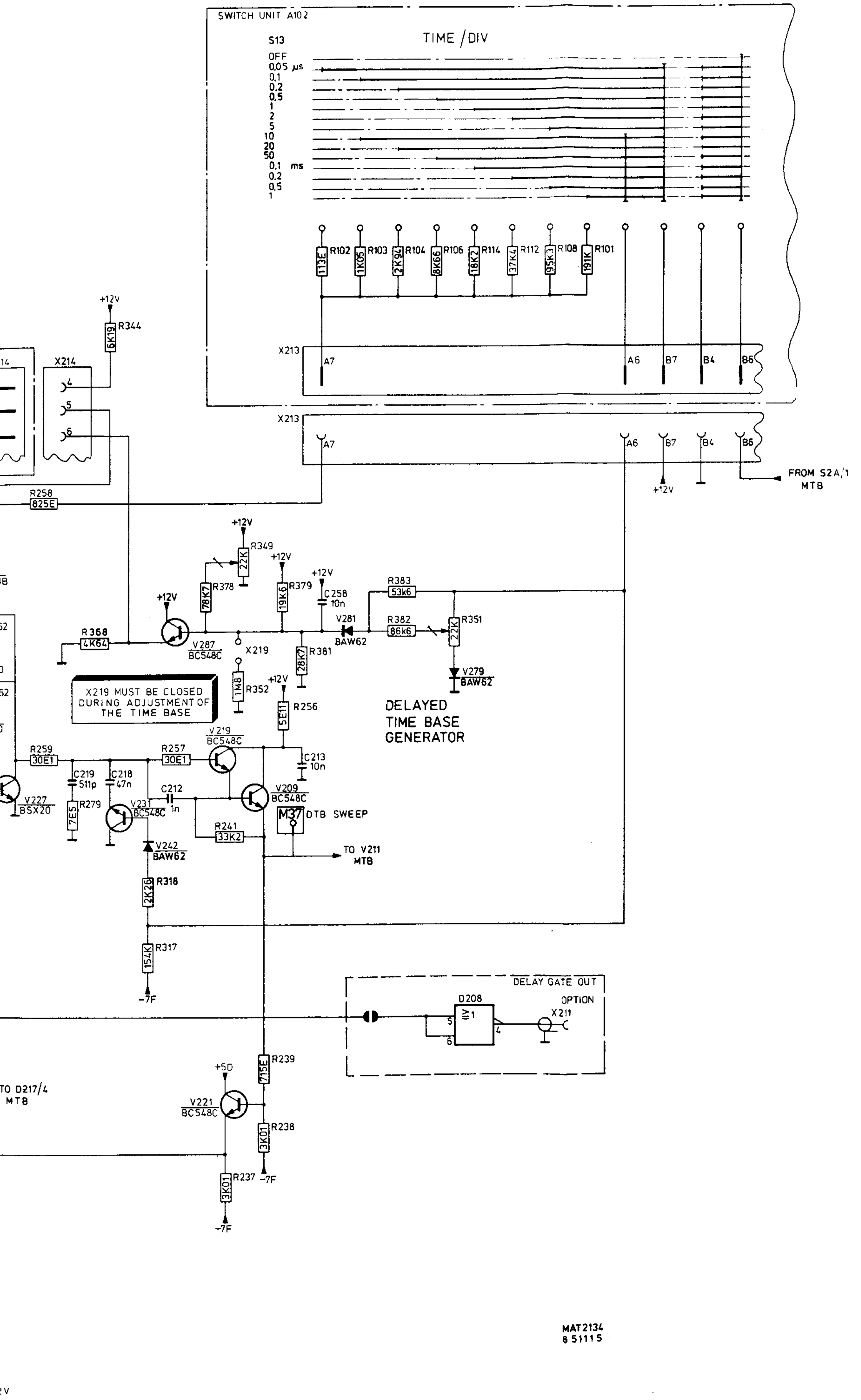


Fig. 8.10. Circuit diagram delayed time-base (unit A2)

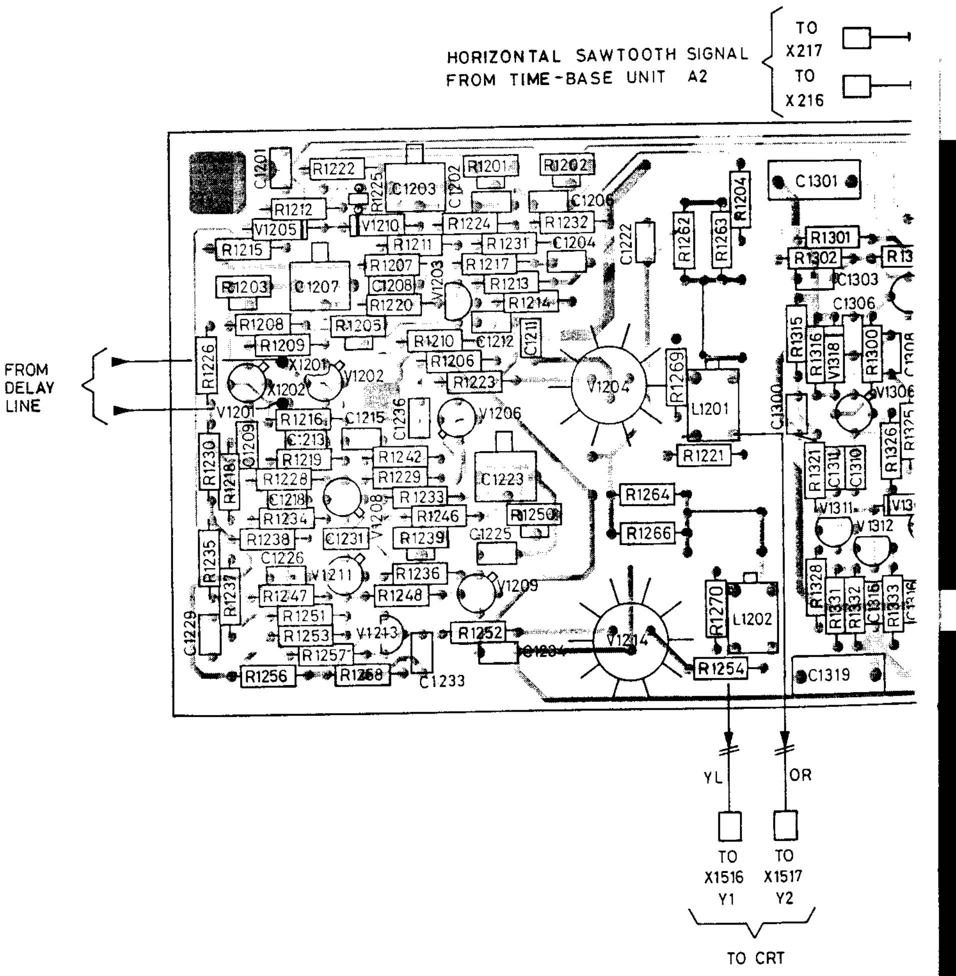


	C	R
3	C209	R233
4	C216	R252
7	C224	R278

EL REF	TYPE
D203	74SN132
D204	74LS02
D207	74F74



SWITCH UNIT A102
S13
TIME / DIV
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
FROM S2A/1 MTB
+12V
R344 6K19
X214
R258 825E
R349 22K
R378 78K7
R379 19K6
C258 10n
V281 BAW62
R383 53k6
R382 86k6
R351 22K
V279 BAW62
R368 4K64
V287 BC548C
X219
R381 28K7
R352 1M8
R256 5E11
X219 MUST BE CLOSED DURING ADJUSTMENT OF THE TIME BASE
DELAYED TIME BASE GENERATOR
R259 30E1
R257 30E1
V219 BC548C
C213 10n
C219 511p
C218 47n
C212 1n
V209 BC548C
V227 BSX20
R279 7E5
V231 BC548C
M37 DTB SWEEP
R241 33K2
V242 BAW62
TO V211 MTB
R318 2K26
R317 154K
-7F
DELAY GATE OUT OPTION
D208
≥1
X211
R239 715E
+5D
V221 BC548C
TO D217/4 MTB
R238 3K01
R237 3K01
MAT 2134
8 5111 S


HORIZONTAL SAWTOOTH SIGNAL
FROM TIME-BASE UNIT A2
TO
X217
TO
X216
FROM
DELAY
LINE
YL
OR
TO
X1516
Y1
TO
X1517
Y2
TO CRT

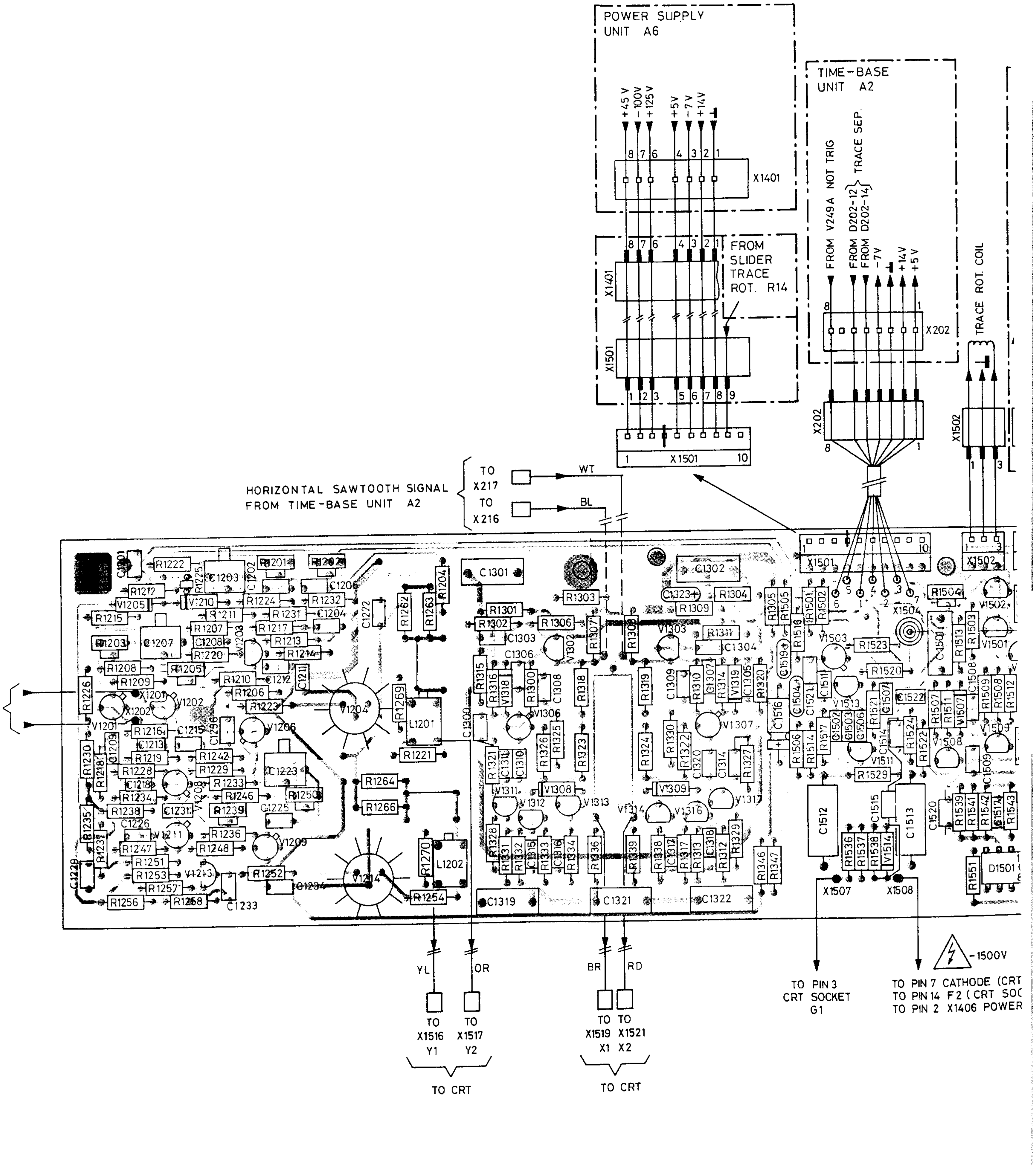


Fig. 8.11. Final amplifier unit p.c.b. A5

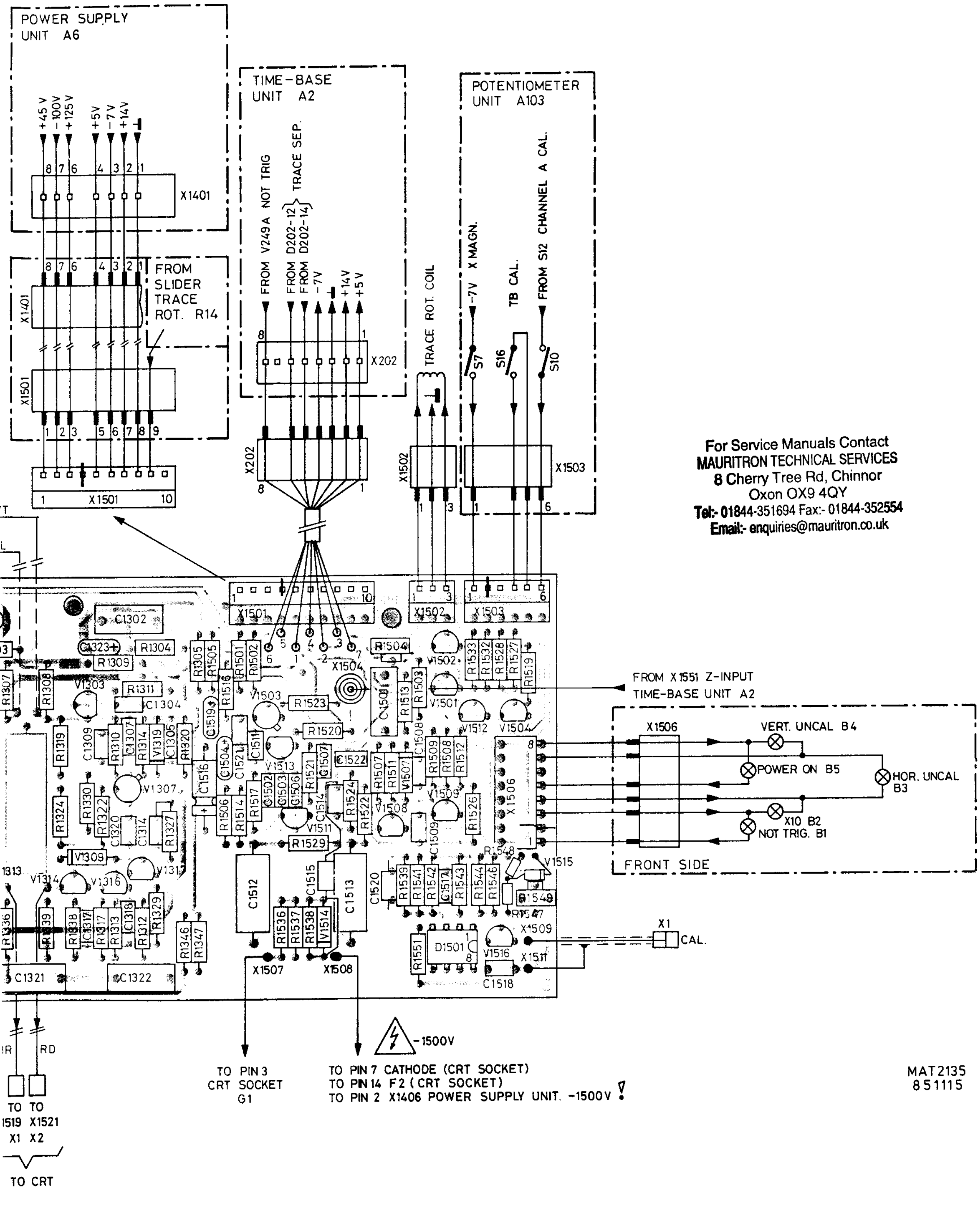


Fig. 8.11. Final amplifier unit p.c.b. A5

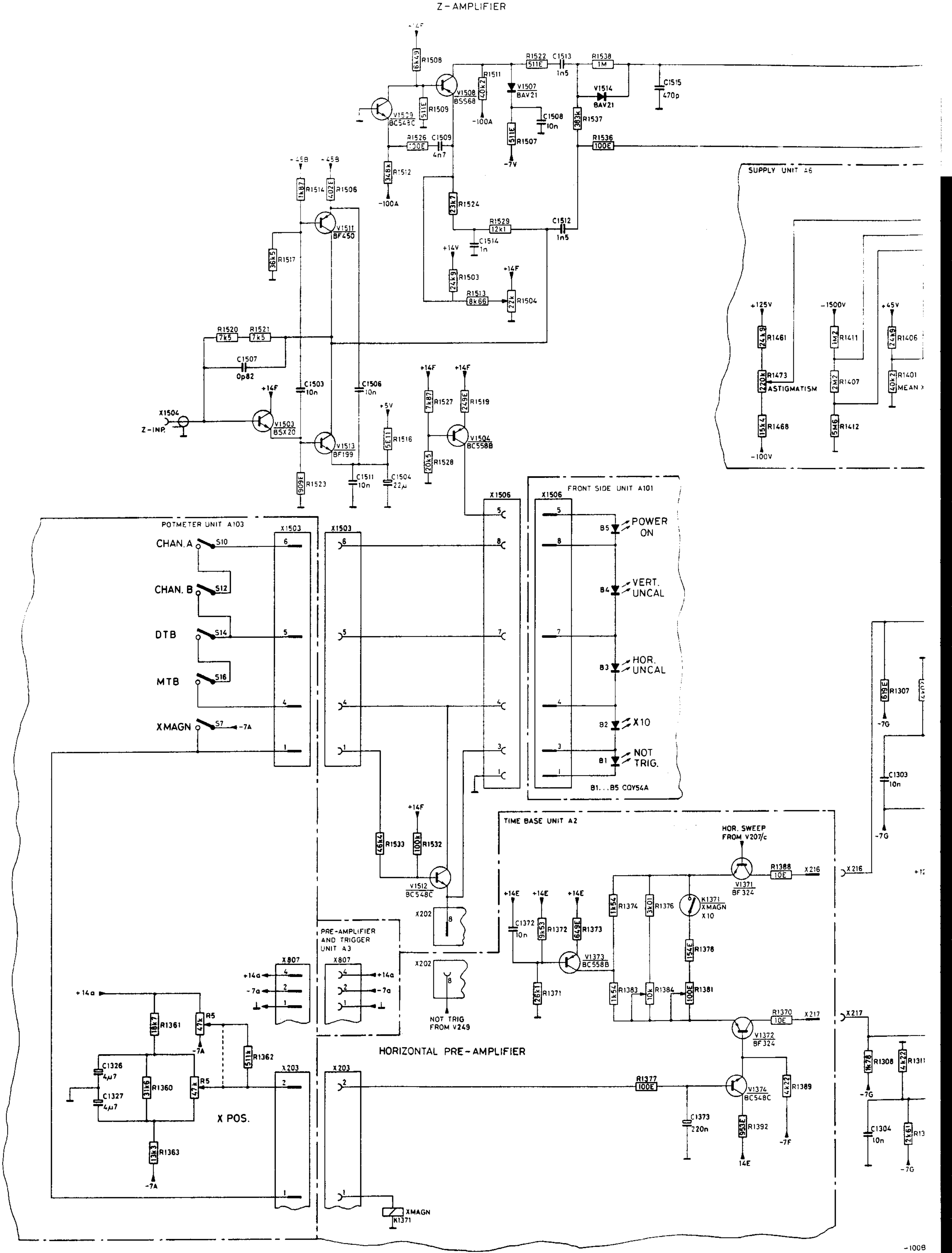
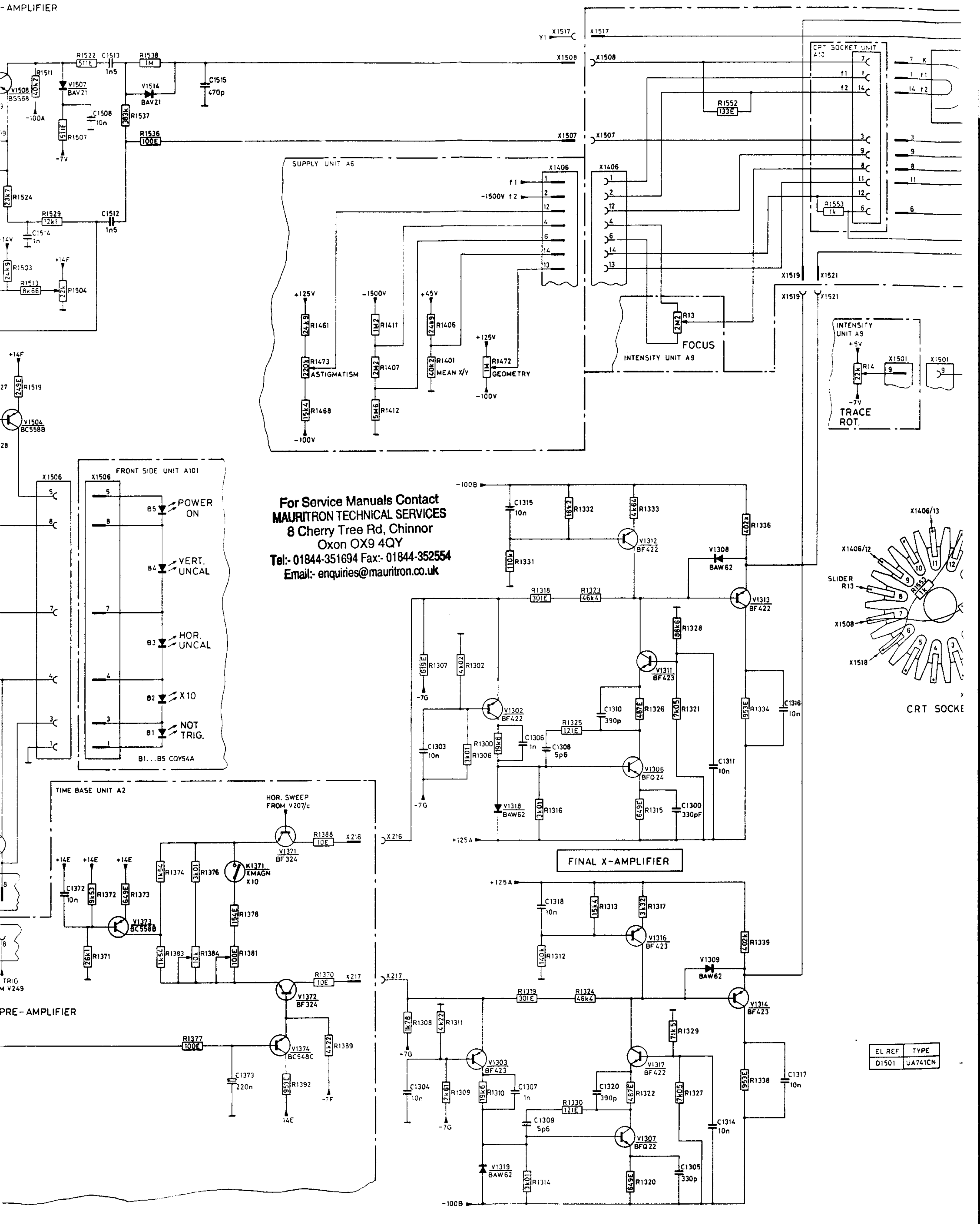
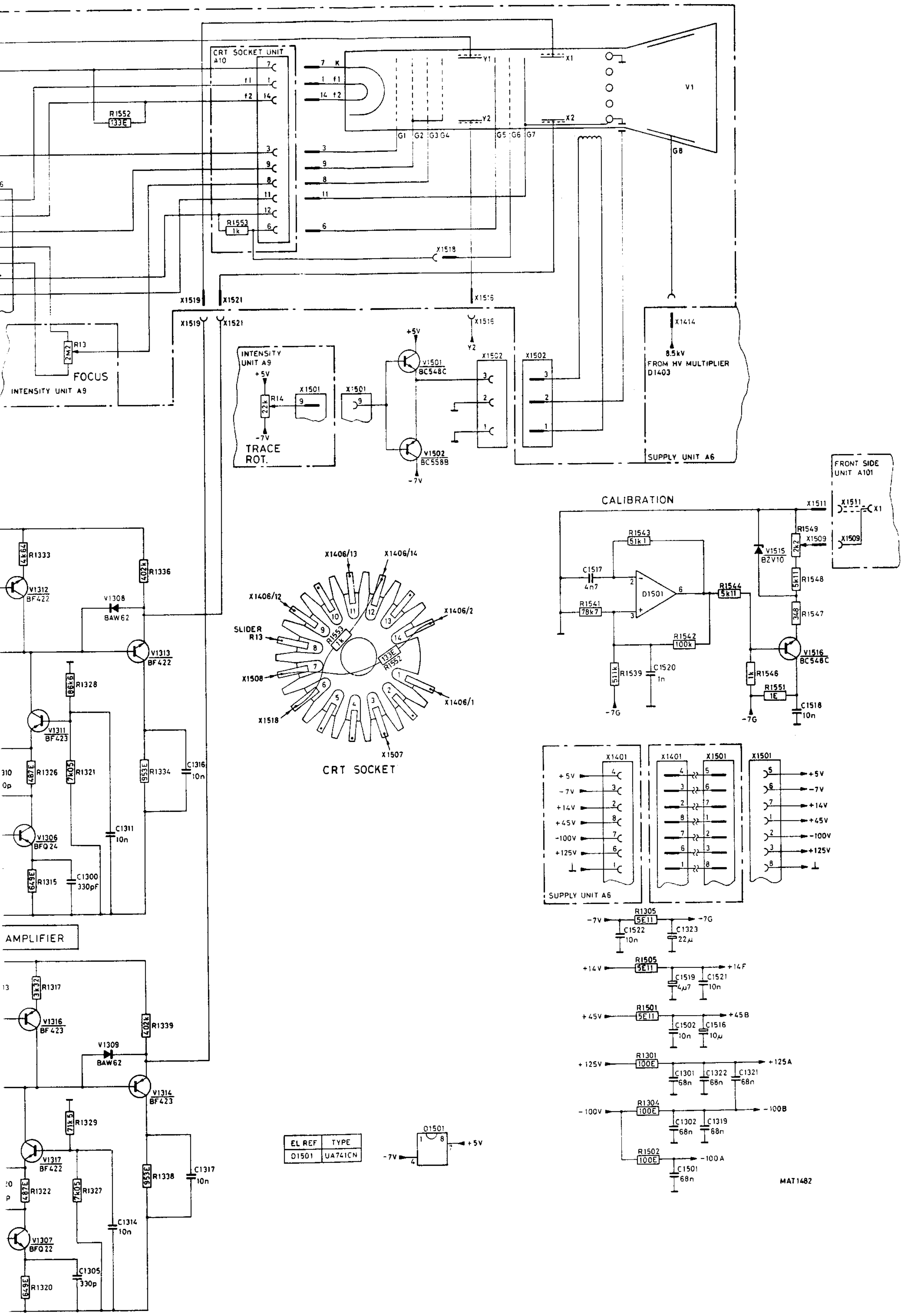


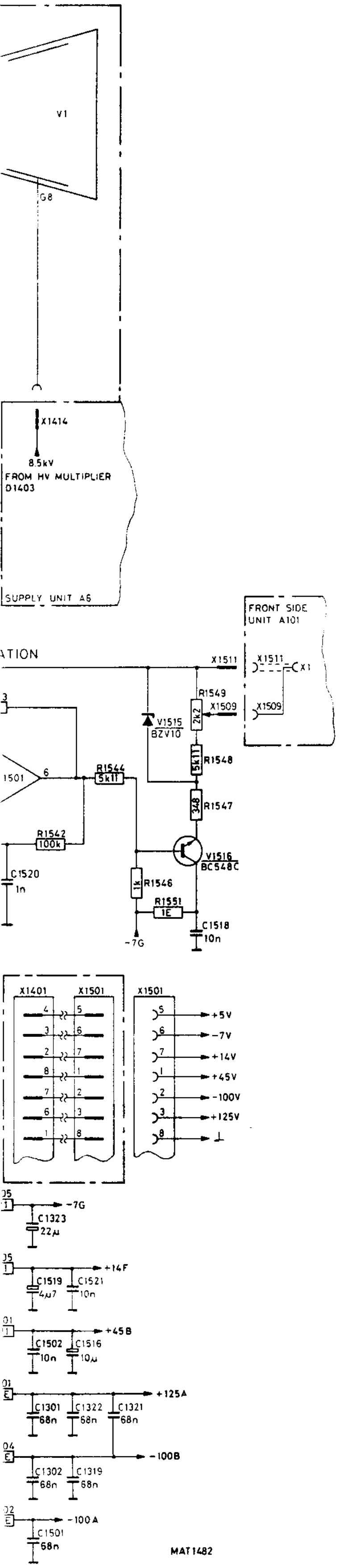
Fig. 8.12. Circuit diagram final X-amplifier, Z-amplifier, calibration unit and display section



EL REF	TYPE
D1501	UA741CN

...n unit and display section


CRT SOCKET UNIT A10
INTENSITY UNIT A9
FOCUS
TRACE ROT.
SUPPLY UNIT A6
FROM HV MULTIPLIER D1403
8.5kV
CALIBRATION
FRONT SIDE UNIT A101
CRT SOCKET
AMPLIFIER
EL REF
TYPE
D1501
UA741CN
MAT1482



V1
G8
X1414
8.5kV
FROM HV MULTIPLIER
D1403
SUPPLY UNIT A6
FRONT SIDE
UNIT A101
X1511
X1509
R1549
2k2
V1515
BZV10
R1548
5k11
R1544
5k11
R1547
348
R1542
100k
C1520
1n
V1516
BC548C
R1546
1k
R1551
1E
C1518
10n
-7G
X1401
X1501
+5V
-7V
+14V
+45V
-100V
+125V
C1323
22µ
+14F
C1519
4µ7
C1521
10n
+45B
C1502
10n
C1516
10µ
+125A
C1301
68n
C1322
68n
C1321
68n
-100B
C1302
68n
C1319
68n
-100A
C1501
68n
MAT1482

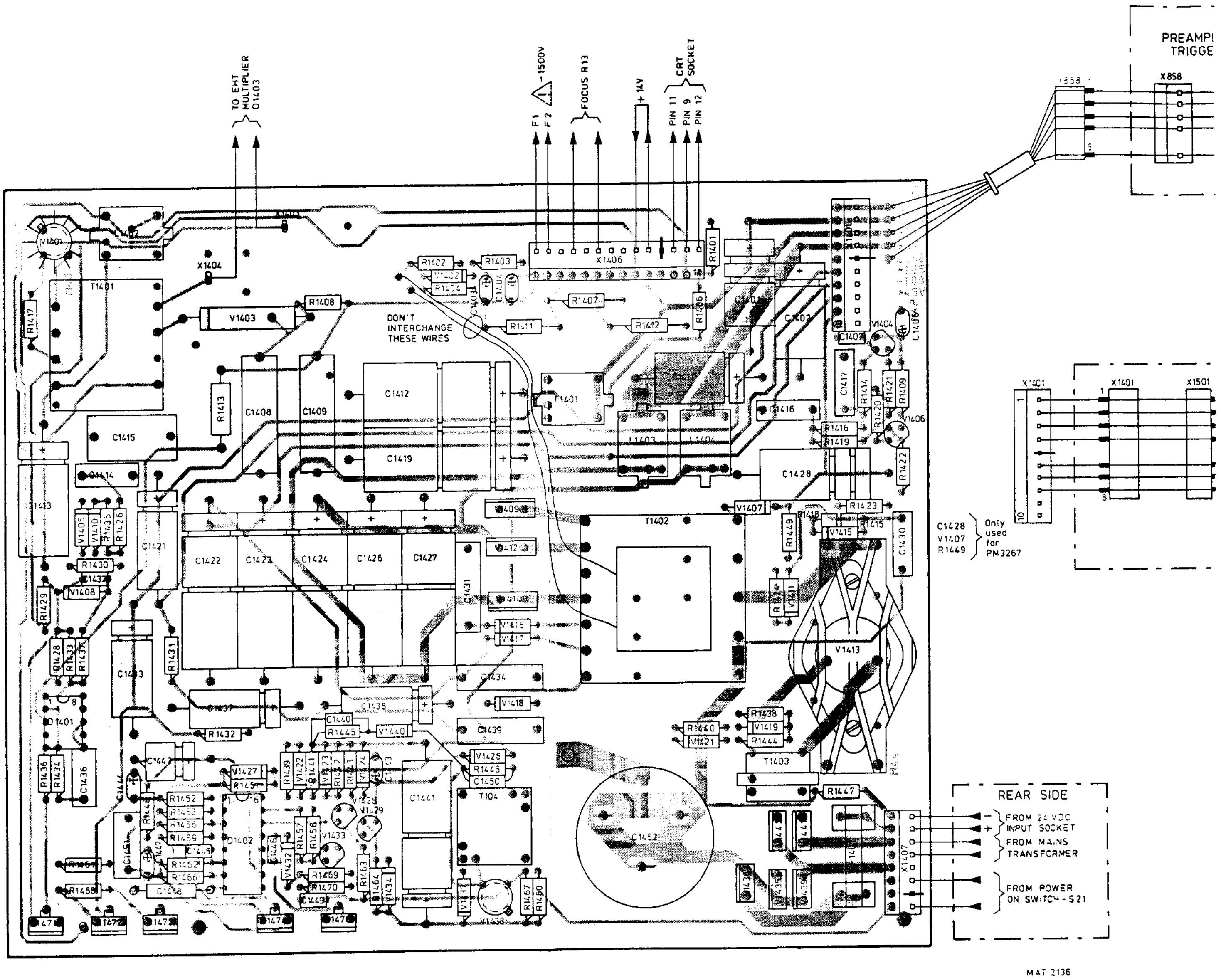
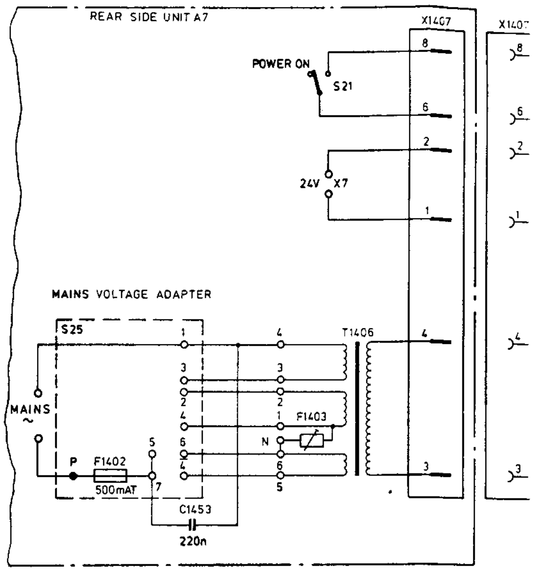
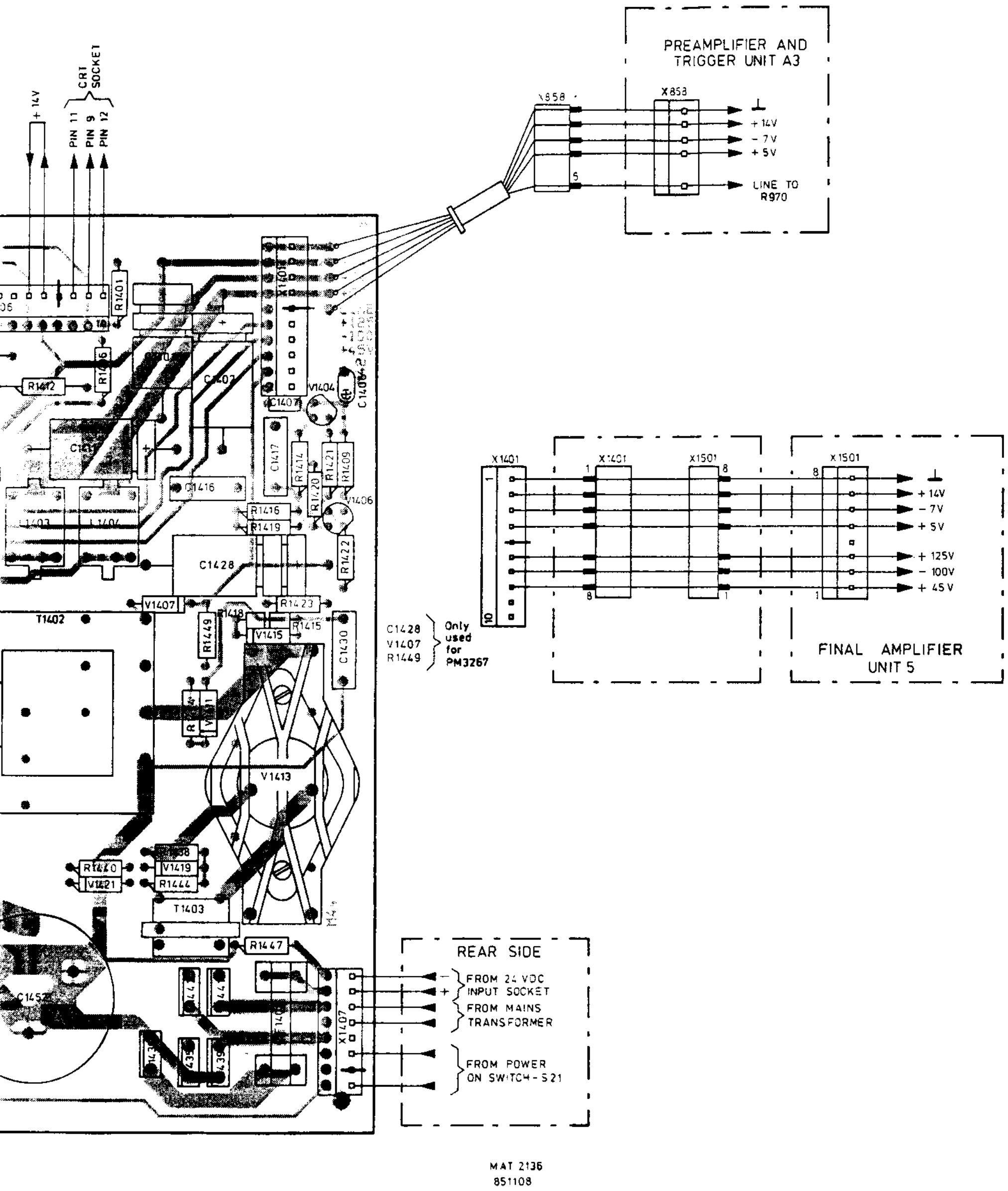
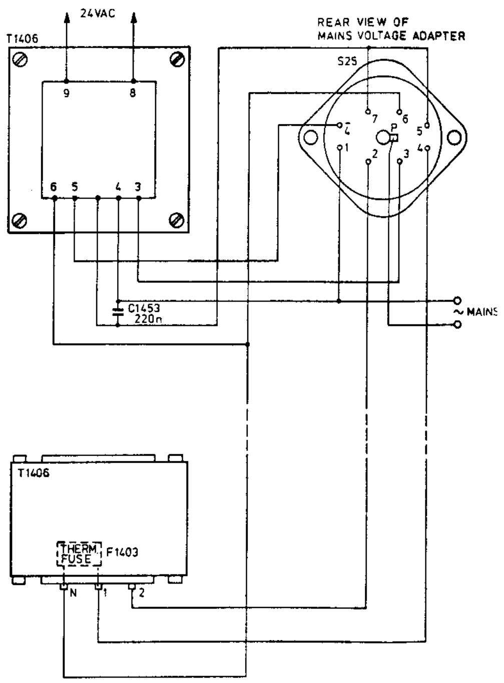


Fig. 8.13 Power supply unit p.c.b. A6.



VOLT SELECT			
	CONNECTION		
110V	1-2	3-4	6-7
220V	2-3	5-6	
240V	2-3	4-7	





For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

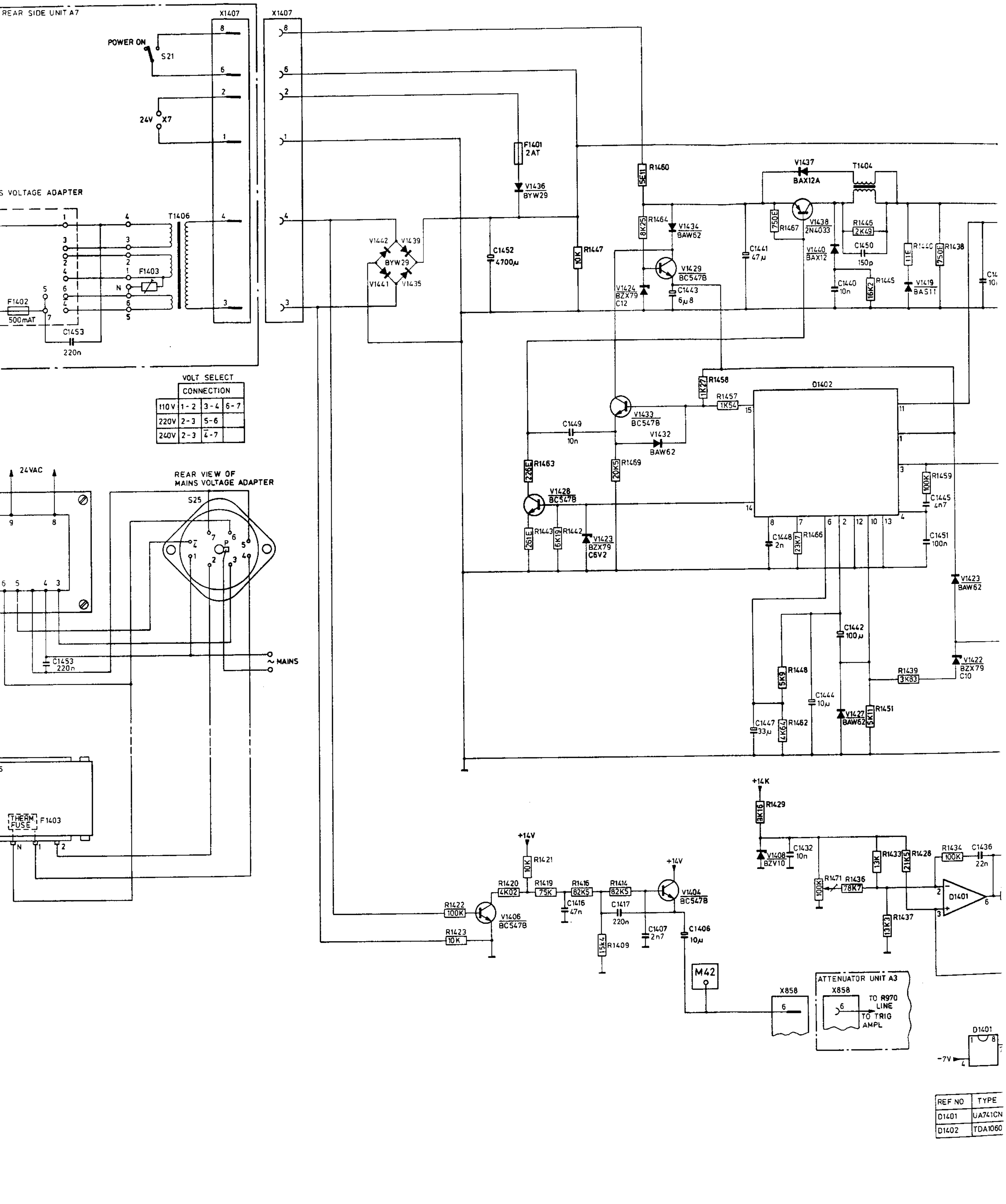
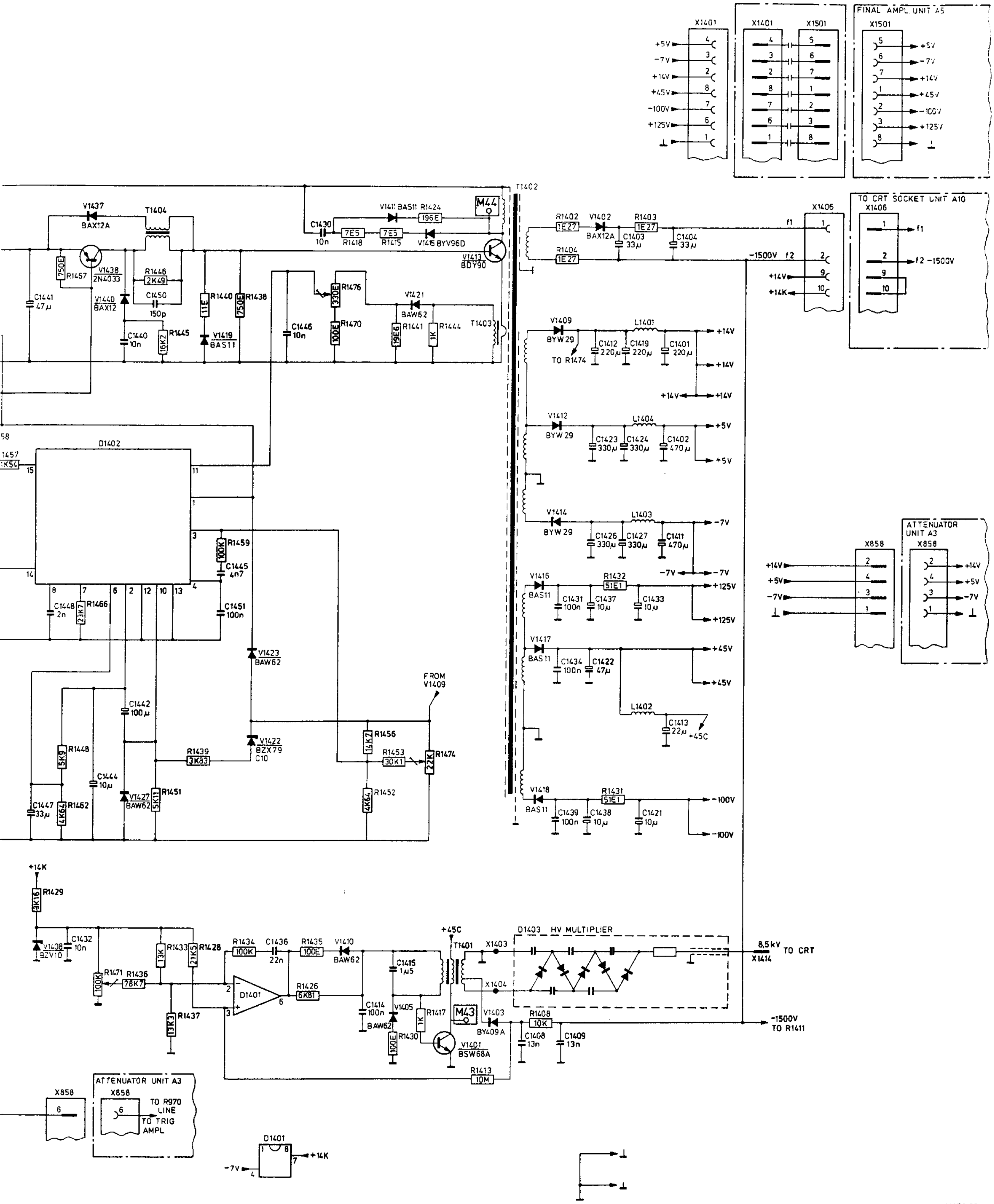


Fig. 8.14. Circuit diagram



REF NO	TYPE
D1401	UA741CN
D1402	TDA1060

MAT2138
851108

Fig. 8.14. Circuit diagram power supply and H. V. generator.

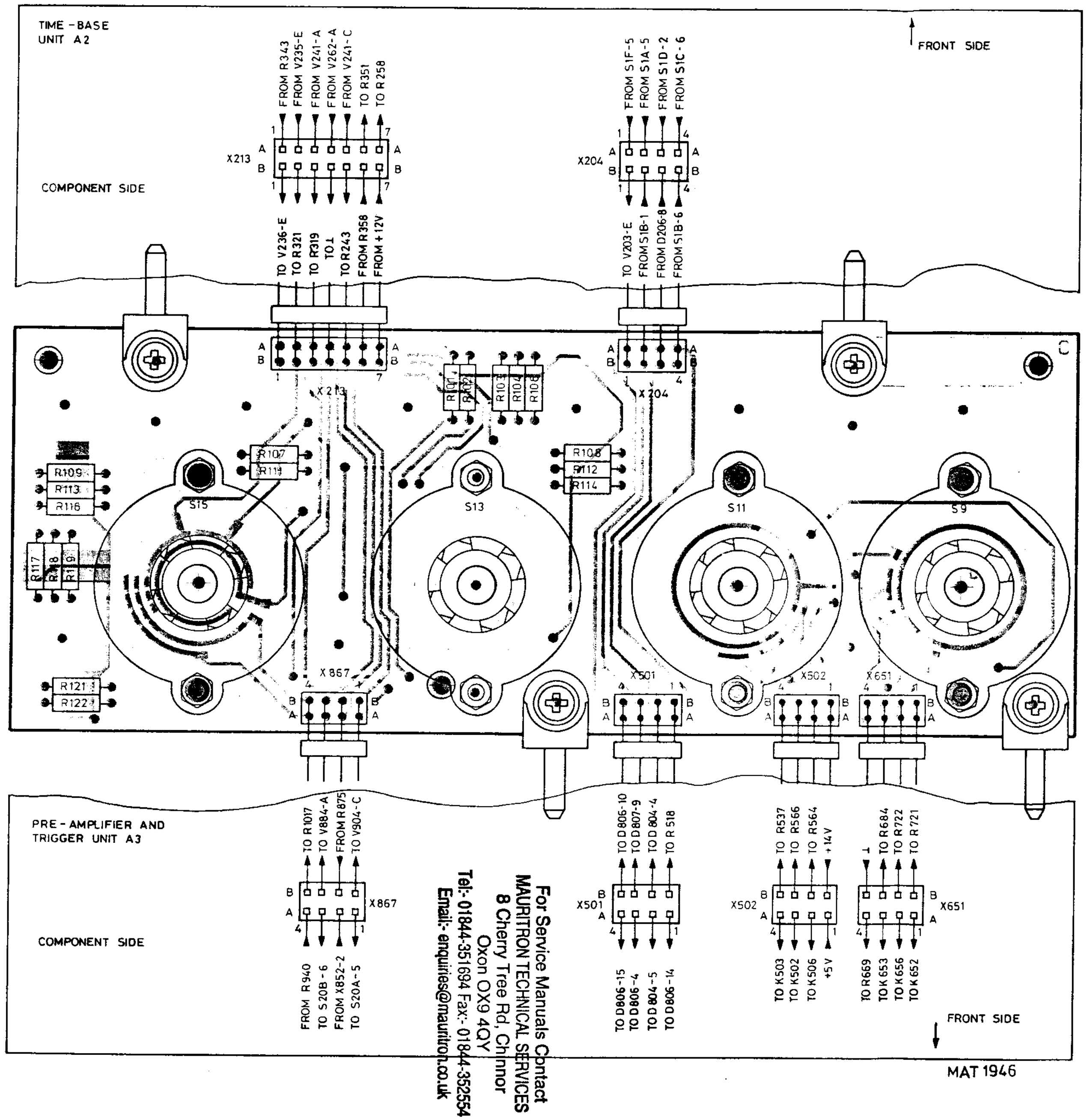


Fig. 8.15. Switch unit p.c.b. A102

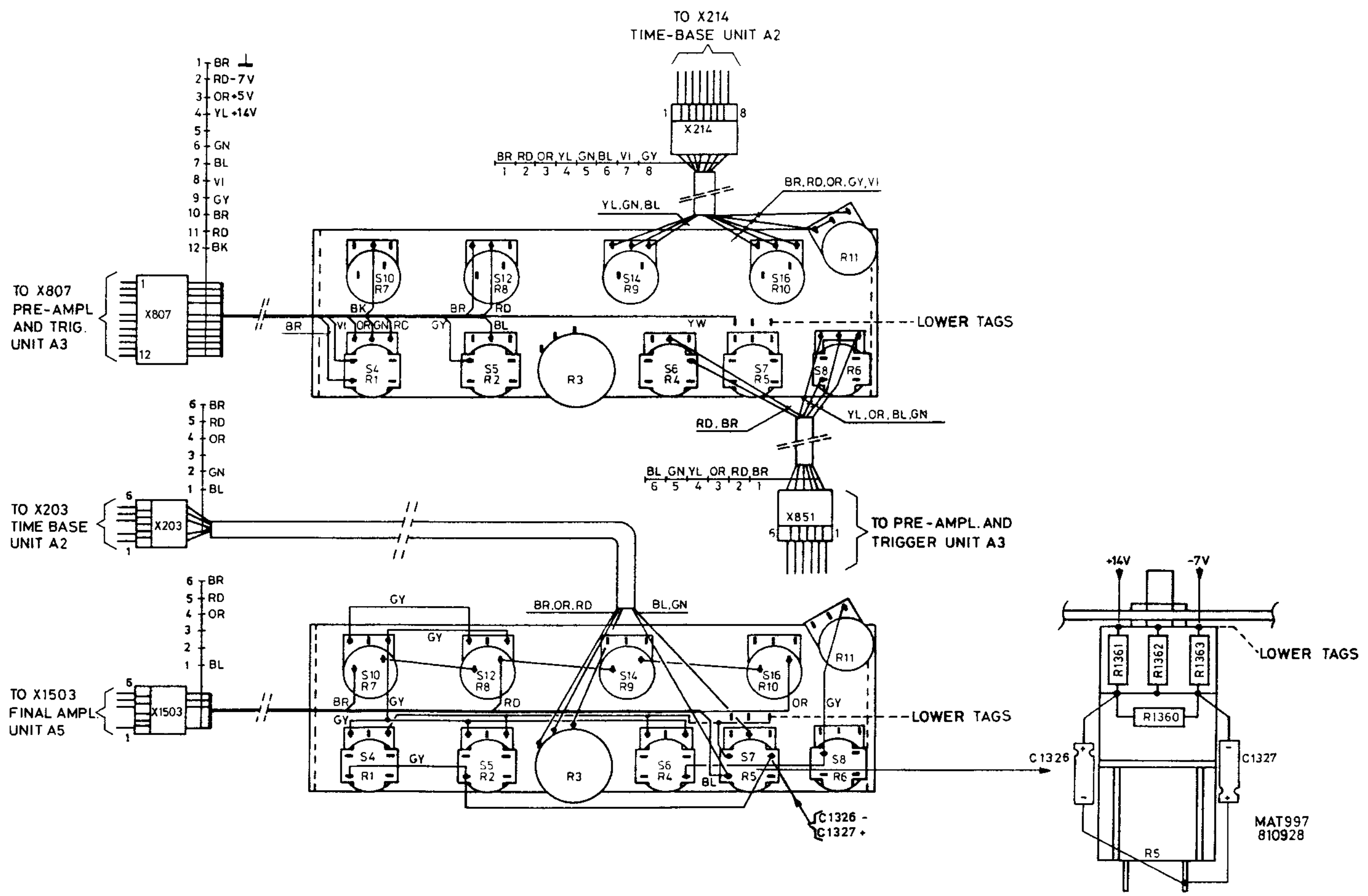


Fig. 8.16. Potentiometer unit A103

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 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 DTB 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

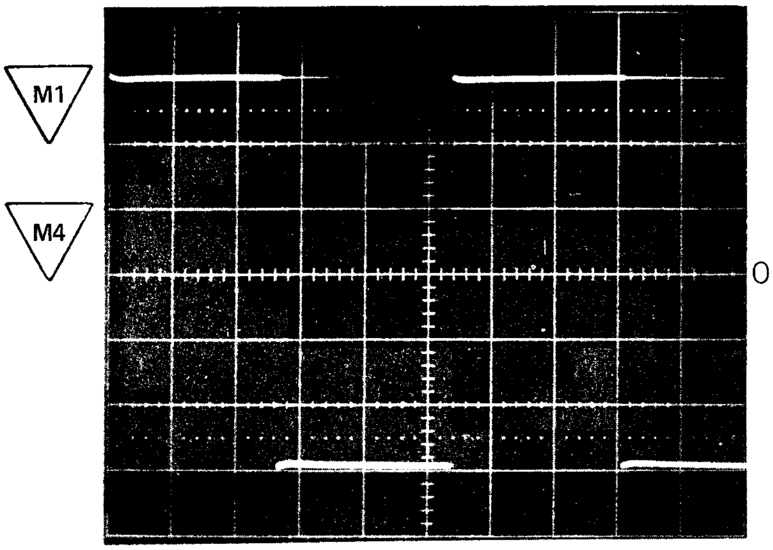
Unit 3: Preamplifier and trigger unit; for measurements on test points M23 ... M29, the trigger source selection unit must be lifted.

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.

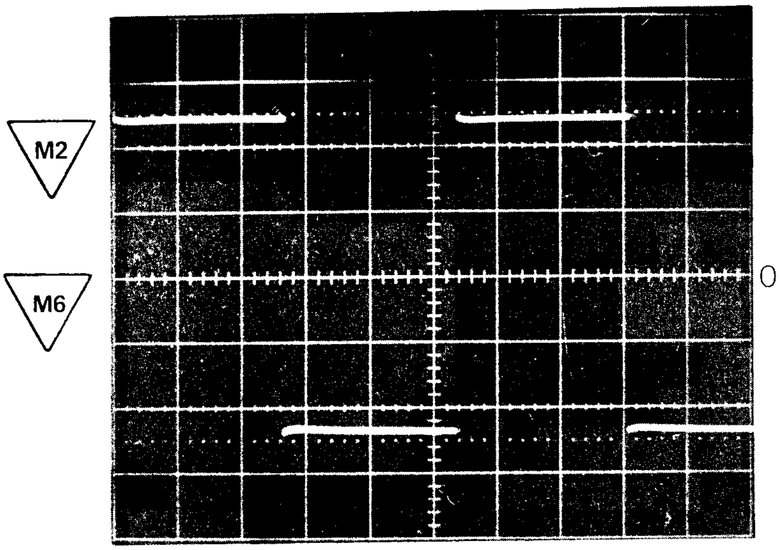
9.2 VERTICAL DEFLECTION AND TRIGGERING

Unit 3



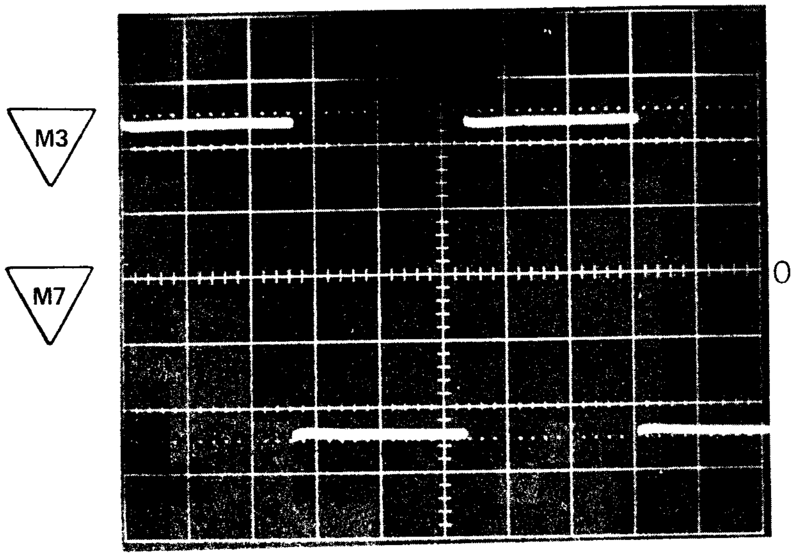
Measuring oscilloscope:
0.1 V/div.
20 μs/div.
DC input coupling

Oscilloscope under test:
M1 = channel A
M4 = channel B



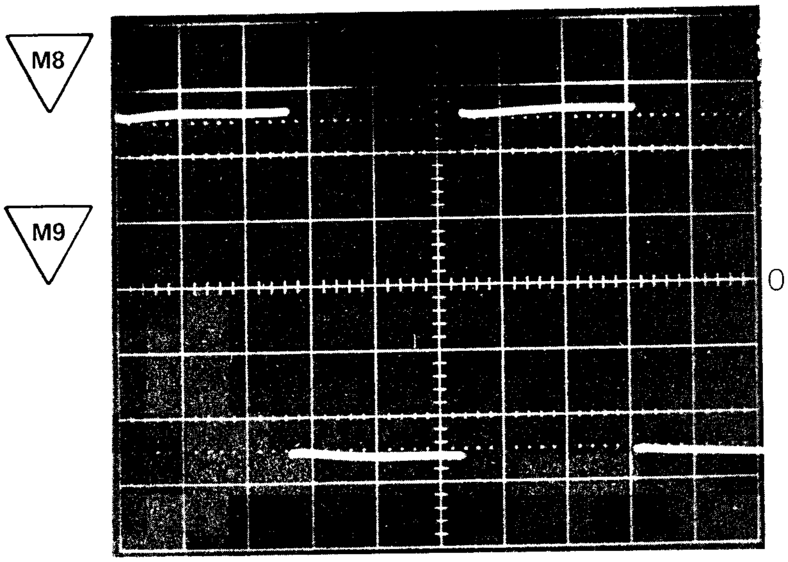
Measuring oscilloscope:
10 mV/div.
20 μs/div.
DC input coupling

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



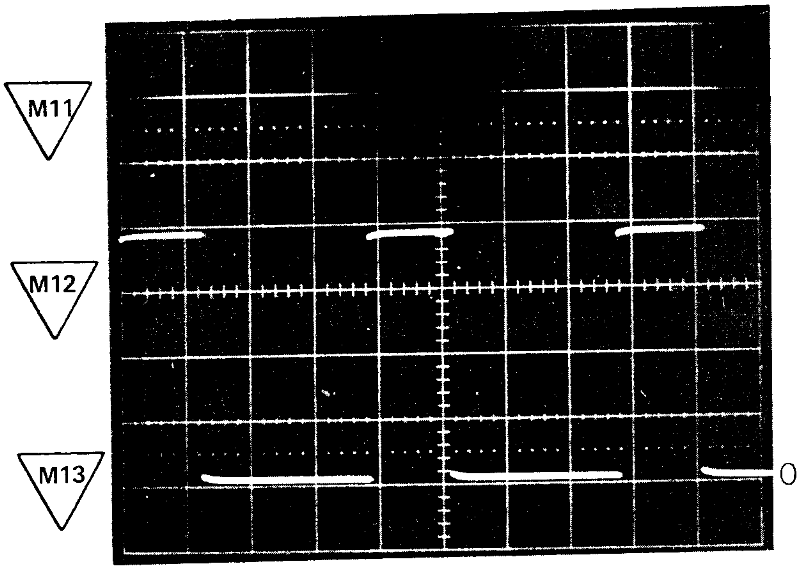
Measuring oscilloscope:
2 mV/div.
20 μs/div.
DC input coupling

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



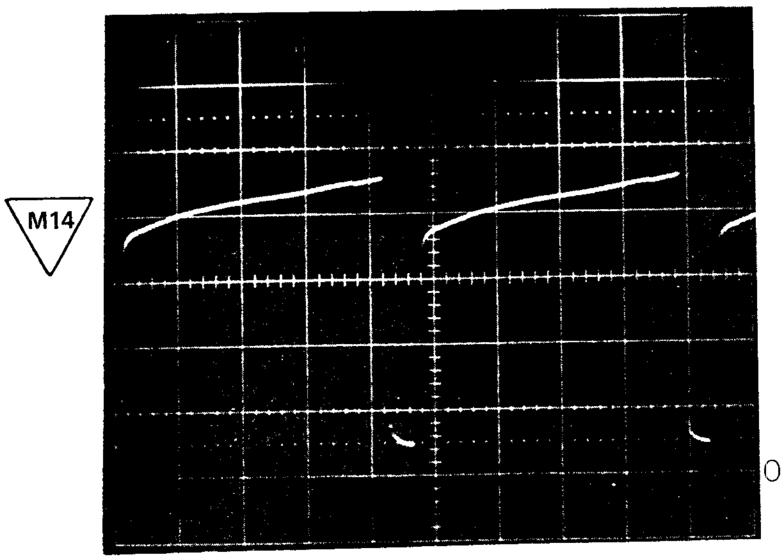
Measuring oscilloscope:
5 mV/div.
20 μs/div.
AC input coupling

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



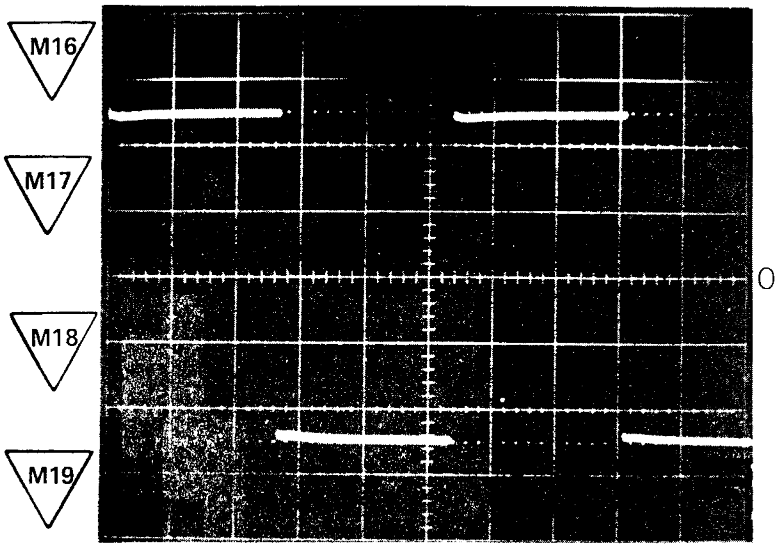
Measuring oscilloscope:
0.1 V/div.
1 ms/div.
DC input coupling

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



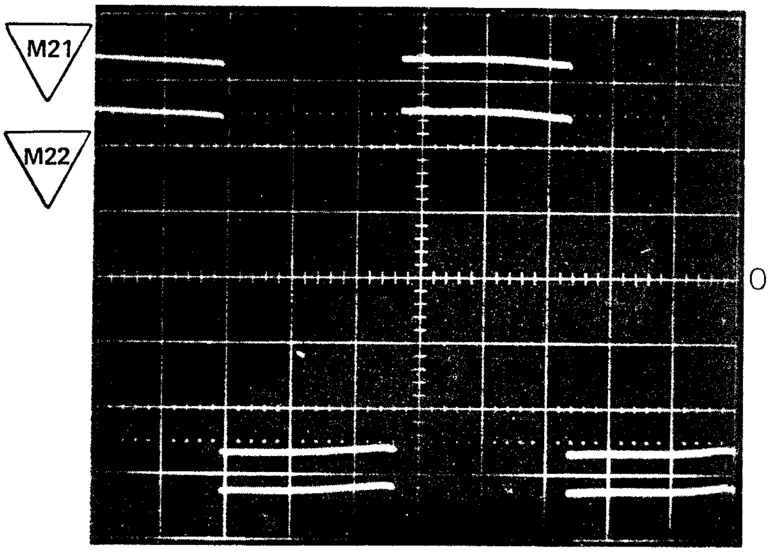
Measuring oscilloscope:
0.1 V/div.
0.2 μs/div.
DC input coupling

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



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

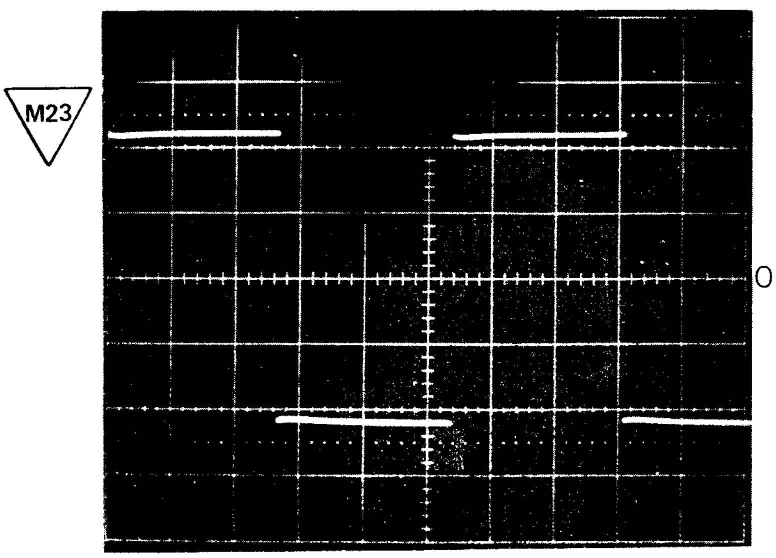
Oscilloscope under test:
M16/M17: MTB triggering on channel A.
M18/M19: MTB triggering on channel B.



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

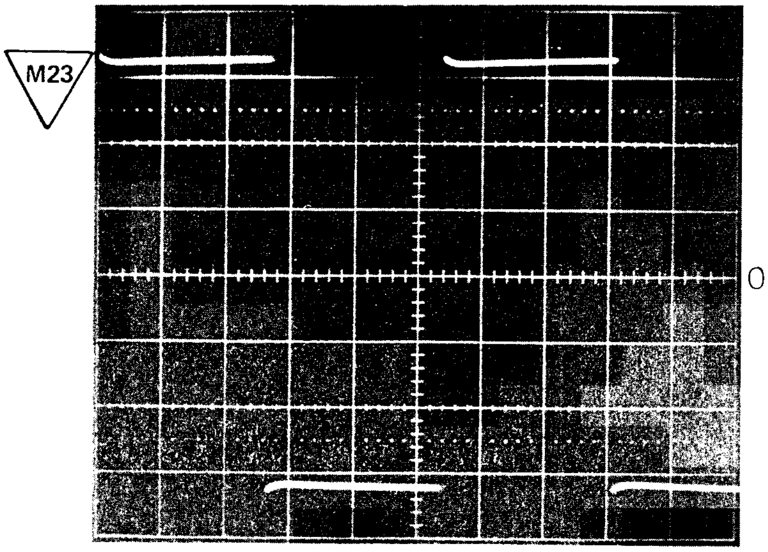
Oscilloscope under test:
MTB triggering via COMP.
Waveform depends on channel A and B position control.
Depress ALT of S1

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



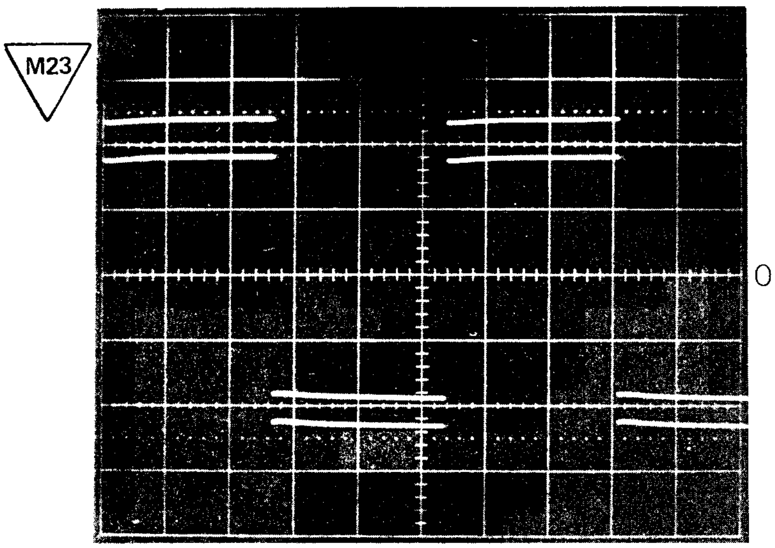
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

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



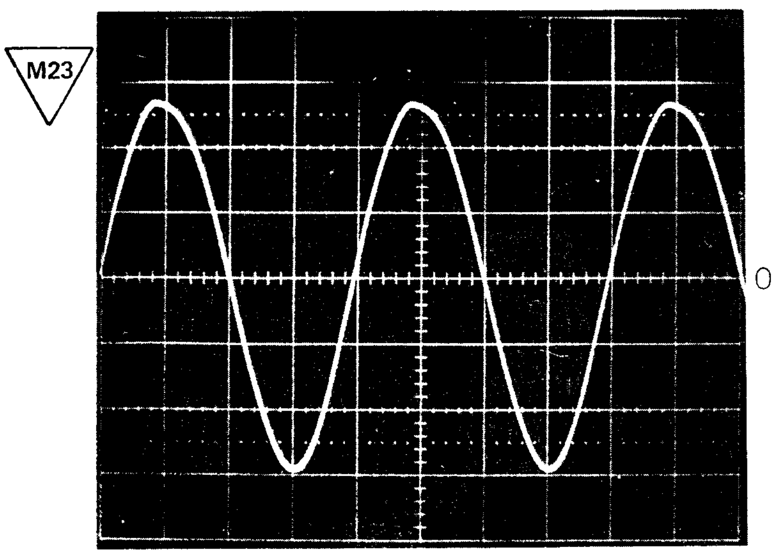
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

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



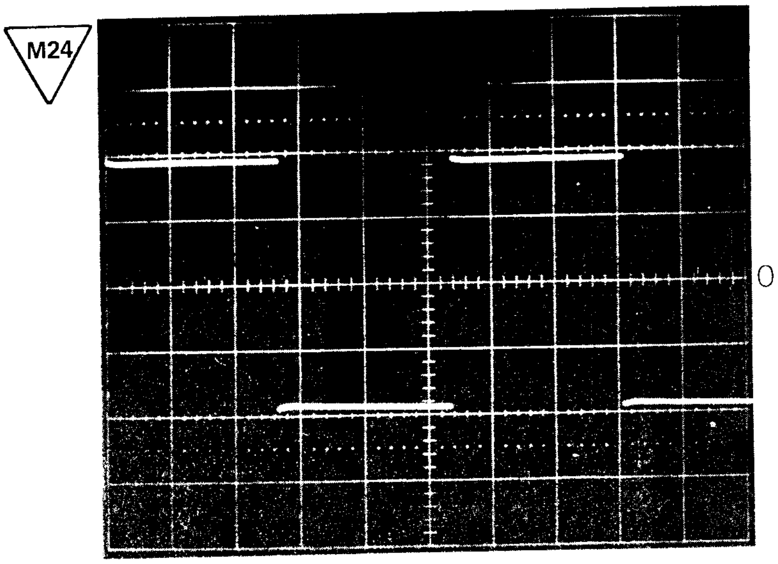
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

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



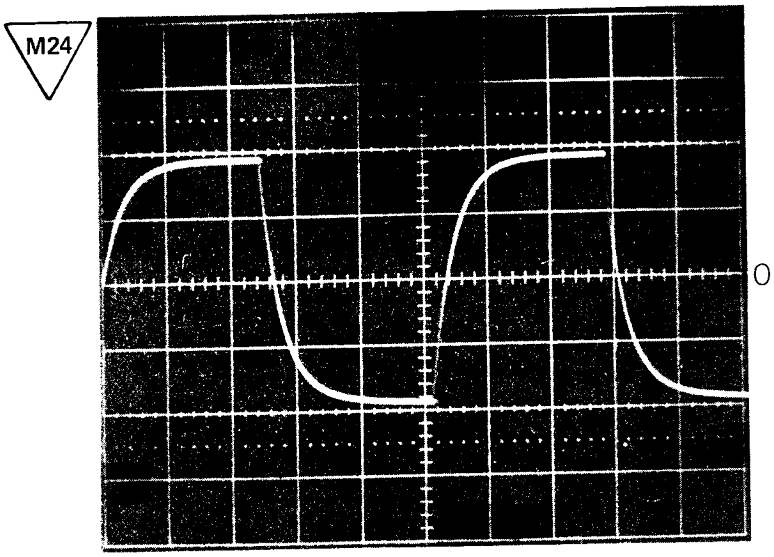
Measuring oscilloscope:
20 mV/div.
5ms/div.
AC input coupling

Oscilloscope under test:
Select MTB triggering via LINE.



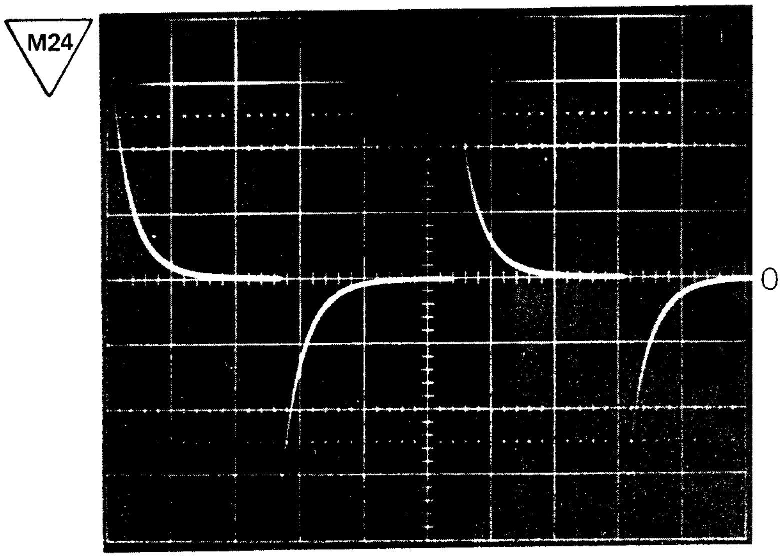
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
DC or TTL trigger coupling of MTB.



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

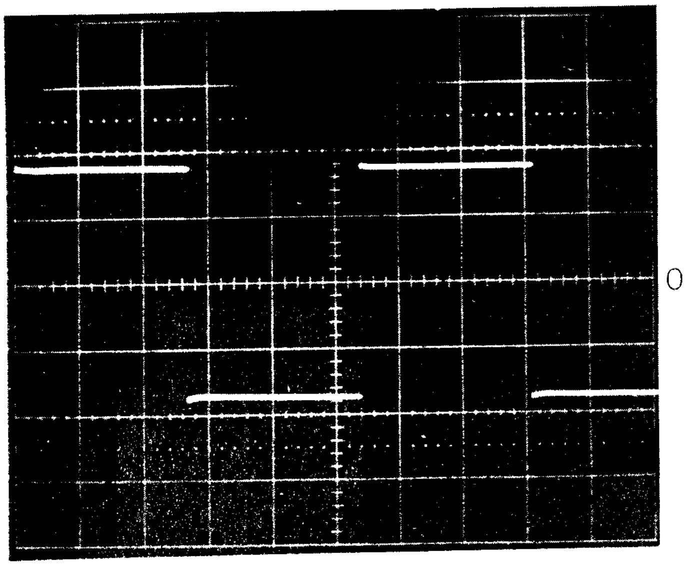
Oscilloscope under test:
LF trigger coupling of MTB.



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

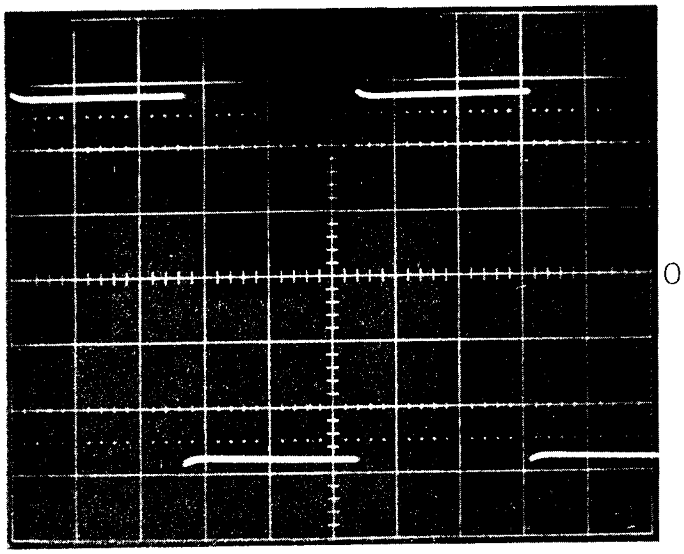
Oscilloscope under test:
HF trigger coupling of MTB.

M26



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

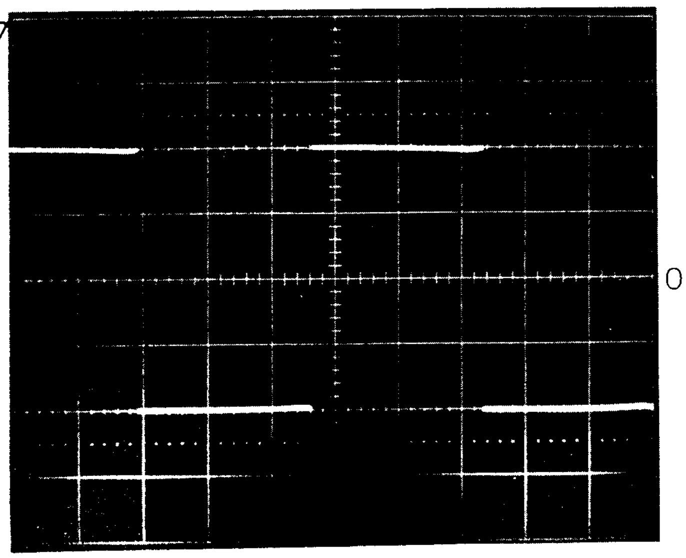
M27



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.

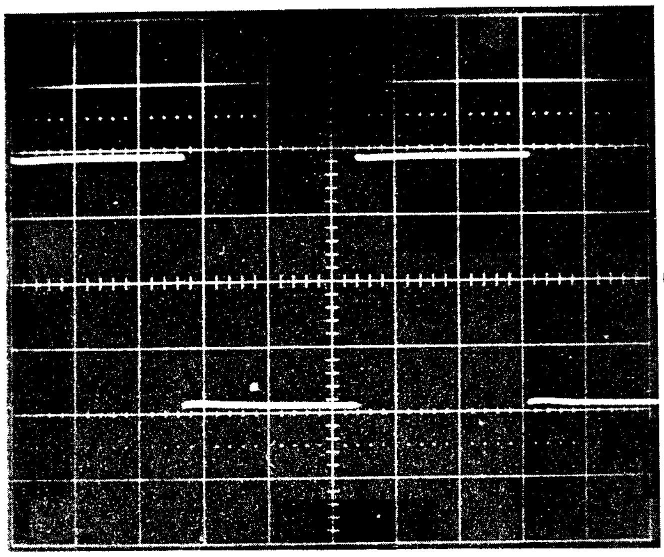
M28



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

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

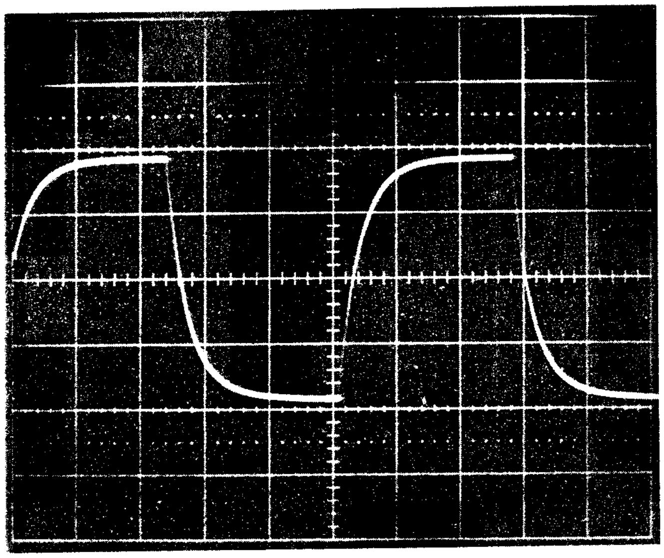
M29



0

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

M29

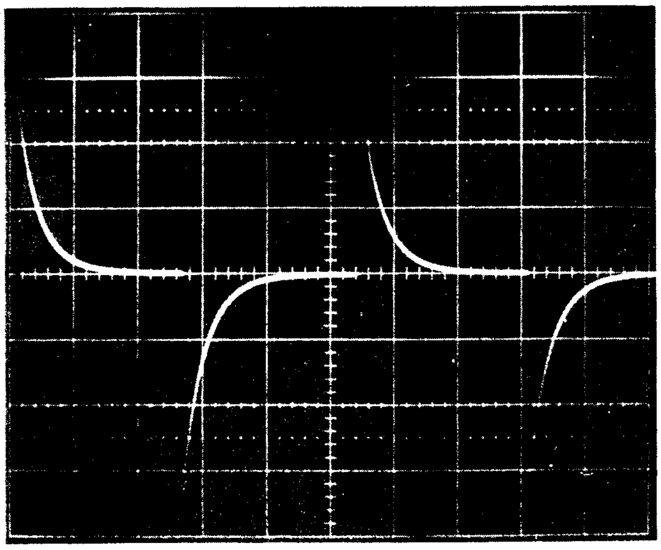


0

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

Oscilloscope under test:
LF trigger coupling of DTB.

M29



0

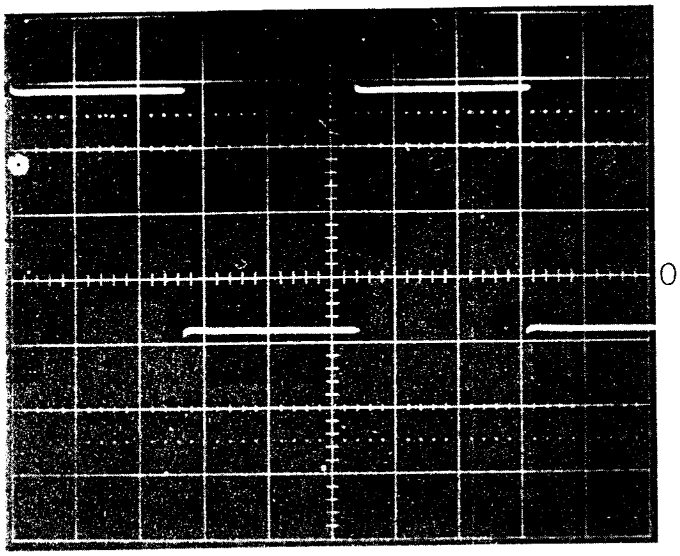
Measuring oscilloscope:
20 mV/div.
20 μs/div.
AC input coupling

Oscilloscope under test:
HF trigger coupling of DTB.

9.3 HORIZONTAL DEFLECTION

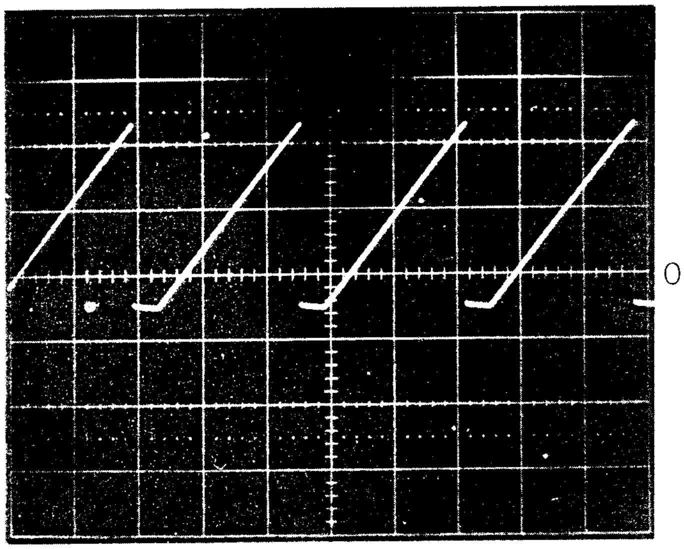
Unit 2

M31



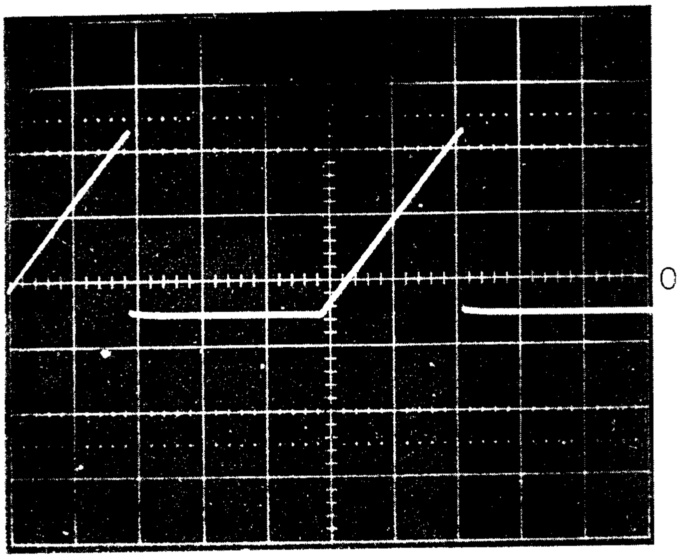
Measuring oscilloscope:
0.1 V/div.
20 μs/div.
DC input coupling

M32



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

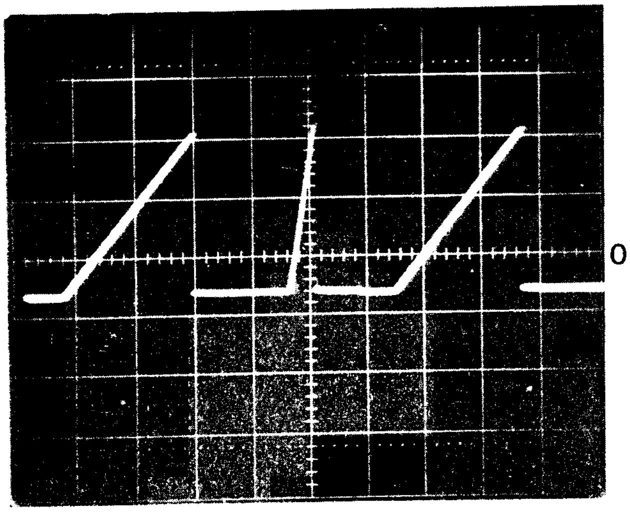
M32



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

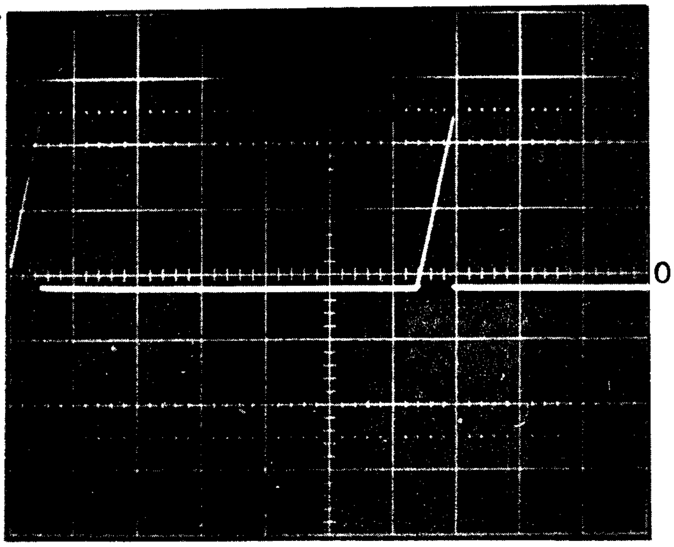
Oscilloscope under test:
Turn the HOLD OFF control fully anti-clockwise.

M32



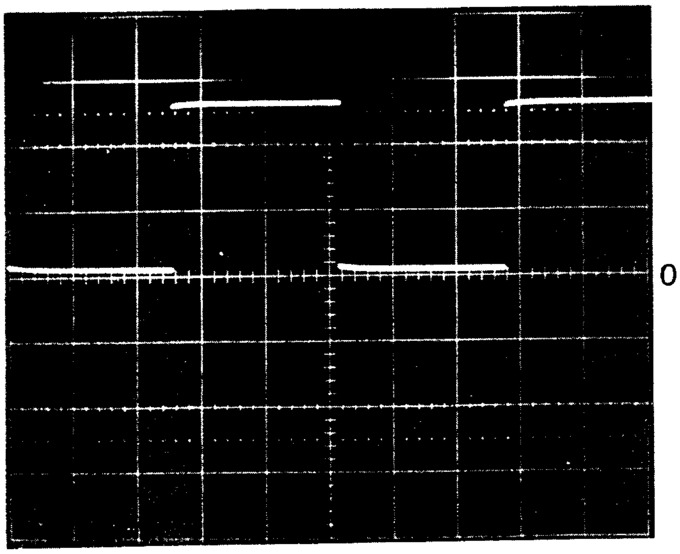
Measuring oscilloscope:
0.2 V/div.
0.5 ms/div.
DC input coupling.
Oscilloscope under test:
Select ALT TB mode (S2).
Adjust the DTB to 20μs/div.
Operate the HOLD OFF control to
avoid "double" triggering.

M33



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

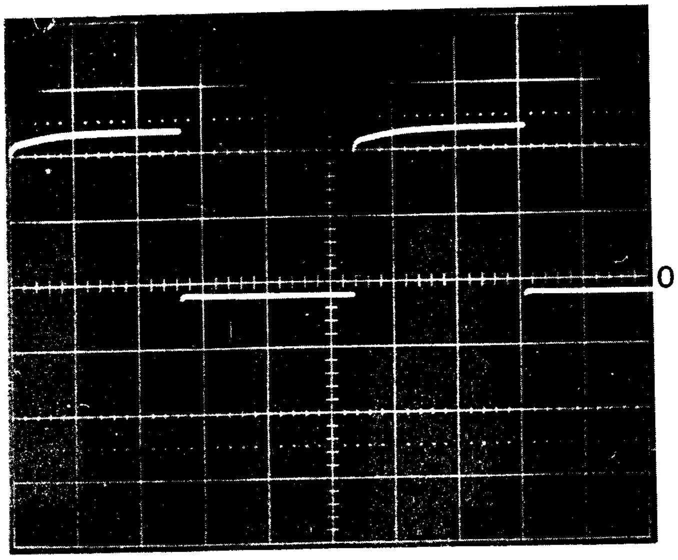
M34



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

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

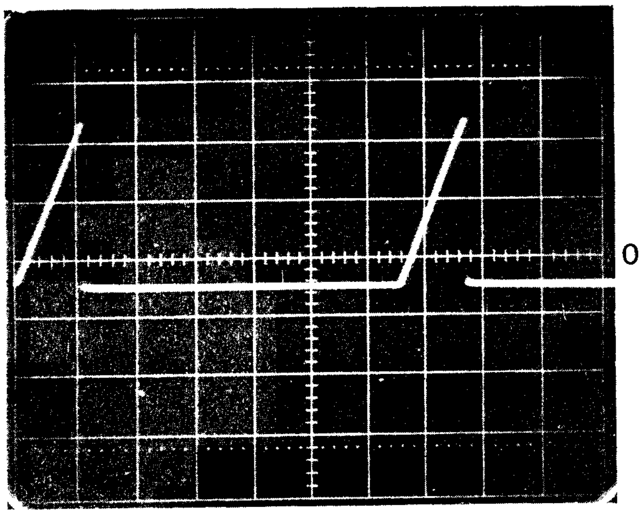
M36



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

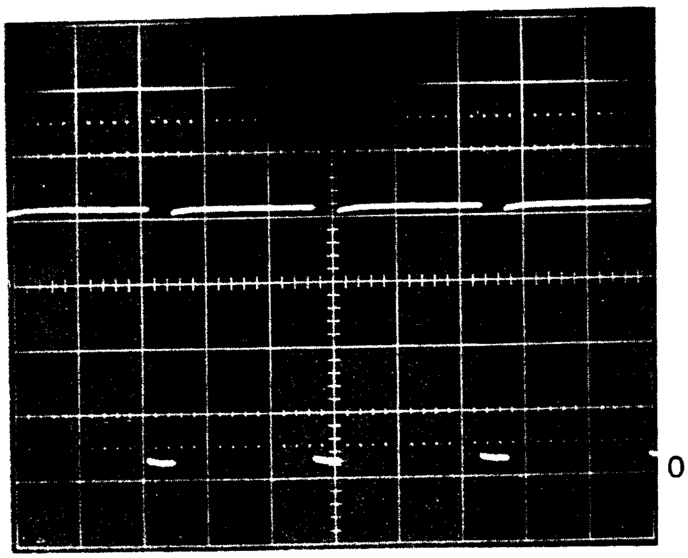
M37



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).

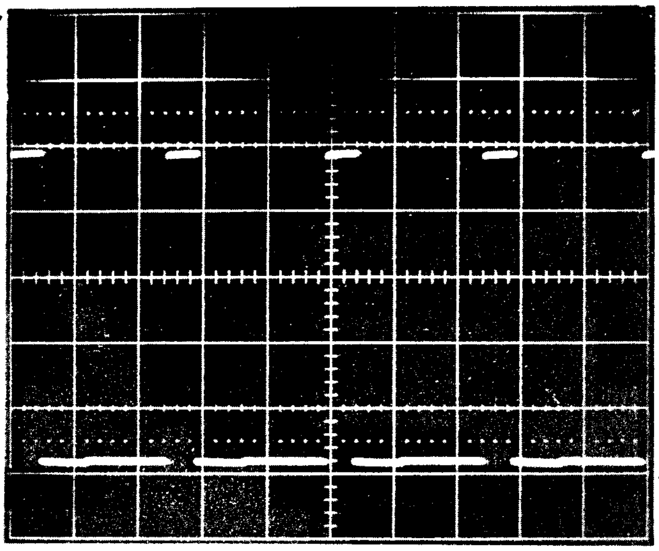
M38



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).

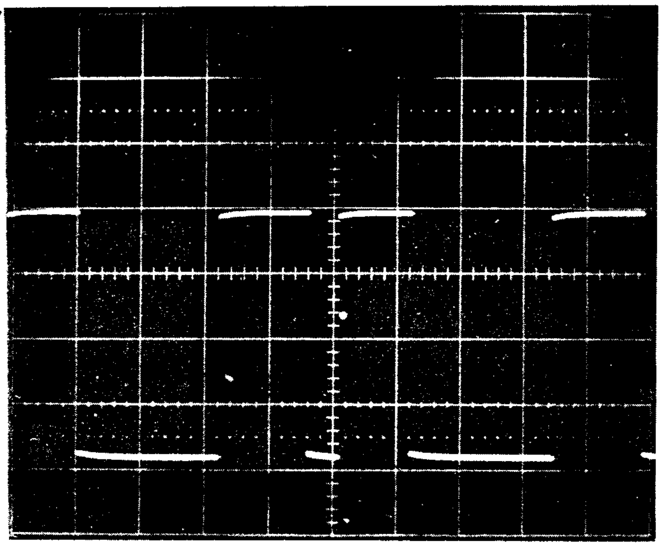
M39



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

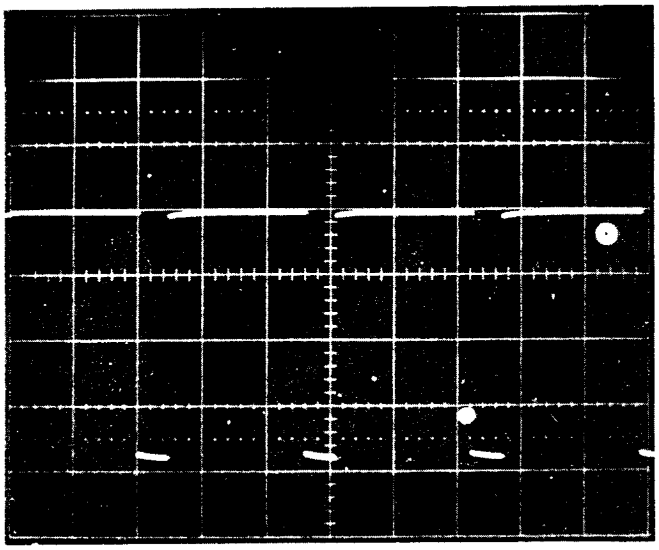
Oscilloscope under test:
Adjust the DTB to 20 μs/div.
Select DTB mode (S2).

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



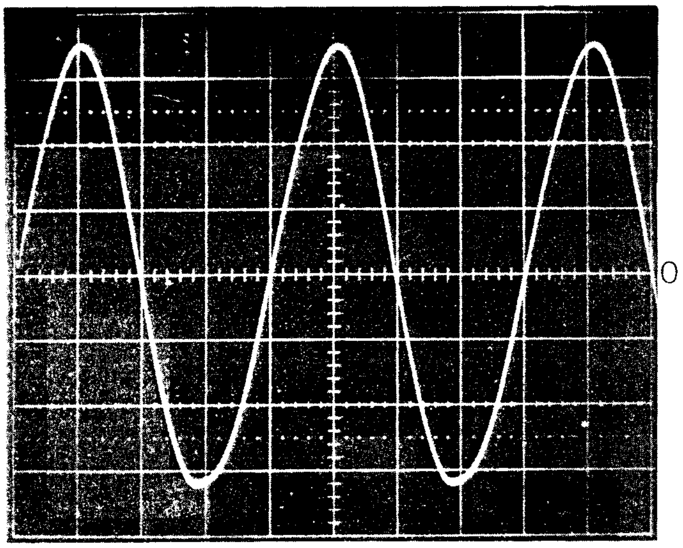
Measuring oscilloscope:
0.1 V/div.
0.5 ms/div.
DC input coupling

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

9.4. POWER SUPPLY

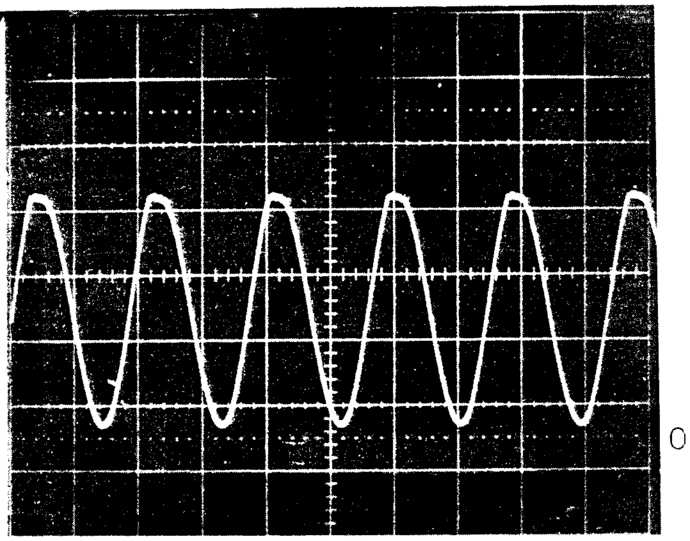
Unit 6

M42



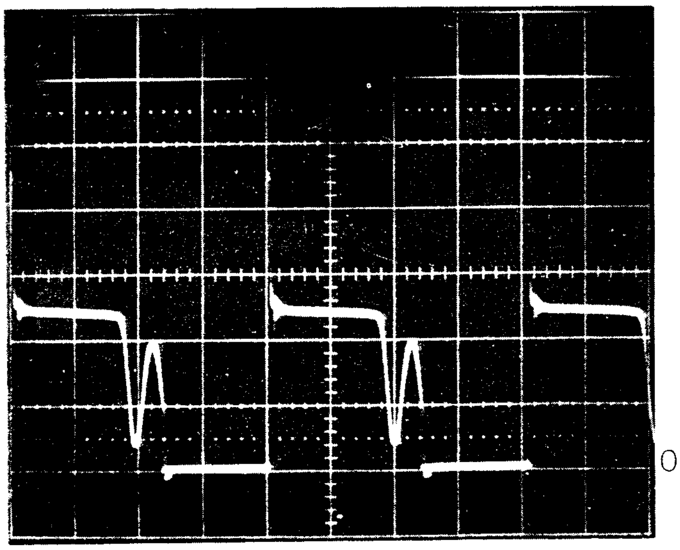
Measuring oscilloscope:
0.1 V/div.
5 ms/div.
DC input coupling

M43



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

M44



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