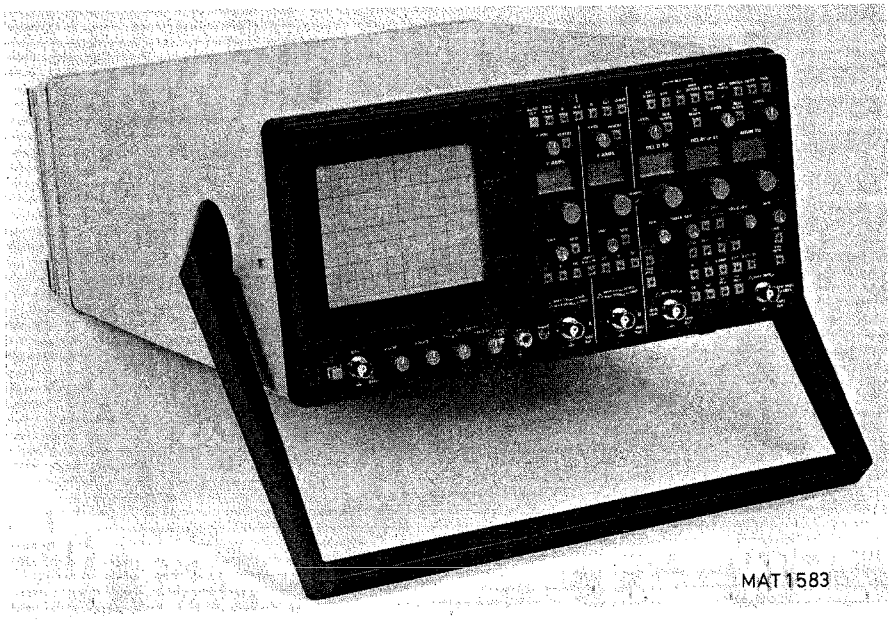
400 MHz VHF Dual Channel, Dual Time Base Oscilloscope

PM3295A - PM3296A

Service Manual

4822 872 05318
870619



WARNING! These servicing instructions are of use by qualified personal only.
To avoid electric shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified do so.

PHILIPS
Industrial &
Electro-acoustic Systems

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.

© N.V. PHILIPS GLOEILAMPENFABRIEKEN-EINDHOVEN-THE NETHERLANDS-1987

PRINTED IN THE NETHERLANDS

CONTENTS

SAFETY INSTRUCTIONS 1

GENERAL INFORMATION 2

INTRODUCTION TO CIRCUIT DESCRIPTION AND DESCRIPTION TO BLOCK DIAGRAM 3

LCD UNIT 4

SWITCH UNIT 5

INTERMEDIATE UNIT 6

CENTRAL PROCESSOR UNIT AND HEF 4094 BUS 7

CRT TEXT UNIT 8

IEEE 488 BUS UNIT 9

VERTICAL ATTENUATOR UNIT 10

EXTERNAL TRIGGER INPUT UNIT 11

ADAPTATION UNIT 12

SIGNAL UNIT 13

FINAL Y AMPLIFIER 14

TIME BASE UNIT 15

FINAL X/Z AMPLIFIER 16

CRT SOCKET 17

PRIMARY CONVERTER UNIT 18

SECONDARY CONVERTER UNIT 19

HIGH VOLTAGE CONVERTER UNIT 20

MOTHERBOARD 21

CRT CONTROLS UNIT AND I.R.-RECEIVER 22

PERFORMANCE CHECK 23

DISMANTLING THE INSTRUMENT 24

CHECKING AND ADJUSTING 25

CORRECTIVE MAINTENANCE AND DESCRIPTION OF SERVICE DIAGNOSTICS 26

SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT 27

PARTS LISTS 28

ACCESSORY INFORMATION 29

1

SAFETY INSTRUCTIONS 1

CONTENTS

1. SAFETY INSTRUCTIONS 1-1
1.1 Introduction 1-1
1.2 Safety precautions 1-1
1.3 Caution and warning statements 1-1
1.4 Symbols 1-1
1.5 Impaired safety protection 1-2
1.6 General clauses 1-2
1.7 CRT replacement 1-2

1. SAFETY INSTRUCTIONS

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

1.1. INTRODUCTION

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.

1.2. 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.

1.3. 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 in order to prevent personal injury.

1.4. SYMBOLS

High voltage $\geq$ 1000 V (red)

Live part (black/yellow)

Read the operating instructions.

Protective earth (grounding) terminal (black)

1.5. 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.

1.6. GENERAL CLAUSES

1.6.1. 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.

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

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

1.6.4. WARNING: 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.

1.6.5. 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 27).

1.6.6. After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in Section 27 have to be performed.

1.7. WARNING IN CASE OF CRT REPLACEMENT
X rays originating in this instrument have been sufficiently screened.
Maximum acceleration voltage 25.4 kV.
The screening is obtained by the construction of the C.R.T. In case the C.R.T. needs to be replaced, make sure it is replaced by the same Philips type D14-401 ../... only.
This repair has to be carried out by a qualified technician.

GENERAL INFORMATION 2

CONTENTS

2. GENERAL INFORMATION 2-1
2.1 Introduction to the V.H.F. oscilloscope 2-1
2.2 Characteristics 2-2

FIGURES

2.1 400 MHz V.H.F. oscilloscope 2-1
2.2 Input resistance R par. and capacitance C par. versus frequency 2-27
2.3 Maximum input voltage (peak to peak) derating versus frequency 2-27

2. GENERAL INFORMATION

2.1. INTRODUCTION TO THE V.H.F. OSCILLOSCOPE FAMILY.

This compact V.H.F. oscilloscope features an extensive bandwidth of 400 MHz and good ergonomic design for its numerous measurement capabilities. A unique feature is the AUTO SET pushbutton facility, which automatically sets various controls of the instrument to suit the input signal value. In this way, optimum ease of operation is obtained as the input signal immediately presents a correct, stable display on the bright c.r.t. screen.

The microprocessor-controlled front panel gives a wide choice of display possibilities.

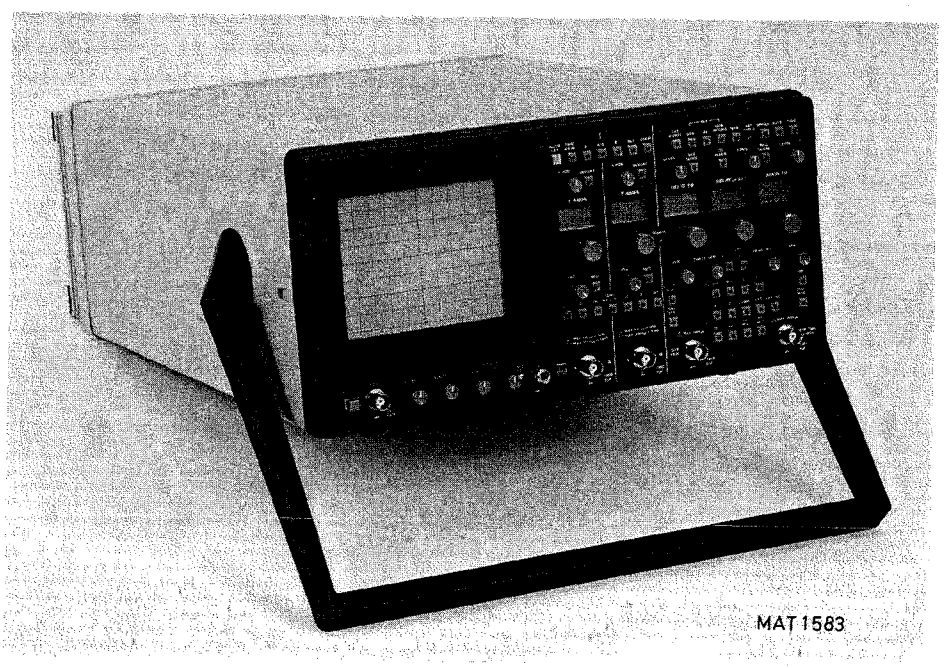


Fig. 2.1. 400 MHz V.H.F. oscilloscope.

The oscilloscope is provided with integrated circuits (including thin-film circuits), which guarantee highly-stable operation.

Furthermore, connection to the local mains is simplified by a tapless switched-mode power supply that covers most voltage ranges in use: 90 V . . . 264 V a.c.

All these features make this oscilloscope suitable for a wide range of measuring applications.

2

2.2 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).
- For definitions of terms, reference is made to IEC Publication 351-1.

B. Safety Characteristics

This apparatus has been designed and tested in accordance with: Safety Class I requirements of IEC Publication 348 Safety Requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B.

The instrument has been supplied in a safe condition

C. Initial Characteristics

Height Without Feat and Accessory Pouch	170 mm (6,7 in)	Add 10 mm (0,4 in) for feet
Feet and accessory pouch included	240 mm (9,4 in)	
Width	340 mm (13,4 in)	Add 46 mm (1,8 in) for handle
Depth Handle Excluded	523 mm (20,6 in)	Add 35 mm (1,4 in) for protective front cover.
With Extended handle	625 mm (24,6 in)	
Mass	13,9 kg (30,7 lb)	

- Operating positions:
  a) Horizontally on bottom feet
  b) Vertically on rear feet
  c) On the carrying handle in three sloping positions= 12°, 20° and 25°

D. CONTENTS

2.2.1. Display
2.2.2. Vertical channel or Y-axis
2.2.3. Channel A and B
2.2.4. Trigger view
2.2.5. Horizontal deflection or X-axis
2.2.6. Main time-base
2.2.7. Delayed time-base

2.2.8. Main time-base triggering
2.2.9. Delayed time-base triggering
2.2.10. Blanking or Z-axis
2.2.11. Auto setting
2.2.12. Cursors
2.2.13. CRT text
2.2.14. Calibrator
2.2.15. Power supply
2.2.16. Sundries
2.2.17. Environmental characteristics
2.2.18. Safety
2.2.19. Accesories
2.2.20. Settings memory (Only for PM 3296A)

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
2.2.1.	DISPLAY Cathode Ray Tube		140mm Rectangular single beam tube with helical vertical deflection system.
	Measuring Area (h. x w.)	80mm x 100mm	8 divisions x 10 divisions
	Screen type: (basic version) (optional)	GH (P31) GM (P7) BE (P11)	
	Total Acceleration Voltage:	24kV	
	Max. Writing Speed		Measured in central 5 div x 5 div of screen; in absence of contrast filter.
	(photographic)	typical 4cm/ns	Single Shot; Phosphor: GH; no prefogging; Lens aperture F:1,2; object to image ratio 1:0,5; Film: Polaroid type 612 (20 000 ASA).
	Graticule	internal, fixed	
	- Illumination	continuously variable	

2

- Engravings: division lines	At 1cm	Horizontal and vertical.
tick marks	At 2mm	On vert. and hor. central axes and on hor. lines at 2cm and 6cm from top.
dots	At 2mm	On dotted lines at 1,5cm and 6,5cm from top.
percentages	100, 90, 10, 0%	To facilitate rise and fall time measurements.

2.2.2. VERTICAL DEFLECTION OR Y-AXIS

Deflection Sources	Ch.A; Ch.B; Ch.A and Ch.B added	Both channels can be inverted, (allowing for A-B and B-A in added position).
	Trigger View (MTB)	
Deflection Modes:	1 Channel only; Alternate; Chopped	Any combination of sources.
- Display Time	350ns	Each source (in chopped mode).
- Display Blanking	150ns	After each display time (in chopped mode).
Visual Signal Delay	20ns (typical)	At Maximum intensity and well focused display.

Delay Difference		
between Ch.A or B and ext. Trigg. View	typ 2ns	Trigger View delayed with resp. to Ch. A or B.
Channel Isolation: of Deselected Channel	100:1	At 100MHz; input to deselected channel equivalent to 8 divisions or less.
between Selected Channels	50:1	At 400MHz; channels with equal V/div settings; input to either channel equivalent to 8 division or less
Y-Signal Output:		Available at BNC on rear of instrument. Y Signal Output is not affected by BW limiter.
- Source	=DTB Trigger Source	
- Coupling	= DTB Trigger Coupling	Ch.A or Ch.B coupling eventually cascaded with DTB trigger coupling
- Voltage into 1M.Ohm	20mV/div + or - 10%	Max. output + or - 80mV (160mV peak to peak).
into 50 Ohm	10mV/DIV +or -10%	Max. output + or - 40mV (80mV peak to peak).
- Freq. response	d.c...typical 300MHz (-3dB)	Terminated with 50 Ohm. At reference temperature. For influence of Trigger Coupling see 2.2.9.

2.2.3. CHANNELS A AND B

Input connector	BNC with Probe Read Out Ring	Probe Read Out causes instrument to change V/div Indication, Input Impedance and Attenuator Setting according to probe (when fitted with a Probe Indicator)

2

Input impedance (in High Z position):		For Frequency >1MHz see Fig.2.2
R parallel	1M.Ohm +or- 1%	In DC position of Input Coupling. In AC pos. of Input Coupling: 18 nF in Series with R. par & C. par; in 0 position of input coupling: R par.= infinite
C parallel	9pF	
Max. input Cap. Difference	1,5pF	Difference between Channel A, Channel B, EXT MTB Trigger and EXT DTB Trigger Inputs.
Input Impedance (in 50 Ohm position):R parallel	50 Ohm + or - 1%	In DC, AC and 0 position of input coupling.
VSWR (typical)	1,3:1	At 400MHz in AC and DC pos. of input coupling
Input Coupling	d.c.; a.c.; 0	In 0 position: channel disconnected from input BNC and connected to ground.
⚠ Max. Input Voltage :		Apparatus should be properly grounded through the protective-ground conductor of the power cord
- In High Z position (d.c. + a.c. pk.)	300V	Up to 1MHz; for >1MHz see Fig. 2.3.
- In 50 Ohm position (d.c.)	5V	Max 50mJ during any 100ms interval.
(a.c. r.m.s.)	5V	
(a.c. peak)	50V	
Deflection coefficient - Steps	1mV...5V/div	In a 1-2-5 sequence of 12 steps;
- Error limit (Ambient: 5...40°C)	+or- 2%	Add 1 % for Ambient: 0...50°C (When Channel is used for X deflection: see 2.2.5, for Trigger View: see 2.2.4.
- Vernier Ratio	1:2,5	Uncalibr.; continuously variable between steps.

Dynamic Range:		When used for Y defl. (for X defl. see 2.2.5.) Compression at limits of dynamic range: 7%
- up to 100MHz in CAL position of vernier	24div but max. 100V	Centered around Hor. Centre line on screen
Vernier in 1:2,5 position	20div but max. 100V	
- up to 350MHz (-3dB)	8 div	
LF Linearity:		Within boundaries of dynamic range. Measured at 50kHz.
Max. Compression or Expansion	0,1 div on 2 div	2 div center screen signal shifted within boundaries of graticule.
Shift Range	+ or - 8 div	From screen center; (for X defl. see 2.2.5.)
Frequency Response (in 50 Ohm position):		When used for Y defl. (for X defl. see 2.2.5.) Z source: 50 Ohm.
- Lower Transition Point of BW	d.c. 10Hz or less (-3dB)	Input Coupling in DC position. Input Coupling in AC position.
- Upper Transition Point of BW		1mV and 2mV/div positions excluded (see 2.2.3.)
(Ambient:15...35°C)	400MHz (-3dB)	
(Ambient:5...40°C)	350MHz (-3dB)	
Freq. Resp. (in Hi.Z pos. through probe):		When used for Y defl. (for X defl. see 2.2.5. Z source: 25 Ohm. (Probe according to 2.2.19.)
- Lower transition Point of BW	d.c. 1Hz or less (-3dB)	Input Coupling in DC position. Input Coupling in AC position.
- Upper Transition Point of BW		1mV and 2mV/div positions excluded (see 2.2.3.).
(Ambient:15...35°C)	400MHz (-3dB)	
(Ambient:5...40°C)	350MHz (-3dB)	
Freq. Resp. (in 1mV and 2mV/div pos.):		When used for Y defl. (for X defl. see 2.2.5.).
Upper Transition Point of BW	70MHz (-3dB)	Typical value at 25°C

2

Bandwidth Limiter: - Starting point of HF rejection	20Mhz (-3dB)	
- Slope	6dB/octave	
Pulse Response (in 50 Ohm position):		When used for Y deflection; Z source: 50 Ohm. Measured over central 6 div.
- Rise Time (Ambient:15...35°C) (Ambient:5...40°C)	 0,88ns or less 1ns or less	1mV and 2mV/div excluded, (see 2.2.3.) (Calculated from Bandwidth x Rise Time = 0,35)
- Pulse Aberrations: (ambient:5...40°C) Overshoot	 5% or less	Tested with a 1ns Rise Time pulse at 20mV/div. Add 2% for ambient:0...50°C
Tilt	2% or less	Effects of AC pos. of input coupling excluded.
- Pulse response (in Hi.Z pos. through probe)		When used for Y defl: Z source 25 Ohm. Measured over central 6 divisions
- Rise Time (Ambient:15...35°C) (Ambient:5...40°C)	 0,88ns or less 1ns or less	1mV and 2mV/div excluded, see 2.2.3. (Calculated from Bandwidth x Rise Time = 0,35).
- Pulse Aberrations:		Tested with a 1ns Rise Time pulse
overshoot	6% or less	
Rise Time (in 1mV and 2mV/div pos.)	5ns or less	When used for Y defl. Measured over central 6 divisions.

Max. Base Line Instability:		
Jump		
- between any V/div positions	0,2 div or 1 mV	Wichever is greater
Common Mode Rejection Ratio:		Both channels at same attenuator setting; vernier of V/div setting adjusted for best CMMR; measured with max. 8 div input at each channel, (+ or - 4div around zero).
- at 1MHz	100:1	
- at 50MHz	20:1	

2.2.4. TRIGGER VIEW

Signal Source	= Trigger Source MTB	COMPosite = Channel A, unless only Channel B is displayed.
Deflection coefficient:		
Ch.A or Ch.B	see 2.2.3.	Except error limit.
EXT	100mV/div	
EXT:10	1V/div	
Error Limit	+ or - 5%	For all sources except LINE
Dynamic Range:		Compression at limits of Dynamic Range: 7%
up to 100MHz	24div	

2

Line deflection	6 div or more	Trigger Source: LINE; 49Hz<Line Freq.<61Hz
Frequency response:		Trigger coupling: DC, HF REJection: OFF, Bandwidth Limiter: OFF.
Trigger source: INT		
(Ambient:15...35°C)	d.c...350MHz (-3dB)	Channel A or B in 50 Ohm position. Z of Signal Source:
(Ambient:5...40°C)	d.c...300MHz	50 Ohm. (-3dB)
Trigger source:EXT		
(Ambient:15...35°C)	d.c...370MHz (-3dB)	Z of Signal Source: 25 Ohm.
(Ambient:5...40°C)	d.c...350MHz (-3dB)	
Pulse Response		Trigg. Coupling: DC, HF REJection: OFF, Band Width Limiter: OFF Distortion due to peak to peak leveling may be visible, when in AUTO position of trigger selector and at trigger frequencies <100Hz.
Rise Time		(Calculated from Bandwidth x Rise Time = 0,35).
Trigger source: INT		Z of Signal Source: 50 Ohm
(Ambient:15...35°C)	1ns	
(Ambient:5...40°C)	1,17ns	
Trigger source: EXT		Z of Signal Source: 25 Ohm
(Ambient:15...35°C)	0,95ns	
(Ambient:5...40°C)	1ns	
Trigger Point	center of screen	Measured at 50kHz.

2.2.5. HORIZONTAL DEFLECTION OR X-AXIS

Deflection Sources	MTB; MTB intensified by DTB; mono DTB; dual DTB;	Can be displayed alternately in a quasi simultaneous way.

	Ext. through Ch.A; Ext. through Ch.B; Ext. through EXT MTB trigger input; Line	Selected by MTB trigger source selector
Trace Separation:		Between MTB INTENSified and (mono or dual) DTB.
Max. Separation	at least 4 div	Symmetrical: (MTB shifting upwards, DTB downwards).
Minimum Shift Range	+ or - 5 unexpand. div.	From screen center.
Deflection coefficient		
Ch.A or Ch.B	see 2.2.3.	Except error limit
EXT	100mV/div	
EXT:10	1V/div	
Error Limit	+ or - 5%	For all sources except LINE.
Dynamic Range	20 div	Measured at 50kHz; Compression at limits of dynamic range: 6%.
Maximum Linearity Error	5%	Measured at 1KHz
Line Deflection	7 +or- 1,5 div	49Hz<line Frequency<61Hz.
Frequency Response:		
- Lower Transition Point of BW	see appropriate Channel	Input coupling of Ch.A or B and coupling of MTB trigger are cascaded.
- Upper Transition Point of BW	2MHz (-3dB)	
Max. Phase Diff. between Hor. and Vert.	3^{o}	Up to 100kHz
Max. Horizontal Display Instability		
- Drift	0,1 div/h	
- Temp. Coefficient	0.05div/K	

2

2.2.6. MAIN TIME BASE

Modes	repetitive	Auto Bright Base Line occurs, when in AUTO Trigger Mode and if during >0,1s no triggerable signal is available.
	single	
Deflection coefficient		Measured over Central 8 unmagnified divisions
- TB Magnifier: OFF		
Steps	10 ns/div... 1 s/div	In a 1-2-5 sequence of 25 steps
Error Limit (Ambient:5...40°C)	+ or - (0,5% of full scale + 1% of reading)	Add 0,5% of full scale for 10ns/ div...50ns/div Add 0,5 % of full scale for Ambient: 0...50°C
- TB Magnifier: x10		
Steps	1 ns/div... 0,1 s/div	In a 1-2-5 sequence of 25 steps
Error Limit (Ambient:5...40°C)	+ or - (1% of full scale + 1,5% of reading)	Add 0,5 % of full scale for Ambient: 0...50°C
- Vernier Ratio	2,5:1	Uncalibrated, contin. variable between steps.
TB Magnification (Hor. Expansion):	10x	
Max. Expansion Unbalance	+ or - 0,4 unexpand. div	When switching from x10 to x1, the center display will not shift more than stated value.
Minimum Visual Display Length	10 unexpanded div	At Normal Intensity.
Variable Hold Off:		
Minimum	1us or 2 div of MTB setting	Whichever is greater
Maximum	6x minimum Hold Off	
Gate Out:		Available at BNC on rear of instrument.
Output impedance	2,3 k.Ohm	
Time Base not running	0V<Output<0,4V	Maximum Current Sink: 2mA
Time Base running	2,4V<Output<5V	Maximum Current Supply: 400uA.

2.2.7. DELAYED TIME BASE

Modes	Mono DTB;	
	Dual DTB;	DTB is displayed twice (alternately),Delta T being the time difference between both DTB displays.
	DTB starting; DTB triggering on first event	after Delay Time.
Deflection Coefficient		Measured over central 8 unmagnified divisions
- TB Magnifier: OFF		
Steps	10ns/div... 0,5 s/div	In a 1-2-5 sequence of 24 steps
Error Limit (Ambient:5...40°C)	+ or - (0,5% of full scale + 1% of reading)	Add 0,5 % of full scale for 10 ns/div...50 ns/div Add 0,5 % of full scale for Ambient:0...50°C
- TB Magnifier: x10		
Steps	1 ns/div... 50 ms/div	In a 1-2-5 sequence of 24 steps
Error Limit (Ambient:5...40°C)	+ or - (1% of full scale + 1,5% of reading)	Add 0.5 % of full scale for Ambient:0...50°C
- Vernier Ratio	2,5:1	Uncalibrated continuously variable between steps.
TB Magnification (Hor. Expansion):	10x	
Max. Expansion Unbalance	+ or - 0.4 unexpand. div	When switching from x10 to x1, the center display will not shift more than stated value.
Delay Time:	20ns...10s	In 25 steps; continuously variable between steps.
- Error Limit (Ambient:5...40°C)	+ or - (1,2% of full scale + 1% of reading + 12ns)	MTB Vernier in CAL position Add 1 % of full scale for Ambient:0...50°C

2

- Position Range	0,2...9,9 x MTB time/div setting	Minimum delay: 20ns on all ranges
- Resolution	1:65000	Related to full scale of 10 MTB divisions.
- Max. Jitter	0,005%+100ps	(=1 part per 20 000)
Time Difference Delta T:		Dual DTB method.
Range	10ns...10 x MTB time/div setting	
Error Limit (Ambient:5...40°C)	+ or - (0,1 % of full reading + 2ns)	Add 0,05% of full scale for first and last 10% of available scale + 0,5% ofrange Add 0,5% of full scale +1% of reading for ambient:0...50°C
Gate out:		Available at BNC on rear of instrument.
- Output impedance	2,3 k.Ohm	
- Time Base not running	0V<Output<0,4V	Maximum Current Sink: 2mA.
- Time Base running	2,4V<Output<5V	Maximum Current Supply: 400uA.

2.2.8. MTB TRIGGERING

Trigger sources	Channel A; Channel B; Composite (Ch. A & B); External; Line	
Input Connector (Ext. Trigg.)	BNC	
Input Impedance (Ext. Trigg.):		For Frequency >1 MHz see Fig. 2.2.
R parallel	1M.Ohm + or - 1%	In DC position of Input Coupling In AC position of Input Coupling: 18 nF in series with R parallel and C parallel
C parallel	9pF	
Max. Input Cap. Difference	1,5pF	Difference between channel A, Channel B, EXT MTB Trigger and EXT DTB Trigger Inputs

Coupling	d.c.;a.c.; LF rejected; HF rejected	
⚠ Maximum Input Voltage (Ext. Trigg.)		Apparatus should be properly grounded through the protective-ground conductor of the power cord.
	300V (d.c. + a.c. peak)	Up to 1MHz; for Frequency >1MHz: see Fig. 2.3.
Min. Trigger sensitivity (Ambient:5...40°C)		In TRIGgered mode.

	up to 100MHz	up to 400MHz	
Ch.A and Ch.B	0,5div	2div	Add 0,1 div for ambient:0...50°C
EXT	50mV	300mV	Add 10mV for Ambient:0...50°C
EXT/10	0,5V	3V	Add 0,1V for ambient:0...50°C

Slope Selection	positive going (+); negative going (-)	
Level Control Range:		NOT TRIG'D led is lit unless triggered.
Ch. A and Ch.B	+ or - 8 div	In TRIG and SINGLE positions of Mode Selector.
EXT	+ or -0,8V	
EXT:10	+ or -8V	
Any Source	related to peak value	In AUTO position of Mode Selector.
Frequency Response:		Trigger not affected by Bandwidth Limiter.
Lower Transition Point of BW		Channel A or Channel B coupling eventually cascaded with Trigger coupling.
	d.c.	Trigger Coupling in DC position
	10Hz (-3dB) or less	Trigger Coupling in AC position
	20kHz (-3dB)	Trigger Coupling in LF REJected position.

2

Higher Transition Point of BW	50kHz (-3dB) See also table with trigger sensitivities	Trigger Coupling in HF REJected position.

2.2.9. DTB TRIGGERING

Trigger sources	Channel A; Channel B; Composite (Ch.A & B); External; End of Delay (STARTS mode)	
Input Connector (Ext/ Trigg.)	BNC	
Input Impedance (Ext. Trigg.):		For Frequency >1 MHz see Fig.2.2
R parallel	1 M.Ohm + or - 1%	In DC position of Input Coupling In AC position of Input Coupling: 18 nF in series with R parallel and C parallel
C parallel	9pF	
Max. Input Cap. Difference	1,5 pF	Difference between Channel A, Channel B, EXT MTB Trigger and EXT DTB Trigger Inputs.
Coupling	d.c.; a.c.; LF rejected; HF rejected	
⚠ Maximum Input Voltage (Ext. Trigg.)		Apparatus should be properly grounded through the protective-ground conductor of the power cord.
	300V (d.c. + a.c. peak)	Up to 1MHz; for Frequency >1MHz: see Fig. 2.3.

Min. Trigger Sensitivity (Ambient:5...40°C)

	up to 100MHz	up to 400MHz	
Ch.A and Ch.B	0,5div	2div	Add 0,1 div for ambient:0...50°C
EXT	50mV	300mV	Add 10mV for Ambient:0...50°C
EXT:10	0,5V	3V	Add 0,1V for ambient:0...50°C

Slope Selection	positive going (+) negative going (-)	
Level Control Range:		
Ch.A and Ch.B	+ or -8 div	
EXT	+ or -0,8V	
EXT:10	+ or -8V	
Frequency Response:		Trigger not affected by Bandwidth Limiter.
Lower Transition Point of BW		Channel A or Channel B coupling eventually cascaded with Trigger coupling.
	d.c.	Trigger Coupling in DC position.
	10Hz (-3dB) or less	Trigger Coupling in AC position;
	20kHz (-3dB)	Trigger Coupling in LF REJection position.
Higher Transition Point of BW	50kHz (-3dB) See also table with trigger sensitivities	Trigger Coupling in HF REJected position.

2.2.10. BLANKING OR Z-AXIS

Input connector	BNC	On rear of instrument
Input Impedance	30 k.Ohm	When input is 0...2,5V, otherwise >10k. Ohm
Input Coupling	d.c.	
Maximum Input Voltage	+ or - 10V	
Sensitivity:		
Unblanked at	0V	Half tones are possible at input voltages between 0V and +2,5V.
Blanked at	+ 2,5V or more	
Response Time	20ns	From unblanked to fully blanked, when input is a transient of 0...+2,5V (rise time 2ns or less).

2

2.2.11. AUTO SETTING

Y Deflection Source	Ch. A and Ch.B	Channel INVERTer not affected by AUTO SET.
Y Deflection Mode - MTB at 1ms/div or lower:	CHOPped	
- MTB at 500us/div or higher:	ALTernate	
Input Impedance: - Accessory with Probe Read Out	according to Probe Read Out	
- otherwise	not affected by AUTO SET	
Y Input Coupling	AC	
Y Deflection:		Each Channel is independently set.
- 10mV < Input at BNC<30V	6 div or less	Vernier not affected by AUTO SET.
- Input at BNC<10mV	Channel at 200mV/div	Due to trigger uncertainty at Freq. >60 MHz or at Duty Cycle <>50%, sensitivity can deviate from given values, but signal will remain visible on screen.
Y Channel Base Line POSITION	center of screen +0,2div Ch.A -0,2div Ch.B	POSition control remains "dead" until setting of knob (when turning) represents actual base line on screen.
Band Width LIMiter	OFF	
X Deflection Source	Main Time Base	All other sources switched off.
X POSITION	not affected by AUTO SET	
MTB Trigger Source:		
Triggerable Signal at EXT Input	EXT	

No signal at EXT input, but triggerable Signal at Channel A or B	Channel A or Channel B	Channel with highest V/div setting is selected. (Channel A when settings are equal)
No Triggerable Signal at any input	Channel A	
MTB Trigger Mode	AUTO	
MTB Trigger Coupling	AC	
TB MAGnifier	OFF	
TB Deflection Coefficient		
MTB		
40 Hz <Sign.Freq. <60 MHz	max.6 signal periods on CRT screen	Vernier not affected by AUTO SET
Signal Freq. >60 MHz	10 ns/div	
when no trigger found	10 us/div	
		Due to trigger uncertainty at Freq. >60 MHz or at Duty Cycle <>50%, MTB setting can deviate from given values, but signal will remain visible on screen.
DTB	Not affected by AUTO SET	
Setting READ OUT on CRT	updated	Intensity of Setting READ OUT not affected by AUTO SET.
Cursors	Not affected by AUTO SET	

2

2.2.12. CURSORS

Cursor Intensity Control	independent of trace intensity but combined with setting read out intensity	In SINGLE mode of MTB, cursors are displayed during max. 0,1s when SINGLE button is pushed.
Modes	Independent	Cursor reading independent of previous reading
	RATIO	Cursor reading in % of previous reading
	TRACK	REF cursor and Delta cursor are tracking
Hor. and Vert. Resolution	0,02mm or better	
Read Out Resolution	3 digits	
Voltage Cursors		
- Error Limit	See error limit of vertical deflection coefficients. See chapt. 2.2.3	Referred to input at BNC,error of probes etc. excluded.
- Minimum Cursor Range	central 7 div	
- RATIO range	(0,1% to 999%)	100% = Value in Cursor Rea Out when Ratio button is pushed.
- Cursor Reference		
	Absolute Value (V) referred to channel A	When only Ch.A is displayed or When a combination of channels is displayed, whilst Ch.B is not MTB trigg. source. Probe factor included when probe is provided with probe read-out.
	Absolute Value (V) referred to channel B	When only Ch.B is displayed or when a combination of channels is displayed, whilst Ch.B is MTB trigg. source. Probe factor included when probe is provided with probe read-out.
	Relative Value (div)	When reference channel is in UNCAL position or When only Trigger View is displayed or when instrument is in X vs. Y deflection mode

Time Cursors		In MTB mode only
- Error Limit	see Error limit of MTB deflection coefficients	see section 2.2.6
- Minimum Cursor Range:	central 9 div.	
- RATIO Range	(0,1% to 999%)	100% = Value in Cursor Read Out, at the moment RATIO button is pushed.
- Cursor Reference	Absolute Value (s,Hz) referred to MTB	When Main Time Base is in CAL position.
	Relative Value (div)	When Main Time Base is in UNCAL position or when instrument is in X vs Y mode.

2.2.13. SETTING READINGS ON CRT

Modes	Settings only	}
		}
	Cursors only	} Incl. Cursor Readings
		}
	Settings + Cursors	}
		}
Intensity Control of CRT text	independent of trace intensity but combined with cursor intensity	In SINGLE position of MTB, setting readings are displayed during max. 0,1s when SINGLE button is pushed.
Vertical settings	Defl.coefficient AC, DC, Ground Invert, UNCAL, 50 ohm	
Horizontal Settings	MTB deflection coefficient.	In MTB, MTB-INTENS and alternate sweep mode.
	DTB deflection coefficient.	In DTB and alternate sweep mode.
	Delay (1/Delay)	s or Hz
Trigger level (in TRIG and SINGLE)		When supplied with IEEE option
when d.c. coupled	in volt (2 digits)	Chann. + Trigg. coupl. both d.c
when a.c. coupled	in div. (2 digits)	Chann. or Trigg. coupl. in a.c

2

2.2.14. CALIBRATOR

Wave Form: Shape	square wave	
Internal Impedance	50 Ohm + or - 1%	
Output Voltage (peak to peak)	0,8V + or - 1% pos. going with respect to ground	Open Voltage: halves when terminated into 50 Ohm.
Output Current (peak to peak)	16mA + or - 2%	When output short circuited; halves when terminated into 50 Ohm.
Frequency	5kHz + or - 0,1%	

2.2.15. POWER SUPPLY

⚠

Source Voltage a.c. (r.m.s.)		
Nominal	100V...240V	
Limits of Operation	90V...264V	
Source Frequency		
Nominal	50 Hz...400 Hz	
Limits of operation	45 Hz...440 Hz	
Source Waveform characteristics:		At Nominal Source Voltage
Max. Waveform Deviation Factor	10%	
Crest factor	1,27...1,56	
Allowable Power Source Interruption:	At least 20ms	At nominal source Voltage. After this time Oscilloscope Settings are saved before instrument goes down. Automatic Power Up after restoration of Power Line Voltage. (For Setting Retention see 2.2.16.
Power Consumption (a.c. source)		

Typical	135W	Options excluded
Limits of Operation	138W	

2.2.16. SUNDRIES

Settings Retention:		When instrument is switched off or during Line Power failure.
- Memory Back Up Voltage	2V...3,5V	
- Memory Back Up Current Drain	typical 0,1uA	At 25°C.
- Recommended Batteries: type	LR 6	According to IEC 285, (= Alkaline Manganese Penlight Battery). e.g. PHILIPS LR6 or DURACELL MN 1500
quantity	2pcs	
- Temperature Rise of batteries	20K	After warming up period of instrument.
- Retention Time	typical 2 years	At 25°C, with recommended (fresh) batteries.
Temperature Range	-30°C...+70°	At -40°C...-30°C Settings Retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer periods (>24h) below -30°C or above 60°C. N.B! UNDER NO CIRCUMSTANCES BATTERIES SHOULD BE LEFT IN THE INSTRUMENT AT TEMPERATURES BEYOND THE RATED RANGE OF THE BATTERY SPECIFICATION!
Finish of housing	epoxy powder coated	
Printed Circuit Boards	glass laminate epoxy	
Cooling	fan aided convection	Maintenance free.

2

2.2.17. 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 & ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

Meets Environmental Requirements of	MIL-T-28800C Type III Class 5, Style D	
Temperature		Memory back Up Batteries removed from instrument, unless batteries meet temperature specifications (see also 2.2.16).
- Operating:		
Min. Low Temperature	0°C	Cf. MIL-T-28800C par. 3.9.2.3. tested cf. par 4.5.5.1.1.
Max. High Temperature	+50°C	Cf. MIL-T-28800C par. 3.9.2.4. tested cf. par 4.5.5.1.1.
- Non Operating: (Storage)		
Min. Low Temperature	-40°C	Cf. MIL-T-28800C par. 3.9.2.3. tested cf. par. 4.5.5.1.1.
Max. High Temperature	+75°C	Cf. MIL-T-28800C par. 3.9.2.4. tested cf. par 4.5.5.1.1.
Maximum Humidity:		Cf. MIL-T-28800C par. 3.9.2.2. tested cf. par. 4.5.5.1.1.
Operating and Non Operating (Storage)	95% Relative Humidity	
Maximum Altitude:		Cf. MIL-T-28800C par. 3.9.3. tested cf. par 4.5.5.2.
		Memory Back Up Batteries removed from instrument, unless batteries meet Maximum Altitude specs.
- Operating	4,5km (15000 feet)	Maximum Operating Temperature derated 3°C for each km (for each 3000 feet) above sea level.

- Non Operating (Storage)	12km (40000 feet)	
Vibration (Operating)		Cf. MIL-T-28800C par 3.9.4.1. tested cf. par. 4.5.5.3.1.
- Freq. 5...15Hz:		
Sweep Time	7 min	
Excursion (pk to pk)	1,5mm	
max. Acceleration	$7m/s^2$ (0,7g)	At 15Hz
- Freq. 15...25Hz		
Sweep Time	3min	
Excursion (pk to pk)	1mm	
max. Acceleration	$13m/s^2$ (1,3g)	At 25Hz
- Freq. 25...55Hz:		
Sweep Time	5min	
Excursion (pk to pk)	0,5mm	
max. Acceleration	30m/s (3g)	At 55Hz
- Resonance Dwell	10min	At each resonance freq. (or at 33Hz if no resonance was found). Excursion cf. 20.06.01. to 20.06.03.
Shock (Operating)		Cf. MIL-T-28800C par. 3.9.5.1. tested cf. par. 4.5.5.4.1.
- Amount of shocks total	18	
each axis	6	(3 in each direction)
- Shock Wave Form	half sine wave	
- Duration	11ms	
- Peak Acceleration	$300m/s^2$ (30g)	
Bench Handling		Cf. MIL-T-28800C par. 3.9.5.3. tested cf. par. 4.5.5.4.3.
Meets requirements of	MIL-STD-810 method 516, proced. V	
Salt Atmosphere:		Cf. MIL-T-28800C par. 3.9.8.1. tested cf. par. 4.5.6.2.1.

2

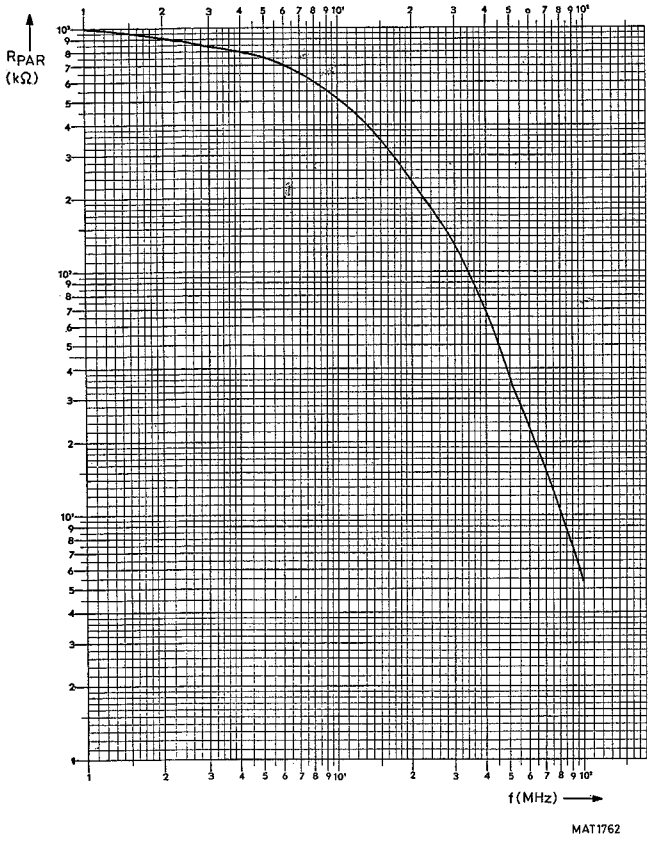
Structural parts meet requirements of	MIL-STD-810 method 509, proced. I salt solution 20%	
EMI (Electro Magnetic Interference) meets requirements of	MIL-STD-461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS02, RS03.
	VDE 0871 and VDE 0875 Grenz-wertklasse B	
Magnetic Radiated Susceptibility:		Tested conforming IEC 351-1 par. 5.1.3.1.
Maximum Deflection Factor	7mm/mT (0,7mm/ gauss)	Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a Flux Intensity (peak to peak value) of 1,42mT (14,2 gauss) and of Symetrical Sine wave Form with a Frequency of 45...66Hz.

2.2.18. SAFETY

Meets requirements of	IEC 348 Class I	
	VDE 0411	Expect for power cord, unless shipped with Universal European power plug
	UL 1244 CSA 556B	Expect for power cord, unless shipped with North American power plug
Max. X-Radiation Approval	ROEV (Germany)	

2.2.19. ACCESSORIES

Accessories furnished with instrument	2x10:1 passive probe PM8929/99	10 M.Ohm, 10:1 Passive Probe with read Out (1m).
	PM9310	Collapsible Viewing Hood
	Blue Contrast Filter	Factory installed
	Operating Manual	
	Front Cover	



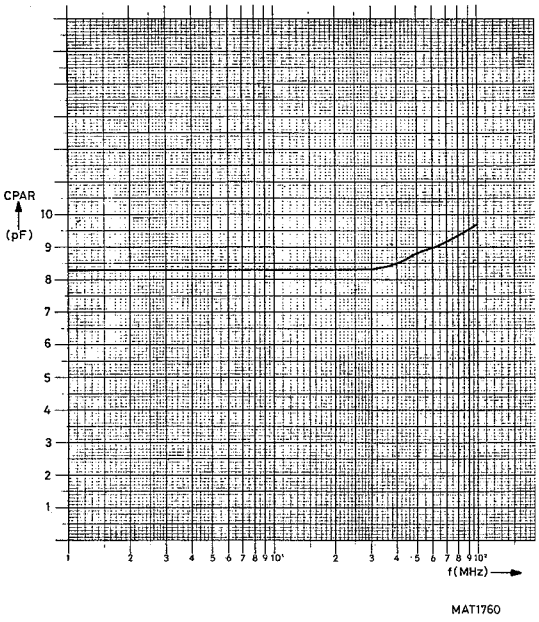


Fig.2.2. Input resistance R par. and capacitance C par. versus frequency.

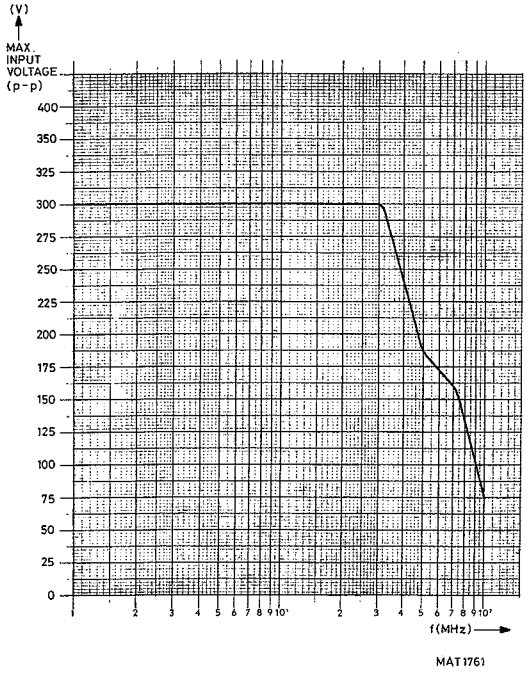


Fig.2.3. Maximum input voltage (peak to peak) derating versus frequency.

2.2.20. SETTINGS MEMORY (ONLY FOR PM3296A)

Memory size

Standard	max. 75 complete front panel settings

Functions

Settings	Save	Actual settings are stored in memory, replacing content of memory cell indicated on CRT
	Insert	Actual settings are stored in memory; insertion is after memory cell indicated on CRT
	Delete	Content of memory cell indicated on CRT is deleted.
	Recall	Actual settings are replaced by content of memory cell indicated on CRT. Actual settings are saved in "last setting" memory (= mem. cell # Ø)
	(Recall) Next	Actual settings are replaced by content of memory cell indicated on CRT increased by 1 (empty cells are skipped). Actual settings are saved in "last setting" memory (= memory cell # Ø)
	(Recall) Previous	Actual settings are replaced by content of memory cell indicated on CRT decreased by 1 (empty cells are skipped). Actual settings are saved in "last setting" memory (= memory cell # Ø)
Memory	Protect	Memory is write protected
	Unprotect	Memory is not write protected
	Identify (#0...9)	Instrument is individualised, no respons to transmitter unless having some indentifier #
Remote control	AUTO setting	Pushing AUTO on transmitter has same result as pushing AUTO button on front panel of instrument, unless instrument is in remote control.

Transmitter

Transmission type		Infra Red	
Batteries	type	R03P	
	number	4 pcs.	
	life	typical 2 years	At normal use
Max. Transmission distance		typical 3,5 m	At an angle of max. 5° off axis
Max. Transmission angle	vert.	+or- 45° off axis	At distance of 0,5 m on axis
	hor.	+or- 35° off axis	At distance of 0,5 m on axis
Dimensions	length	173 mm (6.8 in)	
	width	71 mm (2.6 in)	
	height	16 mm (0,6 in)	
Mass		135 g	Batteries included.
Environmentals			
oper. temp. range		+ 5...+45 °C	
Stor. temp. range		-25...+70°C	Without batteries, unless batteries withstand this temperature range.
Resistance to liquid agents		splash proof	No functional failure after drying 24 h.

INTRODUCTION TO CIRCUIT DESCRIPTION AND DESCRIPTION TO BLOCK DIAGRAM

3

CONTENTS

3. INTRODUCTION TO CIRCUIT DESCRIPTIONS AND BLOCK DIAGRAM DESCRIPTION.

3.1. Introduction to circuit descriptions. 3-1
3.2. Block diagram description. 3-10

FIGURES

3.1. Block diagram. 3-6

3. INTRODUCTION TO CIRCUIT DESCRIPTION AND BLOCK DIAGRAM DESCRIPTION.

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION.

The functioning of the circuits is explained per printed circuit board (p.c.b.). For every p.c.b. a separate chapter is available containing the lay-out of the p.c.b., the belonging circuit diagram (s) and the circuit description.

Location of electical parts.

The itemnumbers of C..., R..., V..., N..., D... and K... have been divided into groups which relate to the circuit, the printed circuit board according to the following table:

Itemnumber	Printed circuit board	Figure
101- 199	LCD-unit	4.1, 4.2
501- 599	Switch unit	5.2, 5.3
1101-1199	Intermediate unit	6.2, 6.3
1601-1699	Central processor unit	7.2, 7.3, 7.4, 7.5
4001-4099	Final Y amplifier	14.1, 14.2
4701-4799	MTB external trigger unit	11.1, 11.2
4801-4899	DTB external trigger unit	11.1, 11.3
4901-5399	Y-signal unit	13.1, 13.2, 13.3, 13.4
5601-5899	X/Z amplifier and chip unit	16.1, 16.2, 16.3
5901-5999	CRT-controls unit	22.1, 22.2
6000-6100	Infra Red receiver (PM3296A)	22.3, 22.4
6201-6299	Primary converter unit	18.3, 18.4
6301-6399	Secondary converter unit	19.4, 19.5
6601-6699	High voltage converter unit	20.2, 20.3
6801-6899	HF-attenuator unit	10.1, 10.2
6901-6999	LF-attenuator unit	10.4, 10.3
7000-7050	Adaptation unit	12.1, 12.2
7301-7399	Mother Board	21.1, 21.2
8001-8099	IEEE 488 bus unit (optional)	9.1, 9.2, 9.3
8201-8299	CRT text unit (optional)	8.1, 8.2, 8.3
8401-8499	CRT-socket unit	17.1, 17.2
9001-9899	Time-base and time base chip-unit	15.10, 15.11, 15.12, 15.13, 15.14

NOTE: In the circuit diagrams you can find several signal names. Some of them have a line on top which means that the signal is low if the related function is on. In these circuit descriptions the line on top of the signal name is not present; it is replaced by the addition "-" directly behind the signal name.

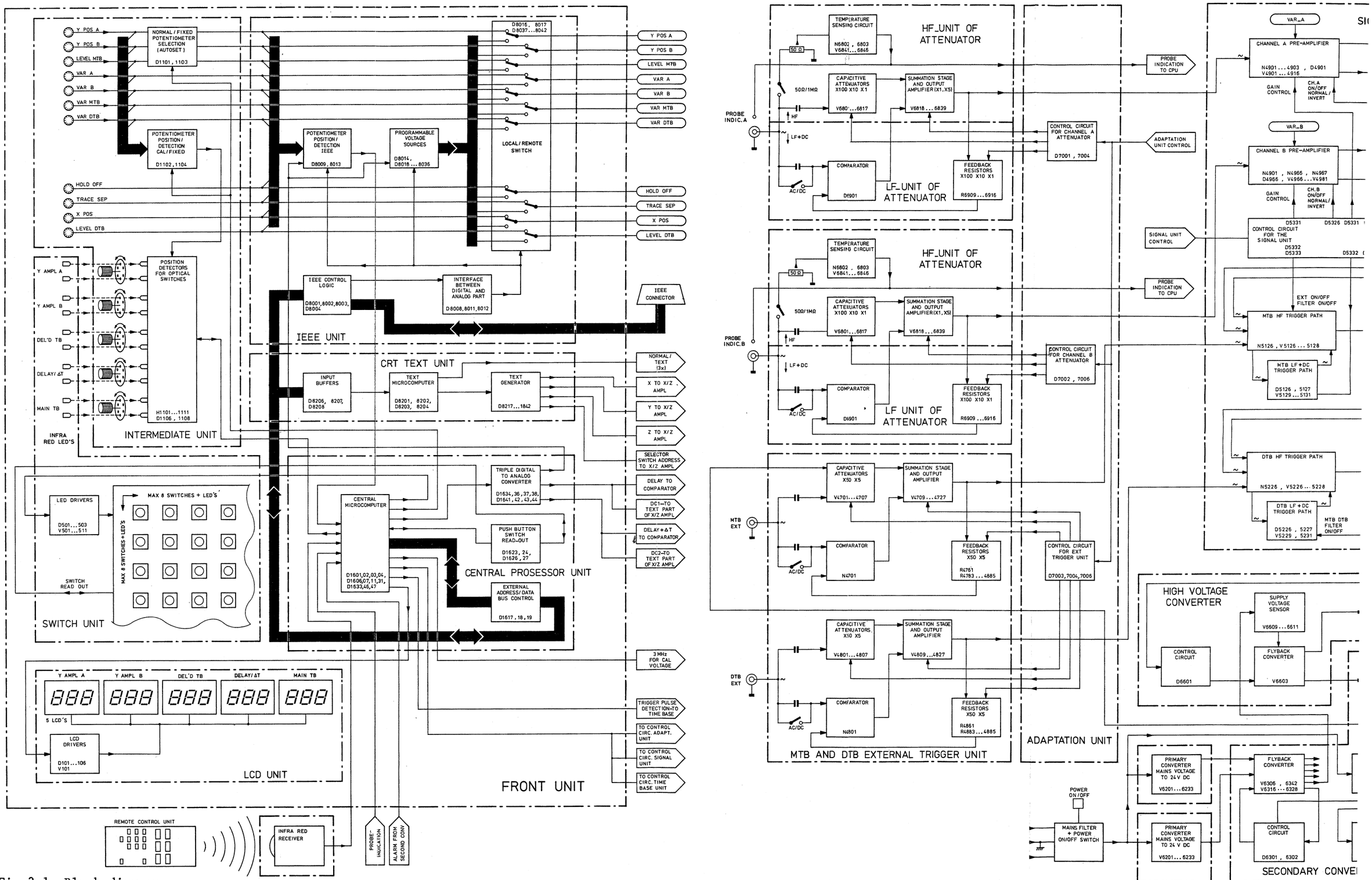


Fig.3.1. Block diagram

SIGNAL UNIT

VAR_A

CHANNEL A PRE-AMPLIFIER
N4901...4903 , D4901
V4901...4916

GAIN CONTROL

CH.A ON/OFF NORMAL/ INVERT

MTB TRIG A
DTB TRIG A
ON/OFF

CHANNEL A TRIGGER PICK OFF
N5116
N5116 , V5117

MTB~

DTB~

VAR_B

CHANNEL B PRE-AMPLIFIER
N4901 , N4966 , N4967
D4966 , V4966...V4981

GAIN CONTROL

CH.B ON/OFF NORMAL/ INVERT

CHANNEL B TRIGGER PICK OFF
N5121
V5121 , 5122

MTB~

DTB~

MTB TRIG B
DTB TRIG B
ON/OFF

CONTROL CIRCUIT FOR THE SIGNAL UNIT
D5331 D5326 D5331 D5326 D5326
D5332 D5333 V5326 V5328 V5329 D5332 D5332 D5333 D5333

Y POS A

CHANNEL A POSITION CONTROL
D5046
V5046...5051

POS A ON/OFF

DELAY LINE DRIVER
N5031 , V5031

A~

B~

TRIG VIEW

BW LIMIT ON/OFF
TRIG VIEW ON/OFF

CHANNEL B POSITION CONTROL
D5081
V5081...5086

POS B ON/OFF

Y POS B

D5326 D5326 D5333 D5326 D5326 D5326 D5326 D5326

ALT

PART OF CRT CONTROLS UNIT
ILLUM
TRACE ROT

PART OF MOTHER BOARD
TRACE ROTATION CIRCUIT
V7301 , 7302

ILLUMINATION CIRCUIT
V7311 , 7312

3 MHz FROM CPU

FREQUENCY DIVIDER AND OUTPUT AMPLIFIER
D7304 , 7308
V7304...7308

CAL 0.8V / 5kHz

DELAY LINE

Y FROM CTU

PART OF MOTHER BOARD
TRACE SEPARATION AND INTENSITY CONTROL
D7301

X FROM CTU

TEXT PART OF X/Z AMPLIFIER

Y-SWEEP GENERATOR
V5761 , 5763

DC1_FROM CPU

DC2_FROM CPU

X-SWEEP GENERATOR
V5759 , 5762

SELECTOR SWITCH ADDRESS FROM CTU

Y-DEFLECTION SELECTOR AND BUFFER STAGE
D5709 , N5701,
N5702 , V5773,
V5774 , 5776

X-DEFLECTION SELECTOR AND BUFFER STAGE
D5702 , N5701,
N5702 , V5769,
V5771 , 5772

TRACE SEP

NORMAL/TEXT FROM CTU

FINAL Y-AMPLIFIER

TRACE SEPARATION AND TEXT CONTROL
D4001...4003
V4011...4016

FINAL Y-AMPLIFIER
D4001 , 4002,
D4004 , 4006,
V4003 , 4004,
V4006 , 4008.

CRT

G1 G3

CRT SOCKET

INTENSITY DEMODULATOR
V8404 , 8406

FOCUS DEMODULATOR
V8407 , 8408

FOCUS CONTROL CIRCUIT
V8409 , 8411

INTENSITY
TRACE READ OUT FOCUS

PART OF CTR CONTROLS UNIT

TIME BASE

TO/FROM CPU

TRIGGER PULSE DETECTION
D9004 , 9101
V9001...9009

VAR MTB

MTB CURRENT SOURCE
N9701 , 9702
N9705 , V9701
V9708 , 9718

MTB GATE AND ALT PULSE CIRCUIT
V9011,9012,9013,
V9014, 9016

MTB GATE OUT

HOLD OFF

HOLD OFF CIRCUIT
D9707 , V9716,
N9161
V9131 ... 9139

ADDITIONAL SUPPLY VOLTAGE STABILISATION
N9601 , 9602
V9601...9611

TRIGGER INPUT MTB
D9102
V9101 , 9102

MTB FLIP FLOP
D9101 , 9102

MAIN TIME BASE
9108, 9113, 9114,
9116, 9118, 9121, 9122, 9123,
9124, 9126, 9127, 9128, 9142

TIME BASE END OF SWEEP FLIP FLOP
D9102

LEVEL MTB

EXT ON/OFF
FILTER ON/OFF

MTB HF TRIGGER PATH
N5126 , V5126 ... 5128

MTB LF+DC TRIGGER PATH
D5126 , 5127
V5129...5131

AUTO LEVEL CONTROL
N5128
V5135...5140

MTB TRIGGER AMPLIFIER
N5129 , V5134 ... 5143

SLOPE

X DEFL

LEVEL DTB

DTB HF TRIGGER PATH
N5226 , V5226 ... 5228

DTB LF+DC TRIGGER PATH
D5226 , 5227
V5229 , 5231

MTB DTB FILTER ON/OFF

DTB TRIGGER AMPLIFIER
N5228 , V5232 ... 5239

SLOPE

Y-OUTPUT AMPLIFIER
D5229
V5242 ... 5248

Y-OUT

DEL/ΔT SWITCH

COMPARATOR
N9301...9304
V9301...9318

DELAY FROM CPU

DELAY+ΔT FROM CPU

TRIGGER INPUT DTB
D9202
V9201 , 9202

TIME BASE CONTROL

CONTROL CIRCUIT FOR THE TIME BASE
D9001
D9003

Z-LOGIC
D9401 , 9402
N9601 , 9403
V9613 ... 9617
V9401 ... 9411

MTB/DTB

DTB FLIP FLOP
D9201 , 9202

DELAYED TIME BASE
9211 , 9217 , 9218 ,
9219 , 9221, 9224 , 9227, 9228 ,
9229 , 9231, 9232 , 9237, 9238

END OF SWEEP

D9002 D9002 D9001 D9003 D9003 D9001 D7301

VAR DTB

DTB CURRENT SOURCE
N9801, 9803, 9806,
V9801, 9816, 9819

X-POS

MTB/DTB/X DEFL SWITCH AND TB MAGNIFIER
V9501 ... 9524

NORMAL/TEXT FROM CTU

HORIZONTAL DISPLAY CONTROL
V9526 ... 9538

DTB GATE CIRCUIT
V9212 , 9236

DTB GATE OUT

FINAL X-AMPLIFIER
N5801 ... 5803
V5801 ... 5803
V5703 ... 5719

PART OF X/Z AMPLIFIER

Z FROM CTU

TEXT INTENSITY PRE-AMPLIFIER
D5801

NORMAL/TEXT SWITCH
V5853 , 5854
V5857 , 5856

FOCUS AMPLIFIER
V5619 ... 5633

FOCUS HF

INTENS HF

INTENSITY PRE-AMPLIFIER
V5851

INTENSITY AMPLIFIER
V5636 ... 5647

Z-MOD

NORMAL/TEXT FROM CTU

LF+DC

MODULATOR
V5648 .. 5657

PART OF X/Z AMPLIFIER

SUPPLY VOLTAGE SENSOR
V6609 ... 6611

FLYBACK CONVERTER
V6603

-3,4K VOLT RECTIFIER + ADJUSTMENT
V6604 ... 6607

+21K VOLT MULTIPLIER
V1851 ... 1861

FLYBACK CONVERTER
V6306 , 6342
V6316 ... 6328

LINE TRIGGER CIRCUIT
N6301/8 , 9 , 10,
N6301/12, 13, 14

LINE TRIG

ALARM TO CPU

TEMPERATURE SENSOR ON MOTHER BOARD

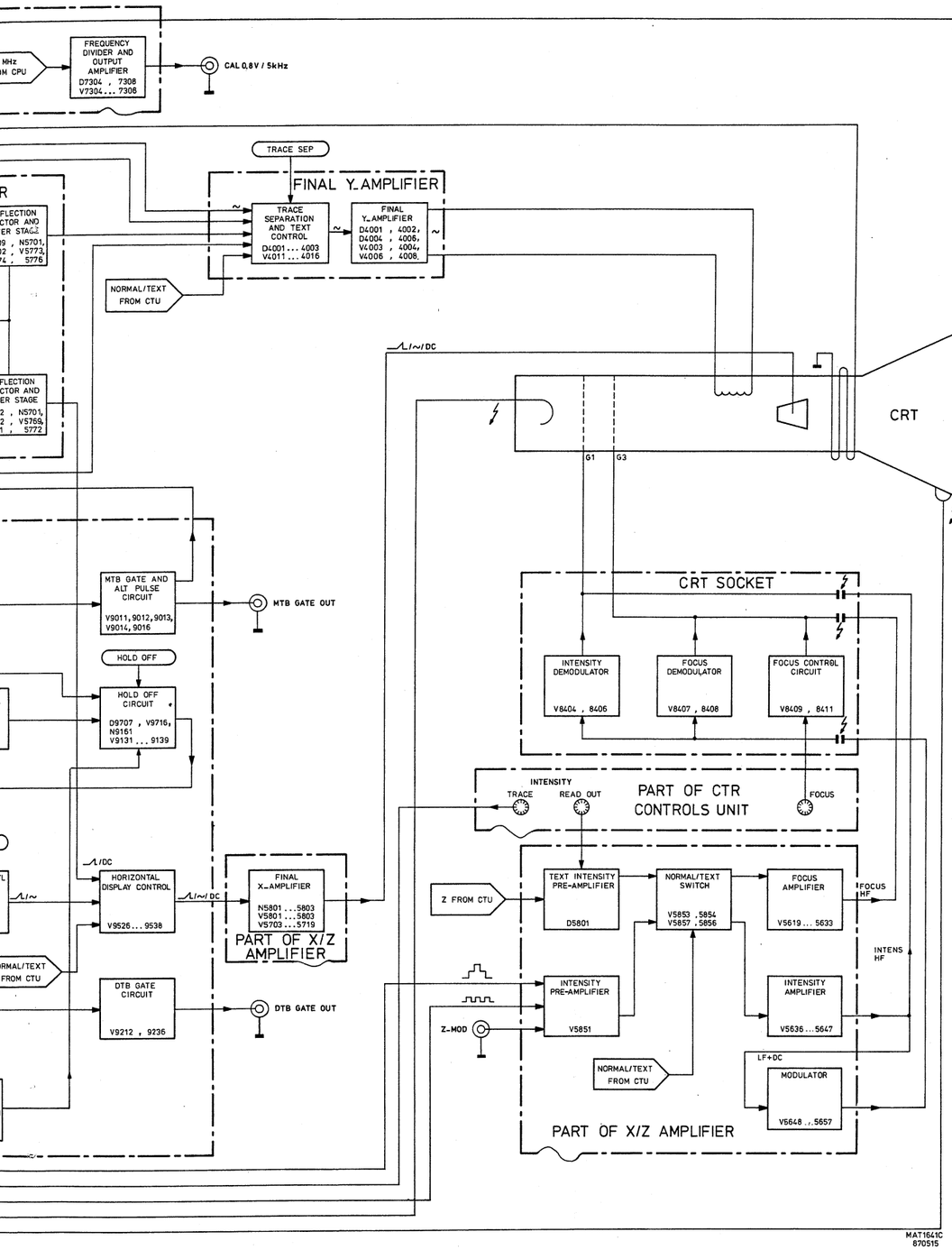
FAN

CONTROL CIRCUIT
D6301 , 6302

FAN CONTROL CIRCUIT
D6302/8, 9, 10

SECONDARY CONVERTER

MAT1641C
870515



3.2 BLOCK DIAGRAM DESCRIPTION (see fig. 3.1.)

Note: this block diagram is a universal one. This means that it is based upon the PM3296A which is the most extensive instrument of the 400 MHz-oscilloscope family.
In PM3295A, the infra-red transmitter and receiver blocks are not present.

3.2.1. Introduction

This block diagram description is based around all the important functional blocks and their interconnections. In order to assist in cross-reference with the circuit diagrams, the blocks include the itemnumbers of the active components they contain.
Furthermore, the blocks are grouped together per printed-circuit board, or a part of it. To facilitate reference, the names of the functional blocks and p.c.b. units are given in text in CAPITALS.
Signal waveforms are also indicated at block interconnections where useful.
In this instrument almost all the controls (potentiometers,pushbutton switches and rotary switches) influence the oscilloscope circuits via a microcomputer (uC) system: as a result, the position of the controls is monitored by the uC, which adjusts the time-base, input attenuators, etc. accordingly to the desired value. For this purpose, control circuits are present at different points in the instrument; e.g. on the y-signal unit, the time-base and in the vicinity of the input units for channel A, B and external triggering.
The control circuits themselves are controlled by the uC .If the IEEE option is installed, an external controller is capable of controlling the instruments functions.
Via the IEEE-bus the controller can also take-in the settings of a a complete front panel. If the instrument is equipped with a remote control (option present in PM3296A) a number of complete "front panels" can be activated to control the oscilloscope.
Another optional unit is the CRT TEXT unit. This unit writes text; e.g. time base and attenuator settings, and also cursors on the c.r.t. screen. During a normal signal display cycle, this cycle is interrupted while text is written. For this purpose, the inputs of the final vertical (Y) amplifier, final horizontal (X) amplifier and the intensity (Z) amplifier are then switched to the X,Y and Z outputs of the TEXT unit.
The MOTHER BOARD of the instrument is a p.c.b. with only few components, but it plays a vital role as a connecting system for control signals between the oscilloscope ciruits and the uC.
The unit also distributes the supply voltages from the power supply to various oscilloscope circuits. Most p.c.b.'s are connected to the MOTHER BOARD.

3.2.2. Front unit

This unit incorporates the necessary circuits to control the oscilloscope functions. It consists of a number of p.c.b's. located one behind the other in parallel with the front text plate. The CENTRAL PROCESSOR UNIT (CPU) forms the heart of the front unit.
The p.c.b's. of the front unit are now described in order from the text plate.

LCD unit

This unit incorporates the LCD read-outs for the sensitivity of the vertical channels and the positions of the MTB and DTB and the delay time. The block LCD DRIVERS is controlled by the CENTRAL PROCESSOR UNIT and incorporates separate drives for each LCD.

Switch unit

This p.c.b. mainly includes the front-panel pushbutton switches. Depending on the instrument version, a maximum of 64 switches can be read-out by the CENTRAL PROCESSOR UNIT. Each pushbutton contains a LED to indicate when the function is on, controlled by the CPU via the LED DRIVERS.
The SWITCH UNIT also contains a number of infra-red LEDs, which help to read-out the rotary switches on the INTERMEDIATE UNIT.

Intermediate unit

This p.c.b. incorporates a number of potentiometers and the rotary switches Y AMPL for the vertical channels, DEL´D TB, DELAY or DELTA T and MAIN TB.

Rotary switches
They are contactless, optical switches. A disc with holes is directly-coupled to the control knob. A pair of infra-red LED´s located on the SWITCH UNIT shine through the holes on to a pair of photo-transistors. These photo-transistors are part of the block POSITION DETECTORS FOR THE OPTICAL SWITCHES. If the disc is rotated,the light beams are interrupted between holes in an on/off/on/off sequence. This results in a pulse pattern at the photo-transistors. The number of pulses is a measure of the number of steps that the control knob has made. By using two photo-transistors per knob, it is possible to detect the direction of rotation of the knob: this information is given by the phase difference between the pulses at the two photo-transistors. If a rotary switch is operated, the POSITION DETECTORS FOR THE OPTICAL SWITCHES send a signal to the CENTRAL PROCESSOR UNIT. After this, the number and phase of the pulses can be read by the processor.

Potentiometers
The signals from the potentiometers HOLD OFF, TRACE SEP, X POS and LEVEL DTB are direcly routed to the outputs of the unit.
The signals from the potentiometers Y POS A, Y POS B and LEVEL MTB are applied to the block NORMAL/FIXED POTENTIOMETER SELECTION. The three outputs in this block are either connected to the associated potentiometer (normal mode) or to a fixed d.c. voltage (after the AUTO SET mode initiated). The block POTENTIOMETER POSITION DETECTION CAL/FIXED detects for the Y POS A, Y POS B or LEVEL MTB (selected by the CPU) whether one of them is moved (after AUTO SET selected) through its mid-position. If so, the CPU is informated via the block POSITION DETECTORS FOR THE OPTICAL SWITCHES, with the result that the potentiometer is active again.
The block POTENTIOMETER POSITION DETECTION CAL/FIXED detects positional state of the potentiometers VAR A, VAR B, VAR MTB or VAR DTB (selected by the CPU); i.e. whether one is in its calibrated position. This information is also routed to the CPU.

Central processor unit (CPU)

The CENTRAL MICROCOMPUTER on this p.c.b. controls all the circuits in the instrument. In addition, it also controls the microcomputers on the IEEE UNIT and the CRT TEXT UNIT.
The CENTRAL MICROCOMPUTER has the following inputs:

- A control signal from the infra-red receiver (present in PM3296A)
- PROBE INDICator signals for the vertical channels A and B. These inform the microcomputer of the types of probes connected to vertical inputs sockets A and B, and adapt the sensitivity of the read-out of the LCDs to them. Any overload of the attenuator 50-ohm input resistors is detected via these inputs.
- ALARM signal from the power supply. This signal ensures that the microcomputer saves important information (e.g. front-panel settings) in its memory (with battery back-up) in the event of power switch-off or failure.
- A signal input from the INTERMEDIATE UNIT defining the position of the rotary switches and potentiometers.
- A signal from the IEEE UNIT (if fitted) to determine the potentiometer positions.

The following output signals are available:

- A 3MHz microcomputer clock pulse. This signal is divided on the MOTHER BOARD to generate a 5 kHz CAL signal.
- A signal for the CONTROL CIRCUIT on the Y signal unit, the time-base and for the vertical input unit and the MTB/DTB external trigger input unit.
- A control circuit for the INTERMEDIATE UNIT blocks NORMAL/FIXED POTENTIOMETER SELECTION and POTENTIOMETER POSITION DETECTION CAL/FIXED.
- A control signal to switch the LEDs on the SWITCH UNIT. The pushbuttons on this unit are read via the PUSHBUTTON SWITCH READ-OUT block.
- A control signal for switching the LCD segments on the LCD UNIT.
- Control signals from the EXTERNAL ADDRES/DATA BUS CONTROL block enable communication between the microcomputer and the IEEE UNIT or the CRT TEXT UNIT.
- Control signals from the microcomputer to the TRIPLE DIGITAL-TO-ANALOG CONVERTER.
This block converts digital information from the microcomputer into three separately controllable output d.c. signals.
These signals provide potentiometer position detection on the IEEE UNIT and start the DTB (after delay time or delay + delta t time) in the COMPARATOR block on the TIME BASE. This block also determines the position of the cursor lines via the signals DC1 and DC2.

CRT text unit

This unit communicates with the CENTRAL PROCESSOR UNIT via the INPUT BUFFERS block. The TEXT MICROCOMPUTER forms the heart of the unit. This block interrupts the normal signal display cycle momentarily if text has to be written on the c.r.t. screen. This is initiated by the output signal NORMAL/TEXT, which interrupts the normal signals for the final Y amplifier, the final X amplifier and the intensity amplifier.

At the same time, the TEXT GENERATOR produces its own raster by starting a slow sweep (´frame TB`) which is applied to the final Y amplifier, and a number of fast sweeps ("line TB") applied to the final X amplifier. As a result,it writes a number of horizontal lines on the screen. The related intensity information applied to the INTENSITY GENERATOR is again generated by the TEXT GENERATOR. The composition of the text is identical to the composition of a television picture.

IEEE unit (optional)

This unit incorporates a digital part and an analog part, the latter being used for IEEE-control of the potentiometers. The heart of the unit consists of the IEEE CONTROL LOGIC that communicates with the CENTRAL PROCESSOR UNIT. This block contains all the circuits required to communicate with the system-bus instruments via the IEEE connector on the rear-panel of the instrument. The IEEE CONTROL LOGIC controls the analog part of the IEEE UNIT via the block "INTERFACE BETWEEN DIGITAL AND ANALOG PART".
The analog part serves two purposes:

- It detects the potentiometer positions and routes this information to the IEEE controller. The POTENTIOMETER POSITION DETECTION IEEE block selects one potentiometer for this purpose. The voltage signal from the potentiometer is compared with a sawtooth voltage from the TRIPLE DIGITAL-TO-ANALOG CONVERTER. If the instantaneous value of the sawtooth equals that from the potentiometer a signal is sent to the CENTRAL MICROCOMPUTER which then registers the potentiometer position since it is also aware of the instantaneous value of the sawtooth (The DAC is controlled by the microcomputer).

- It brings the potentiometer functions under control of the IEEE, whereupon the front-panel controls have no influence. For this purpose the PROGRAMMABLE VOLTAGE SOURCES block contains several voltage sources, one for each potentiometer that must be taken over.
These voltage sources are loaded with a d.c. voltage generated by the output of the TRIPLE DIGITAL-TO-ANALOG CONVERTER on the CENTRAL PROCESSOR UNIT.
The LOCAL/REMOTE SWITCH block permits the oscilloscope circuit to be connected to its associated potentiometer (e.g. Y-POS A) in local mode, or with one of the programmable voltage sources in remote (IEEE) mode.
NOTE: if the IEEE UNIT is not installed, the potentiometer outputs from the INTERMEDIATE UNIT are directly connected to their associated circuits in the oscilloscope.

3.2.3. Vertical attenuator unit

Since channel A and B attenuator units are identical, only channel A is described. The input signal is applied to the vertical input socket. From here the signal is split up into two components; namely:
- the HF (high frequency) component applied to the CAPACITIVE ATTENUATORS block, which gives signal attentuation of x100, x10,or x1,
- the LF and DC (low-frequency and direct current) components applied to the COMPARATOR block. In the input of the COMPARATOR, a d.c. blocking capacitor is present for the AC-coupled mode. This capacitor is short-circuited by a switch contact in the DC-coupled mode.

The output signals from the CAPACITIVE ATTENUATORS and from the COMPARATOR are added and amplified by the SUMMATION STAGE AND OUTPUT AMPLIFIER. This block also enables x5 gain increase for the highest input sensitivity of the instrument. The output signal is routed to the SIGNAL UNIT. A part of the output signal is fed back via the FEEDBACK RESISTORS block to the input of the COMPARATOR where it is compared with the LF and DC components in the input signal. Various feedback resistors can be selected in the FEEDBACK RESISTORS block. This occurs simultaneously with the selection of the attenuation coefficients of the CAPACITIVE ATTENUATORS.
The input impedance of the attenuator unit can be changed from 1M.Ohm to 50 Ohm if the 50-Ohm termination resistor is switched on. If the dissipation in this resistor is excessive, the TEMPERATURE SENSING CIRCUIT gives an alarm to the central micro processor. This alarm is routed via the line that is also used for the probe indicator.

All blocks that are capable of working in different modes (e.g. different attenuation coefficients) are controlled via a CONTROL CIRCUIT from the central microprocessor.This CONTROL CIRCUIT block is not located on the attenuator unit, but is on a separate unit - the ADAPTATION UNIT. The attenuator unit circuits are located on two p.c.b.'s: an HF (high-frequency) unit an and LF (low frequency) unit.

3.2.4. MTB and DTB external trigger unit

This unit incorporates two identical input circuits used external MTB and DTB triggering. Their output signals are routed to the SIGNAL UNIT stage for MTB and DTB triggering.
Each trigger input circuit operates in the same way as the channel A and B attenuators. However, there are fewer attenuation coefficients for the external trigger inputs.
The different modes of this unit are controlled by the central microcomputer via a CONTROL CIRCUIT located on the ADAPTATION UNIT.

3.2.5. Signal unit

This unit incorporates the pre-amplifiers for the vertical A and B channels and the trigger circuits for the MTB and DTB. All these functions are controlled by the contral microcomputer via the CONTROL CIRCUIT FOR THE SIGNAL UNIT block.

Vertical channels A and B
Since both channels are identical, only channel A is described. The signal from the attenuator unit is applied to the CHANNEL A PRE-AMPLIFIER block. This block has a variable gain, influenced by the front-panel VAR potentiometer. The gain is also controllable in steps to give different input sensitivities of the instrument. CHANNEL A PRE-AMPLIFIER has two outputs.
- One output applied to the CHANNEL A TRIGGER PICK-OFF to trigger MTB and/or DTB via channel A.
- The other output signal routed to the DELAY LINE DRIVER. The channel B and the TRIGGER VIEW channel are also added in this block.

The TRIGGER VIEW channel enables display of the MTB trigger source. The TRIGGER VIEW signal is switched in the DELAY LINE DRIVER.
To control the vertical position, either the CHANNEL A POSITION CONTROL block or the CHANNEL B POSITION CONTROL block influences the shift of the DELAY LINE DRIVER signal. This depends on the vertical channel displayed. The DELAY LINE DRIVER also incorporates a bandwidth limiter - a low-pass filter with a cut-off frequency of 20 MHz.

MTB trigger circuit

The MTB HF TRIGGER PATH block receives a trigger signal from one of the vertical channels A or B, or from the MTB external trigger input. One of these signals can be selected for MTB triggering. The HF component in the selected signal is routed to the output of the block provided that HF reject is not on. The LF and DC components are routed through the MTB LF+DC TRIGGER PATH block. Depending on the selected filter mode, the signal is passed through (HF-REject, AC and DC mode) or it is blocked (LF-REject mode).
The output signal from the MTB HF TRIGGER PATH includes the output signal from the MTB LF+DC TRIGGER PATH and is routed to the input of the MTB TRIGGER AMPLIFIER. This block includes the LEVEL MTB and SLOPE functions. A d.c. voltage from the frontpanel LEVEL MTB control is routed via the AUTO LEVEL CONTROL block to the MTB TRIGGER AMPLIFIER. This d.c. voltage determines the instant that a trigger pulse appears on the output. The trigger pulse starts the time-base via the TRIGGER INPUT block.In the AUTO mode of the MTB, the AUTO LEVEL CONTROL ensures that the range of the MTB LEVEL control always lies within the peak-to-peak value of the signal on the c.r.t. screen.
Apart from the MTB trigger pulse output, the MTB TRIGGER AMPLIFIER has two other outputs:
- One carries the TRIGGER VIEW signal applied to the DELAY LINE DRIVER,
- the other input sends a signal to the input switches of the FINAL X AMPLIFIER in order to enable X deflection by a signal from the MTB triggering.

DTB trigger circuit

Basically, this circuit is identical to the MTB trigger circuit. This also has filters (HF TRIGGER PATH, LF+DC TRIGGER PATH) and a DTB TRIGGER AMPLIFIER. However, this amplifier has only one output, which carries the trigger pulse to start the DTB. There is no auto level control, but a Y OUTPUT AMPLIFIER block provides a path to make the DTB trigger signal available at a BNC output socket at the rear of the oscilloscope.

3.2.6. Delay line and final Y-amplifier

The vertical deflection signal from the DELAY LINE DRIVER on the SIGNAL UNIT is applied to the DELAY LINE. This block consists of a long coaxial cable that gives sufficient signal delay to compensate for propagation delay in the trigger circuits. As a result, the leading edge of a fast signal at which triggering occurs is clearly visible on the screen. The output signal from the DELAY LINE is applied to the FINAL Y AMPLIFIER unit. This unit consists of two blocks:
- the FINAL Y AMPLIFIER for driving the vertical deflection system of the c.r.t.
- the TRACE SEPARATION AND TEXT CONTROL, which functions as an input switch for the final amplifier. Depending on the selected display mode the following occurs:

MTB or DTB only: the output signal from the DELAY LINE is directly connected to the input of the FINAL Y AMPLIFIER.

Alternate time base mode: when selected, the displayed signal must be shifted upwards to display the MTB, and downwards to display DTB. The shift distance is adjustable with the front-panel TRACE SEP potentiometer. A signal from the TRACE SEPARATION AND INTENSITY CONTROL block indicates whether the instrument is in the ALT TB mode or not. The CONTROL CIRCUIT FOR SIGNAL UNIT delivers a signal to indicate if MTB (upwards shift) or DTB (downwards shift) is displayed.
Text display mode: in which the signal from the DELAY LINE is not used as an input signal for the final Y amplifier. Instead, a deflection signal is applied from the text display part of the X/Z amplifier (discussed later). The selection between the two input signals is made by the NORMAL/TEXT signal from the CRT TEXT UNIT.

3.2.7. Time base unit

This unit incorporates the main time-base (MTB), the delayed time base unit (DTB) and the input selection switches for the FINAL X AMPLIFIER. All functions are controlled by the central microprocessor via the block CONTROL CIRCUIT FOR THE TIME-BASE. Certain supply voltages that require high degree of accuracy are stabilised by the ADDITIONAL SUPPLY VOLTAGE STABILISATION.

Main time base
The MTB may be started by a trigger pulse applied to the MTB FLIP-FLOP via the TRIGGER INPUT. If the MTB FLIP-FLOP switches over, the current from the MTB CURRENT SOURCE starts to charge a timing capacitor. The sweep time depends on the capacitive value; different selected capacitors are switched into the MTB by the CONTROL CIRCUIT. Thus, a linear sawtooth is generated across the timing capacitor, which can be used for X-deflection. The end of the sawtooth is detected by the TIME BASE END-OF-SWEEP FLIPFLOP, which then activates the HOLD-OFF CIRCUIT. This circuit switches the MTB FLIP-FLOP back so that the MTB sweep is stopped. The HOLD-OFF CIRCUIT keeps the MTB FLIP-FLOP in this position for the selected hold-off time during which further trigger pulses have no effect.The hold-off time is determined by the CONTROL CIRCUIT. The TRIGGER PULSE DETECTION block enables a two-way communication with the central microprocessor as follows:
- it signals to the microprocessor when a trigger pulse occurs,
- it receives a signal from the microprocessor to instruct the MTB whether or not to work in the AUTO (free-run) mode.

The MTB GATE AND ALT PULSE CIRCUIT block converts a signal from the MTB into the MTB GATE OUT pulse (high during MTB sweep); it also provides an ALTernate pulse for display switching to the CONTROL CIRCUIT FOR THE SIGNAL UNIT.

Delayed time-base
The DTB FLIP-FLOP, DELAYED TIME-BASE, DTB CURRENT SOURCE and DTB GATE blocks function in the same way as their counterparts for the MTB. However, some of the DTB functional blocks are simpler. Of special interest is the way in which the DTB is started. The COMPERATOR block plays an important role in this. The block compares the MTB sawtooth signal with a d.c. voltage from the CENTRAL PROCESSOR UNIT. If the instantaneous sawtooth voltage exceeds the d.c. voltage, a signal is sent to the DTB FLIP-FLOP. This flipflop either starts the DTB immmediately (in STARTS DTB mode) or starts it after the receipt of a trigger pulse from the TRIGGER INPUT (in TRIG DTB mode).
In the COMPARATOR, two different d.c. voltages may be selected:
- one for DTB start after the adjusted DELAY TIME
- the other for DTB start after DELAY + delta t.

The selection between these two d.c. voltages is achieved by a control signal from the CONTROL CIRCUIT FOR THE SIGNAL UNIT.

Horizontal display mode switching
In this part of the time-base unit the input signal for the FINAL X AMPLIFIER is selected. The MTB/DTB/X-DEFL SWITCH AND TB MAGNIFIER block enables selection between the MTB sawtooth, DTB sawtooth or the X-deflection signal from the MTB TRIGGER AMPLIFIER. The amplification of this block is increased by a factor of ten if the TB MAGN function is selected. The X POSition shift is also generated in this block. All functions are controlled by the CONTROL CIRCUIT FOR THE TIME BASE. The output signal is applied to a second input switch for the FINAL X AMPLIFIER. This switch is called the HORIZONTAL DISPLAY CONTROL. This block connects the sawtooth input of the FINAL X AMPLIFIER to either the MTB sweep, DTB sweep or X-deflection signal (during normal signal display), or to a deflection signal from the text display part of the final X/Z amplifier unit (discussed later) This selection is made by the NORMAL/TEXT signal from the CRT TEXT UNIT.

3.2.8. Text part of the X/Z amplifier

This part of the circuit is responsible for the vertical and horizontal deflection during the cycle in which text or cursors are displayed. The output of the Y DEFLECTION SELECTOR AND BUFFER STAGE block produces the deflection voltage for the Y-deflection. The output of the X DEFLECTION SELECTOR AND BUFFER STAGE block produces the X-deflection voltage. Each selector has five inputs; the selected input to be connected to the output is determined by the address code coming from the CRT TEXT UNIT. Both selectors receive the same address code and select identical positions.
The five possible switch positions are:

- Position 1: the mode during which text is written on the c.r.t. screen. The Y-deflection is derived from the Y-SWEEP GENERATOR which produces a relatively slow sawtooth (started by the CRT TEXT UNIT). During the sawtooth, the whole screen can be written. The X-deflection is derived from the X-SWEEP GENERATOR which produces a number of fast sawtooth signals (started by the CRT TEXT UNIT). During one sawtooth, one horizontal line is written.

- Position 2 and 3: the mode in which a pair of vertical (time) cursor lines is written on the screen. In position 2, one X-sweep is generated and applied to the Y-deflection. The X-deflection receives a fixed d.c. voltage (DC1).
In Position 3, another X-sweep is generated and again applied to the Y-voltage. The X-deflection receives a fixed d.c. voltage (DC2). Since DC1 and DC2 are different voltages, a complete cycle results in two vertical lines being written on the screen. The horizontal distance between the lines depends on the voltage difference between DC1 and DC2.

- Position 4 and 5: the positions in which a pair of horizontal (volt) cursor lines is written on the screen.
In position 4, one X-sweep is generated and applied to the X-deflection. The Y-deflection receives a fixed d.c. voltage (DC1).
In position 5, another X sweep is generated and again applied to the X-deflection. The Y deflection receives a fixed d.c. voltage (DC2).
Since DC1 and DC2 are different voltages, the complete cycle results in two horizontal lines being written on the screen. The vertical distance between the lines depends on the voltage difference between DC1 and DC2.

3.2.9. Intensity and focusing part of X/Z amplifier

This part of the block diagram determines the intensity and focusing of the spot on the c.r.t. screen. The intensity is controlled by electrode G1 of the c.r.t. Electrode G3 controls the focusing. Since focusing and intensity are inter-related, the focusing of the spot has to be independent of the intensity.
Intensity (and focusing) can be determined either by the text generator part or during the normal signal display by the display mode logic. The selection between the two is made by the NORMAL/TEXT SWITCH block with the NORMAL/TEXT signal from the CRT TEXT UNIT.
In the text display mode, the intensity (Z) signal is derived from the CRT TEXT UNIT. This signal is applied to the TEXT INTENSITY PREAMPLIFIER. The intensity can be manually adjusted via the READ-OUT INTENSITY potentiometer.
In the signal display mode, the intensity signal is derived from the INTENSITY PRE-AMPLIFIER. This block receives the following intensity determining input signal:
- a display blanking signal during switch-over from one vertical channel to another in the CHOP display mode. This signal originates from the CONTROL CIRCUIT FOR THE SIGNAL UNIT.
- a signal from the Z-LOGIC on the TIME-BASE unit. This signal gives a blanked display during the hold-off period of the MTB and flyback of the trace. The display intensity-changes in the MTB intensified mode are also determined by this signal.
- an external signal applied to the Z-MOD input socket for determining the intensity.

The output signal from the NORMAL/TEXT SWITCH is split between the FOCUS AMPLIFIER and the INTENSITY AMPLIFIER. The outputs of both amplifiers are connected to the G3 and G1 electrodes of the c.r.t. Since these electrodes are at a high negative potential, the amplifier outputs are connected via high-voltage blocking capacitors to the c.r.t. These allow only the high-frequency components of the signal to pass and block the low-frequency (LF) and direct-current (DC) components. For this reason, the LF and DC components from the INTENSITY AMPLIFIER output are filtered out and applied to a MODULATOR. This superimposes the LF and DC components on to a high-frequency carrier wave to allow them to be passed via a high-voltage blocking capacitor. Following the capacitor (at -3.4 kV level), the signal is demodulated by an INTENSITY DEMODULATOR and a FOCUS DEMODULATOR.
The output signals from the demodulators (LF+DC components) are re-comined with the HF components received via the blocking capacitors to give the original signals. The Z signal is applied to G1 of the c.r.t. and the focus signal to G3. The focus signal for the c.r.t. spot is also influenced manually via the FOCUS CONTROL CIRCUIT.

3.2.10. Power supplies.

Primary converter.
The mains input voltage is filtered and then applied to two identical blocks, namely, PRIMARY CONVERTER MAINS VOLTAGE TO 24 VDC. Two units are switched in parallel in order to obtain the required output power. The two output voltages, each 24 VDC, are connected in series to give 48 VDC for the SECONDARY CONVERTER UNIT. The primary converters cover all common mains voltage ranges and offer the necessary separation required between the mains voltage and the oscilloscope circuits.

Secondary converter
On this unit, the FLYBACK CONVERTER generates the necessary supply voltages for the oscilloscope circuits. These low-voltage supplies are stabilised by a CONTROL CIRCUIT to the converter. The unit also incorporates the LINE TRIGGER CIRCUIT. This block receives an input signal from the MAINS FILTER and converts this into a 50/60 Hz sinewave of constant amplitude by comparing it with a reference voltage. This signal is used for MTB LINE triggering. The CONTROL CIRCUIT block also generates an alarm signal for the CENTRAL PROCESSOR UNIT to safequard data in the event of mains switch-off or failure, when back-up batteries are fitted. The FAN CONTROL CIRCUIT monitors the temperature inside the instrument by means of a sensor on the MOTHER BOARD. If necessary the FAN speed is automatically adapted, depending on the measured temperature.

High voltage converter
This unit generates the +21 kV for the post-accelerator anode of the c.r.t. and the -3,4 kilovolt for the cathode circuits.The supply voltage from the secondary converter unit is applied to a FLYBACK CONVERTER with a CONTROL CIRCUIT for output voltage stabilisation. The SUPPLY VOLTAGE SENSOR prevents the FLYBACK CONVERTER from starting in the case where the supply voltage is too low. The output a.c. voltage from the converter is rectified to give -3,4 kV and a rectified output is multiplied to give +21 kV.

3.2.11 Auxiliary circuits on mother board

Trace rotation
This block determines the strength and sense of the current passed to the trace rotation coil around the neck of the c.r.t. The trace rotation circuit is adjustable by a front-panel screwdriver-operated TRACE ROT control.

Illumination circuit
This block determines the amount of current passed to the graticule illumination lamps of the c.r.t., controlled by the ILLUM potentiometer on the front panel.

Frequency divider and output amplifier
This block divides the 3 MHz clock frequency from the central microprocessor to a 5 KHz square-wave. This square-wave signal is amplified and stabilised to give a 0,8 V output on the CAL voltage output socket.

CONTENTS

4. CIRCUIT DESCRIPTION OF LCD UNIT 4-1
4.1 Parts list 4-6

FIGURES

4.1. LCD-unit, p.c.b. lay-out. 4-2
4.2. LCD-unit, circuit diagram. 4-4
4.3. Time relation of input signals of LCD-drivers. 4-4

4. CIRCUIT DESCRIPTION OF LCD UNIT (see fig. 4.2.)

The LCD unit incorporates five liquid-crystal displays, each fed from its own driver IC (D101 - D106). The 4 V supply voltage for the driver ICs (pin 2) is derived from the +13,8 V supply input on X101 pin 6 via transistor V101 and its associated circuit. Since the base-emitter voltage of V101 is influenced by the ambient temperature, so is the 4 V supply voltage. The voltage variation is from 4.5 V to 3.5 V over a temperature range between 0 and 80 degrees. This serves to compensate for LCD intensity changes due to variations in ambient temperature.

Each driver controls a maximum of 64 segments of the LCD in two groups of 32 segments; i.e. 32 segment outputs +2 groupselection outputs. Either group 1 of 32 segments (backplane 1) or group 2 or 32 segments (backplane 2) is activated at a time. Each of the 32 outputs (S1 - S32) is connected to two segments in the LCD, one segment opposite backplane 1 and the other opposite backplane 2.
When information is applied to the driver outputs, with BP1 active, it is routed to activate the chosen segments opposite backplane 1; then a moment later, when BP2 is active, information is generated to activate the chosen segments opposite backplane 2, and so on.
The switching between BP1 and BP2 occurs at a frequency of about 2500 Hz derived from the oscillator section of D106 (pins 2, 3 and 4). This frequency is determined by the external RC combination R113/C101. The other drivers D101 - D104 share this 2500 Hz signal (pins 37 and 38 paralleled), therefore their oscillator sections are not used (pins 3 and 4 are earthed).

Each LCD driver has three inputs driven from the central microcomputer:
- LCD (pin 40), a data latch enable input used to select the correct driver from D101 - D106. If pin 40 is at logic high, the LCD is selected to accept data. Conversely, a logic low inhibits data.
- SERCLK (pin 1) is the clock input.
- DATA1 (pin 39) is the signal information input. The clock input receives a row of 35 pulses (see Fig.4.3). In parallel with these clock pulses, a row of 34 data-bits is applied to the DATA input. The data is valid at the negative-going edge of each clock pulse. The row of data-bits starts with a zero start bit. Then the following 32 data-bits determine which of the 32 segments of a row must be activated (data-bit high) and which must remain inactive (data-bit low).
The last data-bit determines for which backplane the data is intended, LCD backplane 1 (data-bit high) or LCD backplane 2 (data-bit low).
This 35th clock pulse ends the information loading cycle.

The clock signals are common to all drivers, as also the DATA 1 signals. The correct LCD driver is selected to receive the applied data pulses by a high logic level on the LCD input, pin 40.

The interconnection and level adaptation between the 5 V TTL microcomputer signals and the LCD drivers that operate on a 4 V supply is achieved by the high-ohmic resistors R101 - R108.

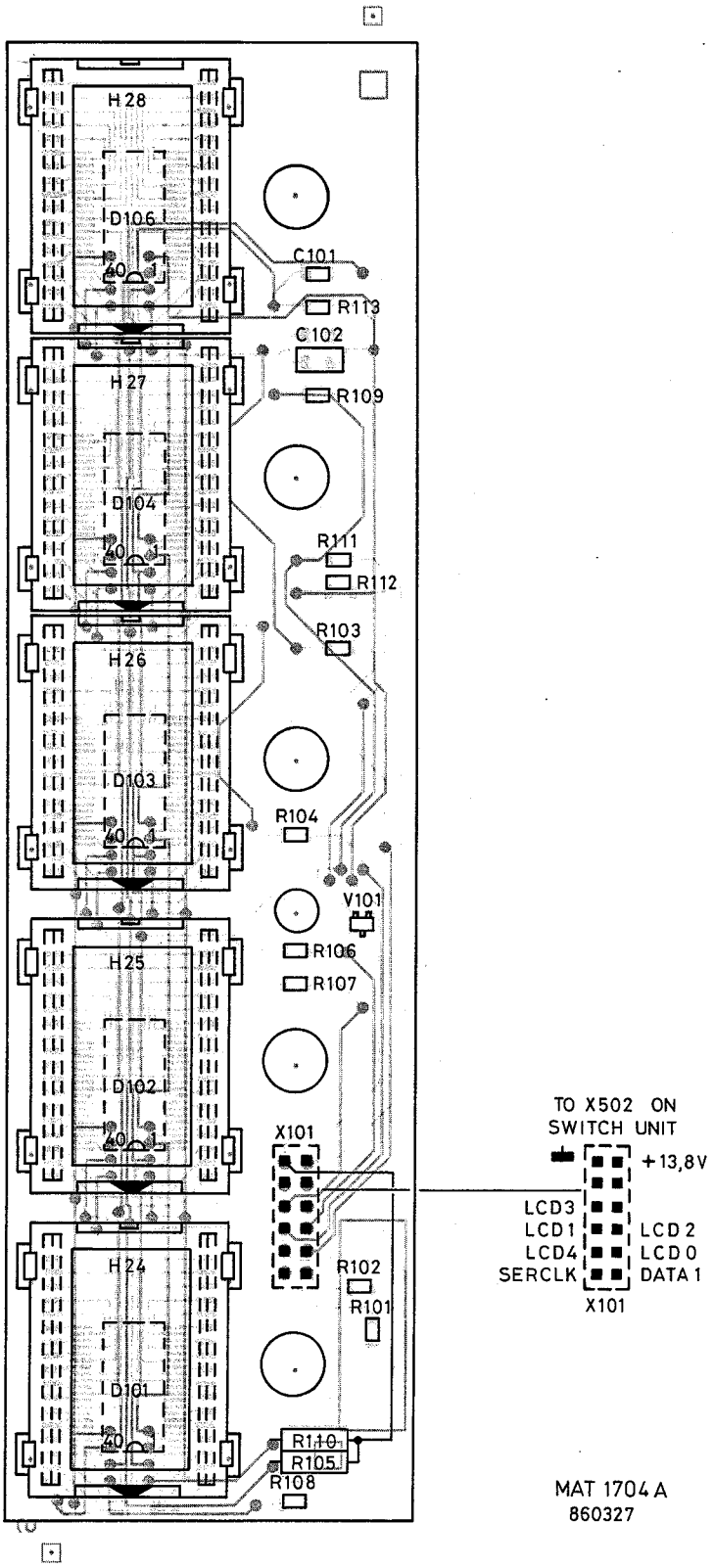


Fig.4.1. LCD-unit, p.c.b. lay-out.

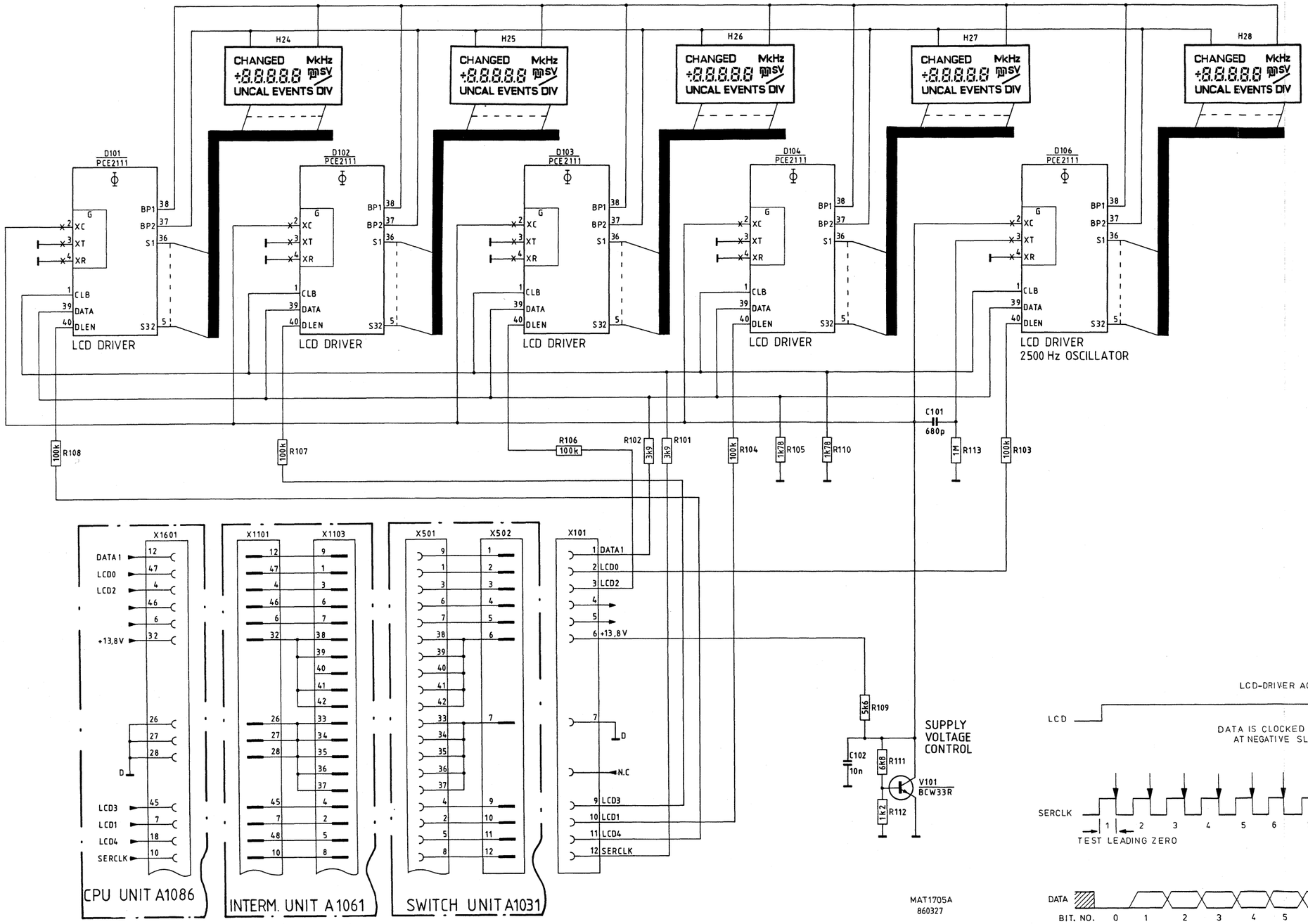


Fig.4.2. LCD-unit, circuit diagram.

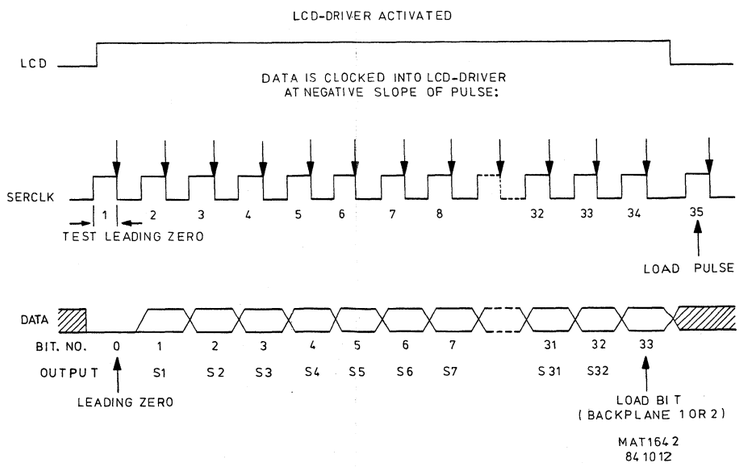


Fig.4.3. Time relation of input signals of LCD-drivers

4.1 PARTS LIST

In this section only electrical parts presents on this unit are listed.
Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

4.1.1 CAPACITORS

POSNR	DESCRIPTION	ORDERING CODE
C 0101	50V 5% 680PF	4822 122 31775
C 0102	50V 10% 10NF	4822 122 31728

4.1.2 INTEGRATED CIRCUITS

POSNR	DESCRIPTION	ORDERING CODE
D 101	PCF 2111T	5322 209 82942
D 102	PCF 2111T	5322 209 82942
D 103	PCF 2111T	5322 209 82942
D 104	PCF 2111T	5322 209 82942
D 106	PCF 2111T	5322 209 82942

4.1.3 RESISTORS

POSNR	DESCRIPTION	ORDERING CODE
R 101	3K9	5322 111 91135
R 102	3K9	5322 111 91135
R 0103	RC-01 5% 100K	4822 111 90214
R 0104	RC-01 5% 100K	4822 111 90214
R 105	1K78	5322 116 53208
R 0106	RC-01 5% 100K	4822 111 90214
R 0107	RC-01 5% 100K	4822 111 90214
R 0108	RC-01 5% 100K	4822 111 90214
R 0109	RC-01 5% 5K6	4822 111 90572
R 110	1K78	5322 116 53208
R 0111	RC-01 5% 6K8	4822 111 90544
R 0112	RC-01 5% 1K2	5322 111 90096
R 0113	RC-01 5% 1M	5322 111 90094

4.1.4 SEMI CONDUCTORS

POSNR	DESCRIPTION	ORDERING CODE
V 0101	BCW33R PEL	5322 130 44342

CONTENTS

5. CIRCUIT DESCRIPTION OF SWITCH UNIT. 5-1
5.1 Parts list 5-9

5

FIGURES

5.1. Time relation of input signals of LED drivers. 5-2
5.2. Switch unit, p.c.b. lay-out. 5-3
5.3. Switch unit, circuit diagram. 5-5

5. CIRCUIT DESCRIPTION OF SWITCH UNIT (See fig. 5.3.)

The switch panel unit incorporates the following main functions:
- the front-panel pushbutton switches grouped in a matrix configuration.
- the front-panel LEDs located in the pushbutton switches and the associated LED drivers.
- the step controls for vertical sensitivity and time-base setting and the DELAY or delta t continuous control.

These main functions are now discussed in more detail.

Pushbutton switches
These switches are located on the crossing points of an 8 x 8 wire matrix: eight horizontal rows 0 to 7 and eight vertical columns 0 to 7. The rows and columns are connected to the CPU unit, which scans the switch positions (see CPU unit circuit description).

The control circuitry for the LED's.
output signals and LED drivers
The LEDs in the pushbuttons are divided into two groups of 32 and driven by the LED driver ICs N501, N502, each with 16 output pins. Each output is derived from an open-collector NPN transistor and drives two LEDs. The anode of one LED of a pair can be switched via transistor V504 to the +5 V supply, the anode of the other LED is switched by transistor V507. Transistors V504 and V507 are switched on and off aternately; i.e. when one is on, the other is off.

This alternate switching for the diode groups is controlled by the 800 Hz square-wave oscillator formed by D503/1,2,3 and R501/C501.
The 800 Hz square-wave is routed via diode V502, network R502/C503, inverter D503/12,13,11, and transistor V503 to V504. The 800 Hz square-wave is also routed via diode V501, and an identical circuit, to transistor V507.
The RC networks R502/C503, R503/C502 give a time delay, which ensures that the switching transistors V504 and V507 are not conductive at the same time.

In addition, the 800 Hz square-wave is routed to two LED drivers N501, N502 on input pins 7. Depending on the logic level applied to pin 7, the sixteen outputs of a LED driver generate the correct control signals for the sixteen LEDs connected to switching transistor V504, or they generate the correct control signals for the sixteen LEDs connected to switching transistor V507. Both LED driver ICs incorporate two registers, each of 16 bits. A register contains the control information for a group of sixteen LEDs. If control pin 7 is at logic low, the contents of the first register are applied to the outputs of the LED driver. If pin 7 is high, the contents of the second register are applied to the outputs.

Input signal for the LED drivers.

Similar to the LCD drivers, the LED drivers also have three input pins:
- input pin 5, used to select either driver N501 or N502 (LED 0 or 1). A logic high enables the driver to accept data.
- input 9, the clock (SERCLK) input.
- input pin 8 is the data input. The clock input receives a row of pulses as shown in Fig. 5.1. In parallel with the clock pulses, a row of data-bits is applied to the data input. The first bit is a logic low start signal; the following 16 bits are loaded into one of the two registers, depending on the 18th data bit (low for the first register, high for the second).

The clock input is common to the two LED drivers, N501, N502. Likewise the data input on pins 8 is common, selection of the appropriate driver being made by a logic high input signal on pin 5 of either N501 or N502.

The rotary switches for vertical sensitivity, MTB, DTB and delay-time. These controls are optical switches formed by LEDs and photo-transistors. Each switch consists of a perforated disc through which the light from two infra-red LEDs falls on two photo-sensitive transistors. If the switch is operated, the movement is detected by the photo-transistors. The dual LEDs and photo-transistors also detect whether the switch movement is clockwise or anticlockwise (see intermediate unit circuit description). The infra-red LEDs are located on the rear of the switch unit. LEDs H501...H506 are supplied with a d.c. current from the +13 V rail via R 514. LEDs H507...H512 are similarly supplied via R516. The perforated discs and their encapsulation are also mounted on the switch print unit.

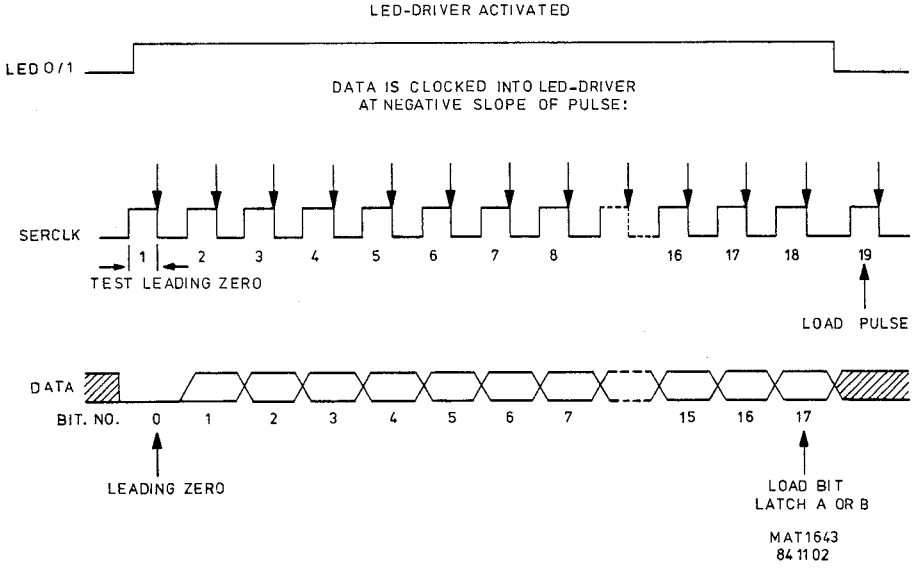
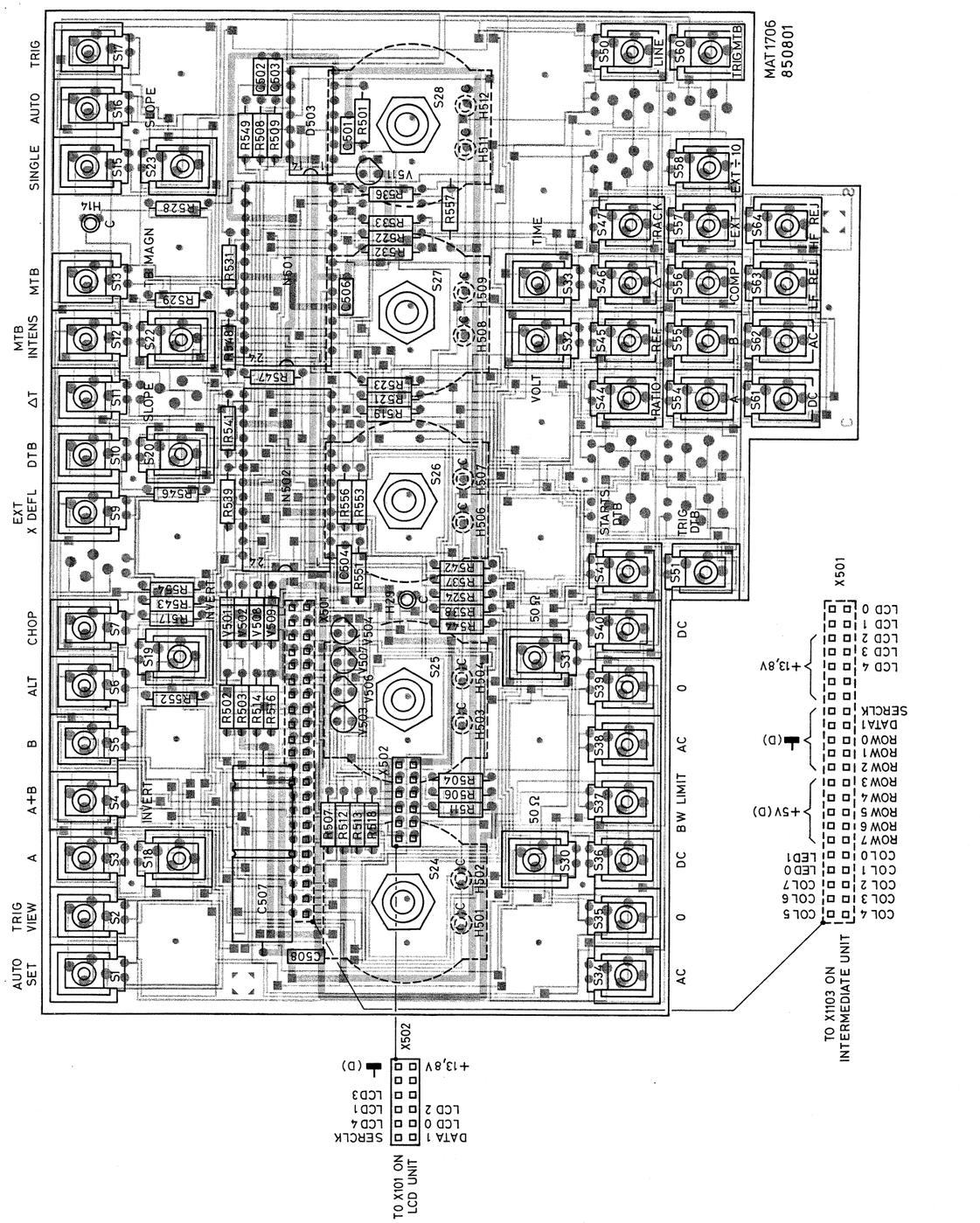


Fig.5.1. Time relation of input signals of LED drivers



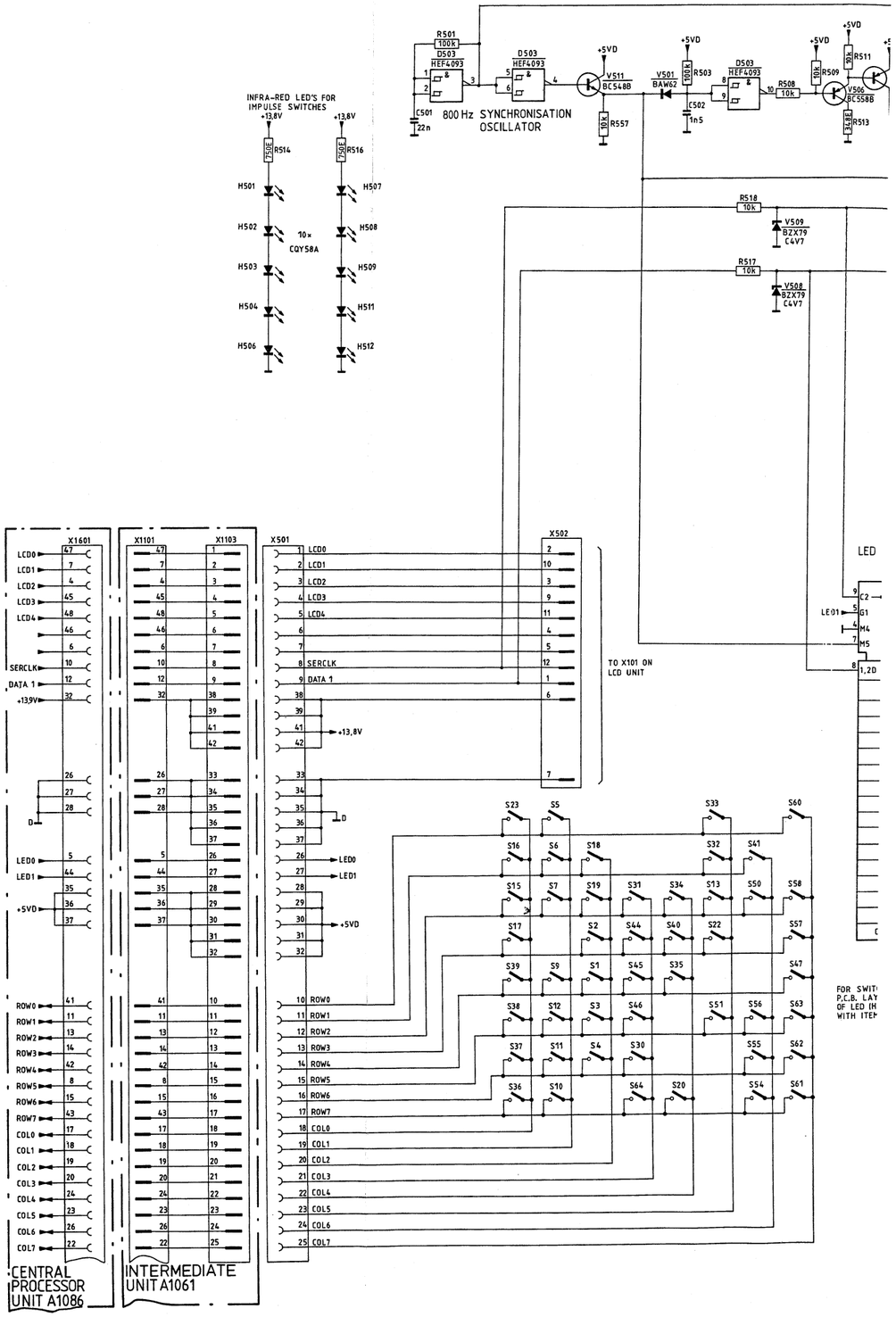


Fig.5.2. Switch unit, p.c.b. lay-out.

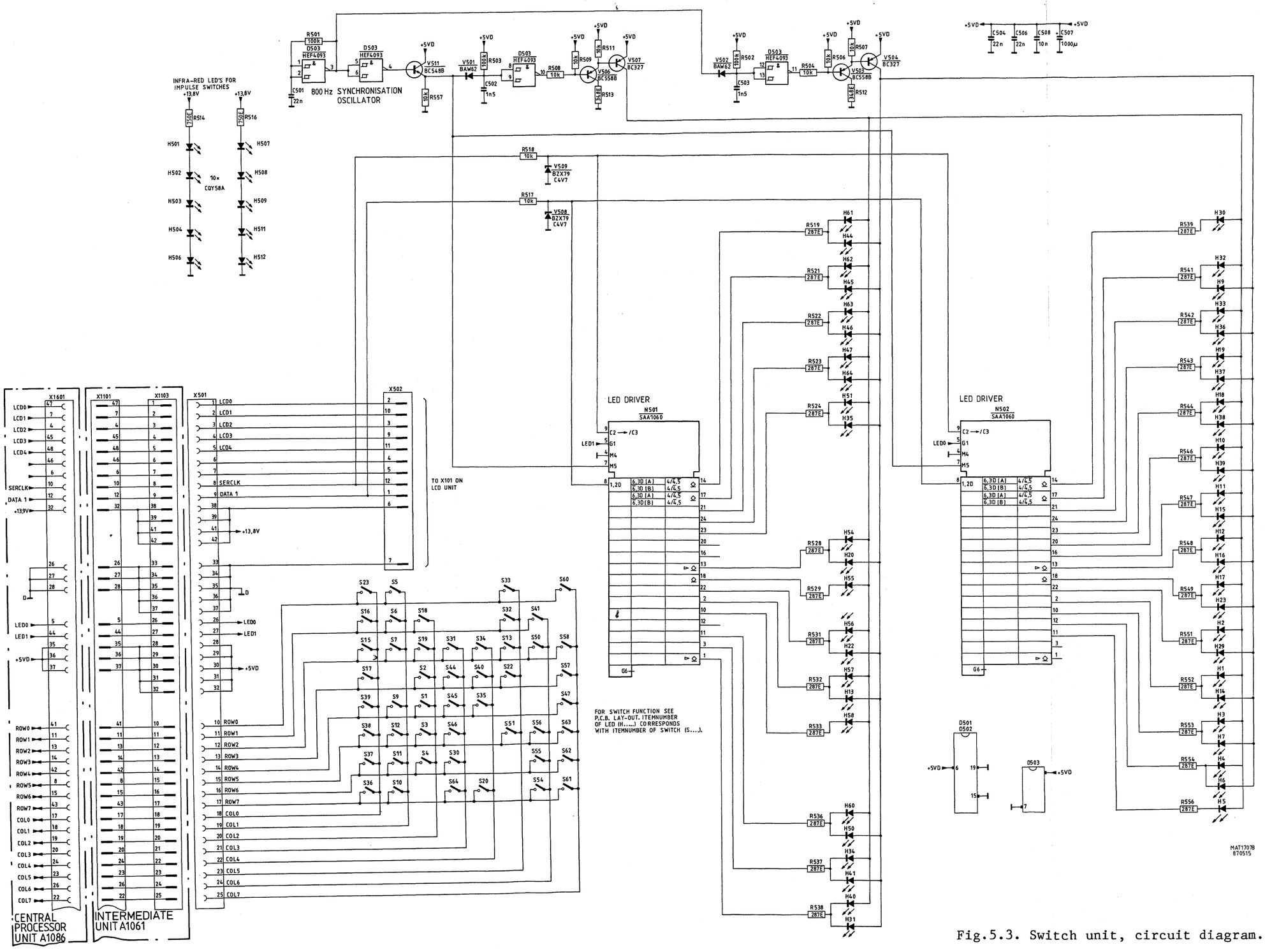


Fig.5.3. Switch unit, circuit diagram.

5.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

5.1.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 0501	CAP.CERAMIC	-20+80%	22NF	4822 122 30103
C 0502	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 0503	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 0504	CAP.CERAMIC	-20+80%	22NF	4822 122 30103
C 0506	CAP.CERAMIC	-20+80%	22NF	4822 122 30103
C 0507		-10+50%	1000UF	4822 124 20768
C 0508		-20+50%	10NF	4822 122 31414

5.1.2 INTEGRATED CIRCUITS

D 0503	INTEGR.CIRCUIT	HEF4093BP	PEL	5322 209 14927
N 0501	INTEGR.CIRCUIT	SAA1060	PEL	4822 209 80512
N 0502	INTEGR.CIRCUIT	SAA1060	PEL	4822 209 80512

5.1.3 RESISTORS

R 0501	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 0502	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 0503	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 0504	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0506	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0507	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0508	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0509	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0511	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0512	RES.METAL FILM	MR25	1%	348E	5322 116 54515
R 0513	RES.METAL FILM	MR25	1%	348E	5322 116 54515
R 0514	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 0516	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 0517	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0518	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 0519	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0521	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0522	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0523	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0524	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0528	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0529	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0531	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0532	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0533	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0536	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0537	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0538	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0539	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0541	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0542	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0543	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0544	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0546	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0547	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 0548	RES.METAL FILM	MR25	1%	287E	5322 116 54506

R 0549	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0551	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0552	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0553	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0554	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0556	RES.METAL FILM	MR25	1% 287E	5322 116 54506
R 0557	RES.METAL FILM	MR25	1% 10K	4822 116 51253

5

5.1.4 SEMI CONDUCTORS

H 0501	DIODE	CQY58A-I	PEL	5322 130 31643
H 0502	DIODE	CQY58A-I	PEL	5322 130 31643
H 0503	DIODE	CQY58A-I	PEL	5322 130 31643
H 0504	DIODE	CQY58A-I	PEL	5322 130 31643
H 0506	DIODE	CQY58A-I	PEL	5322 130 31643
H 0507	DIODE	CQY58A-I	PEL	5322 130 31643
H 0508	DIODE	CQY58A-I	PEL	5322 130 31643
H 0509	DIODE	CQY58A-I	PEL	5322 130 31643
H 0511	DIODE	CQY58A-I	PEL	5322 130 31643
H 0512	DIODE	CQY58A-I	PEL	5322 130 32158
V 0501	DIODE	BAW62	PEL	4822 130 30613
V 0502	DIODE	BAW62	PEL	4822 130 30613
V 0503	TRANSISTOR	BC558B	PEL	4822 130 44197
V 0504	TRANSISTOR	BC327	PEL	4822 130 40854
V 0506	TRANSISTOR	BC558B	PEL	4822 130 44197
V 0507	TRANSISTOR	BC327	PEL	4822 130 40854
V 0508	DIODE,REFERENCE	BZX79-C4V7	PEL	4822 130 34174
V 0509	DIODE,REFERENCE	BZX79-C4V7	PEL	4822 130 34174
V 0511	TRANSISTOR	BC548B	PEL	4822 130 40937

INTERMEDIATE UNIT 6

CONTENTS

6. CIRCUIT DESCRIPTION OF THE INTERMEDIATE UNIT. 6-1
6.1 Parts list 6-9

FIGURES

6.1. Mechanical lay-out of an optical switch. 6-3
6.2. Intermediate unit, p.c.b. lay-out. 6-4
6.3. Intermediate unit, circuit diagram. 6-6

6. CIRCUIT DESCRIPTION OF THE INTERMEDIATE UNIT (see fig.6.3)

This unit incorporates the following control elements:
- potentiometers R1 - R11 and their switching logic
- photo-sensitive transistors for the optical switches, their switching and detection logic.

The potentiometers
All potentiometers are paralleled between earth and the +10 V line, stabilised by the voltage stabiliser N1111. A built-in reference voltage of 7.5 V on pin 6 is applied to the non-inverting input (pin 5) of a comparator. The inverting input (pin 4) is connected to potentiometer R1164 of a voltage divider to compare the reference voltage with a part of the output. Any difference is corrected by N1111. The output voltage is available on pin 10, the output flowing through the currentsensing resistor R1162. The voltage across R1162 is measured on pins 2 and 3 of N1111. If this voltage exceeds 0.7 V, the output voltage on pin 10 cuts off.

The eleven potentiometers can be divided into three groups:
-potentiometers that have no connection with the circuits on the intermediate unit: the slider voltage is directly routed to its associated analog circuit via connector X1102; namely R10 (HOLD OFF), R9 (TRACE SEP), R4 (X POS) and R3 (LEVEL DTB).
-potentiometers connected with circuits on the unit and also directly routed to associated analog circuits via connector X1102; namely, R6 (VAR A), R7 (VAR B), R8 (VAR DTB) and R11 (VAR MTB). On the intermediate board, it is necessary to detect whether or not these potentiometers are in the CAL position. Therefore, each is resistor-connected to a separate input on IC D1102. The function of this IC is explained later.
-potentiometers that can only connect with their analog circuits via the intermediate unit circuits; namely, R1 (A POS), R2 (B POS) and R5 (LEVEL MTB). The analog circuits normally connected to the sliders of these potentiometers are disconnected in the AUTO SET mode by IC D1101 and connected to fixed d.c.voltages. Multiplexer D1101 has three two-position switches. Depending on an addres code on pins 9, 10 and 11, the three switches can select the required position. The switch interconnections with the AUTO SET mode on and off are as follows:

	OUTPUTS		
AUTO SET	PIN 14	PIN 15	PIN 4
OFF	TO PIN 13 (Slider R1)	TO PIN 1 (Slider R2)	TO PIN 3 (Slider R3)
ON	TO PIN 12 (+5 V supply)	TO PIN 2 (+5 V supply)	TO PIN 5 (+3.85 V from R1123/R1124)

The address code for the multiplexer is generated by an addressable latch D1103, which receives the following control signals from the microcomputer:
- the address that determines the output to be changed is applied to pins 1, 2 and 3.
- pin 13 receives a low or high level that is transferred to the selected output.
- a low level on pin 14 enables D1103 to accept data.

Position detection for potentiometers
The potentiometer sliders of R1, R2, R5, R6, R7, R8 and R11 are connected via resistors to inputs of the analog multiplexer D1102, a 16-position switch. Depending on the 4-bit address applied to pins 10, 11, 13, 14, one of the sixteen inputs is connected to the output (pin 1). In this situation, only seven inputs (pins 3 - 9) of D1102 are used.
By changing the address of the multiplexer, all slider voltages are available in sequence on pin 1 of D1102. These slider voltages are thus applied to a double comparator circuit with the operational amplifiers N1104/5,6,7, and N1104/2,3,1.
N1104/5,6,7: the -ve input is connected to +5 V. This comparator operates via the + input if R1, R2 or R5 are moved through their mid-position. If the slider voltage from R1, R2 or R5 rises above +5 V, the output of this comparator rises from 0 to +13 V. This output signal is routed via D1106 pins 7 and 3 to the microcomputer. D1106 is described together with the optical switches.
N1104/3,2,1: The -ve input is connected to a d.c. voltage of +0.38 V. This comparator operates via the + input whether or not R6, R7, R8 and R11 are in their CAL position. If the slider voltage of R6, R7, R8 or R11 rises above +0.38 V, the output of the comparator rises from 0 to +13 V. This output signal is routed via D1108 pins 7 and 3 to the microcomputer. D1108 is described together with the optical switches.

Position detection for optical switches
The rotation of the A channel Y AMPL switch is detected by the photo-transistors H1104 and H1111. If the control is turned from one position to another, light from the infra-red LEDs falls in H1104 and H1111, pulsed via the holes in the perforated disc. As a result, the photo-transistors conduct for some time and their collectors are low (see Fig. 6.1)
The collectors of H1101, H1102, H1103 and H1104 are connected to multiplexer D1106. The collector of H1106 is connected via an inverter D1107/5,6, to D1106. In addition, the output of the operational amplifier N1104/7 is connected to D1106. The multiplexer D1106 is an 8-position switch. When an address is applied to pins 9,10 and 11, output pin 3 is connected with one of the inputs.
If one of the collectors of H1101 - H1104 becomes low, transistor V1113 conducts, giving a high logic level via inverter D1107/1,2, and gate D1109/11,12,13 to the restart (RST 6,5) of the microprocessor. This restart pulse immediately causes the microprocessor to generate different addresses for the multiplexer; as a result, all the inputs are scanned for a while. If the input is reached that is connected with the photo-transistor of the operated switch, the multiplexer stays stable;i.e. it remains connected to the switch while it is being operated. The number of steps made by the switch results in an identical number of pulses at the collector of its photo-transistor. These pulses are routed to the microprocessor via D1106 and inverter D1107.

Figure 6.1. shows that every optical switch has two photo-transistors in order to detect the direction of switch-rotation. The first photo-transistor is connected to multiplexer D1106 as described. The second photo-transistor is connected to an identical second multiplexer D1108. The photo-transistors H1104 and H1111 are used for Y AMPL channel A; H1101 and H1107 are used for Y AMPL channel B; H1103 and H1109 are used for DEL'D TB; H1106 and H1112 are used for DELAY or delta t; H1102 and H1108 are used fro MAIN TB.

The circuit comprising gates D1109/1,2,3, D1109/4,5,6, D1109/8,9,10, and the associated components, detect if the control DELAY or delta t is operated. As this control has no mechanical stop, it may be that photo-transistor H1112 is permanently conducting in its rest position. However, this does not result in a RST 6,5 pulse to the microprocessor via gate D1109/11,12,13. This blocking effect is achieved by capacitors C1117 and C1118, which ensure that only changes in the state of the collector of H1112 are routed to RST 6,5 of the microprocessor.

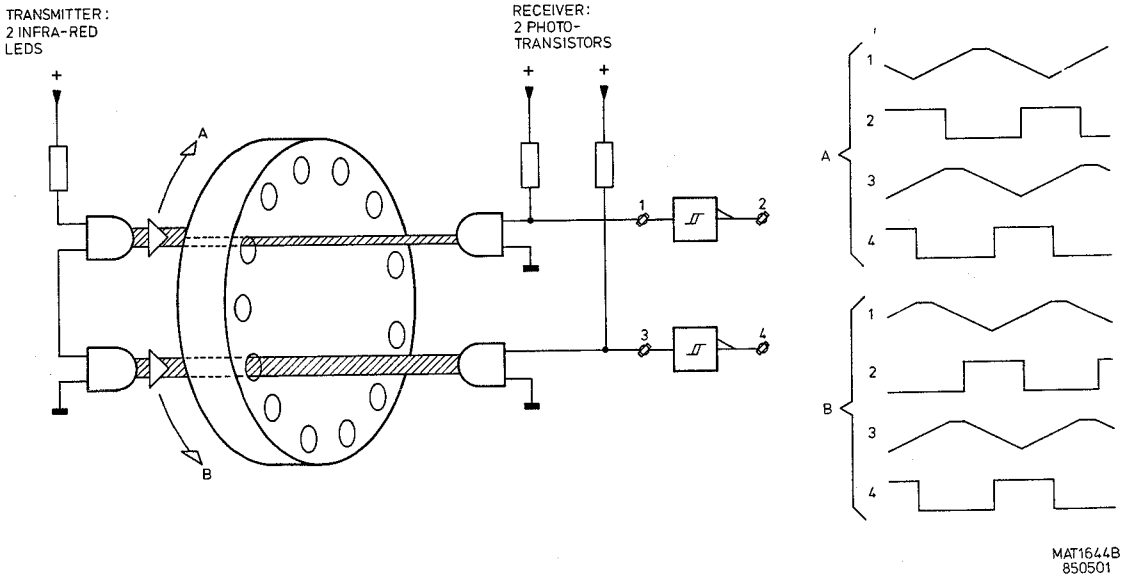


Fig.6.1. Mechanical lay-out of an optical switch.

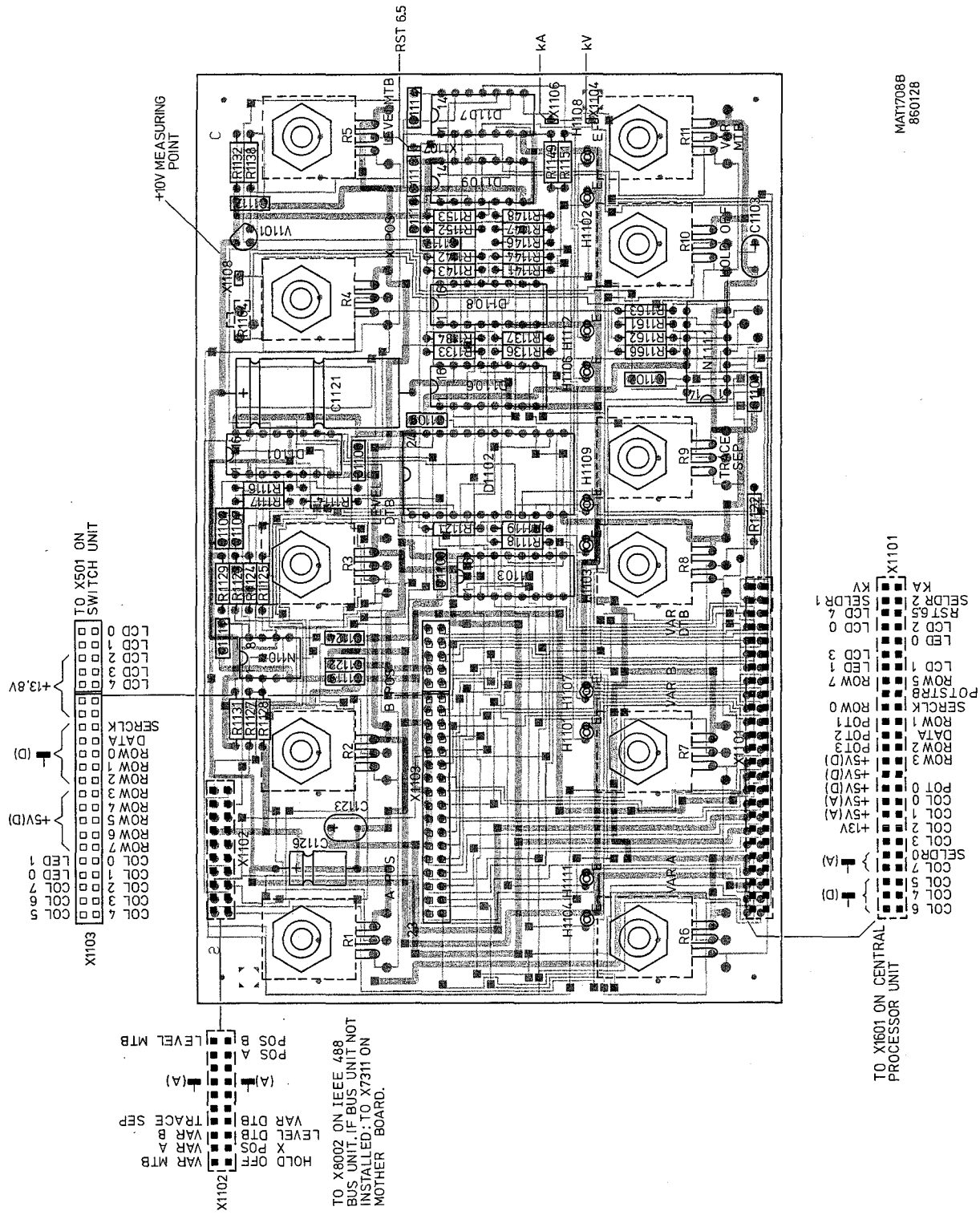
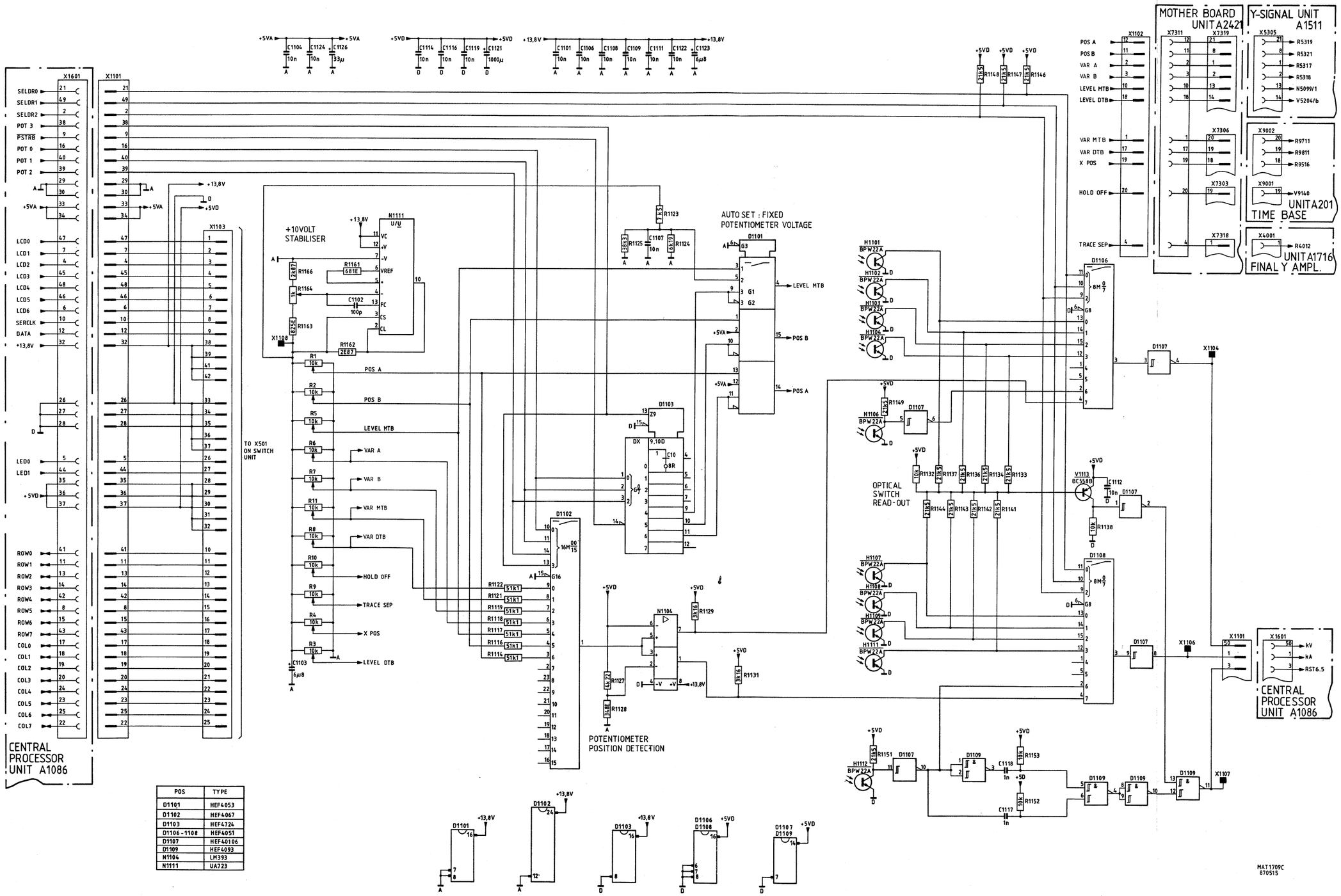


Fig.6.2. Intermediate unit, p.c.b. lay-out.



POS	TYPE
D1101	HEF4053
D1102	HEF4067
D1103	HEF4724
D1106 - 1108	HEF4051
D1107	HEF40106
D1109	HEF4093
N1104	LM393
N1111	UA723

Fig.6.3. Intermediate unit, circuit diagram.

6.1 PARTS LIST

In this section only electrical parts present on this unit are listed.
Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

6.1.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 1101	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1102	CAP.CERAMIC	2%	100PF	4822 122 31316
C 1103	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 1104	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1106	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1107	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1108	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1109	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1111	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1112	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1114	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1116	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1117	CAP.CERAMIC	10%	1NF	4822 122 30027
C 1118	CAP.CERAMIC	10%	1NF	4822 122 30027
C 1119	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1121	CAP.ELECTROLYT.	-10+50%	1000UF	4822 124 20768
C 1122	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1123	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 1124	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1126	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 1623	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 1624	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 1627	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1628	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1629	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1638	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1639	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1641	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1642	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1643	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1644	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1646	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1648	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1657	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 1661	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 1662	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 1663	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 1664	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069

6.1.2 INTEGRATED CIRCUITS

D 1101	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 1102	INTEGR.CIRCUIT	HEF4067BP	PEL	5322 209 14513
D 1103	INTEGR.CIRCUIT	HEF4724BP	PEL	4822 209 10316
D 1106	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
D 1107	INTEGR.CIRCUIT	HEF40106BP	PEL	4822 209 10318
D 1108	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
D 1109	INTEGR.CIRCUIT	HEF4093BP	PEL	5322 209 14927
N 1104	LM393P			4822 209 81223
N 1111	UA723CN SIG			5322 209 85889

6.1.3 RESISTORS

R1-R11					5322 103 50018
R 1114	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1116	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1117	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1118	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1119	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1121	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1122	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 1123	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 1124	RES.METAL FILM	MR25	1%	6K19	5322 116 53263
R 1125		MRS25	1%	38K3	4822 116 53526
R 1127	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 1128	RES.METAL FILM	MR25	1%	348E	5322 116 54515
R 1129	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 1131	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 1132	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1133	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1134	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1136	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1137	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1138	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1141	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1142	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1143	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1144	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1146	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1147	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1148	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1149	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1151	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1152	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1153	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1161	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 1162	RES.METAL FILM	MR25	1%	2E87	5322 116 53179
R 1163	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 1164	POTM.TRIMMER	MTP10	20%	1K	5322 101 10294
R 1166	RES.METAL FILM	MR25	1%	2K87	5322 116 55279

6.1.4 SEMI CONDUCTORS

H 1101	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1102	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1103	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1104	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1106	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1107	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1108	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1109	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1111	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
H 1112	TRANSISTOR	BPW22A-II	PEL	5322 130 42107
V 1101	TRANSISTOR	BC558B	PEL	4822 130 44197

CENTRAL PROCESSOR UNIT AND HEF 4094 BUS 7

CONTENTS

7. CIRCUIT DESCRIPTION OF CENTRAL PROCESSOR UNIT AND HEF 4094 BUS.
7.1. Circuit description of CPU diagram 1. 7-1
7.2. Circuit description of CPU diagram 2. 7-3
7.3. Circuit description of CPU diagram 3. 7-5
7.4. Description of HEF 4094 bus. 7-6
7.5. Parts list 7-16

7

FIGURES

7.1. HEF 4094-bus, configuration and input pulses. 7-7
7.2. HEF 4094-bus: routing across the p.c.b.'s in the instrument. 7-7
7.3. Central processor unit, p.c.b. lay-out. 7-8
7.4. Central processor unit, circuit diagram 1. 7-10
7.5. Central processor unit, circuit diagram 2. 7-11
7.6. Central processor unit, circuit diagram 3. 7-14

7 CIRCUIT DESCRIPTION OF CENTRAL PROCESSOR UNIT AND HEF 4094 BUS.

The central processor unit (CPU) provides microprocessor control of the oscilloscope functions and is given on three diagrams: fig 7.3. (CPU1), fig. 7.4. (CPU2) and fig. 7.5. (CPU3).

7.1. CIRCUIT DESCRIPTION OF CPU DIAGRAM 1.

This diagram basically consists of IC D1601, a 8085 uP (microprocessor) decoder circuits for various related read-write functions, decoding latches for the address and data buses, and the watchdog circuit.

Clock signals
The 6 MHz crystal-controlled clock, on D1601 pins 1 and 2, provides the time reference for all micro-computer actions. It is internally divided to give a 3 MHz square-wave output (CLK) on pin 37. The 3 MHz CLK signal is fed to a divide-by-4096 circuit D1646 to give a 732 Hz restart signal (RST7,5) to microprocessor D1601 on pin 7. This low frequency restart signal is used to initiate various program operations. The 3 MHz CLK signal is also routed via inverter D1621-6 to provide an external clock signal EXCLK- to synchronise the interface bus IEEE control. Via inverter D1622-12, the 3 MHz CLK signal also provides a CALCLK signal for the calibrator on the mother board.

Addres outputs
The sixteen address outputs from D1601 are divided into two groups. Addresses A0 to A7 are decoded from eight address/data bidirectional lines AD0 to AD7 by decoding latch D1603, controlled by the address latch enable signal ALE; addresses A8 to A15 are routed directly to the address bus. The address outputs on the bus are buffered in D1618 and D1619 to provide an external address bus, EXA0 to EXA15, via connector X1603 for the CRT TEXT UNIT and the IEEE unit.

Data I/O lines
The eight bidirectional read/write databus lines D0 to D7 are decoded from the eight address/data lines AD0 to AD7 by decoding latch D1602, controlled by the RD- (read) signal and the ENCPU- (enable CPU) signal. Similarly, the decoding latch D1617 decodes the eight bidirectional external databus lines EXD0 to EXD7 for the CRT TEXT UNIT and IEEE unit controlled by the RD- and ENCPU- signals.

Commands for CRT TEXT and IEEE communication
In address decoder D1613, two address lines A14, A15 are decoded, enable by the IO/M signal from the uP, to give four output combinations:
- The ENCPU- signal is coming from NAND gate D1621-3; inverter D1622-10 provides the ENCPU signal. If ENCPU- is low, the combined address/databits 0...7 carry data for the databus of the CPU. This data goes via latch D1602. If ENCPU is low, the address/data bits 0....7 is applied to the external databus for CTU/IEEE communication via latch D1617.
- CEROM-, a chip enable signal for the programm memory on CPU2.
- Enable signal applied to D1613/15 for decoding address lines A11, A12 to give a further four output ombinations from D1613.
- Two chip select signals ENRAM0- and ENRAM1- for the random-access memories on CPU2.
- An enable signal from pin 10 for two 3-8 decoders D1614 (pin 5) D1616 (pin 5) producing read-write control signals for uP-related functions.

Read decoder D1614 reads the input switches and probe indicators using the three address input lines A0, A1 and A2, also enabled by the read RD signal. One out of the six outputs in use is activated at a time.These are:
-RDROW- for reading row of input switches
-RDCOL- for reading column of input switches
-RDPR0- for detecting the probe 0 type
-RDPR1- for detecting the probe 1 type (not used in this instrument)
-RMEM0- for enabling latch D1609 which reads data into the data bus lines D0...D7
-RMEM1- for enabling latch D1612 which reads data into the data bus lines D0. .D3

Latch D1609/1 takes in the kA and kV information from the impulse switches on the INTERMEDIATE UNIT via connector X1601 and also the COMP signal from the IEEE-unit which scans the position of all the potentiometers.
Latch D1609/19 takes in the input protection signals INPROTA and INPROTB from the ATTENUATOR UNIT, which are active if the 50-ohm input exceeds 5 V.
Latch D1612/19 receives the READY- handshake signal from the CRT TEXT UNIT to confirm a block of data has been taken in; the TBSI input signal from the TIME-BASE confirms that a trigger pulse occurs during the sweep. In AUTO SET mode this information is used to read just the time base setting. In the other time base modes the information inhibits the free run of the time base.
Latch D1612/2 is a buffer for communicating with the CRT TEXT UNIT and IEEE. The external commands are EXRD-, EXWR-, EXIO/M-, EXRES. The TXTINT signal from the TEXT INTENSITY POTENTIOMETER routed via the CPU unit to the CRT TEXT UNIT. It determines the READ OUT potentiometer position. In the OFF position it gives a no interrupt signal to the text generator indicating that no display time is needed for text

Write decoder D1616 is also addressed by input lines A0, A1 and A2, and enabled by the write WR- signal. One of the five outputs is activated at a time . These are:
-WMEM0-, a chip enable signal for the addressable latch D1608.
-WMEM1-, an enable signal for the LCD/LED latch on CPU3.
-WMEM2-, an enable signal for the switch/potentimeter latch on CPU3.
-WRLDAC-, an enable signal for the least-significant byte DAC on CPU2.
-WRMDAC-, an enable signal for the most-significant byte DAC on CPU2.

The bit addressable latch D1608 is addressed by input lines A3, A4 and A5, and enabled by WMEM0- as stated. When addressed, data signal D0 is put into one of eight memory cells to give the following outputs:
- SCL, a serial clock for the internal HEF-bus.
- POTSTR-, a strobe signal for digitising potentiometer positions on the INTERMEDIATE UNIT. This happens via D1647/5,6 on CPU3.
- S/H0, S/H1, sample and hold control for DACs on CPU 2.
- TRIGRES-, for resetting a flip-flop on the TIME-BASE.
- TBS0-,this signal is made low and applied to the time base unit in order to be able to detect a trigger pulse during the sweep (see also time base output signal TBSI)
- WDOG-, main program loop trigger signal to watchdog circuit.

The watchdog and power down circuit
This circuit ensures that the system program is switched off under fault conditions and that memory contents are saved. If the system is operating correctly, pulses from the main program loop are received from D1608-11 via diode V1603 to give a low input on pin 10 of the watchdog trigger circuit D1621 (NAND gate with a feedback loop). The output on pin 8 is therefore high and consequently input 9 is high. The logic high on pin 8 blocks diode V1604.
With the power supply operating correctly, the AL- (alarm) signal via S1602 is high and is passed via R1607 to keep the reset signal RES IN- high (capacitor C1603 charged) for normal on or reset. Transistor V1606 is conducting then in order to keep the TRAP input of the uP low.
This RES IN- signal becomes low under fault conditions:
- AL- is low if the power supply is out of specification and C1603 discharges to make RES IN- low.
- Alternatively, if the main program loop is interrupted, absence of trigger pulses on D1621-10 gives a low on output 1621-8. Consequently, diode V1604 conducts and makes RES IN- low.

In such a fault condition, the logic low on the reset line is passed via base resistor R1609 to cut off transistor V1606. The 5 V collector supply then activates the TRAP input (D1601-6) of the uP. In this way, when the control switches off, the memory contents are saved. On restoration of power, the program is reset.
During a service rouine, switch S1601 is closed and S1602 is open. The earth on S1601 keeps input D1621-10 low, consequently the output (8) is high, which blocks diode V1604 and prevents any interuption of the program. Likewise, with S1602 open, the +5 V supply via R1606 maintains the reset line high to give normal system operation during the service routine.

7.2. CIRCUIT DESCRIPTION OF CPU DIAGRAM 2.

This part of the circuit diagram basically consists of IC D1631 a 2 kbyte (RAM) random-access memory (for PM386A/PM3296A, a further 2 kbyte RAM, D1632), a program memory D1633, supply voltage control for the RAM, and digital-to-analog conversion for the delay voltages, with its reference voltage stabilisation circuit N1634.

Random-acces memory
The 2 kbyte RAM D1631 is used as a "scratch-pad" register for the read/write data signals such as settings of switches, controls , etc. The bidirectional databus D0 to D7 is controlled by address lines A0 to A10, enabled by chip select input G3 and the RD-/WR- (Read, Write)inputs. Optionally, the RAM memory can be extended by an identical 2kbyte plug-in RAM, D1632.

Supply voltage control for RAM
The chip select signals from circuit diagram CPU 1 for the RAM memories are ENRAM0 and ENRAM1.
If ENRAM0 is active (high), transistor V1607 conducts and switches the chip select input D1631-18 low.
If ENRAM1 is active (high), transistor V1608 conducts and switches the chip select input D1632-18 low (if memory option fitted).
Transistors V1616, V1617 are normally switched off.
The rest of this circuit controls the switchover at supply failure to the internal batteries and prevents read/write of RAM contents at low supply voltages.
When the 5 V supply (+5D) is present, the current flowing through the zener reference diode V1612 switches on transistor V1614 (to hold off V1616, V1617) and V1613, which in turn switches on the series regulator V1611 to apply +5D to the VRAM output.

When the supply drops below 4 V (e.g. in power down condition), the current through the zener reference is insufficient to maintain V1613, V1614 conducting. As a result, V1611 also switches off, and if a battery is installed it provides the VRAM supply via diode V1609 which is now conductive.
With V1614 switched off, its collector voltage applies a logic high signal to the bases of V1616, V1617. Thes transistors conduct and inhibit the ENRAM0, ENRAM1 enable signals so that the RAMs cannot be read or written at low supply voltages.

Program memory
The program memory D1633 is a read-only memory (ROM)which has more capacity than the RAMs. It is addressed by lines A0 to A12 and controlled by the RD- and CEROM- signals from circuit diagram CPU 1. For this instrument application, a capacity of 128 kbyte is internally selected by switch S1603. The read-only data outputs are D0 to D7 and are applied to the databus.

Digital-to-analog conversion
Digital information from the databus is clocked into the buffers of D1636 by WRLDAC- (least-significant byte) and into the buffers of D1637 by WRMDAC- (most-significant byte).
Twelve different bits are used to give the full range of the analog output on pin 1 of the 12-bit DAC N1639.
The -VREF (-10 V) on N1639-17 is derived from a reference voltage stabiliser circuit, described later.
The current on output N1639-1, adjustable in steps, is applied to input pin 2 on operational amplifier N1644 which acts as a current-voltage converter. As these steps are coarse, the four least-significant bits of the digital inputs are used to feed in a small current that can be adjusted to bridge the steps. These four bits control four gates D1638, which provide current sources derived from the +5 V rail via resistors to pin 2 of operational amplifier N1641.
The voltage output on N1641-6 produces a small current via R1646 which combines with the step current from the DAC.
The combined output current from N1644-6 is applied to two sample and hold gates N1642, N1643 (analog buffers), and as a DAC signal to the CRT TEXT UNIT for CURSOR control and to determine potentiometer positions on the IEEE unit. A DAC feedback signal is also applied to the N1639-18.
The analog buffers N1642, N1643 are used for holding the instantaneous values for starting the delayed time-bases.
The analog signal from the DAC is clocked into the sample and hold gate by S/H0 for N1642 to give the time-base DELAY voltage: output signal AN0:
The analog signal from the DAC is clocked into the sample and hold gate by S/H1 for N1643 to give the time-base DELAY + delta t voltage: output signal AN1.

Reference voltage stabilisation
The -10 V reference voltage (-VREF) for the DAC circuit is derived from the -13 V line applied via R1654 to N1634. Part of the output on N1634-9 is fed back via the slider of preset R1653 to the operational amplifier input 5 for comparison.
The stabilised -VREF reference voltage is routed from N1634-6 to the DAC reference input N1639-4.

7.3. CIRCUIT DESCRIPTION OF CPU DIAGRAM 3.

This part of circuit diagram basically consists of databus input circuits from switch position reader latches D1623, D1624, D1626, D1627, probe input detector D1628, and databus output circuits for LCD and LED output decoding, HEF-bus outputs and potentiometer strobe signals.

Switch position readers
The microprocessor scans the switch matrix regularly using the latch enable signals RDROW- to read rows and RDCOL- to read columns. Two strobes are necessary to read the matrix: a row strobe and a column strobe to determine the row-column interconnections made by operated switches.
With no switches depressed, the rows and columns are logic high through pull-up resistors. However, during the row strobe, the columns are latched to earth and an operated switch connects an earth to its particular row.
Similarly, during the column strobe, the rows are latched to earth and the operated switch connects an earth to its particular column.
The combined row and column digital signals sent to the databus give the "grid reference" of the particular switches that are operated. The circuit details are now given.
When RDROW- is active, latch D1623 applies earthens to all the columns; the column pull-up resistors are provided by resistor array R1614. Latches not activated D1626 read the rows: logic high if all switches in a column are not activated, logic low if any switches in a column are operated.
When RDCOL- is active, latch D1627 applies earthens to all the rows; the row pull-up resistors are provided by resistor array R1616.
Latches D1624 read the columns; logic high if all switches in a column are not activated, logic low if any switches in a column are operated.

Probe input detector
The sensitivity of a probe connected to the A and/or B input is detected by IC D1628, controlled by a read probe signal RDPRO from the uP. Two analog inputs are provided, one for the Y channel A signal input and one for the B signal input. A current source is used to sense the resistance (i.e. probe type) of a connected probe. Each probe (x1, x10, x100) has a different resistance value. The analog values received are digitised in D1628 and fed to the databus to control the oscilloscope sensitivity read-out in the LC-displays of channel A and B.

LCD and LED decoders
When the WMEM1 signal from CPU 1 is active, latch D1604 clocks the eight databus bits to two separate ICs.
Four input data lines to D1606 (a 4 in-16 out circuit) produce seven LCD and two LED drive outputs.
Three input data lines to D1647 (a TTL/CMOS level adaptor) produce the HEF-bus signals DATA, ENSCP and SERCLK.
The POTSTR- input from CPU 1 gives via D1647/5,6 the PSTRB- signal for the Intermediate unit.
Potentiometer/impulse switch strobe signals
When the WMEM2- signal from CPU 1 is active, latch D1607 clocks the databus bits to provide three strobe signals, SELDR0, SELDR1, SELDR2 for adressing the multiplexers that are scanning the impulse switches.
After level adaptation in D1611 (TTL to CMOS), four strobe signals POT0, POT1, POT2, POT3 are clocked to determine the potentiometer positions on the INTERMEDIATE UNIT

7.4. DESCRIPTION OF HEF 4094 BUS.

As stated, the three HEF-bus signals DATA, ENSCP and SERCLK are generated from the databus of the central microcomputer via level adaptor D1647. As seen Fig. 7.1., the DATA is applied serially to various printed-circuit boards of the oscilloscope via HEF4094 shift registers. Depending on the amount of functions that need to be controlled one or more HEF4094 shift registers are present per p.c.b. These shift registers are all connected in series and a very long shift register is build-up in this way. However, the serial clock signal SERCLK and the enable scope pulses ENSCP are applied in parallel to the various HEF IC's.

Data is valid on the leading edges of the SERCLK pulses when the ENSCP pulses are low.
A serial row of data bits from the central microcomputer is fed to the row of HEF4094 8-stage shift registers to switch the various functions on the p.c.b.'s. A data burst is fed in until all the shift registers are full and then it is transferred to the output buffers to activate the board functions.
Level adaptors are incorporated in the ADAPTATION UNIT to convert the 12 V CMOS levels to 5 V TTL and back.
Figure 7.1. shows the timing diagram of the HEF-bus. When the ENSCP signal is inhibited (high) data is transferred and the next low signal enables a burst of new data to be shifted in.
For the routing of the HEF-bus signals see fig. 7.2.

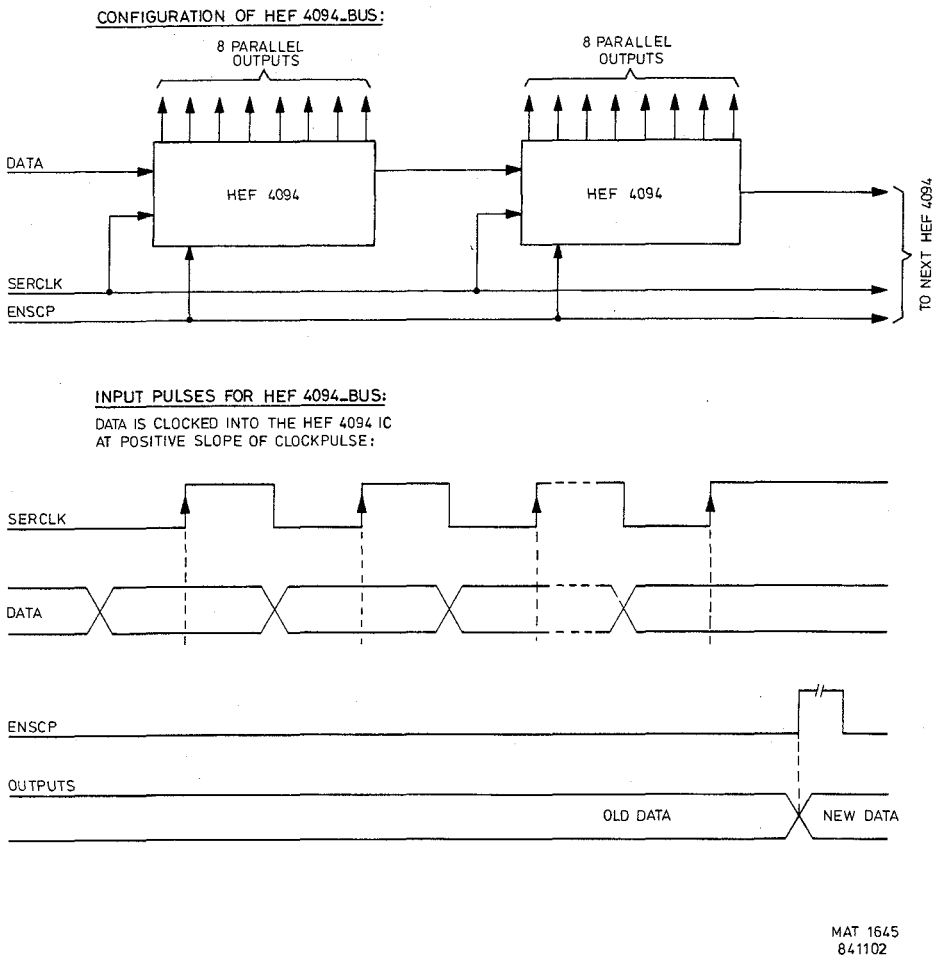


Fig. 7.1. HEF 4094-bus: configuration and input pulses

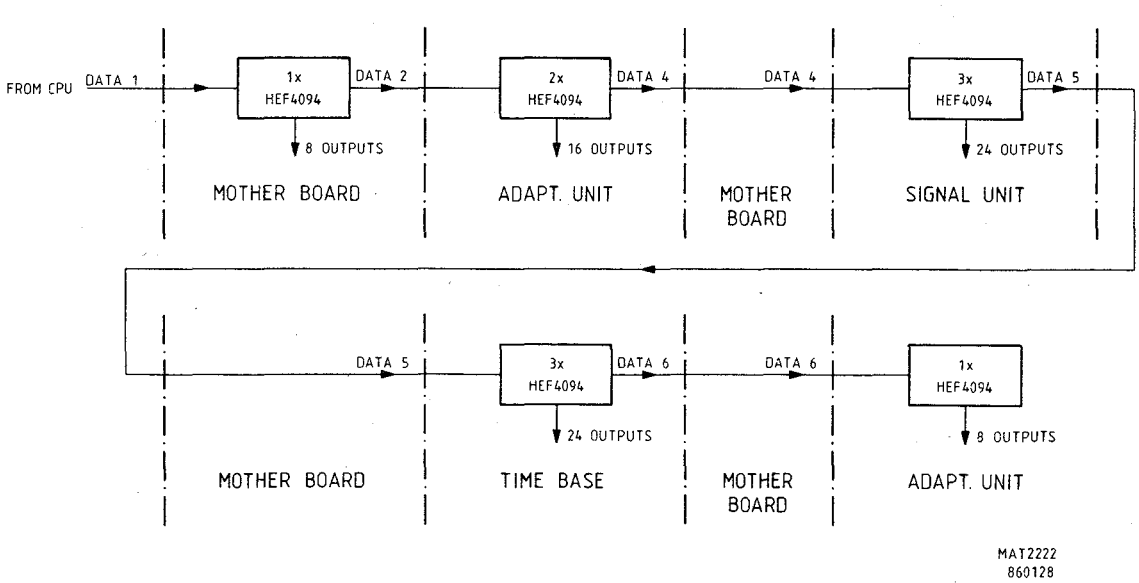


Fig.7.2. HEF 4094-bus: routing across the p.c.b.´s in the instrument

7

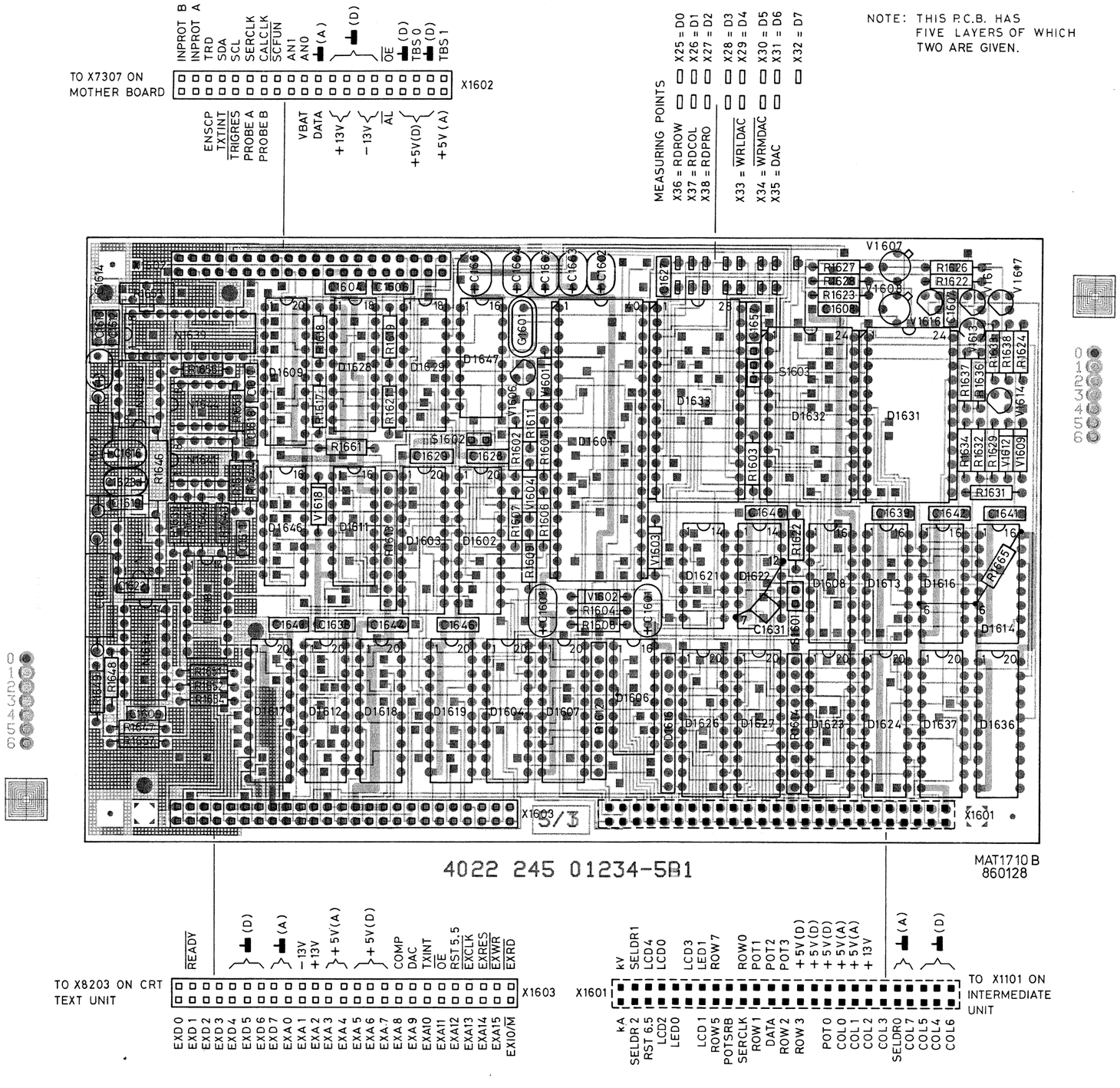


Fig.7.3. Central processor unit, p.c.b. lay-out.

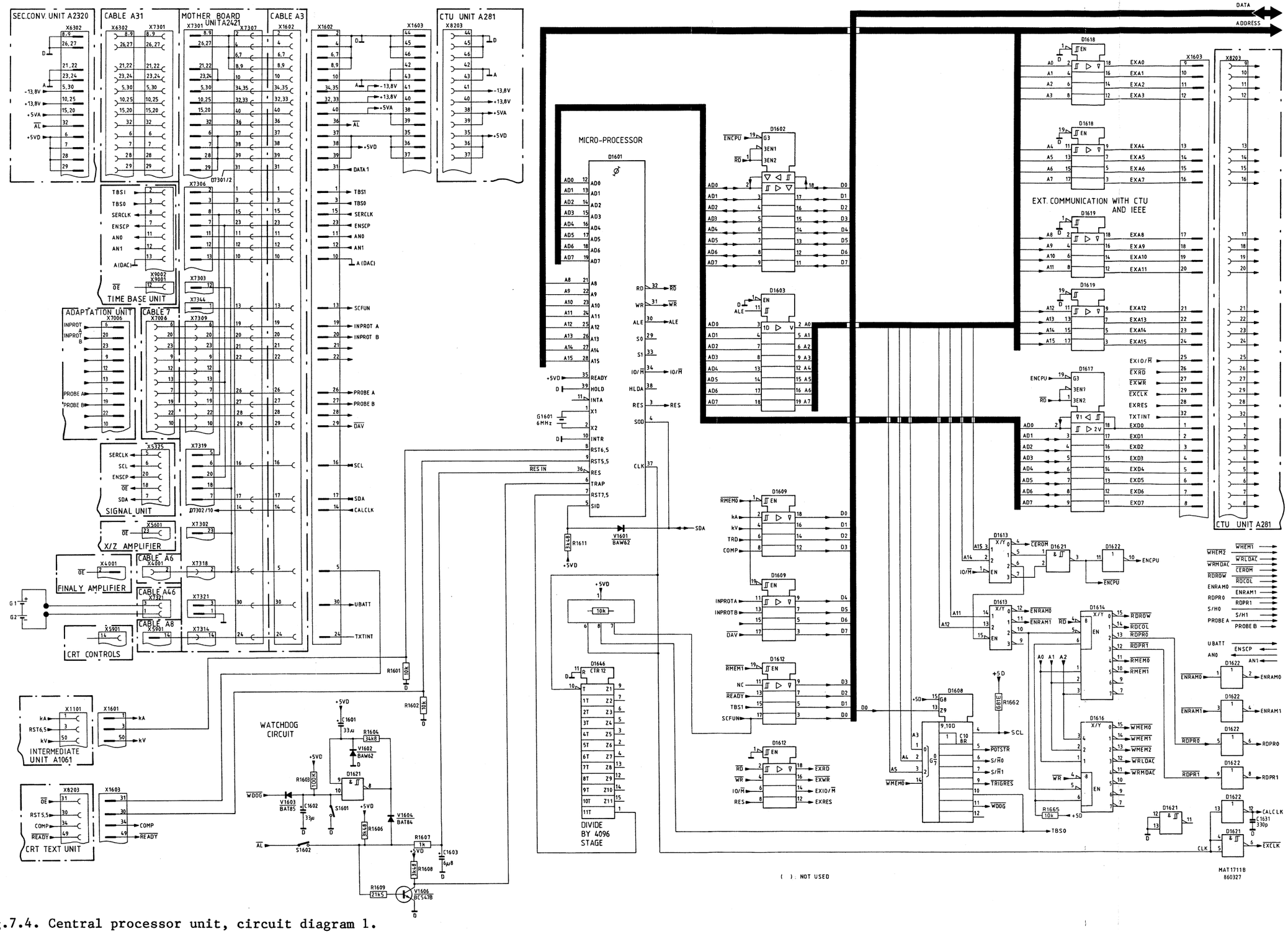
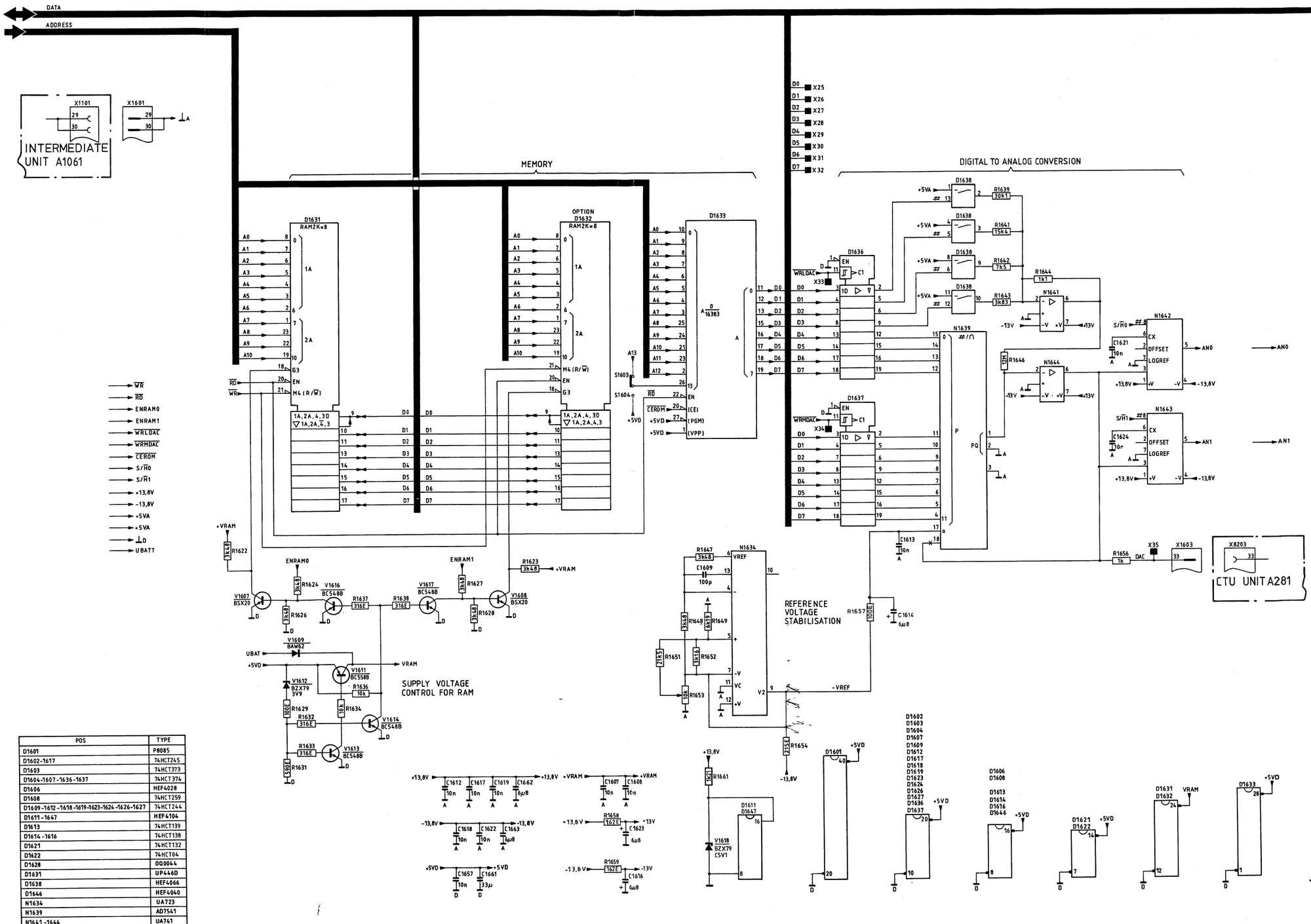


Fig.7.4. Central processor unit, circuit diagram 1.



POS	TYPE
D1601	P8085
D1602-1617	74HCT245
D1603	74HCT373
D1604-1607-1636-1637	74HCT374
D1606	HEF4028
D1608	74HCT259
D1609-1612-1618-1619-1623-1624-1626-1627	74HCT244
D1611-1647	HEF4104
D1613	74HCT139
D1614-1616	74HCT138
D1621	74HCT132
D1622	74HCT04
D1628	QQ0044
D1631	UP446D
D1638	HEF4066
D1646	HEF4040
N1634	UA723
N1639	AD7541
N1641-1644	UA741
N1642-1643	NE5537
D1633	D27128

Fig.7.5. Central processor unit, circuit diagram 2.

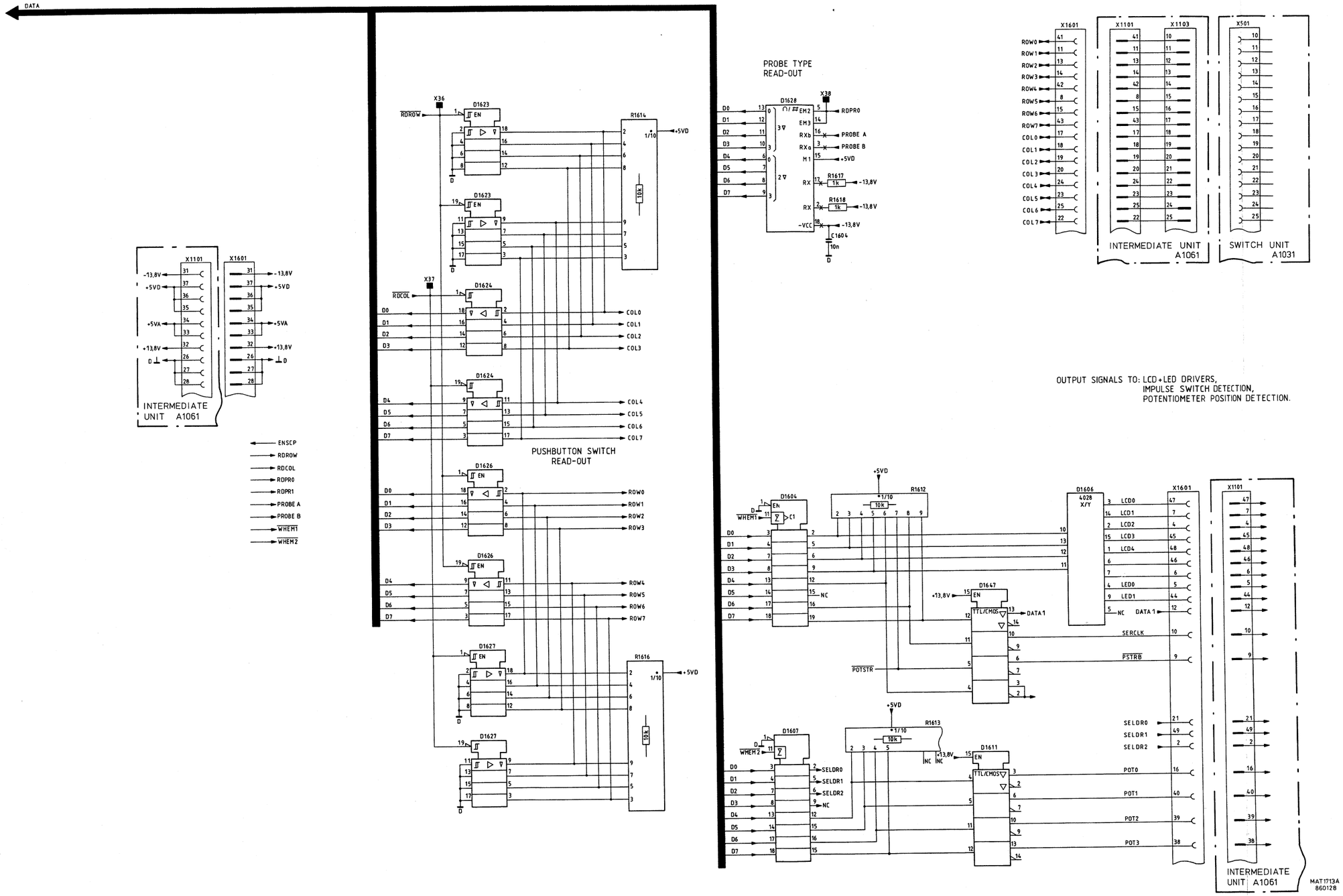


Fig.7.6. Central processor unit, circuit diagram 3.

7.5 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

7

7.5.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 1601	CAP.SOLID ALU.	10V	20%	33UF	4822 124 20945
C 1602	CAP.SOLID ALU.	10V	20%	33UF	4822 124 20945
C 1603	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 1604	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1606	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1607	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1608	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1609	CAP.CERAMIC		2%	100PF	4822 122 31316
C 1611	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1612	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1613	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1614	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 1616	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 1617	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1618	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1619	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1621	CAP.FOIL		63V 1%	10NF	5322 121 54154
C 1622	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 1623	16V 20% 6.8UF				5322 124 14069
C 1624	63V 1% 10NF				5322 121 54154
C 1627	-20+50% 10NF				4822 122 31414
C 1628	-20+50% 10NF				4822 122 31414
C 1629	-20+50% 10NF				4822 122 31414
C 1631	330PF				4822 122 31353
C 1638	-20+50% 10NF				4822 122 31414
C 1639	-20+50% 10NF				4822 122 31414
C 1641	-20+50% 10NF				4822 122 31414
C 1642	-20+50% 10NF				4822 122 31414
C 1643	-20+50% 10NF				4822 122 31414
C 1644	-20+50% 10NF				4822 122 31414
C 1646	-20+50% 10NF				4822 122 31414
C 1648	-20+50% 10NF				4822 122 31414
C 1657	-20+50% 10NF				4822 122 31414
C 1661	10V 20% 33UF				4822 124 40963
C 1662	16V 20% 6.8UF				5322 124 14069
C 1663	16V 20% 6.8UF				5322 124 14069
C 1664	16V 20% 6.8UF				5322 124 14069

7.5.2 INTEGRATED CIRCUITS

D 1601	INTEGR.CIRCUIT	P8085AH	INT	5322 209 50032
D 1602	INTEGR.CIRCUIT	PC74HCT245P	PEL	5322 209 11117
D 1603	INTEGR.CIRCUIT	PC74HCT373P	PEL	5322 209 11118
D 1604	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 1606	INTEGR.CIRCUIT	HEF4028BP	PEL	4822 209 10301
D 1607	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 1608	INTEGR.CIRCUIT	PC74HCT259P	PEL	5322 209 11115
D 1609	INTEGR.CIRCUIT	PC74HCT244P	PEL	5322 209 11116
D 1611	INTEGR.CIRCUIT	HEF4104BP	PEL	4822 209 10273
D 1612	INTEGR.CIRCUIT	PC74HCT244P	PEL	5322 209 11116

D 1613	INTEGR.CIRCUIT	PC74HCT139P	PEL		5322 209 11112
D 1614	INTEGR.CIRCUIT	PC74HCT138P	PEL		5322 209 11111
D 1616	INTEGR.CIRCUIT	PC74HCT138P	PEL		5322 209 11111
D 1617	INTEGR.CIRCUIT	PC74HCT245P	PEL		5322 209 11117
D 1618	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1619	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1621	INTEGR.CIRCUIT	PC74HCT132P	PEL		4822 209 83044
D 1622	INTEGR.CIRCUIT	PC74HCT04P	PEL		4822 209 82341
D 1623	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1624	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1626	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1627	INTEGR.CIRCUIT	PC74HCT244P	PEL		5322 209 11116
D 1631	INTEGR.CIRCUIT	UPD446D-2	NEC		5322 209 81889
D 1632	I.C. ROM	UPD446D-2	NEC		5322 209 81889
D 1636	INTEGR.CIRCUIT	PC74HCT374P	PEL		5322 209 11119
D 1628		OQ 0044			5322 209 11008
D 1637	INTEGR.CIRCUIT	PC74HCT374P	PEL		5322 209 11119
D 1638	INTEGR.CIRCUIT	HEF4066BP	PEL		5322 209 14104
D 1646	INTEGR.CIRCUIT	HEF4040BP	PEL		5322 209 14269
D 1647	INTEGR.CIRCUIT	HEF4104BP	PEL		4822 209 10273
N 1634	INTEGR.CIRCUIT	UA723CN	SIG		5322 209 85889
N 1639	INTEGR.CIRCUIT	AD7541JN	AND		5322 209 86245
N 1641	INTEGR.CIRCUIT	UA741CN	SIG		5322 209 83267
N 1642	INTEGR.CIRCUIT	NE5537N	SIG		5322 209 81729
N 1643	INTEGR.CIRCUIT	NE5537N	SIG		5322 209 81729
N 1644	INTEGR.CIRCUIT	UA741CN	SIG		5322 209 83267

7.5.3 RESISTORS

R 1601	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1602	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1603	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 1604	RES.METAL FILM	MR25	1%	34K8	5322 116 55367
R 1606	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1607	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1608	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1609	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1611	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1612	COMBINATION,RC	-105-103		10K	5322 111 90473
R 1613	COMBINATION,RC	-105-103		10K	5322 111 90473
R 1614	COMBINATION,RC	-105-103		10K	5322 111 90473
R 1616	COMBINATION,RC	-105-103		10K	5322 111 90473
R 1617	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1618	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1619	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1621	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1622	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1623	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1624	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1626	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1627	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1628	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1629	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 1631	RES.METAL FILM	MR25	1%	590E	5322 116 50561
R 1632	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 1633	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 1634	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1636	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 1637	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 1638	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 1639	RES.METAL FILM	MR25	1%	30K1	5322 116 54655
R 1641	RES.METAL FILM	MR25	1%	15K4	5322 116 55459
R 1642	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 1643	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 1644	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 1646	RES.HI-TENSION	VR37	5%	12M	4822 110 42216
R 1647	RES.METAL FILM	MR25	1%	3K48	5322 116 55367

R 1648	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 1649	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 1651	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 1652	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 1653	POTM.TRIMMER	MTP10	20%	10K	5322 101 14066
R 1654	RES.METAL FILM	MR25	1%	215E	5322 116 55274
R 1656	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 1657	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 1658	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 1659	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 1661	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 1662	RES.METAL FILM	MR25	1%	681E	4822 116 51233

7

7.5.4 SEMI CONDUCTORS

V 1601	DIODE	BAW62	PEL	4822 130 30613
V 1602	DIODE	BAW62	PEL	4822 130 30613
V 1603	DIODE	BAT85	PEL	4822 130 31983
V 1604	DIODE	BAT85	PEL	4822 130 31983
V 1606	TRANSISTOR	BC548B	PEL	4822 130 40937
V 1607	TRANSISTOR	BSX20	PEL	4822 130 41705
V 1608	TRANSISTOR	BSX20	PEL	4822 130 41705
V 1609	DIODE	BAW62	PEL	4822 130 30613
V 1611	TRANSISTOR	BC558B	PEL	4822 130 44197
V 1612	DIODE	BZX79-C3V9	PEL	4822 130 31981
V 1613	TRANSISTOR	BC548B	PEL	4822 130 40937
V 1614	TRANSISTOR	BC548B	PEL	4822 130 40937
V 1616	TRANSISTOR	BC548B	PEL	4822 130 40937
V 1617	TRANSISTOR	BC548B	PEL	4822 130 40937
V 1618	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233

7.5.5 MISCELLANEOUS

S 1601	PLUG,ADAPTER	BLUE	5322 263 50107
S 1602	PLUG,ADAPTER	BLUE	5322 263 50107
S 1603	PLUG,ADAPTER	BLUE	5322 263 50107
G 1601	CRYSTAL	6000,000KHZ	4822 242 70392

CRT TEXT UNIT 8

CONTENTS

8. CIRCUIT DESCRIPTION OF CRT TEXT UNIT. 8-1
8.1. Circuit description of diagram 1. 8-1
8.2. Circuit description of diagram 2. 8-2
8.3 Parts list 8-11

FIGURES

8.1. CRT text unit, p.c.b. lay-out. 8-6
8.2. CRT text unit, circuit diagram 1. 8-8
8.3. CRT text unit, circuit diagram 2. 8-9

8. CIRCUIT DESCRIPTION OF CRT TEXT UNIT.

The CRT text unit provides separate microprocessor control of the alphanumeric text that appears on the screen read-out, the circuits being located on the circuit diagrams CRT text 1 and CRT text 2.

8.1. CIRCUIT DESCRIPTION OF DIAGRAM (See fig.8.2.)

This diagram basically consists of IC D8201, a 8085 microprocessor, identical to the central uP, an 8155 random-access memory, programmable input, output port/14 bit counter combination, D8202, a program memory (PROM) D8204, input data latches D8206, D8207, D8208, a latch write decoder circuit with D8213, D8214 and a latch read decoder circuit with D8212.

Text microprocessor
The text microprocessor D8201 is identical to the central microprocessor and operates as described for the CPU UNIT. The 16 address lines are also divided into two groups; address lines A0 to A7 are decoded from eight address/data bidirectional lines AD0 to AD7 by decoding latch D8203, controlled by ALE (adres latch enable).
The 6 MHz clock is internally divided to produce a 3 MHz signal (CLK1) on D8201-37. This is further divided in 7-bit counter D8209 to give a 23.4375 kHz TIME IN signal (CLK2) to RAM D8202.

Random access memory/input, outputport/14 bit counter.
D8202 further divides the CLK2 input D8202-3 by two to give a TIME OUT 14-bit counter output on D8202-6, which is inverted by D8211/3 to form the RST6.5 signal.
The bidirectional address-databus enables CRT text information to be read and written into the RAM, controlled by RD- and WR- signals. The RAM is enabled by address lines A14, A15 via the NAND gate D8211-6.
D8202 produces the following signals:
- SEL0, SEL1, SEL2 for multiplexers on the X/Z AMPLIFIER. Only two text sentences are normally needed at a time, except for service mode or warnings where the full screen is written on.
- DSPL- to start text time-bases (on CRT text diagram 2).
- MULT-: this signal is applied to the reset input of flipflop D8221 on diagram 2. If the signal is low, the text unit works in multitrace mode: several X-sweeps (lines) are generated. This is necessary to write text. If the signal is high, only two X-sweeps are generated. These sweeps are used to write two cursor lines.
- BLANK: this signal is applied to one input of nand-gate D8228/8, 9, 10. If the signal is low the display is blanked. This happens during switching-over between text and signal display.
- SELPG: this "select page" signal is used to select two pages in the video-RAM D8237. This signal is normally high: as a result page 1 is selected. Page 0 (SELPG low) is normally not used.

The text intensity signal TXT INT from the CPU is routed to an input port of D8202 via transistor V8223 to give a TXT OFF signal when the TXT INT input is low.

Program memory
The erasable PROM D8204 is a program read-only memory served by address lines A0 to A1, and controlled by the RD- signal when the chip enable signal CEROM- is active.
The memory capacity is preset for 64 kbyte by switch S8201.

Input data latches
Input data from the CPU central microprocessor is received on lines EXD0 to EXD7.
These input data lines provide the inputs to the three latches D8206, D8207, D8208.
Each 8-bit latch can be written into by the central uP under the control of its own write enable signal, WP0-, WP1-, or WP2-, generated by the latch write decoders D8213, D8214.
Each 8-bit latch can be read to the CRT TEXT UNIT under the control of its own read enable signal, RDCPU0-, RDCPU1- or RDCPU2-, generated by the latch read decoder D8212.

Latch write decoder
The latch write decoder uses the CPU signals EXA14, EXA15, EXIO/M, EXA11, EXA12, EXWR-, EXA0 and EXA1 to address the CRT TEXT UNIT.
These signals are applied to the D8213 and D8214 decoders in cascade to make one of three write signals active, WP0-, WP1- or WP2-, one for each latch.
When the last latch, D8208, is filled, WP2- goes high and gives a high input to NAND gates D8211 (wired as a set/reset flip-flop) to give a READY- signal to the input port of D8202, D8202-39, to say that data is ready to be taken in, and also to the central microprocessor on the CPU UNIT.

Latch read decoders
The latch read decoder uses addresses generated by the text microprocessor to read the latches.
Addresses A14, A15 controlled by the IO/M signal provide inputs for D8212 to generate the chip enable signal CEROM- for the program memory input D8204-20. Output D8212-6 is fed to NOR gate D8216-2 where it is used together with the RD- input as an enable input D8212-15. It controls addresses A0, A1 to provide three read signals, RDCPU0-, RDCPU1- or RDCPU2-, one for each latch if the uP is ready (READY-) to receive the text.
When the last latch, D8202 is read, flip-flop D8211 is reset by RDCPU2-.

8.2. CIRCUIT DESCRIPTION OF DIAGRAM 2 (See fig.8.3.)

This circuit diagram basically consists of a cascaded 16-bit counter, D8222, D8223, D8224, D8226, which generates the X line and Y frame sweeps for the text raster and controls a multiplexer, D8232, D8233, D8234, D8236. This multiplexer addresses a video RAM, D8237, which receives its information from the microprocessor via a latch, D8238.
The text in the video RAM is in ASCII characters and these are latched by D8239 into a character generator, EPROM D8241.
The 8-bit parallel outputs are fed into a shift register, D8242, which supplies a serial output to the Z control output. A 4-bit counter, D8231, provides hold-off at end of X line sweep to cut-off X and to give Z blanking.
A 6 MHz oscillator, gives a clock output D8218-8 to control the shift register and the 16-bit counter.
The text Y output is controlled via gates D8219 and flip-flop D8217.
These various circuit functions are now described in greater detail.

The text Y sweep
The DSPL- signal from the text RAM (on CRT text diagram 1) is applied to flip-flop reset input D8217-13 to give a low output on D8217-3 transferred when a low clock signal is received from gates D8219. By applying the most-significant bits of the 16-bit counter (Q14, Q15) to NAND gate D8219, a low output from D8217-3 is designed to occur after the end of a Y sweep. This Y- signal is routed to the X/Z AMPLIFIER to restart the Y sweep.

The text X sweep
The 6 MHz oscillator consists of a 12 MHz X-tal controlled oscillator around V8206. D8221 divides the 12 MHz signal two times so that a 6 MHz square wave is available. This provides a clock signal (CLK) for the 16-bit counter (and for the shift register, described later), which uses the DSPL- as a master reset signal. The CLK signal provides an increment approximately every 160 ns. A cascade command is given to the next counter when a 4-bit counter is in state 15. With 256 counter states per X line, the end of line is reached at output D8223-15. This end of line output also changes over a flip-flop D8228 to provide an input command to counter D8231-7 which starts at the end of each X line. This provides a hold-off of 16 clock-pulses between X sweeps. During hold-off, a high output on D8231-13 is applied via two inverters D8229-13, D8229-10, to cut off the X- output signal between each text line.
A low MULT- input to the reset of flip-flop D8221 results in repeated X sweeps. At triggering by X-, the flip-flop procuces a high output on D8221-6, which means that with D8219-3 at logic high during a Y sweep the NAND gate D8219-6 output is held low.
Consequently, the inverted signal (high) prevents triggering of flip-flop D8217-12 at the end of an X sweep.
Counter output D8231-13 also provides a trace blanking signal during hold-off via NOR gate D8229-1 and NAND gate D8228-8 to the Z AMPLIFIER. NOR gate D8229-1 is also controlled by a serial QZ signal from the shift register to provide unblanking for the character dots when writing text.

Generating the text characters
The previous sections have described the necessary XY timing signals that are routed to the X/Z AMPLIFIER to produce a raster on the screen by controlling linear sawtooth deflection voltages. The following sections explain how characters are written on to this blank raster. As in television the text characters are superimposed on the raster by video signals that modulate the trace spot intensity. In this case, character writing is achieved by unblanking the Z amplifier at various spots along each line where the characters occur.
Each character is formed by an 8x8 matrix and there is the possibility of 32 characters per line (i.e. 8 x 32 = 256 points per line. As the screen is scanned line by line, a "character line" (8 lines) will be represented by 256 x 8 = 2048 points. A full screen can accommodate 17 "characters lines" (i.e. 2048 x 17 = 34816 points. It follows therefore that all the 16-bit counter output bits Q0 to Q15 are necessary for character writing:
- bits Q0 to Q7 are used to represent the 256 points along a complete line,
- bits Q8, Q9, Q10 represent the 8-line character format and decide which of the eight lines is to be displayed,
- bits Q11 to Q15 represent the 17 "character lines" and decide which of these is to be displayed.

Multiplexer
Counter output bits Q3 to Q7, Q11 to Q15 are applied as input signals to the multiplexers D8233, D8234, D8236. Alternatively, addressbits from the uP are applied depending on the state of the CERAM-signal. When CERAM- is high, the counter outputs address the inputs of the video RAM via the multiplexer.
When CERAM- is low, the uP addresses the VIDEO RAM and data from the uP is written into the video RAM via the multiplexer.
Multiplexer D8232 uses the RD- and CERAM- signals to enable the video RAM.

Video RAM
As described, the multiplexer provides inputs for the video RAM D8237 with either addresses from the uP or positional Q-bits from the counter.When the read input D8237-21 is active, data is loaded into the video RAM from the uP AD0 to AD7 lines via the bidirectional latch D8238. The text in the video RAM consists of ASCII characters. When a command is given to write a character this information is generated as 8 bits to the latch D8239, where it is passed after a time delay to (for synchronisation purposes) to address the character generator.

Character generator
The character generator D8241 consists of a 4 kbyte EPROM, addressed by 12 bits:
- eight bits from the video RAM addressing the character to be generated,
- three bits, Q8 - Q10, representing lines 0 - 7 for the character (defining character height),
- an enable bit (EN).

The character codes generated are clocked as parallel outputs to the shift register.

Shift register
The character parallel inputs to shift register D8242 are read out in serial form, controlled by the CLK output D8218-8 of the 6 MHz oscillator. Counter bits Q0, Q1, Q2, connected via NAND gate D8227-6 give a matrix address every 8 counter pulses on D8242-15 (defining character width). The serial output QZ is routed to NOR gate input D8229-3 to provide the required blanking/unblanking Z control for text display.

Display sequence
The time during which the text is displayed represents a break in the normal oscilloscope signal trace. Normally this break only represents two character lines at the top of the screen and as the signal trace is repetitive, the break is distributed over different parts of the trace. It is therefore generally overwritten and only gives little disturbance of the signal.
However, when the full display area is used, for text during a service routine and for the 50-ohm overload warning, a large part of the signal is cut-off and the light intensity is somewhat reduced.

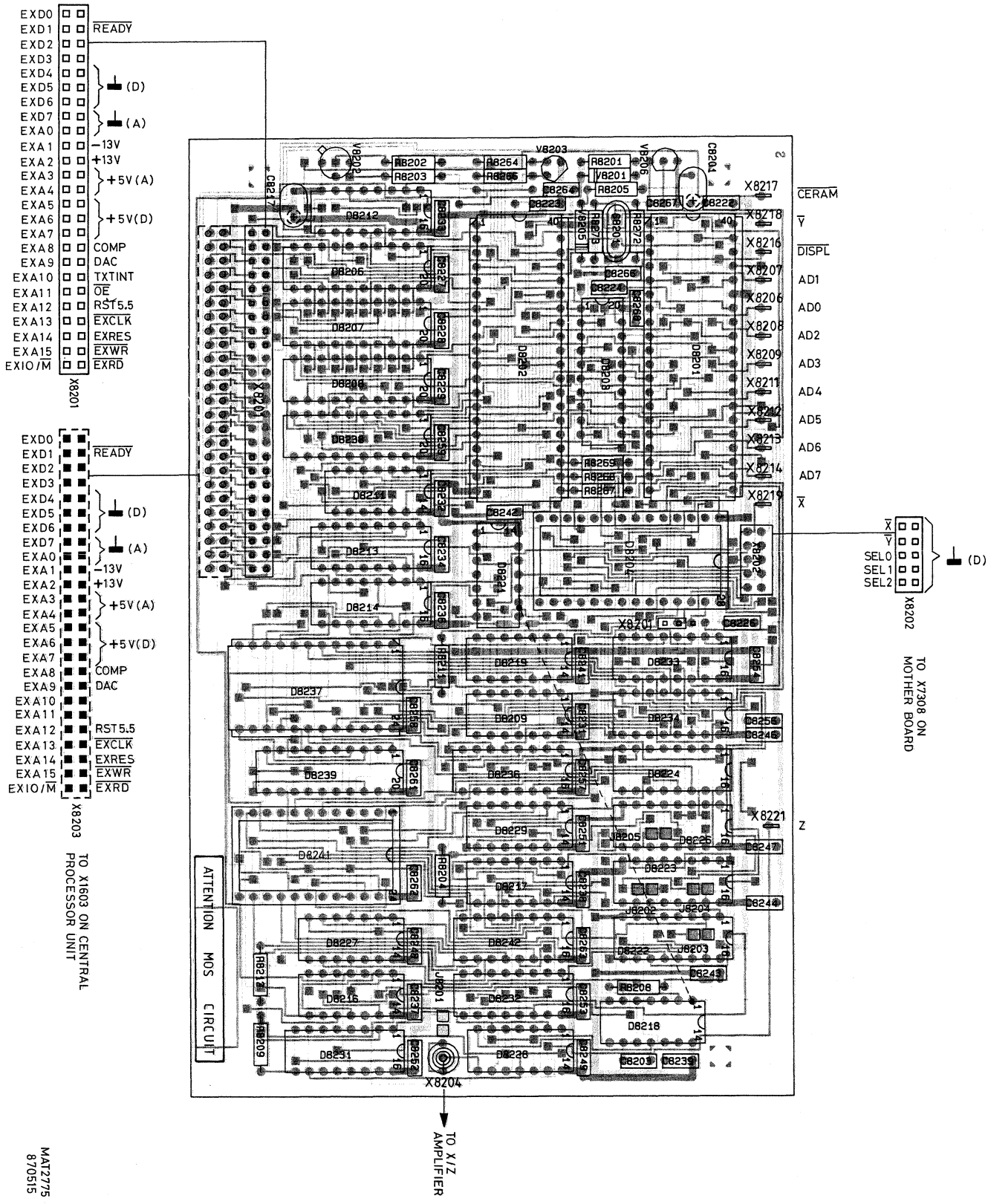
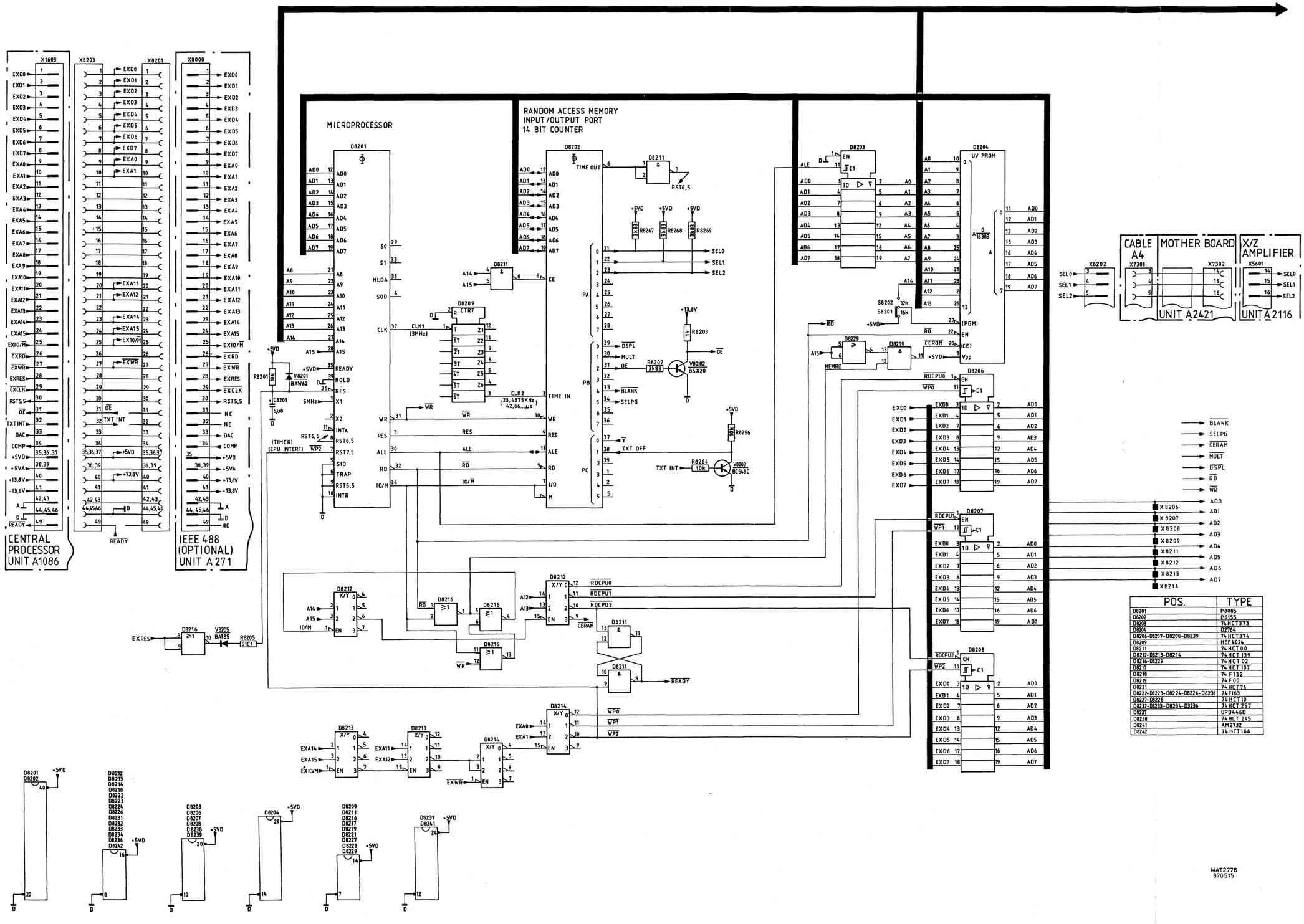


Fig.8.1. CRT text unit, p.c.b. lay-out.



POS.	TYPE
D8201	P8085
D8202	P8155
D8203	74HCT373
D8204	D2764
D8206-D8207-D8208-D8239	74HCT374
D8209	HEF4024
D8211	74HCT00
D8212-D8213-D8214	74HCT139
D8216-D8229	74HCT02
D8217	74HCT107
D8218	74F132
D8219	74F00
D8221	74HCT74
D8222-D8223-D8224-D8226-D8231	74F163
D8227-D8228	74HCT10
D8232-D8233-D8234-D3236	74HCT257
D8237	UPD4460
D8238	74HCT245
D8241	AM2732
D8242	74HCT166

MAT2776
870515

Fig.8.2. CRT text unit, circuit diagram 1

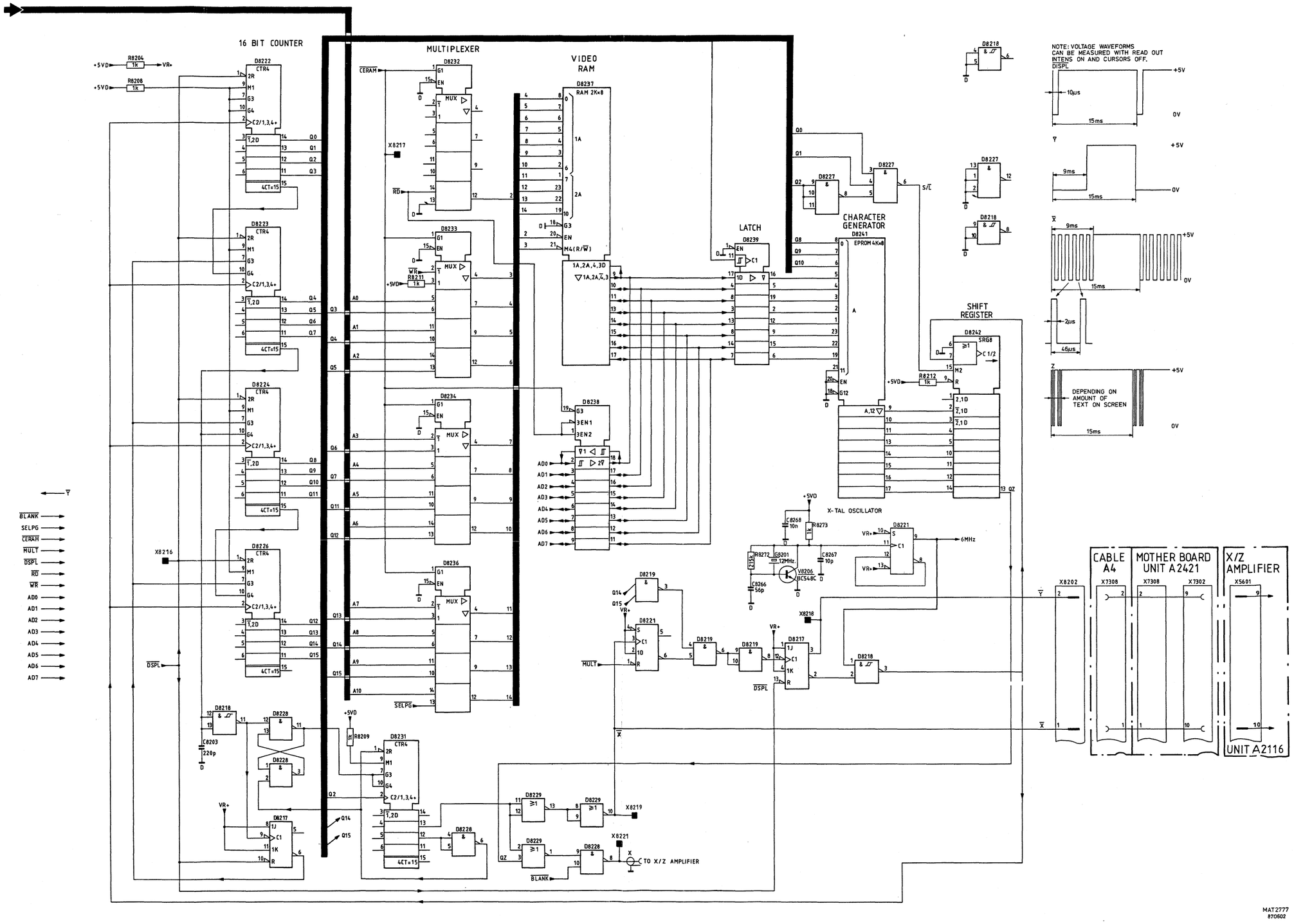


Fig.8.3. CRT text unit, circuit diagram 2.

8.3 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

8.3.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 8201	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 8202	CAP.CERAMIC		2%	220PF	4822 122 30094
C 8203	CAP.CERAMIC		2%	220PF	4822 122 30094
C 8217	CAP.SOLID ALU.	10V	20%	33UF	4822 124 20945
C 8222	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8223	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8224	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8226	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8227	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8228	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8229	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8231	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8232	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8233	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8234	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8236	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8237	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8238	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8239	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8241	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8242	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8243	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8244	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8246	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8247	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8248	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8249	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8251	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8252	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8266			2%	56PF	4822 122 32027
C 8253	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8254	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8256	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8257	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8258	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8267			2%	10PF	4822 122 32185
C 8259	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8261	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8262	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8263	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8264	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8268			-20+50%	10NF	4822 122 31414

8.3.2 INTEGRATED CIRCUITS

D 8201	INTEGR.CIRCUIT	P8085AH	INT	5322 209 50032
D 8202	INTEGR.CIRCUIT	P8155H	INT	5322 209 10526
D 8203	INTEGR.CIRCUIT	PC74HCT373P	PEL	5322 209 11118
D 8206	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 8207	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 8208	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 8209	INTEGR.CIRCUIT	HEF4024BP	PEL	4822 209 10253
D 8211	INTEGR.CIRCUIT	PC74HCT00P	PEL	5322 209 11105
D 8212	INTEGR.CIRCUIT	PC74HCT139P	PEL	5322 209 11112
D 8213	INTEGR.CIRCUIT	PC74HCT139P	PEL	5322 209 11112
D 8214	INTEGR.CIRCUIT	PC74HCT139P	PEL	5322 209 11112
D 8216	INTEGR.CIRCUIT	PC74HCT02P	PEL	5322 209 11106

D 8217	INTEGR.CIRCUIT	PC74HCT107P	PEL	5322 209 11108
D 8218	INTEGR.CIRCUIT	N74F132N	SIG	5322 209 83342
D 8219	INTEGR.CIRCUIT	N74F00N	SIG	5322 209 81908
D 8221	INTEGR.CIRCUIT	PC74HCT74P	PEL	5322 209 11109
D 8222	INTEGR.CIRCUIT	74F163APC	FSC	5322 209 83343
D 8223	INTEGR.CIRCUIT	74F163APC	FSC	5322 209 83343
D 8224	INTEGR.CIRCUIT	74F163APC	FSC	5322 209 83343
D 8226	INTEGR.CIRCUIT	74F163APC	FSC	5322 209 83343
D 8227	INTEGR.CIRCUIT	PC74HCT10P	PEL	5322 209 11107
D 8228	INTEGR.CIRCUIT	PC74HCT00P	PEL	5322 209 11105
D 8229	INTEGR.CIRCUIT	PC74HCT02P	PEL	5322 209 11106
D 8231	INTEGR.CIRCUIT	74F163APC	FSC	5322 209 83343
D 8232	INTEGR.CIRCUIT	PC74HCT257P	PEL	5322 209 11114
D 8233	INTEGR.CIRCUIT	PC74HCT257P	PEL	5322 209 11114
D 8234	INTEGR.CIRCUIT	PC74HCT257P	PEL	5322 209 11114
D 8236	INTEGR.CIRCUIT	PC74HCT257P	PEL	5322 209 11114
D 8237	INTEGR.CIRCUIT	UPD446D-2	NEC	5322 209 81889
D 8238	INTEGR.CIRCUIT	PC74HCT245P	PEL	5322 209 11117
D 8239	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
D 8242	INTEGR.CIRCUIT	PC74HCT166P	PEL	5322 209 11113

8

8.3.3 RESISTORS

R 8201	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 8202	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 8203	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8204	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8205	51E1				5322 116 54442
R 8206	RES.METAL FILM	MR25	1%	215E	5322 116 55274
R 8207	POTM.TRIMMER	MTP10	20%	220E	4822 100 10359
R 8208	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8209	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8211	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8212	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8264	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 8266	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 8267	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 8268	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 8269	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 8272		MRS25	1%	215K	5322 116 53425
R 8273		MRS25	1%	1K	4822 116 53108

8.3.4 SEMI CONDUCTORS

V 8201	DIODE	BAW62	PEL	4822 130 30613
V 8202	TRANSISTOR	BSX20	PEL	4822 130 41705
V 8203	TRANSISTOR	BC548B	PEL	4822 130 40937
V 8205	BAT85			4822 130 31983
V 8206		BC548C	PEL	4822 130 44196

8.3.5 MISCELLANEOUS

G8201	Crystal	12MHz	5322 242 71444

IEEE 488 BUS UNIT 9

CONTENTS

9. CIRCUIT DESCRIPTION OF IEEE 488 BUS UNIT. 9-1
9.1. Circuit description of diagram 1 (digital part) 9-1
9.2. Circuit description of diagram 2 (analog part) 9-2
9.3. Parts list 9-11

FIGURES

9.1. IEEE 488 bus unit, p.c.b. lay-out. 9-5
9.2. IEEE 488 bus unit, circuit diagram 1 (digital part) 9-8
9.3. IEEE 488 bus unit, circuit diagram 2 (analog part) 9-9

9. CIRCUIT DESCRIPTION OF THE IEEE 488 BUS UNIT.

The IEEE-unit is an option that enables the oscilloscope to communicate externally with other instruments in a IEEE-bus system. It consists of two circuit diagrams, a digital part and an analog part. As the IEEE is an option, its operating details are not described in detail. For further information, refer to the relevant IEEE operating manual.

9.1. CIRCUIT DESCRIPTION OF DIAGRAM 1 (See fig.9.2.)

This digital part of the unit mainly consists of a IEEE control uP D8001, two buffers D8002, D8003, a read-only memory D8004 containing the IEEE instructions and a write register to control the analog part.

IEEE control uP and buffers
The IEEE control uP receives external data from the central uP on the bidirectional databus EXD0 to EXD7, controlled by EXRD- (read) and EXWR- (write) commands (when the remote facility is available).The lines are also used to read in data from the memory, D8004 and the write into registers D8008 used for controlling the analog part.
Another bidirectional port connects with buffer D8002 to form the external "multiline message" databus to the IEEE cable, controlled by the data valid "handshake" signal DAV on D8001-36.
The IEEE control is synchronised with the central uP clock by an EXCLK-input D8001-3.
The address lines EXA0, EXA1 and EXA2 on pins 21, 22 and 23 access eight internal registers that determine listener, talker and control communication modes.
Three bidirectional control lines connect to buffer D8003. This produces the five "RAISE"interface management bus lines:
REN - remote enable
ATN - attention
IFC - interface clear
SRQ - service request
EOI - end or identify
It also buffers the other two "handshake" lines NRFD (not ready for data) and NDAC (not data accepted) that together with the DAV signal control the exchange of data bytes between instruments.

Read-only memory
The read-only memory D8004 is switched for 16-kbyte capacity. It is addressed by the external address bus-lines EXA0 to EXA12 from CPU 1 circuit diagram, controlled by the EXRD- signal, and the CEROM-signal decoded from the EXA14, EXA15 and EXIO/M- addresses at output D8006-5. Together with the EXA11 and EX12 addresses an output from D8006-7 is used to decode a chip select signal CEIEC- on D8006-12 for the IEEE control uP.

Write Register for control of analog part of the IEEE-unit.
The EXA addresses decoded by D8006 also produce a signal on D8006-11. Together with the EXWR- signal this enables the write register via NOR gate and inverter D8007. In write register D8008, the inputs EXD0 to EXD7 provide the following outputs for controlling the analog part:
- MUX0 to MUX3 for multiplexer reading of potentiometer positions.
- S/H (sample and hold) selection
- D (data)
- E0, E1 output switch selection for potentiometers.

9.2. CIRCUIT DESCRIPTION OF DIAGRAM 2 (See fig. 9.3.)

If the IEEE unit is installed, the analog part of it is added between the potentiometers on the intermediate unit (voltage range 0.....10 Volt) and the circuits that are controlled by these potentiometers. These circuits are located on the signal unit, time base and final Y amplifier.
The analog IEEE part has the following functions:
- Selection between local (potentiometer voltage) operation or remote operation (voltage from a sample and hold gate) for every potentio-meter function. This selection is done by means of multiplexers.
- Detection by the CPU of the position of a certain potentiometer (in advance manually adjusted). This potentiometer position is digitised by the CPU. This is achieved by comparing the potentiometer voltage (between 0....10 Volt) with a sawtooth signal DAC from the CPU. The comparison is done in comparator N8013.

The comparator
The potentiometer position analog signals from the INTERMEDIATE UNIT on connector X8001 are selected separately in multiplexer D8009, controlled by the MUX0 to MUX3 signals from the digital IEEE unit via a 5 V to 12 V level adaptor D8011.
The selected output on D8009-1 is read into comparator N8013. Each voltage is compared in N8013 with a DAC staircase generator (on the CPU 2 circuit diagram) to determine its value. When the values are equal, a COMP signal is fed back to the CPU to stop the DAC. The uP starts the DAC at 0000 and generates a sawtooth voltage which is compared with the potentiometer slider voltage. When the sawtooth reaches the potentiometer voltage the DAC stops and the COMP output is routed to the central uP to indicate the position. The maximum position is indicated by the four-bit code 1111.

The sample and hold gates
The DAC value from the CPU, applied via R8007 to the common inputs (pin 3) of the sample and hold gates N8018-N8036, is therefore equivalent to the particular potentiometer voltage. This DAC voltage is clocked into a selected S & H gate by one of the signal addresses S0 to S14. The signal addresses S0 to S14 for the sample and hold gates are decoded in D8014 from four address lines at CMOS level, derived from the MUX0 to MUX3 inputs to D8011.

The two-position multiplexers.
The output from a sample and hold gate is connected to one input of a two-position multiplexer, D8037, D8038, D8039, D8041, D8042. For example, the output N8036-5 (SH14) is connected to input pin 5 of multiplexer D8042.
The other input is connected to its potentiometer position input signal; in this example, pin 3 connected to the slider of the potentiometer (connector X8001-19).
Each two-position multiplexer can be switched by a signal (P0 to X POS P14), stored in addressable latches D8016 or D8017 after level adaptation in TTL/CMOS adaptors D8012 or D8011 respectively; e.g. for X POS, the control signal is P14, stored in D8017 under control of the D (data) signal.

The outputs of the multiplexers are connected to the relevant analog oscilloscope circuits; e.g. HOLD OFF to TIME-BASE, or TSA (trace separation analog) to FINAL Y AMPLIFIER, etc.
This means that these analog oscilloscope functions receive their d.c. voltage from the sample and hold gate when the function in remote operation or from the potentiometers in local mode. If the IEEE-unit is not installed, the potentiometer position signals on connector X8001 are directly connected to the analog oscilloscope circuits via connector X8002.

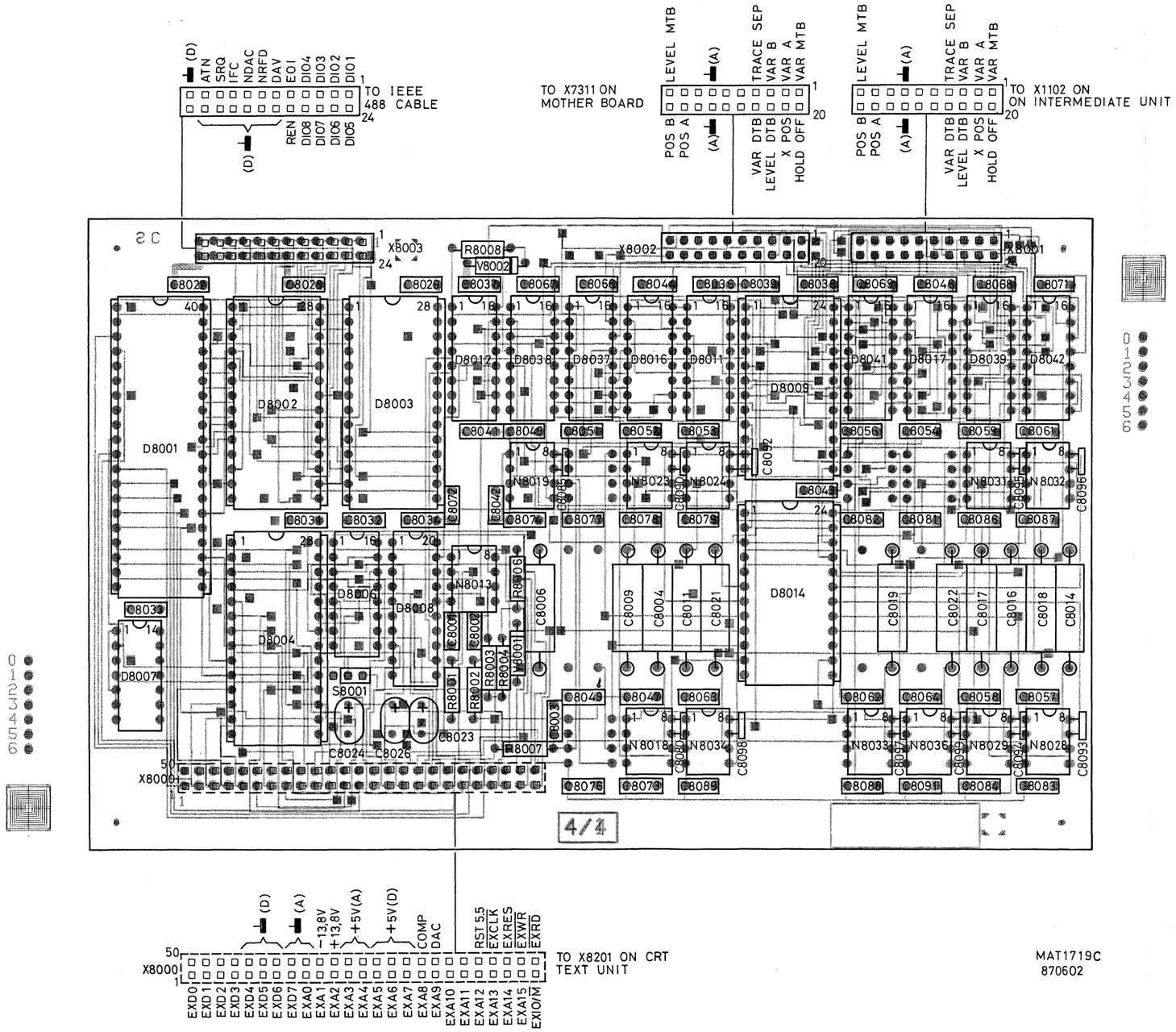


Fig.9.1. IEEE 488 bus unit, p.c.b. lay-out.

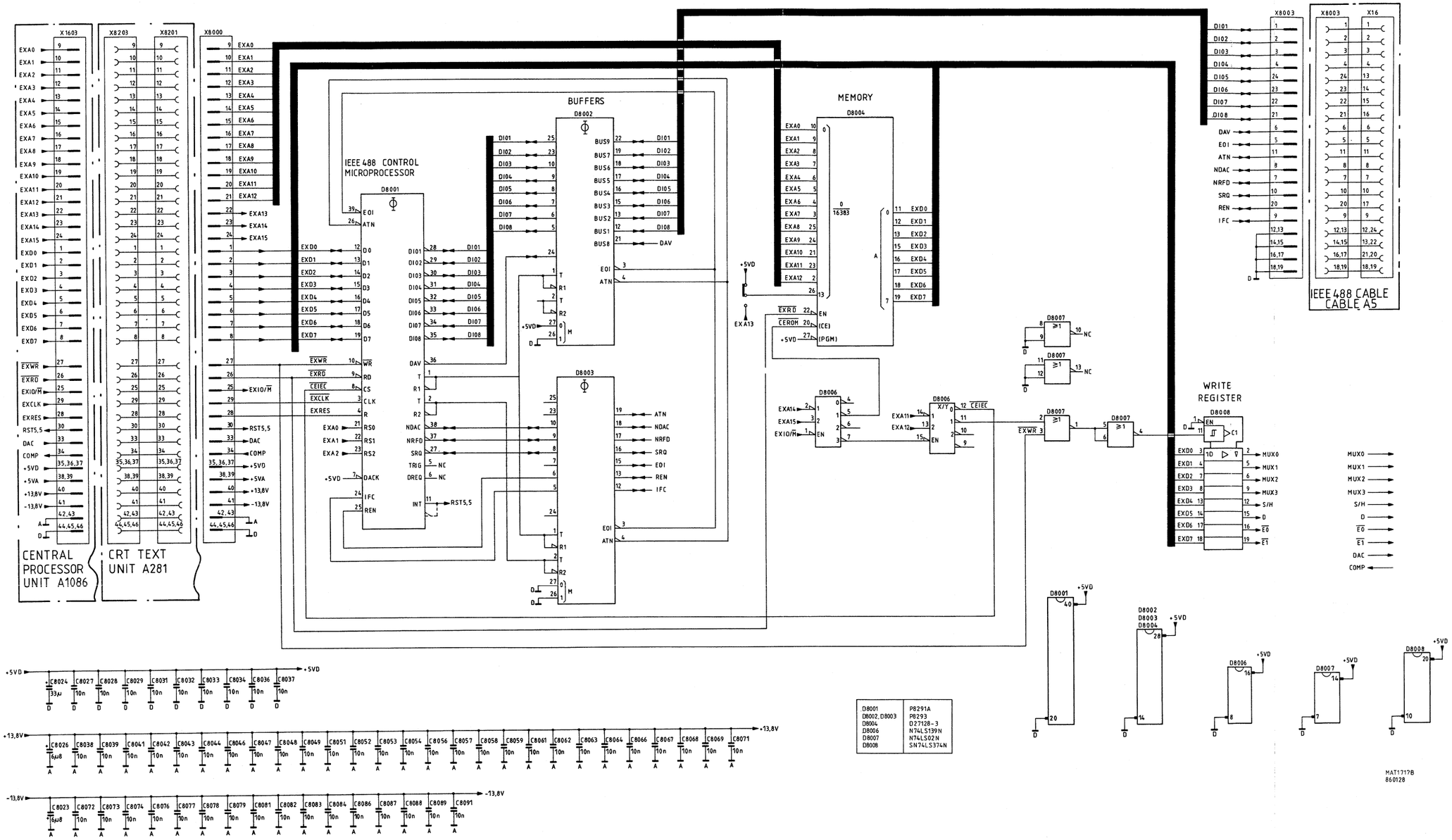
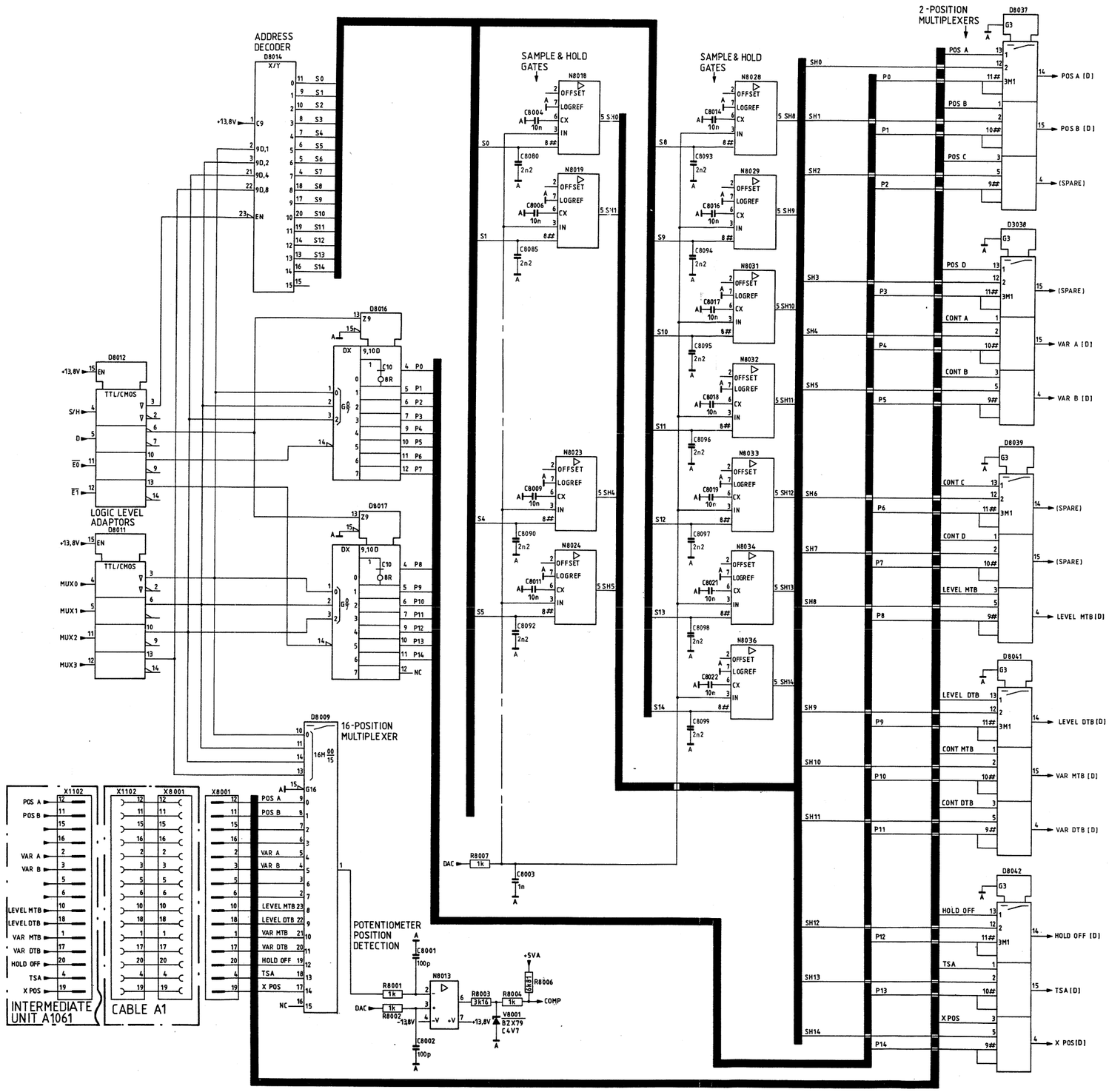
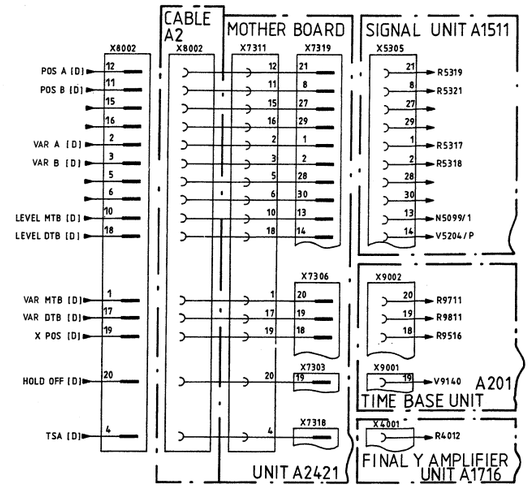
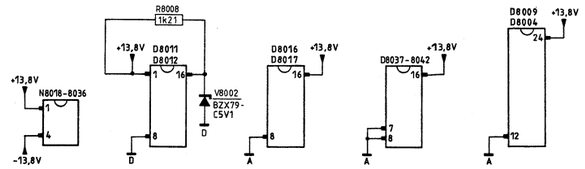


Fig.9.2. IEEE 488 bus unit, circuit diagram 1 (digital part)





D8009	HEF 4067
D8011 - D8012	HEF 4104
N8013	µA 741
D8014	HEF 4514
D8016 - D8017	HEF 4724
N8018T/M N8036	NE 5537
D8037T/M D8042	HEF 4053



[D]: OPTIONAL IEEE 488 BUS

MAT1718C
870602

Fig.9.3. IEEE 488 bus unit, circuit diagram 2 (analog part)

9.3 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

9.3.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 8001	CAP.CERAMIC	2%	100PF	4822 122 31316
C 8002	CAP.CERAMIC	2%	100PF	4822 122 31316
C 8003	CAP.CERAMIC	10%	1NF	4822 122 30027
C 8004	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8006	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8007	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8008	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8009	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8011	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8012	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8013	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8014	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8016	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8017	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8018	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8019	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8021	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8022	CAP.FOIL	63V 1%	10NF	5322 121 54154
C 8023	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 8024	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 8026	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 8027	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8028	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8029	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8031	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8032	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8033	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8034	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8036	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8037	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8038	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8039	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8041	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8042	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8043	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8044	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8046	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8047	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8048	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8049	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8051	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8052	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8053	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8054	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8056	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8057	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8058	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8059	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8061	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8062	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8063	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8064	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8066	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8067	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8068	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

C 8069	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8071	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8072	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8073	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8074	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8076	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8077	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8078	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8079	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8080		10%	2.2NF	5322 122 32818
C 8081		-20+50%	10NF	4822 122 31414
C 8082		-20+50%	10NF	4822 122 31414
C 8083		-20+50%	10NF	4822 122 31414
C 8084		-20+50%	10NF	4822 122 31414
C 8085		10%	2.2NF	5322 122 32818
C 8086		-20+50%	10NF	4822 122 31414
C 8087		-20+50%	10NF	4822 122 31414
C 8088		-20+50%	10NF	4822 122 31414
C 8089		-20+50%	10NF	4822 122 31414
C 8090		10%	2.2NF	5322 122 32818
C 8091		-20+50%	10NF	4822 122 31414
C 8092		10%	2.2NF	5322 122 32818
C 8093		10%	2.2NF	5322 122 32818
C 8094		10%	2.2NF	5322 122 32818
C 8095		10%	2.2NF	5322 122 32818
C 8096		10%	2.2NF	5322 122 32818
C 8097		10%	2.2NF	5322 122 32818
C 8098		10%	2.2NF	5322 122 32818
C 8099		10%	2.2NF	5322 122 32818

9

9.3.2 INTEGRATED CIRCUITS

D 8001	INTEGR.CIRCUIT	P8291A	INT	5322 209 81264
D 8002	INTEGR.CIRCUIT	P8293	INT	5322 209 81265
D 8003	INTEGR.CIRCUIT	P8293	INT	5322 209 81265
D 8006	INTEGR.CIRCUIT	N74LS139N	SIG	5322 209 85839
D 8007	INTEGR.CIRCUIT	N74LS02N	SIG	5322 209 85312
D 8008	INTEGR.CIRCUIT	SN74LS374N	T.I	5322 209 85869
D 8009	INTEGR.CIRCUIT	HEF4067BP	PEL	5322 209 14513
D 8011	INTEGR.CIRCUIT	HEF4104BP	PEL	4822 209 10273
D 8012	INTEGR.CIRCUIT	HEF4104BP	PEL	4822 209 10273
D 8014	INTEGR.CIRCUIT	HEF4514BP	PEL	5322 209 14051
D 8016	INTEGR.CIRCUIT	HEF4724BP	PEL	4822 209 10316
D 8017	INTEGR.CIRCUIT	HEF4724BP	PEL	4822 209 10316
D 8037	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 8038	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 8039	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 8041	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 8042	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
N 8013	INTEGR.CIRCUIT	UA741CN	SIG	5322 209 83267
N 8018	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8019	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8021	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8022	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8023	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8024	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8026	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8027	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8028	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8029	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729

N 8031	INTEGR.CIRCUIT	NE5537N		SIG	5322 209 81729
N 8032	INTEGR.CIRCUIT	NE5537N		SIG	5322 209 81729
N 8033	INTEGR.CIRCUIT	NE5537N		SIG	5322 209 81729
N 8034	INTEGR.CIRCUIT	NE5537N		SIG	5322 209 81729
N 8036	INTEGR.CIRCUIT	NE5537N		SIG	5322 209 81729

9.3.3 RESISTORS

R 8001	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8002	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8003	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 8004	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8006	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 8007	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 8008	RES.METAL FILM	MR25	1%	1K21	5322 116 54557

9.3.4 SEMI CONDUCTORS

V 8001	DIODE,REFERENCE	BZX79-C4V7	PEL	4822 130 34174
V 8002	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233

9.3.5 MISCELLANEOUS

S 8001	PLUG,ADAPTER	BLUE		5322 263 50107

VERTICAL ATTENUATOR UNIT 10

CONTENTS

10. CIRCUIT DESCRIPTION OF VERTICAL ATTENUATOR UNIT.
10.1. Introduction 10-1
10.2. Circuit description of the signal part of the HF attenuator unit. 10-1
10.3. Circuit description of the LF attenuator unit. 10-2
10.4. Circuit description of auxiliary circuits on the HF attenuator unit. 10-2
10.5. Parts list 10-12

FIGURES

10.1. HF attenuator unit, p.c.b. lay-out. 10-5
10.2. HF attenuator unit, circuit diagram. 10-8
10.3. LF attenuator unit, circuit diagram. 10-9
10.4. LF attenuator unit, p.c.b. lay-out. 10-11

10. CIRCUIT DESCRIPTION OF VERTICAL ATTENUATOR UNIT.

10.1 INTRODUCTION

The A and B channel attenuators are identical: so only A is described.
Every attenuator unit consists of two printed circuit boards:
- the h.f. attenuator unit
- the 1.f. attenuator unit

10.2 CIRCUIT DESCRIPTION OF SIGNAL PART OF THE HF ATTENUATOR UNIT (See fig.10.2).

The input from the Y BNC connector (A or B) divides into five paths:
- three identical a.c.-coupled h.f. signal paths with different capacitive attenuation factors.
- a 50-ohm termination path.
- a direct-coupled signal path to the 1.f. attenuator unit.

The h.f. signal paths and the 50-ohm termination are selected by the contacts of reed relays mounted on the 1.f. unit and controlled by buffer D6903. This buffer is controlled by the HEF-bus IC D7001) on the adaptation unit.
Dealing first with the 50-ohms termination, the reed relay contact connects the input signal across 50-ohms (an array with two 100-ohm resistors connected in parallel to earth). The array includes a temperature sensor which activates a temperature-sensing circuit N6803 if the input signal exceeds 5 V.
The three h.f. paths are a.c.-coupled via C6801 (0.01x range), C6809 (1x range) and C6814 (0.1x range), which form part of the RC attenuators. The attenuator stages are each followed by a FET impedance converter stage (V6806 in the 1x path). A diode clipper in the gate circuit of the two lower ranges protects the input source follower of the impedance converter from excessive input voltages.
The impendance converter is switched by a PNP transistor (V6807) in its drain circuit. A +5 V switches it off and a +4.2. V switches it on.
The signal is then coupled via a diode (V6812) to transistor V6829, part of a summation stage (where also the 1.f. signal is added).
When "0" coupling is selected, transistor V6828 takes over the current normally drawn by one of the coupling diodes (V6811 or V6812) in the h.f. path. This serves to maintain the circuit in d.c. balance.
The gain of the summation stage is determined by the ratio of its collector resistance to its emitter resistance, $\frac{Rc}{Re}$.
In the x1 position, the collector resistance of V6829 is R6851 + (R6850//R6853), switched by V6819,
In the x5 position, used for the 2mV, 1mV/div, the collector resistance of V6829 is R6863 + R6852 + (R6853//R6854), switched by V6822. In the x5 position the bandwidth of the summation stage is reduced.
Switching is achieved by the logic level applied to the base of V6826; -1 V selects the x1 range, +5 V selects the x5 range.
The output signal from the summation stage V6829 and V6833 is routed to the output amplifier with V6837 and V6839. The output signal from this amplifier is routed to the signal unit via a coaxial cable. A part of the output signal is routed to the feedback loop on the 1.f. attenuator unit.

10.3 CIRCUIT DESCRIPTION OF THE LF ATTENUATOR UNIT (see fig.10.3.)

The 1.f. or d.c. path is chosen by the AC/DC reed relay switch contact. When "0" input coupling is chosen, the FET switch V6904 is switched off by a NUL- (-10 V) signal on its gate.
The signal on the d.c. path is fed to the operational amplifier N6901 together with the d.c. input (via R6909)
Any difference in the comparator is applied to the summation stage consisting of V6836, V6833 and V6829 on the HF unit. Note that when added, the h.f. signal and the 1.f. and d.c signal shown at the summation stage form a reconstituted version of the square-wave applied to the input.
Feedback capacitors in the operational amplifier N6901 ensure that the frequency response of the d.c. path matches that of the a.c. path. Feedback capacitor C6906 is always in circuit. The feedback capacitors C6907 and C6908 are switched into the circuit by the FET-switches V6906 and V6907. In the x0,1 attenuation position C6906 and C6907 are in circuit. In the x0,01 attenuation position C6906, C6907 and C6908 are all in circuit as feedback capacitance. The connection between the inverting input of operational amplifier N6901 and the output of the attenuator unit is made via a network of switcheable feedback resistors. The amount of resistors switched into the circuit by FET-switches depends on the attenuator setting.
The feedback resistance networks are:
x1 : R6909 (always in circuit)
x0.1 : R6909, R6914, R6911, R6912, switched by V6911
x0.01: R6909, R6914, R6911, R6912, R6913 switched by V6911 and V6913.
In the x5 gain increase position, resistor R6916 in the feedback circuit is switched to earth by V6908 to provide the necessary correction.

10.4 CIRCUIT DESCRIPTION OF THE AUXILIARY CIRCUITS ON THE HF ATTENUATOR (See fig.10.2)

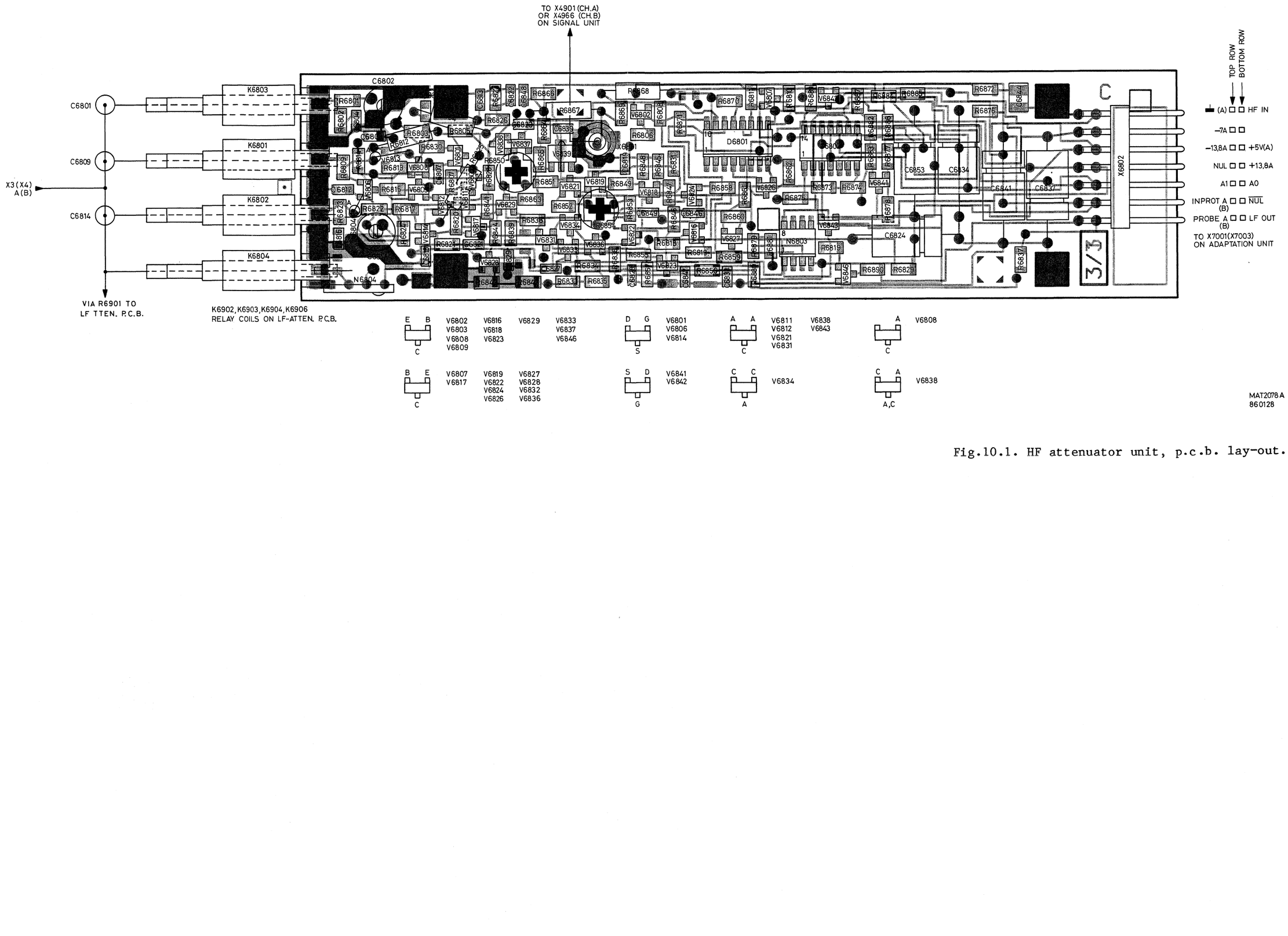
There are three auxiliary circuits:
- Multiplexer D6801 for h.f. attenuator switching
- Window discriminator for 50 Ohm terminator protection (N6802)
- Temperature sensing circuit for 50-ohm input termination N6802)

Multiplexer D6801 is controlled by the HEF-bus (address lines A0 and A1) to select the x1, x10 and x100 capacitive attenuators for the h.f. unit, on pins 12, 14 and 15 respectively. These pins are connected with V6807/base, V6816/base and V6802/base.
The x1 and x5 ranges are also selected by switching -1 V or +5 V to V6826/base. These voltages are made by multiplexer D6801/3, 1, 5, 2, 4 and voltage divider resistors R6871 and R6862.

The window discriminator checks the voltage across the h.f. attenuator output by means of two operational amplifiers N6802. One detects the positive signal peak and the other detects the negative signal peak. The resultant outputs are summed, and if the input voltage of 5 V is exceeded (measured with the attenuator in the x0,1-position during this measurement), the summation amplifier N6802/8, 9, 14 switches off transistor V6842. This gives a logic high (unsafe) signal to the central microprocessor. In this situation it is not possible to switch from 1M.Ohm to 50 Ohm input impedance.

Temperature sensing circuit.
This circuit consists of operational amplifier N6803. The temperature of the 50 ohm termination resistor is measured by a 1 kiloohm resistor present inside N6804 with a temperature co-efficient of +0,75 percent per degree Celsius. If the temperature gets too high, operational amplifier input N6803/2 goes high and switches V6846 on. V6846 switches resistor R6890 between the probe indication line and earth. The central microcomputer knows that either a high-ohmic probe or a 50 ohm overload is present now. The detection between the two is done as follows:

- The window of the discriminator is changed from 5 to 25 Volt in combination with the x0,01 attenuator section), via a low level from opamp output D6803/1 applied to the window discriminator via diode V6843 and switching FET V6841.
- The microcomputer switches the x0,01 attenuator section on for a moment and looks at the discriminator output: if the output is low, the voltage across the 50 ohm resistor is between 5 and 25 Volt and the current through the ohm resistor is such that it can be switched off. With the discriminator output being high, the voltage is above 25 Volt and the current through the 50 Ohm resistor is too high to be switched off. Now a warning becomes visible for the user on the CRT of the instrument (if the text display is on).
- Some seconds after having switched-off the 50 ohm-resistor, the microcomputer looks again to the probe-indication line. The temperature-sensing resistor is cooled down again and the probe indication line must be free again; if not the microcomputer knows that it was not a 50 ohm overload but that a high-ohmic probe is connected.



MAT2078 A
860128

Fig.10.1. HF attenuator unit, p.c.b. lay-out.

ATTENUATOR SECTIONS TO BE
ACTIVE AS FUNCTION OF AMPL/DIV SETTING.

AMPL / DIV	ATTENUATOR
1mV, 2mV	x 1 . x 5
5mV, 10mV, 20mV	x 1 x 1
50mV, 100mV, 200mV	x 0,1 x 1
500mV, 1V, 2V, 5V	x 0,01 x 1

A1	A0	ATTENUATION
0	0	1×
0	1	0,1×
1	0	0,01×
1	1	5×

TYPE	MARKING
BAW 56	A1
BAT 17	A3
BAV 70	A4
BAV 99	A7
BCW 30	C2
BCW 30R	C5
BCW 33R	D6
BFS 20	G1
BFS 20R	G4
BSR 56	M4
BFR 92	P1
BFR 92R	P4
BFR 93	R1
BFR 93R	R4
BFQ 19	S8
BFT 92	W1
BFT 93	X1

POS	TYPE
D6801	HEF4052
N6802	LM 339
N6803	LM358
N6804	OM545

Fig.10.2. HF attenuator unit, circuit diagram

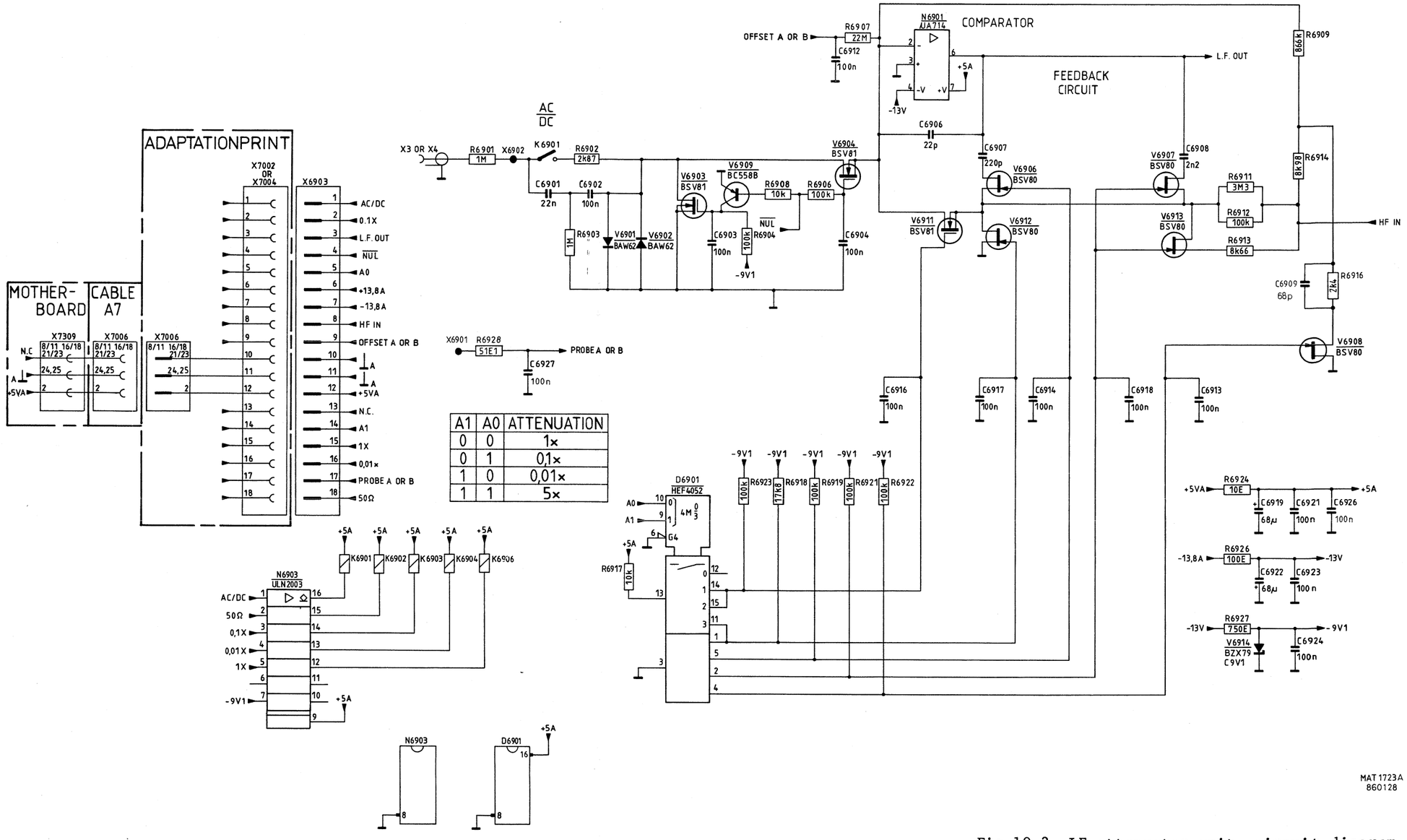


Fig.10.3. LF attenuator unit, circuit diagram.

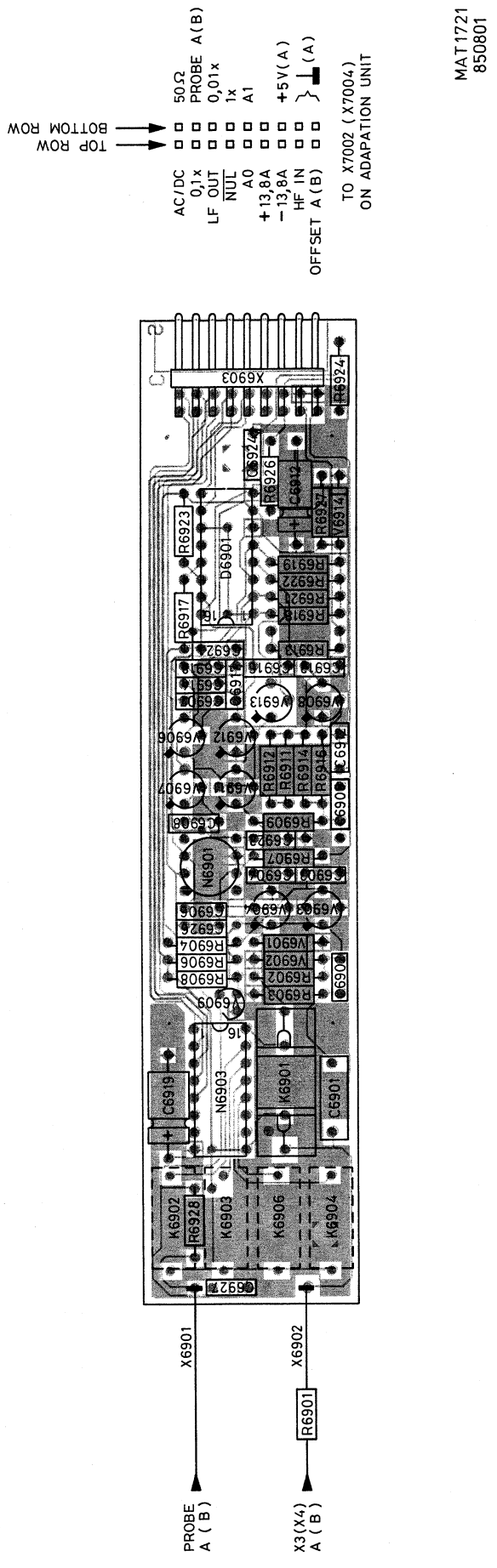


Fig.10.4. LF attenuator unit, p.c.b. lay-out.

10.5 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

10.5.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 6802	CAP.TRIMMER	63V		2.5-5PF	5322 125 50305
C 6803	CAP.CHIP	50V	5%	33PF	5322 122 32659
C 6804	CAP.CHIP	50V	5%	18PF	5322 122 32965
C 6806	2.7PF				5322 122 31873
C 6807	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6808	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6812	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6813	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6816	CAP.CHIP	50V	5%	22PF	5322 122 32658
C 6817	3P5-10P TRIMCAP				5322 125 50306
C 6818	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6819	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 6821	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6822	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6823	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6824	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6827	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6828	CAP.CHIP	50V	10%	1NF	5322 122 32662
C 6829	CAP.CERAMIC	50V	5%	2.7PF	5322 122 31873
C 6832	CAP.CHIP	50V	10%	100NF	5322 122 32657
C 6833	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6834	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6837	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6839	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6841	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6844	CAP.CHIP	50V	10%	100NF	5322 122 32657
C 6846	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6847	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6848	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6849	CAP.CHIP	50V	10%	22NF	5322 122 32656
C 6853	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6901	CAP.FOIL	400V	10%	22NF	5322 121 40308
C 6902	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6903	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6904	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6906	CAP.CERAMIC		2%	22PF	4822 122 31063
C 6907	CAP.CERAMIC		2%	220PF	4822 122 30094
C 6908	CAP.CERAMIC		10%	2.2NF	4822 122 30114
C 6912	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6913	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6914	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6916	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6917	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6918	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6919	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6921	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6922	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 6923	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6924	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6926	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 6927	CAP.FOIL	63V	10%	100NF	5322 121 42386

10.5.2 INTEGRATED CIRCUITS

D 6801	INTEGR.CIRCUIT	HEF4052BT	PEL		5322 209 11102
D 6901	INTEGR.CIRCUIT	HEF4052BP	PEL		4822 209 10263
6802	INTEGR.CIRCUIT	LM339DP		MOTA	4822 209 83329
N 6803	INTEGR.CIRCUIT	LM358D	MOT		5322 209 82941
N 6901	INTEGR.CIRCUIT	UA714HC	FSC		5322 209 86169
N 6903	INTEGR.CIRCUIT	ULN2003N	SIG		5322 209 86296
N 6804	INTEGR.CIRCUIT	OM545			5322 209 83451

10.5.3 RESISTORS

R 6801	RES.CHIP	RC-01	5%	180E	5322 111 90242
R 6802	RES.CHIP	RC-01	5%	39E	4822 111 90361
R 6803	RES.CHIP	RC-01	5%	13E	4822 111 90343
R 6804	RES.CARBON	0,125W	5%	100M	5322 111 30376
R 6805	RES.CHIP	RC-01	5%	68K	4822 111 90202
R 6806	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 6807	RES.CHIP	RC-01	5%	150E	5322 111 90098
R 6808	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6809	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 6810	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 6811	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6812	RES.CARBON	0,125W	5%	100M	5322 111 30376
R 6813	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6814	RES.CHIP	RC-01	5%	68K	4822 111 90202
R 6815	RES.CHIP	RC-01	5%	150E	5322 111 90098
R 6817	RES.CHIP	RC-01	5%	68E	4822 111 90203
R 6818	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 6819	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6820	RES.CHIP	RC-01	5%	150E	5322 111 90098
R 6821	RES.CHIP	RC-01	5%	68K	4822 111 90202
R 6822	RES.CHIP	RC-01	5%	15E	4822 111 90344
R 6823	RES.CHIP	RC-01	5%	15E	4822 111 90344
R 6824	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 6825	RES.CARBON	0,125W	5%	100M	5322 111 30376
R 6826	RES.CHIP	RC-01	5%	27K	4822 111 90542
R 6827	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6828	RES.CHIP	RC-01	5%	560E	5322 111 90113
R 6829	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 6830	RES.CHIP	RC-01	5%	110E	4822 111 90335
R 6831	RES.CHIP	RC-01	5%	270E	4822 111 90154
R 6833	RES.CHIP	RC-01	5%	180E	5322 111 90242
R 6834	RES.CHIP	RC-01	5%	33E	4822 111 90357
R 6835	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6836	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 6837	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6838	RES.CHIP	RC-01	1%	100E	5322 111 91134
R 6839	RES.CHIP	RC-01	5%	470E	5322 111 90109
R 6841	RES.CHIP	RC-01	5%	6E8	4822 111 90254
R 6842	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6843	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6844	RES.CHIP	RC-01	5%	270E	4822 111 90154
R 6845	RES.CHIP	RC-01	5%	1K8	5322 111 90101
R 6846	RES.CHIP	RC-01	5%	3K9	4822 111 90571
R 6847	RES.CHIP	RC-01	5%	180E	5322 111 90242
R 6848	RES.CHIP	RC-01	5%	680E	4822 111 90162
R 6849	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 6850	POTM.SLIDE	0.3W	25%	100E	5322 105 20029
R 6851	RES.CHIP	RC-01	5%	110E	5322 111 90877
R 6852	RES.CHIP	RC-01	5%	220E	4822 111 90178
R 6853	RES.CHIP	RC-01	5%	390E	5322 111 91205
R 6854	POTM.SLIDE	0.3W	25%	470E	5322 105 20028
R 6855	RES.CHIP	RC-01	5%	22E	4822 111 90186
R 6856	RES.CHIP	RC-01	5%	180E	5322 111 90242

R 6857	RES.CHIP	RC-01	5%	1K5	4822 111 90151
R 6858	RES.CHIP	RC-01	5%	2K2	4822 111 90248
R 6859	RES.CHIP	RC-01	5%	470E	5322 111 90109
R 6860	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6861	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6862	RES.CHIP	RC-01	5%	4K7	5322 111 90111
R 6863	RES.CHIP	RC-01	5%	33E	4822 111 90357
R 6864	RES.CHIP	RC-01	5%	270E	4822 111 90154
R 6865	RES.CHIP	RC-01	5%	33E	4822 111 90357
R 6866	RES.CHIP	RC-01	5%	33E	4822 111 90357
R 6867	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 6868	RES.METAL FILM	MR25	1%	536E	5322 116 50621
R 6869	RES.CHIP	RC-01	5%	330E	5322 111 90106
R 6870	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6871	RES.CHIP	RC-01	5%	4K7	5322 111 90111
R 6872	RES.CHIP	RC-01	5%	680E	4822 111 90162
R 6873	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6874	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6875	RES.CHIP	RC-01	5%	1K5	4822 111 90151
R 6876	RES.CHIP	RC-01	5%	120K	4822 111 90568
R 6877	RES.CHIP	RC-01	5%	68K	4822 111 90202
R 6878	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6879	RES.CHIP	RC-01	5%	15K	4822 111 90196
R 6880	RES.CHIP	RC-01	5%	1K8	5322 111 90101
R 6881	RES.CHIP	RC-01	5%	15K	4822 111 90196
R 6882	RES.CHIP	RC-01	5%	6.8K	4822 111 90544
R 6883	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 6884	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6885	RES.CHIP	RC-01	5%	68K	4822 111 90202
R 6886	RES.CHIP	RC-01	5%	220K	4822 111 90197
R 6887	RES.CHIP	RC-01	5%	3K3	4822 111 90157
R 6889	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6890	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6894	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6901	RES.METAL FILM	MR30	1%	1M	4822 116 51279
R 6902	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 6903	RES.METAL FILM	VR25	10%	1M	4822 116 52843
R 6904	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6906	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6907	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 6908	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 6909	RES.METAL FILM		0.1%	866K	5322 116 53174
R 6911	RES.HI-TENSION	VR25	5%	3M3	4822 110 72201
R 6912	RES.METAL FILM		0.1%	100K	5322 116 51703
R 6913	RES.METAL FILM		0.1%	8K66	5322 116 51778
R 6914	RES.METAL FILM		0.1%	8K98	5322 116 53175
R 6916	RES.METAL FILM		0.1%	2K4	5322 116 53502
R 6917	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 6918	RES.METAL FILM	MR25	1%	17K8	5322 116 54637
R 6919	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6921	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6922	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6923	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6924	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 6926	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6927	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 6928	51E1				5322 116 54442

10.5.4 SEMI CONDUCTORS

V 6801	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 6802	TRANSISTOR	BCW30	TAPE	PEL	5322 130 44335
V 6803	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 6804	DIODE	BAS45		PEL	5322 130 32256
V 6806	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 6807	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 6808	BAT 17				5322 130 31544
V 6809	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 6811	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 6812	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 6813	DIODE	BAS45		PEL	5322 130 32256
V 6814	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 6816	TRANSISTOR	BCW30	TAPE	PEL	5322 130 44335
V 6817	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 6818	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 6819	BFR 93R				5322 130 44802
V 6821	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 6822	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 6823	TRANSISTOR	BFS20		PEL	5322 130 42718
V 6824	TRANSISTOR	BCW33R	TAPE	PEL	5322 130 44342
V 6826	TRANSISTOR	BCW33R	TAPE	PEL	5322 130 44342
V 6827	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 6828	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 6829	BFR 93				5322 130 44801
V 6831	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 6833	BFT 93				5322 130 44824
V 6834	DIODE	BAW56	TAPE	PEL	5322 130 30691
V 6836	TRANSISTOR	BFS20R		PEL	5322 130 44177
V 6837	TRANSISTOR	BFT92		PEL	5322 130 44711
V 6838	DIODE	BAV99	TAPE	PEL	5322 130 34337
V 6839	TRANSISTOR	BFQ19		PEL	4822 130 42354
V 6841	TRANSISTOR	BSR56		PEL	4822 130 42633
V 6842	TRANSISTOR	BSR56		PEL	4822 130 42633
V 6843	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 6846	TRANSISTOR	BCW30	TAPE	PEL	5322 130 44335
V 6901	DIODE	BAW62		PEL	4822 130 30613
V 6902	DIODE	BAW62		PEL	4822 130 30613
V 6903	TRANSISTOR,FET	BSV81		PEL	5322 130 44041
V 6904	TRANSISTOR,FET	BSV81		PEL	5322 130 44041
V 6906	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 6907	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 6908	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 6909	TRANSISTOR	BC558B		PEL	4822 130 44197
V 6911	TRANSISTOR,FET	BSV81		PEL	5322 130 44041
V 6912	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 6913	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 6914	DIODE,REFERENCE	BZX79-C9V1		PEL	4822 130 30862

10.5.5 MISCELLANEOUS

K 6901	reed relay complete		5322 280 20145
K 6902	reed relay coil		5322 280 10175
K 6903	reed relay coil		5322 280 10175
K 6904	reed relay coil		5322 280 10175
K 6906	reed relay coil		5322 280 10175
K 6801	CONTACT,REED	RI20-SI	5322 280 24135
K 6802	CONTACT,REED	RI20-SI	5322 280 24135
K 6803	CONTACT,REED	RI20-SI	5322 280 24135
K 6804	CONTACT,REED	RI20-SI	5322 280 24135

EXTERNAL TRIGGER INPUT UNIT 11

CONTENTS

11. CIRCUIT DESCRIPTION OF MTB/DTB EXTERNAL TRIGGER UNIT.
11.1. Circuit description of MTB external trigger input. 11-1
11.2. Circuit description of DTB external trigger input. 11-2
11.3 Parts list 11-11

FIGURES

11.1. External MTB/DTB trigger unit, p.c.b. lay-out. 11-5
11.2. External MTB trigger input, circuit diagram. 11-8
11.3. External DTB trigger input, circuit diagram. 11-9

11. CIRCUIT DESCRIPTION OF MTB/DTB EXTERNAL TRIGGER UNIT.

11.1. CIRCUIT DESCRIPTION OF MTB EXTERNAL TRIGGER INPUT (See fig.11.2.)

The control signals for this unit come from D7003 on the adaptation unit.
The MTB trigger input unit is similar to the vertical attenuator unit except that there are only two different attenuator positions, x0,2 and x0,02. Consequently, the MTB TRIG or X DEFL input socket is coupled to two h.f. paths and one l.f. path.
Alternatively, a LINE input signal can be switched via FET V4739 to provide triggering or X deflection.

The two h.f. paths have no input switching reed relay contacts.
The x0,2 attenuator consists of the L-network C4701, R4701, R4702, C4702 in the gate circuit of FET V4701.
A logic low control signal on the base of the base of V4728 causes this transistor to conduct, which turns on source-follower FET V4701. In turn, V4703 conducts and the signal is passed via switching diode V4704 to the summation amplifier V4709, V4711.
The logic low control signal is also aplied to a switching network, V4719, V4721, V4722, which provides the collector load via diode V4727 for V4709 in the x0,2 position. The x0,2 gain adjust is R4751.
The x0,02 attenuator consists of a double L-network C4707, R4708, R4709, C4708, and R4711, C4709, R4712, C4711 in the gate circuit of FET V4706. The control and switching circuits (V4731, V4726, V4724, V4723) are identical to the x0,2 position section. When the x0,02 position is selected, the gain adjustment in the collector load of V4709 is the V4753.

The l.f. path is connected via resistor R4777 to the AC/DC switch K4701, which is controlled by a reed relay in the collector of transistor V4748.
The a.c. path is via C4742 (two series capacitors to reduce leakage) and C4743 in series. Reversed diodes V4732, V4733 to earth provide input protection. With external triggering selected, FET V4734 is off and FET V4736 is on. The l.f. or d.c. signals are therefore fed via V4736 to pin 2 of operational amplifier N4701, together with the feedback signal from the output via R4761, R4783 and C4748 in the x0,2 position; also via R4784//R4785 and C4749 in x0,02 position as V4737 and V4738 are conducting (diode V4746 blocked by logic high from N4702/1).
The output on pin 6 of the operational amplifier N4701 is applied via the base of buffer amplifier V4713 to the summation amplifier V4711/V4709. Here, the h.f. signal and l.f. signals recombine. This reconsituted input signal is applied to V4717 and emitter follower V4718 which together form the low-impedance output driver stage. This driver stage feeds the MTB trigger circuit on the signal unit via a coaxial cable.

When LINE TRIG is selected, the EXT TRIG is inhibited by the LINE control signal applied to inputs 9 and 12 of operational amplifiers N4702:
- The LINE- output on N4702-8 cuts off the h.f. path FETs V4701 and V4706 via switching diodes V4729. This output also switches off the l.f. path FET V4736 via diode V4744.
  Transistor V4714 (switched on in LINE trigger mode) ensures that the circuit d.c. balance is maintained by taking over the current from the switching diodes V4704.
- the LINE output on N4702-14 switches on FET V4734 to short circuit the l.f. signal to earth via diode V4743. The LINE control signal also switches on FET V4739 to provide a LINE TRIG signal path via its source, V4738 and R4783 to the output. A parallel path is also provided via R4784//R4785.

The source-drain capacitance of FET V4738 (switched off in the x0,2 position) is prevented from giving cross-talk by the circuit V4742 and FET V4741. In the x0,2 position, a -14 V output on N4702-1 turns on V4742 and thus FET V4741, which clamps the drain to earth.

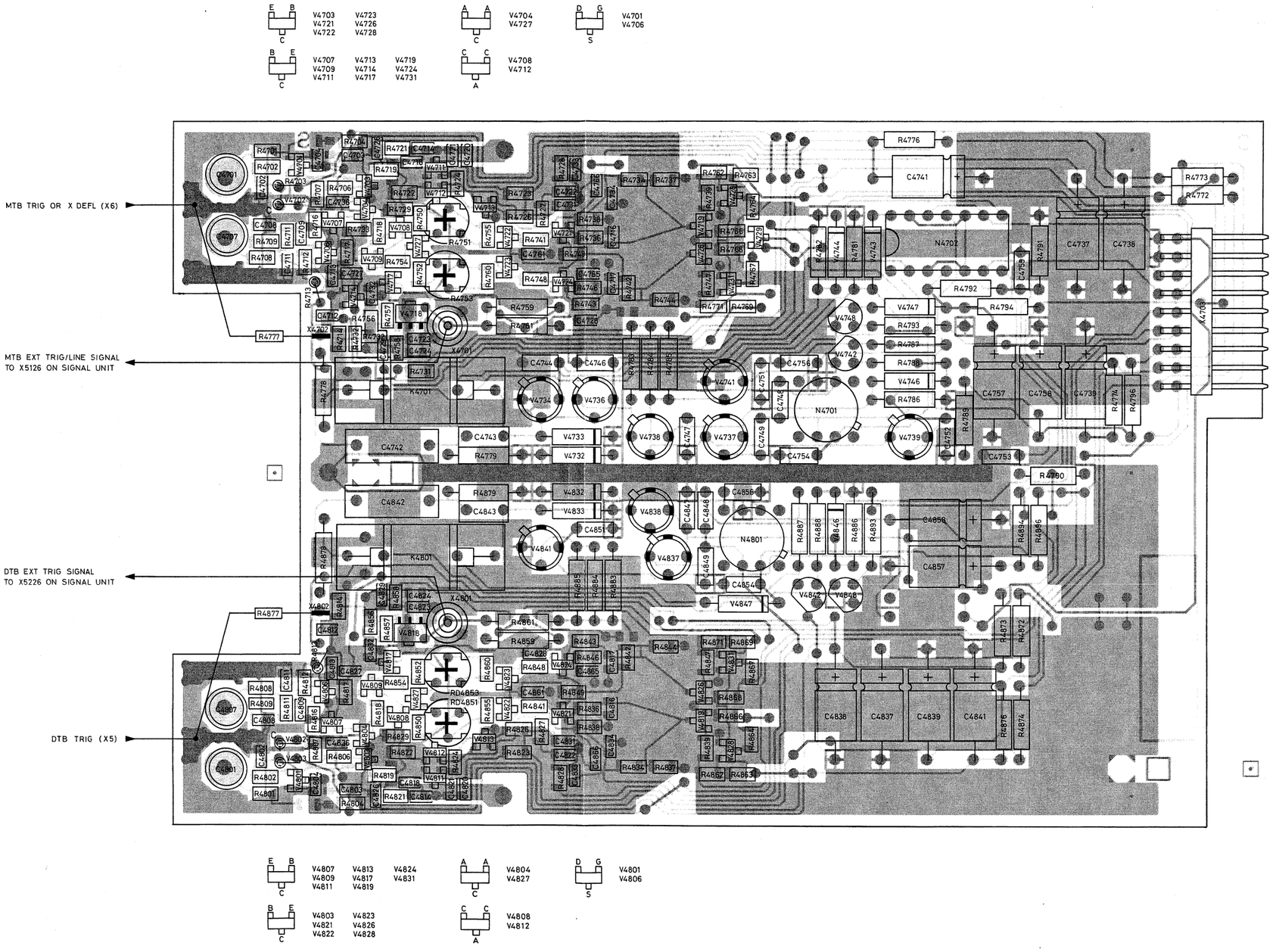
11.2. CIRCUIT DESCRIPTION OF DTB EXTERNAL TRIGGER INPUT (See fig.11.3.)

The control signals for this unit come from D7003 on the adaptation unit.
The DTB trigger input unit is almost identical to the MTB trigger input unit except that there is no LINE TRIG input. There are two different attenuator positions, x0,2 and x0,02. Consequently, the DTB TRIG input socket is coupled to two h.f. paths and one l.f. path. The two h.f. paths have no input switching with reed-relays.

The x0,2 attenuator consists of the L-network C4801, R4801, R4802, C4802 in the gate circuit of FET V4801.
A logic low DTB control signal on the base of V4828 causes this transistor to conduct, which turns on source-follower FET V4801. In turn, V4803 conducts and the signal is passed via diode V4804 to the summation amplifier V4809, V4811.
The logic low control signal is also applied to a switching network, V4819, V4821, V4822, which provides the collector load via diode V4827 for V4809 in the x0,2 position. The x0,2 gain adjust is R4851.
The x0,02 attenuator consists of a double L-network C4807, R4808, R4809, C4804, and R4811, C4809, R4812, C4811 in the gate circuit of FET V4806. The control and switching circuits (V4831, V4826, V4824, V4823) are identical to the x0,2 position. When the x0,02 position is selected, the gain adjustment in the colllector load of V4809 is then R4853.

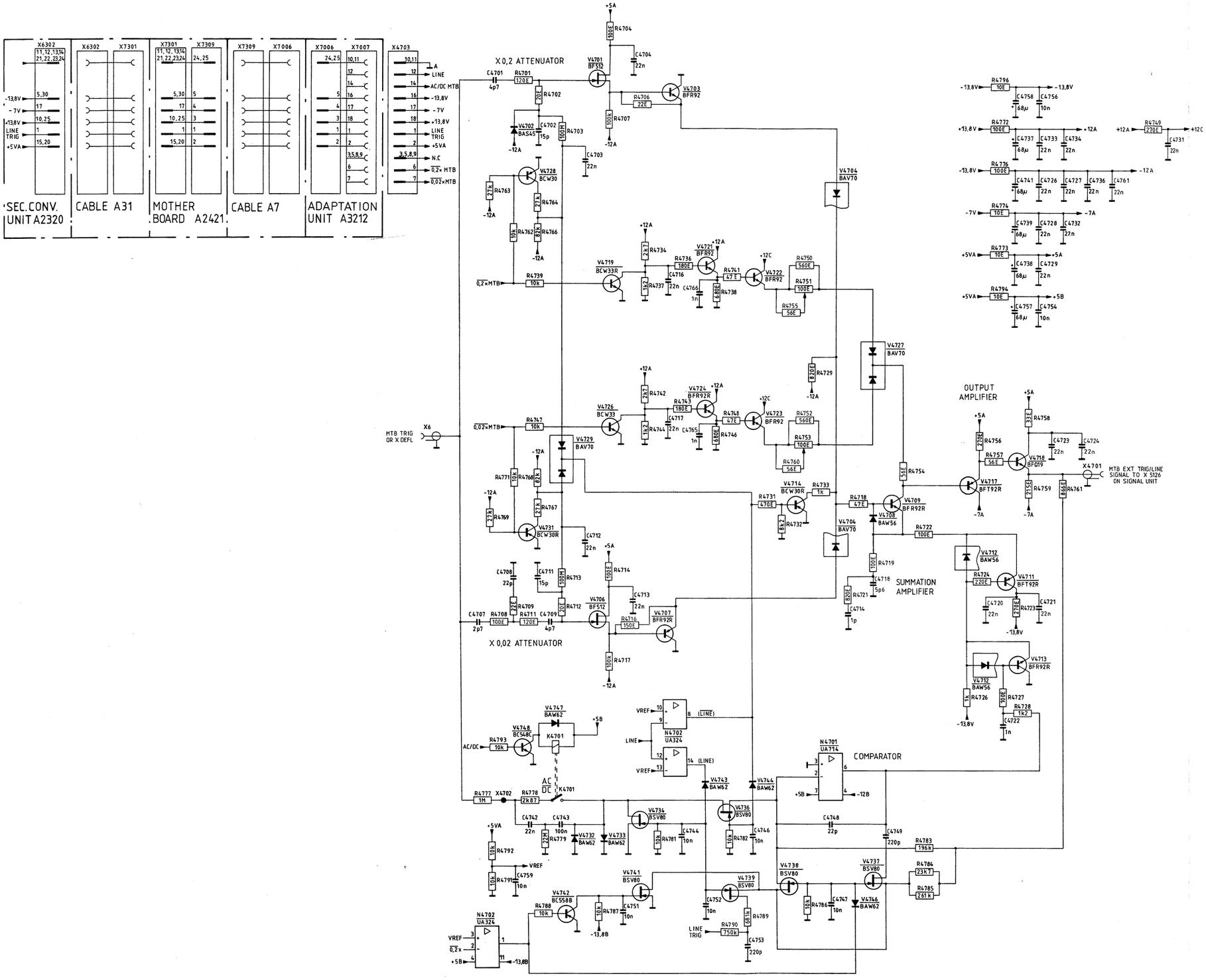
The l.f. path is connected via resistor R4877 to the AC/DC switch K4801, which is controlled by a reed relay in the collector of transistor V4848.
The a.c. path is via C4842 (two series capacitors to reduce leakage) and C4843 in series. Reversed diodes V4832, V4833 to earth provide input protection.
The l.f. or d.c. signals are fed to pin 2 of operational amplifier N4801, together with the feedback signal from the output via R4861, R4883 and C4848 in te x0,2 position; also via R4884//R4885 and C4849 in position x0,02 as V4837 and V4838 are conducting (diode V4846 blocked by logic high from N4802).The output on pin 6 of the operational amplifier N4801 is applied via the base of buffer amplifier V4813 to the summation amplifier. Here, the h.f. signal and l.f. signals recombine.

This reconsituted input signal is applied to the V4817 and emitter follower V4818 which together form the low-impedance output driver stage.
The source-drain capacitance of FET V4838 (switched off in the x0,2 position) is prevented from giving cross-talk by the circuit V4842 and FET V4841. In the x0,2 position, a -14 V output on N4802-1 turns on V4842 and thus FET V4841, which clamps the drain to earth.



MAT 2076A
860307

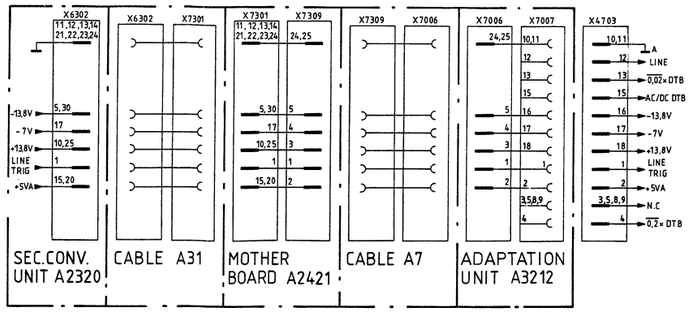
Fig.11.1. External MTB/DTB trigger unit, p.c.b. lay-out.

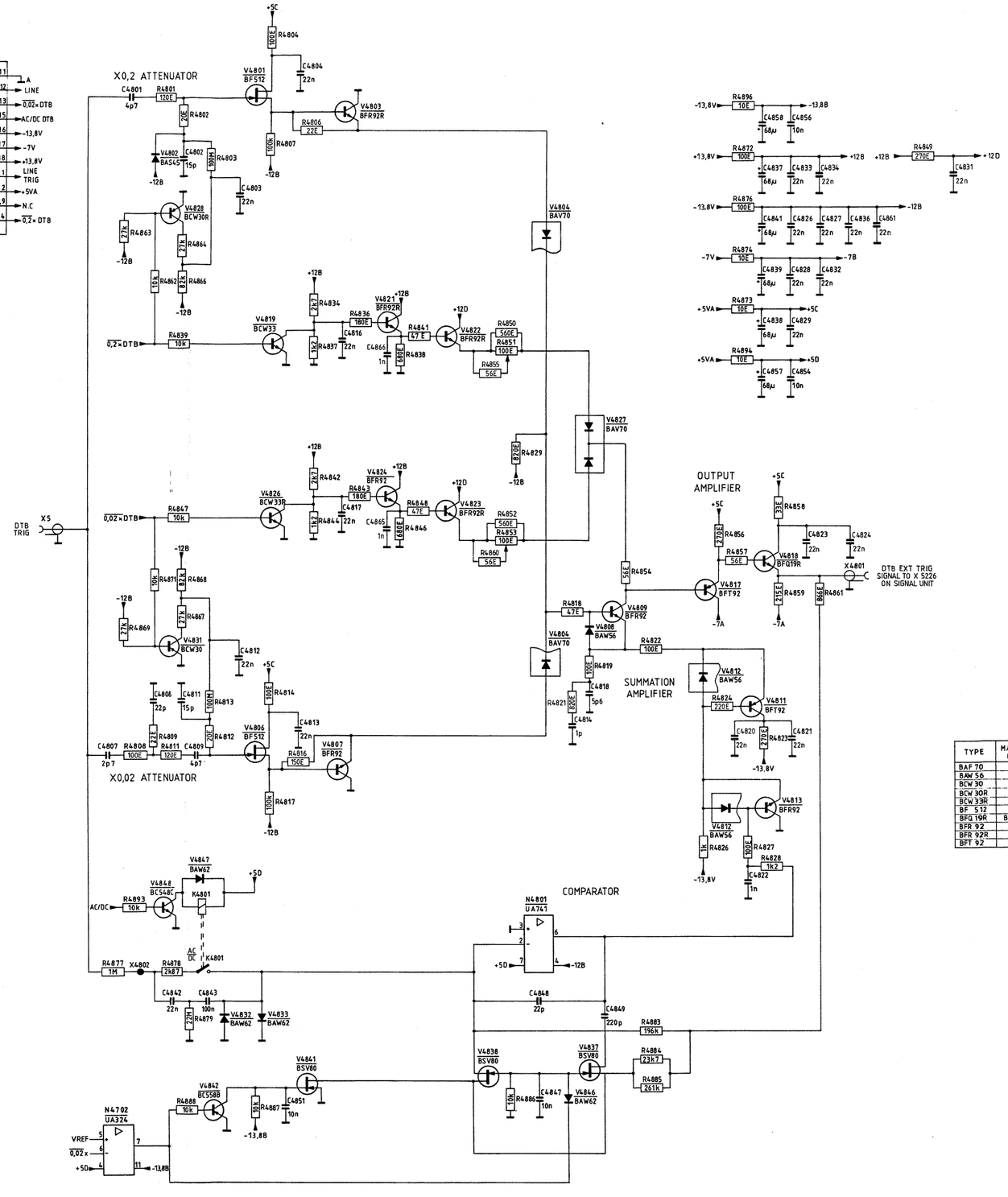


TYPE	MARKING CODE
BAV 70	A4
BAW 56	A1
BCW 30	C2
BCW 30R	C5
BCW 33	D3
BCW 33R	D6
BF512	S8
BFQ19	BFQ19
BFR 92	P1
BFR 92R	P4
BFT 92R	W4

MAT1724B
860307

Fig.11.2. External MTB trigger input, circuit diagram.





TYPE	MARKING CODE
BAF 70	A4
BAW 56	A1
BCW 30	C2
BCW 30R	C5
BCW 33R	D6
BF 512	S8
BFQ 19R	BFQ 19R
BFR 92	P1
BFR 92R	P4
BFT 92	W1

Fig.11.3. External DTB trigger input, circuit diagram.

11.3 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

11.3.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 4702	CAP.CERAMIC	50V 5%	15PF	5322 122 32481
C 4703	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4704	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4708	CAP.CHIP	50V 5%	22PF	5322 122 32658
C 4709	CAP.CERAMIC	50V 5%	4.7PF	5322 122 32451
C 4711	CAP.CERAMIC	50V 5%	15PF	5322 122 32481
C 4712	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4713	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4714	CAP.CERAMIC	50V 5%	3.3PF	5322 122 32449
C 4716	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4717	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4718	CAP.CERAMIC	50V 5%	4.7PF	5322 122 32451
C 4720	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4721	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4722	CAP.CHIP	50V 5%	1NF	5322 122 32531
C 4723	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4724	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4726	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4727	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4728	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4729	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4731	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4732	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4733	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4734	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4736	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4737	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4738	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4739	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4741	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4742	CAP.FOIL	400V 10%	22NF	5322 121 40308
C 4743	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 4744	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4746	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4747	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4748	CAP.CERAMIC	2%	22PF	4822 122 31063
C 4749	CAP.CERAMIC	2%	220PF	4822 122 30094
C 4751	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4752	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4753	CAP.CERAMIC	2%	220PF	4822 122 30094
C 4754	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4756	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4757	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4758	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 4759	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4761	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4765	CAP.CHIP	50V 5%	1NF	5322 122 32531
C 4766	CAP.CHIP	50V 5%	1NF	5322 122 32531
C 4802	CAP.CERAMIC	50V 5%	15PF	5322 122 32481
C 4803	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4804	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 4808	CAP.CHIP	50V 5%	22PF	5322 122 32658

C 4809	CAP.CERAMIC	50V	5%	4.7PF	5322 122 32451
C 4811	CAP.CERAMIC	50V	5%	15PF	5322 122 32481
C 4812	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4813	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4814	CAP.CERAMIC	50V	5%	3.3PF	5322 122 32449
C 4816	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4817	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4818	CAP.CERAMIC	50V	5%	4.7PF	5322 122 32451
C 4820	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4821	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4822	CAP.CHIP	50V	5%	1NF	5322 122 32531
C 4823	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4824	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4826	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4827	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4828	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4829	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4831	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4832	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4833	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4834	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4836	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4837	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4838	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4839	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4841	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4842	CAP.FOIL	400V	10%	22NF	5322 121 40308
C 4843	CAP.FOIL	63V	10%	100NF	5322 121 42386
C 4847	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 4848	CAP.CERAMIC		2%	22PF	4822 122 31063
C 4849	CAP.CERAMIC		2%	220PF	4822 122 30094
C 4851	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 4854	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 4856	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 4857	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4858	CAP.ELECTROLYT.	-10+50%		68UF	4822 124 20689
C 4861	CAP.CHIP	50V	10%	22NF	5322 122 32654
C 4865	CAP.CHIP	50V	5%	1NF	5322 122 32531
C 4866	CAP.CHIP	50V	5%	1NF	5322 122 32531
C 4889	CAP.CERAMIC		10%	4.7NF	4822 122 31125

11.3.2 INTEGRATED CIRCUITS

N 4701	INTEGR.CIRCUIT	UA714HC	FSC	5322 209 86169
N 4702	INTEGR.CIRCUIT	UA324PC	FSC	5322 209 82561
N 4801	INTEGR.CIRCUIT	UA714HC	FSC	5322 209 86169

11.3.3 RESISTORS

R 4701	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 4702	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 4703	RES.CARBON	0,125W	5%	100M	5322 111 30376
R 4704	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 4706	RES.CHIP	RC-01	5%	150E	5322 111 90098
R 4707	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 4708	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 4709	RES.CHIP	RC-01	5%	22E	4822 111 90186
R 4711	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 4712	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 4713	RES.CARBON	0,125W	5%	100M	5322 111 30376
R 4714	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 4716	RES.CHIP	RC-01	5%	150E	5322 111 90098
R 4717	RES.CHIP	RC-01	5%	100K	4822 111 90214

R 4718	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4719	RES.CHIP	RC-01	5% 120E	4822 111 90339
R 4721	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4722	RES.CHIP	RC-01	5% 100E	5322 111 91134
R 4723	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4724	RES.CHIP	RC-01	5% 22E	4822 111 90186
R 4726	RES.CHIP	RC-01	5% 1K	5322 111 90092
R 4727	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 4728	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4729	RES.CHIP	RC-01	5% 820E	4822 111 90171
R 4731	RES.CHIP	RC-01	5% 470E	5322 111 90109
R 4732	RES.CHIP	RC-01	5% 8K2	5322 111 90118
R 4733	RES.CHIP	RC-01	5% 1K	5322 111 90092
R 4734	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4736	RES.CHIP	RC-01	5% 180E	5322 111 90242
R 4737	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4738	RES.CHIP	RC-01	5% 680E	4822 111 90162
R 4739	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4741	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4742	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4743	RES.CHIP	RC-01	5% 180E	5322 111 90242
R 4744	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4746	RES.CHIP	RC-01	5% 680E	4822 111 90162
R 4747	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4748	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4749	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4750	RES.CHIP	RC-01	5% 560E	5322 111 90113
R 4751	POTM.SLIDE	0.3W	25% 100E	5322 105 20029
R 4752	RES.CHIP	RC-01	5% 560E	5322 111 90113
R 4753	POTM.SLIDE	0.3W	25% 100E	5322 105 20029
R 4755	RES.CHIP	RC-01	5% 56E	4822 111 90239
R 4756	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4757	RES.CHIP	RC-01	5% 22E	4822 111 90186
R 4758	RES.CHIP	RC-01	5% 33E	4822 111 90357
R 4759	RES.METAL FILM	MR25	1% 215E	5322 116 55274
R 4760	RES.CHIP	RC-01	5% 56E	4822 111 90239
R 4761	RES.METAL FILM	MR25	1% 866E	5322 116 54543
R 4762	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4763	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4764	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4766	RES.CHIP	RC-01	5% 82K	4822 111 90575
R 4767	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4768	RES.CHIP	RC-01	5% 82K	4822 111 90575
R 4769	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4771	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4772	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 4773	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4774	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4776	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 4777	RES.METAL FILM	MR30	1% 1M	4822 116 51279
R 4778	RES.METAL FILM	MR25	1% 2K87	5322 116 55279
R 4779	RES.METAL FILM	VR25	10% 22M	5322 116 51785
R 4781	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4782	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4783	RES.METAL FILM		0.1% 196K	5322 116 52386
R 4784	RES.METAL FILM		0.1% 23K7	5322 116 53169
R 4785	RES.METAL FILM	MR25	1% 261K	5322 116 54736
R 4786	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4787	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4788	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4789	RES.METAL FILM	MR25	1% 681K	5322 116 55284
R 4790	RES.METAL FILM	MR25	1% 750K	5322 116 55532
R 4791	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4792	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 4793	RES.METAL FILM	MR25	1% 10K	4822 116 51253

R 4794	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4796	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4801	RES.CHIP	RC-01	5% 120E	4822 111 90339
R 4802	RES.CHIP	RC-01	5% 18E	5322 111 90139
R 4803	RES.CARBON	0,125W	5% 100M	5322 111 30376
R 4804	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 4806	RES.CHIP	RC-01	5% 150E	5322 111 90098
R 4807	RES.CHIP	RC-01	5% 100K	4822 111 90214
R 4808	RES.CHIP	RC-01	5% 120E	4822 111 90339
R 4809	RES.CHIP	RC-01	5% 15E	4822 111 90344
R 4811	RES.CHIP	RC-01	5% 120E	4822 111 90339
R 4812	RES.CHIP	RC-01	5% 18E	5322 111 90139
R 4813	RES.CARBON	0,125W	5% 100M	5322 111 30376
R 4814	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 4816	RES.CHIP	RC-01	5% 150E	5322 111 90098
R 4817	RES.CHIP	RC-01	5% 100K	4822 111 90214
R 4818	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4819	RES.CHIP	RC-01	5% 120E	4822 111 90339
R 4821	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4822	RES.CHIP	RC-01	5% 100E	5322 111 91134
R 4823	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4824	RES.CHIP	RC-01	5% 22E	4822 111 90186
R 4826	RES.CHIP	RC-01	5% 1K	5322 111 90092
R 4827	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 4828	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4829	RES.CHIP	RC-01	5% 820E	4822 111 90171
R 4834	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4836	RES.CHIP	RC-01	5% 180E	5322 111 90242
R 4837	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4838	RES.CHIP	RC-01	5% 680E	4822 111 90162
R 4839	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4841	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4842	RES.CHIP	RC-01	5% 2K7	4822 111 90569
R 4843	RES.CHIP	RC-01	5% 180E	5322 111 90242
R 4844	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 4846	RES.CHIP	RC-01	5% 680E	4822 111 90162
R 4847	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4848	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 4849	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4850	RES.CHIP	RC-01	5% 560E	5322 111 90113
R 4851	POTM.SLIDE	0.3W	25% 100E	5322 105 20029
R 4852	RES.CHIP	RC-01	5% 560E	5322 111 90113
R 4853	POTM.SLIDE	0.3W	25% 100E	5322 105 20029
R 4855	RES.CHIP	RC-01	5% 33E	4822 111 90357
R 4856	RES.CHIP	RC-01	5% 270E	4822 111 90154
R 4857	RES.CHIP	RC-01	5% 22E	4822 111 90186
R 4858	RES.CHIP	RC-01	5% 33E	4822 111 90357
R 4859	RES.METAL FILM	MR25	1% 215E	5322 116 55274
R 4860	RES.CHIP	RC-01	5% 56E	4822 111 90239
R 4861	RES.METAL FILM	MR25	1% 866E	5322 116 54543
R 4862	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4863	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4864	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4866	RES.CHIP	RC-01	5% 82K	4822 111 90575
R 4867	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4868	RES.CHIP	RC-01	5% 82K	4822 111 90575
R 4869	RES.CHIP	RC-01	5% 27K	4822 111 90542
R 4871	RES.CHIP	RC-01	5% 10K	4822 111 90249
R 4872	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 4873	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4874	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 4876	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 4877	RES.METAL FILM	MR30	1% 1M	4822 116 51279
R 4878	RES.METAL FILM	MR25	1% 2K87	5322 116 55279
R 4879	RES.METAL FILM	VR25	10% 22M	5322 116 51785

R 4883	RES.METAL FILM		0.1%	196K	5322 116 52386
R 4884	RES.METAL FILM		0.1%	23K7	5322 116 53169
R 4885	RES.METAL FILM	MR25	1%	261K	5322 116 54736
R 4886	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4887	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4888	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4893	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4894	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4896	RES.METAL FILM	MR25	1%	10E	5322 116 50452

11.3.4 SEMI CONDUCTORS

V 4701	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 4702	DIODE	BAS45		PEL	5322 130 32256
V 4703	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4704	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 4706	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 4707	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4708	DIODE	BAW56	TAPE	PEL	5322 130 30691
V 4709	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4711	TRANSISTOR	BFT92R		PEL	5322 130 44713
V 4712	DIODE	BAW56	TAPE	PEL	5322 130 30691
V 4713	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4714	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 4717	TRANSISTOR	BFT92R		PEL	5322 130 44713
V 4718	TRANSISTOR	BFQ19		PEL	4822 130 42354
V 4719	TRANSISTOR	BCW33R	TAPE	PEL	5322 130 44342
V 4721	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4722	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4723	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4724	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4726	TRANSISTOR	BCW33	TAPE	PEL	5322 130 44337
V 4727	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 4728	TRANSISTOR	BCW30	TAPE	PEL	5322 130 44335
V 4729	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 4731	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 4732	DIODE	BAW62		PEL	4822 130 30613
V 4733	DIODE	BAW62		PEL	4822 130 30613
V 4734	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4736	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4737	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4738	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4739	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4741	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4742	TRANSISTOR	BC558B		PEL	4822 130 44197
V 4743	DIODE	BAW62		PEL	4822 130 30613
V 4744	DIODE	BAW62		PEL	4822 130 30613
V 4746	DIODE	BAW62		PEL	4822 130 30613
V 4747	DIODE	BAW62		PEL	4822 130 30613
V 4748	TRANSISTOR	BC548C		PEL	4822 130 44196
V 4801	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 4802	DIODE	BAS45		PEL	5322 130 32256
V 4803	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4804	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 4806	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 4807	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4808	DIODE	BAW56	TAPE	PEL	5322 130 30691
V 4809	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4810	DIODE	BAW62		PEL	4822 130 30613
V 4811	TRANSISTOR	BFT92		PEL	5322 130 44711
V 4812	DIODE	BAW56	TAPE	PEL	5322 130 30691
V 4813	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4814	DIODE	BAV21		PEL	4822 130 30842
V 4817	TRANSISTOR	BFT92		PEL	5322 130 44711
V 4818	TRANSISTOR	BFQ19R		PEL	5322 130 42719

V 4819	TRANSISTOR	BCW33	TAPE	PEL	5322 130 44337
V 4821	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4822	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4823	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 4824	TRANSISTOR,FET	BFR92		PEL	5322 130 42145
V 4826	TRANSISTOR	BCW33R	TAPE	PEL	5322 130 44342
V 4827	DIODE	BAV70	TAPE	PEL	5322 130 34331
V 4828	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 4831	TRANSISTOR	BCW30	TAPE	PEL	5322 130 44335
V 4832	DIODE	BAW62		PEL	4822 130 30613
V 4833	DIODE	BAW62		PEL	4822 130 30613
V 4837	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4838	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4841	TRANSISTOR,FET	BSV80		PEL	5322 130 34044
V 4842	TRANSISTOR	BC558B		PEL	4822 130 44197
V 4846	DIODE	BAW62		PEL	4822 130 30613
V 4847	DIODE	BAW62		PEL	4822 130 30613
V 4848	TRANSISTOR	BC548C		PEL	4822 130 44196

ADAPTATION UNIT 12

CONTENTS

12. CIRCUIT DESCRIPTION OF ADAPTATION UNIT. 12-1
12.1 Parts list 12-6

FIGURES

12.1. Adaptation unit, p.c.b. lay-out. 12-2
12.2. Adaptation unit, circuit diagram. 12-4

12. CIRCUIT DESCRIPTION OF ADAPTATION UNIT (see fig.12.2.)

The adaptation unit, connected to the series HEF-bus, serves as the control unit for the vertical A, B, and EXT input units, which operate at 5 V TTL. It converts the 12 V serial bus input from the CPU to 5 V input and then back to 12 V for the other units on the mother board and time base. The unit comprises a high-to-low voltage translator D7004, which receives the 12 V level signals DATA 2, ENSCP and SERCLK in serial form from the CPU. This is converted to 5 V and routed on the adaptation unit through the serial data in/parallel data out HEF-bus decoders D7001 and D7002. Decoder D7001 controls the functions for the channel A input attenuator. D7002 does the same for channel B. The serial DATA out signal from D7002 is then fed to the low-to-high voltage translator D7006, which sends it on the DATA5 line at 12 V level to the mother board.
After serving the 12 V units on the mother board and time base, the serial data is returned to the adaptation unit on DATA8 and again converted into 5 V in D7004 to serve D7003, the last IC of the HEF-bus. D7003 controls the MTB/DTB external trigger input. The parallel outputs of the HEF-bus units, D7001, D7002 and D7003 appear on pins 4, 5, 6, 7, 14, 13, 12, 11 with the switching and ranging functions as shown on the diagram.

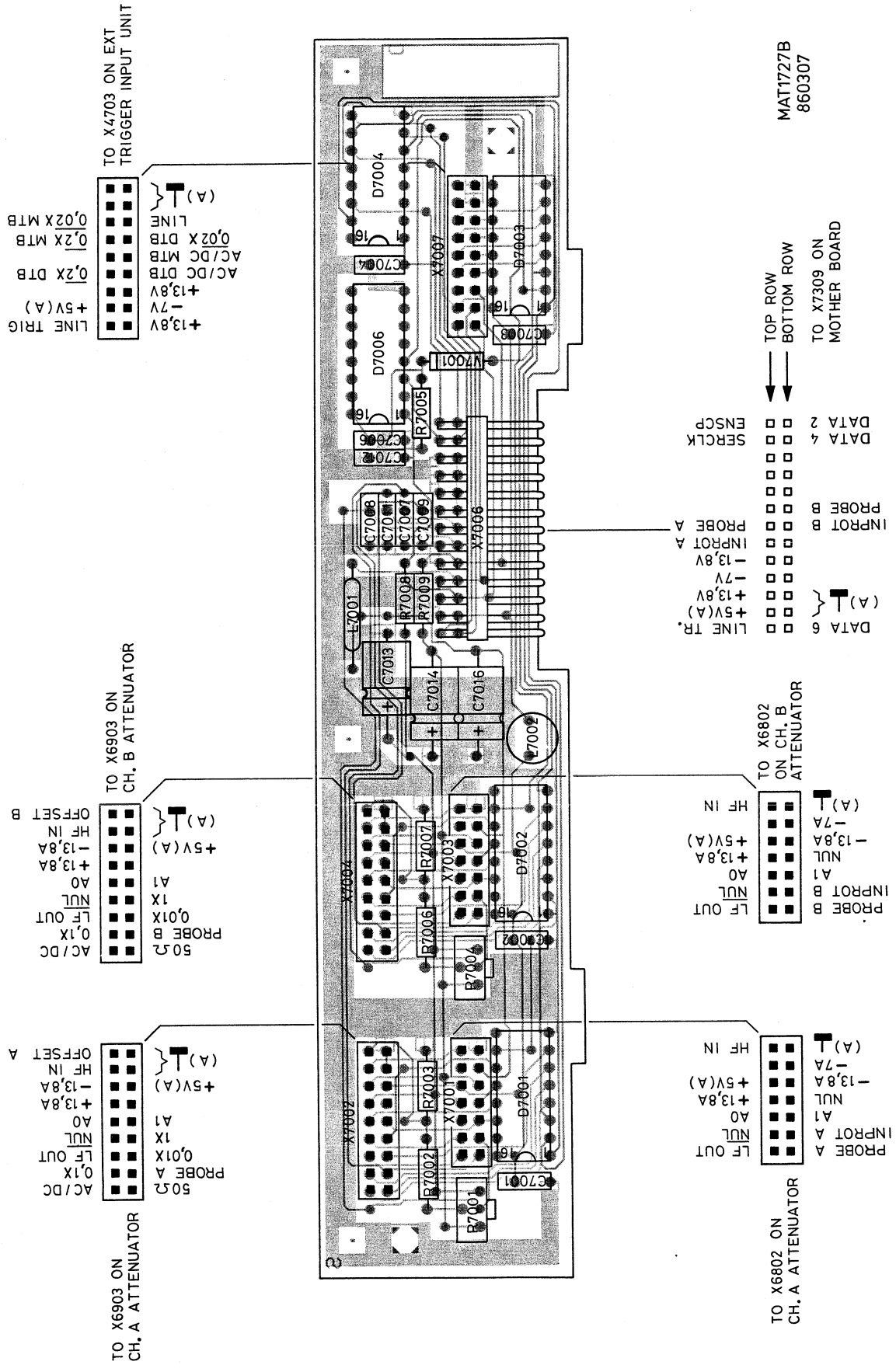
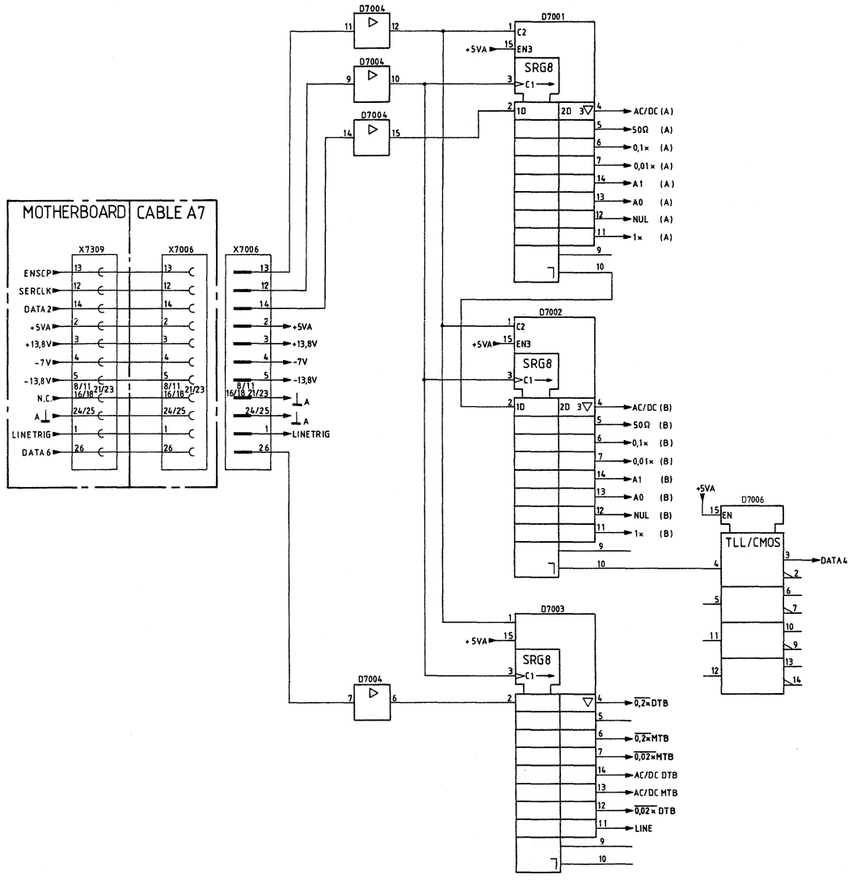
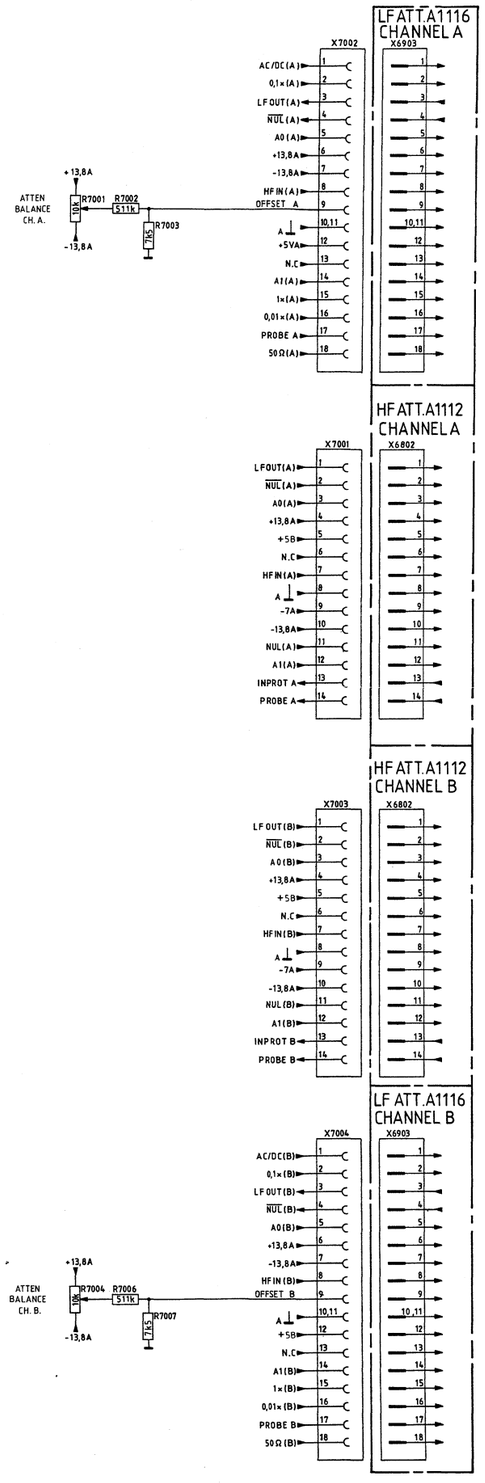
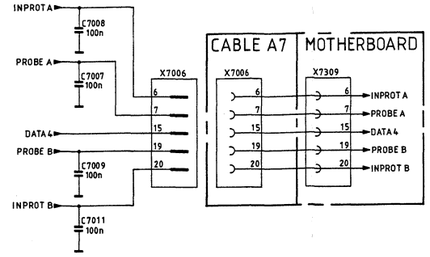
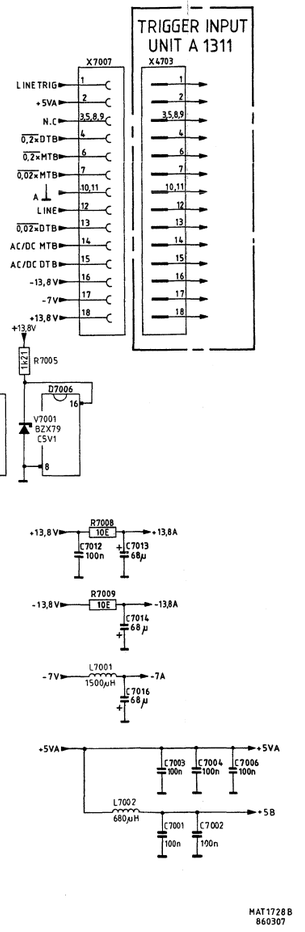


Fig.12.1. Adaptation unit, p.c.b. lay-out.









POS	TYPE
D7001-D7002-D7003	HEF4094
D7004	HEF4050
D7006	HEF4104

MAT1728B
860307

Fig.12.2. Adaptation unit, circuit diagram

12

12.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

12.1.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 7001	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7002	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7003	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7004	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7006	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7007	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7008	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7009	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7011	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7012	CAP.FOIL	63V 10% 100NF		5322 121 42386
C 7013	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 7014	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 7016	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689

12.1.2 INTEGRATED CIRCUITS

D 7001	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7002	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7003	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7004	INTEGR.CIRCUIT	HEF4050BP	PEL	4822 209 10261
D 7006	INTEGR.CIRCUIT	HEF4104BP	PEL	4822 209 10273

12.1.3 RESISTORS

R 7001	POTM.TRIMMER	MTP10	20%	10K	5322 101 14066
R 7002	RES.METAL FILM	MR25	1%	511K	5322 116 55258
R 7003	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 7004	POTM.TRIMMER	MTP10	20%	10K	5322 101 14066
R 7005	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 7006	RES.METAL FILM	MR25	1%	511K	5322 116 55258
R 7007	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 7008	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 7009	RES.METAL FILM	MR25	1%	10E	5322 116 50452

12.1.4 SEMI CONDUCTORS

V 7001	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233

12.1.5 MISCELLANEOUS

L 7001	COIL	1500UH	TDK	4822 156 21293
L 7002	COIL	680UH	TDK	5322 157 52364

SIGNAL UNIT 13

CONTENTS

13. CIRCUIT DESCRIPTION OF SIGNAL UNIT.
13.1. Circuit description of diagram 1 (channel A and B) 13-1
13.2. Circuit description of diagram 2 (MTB and DTB triggering) 13-3
13.3. Circuit description of diagram 3 (control circuits) 13-4
13.4 Locationlist of components on signal unit 13-17
13.5. Parts list 13-24

FIGURES

13.1. Signal unit, p.c.b. lay-out. 13-8
13.2. Signal unit, circuit diagram 1 (channel A and B) 13-10
13.3. Signal unit, circuit diagram 2 (MTB/DTB triggering) 13-11
13.4. Signal unit, circuit diagram 3 (control circuits) 13-14

13. CIRCUIT DESCRIPTION OF SIGNAL UNIT.

13.1. CIRCUIT DESCRIPTION OF DIAGRAM 1 (see fig.13.2.)

The signal unit follows the input attenuator circuits and is divided over three circuit diagrams.
- Diagram 1 containing the A and B amplifier channels, gain and channel selection.
- Diagram 2, which provides the MTB/DTB trigger filtering and amplifier circuits.
- Diagram 3, which provides the necessary control circuits.

A and B amplifier channels (diagram 1)

As the A and B channels are identical, only the A channel is described.
The 50-ohm unbalanced input signal for the A attenuator is applied to pin 3 of the integrated circuit N4903, the signal base of a differential amplifier.
Basically, N4903 (OM546) contains three identical common-base circuits responsible for the gain control (divide by 1, 2 and 4), a multiplier circuit and a normal/invert, channel on/off circuit. These circuits are controlled from the associated external networks as follows:
- Supply voltage adaption is achieved by n.p.n. transistor V4903 (provides +2 V on pin 28) and p.n.p. transistor V4904 (-10 V on pin 1).
- Gain adjustment is achieved by R4902 (GAIN), which provides a constant-current source with operational amplifier N4901 and transistor V4902. This constant current of 4 mA is applied to pin 29.
- Normal/invert is controlled by 0 V and +5 V logic signals on pins 11 and 12 derived from the HEF-bus:
  - CHAN A NORMAL input on pin 11 (+5 V normal, 0 V inverted).
  - CHAN A INVERT input on pin 12 (+5 V invert, 0 V normal).
  This allows the inverted signals to be compared.

Transistors V4908 and V4907 provide current sources on pins 25 and 26, which should be almost equal for well-adjusted normal/invert balance. The balance potentiometers are:

divide by		potentiometer
1	:	R4927
2	:	R4928
4	:	R4929
2.5.	:	R4931 (associated with the continuous control balance)

The trim-pots are selected by D4901 controlled from the HEF-bus.
-The continuous control, gain adjustment and extra 2.5 gain decrease for the least sensitive position of the instrument is achieved in the multiplier stage.
The continuous gain control output apears on the combined collectors of V4912 and V4914 (N4903-7). Any reduction in the 4 mA current applied to D4903/pin 7 results in a gain increase in the multiplier stage. If V4912 is on (5 V/div position) the current is determined by the CONT A (VAR) control and the preset R4952. A divide by 2.5 base signal on V4912 brings it into conduction and diode V4911 switches the control signal via the output of operational amplifier N4902 to the base of V4912.

Conversely, a logic low input from D5333-14 of the HEF-bus switches via V5333 to give a CHAN A INVERT signal via inverter D5328-6 and AND-gate D5329-6 (high). At the same time, a logic low in D5329-10 inhibits the CHAN NORMAL signal (low on D5329-8).
These selection modes can be summarised in the following truth table.

MODES SELECTED	OUTPUT SIGNALS TO CHANNEL A SWITCH N4903: CHAN A OFF	CHAN A INVERT	CHAN A NORMAL
CHAN A OFF	H	L	L
CHAN A NORMAL	L	L	H
CHAN A INVERT	L	H	L

- Output pin 1 of D5326 provides the ON/OFF TRIG VIEW signal used by MTB trigger amplifier N5129/pin 15 on diagram 2.
- Output pin 4 of D5326 provides the ON/OFF POS B output and the CHAN B OFF, CHAN B NORMAL/INVERT commands as described for channel A. The NORMAL/INVERT functions are controlled from HEF-bus line D5333-13 and the truth table is as follows:

MODES SELECTED	OUTPUT SIGNALS TO CHANNEL B SWITCH N4967: CHAN B OFF	CHAN B INVERT	CHAN B NORMAL
CHAN B OFF	H	L	L
CHAN B INVERT	L	H	L
CHAN V NORMAL	L	L	H

- Output pin 8 (CHOP SWITCH) switches the 2 MHz chop oscillator via R5340: High = oscillator on
  Low = oscillator off
  An oscillator output via NAND-gate D5327 and V5327 provides a blankingsignal to the X/Z amplifier during the channel change over period in the CHOP mode.

- Output pin 23 routes the DTB B signal to N5121/pin 24 on diagram 2.
- Output pin 24 routes the DTB A signal to N5116/pin 24 on diagram 2.
- Output pin 26 routes the MTB B signal to N5121/pin 15 on diagram 2.
- Output pin 27 routes the MTB A signal to N5116/pin 15 on diagram 2.
- Output pin 12 of D5326 connects the DTBS (DTB switch) signal to the Mother Board (delay=0 V, delay + delta t = +12 V). This signal is used on the time base unit.
- Output pin 11 of D5326 connects the TS (trace separation) signal to the Final Y Amp control (MTB trace = 0 V, DTB trace = +12 V)
- Output pin 10 of D5326 connects the TBS (time-base switch) choice via the Mother Board (MTB = +12 V, DTB = 0 V). This signal is used on the time base unit.

The remaining control circuits on diagram 3 consist of:
- A -5 V supply for various circuit elements, derived by V5337 from the -13 V supply line.
- Integrated circuits D5331, D5332 and D5333 of the HEF 4094-bus, controlled by the serial-bus signals DATA6, ENSCP and SERCLK coming from the central microcomputer via the adaptation unit and the mother board. The parallel outputs from D5331, D5332 and D5333 are active high and operate the logic levels of 0 V and +12 V.

NOTE: if more than one vertical channel must be displaued in combination with MAIN TB intensified and DEL´D TB, the control IC D 5326 controls the display sequence as follows:
- the vertical channels are displayed in the sequence A, A+B, B, TRIG VIEW and then again A, A+B, ... and so on. If a channel in this row is not selected it is of course skipped.
- a vertical channel (e.g. Channel A) is displayed first with MAIN TB intensified and then with DEL´D TB. After this the next vertical channel (in this case Channel B) is displayed first with MAIN TB intensified and then with DEL´D TB.

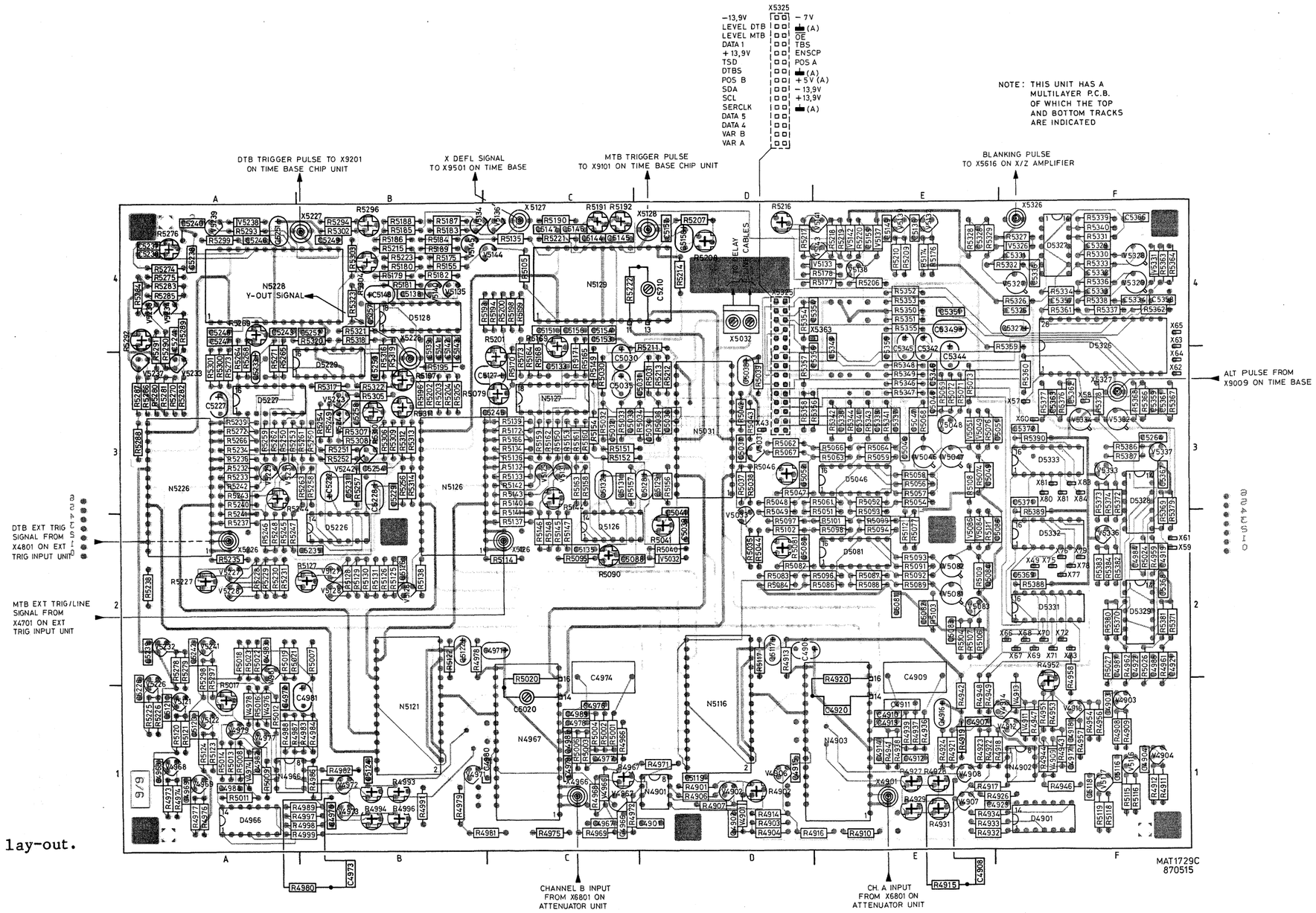


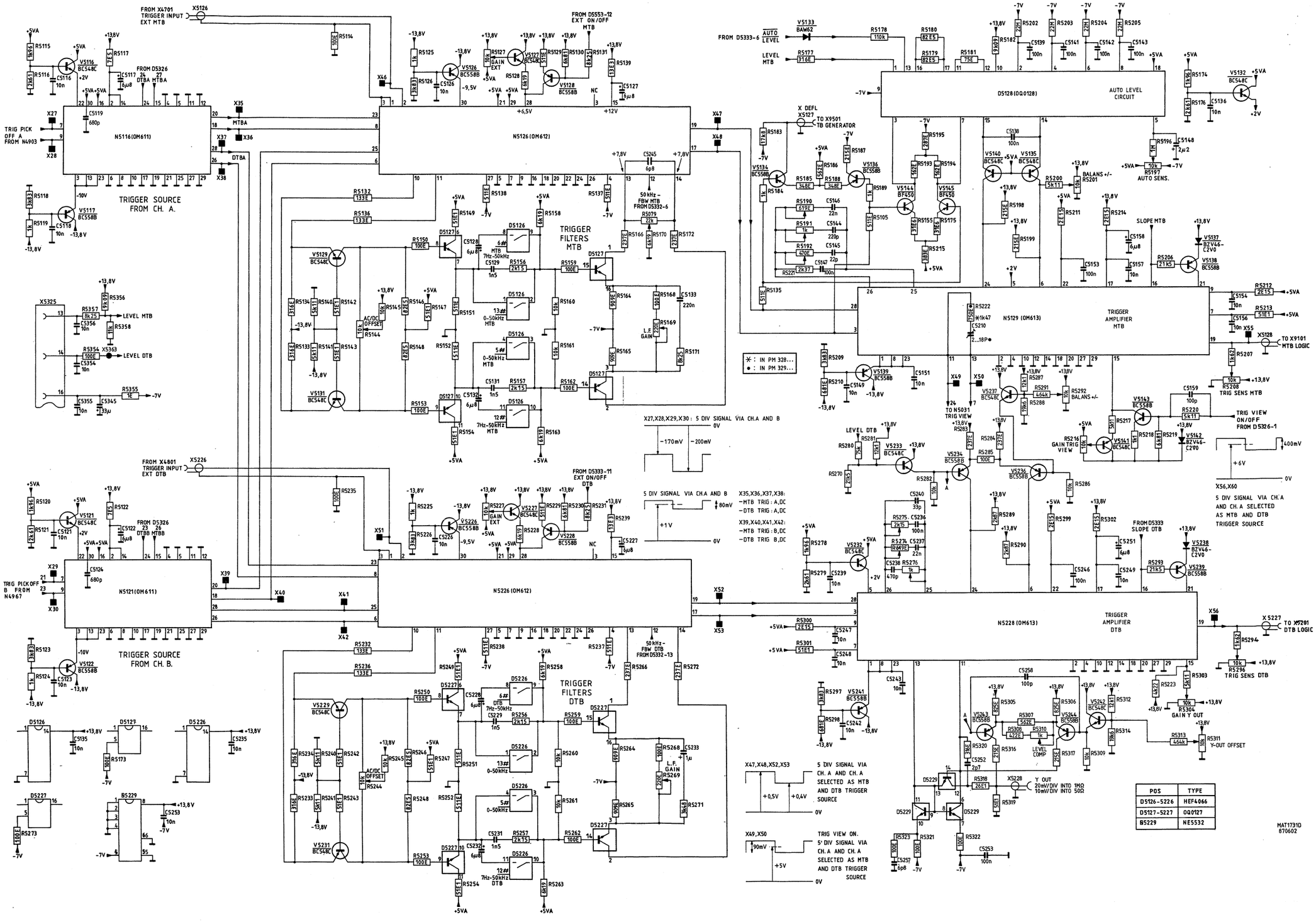
Fig.13.1. Signal unit, p.c.b. lay-out.

PRE-AMPLIFIER SECTIONS TO BE ACTIVE AS FUNCTION OF AMPL/DIV SETTING

AMPL/DIV	PRE-AMPL.
1mV 5mV 50mV 500mV	÷ 1
2mV 10mV 100mV 1V	÷ 2
20mV 200mV 2V 5V	÷ 4
5V	÷ 2.5

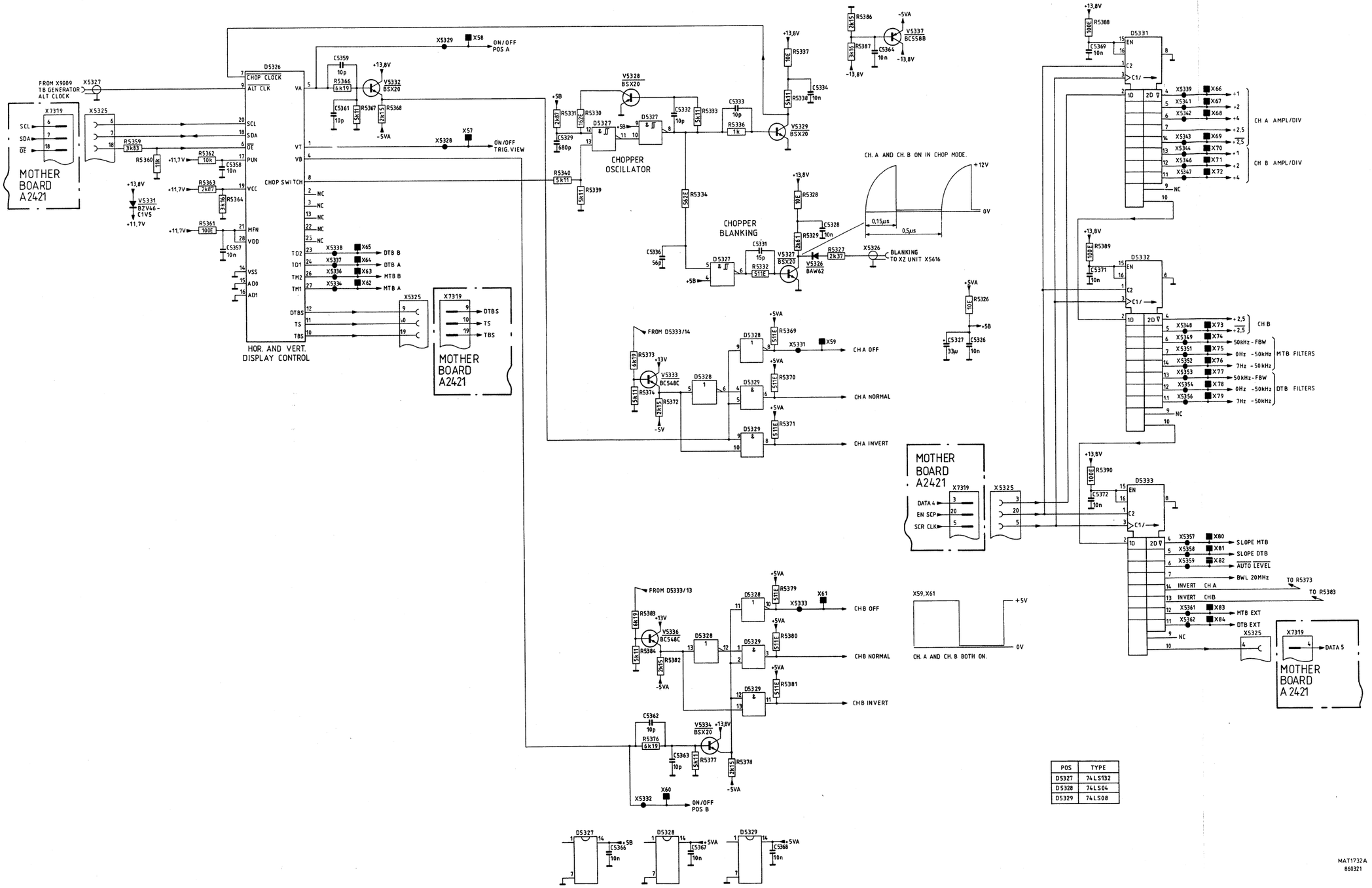
POS	TYPE
D4901-4966	HEF4066
D5046-5081	GQ0127
N4901-4902-4966	NE5532N

Fig.13.2. Signal unit, circuit diagram 1 (Channel A and B)



POS	TYPE
D5126-5226	HEF4066
D5127-5227	00D127
B5229	NE5532

Fig.13.3. Signal unit, circuit diagram 2 (MTB/DTB triggering)



POS	TYPE
D5327	74LS132
D5328	74LS04
D5329	74LS08

Fig.13.4. Signal unit, circuit diagram 3 (Control circuits)

13.4 LOCATION LIST OF COMPONENTS ON SIGNAL UNIT

13.4.1 CAPACITORS

C 4901	D1	C 5036	D3	C 5158	D4
C 4902	D1	C 5037	D3	C 5159	E4
C 4903	F1	C 5038	D3	C 5226	A1
C 4904	F1	C 5039	D2	C 5227	A3
C 4905	E1	C 5041	D3	C 5228	B3
C 4906	D2	C 5046	E3	C 5229	A2
C 4907	E1	C 5047	E3	C 5230	A2
C 4908	E1	C 5048	E3	C 5231	B3
C 4909	E2	C 5049	E3	C 5232	B3
C 4910	E1	C 5051	F3	C 5233	A3
C 4911	E1	C 5052	D3	C 5234	
C 4912	E1	C 5081	E2	C 5235	B2
C 4913	E1	C 5082	E2	C 5236	A4
C 4914	E1	C 5083	E2	C 5237	A4
C 4915	D1	C 5084	E2	C 5238	A4
C 4916	E1	C 5086	F2	C 5239	A2
C 4917	F1	C 5087	D2	C 5240	A4
C 4918	F1	C 5088	C2, D2	C 5241	A4
C 4919	F2	C 5116	F1	C 5242	A2
C 4921	F2	C 5117	D2	C 5243	A4
C 4922	F2	C 5118	F1	C 5245	B3
C 4923	B1	C 5119	D1	C 5246	A4
C 4943	B1	C 5121	A1	C 5247	A4
C 4965	C1	C 5122	B2	C 5248	A4
C 4966	C1	C 5123	A1	C 5249	B4
C 4967	C1	C 5124	B1	C 5251	A4
C 4968	A1	C 5125	B2	C 5252	A4
C 4969	A1	C 5126	B2	C 5253	B3
C 4971	C2	C 5127	C3	C 5254	B3
C 4972	A1	C 5128	D3	C 5256	
C 4973		C 5129	D3	C 5257	B4
C 4974	C2	C 5131	C3	C 5258	B3
C 4975	B1	C 5132	C3	C 5264	F3
C 4976	C1	C 5133	C3	C 5326	F4
C 4977	C1	C 5134		C 5327	F4
C 4978	C1	C 5135	C2	C 5328	E4
C 4979	C1	C 5136	E4	C 5329	F4
C 4980	C1	C 5138	B4	C 5331	F4
C 4981	B1	C 5139	B4	C 5332	F4
C 4982	A1	C 5141	B4	C 5333	F4
C 4983	A2	C 5142	B4	C 5334	F4
C 4984	C1	C 5143	B4	C 5336	F4
C 4985	C1	C 5144	C4	C 5337	E3
C 4986	F2	C 5145	C4	C 5338	E3
C 4987	F2	C 5146	C4	C 5339	E3
C 4988	A1	C 5147	C4	C 5341	E3
C 4989	A1	C 5148	B4	C 5342	E4
C 5030	C3	C 5149	E4	C 5343	E4
C 5031	D3	C 5151	C4	C 5344	E3
C 5032	C3	C 5153	C4	C 5345	E4
C 5033	C3	C 5154	C4	C 5346	E3
C 5034	D3	C 5156	C4	C 5349	E4
C 5035	C3	C 5157	D4	C 5351	E4

C 5354	E4
C 5355	E4
C 5356	E3
C 5357	F4
C 5358	F4
C 5359	F3
C 5361	F3
C 5362	F3
C 5363	F3
C 5364	
C 5366	F4
C 5367	F3
C 5368	F2
C 5369	F2
C 5371	F3
C 5372	F3

13.4.2 INTEGRATED CIRCUITS

D 4901	F1	N 4901	D1
D 4966	A1	N 4902	F1
D 5046	E3	N 4903	E1
D 5081	E2	N 4966	A1
D 5126	C2	N 4967	C1
D 5127		N 5031	D3
D 5128	B4	N 5116	D1
D 5226	B2	N 5121	B1
D 5227	A3	N 5126	B3
D 5229	B3	N 5127	C3
D 5326	F4	N 5129	C4
D 5327	F4	N 5226	A3
D 5328	F3	N 5228	A4
D 5329	F2		
D 5331	F2		
D 5332	F2		
D 5333	F3		

13.4.3 RESISTORS

R 4901	D1	R 4971	D1	R 5038	D3
R 4902	D1	R 4972	C1	R 5039	D3
R 4903	D1	R 4973	A1	R 5040	D2
R 4904	D1	R 4974	A1	R 5041	D2
R 4906	D1	R 4975	C1	R 5042	D3
R 4907	D1	R 4976	A1	R 5043	D3
R 4908	F1	R 4977	A1	R 5044	D2
R 4909	F1	R 4978	B2	R 5046	D3
R 4910	E1	R 4979	B1	R 5047	D3
R 4911	F1	R 4981	B1, C1	R 5048	D3
R 4912	F1	R 4982	B1	R 5049	D3
R 4913	D2	R 4983	B1	R 5051	E3
R 4914	D1	R 4984	B1	R 5052	E3
R 4916	D1, E1	R 4986	B1	R 5053	E3
R 4917	E1	R 4987	A1	R 5054	E3
R 4918	F1	R 4988	A1	R 5056	E3
R 4919	E1	R 4989	B1	R 5057	E3
R 4921	E1	R 4991	B1	R 5058	E3
R 4922	E1	R 4992		R 5059	
R 4923	E1	R 4993	B1	R 5061	E3
R 4924	E1	R 4994	B1	R 5062	D3
R 4926	F1	R 4996	B1	R 5063	E3
R 4927	E1	R 4997	B1	R 5064	E3
R 4928	E1	R 4998	B1	R 5066	E3
R 4929	E1	R 4999	B1	R 5067	D3
R 4931	E1	R 5001	C1	R 5068	E3
R 4932	E1	R 5002	C1	R 5069	E3
R 4933	E1	R 5003	C1	R 5071	E3
R 4934	E1	R 5004	C1	R 5072	E3
R 4936	E1	R 5006	C1	R 5073	E3
R 4937	E1	R 5007	B2	R 5074	E3
R 4938	E1	R 5008	A1	R 5076	E3
R 4939	E1	R 5009	A1	R 5077	E2
R 4941	E1	R 5011	A1	R 5079	C3
R 4942	E1	R 5012	A1	R 5081	D2
R 4943	F1	R 5013	A1	R 5082	D2
R 4944	F1	R 5014	A1	R 5083	D2
R 4946	F1	R 5016	A1	R 5084	D2
R 4947	F1	R 5017	A1	R 5086	E2
R 4948	E1	R 5018	A2	R 5087	E2
R 4949	E1	R 5019	A2	R 5088	E2
R 4951	F1	R 5021	A2	R 5089	E2
R 4952	F2	R 5022	A2	R 5090	C2
R 4953	F1	R 5023	A2	R 5091	E2
R 4954	F1	R 5024	F2	R 5092	E2
R 4956	F1	R 5026	F2	R 5093	E2
R 4957	F1	R 5027	F2	R 5094	E2
R 4958	F2	R 5030	C3	R 5095	C2
R 4959	F2	R 5031	D3	R 5096	E2
R 4961	F2	R 5032	C3		
R 4962	F2	R 5033	C3	R 5097	D2
R 4966	C1	R 5034	D3	R 5098	E2
R 4967	C1	R 5035	D2	R 5099	E2
R 4968	C1	R 5036	D3	R 5101	E2
R 4969	C1	R 5037	D3	R 5102	D2

R 5103	E2	R 5161	C3	R 5218	E4
R 5104	E2	R 5162	C3	R 5219	E4
R 5105	C4	R 5163	C3	R 5220	E4
R 5106	E2	R 5164	C3	R 5221	C4
R 5107	E2	R 5165	C3	R 5222	B4
R 5108	E3	R 5166	C3	R 5223	B4
R 5109	E2	R 5168	C3		
R 5111	E2	R 5169	C4	R 5225	A1
R 5112	E2	R 5170	C3	R 5226	A1
R 5114	C2	R 5171	C3	R 5227	A2
R 5115	F1	R 5172	C3	R 5228	A2
R 5116	F1	R 5173	C3	R 5229	A2
R 5117	D2	R 5174	E4	R 5230	A2
R 5118	F1	R 5175	B4	R 5231	A2
R 5119	F1	R 5176	E4	R 5232	A3
R 5120	A1	R 5177	E4	R 5233	A3
R 5121	A1	R 5178	E4	R 5234	A3
R 5122	B2	R 5179	B4	R 5235	A2
R 5123	A1	R 5180	B4	R 5236	A3
R 5124	A1	R 5181	B4	R 5237	A2
R 5125	B2	R 5182	B4	R 5238	A2
R 5126	B2	R 5183	B4	R 5239	A3
R 5127	B2	R 5184	B4	R 5240	A3
R 5128	B2	R 5185	B4	R 5241	A3
R 5129	B2	R 5186	B4	R 5242	A3
R 5130	B2	R 5187	B4	R 5243	A3
R 5131	B2	R 5188	B4	R 5244	A3, B3
R 5132	C3	R 5189	B4	R 5245	A2
R 5133	C3	R 5190	C4	R 5246	A2
R 5134	C3	R 5191	C4	R 5247	A2
R 5135	C4	R 5192	C4	R 5248	A2
R 5136	C3	R 5193	C4	R 5249	B3
R 5137	C2	R 5194	C4	R 5250	A3
R 5138	B2	R 5195	B3	R 5251	B3
R 5139	C3	R 5196	B3	R 5252	B3
R 5140	C3	R 5197	B3	R 5253	A3
R 5141	C3	R 5198	C4	R 5254	B3
R 5142	C3	R 5199	C4	R 5256	B3
R 5143	C3	R 5200	C4	R 5257	B3
R 5144	C3	R 5201	C4	R 5258	B3
R 5145	C2	R 5202	B3	R 5259	A3
R 5146	C2	R 5203	B3	R 5260	B3
R 5147	C2	R 5204	B3	R 5261	B3
R 5148	C2	R 5205	B3	R 5262	A3
R 5149	C3	R 5206	E4	R 5263	B3
R 5150	C3	R 5207	D4	R 5264	A3
R 5151	C3	R 5208	D4	R 5265	A3
R 5152	C3	R 5209	E4	R 5266	A3
R 5153	C3	R 5210	E4	R 5268	A3
R 5154	C3	R 5211	D4	R 5269	A4
R 5155	B4	R 5212	D3	R 5270	A3
R 5156	D3	R 5213	D3	R 5271	A3
R 5157	C3	R 5214	D4	R 5272	A3
R 5158	C3	R 5215	B4	R 5273	A3
R 5159	C3	R 5216	D4	R 5274	A4
R 5160	C3	R 5217	D4	R 5275	A4

R 5276	A4	R 5331	F4	R 5388	F2
R 5277	A4	R 5332	F4	R 5389	F3
R 5278	A2	R 5333	F4	R 5390	F3
R 5279	A2	R 5334	F4		
R 5280	A3	R 5336			
R 5281	A3	R 5337	F4		
R 5282	A3	R 5338	F4		
R 5283	A4	R 5339	F4		
R 5284	A4	R 5340	F4		
R 5285	A4	R 5341	E3		
R 5286	A3	R 5342	E3		
R 5287	A3	R 5343	E3		
R 5288	A3	R 5344	E3		
R 5289	A4	R 5346	E3		
R 5290	A3, A4	R 5347	E3		
R 5291	A3, A4	R 5348	E3		
R 5292	A4	R 5349	E3		
R 5293	A4	R 5350	E4		
R 5294	B4	R 5351	E4		
R 5296	B4	R 5352	E4		
R 5297	A2	R 5353	E4		
R 5298	A2	R 5354	D4		
R 5299	A4	R 5355	E4		
R 5300	A3	R 5356	E3		
R 5301	A3	R 5357	D3		
R 5302	B4	R 5358	D3		
R 5303	B4	R 5359	F4		
R 5304	B4	R 5360	F3		
R 5305	B3	R 5361	F4		
R 5306	B3	R 5362	F4		
R 5307	B3	R 5363	F4		
R 5308	B3	R 5364	F4		
R 5309	B3	R 5366	F3		
R 5310	B3	R 5367	F3		
R 5311	B3	R 5368	F3		
R 5312	B3	R 5369	F3		
R 5313	B3	R 5370	F2		
R 5314	B3	R 5371	F2		
R 5316	B3	R 5372	F3		
R 5317	B3	R 5373	F3		
R 5318	B4	R 5374	F3		
R 5319	B3	R 5376	F3		
R 5320	B4	R 5377	F3		
R 5321	B4	R 5378	F3		
R 5322	B3	R 5379	F3		
R 5323	B4	R 5380	F2		
R 5324		R 5381	F2		
R 5326	F4	R 5382	F2		
R 5327	F4	R 5383	F2		
R 5328	E4	R 5384	F2		
R 5329	E4	R 5386	F3		
R 5330	F4	R 5387	F3		

SEMI-CONDUCTORS

V 4901	D1	V 5136	C4
V 4902	D1	V 5137	E4
V 4903	F1	V 5138	E4
V 4904	F1	V 5139	E4
V 4906	D1	V 5140	B4
V 4907	E1	V 5141	E4
V 4908	E1	V 5142	E4
V 4909	F1	V 5143	E4
V 4910	F1	V 5144	C4
V 4911	F1	V 5145	B4
V 4912	F1	V 5226	A1
V 4913	F1	V 5227	A2
V 4914	F1	V 5228	A2
V 4916	F1	V 5229	A3
V 4966	C1	V 5231	A3
V 4967	C1	V 5232	A2
V 4968	A1	V 5233	A3
V 4969	A1	V 5234	A4
V 4971	B1	V 5236	A4
V 4972	B1	V 5237	A3
V 4973	B1	V 5238	A4
V 4974	A1	V 5239	A4
V 4976	A1	V 5241	A2
V 4977	A1	V 5242	B3
V 4978	A1	V 5243	B3
V 4979	A1	V 5244	B3
V 4981	A2	V 5326	F4
V 5031	D3	V 5327	F4
V 5032	D2	V 5328	F4
V 5033	D3	V 5329	F4
V 5046	E3	V 5331	
V 5047	E3	V 5332	F3
V 5048	E3	V 5333	F3
V 5049	E3	V 5334	F3
V 5051	E3	V 5336	F2
V 5081	E2	V 5337	F3
V 5082	E2		
V 5083	E2		
V 5084	E2		
V 5086	E2		
V 5116	F1		
V 5117	F1		
V 5121	A1		
V 5122	A1		
V 5126	B2		
V 5127	B2		
V 5128	B2		
V 5129	C3		
V 5131	C3		
V 5132	E4		
V 5133	E4		
V 5134	B4		
V 5135	B4		

N 4901 D1
N 4902 F1
N 4903 E1
N 4966 A1
N 4967 C1
N 5031 D3
N 5116 D1
N 5121 B1
N 5126 B3
N 5127 C3
N 5129 C4
N 5226 A3
N 5228 A4

CONNECTORS

X 4901 E1
X 4966 C1
X 5032 D4
X 5126 C2
X 5127 C4
X 5128 D4
X 5226 A2
X 5227 B4
X 5228 B4
X 5325 D4
X 5326 F4
X 5327 F3
X 5363 E4

13.5 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

13.5.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 4901	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4902	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4903	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4904	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4905	CAP.CERAMIC	0.25PF	01.8PF	5322 122 32162
C 4906	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 4907	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 4908	CAP.CERAMIC	2%	100NF	5322 121 42492
C 4909	CAP.FOIL	100V 5%	1UF	5322 121 40197
C 4910	CAP.CERAMIC	10%	4.7NF	4822 122 31125
C 4911	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 4912	CAP.FOIL	100V 10%	33NF	5322 121 42497
C 4913	CAP.FOIL	100V 10%	10NF	5322 121 42495
C 4914	CAP.CERAMIC	10%	2.2NF	4822 122 30114
C 4915	CAP.CERAMIC	2%	330PF	4822 122 31353
C 4916	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 4917	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4918	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4919	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4920	3.3PF			4822 122 31821
C 4921	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4922	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4923	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4965	CAP.CERAMIC	0.25PF	01.8PF	5322 122 32162
C 4966	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4967	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4968	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4969	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4971	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 4972	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 4973	CAP.CERAMIC	2%	100NF	5322 121 42492
C 4974	CAP.FOIL	100V 5%	1UF	5322 121 40197
C 4975	CAP.CHIP	0.25PF	4.7PF	4822 122 31822
C 4976	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 4977	CAP.FOIL	100V 10%	33NF	5322 121 42497
C 4978	CAP.FOIL	100V 10%	10NF	5322 121 42495
C 4979	CAP.CERAMIC	10%	2.2NF	4822 122 30114
C 4980	CAP.CERAMIC	2%	330PF	4822 122 31353
C 4981	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 4982	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4983	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4984	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4986	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4987	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4988	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5020	1.8/10PF			5322 125 50049
C 5030	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5031	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5032	CAP.FOIL	100V 10%	22NF	5322 121 42496
C 5033	CAP.CERAMIC	10%	3.3NF	4822 122 30099
C 5034	CAP.CERAMIC	10%	680PF	4822 122 30053
C 5035	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069

C 5036	CAP.CERAMIC	2%	150PF	4822 122 31413
C 5037	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5038	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5039	CAP.CERAMIC	0.25PF	2.2PF	4822 122 31036
C 5041	CAP.CERAMIC	0.25PF	2.2PF	4822 122 31036
C 5046	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5047	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5048	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5049	CAP.CERAMIC	2%	22PF	4822 122 31063
C 5051	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5052	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5081	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5082	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5083	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5084	CAP.CERAMIC	2%	22PF	4822 122 31063
C 5086	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5087	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5088	CAP.FOIL	63V 10%	680NF	5322 121 42494
C 5116	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5117	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5118	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5119	CAP.CERAMIC	10%	680PF	4822 122 30053
C 5121	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5122	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5123	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5124	CAP.CERAMIC	10%	680PF	4822 122 30053
C 5126	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5127	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5128	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5129	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 5131	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 5132	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5133	CAP.CERAMIC	10%	4.7NF	4822 122 31125
C 5134	CAP.CERAMIC	2%	22PF	4822 122 31063
C 5135	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5136	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5138	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5139	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5141	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5142	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5143	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5144	CAP.CERAMIC	10%	1NF	4822 122 30027
C 5145	CAP.CERAMIC	2%	100PF	4822 122 31316
C 5146	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5147	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5148	CAP.TANTAL	16V 20%	2.2UF	4822 124 10204
C 5149	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5151	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5153	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5154	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5156	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5157	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5158	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5159	CAP.CERAMIC	2%	100PF	4822 122 31316
C 5210	2/18PF			5322 125 50051
C 5226	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5227	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5228	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5229	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 5231	CAP.CERAMIC	10%	1.5NF	4822 122 31169
C 5232	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5233	CAP.CERAMIC	10%	4.7NF	4822 122 31125
C 5234	CAP.CERAMIC	2%	22PF	4822 122 31063
C 5235	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5236	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5237	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

C 5238	CAP.CERAMIC	10%	1NF	4822 122 30027
C 5239	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5240	CAP.CERAMIC	2%	100PF	4822 122 31316
C 5242	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5243	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5246	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5247	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5248	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5249	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5251	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5252	CAP.CHIP	0.25PF	3.3PF	4822 122 31821
C 5253	CAP.FOIL	63V 10%	100NF	5322 121 42492
C 5256	CAP.CERAMIC	2%	150PF	4822 122 31413
C 5257	CAP.CERAMIC	2%	22PF	4822 122 31063
C 5326	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5327	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 5328	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5329	CAP.CERAMIC	10%	680PF	4822 122 30053
C 5331	CAP.CHIP	2%	15PF	4822 122 31823
C 5332	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5333	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5334	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5336	CAP.CERAMIC	2%	56PF	4822 122 32027
C 5337	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5338	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5339	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5341	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5342	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 5343	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5344	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5345	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 5346	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5349	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 5351	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5354	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5355	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5356	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5357	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5358	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5359	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5361	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5362	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5363	CAP.CERAMIC	2%	10PF	4822 122 32185
C 5364	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5366	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5367	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5368	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5369	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5371	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5372	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

13.5.2 INTEGRATED CIRCUITS

D 4966	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
D 5046	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5081	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5126	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
D 5128		OQ0128		5322 209 82925
D 5127	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5226	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
D 5227	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5229	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5327	INTEGR.CIRCUIT	N74LS132N	SIG	5322 209 85201
D 5328	INTEGR.CIRCUIT	N74LS04N	SIG	4822 209 80783
D 5329	INTEGR.CIRCUIT	N74LS08N	SIG	5322 209 84995
D 5331	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 5332	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 5333	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D5326 (type: OQ0200)				5322 209 82924)

N 5031	OM547				5322 209 82928
N 4901	INTEGR.CIRCUIT	NE5532N		SIG	5322 209 86234
N 4902	INTEGR.CIRCUIT	NE5532N		SIG	5322 209 86234
N 4903	OM546				5322 209 82926
N 4967	OM546				5322 209 82926
N 4966	INTEGR.CIRCUIT	NE5532N		SIG	5322 209 86234
N 5126	OM612				5322 209 82929
N 5226	OM612				5322 209 82929
N 5129	OM613				5322 209 82931
N 5228	OM613				5322 209 82931
N 5116	OM611				5322 209 82927
N 5121	OM611				5322 209 82927

13.5.3 RESISTORS

R 4901	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 4902	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 4903	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4904	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4906	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4907	RES.METAL FILM	MR25	1%	1K21	4822 116 52956
R 4908	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 4909	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 4910	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4911	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 4912	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 4913	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 4914	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 4915	51.1E				5322 116 54442
R 4916	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 4917	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4918	RES.METAL FILM		0.1%	158E	5322 116 53172
R 4919	RES.METAL FILM		0.1%	158E	5322 116 53172
R 4920	750E				4822 116 51234
R 4921	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4922	RES.METAL FILM	MR25	0.1%	100E	5322 116 51701
R 4923	RES.METAL FILM	MR25	0.1%	100E	5322 116 51701
R 4924	RES.METAL FILM	MR25	1%	1K78	5322 116 50515
R 4926	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4927	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4928	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4929	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4931	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4932	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 4933	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 4934	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 4936	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 4937	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 4938	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 4939	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 4941	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4942	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 4943	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4944	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 4946	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 4947	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4948	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 4949	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 4951	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 4952	POTM.SLIDE	0.3W	25%	2K2	5322 105 20033
R 4953	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 4954	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 4956	RES.METAL FILM	MR25	1%	13K3	4822 116 51253
R 4957	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4958	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4959	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 4961	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 4962	RES.METAL FILM	MR25	1%	2K15	5322 116 50767

R 4966	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 4967	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 4968	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4969	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4971	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4972	RES.METAL FILM	MR25	1%	1K21	4822 116 52956
R 4973	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 4974	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 4975	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4976	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 4977	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 4978	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 4979	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 4980	51.1E				5322 116 54442
R 4981	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 4982	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4983	RES.METAL FILM		0.1%	158E	5322 116 53172
R 4984	RES.METAL FILM		0.1%	158E	5322 116 53172
R 4986	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4987	RES.METAL FILM	MR25	0.1%	100E	5322 116 51701
R 4988	RES.METAL FILM	MR25	0.1%	100E	5322 116 51701
R 4989	RES.METAL FILM	MR25	1%	1K78	5322 116 50515
R 4991	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4992	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4993	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4994	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4996	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4997	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 4998	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 4999	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 5001	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5002	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 5003	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5004	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 5006	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5007	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 5008	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5009	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5011	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 5012	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5013	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5014	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5016	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 5017	POTM.SLIDE	0.3W	25%	2K2	5322 105 20033
R 5018	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 5019	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 5020	750E				4822 116 51234
R 5021	RES.METAL FILM	MR25	1%	10K	5322 116 55276
R 5022	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5023	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5024	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5026	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5027	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5030	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 5031	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 5032	RES.METAL FILM	MR25	1%	287E	5322 116 53221
R 5033	RES.METAL FILM	MR25	1%	261E	5322 116 54502
R 5034	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5035	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5036	RES.METAL FILM	MR25	1%	26E1	5322 116 50876
R 5037	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5038	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 5039	RES.METAL FILM	MR25	1%	14E7	5322 116 50412
R 5040	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5041	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 5042	RES.METAL FILM	MR25	1%	23E7	5322 116 54014
R 5043	RES.METAL FILM	MR25	1%	5K11	5322 116 54595

R 5044	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5046	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5047	RES.METAL FILM	MR25	1%	162K	5322 116 54716
R 5048	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5049	RES.METAL FILM	MR25	1%	316K	5322 116 55268
R 5051	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5052	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5053	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5054	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5056	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5057	RES.METAL FILM	MR25	1%	147E	5322 116 50766
R 5058	RES.METAL FILM	MR25	1%	147E	5322 116 50766
R 5059	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5061	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5062	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 5063	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 5064	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5066	RES.METAL FILM	MR25	1%	56K2	4822 116 51264
R 5067	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5068	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5069	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5071	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5072	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 5073	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5074	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5076	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5077	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5079	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 5081	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5082	RES.METAL FILM	MR25	1%	162K	5322 116 54716
R 5083	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5084	RES.METAL FILM	MR25	1%	316K	5322 116 55268
R 5086	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5087	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5088	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5089	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5090	POTM.SLIDE	0.3W	25%	47K	5322 105 20036
R 5091	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5092	RES.METAL FILM	MR25	1%	147E	5322 116 50766
R 5093	RES.METAL FILM	MR25	1%	147E	5322 116 50766
R 5094	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5095	RES.METAL FILM	MR25	1%	12K1	5322 116 50572
R 5096	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5097	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 5098	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 5099	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5101	RES.METAL FILM	MR25	1%	56K2	4822 116 51264
R 5102	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5103	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5104	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5105	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5106	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5107	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 5108	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5109	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5111	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5112	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5114	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5115	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5116	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 5117	RES.METAL FILM	MR25	1%	7E5	5322 116 54417
R 5118	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5119	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5120	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5121	RES.METAL FILM	MR25	1%	2K61	5322 116 50671

R 5122	RES.METAL FILM	MR25	1%	7E5	5322 116	54417
R 5123	RES.METAL FILM	MR25	1%	3K83	5322 116	54589
R 5124	RES.METAL FILM	MR25	1%	1K	4822 116	51235
R 5125	RES.METAL FILM	MR25	1%	1K	4822 116	51235
R 5126	RES.METAL FILM	MR25	1%	3K83	5322 116	54589
R 5127	POTM.TRIMMER	0.3W	25%	10K	4822 105	10455
R 5128	RES.METAL FILM	MR25	1%	6K19	5322 116	53263
R 5129	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5130	RES.METAL FILM	MR25	1%	6K81	4822 116	51252
R 5131	RES.METAL FILM	MR25	1%	8K25	5322 116	51498
R 5132	RES.METAL FILM	MR25	1%	133E	5322 116	54482
R 5133	RES.METAL FILM	MR25	1%	316E	5322 116	54511
R 5134	RES.METAL FILM	MR25	1%	316E	5322 116	54511
R 5135	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5136	RES.METAL FILM	MR25	1%	133E	5322 116	54482
R 5137	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5138	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5139	RES.METAL FILM	MR25	1%	13E3	5322 116	51047
R 5140	RES.METAL FILM	MR25	1%	5K11	5322 116	54595
R 5141	RES.METAL FILM	MR25	1%	5K11	5322 116	54595
R 5142	RES.METAL FILM	MR25	1%	51E1	5322 116	54442
R 5143	RES.METAL FILM	MR25	1%	51E1	5322 116	54442
R 5144	POTM.TRIMMER	0.3W	25%	10K	4822 105	10455
R 5145	RES.METAL FILM	MR25	1%	10K	4822 116	51253
R 5146	RES.METAL FILM	MR25	1%	82E5	4822 116	52814
R 5147	RES.METAL FILM	MR25	1%	51E1	5322 116	54442
R 5148	RES.METAL FILM	MR25	1%	82E5	4822 116	52814
R 5149	RES.METAL FILM	MR25	1%	51E1	5322 116	54442
R 5150	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5151	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5152	RES.METAL FILM	MR25	1%	511E	4822 116	51282
R 5153	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5154	RES.METAL FILM	MR25	1%	51E1	5322 116	54442
R 5155	RES.METAL FILM	MR25	1%	31E6	5322 116	54034
R 5156	RES.METAL FILM	MR25	1%	2K15	5322 116	50767
R 5157	RES.METAL FILM	MR25	1%	2K15	5322 116	50767
R 5158	RES.METAL FILM	MR25	1%	6K19	5322 116	55426
R 5159	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5160	RES.METAL FILM	MR25	1%	10K	4822 116	51253
R 5161	RES.METAL FILM	MR25	1%	10K	4822 116	51253
R 5162	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5163	RES.METAL FILM	MR25	1%	6K19	5322 116	55426
R 5164	RES.METAL FILM	MR25	1%	909E	5322 116	55278
R 5165	RES.METAL FILM	MR25	1%	750E	4822 116	51234
R 5166	RES.METAL FILM	MR25	1%	237E	5322 116	50679
R 5168	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5169	POTM.SLIDE	0.3W	25%	220E	5322 105	20031
R 5170	RES.METAL FILM	MR25	1%	6.19K	5322 116	55426
R 5171	RES.METAL FILM	MR25	1%	4K22	5322 116	50729
R 5172	RES.METAL FILM	MR25	1%	237E	5322 116	50679
R 5173	RES.METAL FILM	MR25	1%	100E	5322 116	55549
R 5174	RES.METAL FILM	MR25	1%	1K96	5322 116	54571
R 5175	RES.METAL FILM	MR25	1%	31E6	5322 116	54034
R 5176	RES.METAL FILM	MR25	1%	2K61	5322 116	50671
R 5177	RES.METAL FILM	MR25	1%	316E	5322 116	54511
R 5178	RES.METAL FILM	MR25	1%	10K	5322 116	54623
R 5179	RES.METAL FILM	MR25	1%	82E5	4822 116	52814
R 5180	RES.METAL FILM	MR25	1%	82E5	4822 116	52814
R 5181	RES.METAL FILM	MR25	1%	75E	5322 116	53339
R 5182	RES.METAL FILM	MR25	1%	9K09	4822 116	51284
R 5183	RES.METAL FILM	MR25	1%	17K8	5322 116	54637
R 5184	RES.METAL FILM	MR25	1%	1K	4822 116	51235
R 5185	RES.METAL FILM	MR25	1%	34E8	5322 116	54027
R 5186	RES.METAL FILM	MR25	1%	562E	4822 116	51231
R 5187	RES.METAL FILM	MR25	1%	215E	5322 116	55274

R 5188	RES.METAL FILM	MR25	1%	34E8	5322 116 54027
R 5189	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5190	POTM.SLIDE	0.3W	25%	1K	5322 105 20032
R 5191	POTM.SLIDE	0.3W	25%	1K	5322 105 20032
R 5192	POTM.SLIDE	0.3W	25%	470E	5322 105 20028
R 5193	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 5194	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 5195	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 5196	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 5197	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5198	RES.METAL FILM	MR25	1%	215E	5322 116 55274
R 5199	RES.METAL FILM	MR25	1%	215E	5322 116 55274
R 5200	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5201	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5202	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 5203	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 5204	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 5205	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 5206	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5207	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 5208	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5209	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5210	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5211	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 5212	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 5213	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5214	RES.METAL FILM	MR25	1%	2E15	5322 116 55536
R 5215	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5216	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5217	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5218	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 5219	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 5220	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5221	RES.METAL FILM	MR25	1%	2.37K	5322 116 54576
R 5223	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 5222				750E	4822 116 51234
R 5225	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5226	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5227	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5228	RES.METAL FILM	MR25	1%	6K19	5322 116 53263
R 5229	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5230	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 5231	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 5232	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 5233	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 5234	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 5235	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5236	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 5237	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5238	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5239	RES.METAL FILM	MR25	1%	13E3	5322 116 51047
R 5240	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5241	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5242	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5243	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5244	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5245	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5246	RES.METAL FILM	MR25	1%	82E5	4822 116 52814
R 5247	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5248	RES.METAL FILM	MR25	1%	82E5	4822 116 52814
R 5249	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 5250	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5251	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5252	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5253	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5254	RES.METAL FILM	MR25	1%	51E1	5322 116 54442

R 5256	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 5257	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 5258	RES.METAL FILM	MR25	1% 6K19	5322 116 55426
R 5259	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5260	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 5261	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 5262	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5263	RES.METAL FILM	MR25	1% 6K19	5322 116 55426
R 5264	RES.METAL FILM	MR25	1% 909E	5322 116 55278
R 5265	RES.METAL FILM	MR25	1% 750E	4822 116 51234
R 5266	RES.METAL FILM	MR25	1% 237E	5322 116 50679
R 5268	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5269	POTM.SLIDE	0.3W 25%	220E	5322 105 20031
R 5270	RES.METAL FILM	MR25	1% 21K5	5322 116 50451
R 5271	RES.METAL FILM	MR25	1% 4K22	5322 116 50729
R 5272	RES.METAL FILM	MR25	1% 237E	5322 116 50679
R 5273	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5274	POTM.SLIDE	0.3W 25%	1K	5322 105 20032
R 5275	RES.METAL FILM	MR25	1% 1K47	5322 116 50635
R 5276	POTM.SLIDE	0.3W 25%	1K	5322 105 20032
R 5278	RES.METAL FILM	MR25	1% 1K96	5322 116 54571
R 5279	RES.METAL FILM	MR25	1% 2K61	5322 116 50671
R 5280	RES.METAL FILM	MR25	1% 75K	4822 116 51267
R 5281	RES.METAL FILM	MR25	1% 12K1	5322 116 50572
R 5282	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 5283	RES.METAL FILM	MR25	1% 237E	5322 116 50679
R 5284	RES.METAL FILM	MR25	1% 237E	5322 116 50679
R 5285	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5286	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 5287	RES.METAL FILM	MR25	1% 12K1	5322 116 50572
R 5288	RES.METAL FILM	MR25	1% 19K6	5322 116 54641
R 5289	RES.METAL FILM	MR25	1% 2K87	5322 116 55279
R 5290	RES.METAL FILM	MR25	1% 2K87	5322 116 55279
R 5291	RES.METAL FILM	MR25	1% 464K	5322 116 55207
R 5292	POTM.TRIMMER	0.3W 25%	10K	4822 105 10455
R 5293	RES.METAL FILM	MR25	1% 21K5	5322 116 50451
R 5294	RES.METAL FILM	MR25	1% 1K62	5322 116 55359
R 5296	POTM.TRIMMER	0.3W 25%	10K	4822 105 10455
R 5297	RES.METAL FILM	MR25	1% 3K83	5322 116 54589
R 5298	RES.METAL FILM	MR25	1% 681E	4822 116 51233
R 5299	RES.METAL FILM	MR25	1% 2E15	5322 116 55536
R 5300	RES.METAL FILM	MR25	1% 2E15	5322 116 55536
R 5301	RES.METAL FILM	MR25	1% 51E1	5322 116 54442
R 5302	RES.METAL FILM	MR25	1% 2E15	5322 116 55536
R 5303	RES.METAL FILM	MR25	1% 5K11	5322 116 54595
R 5304	POTM.TRIMMER	0.3W 25%	10K	4822 105 10455
R 5305	RES.METAL FILM	MR25	1% 825E	5322 116 54541
R 5306	RES.METAL FILM	MR25	1% 825E	5322 116 54541
R 5307	RES.METAL FILM	MR25	1% 422E	5322 116 50459
R 5308	RES.METAL FILM	MR25	1% 422E	5322 116 50459
R 5309	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 5310	POTM.SLIDE	0.3W 25%	1K	5322 105 20032
R 5311	POTM.TRIMMER	0.3W 25%	10K	4822 105 10455
R 5312	RES.METAL FILM	MR25	1% 12K1	5322 116 50572
R 5313	RES.METAL FILM	MR25	1% 464K	5322 116 55207
R 5314	RES.METAL FILM	MR25	1% 19K6	5322 116 54641
R 5316	RES.METAL FILM	MR25	1% 215E	5322 116 55274
R 5317	RES.METAL FILM	MR25	1% 215E	5322 116 55274
R 5318	RES.METAL FILM	MR25	1% 51E1	5322 116 54442
R 5319	RES.METAL FILM	MR25	1% 51E1	5322 116 54442
R 5320	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5321	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5322	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 5323	RES.METAL FILM	MR25	1% 100E	5322 116 55549

R 5324	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5326	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 5327	RES.METAL FILM	MR25	1%	2K37	5322 116 54576
R 5328	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 5329	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 5330	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 5331	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 5332	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5333	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5334	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 5336	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5337	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 5338	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5339	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5340	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5341	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5342	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5343	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5344	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5346	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5347	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5348	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5349	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5350	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5351	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5352	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5353	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5354	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5355	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 5356	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 5357	RES.METAL FILM	MR25	1%	8K25	5322 116 53267
R 5358	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 5359	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5360	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 5361	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5362	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5363	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 5364	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5366	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5367	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5368	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5369	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5370	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5371	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5372	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5373	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5374	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5376	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5377	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5378	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5379	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5380	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5381	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5382	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5383	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5384	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5386	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5387	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5388	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5389	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5390	RES.METAL FILM	MR25	1%	100E	5322 116 55549

13.5.4 SEMI CONDUCTORS

V 4901	DIODE,REFERENCE	BZV12	PEL	5322 130 34269
V 4902	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4903	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4904	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4906	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4907	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4908	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4909	DIODE,REFERENCE	BZV12	PEL	5322 130 34269
V 4911	DIODE	BAW62	PEL	4822 130 30613
V 4912	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4913	DIODE	BAW62	PEL	4822 130 30613
V 4914	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4916	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4966	DIODE,REFERENCE	BZV12	PEL	5322 130 34269
V 4967	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4968	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4969	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4971	TRANSISTOR	BC548C	PEL	4822 130 44196
V 4972	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4973	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4974	DIODE,REFERENCE	BZV12	PEL	5322 130 34269
V 4976	DIODE	BAW62	PEL	4822 130 30613
V 4977	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4978	DIODE	BAW62	PEL	4822 130 30613
V 4979	TRANSISTOR	BC558B	PEL	4822 130 44197
V 4981	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5031	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5032	DIODE	BAW62	PEL	4822 130 30613
V 5033	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5046	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5047	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5048	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5049	DIODE	BAW62	PEL	4822 130 30613
V 5051	DIODE	BAW62	PEL	4822 130 30613
V 5081	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5082	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5083	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5084	DIODE	BAW62	PEL	4822 130 30613
V 5086	DIODE	BAW62	PEL	4822 130 30613
V 5116	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5117	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5121	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5122	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5126	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5127	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5128	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5129	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5131	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5132	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5133	DIODE	BAW62	PEL	4822 130 30613
V 5134	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5135	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5136	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5137	DIODE,REFERENCE	BZV46-C2V0	PEL	4822 130 31248
V 5138	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5139	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5140	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5141	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5142	DIODE,REFERENCE	BZV46-C2V0	PEL	4822 130 31248
V 5143	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5144	TRANSISTOR	BF450	PEL	4822 130 44237
V 5145	TRANSISTOR	BF450	PEL	4822 130 44237

V 5226	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5227	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5228	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5229	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5231	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5232	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5233	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5234	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5236	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5237	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5238	DIODE,REFERENCE	BZV46-C2V0	PEL	4822 130 31248
V 5239	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5241	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5242	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5243	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5244	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5326	DIODE	BAW62	PEL	4822 130 30613
V 5327	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5328	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5329	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5331	DIODE,REFERENCE	BZV46-C2V0	PEL	4822 130 31248
V 5332	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5333	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5334	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5336	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5337	TRANSISTOR	BC558B	PEL	4822 130 44197

FINAL Y AMPLIFIER 14

CONTENTS

14. CIRCUIT DESCRIPTION OF FINAL Y AMPLIFIER. 14-1
14.1 Parts list 14-6

FIGURES

14.1. Final Y amplifier, p.c.b. lay-out. 14-2
14.2. Final Y amplifier, circuit diagram. 14-4

14. CIRCUIT DESCRIPTION OF FINAL Y AMPLIFIER (See fig.14.2.)

The final Y amplifier is thin-film IC N4004. The amplifier drives the vertical deflection system of the CRT. The main input signals for the amplifier are the vertical deflection signal from the delay-line cable (applied via X4007/pin 1 and 2) and the vertical positioning signals for the text (applied via coax input sockets X4011 and X4012).

The vertical deflection signal from the delay-line is applied at 50 ohm impedance level to the bases (pin 4 and 25 of N4004) of a series-feedback amplifier consisting of two PNP transistors. The emitters of these transistors (pin 1 and 28) are connected with circuitry for square-wave compensation. C4018/C4019/R4050 is used for high-frequency compensation. For the lower frequencies are used C4012/R4034, C4014/R4041, C4016/R4039 and C4036/R4038; the high frequencies are blocked via the chokes L4001 and L4002. For the highest frequencies there are two circuits with varicap diodes present inside N4004. The varicaps are adjusted with DC-voltages coming via the trimming potentiometers R4047 and R4048. The current for the emitters (pin 1 and 28) of N4004 is coming from current source V4006. This current is divided via V4003 and V4004.

In spite of the compensation circuitry described above, the amplifier N4004 shows considerable errors for square-wave signals with frequencies under 100 Hz. The circuit between the operational amplifiers N4001 compensates for this. The inputs 5 and 6 of N4001 receive via low-pass filters the low frequency components of the signal from the delay-line. N4001 adds these two signals. The output (pin 7) of N 4001 feeds four different integrating networks with different time constants. The signals from the integrators are picked off via trimming potentiometers. The potentiometer signals are added at the input (pin 2) of operational amplifier N4001. Compensation is achieved because the output (pin 1) of this amplifier is connected with the base of V4003.

The amplifier drives the c.r.t. via coils that act as vertical deflection plates. These coils have a characteristic impedance that matches the amplifier output and are, in fact, transmission lines that coincide with the travelling time of the electron beam along the tube. These coils terminate in the resistance network N4011 of 2x 165 ohms. V4008 is a current source for the output amplifier circuit inside N4004.

The trace separation for the MTB and DTB displays, and the Y sawtooth time-base for the CRT text/cursor display are applied to the main Y amplifier input via a balanced amplifier V4013/V4014. This amplifier is fed by current sources V4011, V4012 and V4016. This balanced amplifier is controlled by the outputs of muliplexer D4003.
The switching control signals for D4003 are as follows:

OEN - the text enable signal (+12 V) on V4001/anode, which is routed to input D4003-9 and via diode V4001 of a discrete OR-gate to D4003-10.

TS - the trace separation signal for MTB (0 V) or DTB (+12 V) which is routed to input D4003-11

TSD - the single (+12 V) or alternate (0 V) time-base signal which is routed via diode V4002 of a discrete OR-gate to D4003-10.

These three switching control signals select the following trace deflection signals:
The analog trace separation signal TSA (0 - 10 V) on R4012 which is applied via an operational amplifier to give a +7 V to +5 signal on input D4003-13 determined by the position of the TRACE SEP control. This output from the operational amplifier is inverted in a second operational amplifier to give a corresponding signal of +5 V to +7 V on input D4003-12, determined by the position of the TRACE SEP control.

These two inputs are selected as the base-signal for V4014 by the TS signal (MTB = 0 V, DTB = +12 V) on D4003-11. The selected output is routed via output D4003-14 to input D4003-2. If alternate TB is selected and text OEN is off, the 0 V input on D4003-10 switches the selected alternate TB square-wave on D4003-2 via output D4003-15 to the base of V4014.

If text OEN or the TSD single TB signal (+12 V) is applied to input D4003-10, then the fixed +6.3 V on D4003-1 is switched via output D4003-15 to the base of V4014. TEXT Y sweep sawtooth signal is applied to input D4003-3, selected bythe OEN (+12 V) signal. The output D4003-4 is applied to the base of V4013 of the balanced amplifier. If text OEN is inactive (0 V), a fixed+6.3 V on input D4003-5 is switched via D4003-4 to the base of V4013. The operational amplifier N4005 is used for LF square-wave compensationduring the time that text is written on the CRT-screen; during this time is the control signal OEN active and low. This compensation is achieved by means of a simple comparison of the balanced (antiphase) signals at the text inputs (X4011 and X4012) and the outputs of the final amplifier (pin 10 and 19 of N4004 via resistors that are integrated in termination network N4011). Trimming potentiometer R4070 is used for adjusting the vertical position of the text on the screen. Comparison is done at the inputs (pin 2 and 3) of N4005. The output (pin 6) drives the base of V4004 via bridge X4013 (open during calibration) and electronic switch D4009/3,4,5 (only closed when text is written).

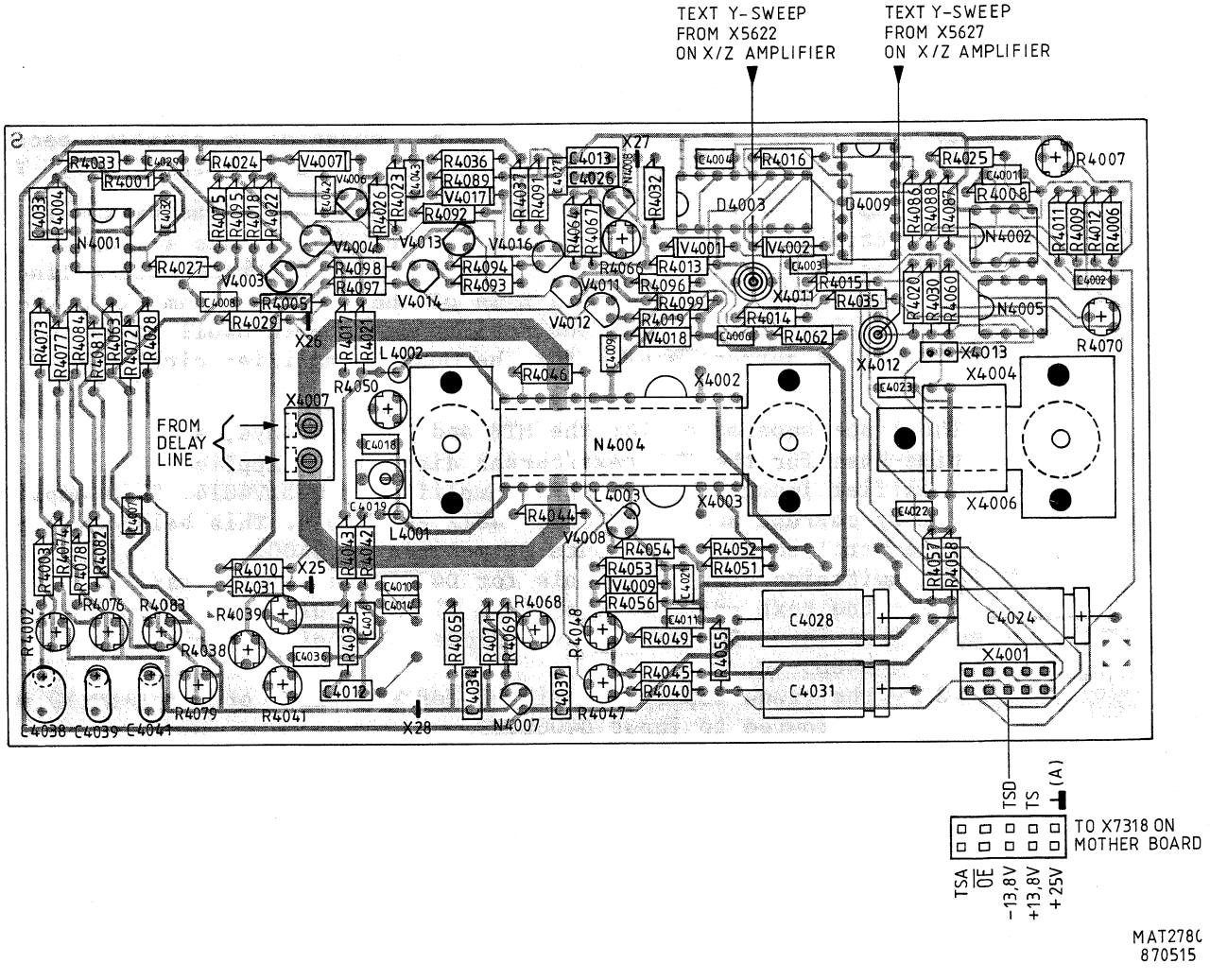
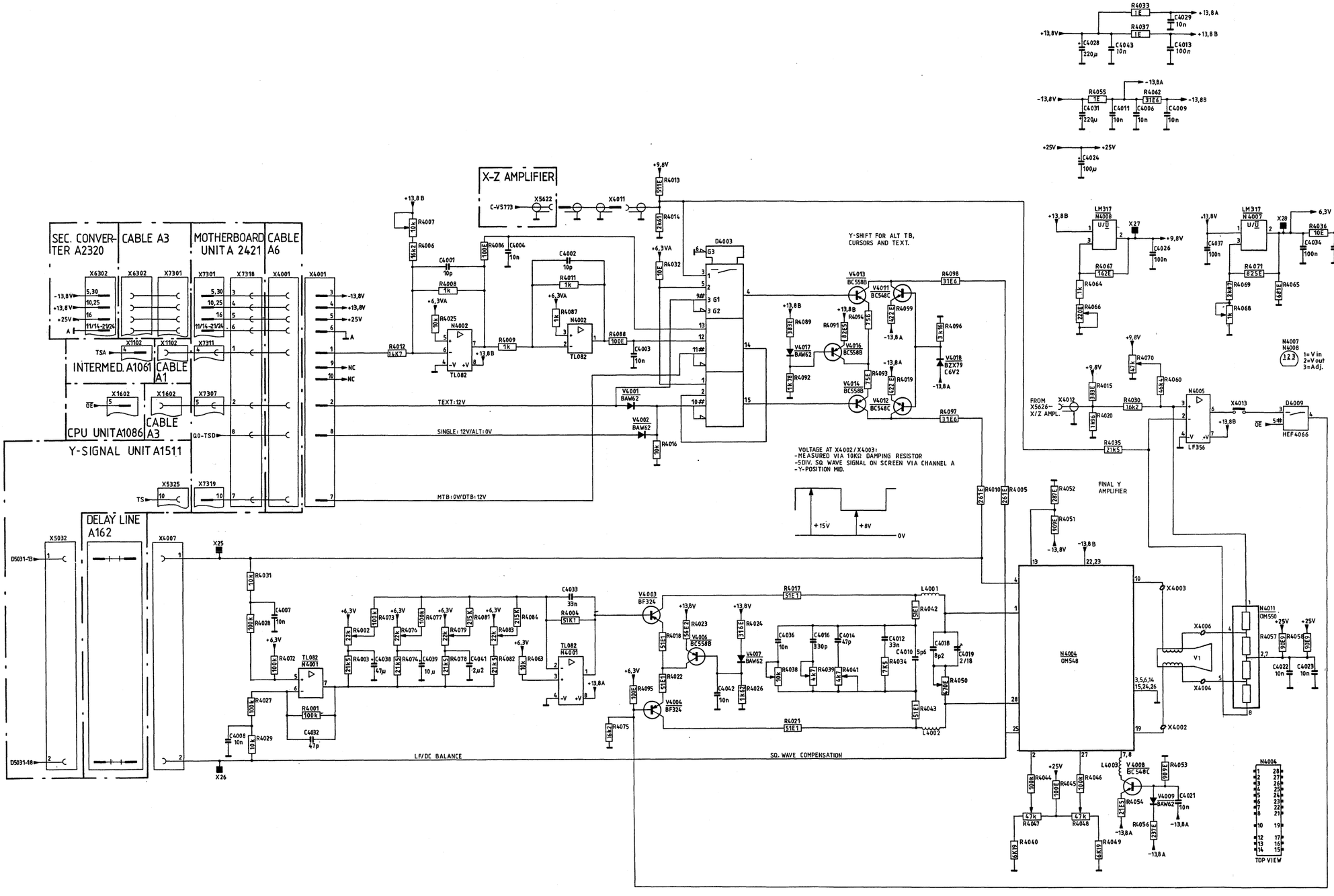


Fig.14.1. Final Y amplifier, p.c.b. lay-out.



MAT 2781
860321

Fig.14.2. Final Y amplifier, circuit diagram.

14

14.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

14.1.1 CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE
C 4001	2%	10PF	4822 122 32185
C 4002	2%	10PF	4822 122 32185
C 4003	-20+50%	10NF	4822 122 31414
C 4004	-20+50%	10NF	4822 122 31414
C 4006	-20+50%	10NF	4822 122 31414
C 4007	-20+50%	10NF	4822 122 31414
C 4008	-20+50%	10NF	4822 122 31414
C 4009	-20+50%	10NF	4822 122 31414
C 4010	0.25PF	5.6PF	5322 122 32163
C 4011	-20+50%	10NF	4822 122 31414
C 4012	100V 10%	33NF	5322 121 42489
C 4013	63V 10%	100NF	5322 121 42386
C 4014	2%	47PF	4822 122 31072
C 4016	2%	330PF	4822 122 31353
C 4018	0.25PF	8.2PF	4822 122 31052
C 4019	300V	2/18PF	5322 125 50051
C 4021	-20+50%	10NF	4822 122 31414
C 4022	-20+50%	10NF	4822 122 31414
C 4023	-20+50%	10NF	4822 122 31414
C 4024	-10+50%	100UF	4822 124 20715
C 4026	63V 10%	100NF	5322 121 42386
C 4027	-20+50%	10NF	4822 122 31414
C 4028	-10+50%	220UF	4822 124 20693
C 4029	-20+50%	10NF	4822 122 31414
C 4031	-10+50%	220UF	4822 124 20693
C 4032	2%	47PF	4822 122 31072
C 4033	100V 10%	33NF	5322 121 42489
C 4034	63V 10%	100NF	5322 121 42386
C 4036	-20+50%	10NF	4822 122 31414
C 4037	63V 10%	100NF	5322 121 42386
C 4038	6.3V 20%	47UF	4822 124 10197
C 4039	6.3V 20%	10UF	4822 124 21314
C 4041	16V 20%	2.2UF	4822 124 10204
C 4042	-20+50%	10NF	4822 122 31414
C 4043	-20+50%	10NF	4822 122 31414

14.1.2 INTEGRATED CIRCUITS

D 4003	HEF4053BP	PEL	5322 209 10576
D 4009	HEF4066BP	PEL	5322 209 10357
N 4001	TL082CP	T.I	5322 209 86064
N 4002	TL082CP	T.I	5322 209 86064
N 4004	OM 548		5322 209 82932
N 4005	LF356N	NSC	5322 209 86422
N 4007	LM317LZ	MOT	5322 209 82943
N 4008	LM317LZ	MOT	5322 209 82943
N 4011	OM 550		5322 209 72058

14.1.3 RESISTORS

R 4001	MRS25 1% 100K	4822 116 52973	
R 4002	0.3W 25% 22K	5322 105 20035	
R 4003	MRS25 1% 21K5	5322 116 53241	
R 4004	MRS25 1% 51K1	4822 116 53121	
R 4005	MRS25 1% 261E	5322 116 53549	
R 4006	MRS25 1% 16K2	5322 116 53589	
R 4007	0.3W 25% 10K	4822 105 10455	
R 4008	MRS25 1% 1K	4822 116 53108	
R 4009	MRS25 1% 1K	4822 116 53108	
R 4010	MRS25 1% 261E	5322 116 53549	
R 4011	MRS25 1% 1K	4822 116 53108	
R 4012	MRS25 1% 14K7	4822 116 53531	
R 4013	MRS25 1% 511E	5322 116 53135	
R 4014	MRS25 1% 2K61	5322 116 53327	
R 4015	MRS25 1% 383E	5322 116 53332	
R 4016	MRS25 1% 10K	4822 116 53022	
R 4017	MRS25 1% 51E1	5322 116 53213	
R 4018	MRS25 1% 51E1	5322 116 53213	
R 4019	MRS25 1% 422E	5322 116 53592	
R 4020	MRS25 1% 1K96	5322 116 53237	
R 4021	MRS25 1% 51E1	5322 116 53213	
R 4022	MRS25 1% 51E1	5322 116 53213	
R 4023	MRS25 1% 56E2	5322 116 53644	
R 4024	MRS25 1% 316E	5322 116 53514	
R 4025	MRS25 1% 10K	4822 116 53022	
R 4026	MRS25 1% 1K62	5322 116 53257	
R 4027	MRS25 1% 100K	4822 116 52973	
R 4028	MRS25 1% 100K	4822 116 52973	
R 4029	MRS25 1% 10K	4822 116 53022	
R 4030	MRS25 1% 16K2	5322 116 53589	
R 4031	MRS25 1% 10K	4822 116 53022	
R 4032	MRS25 1% 10E	4822 116 52891	
R 4033	MRS25 1% 1E	4822 116 52976	
R 4034	MRS25 1% 7K5	4822 116 53028	
R 4035	MRS25 1% 21K5	5322 116 53241	
R 4036	MRS25 1% 10E	4822 116 52891	
R 4037	MRS25 1% 1E	4822 116 52976	
R 4038	0.3W 25% 10K	4822 105 10455	
R 4039	0.3W 25% 4K7	5322 105 20034	
R 4040	MRS25 1% 6K19	5322 116 53263	
R 4041	0.3W 25% 4K7	5322 105 20034	
R 4042	MRS25 1% 51E1	5322 116 53213	
R 4043	MRS25 1% 51E1	5322 116 53213	
R 4044	MRS25 1% 100K	4822 116 52973	
R 4045	MRS25 1% 100E	5322 116 53126	
R 4046	MRS25 1% 100K	4822 116 52973	
R 4047	0.3W 25% 47K	5322 105 20036	
R 4048	0.3W 25% 47K	5322 105 20036	
R 4049	MRS25 1% 6K19	5322 116 53263	
R 4050	0.3W 25% 470E	5322 105 20028	
R 4051	MRS25 1% 909E	4822 116 53533	
R 4052	MRS25 1% 287E	5322 116 53221	
R 4053	MRS25 1% 909E	4822 116 53533	
R 4054	MRS25 1% 21E5	5322 116 53426	
R 4055	MRS25 1% 1E	4822 116 52976	
R 4056	MRS25 1% 237E	5322 116 53259	
R 4057	MRS25 1% 90E9	5322 116 53626	
R 4058	MRS25 1% 90E9	5322 116 53626	
R 4060	MRS25 1% 46K4	5322 116 53314	
R 4062	MRS25 1% 31E6	5322 116 54964	
R 4063	MRS25 1% 10K	4822 116 53022	

R 4064	MRS25 1% 1K	4822 116 53108
R 4065	MRS25 1% 681E	4822 116 53123
R 4066	0.3W 25% 220E	5322 105 20031
R 4067	MRS25 1% 162E	5322 116 53523
R 4068	0.3W 25% 470E	5322 105 20028
R 4069	MRS25 1% 2K87	5322 116 53513
R 4070	0.3W 25% 47K	5322 105 20036
R 4071	MRS25 1% 825E	5322 116 53541
R 4072	MRS25 1% 100K	4822 116 52973
R 4073	MRS25 1% 100K	4822 116 52973
R 4074	MRS25 1% 21K5	5322 116 53241
R 4075	MRS25 1% 16K2	5322 116 53589
R 4076	0.3W 25% 22K	5322 105 20035
R 4077	MRS25 1% 100K	4822 116 52973
R 4078	MRS25 1% 21K5	5322 116 53241
R 4079	0.3W 25% 22K	5322 105 20035
R 4081	MRS25 1% 215K	5322 116 53425
R 4082	MRS25 1% 21K5	5322 116 53241
R 4083	0.3W 25% 22K	5322 105 20035
R 4084	MRS25 1% 215K	5322 116 53425
R 4086	MRS25 1% 100E	5322 116 53126
R 4087	MRS25 1% 1K	4822 116 53108
R 4088	MRS25 1% 100E	5322 116 53126
R 4089	MRS25 1% 383E	5322 116 53332
R 4091	MRS25 1% 82E5	5322 116 53538
R 4092	MRS25 1% 1K78	5322 116 53208
R 4093	MRS25 1% 75E	5322 116 53339
R 4094	MRS25 1% 75E	5322 116 53339
R 4095	MRS25 1% 100E	5322 116 53126
R 4096	MRS25 1% 3K16	4822 116 53021
R 4097	MRS25 1% 31E6	5322 116 54964
R 4098	MRS25 1% 31E6	5322 116 54964
R 4099	MRS25 1% 422E	5322 116 53592

14

14.1.4 SEMI CONDUCTORS

V 4001	BAW62	PEL	4822 130 30613
V 4002	BAW62	PEL	4822 130 30613
V 4003	BF324	PEL	4822 130 41448
V 4004	BF324	PEL	4822 130 41448
V 4006	BC558B	PEL	4822 130 44197
V 4007	BAW62	PEL	4822 130 30613
V 4008	BC548C	PEL	4822 130 44196
V 4009	BAW62	PEL	4822 130 30613
V 4011	BC548C	PEL	4822 130 44196
V 4012	BC548C	PEL	4822 130 44196
V 4013	BC558B	PEL	4822 130 44197
V 4014	BC558B	PEL	4822 130 44197
V 4016	BC558B	PEL	4822 130 44197
V 4017	BAW62	PEL	4822 130 30613
V 4018	BZX79-C6V2	PEL	4822 130 34167

TIME BASE UNIT 15

CONTENTS

15. CIRCUIT DESCRIPTION OF TIME BASE.
15.1. Main time base circuit description. 15-1
15.2. Delayed time base curcuit description. 15-9
15.3. Circuit description of horizontal logic, Z logic and intensity circuit. 15-16
15.4. Location list of components on time base. 15-32
15.5. Parts list 15-39

FIGURES

15.1. Voltage waveforms in MTB circuits. 15-2
15.2. Control data from HEF 4094 bus for MTB, Hold Off and DTB TIME/DIV settings. 15-9
15.3. Voltage waveforms in the DTB circuits. 15-12
15.4. Start of the DELAY and delta t sweep at the lefthand and righthand side of the screen. 15-13
15.5. DTB display sequence. 15-14
15.6. Voltage waveforms in Z logic in MTB INTENSified mode. 15-17
15.7. Logic levels in INTENSity control circuit. 15-18
15.8. Graph of range of INTENSity control circuit as a function of the HEF 4094 bus signals Z1 and Z2. 15-19
15.9. Graph of range of INTENSity control circuit. 15-20
15.10 Time base unit p.c.b. lay-out. 15-23
15.11 Time base chip unit, p.c.b. lay-out. 15-24
15.12 Main time base circuit diagram. 15-26
15.13 Delayed time base circuit diagram. 15-27
15.14 Circuit diagram of horizontal logic, Z logic and intensity circuit. 15-30

15. CIRCUIT DESCRIPTION OF TIME BASE

15.1. MAIN TIME BASE CIRCUIT DESCRIPTION (See fig.15.12)

MTB trigger input circuit and logic.

The positive going MTB trigger current signal is applied via a 50 ohm adaption resistor R9101 to the common-base transistor V9101.
The series feedback amplifiers V9351 and V9352 convert the input voltages signal into symmetrical current signals. The gain of this stage is determined by R9354. These current signals are fed to a Schmitt-trigger circuit to sharpen up the edges of the trigger pulse. This Schmitt-trigger circuit consists of V9354, V9353, V9356 and V9357.
This circuit is biased in such a way that very fast switching is achieved.
The output voltage signal is fed via two emitter-followers V9358 and V9102, which function as a buffer, to the clock-inputs of D-type flip flops D9101.
This flip flop consists of 3 parts, each having different functions, as follows:
- D9101-3-4-7-8 is the trigger detect flip-flop
- D9101-17-18-13-14 is the time-base start flip-flop
- D9101-2-23-11-12 is the jitter elimination flip-flop

The delay of 1ns between the trigger input circuit and D9101-16 compensates switching delays in D9101-2-23-11-12, thus providing very fast triggering.

AUTO free run mode (no triggers)

In the AUTO (free run) mode, the start logic circuit operates as follows: (see also fig.15.1)
The AT- signal from the HEF-bus is low (after level adaptation) and this low is applied to input 4 of NOR-gate D9102.
The SR- input from the HEF-bus is high, so diode V9017 is blocked and transistor V9103 is off. This gives a low on the other input of NOR-gate D9102 (3) and on S of D9101 (18). This means that the S input of D9101 (18) is low and the R input (pin 17) is high, which is the start condition for automatic triggering in the free-run mode; i.e. Q-output (pin 13) is high and a start MTB signal is given.

During a sawtooth sweep, the EOS1 (end of sweep) signal fed back from the sawtooth generator output to the S input of D9101-23 is low. Reset input D9101-2 is high because of inverter D9102-1-2-7-8. This gives a low Q (D9101-11) output which is connected directly to the S input of START flip-flop (D9101-18). (E.O.S.2)
With inputs R (D9101-17) and S (D9101-18) both low, the output Q (D9101-14) is low and Q- is high. This means that the Q output is held high during the MTB sweep.
At the end of sweep the EOS1 signal goes high, the Q output D9101-11 goes high to make the S input of start flip-flop high. In turn, the Q-output D9101-13 goes low to end the sweep (no START MTB signal).

After the hold off time EOS 1 becomes low again (gives main time base free). Yet input of D9101-23 is low. Reset input is high (via D9102-1-2-7-8). This gives a low Q output, which is directly connected to the S input of the start flip-flop (D9101-18).
With reset input (D9101-17) high and set input low (D9101-18), the output Q- (pin 13) is high, so the time base generator is started for the next sweep.

For blanking purpose, the EOS1 signal and the Q output of the Start flip-flop are fed to the two-input NOR-gate D9102 (23 and 24). During the sweep both inputs are low and a high output gives Z unblanking. At the end of the sweep both inputs are high and a low output gives Z blanking.

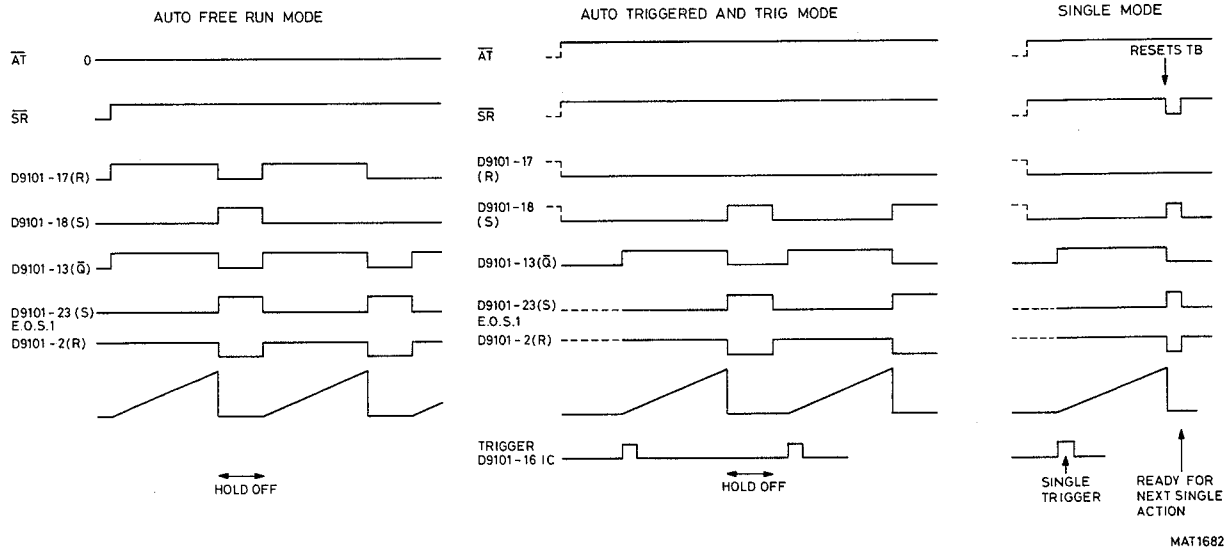


Fig.15.1.Voltage wave forms in MTB circuits

AUTO triggered and TRIG mode (see fig.15.1)
In the AUTO triggered and TRIG mode the AT- signal is high, which gives a high on NOR-gate D9102-4 making the reset input of D9101-17 low.
SR- (coming from the HEF bus) is high, therefore diode V9017 is blocked and the high on the base of V9103 holds this transistor off. The set input of D9101(18) is therefore low.
With the S and R inputs low, this is the start condition to accept triggers. When a trigger arrives on the clock input (16), the data (earth) on the D input (D9101-15) is clocked out on Q (Q is low). Conversely, the Q- output is high, which provides the START MTB trigger signal on X37 to start the MTB sawtooth generator.
During the sawtooth sweep, the EOS1 (end of sweep) signal fed back from the sawtooth generator output to the S input of D9101-23 is low. Reset input D9101-2 is high because of inverter D9102-1-2-7-8.
This gives a low Q output which is connected directly to the S input of START flip-flop (D9101-18).

With inputs R (D9101-17) and S (D9101-18) both low, the output Q (D9101-14) is low and Q- is high. This means that the Q- output is held high during the MTB sweep.At the end of sweep the EOS1 signal goes high, the Q output D 9101-11goes high to make the S input of the start flip-flop high. In turn, the Q- output (D9101-13) goes low to end the sweep. After the hold off time EOS 1 becomes low again (gives main time base free). Yet input of D9101-(23) is low. Reset input high (via D9102-1-2-7-8). This gives a low Q output, which is directly connected to the S input of the start flip-flop (D9101-18). This start flip-flop is in start condition, S and R input both low, and waits on a trigger signal on the clock input (16).

As stated, D9101-2-23-11-12 flip-flop eliminates jitter that could be caused by high frequency trigger pulses occurring during the MTB sweep. At frequencies higher than 50 MHz, a divide-by-two circuit formed by R9193, R9194 and C9107 in the input circuit of D9102-1-2-7-8 operates to skip alternate trigger pulses. During a sweep, the S input of D9101-(23) is low (EOS1 inactive). Both inputs of D9102-(1 and 2) are low, therefore the R input D9101-2 is high, giving a low output on Q. This is connected to the S input of D9101-(18), which is low already, so triggers on clock input of D9101 have no effect on the START flip-flop.

At the end of MTB sweep the S input of D9101(23) is high (EOS1 active).
If the trigger frequency is higher than 50 MHz then the divide-by-two circuit holds the lower input of D9101-(1) high, so the output low is applied to the R input of D9101-(2). The high Q output is routed to the S input of D9101-(19). Considering the R input of D9101-(17). The SR- signal input is high, therefore it gives a low to the upper input of D9102-(3), which is not effective because this input is high (high already on S).
The AT- input is high in AUTO triggered so the lower input of D9102-(4) is high. Together with the high on the upper input gives a low output, which is applied to the R input of D9101-(17). In this set state (S high, R low), Q is high and Q- is low, so the unwanted trigger is skipped.

SINGLE mode (see fig.15.1)
In SINGLE mode the hold off sawtooth generator is switched off (V9134 conducts).
If the button Single is depressed the start flip flop starts the MTB sawtooth generator once on receipt of a trigger on the clock input (D9101-16). The set and reset input are both low because AT- and SR- are both high (see AUTO triggered and TRIG mode).
The main time base generator sawtooth is high at the end of the sweep (D9102-19).
The MTB generator must be immediately reset for the next SINGLE action because the hold off is switched-off.
This is done by the SR- signal, which is low for a moment. At the moment that SR- is low, V9103 conducts, D9101-18 (set) is high and D9101-17 (reset) is low.
So the Q- output 13 is low.

SR- low for a moment gives that V9129 conducts, so a logic high is fed to the MTB-HOLD OFF logic D9102-18. As a result EOS1 becomes low, which results in D9101-23 low and D9101-2 high and D9101-11 low.Now the main time base logic is ready for the next SINGLE action (on receipt of a trigger).

Trigger detection mode (during AUTO free run.)
Trigger detection during the MTB sweep is done via D-flip-flop 9101-3-4-7-8, NOR GATE D9004-1-8-2-9 and inverter D9004-3-6.
This trigger detection circuit gives also setting information to the uP via TBS 1 during the AUTO SET mode (see section: AUTO SET mode).

To indicate the uP if there are trigger pulses during the sweep, the circuit functions as follows:
In this mode the signal TBS0 is high; input 8 of D9004 is also high, so output 9 is low, independent of the other inputs.
This output is clamped to ECL level by diodes V9006/V9007 and the level adaptor V9002.
The low level on D9004-9 is fed to the data input of D9101-(6).
The reset input 4 is low. The set input 3 is low, because TR- is high and V9001 blocks.
With set and reset input both low the data input level (low) is clocked out on the Q-output 7 when a trigger occurs on the clock input 5.
This low Q output is fed as TBS1 to the uP to indicate that the NOT TRIG'D LED must be switched off.
Every 100 ms the TR- signal is low to reset the trigger detection circuit. If TR- is low for a moment, V9001 conducts and a logic high is fed to the S input 3 of D9101, which results in a high Q output 7.
When TR- is high again the uP reads TBS1
- If no trigger pulses were detected the Q output 7 will still be high, so TBS1 is also high.
  This results in AUTO mode for AUTO free-run of the time base.
  In TRIG mode the uP will switch on the NOT TRIG'D led (no trace).
- If a trigger pulse was detected then the Q output 7 is low (TBS1 also low) and the time base is triggered on receipt of the next trigger pulses (clock-pulses).

AUTO SET mode
To give setting information for AUTO SETting to the uP, via TBS1, the trigger detection circuit functions as follows:

In this mode TBS0 is low.
This means that output 9 of D9004 depends on the logic levels on inputs 1 and 2.
Input 1 is high during the MTB sweep, so output 9 is low during the sweep.
The data input D9101-6 is also low.
At the moment that TR- was low and the set input D9101-3 was high, the Q output 7 was set to high level.
After TR- (so TR- is high) the set input D9101-3 is low.
With both set and reset low, the data input level (low during sweep) is clocked out on Q on receipt of a trigger on the clock input D9101-5.

So if a trigger occurs during the sweep, Q output D9101-7 is low.
This low Q output is held via the D9004-3-6 inverter on input D9004-2 as follows:
Input D9004-3 is low, so output 6 is high. Input D9004-2 which is also high holds the data input 6 of D9101 low.
If the uP has read the low TBS1, the TR- signal is low again (every 100 ms). This makes D9101-3 (set input) high. As a result the Q output D9101-7 is high again and ready for the next detection action.
If no triggers occur during the sweep then the D flip flop D9101(5) has no clock pulses so the output Q stays high.
If in between the time base sweeps triggers occur on the clock input D9101-5 then the situation is as follows:
The three inputs of D9004(2-8-1) are low.
Output D9004-9 is high, so on triggers (clock pulses) a high is clocked out on Q output D9101-7, so TBS1 is high in between the sweeps (no trigger detect situation).

MTB Sawtooth Generator

The START MTB pulse from the Start flip-flop Q output is converted from a positive-going voltage to a current and applied to the common-base transistor V9108. The collector voltage is clamped at +1.5 V ... -0.6 V (ECL level) by diodes V9112, V9111 and V9109. The signal is then fed two ways via resistors and speed-up capacitors.
The switching transistors V9113/V9116 take over the current from the MTB CURRENT SOURCE at flyback. The START MTB pulse switches V9113 on and V9116 blocks. The constant current is applied via diode V9117 to charge the timing capacitors. At the end of the START MTB pulse (at flyback), V9113 is switched off and V9116 conducts to take over the current of the current source; i.e. it is not fed to the timing capacitors. The buffer V9121 is inserted to provide sawtooth isolation.

The switching transistors V9114/V9118 are used to discharge the timing capacitors during flyback.
The START MTB pulse switches on V9114 and V9118 blocks. At the end of the MTB START pulse (at flyback), V9118 is switched on by the negative slope of the START MTB pulse and quickly discharges the timing capacitors. Diode V9119 prevents a current surge by V9118 after discharge.
The small timing capacitors C9114, C9117 are permanently in circuit. For the slower ranges, extra capacitors are switched in; namely, C9116, controlled by M2 from the HEF-bus via V9122, and, for the slowest time-base settings, C9118, controlled by M3 from the HEF-bus via V9123 (see fig.15.2).
The sawtooth waveform is buffered by FETs V9141 and the two emitter-followers V9124 and V9126, which compensate for base-emitter voltage changes. The low-impedance output is applied via the common-base transistor V9128, which provides a current MTB sweep output to the HORIZONTAL SELECTION circuit. Transistor V9142 provides the current source for the output stage. Another signal path is via emitter-follower V9127, which acts as a sawtooth isolator. This emitter output is low during the sweep but goes high momentarily at the end of the sweep.

This signal is applied to the MTB-HOLD-OFF LOGIC, where the low at the end of the MTB (EOS4) is used to start the hold-off period. Two NOR-gates D9102-20-19-13-14 and D9102-17-18-15-16 are switched as a flip-flop. The flip-flop D9102 logic levels are:

pins 19 and 20: high -> pin 13: high (EOS1)
pin 14: low (EOS4)
pins 17 and 18: low -> pin 15: high
pin 16: low

The high EOS1 signal is fed back to D9101-23 to set the end of MTB sweep logic and a low MTB EOS4 signal is used as the hold-off start condition.

Alternate Circuit and MTB Gate

During the MTB sweep, V9011 base is low, it conducts and causes V9012 to block. The collector goes low and V9013 blocks. The high on its collector therefore switches on V9016 which gives a high output (+12 V) during sweeps. This provides the ALT output to OQ 0200 on the Y-signal unit.
The MTB GATE output is derived from the collector of V9014. During the sweep the base is low; npn transistor V9014 therefore blocks to give a high (5 V) output gating pulse on BNC connector X12.

MTB current source and hold off current source

This circuit provides a constant-current source for the charging circuits of the MTB timing capacitors, dependent on the particular time-base setting and the position of the VAR control.
Basically, it consists of range adjustment resistors switched by an analog selector switch to pass a certain current to a seven step resistor level-shifter. This current is applied to an operational amplifier for comparison and gives a voltage reference to the current source amplifier that supplies the constant current for the MTB

5

The circuit details are as follows.

MTB settings adjustment points.
The adjustment range of the presets R9704, R9702, R9703 is determined by the timing capacitor values of the 1 ns, 10 ns and 1 ms ranges.
The analog switch selectors D9706 are energised from the HEF-bus (see fig.15.2) to switch the selector range current to the negative input, pin 6, of level shifter N9701.

MTB continuous circuit.
The VAR MTB control R11 is also connected via a comparator N9701/V9701 to the negative input, pin 6, of the level shifter N9701. The divider network R9751/R9717 provides 100 mV bias voltage for the dead angle when the VAR control is in its minimum position.
The level shifter consists of the operational amplifier N9701 and an accurate seven-step load resistor network across a constant supply voltage.
As a result, a current is fed to the operational amplifier and compared to the current at the positive input to give a fixed output voltage. This voltage is taken off by a multiplexer (D7403) controlled from the HEF-bus (S0, S1 and S2, see fig.15.2.) to give the range CAL voltage (U_{CSM}) on test-point X28. In the CAL position (VAR control clockwise) the U_{CSM} has seven voltage steps for the time base position x0.5, x1, x2, x5, x10, x20, x50.

However, in the UNCAL position of the VAR control R11, current is drawn from the level shifter negative input, which means that the U_{CSM} at the multiplexer output is reduced to cover the gap between steps depending on the setting of the VAR control. This operates as follows. When the VAR control R11 is increased, N9701-3 input goes high and consequently the high output on N9701-1 causes V9701 to conduct and draws current from the seven-step resistor network. This produces a corresponding reduction in the U_{CSM}. To prevent errors in the CAL position of R11 (which is not mechanically switched), the pre-voltage of +100 mV on the emitter of V9701 gives a dead angle for the potentiometer, as explained.

MTB current source.
The U_{CSM} on X28 is applied to the actual current source stage, consisting of operational amplifier comparator N9702 and transistor V9708. The current source is derived from the +18 V on this comparator (pin 7), the U_{CSM} giving a fixed output on N9702-6 to drive the current transistor V9708. The U_{CSM} is proportional to the time-base settings; e.g. the lower the U_{CSM} the lower the current I_{MTB} to the MTB sawtooth generator (emitter of V9121).
In the x100 position a high logic signal from the HEF-bus (M100, see fig.15.2) switches on the reed relay K9704 via V9719 to switch R9729 in parallel with R9728 in the emitter circuit of V9708. A reed relay is used to reduce errors that would otherwise be caused by any contact resistance. In this way the current I_{MTB} is increased 100 times.

Hold off current source.
A HOLD OFF current source is included, which is driven from the U_{CSM} (X28) when adapted to the time-base setting, or from a fixed potential at 0.5 us and faster sweep speeds. When COM- is high (not active: 1 s ...0.5 us) the U_{CSM} from the MTB current source is applied via selector switch D9707 contacts 4 and 3 to the positive input of comparator N9161. The hold-off current source is then derived from the +18 supply to N9161 via the current transistor V9716.

When COM- is low (active: 0.5 us ... 10 ns) the fixed potential U_{CSH} on D9707-1 is applied via the selector switch D9707 contacts 1 and 2 to the positive input of comparator N9161. Switch D9707 contacts 8 and 9 serve as an inverter for the COM- signal to activate D9707-13. In the x100 position the M100 input (high) from the HEF-bus switches on V9719, which in turn switches on V9717. This connects R9738 with R9737 to give x100 hold off current I_{HO}, which is fed to the HOLD OFF sawtooth generator collector of V9133). The x100 for the MTB current source, reed relay K9704, is also switched on via V9719 as described.

The Hold off sawtooth generator.

The EOS4 signal corresponding to the high point of the MTB sawtooth waveform is routed as a low start signal for the hold-off, which blocks V9131, which also acts as a level adaptor (12 V to 5 V level). In turn, this blocks the current switch V9133. The HOLD-OFF CURRENT SOURCE feeds the switching transistors V9133/V9134. During the hold-off period, these transistors are blocked and the current charges the hold-off timing capacitors.
At discharges (the flyback period), V9133 conducts to take over the current from the current source. Transistor V9134 is controlled from the HEF4094 bus, D7301-13, which is located on the motherboard to switch off the hold-off function in the SINGLE mode. A high input on its base switches it on, thus preventing the timing capacitors from being charged. Timing capacitor C9129 is permanently in circuit and determines the minimum hold-off period to allow the MTB timing capacitors to discharge completely. The other timing capacitors are switched in:
- C9131 by V9136, controlled by H2 from the HEF-bus } See fig. 15.2
- C9132 by V9137, controlled by H3 from the HEF-bus.}

15

The hold-off sawtooth is picked-off via two emitter followers V9138/V9139 in Darlington configuration, which compensate for base-emitter voltage variations and give a low-output impedance.

The HOLD OFF control R10 is coupled via diode V9143 to comparator N9161 to give a variable d.c. level (HOLD OFF DC LEVEL) on the output, which is superimposed on the HOLD OFF sawtooth signal. The selected level determines the maximum hold-off by controlling the switching level of D9102-18 (Hold-off logic). The d.c. level shifts the sawtooth upwards so that the hold-off is reduced; i.e. it reached the switchinglevel of flip-flop D9102-18 faster. Consequently, the EOS H.O. goes high and the MTB is then free for another sawtooth sweep as follows:

```
D9102-18: high, as a result
D9102-16: high, D9102-15 } low, ->  D9102-14: high
                D9102-19 }          D9102-13: low
                D9102-20 }          EOS    1: low
```

In the SINGLE mode, the SR- (SINGLE RESET) input to the base of V9129 is low. This transistor switches on to give a high on EOS H.O. as there is no hold-off required in the SINGLE mode.

TIME/DIV. TABLE

SET-TINGS	MAIN TIME BASE: CURRENT SOURCE S2	S1	S0	M100	COM-1nsM	10nsM	SWEEP M2	M3	H.OFF SWEEP H2	H3	DELAYED TIME BASE: CURRENT SOURCE 02	01	00	D100	1nsD	10nsD	SWEEP D2	D3
1 s	0	0	0	0	1	0	0	0	1	0	1	–	–	–	–	–	–	–	–
0.5	0	0	1	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1
0.2	1	0	1	0	1	0	0	0	1	0	1	1	0	1	0	0	0	0	1
0.1	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0	0	0	0	1
50ms	0	1	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	1
20	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	1
10	1	1	0	0	1	0	0	0	1	0	1	1	1	0	0	0	0	0	1
5	0	0	1	1	1	0	0	0	1	0	1	0	0	1	1	0	0	0	1
2	1	0	1	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	1
1	0	1	1	1	1	0	0	0	1	0	1	0	1	1	1	0	0	0	1
0.5	0	1	0	1	1	0	0	0	1	0	1	0	1	0	1	0	0	0	1
0.2	1	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0
0.1	1	1	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0	1	0
50us	0	0	1	1	1	0	0	1	0	1	0	0	1	1	0	0	0	1	0
20	1	0	1	1	1	0	0	1	0	1	0	1	0	1	1	0	0	1	0
10	0	1	1	1	1	0	0	1	0	1	0	0	1	1	1	0	0	1	0
5	0	1	0	1	1	0	0	1	0	1	0	0	1	0	1	0	0	1	0
2	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
0.5	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
0.2	1	0	1	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0
0.1	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
50ns	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
20ns	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
10ns	1	1	0	1	0	0	1	0	0	0	0	1	1	0	1	0	1	0	0
1ns	1	1	0	1	0	1	*	0	0	0	0	1	1	0	1	1	*	0	0

* : TB MAGN on = 1, TB MAGN off = 0.

FIG.15.2 Control data from HEF 4094-bus for MTB, Hold off and DTB TIME/DIV. settings.

15.2. DELAYED TIME BASE CIRCUIT DESCRIPTION (see fig.15.13)

DTB trigger input circuit and DTB logic.

The DTB trigger input circuit is similar to that of the MTB.

The positive going DTB trigger current signal is applied via a 50 ohm adaption resistor R9201 to the common-base transistor V9201. The series feedback amplifiers V9372 and V9373 convert the input voltage signal into symmetrical current signals. The gain of this stage is determined by R9375. These current signals are fed to a Schmitt-trigger circuit to sharpen up the edges of the trigger pulse.

This Schmitt-trigger circuit consists of V9374, V9376, V9378 and V9377.
This circuit is biased in such a way that very fast switching is achieved. The output voltage signal is fed via two emitter-followers V9379 and V9202, which functions as a buffer, to the clock input of D-flip flop D9201-1.

DTB logic
In the normal situation, the S and R inputs (D9201-23 and 2) are low when a trigger is received and data information (data to earth) is clocked to the Q output; i.e. Q is low, Q- is high. The Q- high output starts the DTB sweep (D9201-12)

The starting conditions are dependent on STM- signal (STARTS ON MAIN), derived from the HEF-bus:
- When this signal is active low, the DTB starts immediately after the MTB.
- When this signal is inactive high, the DTB waits for a DTB trigger.

DTB is off
The DTB is switched off as follows:
Input signal DTB OFF coming from the HEF bus is high in this mode and STM- is not effective.
This causes V9206 to conduct, and diodes V9209 and V9208 block. Input D9202-19 is low because of R9218 and the S input of the start flip flop is also low (9201-23).
Depending on the STM- signal the start flip flop either clocks-in one trigger, when STM- is high (DTB TRIG mode) or is reset, when STM- is low (STARTS DTB mode) and starts the DTB sawtooth generator once (Q-/D9201-12 is high) up to the moment that EOS DET. is high. This EOS DET, signal can not set D9201-18 for another sweep, because diode switch V9208/V9209 is blocked, so the DTB is off.

DTB awaiting trigger (TRIG DTB mode)
With STM- high, the lower input of NOR-gate D9202-20 is high.
The DTB is on, so the DTB OFF signal is low. V9206 blocks and diode V9208 concucts because the cathode is low (D9202-12 is low).
D9202-12 is low because both inputs of the NOR gate are low. (MTB EOS 3 is low and D9202-23 is also low after the delay time)
Diode switch V9208 conducts which makes the junction V9208/V9209 low. As a result V9209 blocks and D9202-19 and the S input (D9201-23) are held low by R9218. With D9202-20 high and D9202-19 low, the output (14) is low, so the reset input D9201-2 is also low.

With both the R and S inputs low, after the delay time, the DTB start flip-flop D9201-1-11-12 is therefore awaiting a trigger to clock in the data input. On the arrival of a trigger, the data is clocked to Q (low), which gives the high start output on Q-(D9201-12).

DEFLECTION MODE TABLE

Front-panel modes	HEF-bus signal bits						
	Single	Doff	STM-	AT-	x10	SR-	X DEFL
AUTO	0	x	x	0	x	1	0
TRIG	0	x	x	1	x	1	0
SINGLE	1	x	x	1	x	see *	0
STARTS	x	x	0	x	x	x	x
x10 (X MAGN)	x	x	x	x	1	x	x
X DEFL	x	1	x	x	x	0	1
MTB	x	1	x	x	x	1	0
MTB INTENS	x	0	x	x	x	1	0
MTB INTENS + DTB	x	0	x	x	x	1	0
DTB	x	0	x	x	x	1	0
MTB INTENS delta t	x	0	x	x	x	1	0
MTB INTENS delta t +2 DTB´s	x	0	x	x	x	1	0
2 DTB´S	x	0	x	x	x	1	0
x= not effective							

* : signal normally high, becomes low for a moment after operation of SINGLE pushbutton.

DTB starts immediately after selected delay time (STARTS DTB mode)
In the STARTS mode STM- is low, so D9202-20 is also low.
The DTB OFF signal is low, so V9206 blocks.
As previously described diode switch V9208 conducts and V9209 blocks, so D9202-19 and D9201-23 are held low by R9218.
NOR gate output D9202-14 being high (both inputs low). This results in reset input D9201-2 being high and the set input D9201-23 is low. The output Q- of the start flip flop becomes high, so the delayed time base generator is started immediately after the selected delay time.

DUAL DTB mode
The first and second delayed time base part are alternately displayed together with the main time base controlled by the DTB comparator, which in turn is controlled by the DTBS signal coming from the OQ 0200 (D5326 on Y signal unit).
After de selected delay or delta t, an active high is fed to the S input of the Schmitt trigger D9201-18 (reset input is low), which is held by the high Q output fed back via resistor R9332. Output Q- is therefore low, which gives a low on input of NOR-gate D9202-23. The other input is low (D9202-24) MTB EOS 3, therefore, the NOR-gate output (pinl2) low. This low output causes diode switch V9208 to conduct which makes the junction of V9208/V9209 low. Diode switch V9209 blocks, and the upper input of NOR-gate D9202-19 and the S input of the start flip-flop are held low by the earth on R9218.
Since STM- is low, the lower input of D9202-20 is also low: so the R input of the start flip-flop is high. With S low, and R high, the Q output is low and the Q- is high, which is the condition for starting the DTB

End of sweep The end of the DTB sweep is signalled by a high on the DTB EOS DETect line fed back from R9259, the emitter resistor of V9231. The resulting high condition on the S input of D9201-(3) is held by the high output fed back from Q. This high is also fed to the NOR-gate D9202-(1) to give a low blanking output Z-DTB to the Z control (D9202-7).
At the end of the MTB sweep (MTB EOS3), the R inputs of D9201-17 and 4 are high. The high on input R of D9201-(4) resets this flip-flop and the Q output (pin 7) now goes low. This gives a low on the upper input of NOR-gate D9202-(1). The lower input is now high (9202-2), because MTB EOS 3 is high, which makes the S input of the start flip flop (D9201-23) high via D9202-12 and diode switch V9208/V9209. As a result the Q output D9201-11 is high and D9202-2 is also high which gives a low output level for Z-DTB blanking.

MTB EOS 3 becomes high at the end of the MTB sawtooth . The DTB sawtooth is discharged at this moment (start flip flop is set as described).
This is done at the same time as the MTB sawtooth to prevent interference during the MTB sawtooth (see fig.15.3).
The discharging of the DTB sawtooth is held by the reset of D9201-(4) which is low during the MTB sweep. This results in a low set input level of the start flip flop (D9201-23) via D9202-12 and diode switch V9208/V9209. So the Q- output stays high until the moment that the MTB sawtooth is completed (MTB EOS 3 becomes high).

If the DTB starts for the next sweep, the Q output of D9201-(11) goes low and the lower input of the NOR-gate D9202-(2) gives a high output to unblank the trace during the DTB sweep.

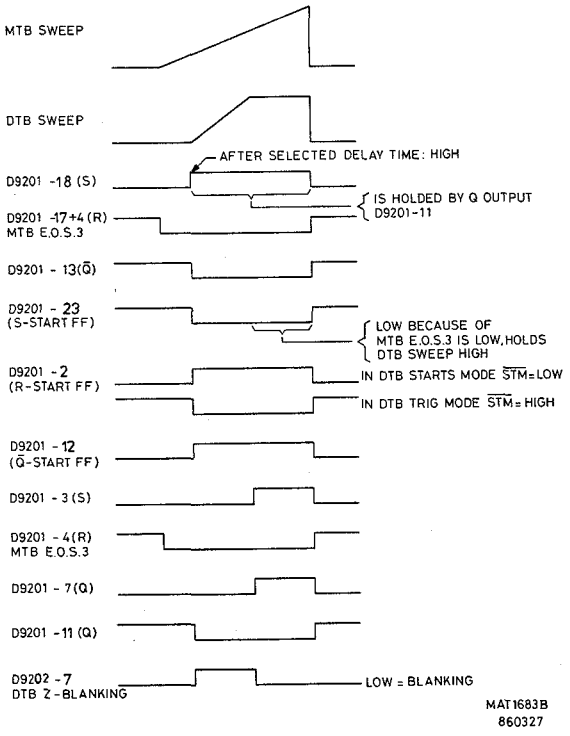


Fig.15.3. Voltage waveforms in the DTB circuits.

DTB Comparator

The DTB comparator stage compares the MTB sawtooth signal wich a d.c. voltage derived from the CPU to give a start signal for the DTB. Two different d.c. levels can be selected. The d.c. level for the DELAY mode can be compared with the MTB sweep for DTB start after the adjusted DELAY TIME, and the delta t d.c. level compared with the MTB sweep for DTB start after DELAY delta t (alternately).
The input signals AN0 and AN1 from the microprocessor digital-to-analog converter provide the d.c. levels to the DELAY and delta t potentiometers. Two voltage dividers are provided for each d.c. level; one to adjust the start of the delayed part on the left side of the screen (START) and one to adjust the start of the delayed part on the right side (END), although these are interdependent (see fig.15.4).
The resuting d.c. levels are routed via input 3 of the buffer voltage followers N9302 to the comparator; d.c. DELAY to pin 6 and d.c. delta t to pin 4.

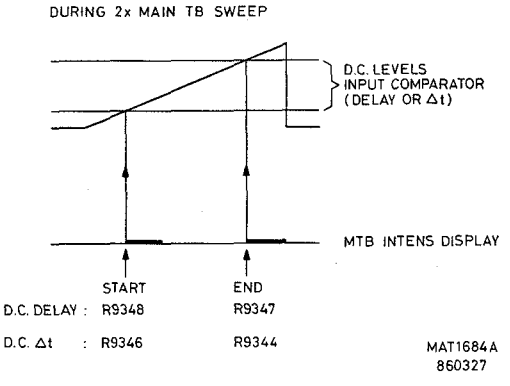


Fig.15.4. Start of the DELAY and delta t sweep at the lefthand side and the righthand side of the screen.

The current sources for the comparator are derived from transistors V9313 and V9312. The base of V9312 is fixed biased by a potential divider; the base of V9313 is controlled by an operational amplifier, which compares and equalises the current sources. This is necessary, because these currents determine the points on which the DTB starts.

The MTB sweep is applied on the bases of the other transistors of the long-tailed pairs that carry the d.c. input voltages. When the MTB sawtooth reaches the selected d.c. DELAY level the comparator draws current from V9306.
When the MTB sawtooth crosses the selected d.c. delta t level the comparator draws current from V9307.

Signal selection is made from the DTBS signal (Delayed Time Base Switch) coming from the OQ 0200 (D5326) on the Y signal unit.
The two DTB parts (DELAY and delta t) are alternately displayed (see fig.15.5). The sequence of the selection depends also on the selected vertical display mode (s) (see section 13.3).
When DTBS is high, the DUAL DTB mode is selected. Transistors V9304 and V9308 conduct and V9306 and V9307 block because the emitter of voltage source V9309 is at 8 V. Current is therefore drawn via V9308 from V9318 which means that the delta t trace is visible.

When DTBS is low, the SINGLE DTB mode is selected. Now V9304 and V9308 block and V9306 conducts so the current path is via V9306 and the DELAY trace is visible.

Diodes V9301 and V9302 provide clamping to limit the voltage swing between the DTBS signal input and the bases of V9306 and V9307.

The output transistor V9318 provides an output voltage on its collector which is clamped to ECL level by diodes V9316, V9317 and zener diode V9311. The output gives an active high at the end of the delay time via R9319 to drive the S input of the Schmitt trigger D9201-(18) of the DTB logic.

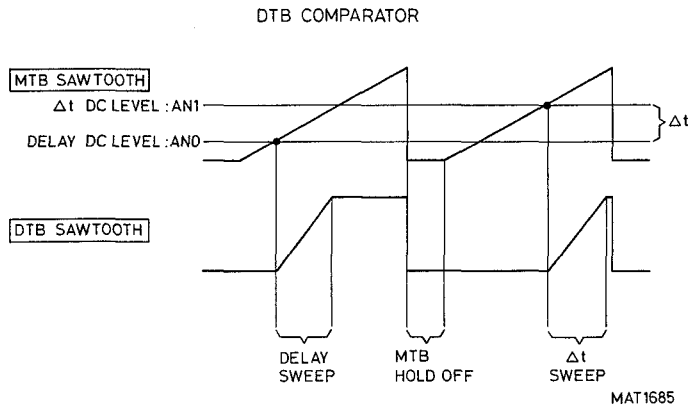


Fig.15.5. DTB display sequence.

15

DTB Sawtooth Generator

The DTB sawtooth generator is similar to that of the MTB. A high signal from the Q- output of the start flip-flop (START DTB on X43) is applied as a current input to the common-base transistor V9211. The resulting collector output is clamped by diodes V9213, V9214 and V9216 and splits into three different paths.

- During the DTB sweep, the high on the base of switching transistor V9218 switches this on, and the low on the collector blocks switching transistor V9219.
  At the end of the sweep the situation is reversed and V9219 takes over the current from the DTB CURRENT SOURCE.

- During the DTB sweep, the high signal applied to the base of switching transistor V9217 causes this to conduct and the low on its collector blocks switching transistor V9221. At the end of the sweep the situation is reversed and V9221 conducts to provide rapid discharge of the timing capacitors.

- During the DTB sweep, the high signal applied to the base of V9212 switches this on and the low collector output switches off V9236. This gives a high DTB GATE output during sweeps.

The timing capacitors permanently in circuit are C9213 and preset C9216.
Extra capacitors for the slower ranges are:
- C9214 controlled by D2 of the HEF-bus via V9226 } see fig. 15.2
- C9217 controlled by D3 of the HEF-bus via V9227.}

The timing capacitors are charged by the current source via the sawtooth isolation stage V9224.

A double FET, V9237 provides a high-impedance buffer stage and two emitter-followers V9228/V9229 in Darlington configuration provide a low-impedance for the DTB sweep output.
The common-base stage V9232 provides the DTB SWEEP OUT signal, drawing current from the X-PRE-AMPLifier.
Transistor V9238 acts as a current source for the output stage. The other DTB sweep output via emitter-follower V9231 (DTB EOS DET), is fed back to the DTB logic circuits.

DTB Current Source
This circuit provides a constant-current source for the charging circuits of the DTB timing capacitors that is dependent on the particular time-base setting and the position of the VAR control. Basically, it consists of range adjustment resistors switched by an analog selector switch to pass a certain current to a six-step resistor level-shifter. This current is applied to an operational amplifier for comparison and gives a voltage reference to the current source amplifier that supplies the constant current for the DTB.

The circuit details are as follows

Adjustment points DTB settings
The adjustment range of the presets R9802, R9803, R9804 is determined by the timing capacitor values of the 1 ns, 10 ns and 1 ms ranges.

The analog switch selectors N9806 are energised from the HEF-bus (see fig.15.2) to switch the selected range current to the negative input of level shifter N9801. Preset R9847 for the 10 us range is permanently connected to the negative input of N9801.

The level shifter consists of the operational amplifier N9801 and an accurate six-step load resistor network across a constant supply voltage.
As a result, a current is fed to the operational amplifier and compared to the current at the positive input to give a fixed output voltage. This voltage is taken off by a multiplexer controlled from the HEF-bus (00, 01, 02, see fig.15.2) to give the range CAL voltage (U_{CALDTB}) on test-point X29.

In the CAL position (VAR control clockwise) the U_{CALDTB} has six voltage steps for the time base positions x1, x2, x5, x10, x20, x50. However, in the UNCAL position of the VAR DTB control R8, current is drawn from the level shifter negative input, which means that the U_{CALDTB} at the multiplexer output is reduced to cover the gap between steps depending on the setting of the VAR control.
This operates as follows. When the VAR control R8 is increased, N9801-3 input goes high and consequently the high output on N9801-1 causes V9801 to conduct and draws current from the six step resistor network.

This produces a corresponding reduction in the U_{CALDTB}. To prevent errors in the CAL position of R8 (which is not mechanically switched), a pre-voltage of +100 mV on the emitter of V9801 gives a dead angle for the potentiometer.

The U_{CALDTB} on X29 is applied to the actual current source stage, consisting of operational amplifier comparator N9802 and transistor V9816.
The current source is derived from the +18 V on this comparator (pin 7), the U_{CALDTB} giving a fixed output on N9802-6 to drive the current transistor V9816.
The U_{CALDTB} is proportional to the time-base settings; e.g. the lower the current I_{DTB} to the DTB sawtooth generator (emitter of V9224), the lower the DTB sawtooth speed.
In the x100 position a high logic signal from the HEF-bus (D100) switches on the reed relay K9804 via V9819 to switch R9829 in parallel with R9828 in the emitter circuit of V9816. A reed relay is used to reduce errors that would otherwise be caused by any contact resistance. In this way the current I_{DTB} is 100 times increased.

15.3. CIRCUIT DESCRIPTION OF HORIZONTAL LOGIC, Z LOGIC AND INTENSITY CIRCUIT (See fig. 15.14)

The Z-logic circuits for the DTB are similar to those for the MTB, except that opposite logic polarity is used. Therefore only the Z-logic in MTB mode is described.
The logic is selected by the TBS signal from X9001-11 (the 0Q 0200); MTB ON is high, DTB ON is low.

15

Horizontal switch logic - MTB ON

Input 13 of NOR-gate D9401 is high, so output 11 is low. The output is TTL adapted to ECL for the time-base chip print by level adaptors V9411, V9403 with diode clamps V9401...V9412. The low output is applied to NOR-gate input 5. The other input (6) is also low because the X deflection is off. Therefore, output D9401-4 is high. This TBS M signal is applied via R9502 to the base of V9501 (HORIZONTAL SWITCH). This high input blocks V9501 so that current is drawn from the X PRE-AMPL via diode V9502 by the MTB.

Considering the DTB position:
input 8 of NOR-gate D9401 is high and input 9 is low (X DEFL. off) so output 10 is low. Therefore the DTB horizontal switch V9233 concucts and diode V9503 blocks. The sawtooth on the DTB is thus fed to earth; i.e. not to the horizontal amplifier.

The X DEFL. input from the HEF-bus to the horizontal switch is normally low (X DEFL. off), so V9539 conducts and earths the X-DEFL signal present on the collector of V9533, derived from the Y signal unit via X9501. Diode V9504 is blocked.

Z-logic
The horizontal switch logic is also fed to the Z circuit. The function of the Z circuit is to provide the logic for switching the intensity regulation circuit, depending on which time-base functions are operating.

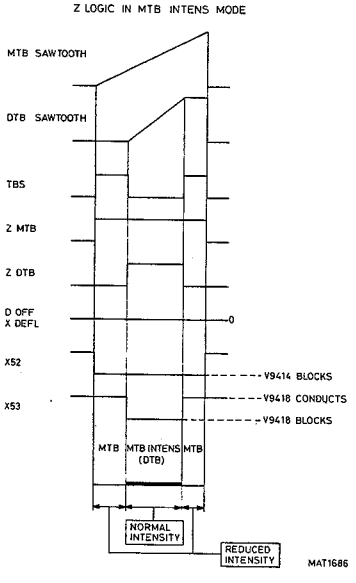
MTB on only: (condition-V9414 and V9418 base low)
The high via R9402 is applied to one input of AND-gate D9402-(9). The other input is also high during the MTB sweep (Z MTB) so via the output, the high is fed to input 4 of the MTB NOR-gate D9403 to give a low output to the base of V9414.

The D OFF signal from the HEF-bus is high via R9404 to AND-gate D9402-13 so the input 13 of the DTB NOR-gate D9403 is high. With one input (pin 13) high the output (pin 14) of D9403 is low. So the base of V9418 is also low. Both transistors, V9414 and V9418 are blocked. Equal currents are drawn from the Z amplifier via V9416 and V9417 by the current sources V9422 and V9421.

When DTB on only : (condition - V9414 base low, V9418 base low)
The low on input 13 of D9401 gives a high on output 11 because input 12 is also low. This high is fed via R9403 to give a high on the input 4 of AND-gate D9402. During the DTB sweep the other input (5) is high (Z DTB), so the output (2) is high, which gives a high input to the MTB NOR-gate D9403(6) to give a low output to the base of V9414 (this V9414 is blocked).

Input 12 of the DTB NOR-gate D9403 is low because the X-DEFL is low. The low Z MTB is applied to input 12 of AND-gate D9402, the output (15) of which gives a low to the input 13 of the DTB NOR-gate D9403. Finally, the low D OFF input gives a high output on D9401-3, which in turn gives a high input 6 of AND-gate D9402. This results in a high to input 11 of the DTB NOR-gate D9403. The output to the base of V9418 is low. V9418 blocks, as a result V9417 conducts. Both transistors, V9414 and V9418 are blocked. Equal currents are drawn from the Z amplifier via V9416 and V9417 by the current sources V9422 and V9421.

MTB Intens mode:
Input signal TBS (Time Base Switch) is high during the MTB part and low during the DTB part (intensified part).
In MTB INTENS mode the intensity of the MTB part is reduced (see fig. 15.6) and the DTB part has normal intensity. The logic levels in this mode are given in fig.15.7.
At the moment that the MTB is on, Z MTB is high and Z DTB is low. The inputs of AND-gate D9402-(10 and 9) are high. This gives a high output (14) which is fed to input 4 of MTB NOR-gate D9403. Therefore a low output is supplied to the base of V9414 (X52).



With Z DTB low and D OFF low and Z MTB high all inputs of D9403 (12-9-13-11-10) are low. This results in a low output 15 and a high output 14. This high output is fed to the base of V9418. So V9418 conducts and V9417 blocks. In this way the intensity of the MTB part is reduced.

Fig.15.6. Voltage waveforms in Z logic in MTB INTENSified mode.

15

Intensity Reduction Circuit

Intensity reduction is achieved by two transitor stages that are separately switched from the HEF-bus to adapt the voltage range of the INTENS potentiometer to the various time-base settings.

Z1 and Z2 TABLE

MTB SETTINGS	AUTO/TRIG				SINGLE			
	x1		X MAGN x10		x1		X MAGN x10	
	Z1	Z2	Z1	Z2	Z1	Z2	Z1	Z2
1 s	1	0	1	0	1	0	1	0
0.5	1	0	1	0	1	0	1	0
0.2	1	0	1	0	1	0	1	0
0.1	1	0	1	0	1	0	1	0
50 ms	1	0	0	1	1	0	0	1
20	1	0	0	1	1	0	0	1
10	1	0	0	1	1	0	0	1
5	0	1	0	1	0	1	0	1
2	0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0	1
0.5	0	1	0	1	0	1	0	1
0.2	0	1	0	1	0	1	0	1
0.1	0	1	0	1	0	1	0	1
50 us	0	1	0	1	0	1	0	1
20	0	1	0	0	0	1	0	0
10	0	1	0	0	0	1	0	0
5	0	1	0	0	0	1	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
0.2	0	0	0	0	0	0	0	0
0.1	0	0	0	0	0	0	0	0
50 ns	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
X DEFL	1	0	1	0	1	0	1	0

Fig.15.7. Logic levels in INTENSity control circuit.

The INTENS control R14 is connected between 0 V and +13.8 V. The slider is connected via R9637 to the high-impedance positive input of buffer N9601, which provides a low-impedance output to the Z intensity regulation circuit. The INTENS control is also connected to two diode switching circuits that can influence the intensity range as shown in fig.15.8 The logic levels of the control signals Z1 and Z2 are given in Fig.15.7.

These circuits operate as follows:

- With the base control HEF-bus signals Z1 and Z2 off (logic low), transitors V9613 and V9614 are off and diodes V9617, V9616 are blocked. Consequently, the full range of the INTENS control is applied to the Z INTENS circuit.

- If Z1 signal is high V9613 conducts and if the INTENS voltage from R14 is higher than 1,17 + 0,6 = ≃1,8V then diode V9617 conducts and reduces the intensity range as shown, via the input buffer.

- If Z2 signal is high, V9614 conducts and if the INTENS voltage from R14 is higher than 3,8 + 0,6 = ≃4,4V then diode V9616 conducts and reduces the intensity range as shown, via the input buffer.

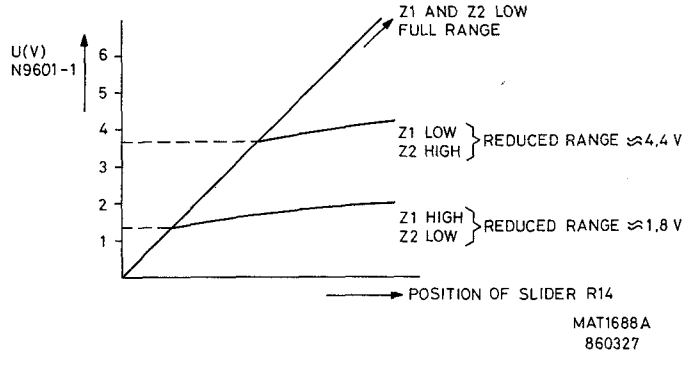


Fig.15.8. Graph of range of INTENSity control circuit as a function of the HEF 4094 bus signals Z1 and Z2.

INTENS Regulation Circuit

The main function of the intensity regulation circuit is to draw different currents from the Z pre-amplifier according to the different trace requirements.
The circuit basically comprises two switching transistor pairs, V9414/V9416 and V9418/V9417 and two current sources V9422 and V9421. The bias voltages of the current sources are controlled by zener diodes V9423 and V9419.
The current drawn from the Z pre-amplifier normally increases with increased INTENS control setting.
When the MTB mode is chosen, inputs to both V9414 and V9418 are low and normal regulation takes place linearly from the INTENS control (see level b of fig.15.9) In this event, both current sources draw current from the Z pre-amplifier via V9416 and V9417. When MTB INTENS is selected the intensified part (DTB) has normal intensity (as in MTB only mode) and both current sources drawn current from the Z-preamplifier. The MTB part intensity is reduced by subtracting the current from the current source V9421 (X53 is high, V9418 conducts) from the total current (see level a of fig.15.9)

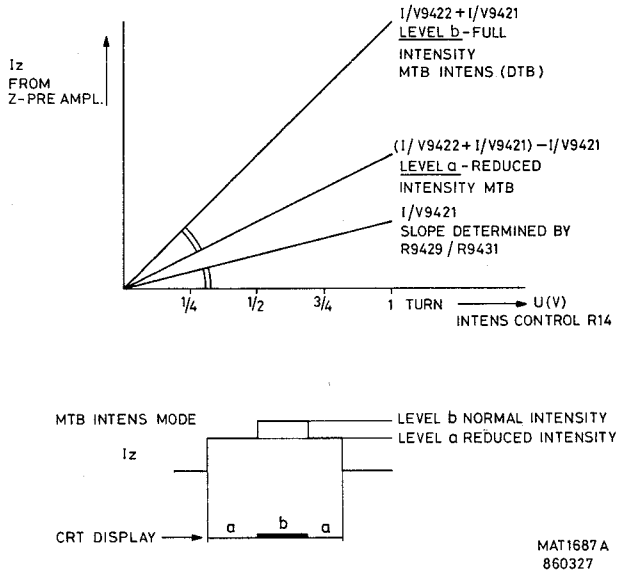


Fig.15.9. Graph of range of INTENSity control circuit.

In MTB INTENS mode switching alternates between the a and b levels (b level for the DTB and a level for MTB part).

Summarising, during the MTB and DTB sweep, the low on the base of V9414 switches this transistor off and V9416 is switched on. Current is drawn by V9422 via V9416 from the Z PRE-amplifier.

Stabilisation Circuit

The selected sawtooth current signal is fed from the horizontal switch stages via diode switches V9502, V9503, or V9504 to the emitter of common-base transistor V9506. The collector supply of this transistor is voltage stabilised by a feedback operational amplifier N9708 and capacitive filters to prevent interference. The resulting voltage waveform at the collector of V9506 is a sawtooth with an amplitude between +1 V and +4 V. This is applied to the base of emitter-follower V9507 to provide a low-impedance output to the X-pre-amplifier.

X Pre-amplifier

The X POS control provides an input that can be varied between 0 V and +10 V. The slider potential is connected via a low-pass RC filter to the base of emitter-follower V9508.
The X pre-amplifier proper consists of three series feedback amplifiers (Cherry stages), V9509/V9511, V9512/V9513, V9514/V9516, which can be separately selected by switching their emitter stages. These stages carry the separate GAIN presets for the x10, x1 and X-DEFL. In the X-DEFL stage the resistors R9527 and R9526 provide that the spot (in X-DEFL mode) is in the center of the screen. Active high signals from the HEF-bus switch the x10 and X-DEFL. amplifiers via V9522 and V9524 respectively.
The x1 stage is switched via V9523 when the x10 and X-DEFL. input signals are low.

The current source (10 mA), always switched to one of these stages, is V9528, which gives the U_{REF} on the common emitter circuit of the switching transistors.

X Signal-Text Switch

The asymmetrical sawtooth is fed to the X signal-text switch, controlled by EO- signal from the Y Signal Unit. As its name implies, this stage selects either the X signal or the text to feed the Final X Amplifier.
Basically, it consists of a long-tailed pair, V9537/V9538, coupled by two pnp transistors V9527 and V9526 to a diode switching network.

X signal : with EO- low, V9537 is switched off. The correspoding high on its collector is applied to the base of pnp transistor V9527 to switch it off. The low on the collector causes diodes V9534 and V9531 to block; i.e. they do not short-circuit the X signal, which is fed via diodes V9536 and V9532 to the Final X Amplifier.

With V9537 off, V9538 conducts and its collector goes low. This is applied to the base of pnp transistor V9526, which also conducts. The high on its collector causes diodes V9518 and V9519 to conduct which shorts out the TEXT input. Diodes V9517 and V9521 are blocked.

TEXT : with EO- high, V9537 is switched on and its collector is low. The pnp transistor V9527 conducts and the high on its collector causes diodes V9534 and V9531 to conduct, which short-circuits the X signal and blocks the path via diodes V9536 and V9532.

With V9537 on, V9538 switches off and its collector goes high. This is applied to the base of V9526 which blocks. The low on its collector blocks diodes V9518 and V9519 ; i.e. they do not short-circuit the TEXT input, which is now routed via diodes V9517 and V9521 to the Final X Amplifier.

Time-base supply voltages

The +25 V input from the secondary converter is fed via R9727 to a zener diode V9709. This diode, with smoothing capacitor C9704 across it, provides the 18 V supply for the operational amplifiers of the current sources.
The 25 V input also supplies a voltage regulator N9602 for the 5.15 V reference voltage (UREF). Preset R9623 provides an adjustment for the UREF.
In turn, UREF is applied to three voltage regulators with outputs of +12 V, -12 V and +15 V.

The regulator circuits are identical, and therefore only the +12 V circuit is described.
It consists of an operational amplifier N9601 with a zener diode V9603 in the output to keep the regulator voltage within the 10 V working range of N9601. The output from the zener diode feeds the base of the emitter-follower V9601. The feedback voltage (5.15 V) from the junction of the output resistors R9604, R9606 is applied to the negative input of the operational amplifier to control the output voltage. Transistor V9602 provides short-circuit current protection for the base-emitter junction of the output transistor V9601.
The +15 V voltage regulator circuit is fitted with a larger zener diode (V9608 = 12 V) to drop the extra regulation voltage. The three voltage outputs can be checked on test-points:

X31 = + 12 V
X32 = - 12 V
X33 = + 15 V

om the horizontal switch
04 to the emitter of
pply of this transistor
l amplifier N9708 and
e resulting voltage
:h with an amplitude
base of emitter-follower
X-pre-amplifier.

e varied between 0 V and
low-pass RC filter to

eries feedback
V9513, V9514/V9516,
heir emitter stages.
r the x10, x1 and X-
nd R9526 provide that
he screen. Active high
EFL. amplifiers via

and X-DEFL. input

one of these stages, is
er circuit of the

l-text switch,
. As its name implies,
ext to feed the Final X

9537/V9538, coupled by
switching network.

The correspoding
pnp transistor V9527
es diodes V9534 and
the X signal, which is
mplifier.

r goes low. This is
ich also conducts. The
9519 to conduct which
21 are blocked.

TEXT : with EO- high, V9537 is switched on and its collector is low. The pnp transistor V9527 conducts and the high on its collector causes diodes V9534 and V9531 to conduct, which short-circuits the X signal and blocks the path via diodes V9536 and V9532.

With V9537 on, V9538 switches off and its collector goes high. This is applied to the base of V9526 which blocks. The low on its collector blocks diodes V9518 and V9519 ; i.e. they do not short-circuit the TEXT input, which is now routed via diodes V9517 and V9521 to the Final X Amplifier.

Time-base supply voltages

The +25 V input from the secondary converter is fed via R9727 to a zener diode V9709. This diode, with smoothing capacitor C9704 across it, provides the 18 V supply for the operational amplifiers of the current sources.
The 25 V input also supplies a voltage regulator N9602 for the 5.15 V reference voltage (UREF). Preset R9623 provides an adjustment for the UREF.
In turn, UREF is applied to three voltage regulators with outputs of +12 V, -12 V and +15 V.

The regulator circuits are identical, and therefore only the +12 V circuit is described.
It consists of an operational amplifier N9601 with a zener diode V9603 in the output to keep the regulator voltage within the 10 V working range of N9601. The output from the zener diode feeds the base of the emitter-follower V9601. The feedback voltage (5.15 V) from the junction of the output resistors R9604, R9606 is applied to the negative input of the operational amplifier to control the output voltage. Transistor V9602 provides short-circuit current protection for the base-emitter junction of the output transistor V9601.
The +15 V voltage regulator circuit is fitted with a larger zener diode (V9608 = 12 V) to drop the extra regulation voltage. The three voltage outputs can be checked on test-points:

X31 = + 12 V
X32 = - 12 V
X33 = + 15 V

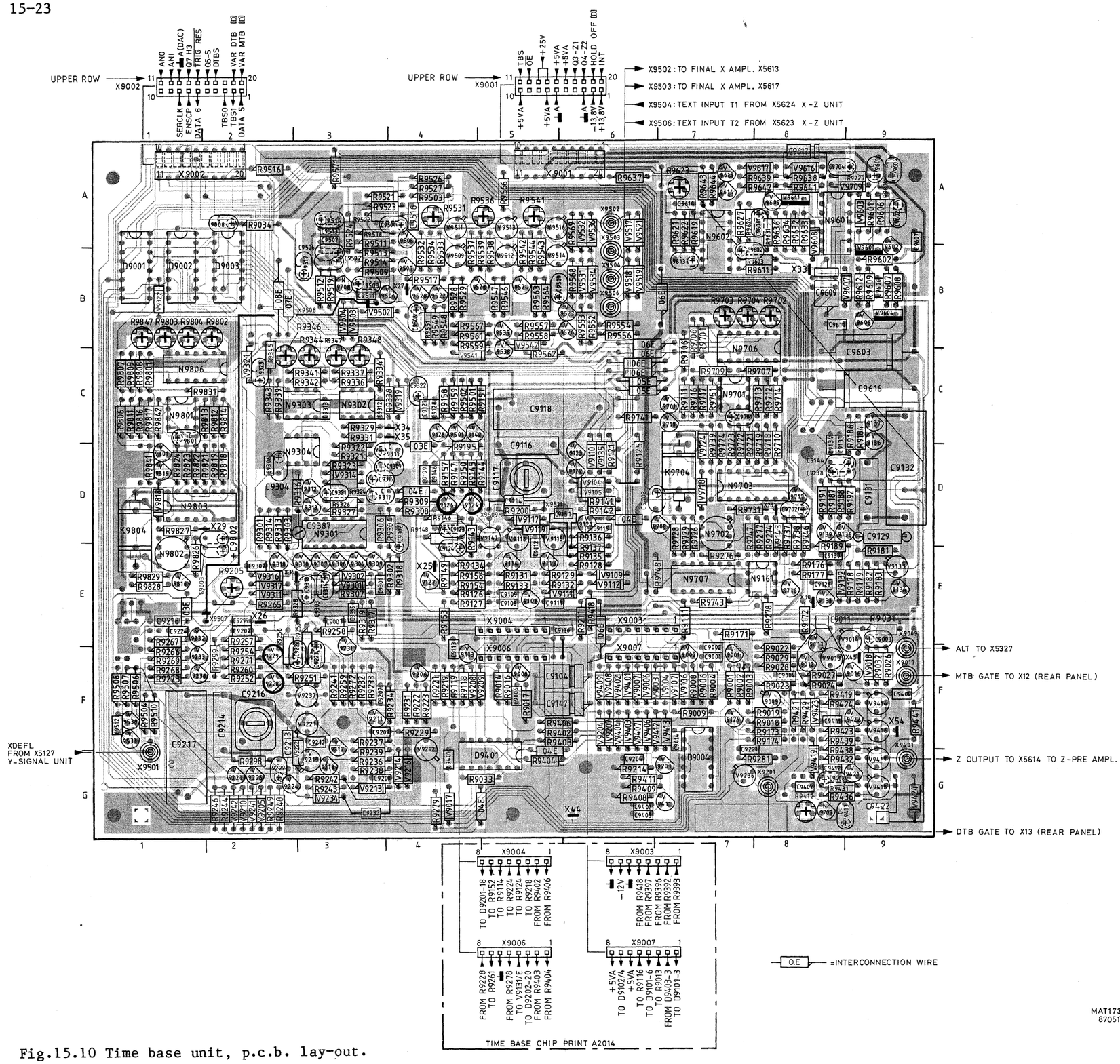


Fig.15.10 Time base unit, p.c.b. lay-out.

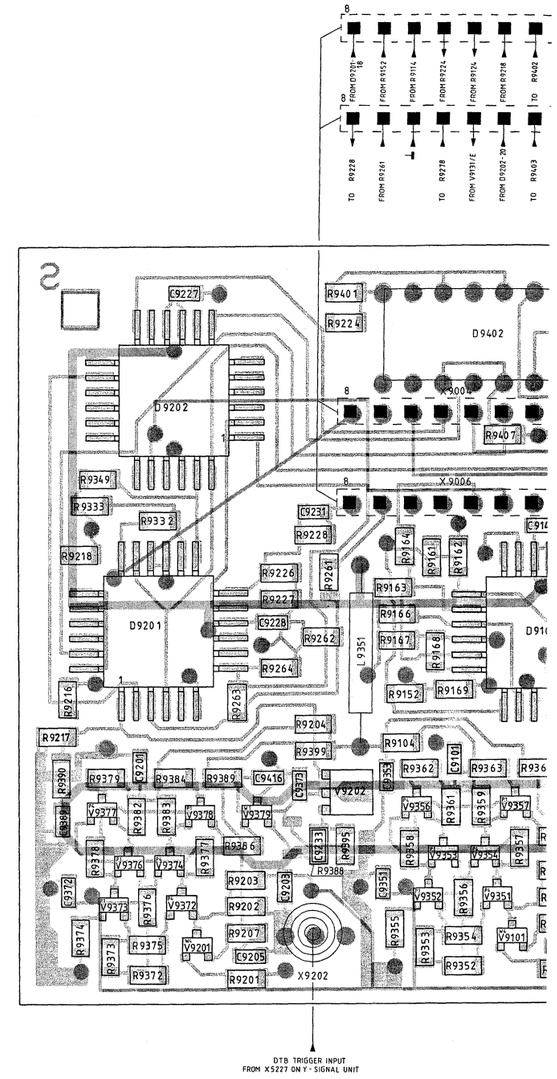
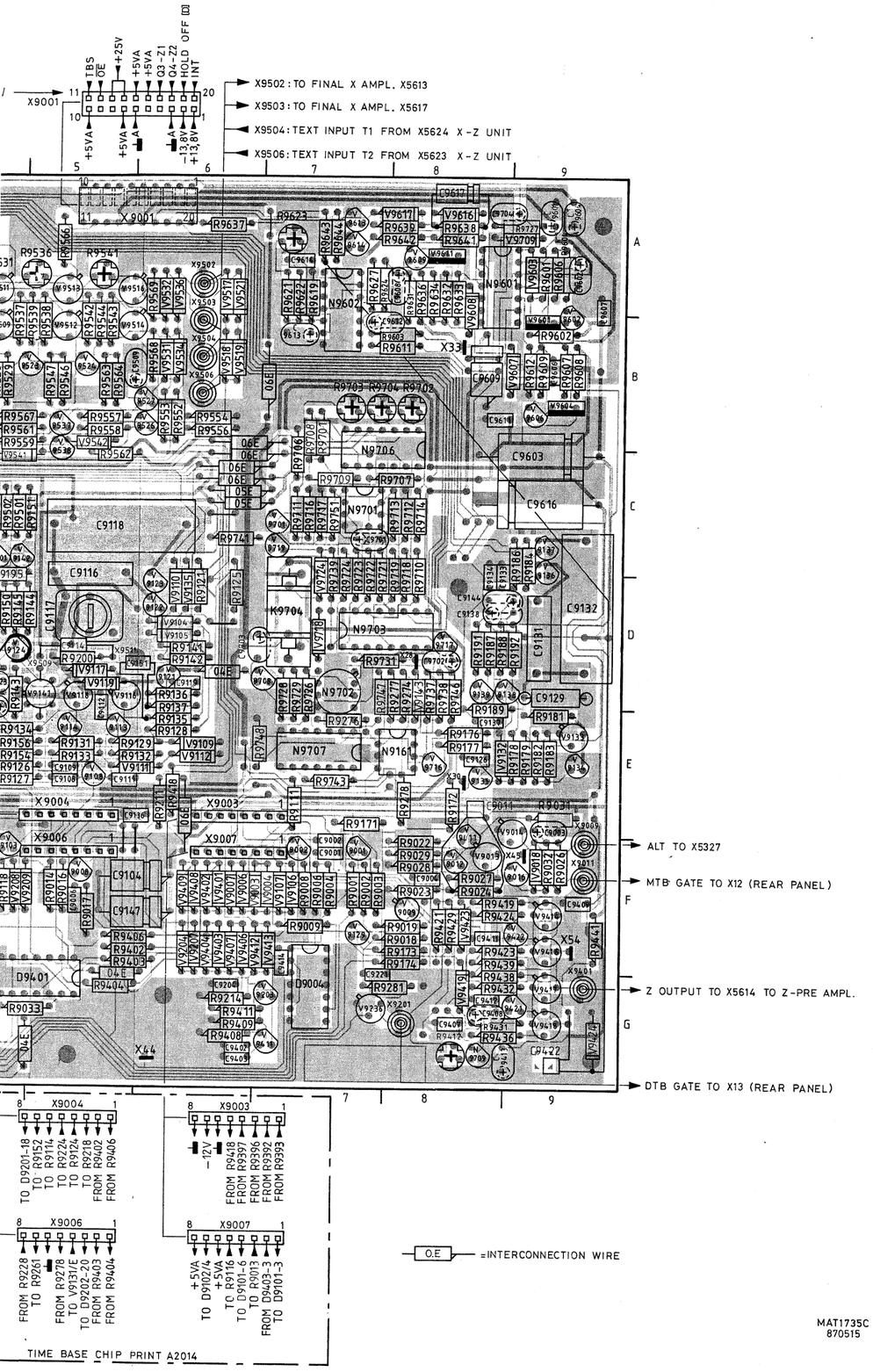


Fig.15.11 Time base chip unit, p.c.b. lay-



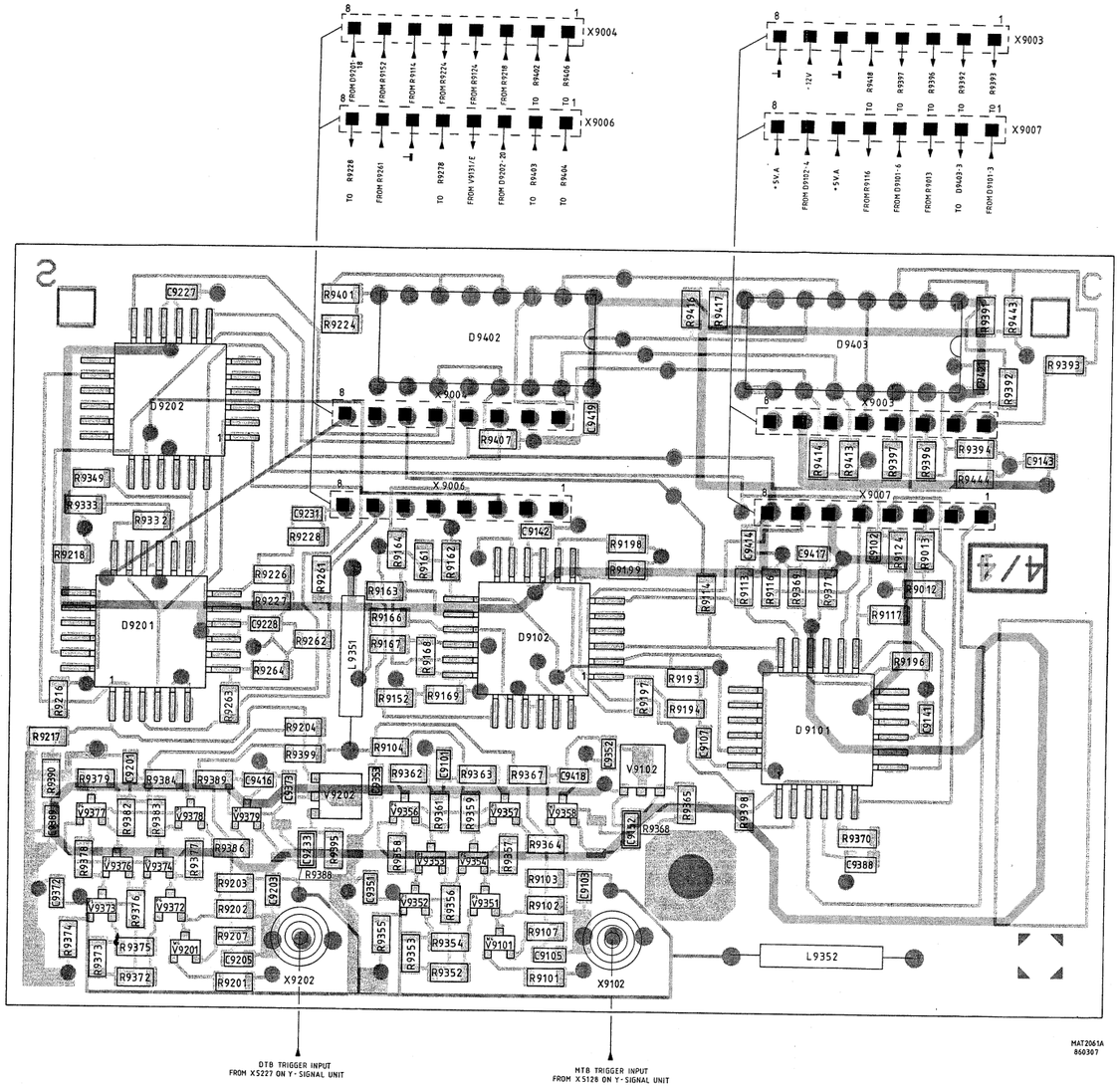
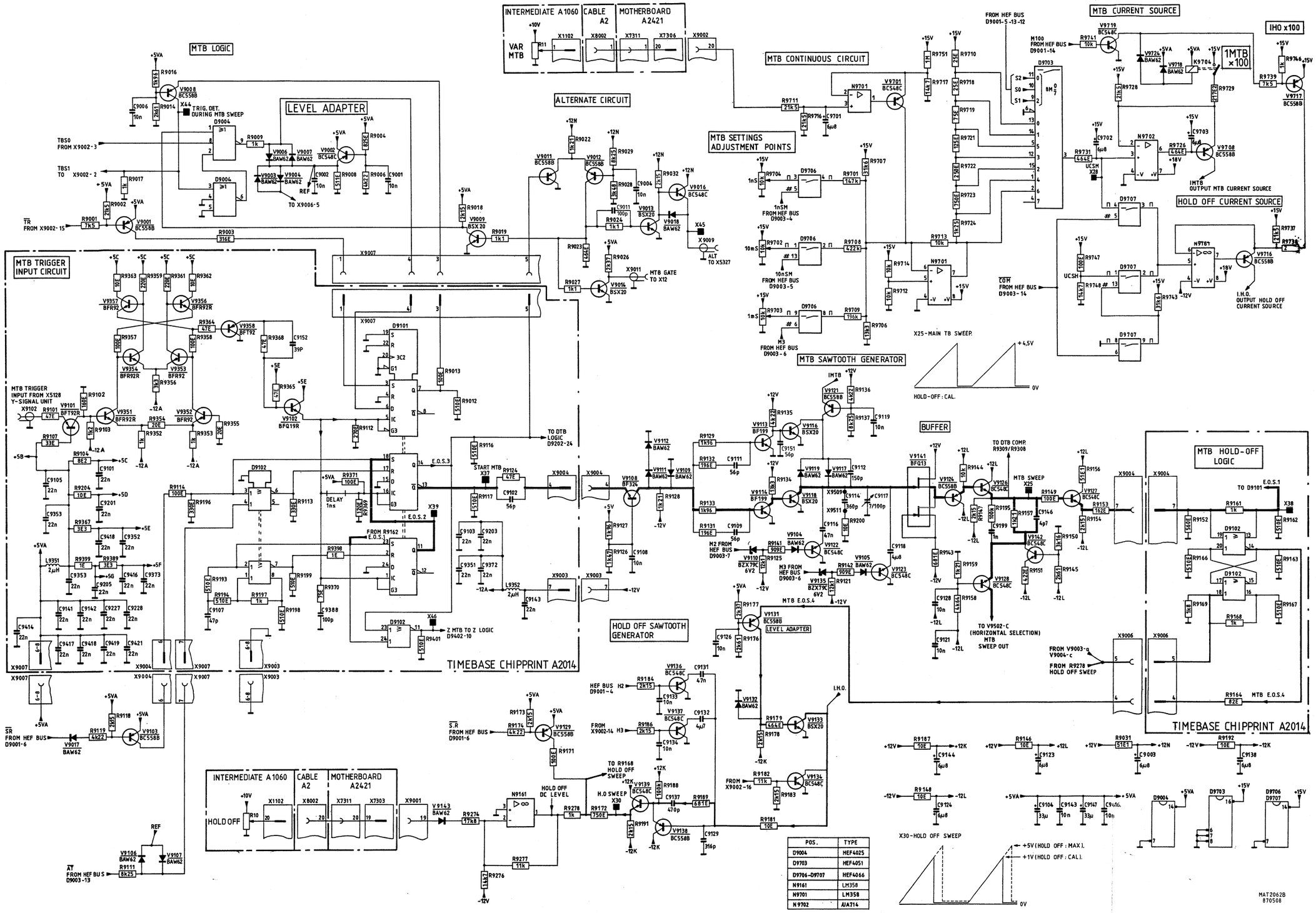
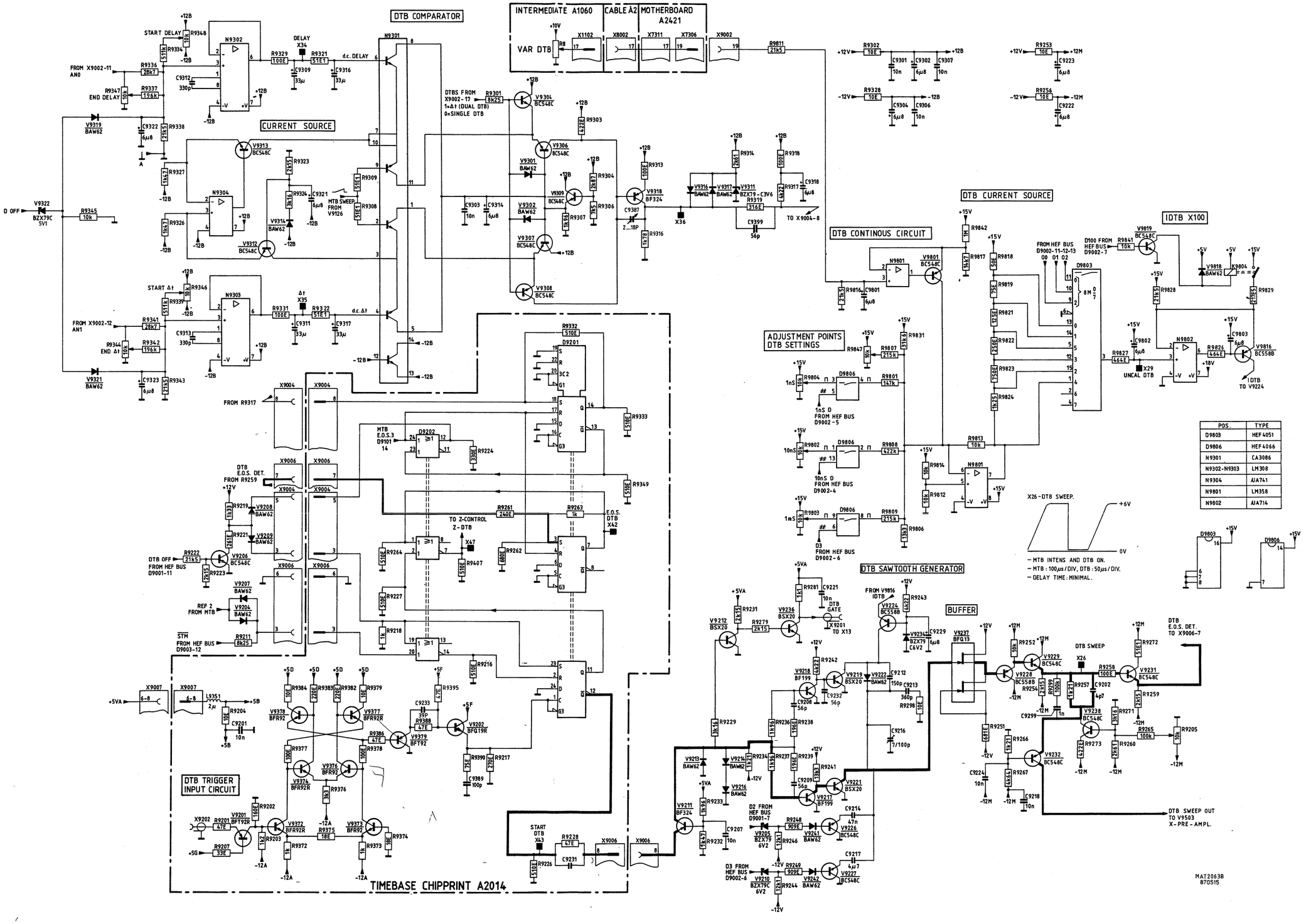


Fig.15.11 Time base chip unit, p.c.b. lay-out.



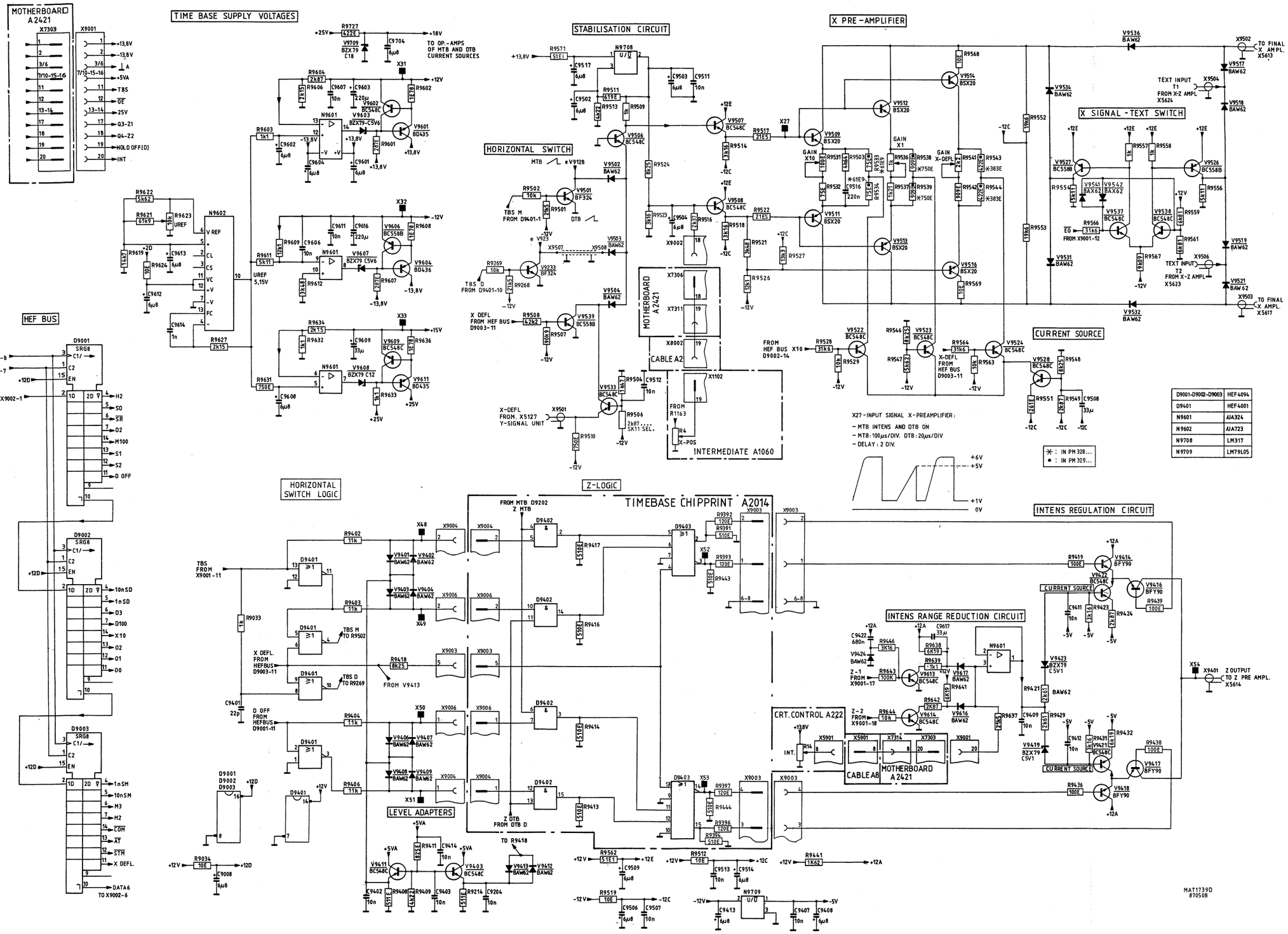
POS.	TYPE
D9004	HEF4025
D9703	HEF4051
D9706-D9707	HEF4066
N9161	LM358
N9701	LM358
N9702	AJA714

Fig.15.12 Main time base circuit diagram.



POS.	TYPE
D9803	HEF4051
D9806	HEF4066
N9301	CA3086
N9302-N9303	LM308
N9304	AJA741
N9801	LM358
N9802	AJA714

Fig.15.13 Delayed time base circuit diagram.



D9001-D9002-D9003	HEF 4094
D9401	HEF 4001
N9601	AJA324
N9602	AJA723
N9708	LM317
N9709	LM79L05

Fig.15.14 Circuit diagram of horizontal logic, Z logic and intensity circuit.

15

15.4 LOCATION LIST OF COMPONENTS ON TIME BASE (CH = located on chip unit)

15.4.1 CAPACITORS

C 9001	F7	C 9212	F3	C 9417	CH
C 9002	E7, F7	C 9213	F2	C 9418	CH
C 9003	E9	C 9214	F2	C 9419	CH
C 9004	F8	C 9216	F2	C 9421	CH
C 9006	F5	C 9217	F1	C 9502	B3
C 9007	E3	C 9218	E1	C 9503	B3
C 9008	A2	C 9221	F7, F8	C 9504	A3
C 9009	CH	C 9222	F3	C 9506	B3
C 9101	CH	C 9223	F3	C 9507	A3
C 9102	CH	C 9224	E1	C 9508	B4
C 9103	CH	C 9227	CH	C 9509	B5
C 9104	F5, F6	C 9228	CH	C 9511	B3
C 9105	CH	C 9229	G2	C 9512	F1
C 9107	CH	C 9231	CH	C 9513	A3
C 9108	E5	C 9232	G3	C 9514	A3
C 9109	E5	C 9299	E2	C 9516	A4
C 9111	E5	C 9301	E3	C 9517	B3
C 9112	E5	C 9302	D4	C 9601	A9
C 9113	E4, F4	C 9303	E3	C 9602	A9
C 9114	D5	C 9304	D2	C 9603	C9
C 9116	D5	C 9306	D2	C 9604	A9
C 9117	D5	C 9307	E2	C 9606	B9
C 9118	C5	C 9309	D3, D4	C 9607	A9, B9
C 9119	D6	C 9311	D3, D4	C 9608	A8
C 9121	C4	C 9312	C3	C 9609	B8
C 9123	D4	C 9313	C3	C 9611	B8
C 9124	E4	C 9314	E3	C 9612	B7, B8
C 9126	E8	C 9316	D3	C 9613	B7
C 9128	C4	C 9317	D3	C 9614	A7
C 9129	D9	C 9318	E3	C 9616	C9
C 9131	D9	C 9321	D3	C 9701	C7
C 9132	D9	C 9322	C4	C 9702	D8
C 9133	C8, D8	C 9323	C2	C 9703	D6, D7
C 9134	C8, D8	C 9351	CH	C 9704	A8, A9
C 9136	E5, E6	C 9352	CH	C 9801	C1
C 9137	E8	C 9353	CH	C 9802	D2
C 9138	D8, D9	C 9372	CH	C 9803	E2
C 9141	CH	C 9373	CH		
C 9142	CH	C 9388	CH		
C 9143	CH	C 9389	CH		
C 9144	D8, D9	C 9399	E3		
C 9146	D4	C 9401	G4		
C 9147	F5, F6	C 9402	G6		
C 9151	E6	C 9403	G6		
C 9199	D4	C 9404	G9		
C 9201	CH	C 9406	G9		
C 9202	E2	C 9407	G8		
C 9203	CH	C 9408	G8		
C 9204	G6	C 9409	F9		
C 9205	CH	C 9411	F8		
C 9206	CH	C 9412	G8		
C 9207	F3	C 9413	G8, G9		
C 9208	G3	C 9414	F7		
C 9209	F3	C 9416	CH		

15.4.2. INTEGRATED CIRCUITS

D 9001	B1
D 9002	B1
D 9003	B2
D 9004	F7, G7
D 9101	CH
D 9102	CH
D 9201	CH
D 9202	CH
D 9401	F5, G5
D 9402	CH
D 9403	CH
D 9703	CH
D 9706	CH
D 9707	CH
D 9803	CH
D 9806	CH
N 9161	E8
N 9301	D3
N 9302	C3
N 9303	C3
N 9304	D3
N 9601	A8
N 9602	A7, B7
N 9701	C7
N 9702	D7
N 9703	D7, D8
N 9706	B7, C8
N 9707	E7
N 9708	B3
N 9709	G8
N 9801	C1
N 9802	E1

15.4.3 RESISTORS

R 9001	F7	R 9146	D4	R 9217	CH
R 9002	F7	R 9147	D4	R 9218	CH
R 9003	F7	R 9148	D4	R 9219	F4
R 9004	F7	R 9149	E4	R 9221	F4
R 9006	F7	R 9150	D4	R 9222	F4
R 9008	F7	R 9151	C5	R 9223	F4
R 9009	F7	R 9152	CH	R 9224	CH
R 9012	CH	R 9153	E4	R 9226	CH
R 9013	CH	R 9154	E4	R 9227	CH
R 9014	F5	R 9156	E4	R 9228	CH
R 9016	F5	R 9157	D4	R 9229	F4
R 9017	F5	R 9158	C4	R 9231	F4
R 9018	F8	R 9159	C4	R 9232	F3
R 9019	F8	R 9161	CH	R 9233	F3
R 9022	CH	R 9162	CH	R 9234	F4
R 9023	F8	R 9163	CH	R 9236	G3
R 9024	F8	R 9164	CH	R 9237	F3
R 9026	F9	R 9166	CH	R 9238	G3
R 9027	F8	R 9167	CH	R 9239	F3, G3
R 9028	F8	R 9168	CH	R 9241	F3
R 9029	F8	R 9169	CH	R 9242	G3
R 9031	E9	R 9171	E7	R 9243	G3
R 9032	F9	R 9172	E8	R 9244	G2
R 9033	G4, G5	R 9173	F8	R 9246	G2
R 9034	A2	R 9174	F8	R 9248	G2
R 9101	CH	R 9176	E8	R 9249	G2
R 9102	CH	R 9177	E8	R 9251	F3
R 9103	CH	R 9178	E9	R 9252	F2
R 9104	CH	R 9179	E9	R 9253	E3, F3
R 9107	CH	R 9181	E9	R 9254	F2
R 9111	E7	R 9182	E9	R 9256	E2, F2
R 9113	CH	R 9183	E9	R 9257	E2
R 9114	CH	R 9184	C9	R 9258	E3
R 9116	CH	R 9186	C9	R 9259	F3
R 9117	CH	R 9187	D8	R 9260	F2
R 9118	F4	R 9188	D8	R 9261	CH
R 9119	F4	R 9189	E8	R 9262	CH
R 9121	D6	R 9191	D8	R 9263	CH
R 9124	CH	R 9192	D9	R 9264	CH
R 9125	D6	R 9193	CH	R 9265	E2
R 9126	E4	R 9194	CH	R 9266	F1
R 9127	E4	R 9195	D4	R 9267	E1
R 9128	E6	R 9196	CH	R 9268	F1
R 9129	E5	R 9197	CH	R 9269	F1
R 9131	E5	R 9198	CH	R 9271	F2
R 9132	E5	R 9199	CH	R 9272	F3
R 9133	E5	R 9200	D5	R 9273	F1
R 9134	E4	R 9201	CH	R 9274	D8
R 9135	E6	R 9202	CH	R 9276	E7
R 9136	D6	R 9203	CH	R 9277	D8
R 9137	E6	R 9204	CH	R 9278	E8
R 9141	D6	R 9205	E2	R 9279	G4
R 9142	D6	R 9207	CH	R 9281	G8
R 9143	D4	R 9211	E6	R 9298	G2
R 9144	D4	R 9214	G6	R 9299	F2
R 9145	D4	R 9216	CH	R 9301	D2

R 9302	E4	R 9384	CH	R 9517	B4
R 9303	D2	R 9386	CH	R 9518	A3
R 9304	D4	R 9387	CH	R 9519	B3
R 9306	D3	R 9388	CH	R 9521	A3
R 9307	E3	R 9390	CH	R 9522	A3, A4
R 9308	D4	R 9391	CH	R 9523	A3, A4
R 9309	D4	R 9392	CH	R 9524	A3, A4
R 9313	D2	R 9393	CH	R 9526	A4
R 9314	D2	R 9394	CH	R 9527	A4
R 9316	D3	R 9395	CH	R 9528	B4
R 9317	E3	R 9396	CH	R 9529	B4
R 9318	E4	R 9397	CH	R 9531	A4
R 9319	E3	R 9401	CH	R 9532	B4
R 9321	D3	R 9402	F5	R 9533	B4
R 9322	D3	R 9403	F5	R 9534	B4
R 9323	D3	R 9404	G5	R 9536	A5
R 9324	D3	R 9406	F5	R 9537	B4
R 9326	D3	R 9407	CH	R 9538	A5, B5
R 9327	D3	R 9408	G6	R 9539	A5, B5
R 9328	E2, E3	R 9409	G6	R 9541	A5
R 9329	C3	R 9411	G6	R 9542	A5, B5
R 9331	C3	R 9412	G8	R 9543	A5, B5
R 9332	CH	R 9413	CH	R 9544	A5, B5
R 9333	CH	R 9414	CH	R 9546	B5
R 9334	C3	R 9416	CH	R 9547	B5
R 9336	C3	R 9417	CH	R 9548	B4
R 9337	C3	R 9418	E6	R 9549	B4
R 9338	C4	R 9419	F8, F9	R 9551	B4
R 9339	C2	R 9421	F8	R 9552	B6
R 9341	C3	R 9423	F8, F9	R 9553	B6
R 9342	C3	R 9424	F8, F9	R 9554	B6
R 9343	C2	R 9427	G8	R 9556	B6
R 9344	C3	R 9428	CH	R 9557	B5
R 9345	C2	R 9429	F8	R 9558	B5
R 9346	C2	R 9431	G8, G9	R 9559	C4, B4
R 9347	C3	R 9432	G8, G9	R 9561	B4
R 9348	C3	R 9436	G8, G9	R 9562	C5
R 9349	CH	R 9438	F8, F9	R 9563	B5
R 9362	CH	R 9439	F8, F9	R 9564	B5
R 9363	CH	R 9441	F9	R 9566	A5
R 9364	CH	R 9443	CH	R 9567	B4
R 9365	CH	R 9444	CH	R 9568	B6
R 9366	CH	R 9501	C4	R 9569	A6
R 9368	CH	R 9502	C4	R 9571	A3
R 9369	CH	R 9503	A4	R 9601	A9
R 9370	CH	R 9504	F1	R 9602	B9
R 9371	CH	R 9506	F1	R 9603	B8
R 9372	CH	R 9507	F1	R 9604	A9
R 9373	CH	R 9508	F1	R 9606	A9
R 9374	CH	R 9509	B3	R 9607	B9
R 9375	CH	R 9511	A3	R 9608	B9
R 9376	CH	R 9512	B3	R 9609	B9
R 9377	CH	R 9513	B3	R 9611	B8
R 9378	CH	R 9514	B3	R 9612	B9
R 9379	CH	R 9516	A2	R 9619	A7

R 9619	A7	R 9802	B2
R 9621	A7	R 9803	B1
R 9622	A7	R 9804	B1
R 9623	A7	R 9806	C1
R 9624	A7	R 9807	C1
R 9627	A7	R 9808	C1
R 9631	A8	R 9809	C1
R 9632	A8	R 9811	C1
R 9633	A8	R 9812	C2
R 9634	A8	R 9813	C2
R 9636	A8	R 9814	C2
R 9637	A6	R 9816	C1
R 9638	A8	R 9817	C1
R 9639	A8	R 9818	D2
R 9641	A8	R 9819	D2
R 9642	A8	R 9821	D2
R 9643	A7	R 9822	D1
R 9644	A7	R 9823	D1
R 9701	B7	R 9824	D1
R 9702	B8	R 9826	E1
R 9703	B7	R 9827	D1
R 9704	B7	R 9828	E1
R 9706	C7	R 9829	E1
R 9707	C8	R 9831	C2
R 9708	B7	R 9841	D1
R 9709	C7	R 9842	C1
R 9710	D8	R 9847	B1
R 9711	C7		
R 9712	C8		
R 9713	C8		
R 9714	C8		
R 9716	C7		
R 9717	C7		
R 9718	D8		
R 9719	D8		
R 9721	D7		
R 9722	D7		
R 9723	D7		
R 9724	D7		
R 9726	D7		
R 9727	A9		
R 9728	D7		
R 9729	D7		
R 9731	D7, D8		
R 9737	D8		
R 9738	D8		
R 9739	D7		
R 9741	C6		
R 9743	E7		
R 9746	D8		
R 9747	D7		
R 9748	E7		
R 9751	C7		
R 9801	C1		

15.4.4. SEMI CONDUCTORS

V 9001	F7	V 9201	CH	V 9353	CH
V 9002	F7	V 9202	CH	V 9354	CH
V 9003	F6, F7	V 9203	G7	V 9356	CH
V 9004	F7	V 9204	F6	V 9357	CH
V 9006	F6	V 9205	G2	V 9358	CH
V 9007	F6	V 9206	F4	V 9372	CH
V 9008	F5	V 9207	F6	V 9373	CH
V 9009	F8	V 9208	F4	V 9374	CH
V 9011	E8	V 9209	F4, F5	V 9376	CH
V 9012	F8	V 9210	G2	V 9377	CH
V 9013	F8	V 9211	F3	V 9378	CH
V 9014	E9	V 9212	F4, G4	V 9379	CH
V 9016	F9	V 9213	G3	V 9401	F6
V 9017	G7	V 9214	G4	V 9402	F6
V 9018	F9	V 9216	G4	V 9403	F6
V 9101	CH	V 9217	F4	V 9404	F6
V 9102	CH	V 9218	G3	V 9406	F6
V 9103	F4	V 9219	G3	V 9407	F6
V 9104	D6	V 9221	F3	V 9408	F6
V 9105	D6	V 9222	F3, G3	V 9409	F6
V 9106	F7	V 9224	G2	V 9411	G7
V 9107	F7	V 9226	G2	V 9412	F6, F7
V 9108	E5	V 9227	G2	V 9413	F7
V 9109	E6	V 9228	F2	V 9414	F9
V 9110	D6	V 9229	F2	V 9416	F9
V 9111	E5, E6	V 9231	E3, F3	V 9417	G9
V 9112	E6	V 9232	E1	V 9418	G9
V 9113	E5	V 9233	F1	V 9419	G8
V 9114	E5	V 9234	G3	V 9421	G9
V 9116	D5	V 9236	G7	V 9422	F9
V 9117	D5	V 9237	F3	V 9423	F8
V 9118	D5	V 9238	F1	V 9424	G8
V 9119	D5	V 9241	G2	V 9501	C4
V 9121	D6	V 9242	G2	V 9502	B3
V 9122	CH	V 9301	E3	V 9503	B3
V 9123	CH	V 9302	E3	V 9504	B3
V 9124	CH	V 9304	E3	V 9506	B4
V 9126	CH	V 9306	E3	V 9507	B4
V 9127	E4	V 9307	E3	V 9508	A4
V 9128	C4	V 9308	E3	V 9509	B4
V 9129	F7	V 9309	E3	V 9511	A4
V 9131	E8	V 9311	E2	V 9512	B5
V 9132	E8, E9	V 9312	D3	V 9513	B5
V 9133	E9	V 9313	D3	V 9514	B5
V 9134	E9	V 9314	D3	V 9516	B5
V 9135	D6	V 9316	E2	V 9517	A6
V 9136	C9	V 9317	E2	V 9518	B6
V 9137	C9	V 9318	E2	V 9519	B6
V 9138	D9	V 9319	C4	V 9521	A6
V 9139	D8	V 9321	C2	V 9522	B4
V 9141	D5	V 9322	B1	V 9523	B5
V 9142	C4	V 9351	CH	V 9524	B5
V 9143	D8	V 9352	CH	V 9526	B6

V 9527	B6
V 9528	B4
V 9531	B6
V 9532	A6
V 9533	F1
V 9534	B6
V 9536	A6
V 9537	B5
V 9538	B5, C5
V 9539	F1
V 9541	C4
V 9542	B5
V 9601	B9
V 9602	B9
V 9603	A9
V 9604	B9
V 9606	B9
V 9607	B9
V 9608	A8
V 9609	A8
V 9611	A8
V 9613	A7
V 9614	A7
V 9616	A8
V 9617	A8
V 9701	C7
V 9708	D7
V 9709	A9
V 9716	E8
V 9717	D8
V 9718	D7
V 9719	C7
V 9724	D7
V 9801	D1
V 9816	E1
V 9818	D1
V 9819	D1
K 9704	D7
K 9804	D1

15.5 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

15.5.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 9001	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9002	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9003	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9004	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9006	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9007	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9011		2%	100PF	4822 122 31316
C 9008	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9009	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9101	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9102	CAP.CHIP	50V 5%	56PF	5322 122 32661
C 9103	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9104	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 9105	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9107	CAP.CERAMIC	50V 5%	47PF	5322 122 32452
C 9108	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9109	CAP.CERAMIC	2%	56PF	4822 122 32027
C 9111	CAP.CERAMIC	2%	56PF	4822 122 32027
C 9112	CAP.CERAMIC	2%	150PF	4822 122 31413
C 9113	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9114	CAP.FOIL	630V 1%	360PF	4822 121 50551
C 9116	CAP.FOIL	400V 5%	47NF	5322 121 42487
C 9117	CAP.TRIMMER	200V	7/100PF	5322 125 50046
C 9118	CAP.FOIL	100V 5%	4.7UF	4822 121 41975
C 9119	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9121	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9123	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9124	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9126	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9128	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9129	CAP.FOIL	630V 1%	316PF	4822 121 50531
C 9131	CAP.FOIL	400V 5%	47NF	5322 121 42487
C 9132	CAP.FOIL	100V 5%	4.7UF	4822 121 41975
C 9133	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9134	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9136	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9137	CAP.CERAMIC	10%	470PF	4822 122 30034
C 9138	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9141	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9142	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9143	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9144	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9146	CAP.CHIP	0.25PF	4.7PF	4822 122 31822
C 9147	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 9152	39PF			4822 122 31972
C 9199	CAP.CERAMIC	10%	1NF	4822 122 30027
C 9201	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9202	CAP.CHIP	0.25PF	4.7PF	4822 122 31822
C 9203	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9204	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9205	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9206	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9207	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

C 9208	CAP.CERAMIC	2%	56PF	4822 122 32027
C 9209	CAP.CERAMIC	2%	56PF	4822 122 32027
C 9212	CAP.CERAMIC	2%	150PF	4822 122 31413
C 9213	CAP.FOIL	630V 1%	360PF	4822 121 50551
C 9214	CAP.FOIL	400V 5%	47NF	5322 121 42487
C 9216	CAP.TRIMMER	200V	7/100PF	5322 125 50046
C 9217	CAP.FOIL	100V 5%	4.7UF	4822 121 41975
C 9218	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9221	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9222	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9223	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9224	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9227	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9228	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9229	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9231	CAP.CHIP	50V 5%	56PF	5322 122 32661
C 9233	39PF			4822 122 31972
C 9299	CAP.CERAMIC	10%	1NF	4822 122 30027
C 9301	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9302	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9303	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9304	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9306	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9307	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9309	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 9311	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 9312	CAP.CERAMIC	2%	330PF	4822 122 31353
C 9313	CAP.CERAMIC	2%	330PF	4822 122 31353
C 9314	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9316	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 9317	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945
C 9318	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9321	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9322	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9323	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9351	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9352	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9353	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9372	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9373	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9387	2-18P TRIMCAP			5322 125 50051
C 9388	CAP.CHIP	50V 5%	100PF	5322 122 32532
C 9389	CAP.CHIP	50V 5%	100PF	5322 122 32532
C 9399	CAP.CERAMIC	2%	56PF	4822 122 32027
C 9401	CAP.CERAMIC	2%	22PF	4822 122 31063
C 9402	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9403	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9407	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9408	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9409	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9411	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9412	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9413	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9414	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9416	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9422		**63V 10%**	**680NF**	**5322 121 42494**
C 9417	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9418	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9419	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9421	CAP.CHIP	50V 10%	22NF	5322 122 32654
C 9502	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9503	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9504	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9506	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9507	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9508	CAP.SOLID ALU.	10V 20%	33UF	4822 124 20945

C 9509	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9511	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9512	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9513	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9514	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9516	CAP.FOIL	63V 10%	220NF	5322 121 42493
C 9517	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9601	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9602	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9603	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20693
C 9604	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9606	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9607	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9608	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9609	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 9617		-10+50%	33UF	4822 124 20712
C 9611	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 9612	CAP.SOLID ALU.	25V 20%	6.8UF	5322 124 14081
C 9613	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9614	CAP.CERAMIC	10%	1NF	4822 122 30027
C 9616	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20693
C 9701	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9702	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9703	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9704	CAP.SOLID ALU.	25V 20%	6.8UF	5322 124 14081
C 9801	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9802	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069
C 9803	CAP.TANTAL	16V 20%	6.8UF	5322 124 14069

15.5.2 INTEGRATED CIRCUITS

D 9001	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 9002	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 9003	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 9004	INTEGR.CIRCUIT	HEF4025BP	PEL	4822 209 10254
D 9101	INTEGR.CIRCUIT	F100131FC	FSC	5322 209 82939
D 9102	INTEGR.CIRCUIT	F100102FC	FSC	5322 209 85518
D 9201	INTEGR.CIRCUIT	F100131FC	FSC	5322 209 82939
D 9202	INTEGR.CIRCUIT	F100102FC	FSC	5322 209 85518
D 9401	INTEGR.CIRCUIT	HEF4001BP	PEL	4822 209 10246
D 9402	INTEGR.CIRCUIT	MC10104P	MOT	5322 209 11103
D 9403	INTEGR.CIRCUIT	MC10109P	MOT	5322 209 11104
D 9703	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
D 9706	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
D 9707	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
D 9803	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
D 9806	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
N 9161	INTEGR.CIRCUIT	LM358N	N.S	4822 209 70672
N 9301	INTEGR.CIRCUIT	CA3086	RCA	5322 209 86236
N 9302	INTEGR.CIRCUIT	LM308AN	N.S	5322 209 86056
N 9303	INTEGR.CIRCUIT	LM308AN	N.S	5322 209 86056
N 9304	INTEGR.CIRCUIT	UA741CN	SIG	5322 209 83267
N 9601	INTEGR.CIRCUIT	UA324PC	FSC	5322 209 82561
N 9602	INTEGR.CIRCUIT	UA723CN	SIG	5322 209 85889
N 9701	INTEGR.CIRCUIT	LM358N	SIG	4822 209 81472
N 9702	INTEGR.CIRCUIT	UA714HC	FSC	5322 209 86169
N 9708	INTEGR.CIRCUIT	LM317LZ	MOT	5322 209 82943
N 9709	INTEGR.CIRCUIT	LM79L05ACZ	N.S	5322 209 86434
N 9801	INTEGR.CIRCUIT	LM358N	SIG	4822 209 81472
N 9802	INTEGR.CIRCUIT	UA714HC	FSC	5322 209 86169

15.5.3 RESISTORS

R 9001	RES.METAL FILM	MR25	1% 7K5	5322 116 54608
R 9002	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 9003	RES.METAL FILM	MR25	1% 316E	5322 116 54511
R 9004	RES.METAL FILM	MR25	1% 825E	5322 116 54541
R 9006	RES.METAL FILM	MR25	1% 4K22	5322 116 50729
R 9008	RES.METAL FILM	MR25	1% 511E	4822 116 51282
R 9009	RES.METAL FILM	MR25	1% 1K	4822 116 51235
R 9012	RES.CHIP	RC-01	5% 510E	4822 111 90245

R 9013	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 9014	RES.METAL FILM	MR25	1% 2K61	5322 116 50671
R 9016	RES.METAL FILM	MR25	1% 1K96	5322 116 54571
R 9017	RES.METAL FILM	MR25	1% 1K	4822 116 51235
R 9018	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 9019	RES.METAL FILM	MR25	1% 1K1	4822 116 51236
R 9022	RES.METAL FILM	MR25	1% 1K21	5322 116 54557
R 9023	RES.METAL FILM	MR25	1% 464E	5322 116 50536
R 9024	RES.METAL FILM	MR25	1% 1K1	4822 116 51236
R 9026	RES.METAL FILM	MR25	1% 2K37	5322 116 54576
R 9027	RES.METAL FILM	MR25	1% 1K1	4822 116 51236
R 9028	RES.METAL FILM	MR25	1% 3K48	5322 116 55367
R 9029	RES.METAL FILM	MR25	1% 8K25	5322 116 51498
R 9031	RES.METAL FILM	MR25	1% 51E1	5322 116 54442
R 9032	RES.METAL FILM	MR25	1% 2K15	5322 116 53239
R 9033	RES.METAL FILM	MR25	1% 1K	4822 116 51235
R 9034	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 9101	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 9102	RES.CHIP	RC-01	5% 160E	5322 111 90878
R 9103	RES.CHIP	RC-01	5% 1K2	5322 111 90096
R 9104	RES.CHIP	RC-01	5% 8E2	4822 111 90357
R 9107	RES.CHIP	RC-01	5% 33E	4822 111 90357
R 9111	RES.METAL FILM	MR25	1% 8K25	5322 116 51498
R 9113	RES.CHIP	RC-01	5% 330E	5322 111 90106
R 9114	RES.CHIP	RC-01	5% 100E	5322 111 90091
R 9116	RES.CHIP	RC-01	5% 510E	4822 111 90245
R 9117	RES.CHIP	RC-01	5% 510E	4822 111 90245
R 9118	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 9119	RES.METAL FILM	MR25	1% 4K22	5322 116 50729
R 9121	RES.METAL FILM	MR25	1% 12K1	5322 116 50572
R 9124	RES.CHIP	RC-01	5% 47E	4822 111 90217
R 9125	RES.METAL FILM	MR25	1% 12K1	5322 116 50572
R 9126	RES.METAL FILM	MR25	1% 1K47	5322 116 50635
R 9127	RES.METAL FILM	MR25	1% 1K96	5322 116 54571
R 9128	RES.METAL FILM	MR25	1% 1K21	5322 116 54557
R 9129	RES.METAL FILM	MR25	1% 1K96	5322 116 54571
R 9131	RES.METAL FILM	MR25	1% 1K96	5322 116 54571
R 9132	RES.METAL FILM	MR25	1% 196E	5322 116 55273
R 9133	RES.METAL FILM	MR25	1% 196E	5322 116 55273
R 9134	RES.METAL FILM	MR25	1% 13K3	5322 116 55276
R 9135	RES.METAL FILM	MR25	1% 4K22	5322 116 50729
R 9136	RES.METAL FILM	MR25	1% 4K22	5322 116 50729
R 9137	RES.METAL FILM	MR25	1% 8K25	5322 116 51498
R 9141	RES.METAL FILM	MR25	1% 909E	5322 116 55278
R 9142	RES.METAL FILM	MR25	1% 909E	5322 116 55278
R 9143	RES.METAL FILM	MR25	1% 681E	4822 116 51233
R 9144	RES.METAL FILM	MR25	1% 10K	4822 116 51253
R 9145	RES.METAL FILM	MR25	1% 2K61	5322 116 50671
R 9146	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 9147	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 9148	RES.METAL FILM	MR25	1% 10E	5322 116 50452
R 9149	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 9150	RES.METAL FILM	MR25	1% 3K16	5322 116 50579
R 9151	RES.METAL FILM	MR25	1% 422E	5322 116 50459
R 9152	RES.CHIP	RC-01	5% 1K	5322 111 90092
R 9153	RES.METAL FILM	MR25	1% 162E	5322 116 50417
R 9154	RES.METAL FILM	MR25	1% 2K15	5322 116 50767
R 9156	RES.METAL FILM	MR25	1% 51E1	5322 116 54442
R 9157	RES.METAL FILM	MR25	1% 1K21	5322 116 54557
R 9158	RES.METAL FILM	MR25	1% 4K64	5322 116 50484
R 9159	RES.METAL FILM	MR25	1% 1K21	5322 116 54557
R 9161	RES.CHIP	RC-01	5% 1K	5322 111 90092
R 9162	RES.CHIP	RC-01	5% 510E	4822 111 90245
R 9163	RES.CHIP	RC-01	5% 510E	4822 111 90245
R 9164	RES.CHIP	RC-01	5% 82E	4822 111 90124

R 9166	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9167	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9168	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9169	RES.CHIP	RC-01	5%	1K8	5322 111 90101
R 9171	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9172	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 9173	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9174	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9176	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 9177	RES.METAL FILM	MR25	1%	2K37	5322 116 54576
R 9178	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9179	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9181	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9182	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9183	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9184	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9186	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9187	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9188	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 9189	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 9191	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9192	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9193	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9194	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9195	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 9196	RES.CHIP	RC-01	5%	330E	5322 111 90106
R 9197	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9198	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9199	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9200	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9201	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9202	RES.CHIP	RC-01	5%	160E	5322 111 90878
R 9203	RES.CHIP	RC-01	5%	1K2	5322 111 90096
R 9204	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9205	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9207	RES.CHIP	RC-01	5%	33E	4822 111 90357
R 9211	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9214	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 9216	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9217	RES.CHIP	RC-01	5%	270E	4822 111 90154
R 9218	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9219	RES.METAL FILM	MR25	1%	1K33	5322 116 55422
R 9221	RES.METAL FILM	MR25	1%	261E	5322 116 54502
R 9222	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9223	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9224	RES.CHIP	RC-01	5%	330E	5322 111 90106
R 9226	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9227	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9228	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9229	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9231	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9232	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 9233	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 9234	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 9236	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 9237	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 9238	RES.METAL FILM	MR25	1%	196E	5322 116 55273
R 9239	RES.METAL FILM	MR25	1%	196E	5322 116 55273
R 9241	RES.METAL FILM	MR25	1%	13K3	5322 116 55276
R 9242	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9243	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9244	RES.METAL FILM	MR25	1%	12K1	5322 116 50572
R 9246	RES.METAL FILM	MR25	1%	12K1	5322 116 50572
R 9248	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 9249	RES.METAL FILM	MR25	1%	909E	5322 116 55278

R 9251	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 9252	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9253	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9254	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9256	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9257	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 9258	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9259	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9260	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 9261	RES.CHIP	RC-01	5%	160E	5322 111 90878
R 9262	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9263	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9264	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9265	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 9266	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 9267	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 9268	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9269	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9271	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9272	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9273	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9274	RES.METAL FILM	MR25	1%	17K8	5322 116 54637
R 9276	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 9277	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9278	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 9279	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9281	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 9298	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9299	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 9301	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9302	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9303	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9304	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 9306	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 9307	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 9308	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9309	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9313	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9314	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 9316	RES.METAL FILM	MR25	1%	1K78	5322 116 50515
R 9317	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9318	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9319	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 9321	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9322	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9323	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9324	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9326	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 9327	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 9328	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9329	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9331	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9332	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9333	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9334	RES.METAL FILM	MR25	1%	511K	5322 116 55258
R 9336	RES.METAL FILM	MR25	1%	28K7	5322 116 55462
R 9337	RES.METAL FILM	MR25	1%	196K	5322 116 55364
R 9338	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9339	RES.METAL FILM	MR25	1%	511K	5322 116 55258
R 9341	RES.METAL FILM	MR25	1%	28K7	5322 116 55462
R 9342	RES.METAL FILM	MR25	1%	196K	5322 116 55364
R 9343	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9344	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9345	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9346	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455

R 9347	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9348	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9349	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9352	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9353	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9354	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 9355	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 9356	RES.CHIP	RC-01	5%	3K3	4822 111 90157
R 9357	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 9358	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 9361	220E				4822 111 90178
R 9362	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9363	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9364	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9365	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9367	3.3E				4822 111 90388
R 9368	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9369	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9370	RES.CHIP	RC-01	5%	75E	5322 111 90879
R 9371	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 9372	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9373	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 9374	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 9375	RES.CHIP	RC-01	5%	18E	5322 111 90139
R 9376	RES.CHIP	RC-01	5%	3K3	4822 111 90157
R 9377	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 9378	RES.CHIP	RC-01	5%	100E	5322 111 90091
R 9379	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9382	220E				4822 111 90178
R 9383	220E				4822 111 90178
R 9384	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9386	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9388	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9389	3.3E				4822 111 90388
R 9390	RES.CHIP	RC-01	5%	75E	5322 111 90879
R 9391	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9392	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9393	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9394	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9395	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9396	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9397	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9398	1E				4822 111 90184
R 9399	1E				4822 111 90184
R 9401	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9402	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9403	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9404	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9406	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 9407	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9408	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 9409	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9411	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 9412	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9413	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9414	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9416	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9417	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9418	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9419	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9421	RES.METAL FILM	MR25	1%	2.61K	5322 116 50671
R 9423	RES.METAL FILM	MR25	1%	3.16K	5322 116 50579
R 9424	RES.METAL FILM	MR25	1%	2.87K	5322 116 55279
R 9429	RES.METAL FILM	MR25	1%	2.61K	5322 116 50671
R 9431	RES.METAL FILM	MR25	1%	3.16K	5322 116 50579
R 9432	RES.METAL FILM	MR25	1%	6.19K	5322 116 55426
R 9436	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9438	RES.METAL FILM	MR25	1%	100E	5322 116 55549

R 9439	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9441	RES.METAL FILM	MR25	1%	1K62	5322 116 53257
R 9443	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9444	RES.CHIP	RC-01	5%	510E	4822 111 90245
R 9501	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9446		MRS25	1%	3K16	4822 116 53021
R 9502	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9504	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 9506	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 9507	RES.METAL FILM	MR25	1%	90K9	5322 116 54694
R 9508	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 9509	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 9510	750E				4822 116 51234
R 9511	RES.METAL FILM	MR25	1%	619E	4822 116 51232
R 9512	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9513	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 9514	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9516	RES.METAL FILM	MR25	1%	2K37	5322 116 54576
R 9517	RES.METAL FILM	MR25	1%	21E5	5322 116 50677
R 9518	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9519	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9521	RES.METAL FILM	MR25	1%	3K48	4822 116 53315
R 9522	RES.METAL FILM	MR25	1%	21E5	5322 116 53426
R 9523	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 9524	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9526	RES.METAL FILM	MR25	1%	12K1	4822 116 52957
R 9527	RES.METAL FILM	MR25	1%	13K3	5322 116 53489
R 9528	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9529	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9531	POTM.SLIDE	0.3W	25%	100E	5322 105 20029
R 9532	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 9533	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 9534	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 9536	POTM.SLIDE	0.3W	25%	1K	5322 105 20032
R 9537	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 9538	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 9539	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 9541	POTM.SLIDE	0.3W	25%	2K2	5322 105 20033
R 9542	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 9543	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9544	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9546	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9547	RES.METAL FILM	MR25	1%	5K62	4822 116 51281
R 9548	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 9549	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 9551	RES.METAL FILM	MR25	1%	261E	5322 116 54502
R 9552	RES.METAL FILM	MR25	1%	19K6	5322 116 54641
R 9553	RES.METAL FILM	MR25	1%	19K6	5322 116 54641
R 9554	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 9556	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 9557	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 9558	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 9559	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 9561	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 9562	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9563	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9564	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9566	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9567	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 9568	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9569	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9571	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 9601	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 9602	RES.METAL FILM	MR25	1%	1E78	5322 116 51755
R 9603	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 9604	RES.METAL FILM	MR25	1%	2K87	5322 116 55279

R 9606	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9607	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 9608	RES.METAL FILM	MR25	1%	1E78	5322 116 51755
R 9609	RES.METAL FILM	MR25	1%	12K1	5322 116 50572
R 9611	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 9612	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 9619	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 9621	RES.METAL FILM	MR25	1%	61K9	4822 116 51265
R 9622	RES.METAL FILM	MR25	1%	5K62	4822 116 51281
R 9623	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9624	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 9627	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9631	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 9632	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 9633	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 9634	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 9636	RES.METAL FILM	MR25	1%	1E78	5322 116 51755
R 9637	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9638	RES.METAL FILM	MR25	1%	6K19	5322 116 53263
R 9639	RES.METAL FILM	MR25	1%	1K1	5322 116 53473
R 9641	RES.METAL FILM	MR25	1%	6K19	5322 116 53263
R 9642	RES.METAL FILM	MR25	1%	1.96K	5322 116 54571
R 9643	RES.METAL FILM	MR25	1%	100K	4822 116 52973
R 9644	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9701	RES.METAL FILM	MR25	1%	147K	5322 116 54712
R 9702	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9703	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9704	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9706	RES.METAL FILM	MR25	1%	13K3	5322 116 55276
R 9707	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9708	RES.METAL FILM	MR25	1%	422K	5322 116 55247
R 9709	RES.METAL FILM	MR25	1%	196K	5322 116 53661
R 9710	RES.METAL FILM		0.1%	25E	5322 116 53164
R 9711	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9712	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9713	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9714	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9716	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9717	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 9718	RES.METAL FILM		0.1%	25E	5322 116 53164
R 9719	RES.METAL FILM		0.1%	75E	5322 116 53168
R 9721	RES.METAL FILM		0.1%	125E	5322 116 53176
R 9722	RES.METAL FILM		0.1%	250E	5322 116 53166
R 9723	RES.METAL FILM		0.1%	750E	5322 116 53173
R 9724	RES.METAL FILM		0.1%	1K25	5322 116 53177
R 9726	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9727	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9728	RES.METAL FILM		0.1%	21K5	5322 116 53167
R 9729	RES.METAL FILM		0.1%	217E2	5322 116 53178
R 9731	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9737	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9738	RES.METAL FILM	MR25	1%	215E	5322 116 55274
R 9739	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 9741	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9743	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9746	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 9747	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9748	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 9751	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 9801	RES.METAL FILM	MR25	1%	147K	5322 116 54712
R 9802	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9803	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9804	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 9806	RES.METAL FILM	MR25	1%	13K3	5322 116 55276
R 9807	RES.METAL FILM	MR25	1%	215K	5322 116 54728

R 9808	RES.METAL FILM	MR25	1%	422K	5322 116 55247
R 9809	RES.METAL FILM	MR25	1%	215K	5322 116 54728
R 9811	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9812	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9813	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9814	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9816	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 9817	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 9818	RES.METAL FILM		0.1%	50E	5322 116 53165
R 9819	RES.METAL FILM		0.1%	75E	5322 116 53168
R 9821	RES.METAL FILM		0.1%	125E	5322 116 53176
R 9822	RES.METAL FILM		0.1%	250E	5322 116 53166
R 9823	RES.METAL FILM		0.1%	750E	5322 116 53173
R 9824	RES.METAL FILM		0.1%	1K25	5322 116 53177
R 9826	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9827	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9828	RES.METAL FILM		0.1%	21K5	5322 116 53167
R 9829	RES.METAL FILM		0.1%	217E2	5322 116 53178
R 9831	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9841	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9842	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 9847	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455

15.5.4 SEMI CONDUCTORS

V 9001	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9002	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9003	DIODE	BAW62	PEL	4822 130 30613
V 9004	DIODE	BAW62	PEL	4822 130 30613
V 9006	DIODE	BAW62	PEL	4822 130 30613
V 9007	DIODE	BAW62	PEL	4822 130 30613
V 9008	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9009	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9011	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9012	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9013	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9014	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9016	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9017	DIODE	BAW62	PEL	4822 130 30613
V 9018	DIODE	BAW62	PEL	4822 130 30613
V 9101	TRANSISTOR	BFT92R	PEL	5322 130 44713
V 9102	TRANSISTOR	ON4039	PEL	5322 130 42537
V 9103	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9104	DIODE	BAW62	PEL	4822 130 30613
V 9105	DIODE	BAW62	PEL	4822 130 30613
V 9106	DIODE	BAW62	PEL	4822 130 30613
V 9107	DIODE	BAW62	PEL	4822 130 30613
V 9108	TRANSISTOR	BF324	PEL	4822 130 41448
V 9109	DIODE	BAW62	PEL	4822 130 30613
V 9110	DIODE,REFERENCE	BZX79-C6V2	PEL	4822 130 34167
V 9111	DIODE	BAW62	PEL	4822 130 30613
V 9112	DIODE	BAW62	PEL	4822 130 30613
V 9113	TRANSISTOR	BF199	PEL	4822 130 44154
V 9114	TRANSISTOR	BF199	PEL	4822 130 44154
V 9116	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9117	DIODE	BAW62	PEL	4822 130 30613
V 9118	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9119	DIODE	BAW62	PEL	4822 130 30613
V 9121	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9122	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9123	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9124	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9126	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9127	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9128	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9129	TRANSISTOR	BC558B	PEL	4822 130 44197

V 9131	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9132	DIODE	BAW62	PEL	4822 130 30613
V 9133	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9134	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9135	DIODE,REFERENCE	BZX79-C6V2	PEL	4822 130 34167
V 9136	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9137	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9138	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9139	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9141	TRANSISTOR,FET	BFQ13	PEL	5322 130 44404
V 9142	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9143	DIODE	BAW62	PEL	4822 130 30613
V 9201	TRANSISTOR	BFT92R	PEL	5322 130 44713
V 9202	TRANSISTOR	ON4039	PEL	5322 130 42537
V 9203	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9204	DIODE	BAW62	PEL	4822 130 30613
V 9205	DIODE,REFERENCE	BZX79-C6V2	PEL	4822 130 34167
V 9206	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9207	DIODE	BAW62	PEL	4822 130 30613
V 9208	DIODE	BAW62	PEL	4822 130 30613
V 9209	DIODE	BAW62	PEL	4822 130 30613
V 9210	DIODE,REFERENCE	BZX79-C6V2	PEL	4822 130 34167
V 9211	TRANSISTOR	BF324	PEL	4822 130 41448
V 9212	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9213	DIODE	BAW62	PEL	4822 130 30613
V 9214	DIODE	BAW62	PEL	4822 130 30613
V 9216	DIODE	BAW62	PEL	4822 130 30613
V 9217	TRANSISTOR	BF199	PEL	4822 130 44154
V 9218	TRANSISTOR	BF199	PEL	4822 130 44154
V 9219	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9221	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9222	DIODE	BAW62	PEL	4822 130 30613
V 9224	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9226	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9227	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9228	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9229	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9231	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9232	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9233	TRANSISTOR	BF324	PEL	4822 130 41448
V 9234	DIODE,REFERENCE	BZX79-C6V2	PEL	4822 130 34167
V 9236	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9237	TRANSISTOR,FET	BFQ13	PEL	5322 130 44404
V 9238	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9241	DIODE	BAW62	PEL	4822 130 30613
V 9242	DIODE	BAW62	PEL	4822 130 30613
V 9301	DIODE	BAW62	PEL	4822 130 30613
V 9302	DIODE	BAW62	PEL	4822 130 30613
V 9304	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9306	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9307	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9308	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9309	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9311	DIODE,REFERENCE	BZX79-C3V6	PEL	5322 130 34834
V 9312	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9313	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9314	DIODE	BAW62	PEL	4822 130 30613
V 9316	DIODE	BAW62	PEL	4822 130 30613
V 9317	DIODE	BAW62	PEL	4822 130 30613
V 9318	TRANSISTOR	BF324	PEL	4822 130 41448
V 9319	DIODE	BAW62	PEL	4822 130 30613
V 9321	DIODE	BAW62	PEL	4822 130 30613
V 9322	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233
V 9351	TRANSISTOR	BFR92R	PEL	5322 130 44606
V 9352	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9353	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9354	TRANSISTOR	BFR92R	PEL	5322 130 44606
V 9356	TRANSISTOR	BFR92R	PEL	5322 130 44606

V 9357	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9358	TRANSISTOR	BFT92	PEL	5322 130 44711
V 9372	TRANSISTOR	BFR92R	PEL	5322 130 44606
V 9373	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9374	TRANSISTOR	BFR92R	PEL	5322 130 44606
V 9376	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9377	TRANSISTOR	BFR92R	PEL	5322 130 44606
V 9378	TRANSISTOR,FET	BFR92	PEL	5322 130 42145
V 9379	TRANSISTOR	BFT92	PEL	5322 130 44711
V 9401	DIODE	BAW62	PEL	4822 130 30613
V 9402	DIODE	BAW62	PEL	4822 130 30613
V 9403	DIODE	BAW62	PEL	4822 130 30613
V 9404	DIODE	BAW62	PEL	4822 130 30613
V 9406	DIODE	BAW62	PEL	4822 130 30613
V 9407	DIODE	BAW62	PEL	4822 130 30613
V 9408	DIODE	BAW62	PEL	4822 130 30613
V 9409	DIODE	BAW62	PEL	4822 130 30613
V 9411	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9412	DIODE	BAW62	PEL	4822 130 30613
V 9413	DIODE	BAW62	PEL	4822 130 30613
V 9424		BAW62	PEL	4822 130 30613
V 9414	TRANSISTOR	BFY90	PEL	4822 130 40493
V 9416	TRANSISTOR	BFY90	PEL	4822 130 40493
V 9417	TRANSISTOR	BFY90	PEL	4822 130 40493
V 9418	TRANSISTOR	BFY90	PEL	4822 130 40493
V 9419	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233
V 9421	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9422	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9423	DIODE	BZX79-C5V1	PEL	4822 130 34233
V 9501	TRANSISTOR	BF324	PEL	4822 130 41448
V 9502	DIODE	BAW62	PEL	4822 130 30613
V 9503	DIODE	BAW62	PEL	4822 130 30613
V 9504	DIODE	BAW62	PEL	4822 130 30613
V 9506	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9507	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9508	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9509	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9511	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9512	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9513	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9514	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9516	TRANSISTOR	BSX20	PEL	4822 130 41705
V 9517	DIODE	BAW62	PEL	4822 130 30613
V 9518	DIODE	BAW62	PEL	4822 130 30613
V 9519	DIODE	BAW62	PEL	4822 130 30613
V 9521	DIODE	BAW62	PEL	4822 130 30613
V 9522	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9523	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9524	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9526	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9527	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9528	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9531	DIODE	BAW62	PEL	4822 130 30613
V 9532	DIODE	BAW62	PEL	4822 130 30613
V 9533	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9534	DIODE	BAW62	PEL	4822 130 30613
V 9536	DIODE	BAW62	PEL	4822 130 30613
V 9537	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9538	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9539	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9541	DIODE	BAW62	PEL	4822 130 30613
V 9542	DIODE	BAW62	PEL	4822 130 30613
V 9601	TRANSISTOR	BD435	PEL	4822 130 40982
V 9602	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9603	DIODE,REFERENCE	BZX79-C5V6	PEL	4822 130 34173

V 9604	TRANSISTOR	BD436	PEL	4822 130 40995
V 9606	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9607	DIODE,REFERENCE	BZX79-C5V6	PEL	4822 130 34173
V 9608	DIODE	BZX79-C12	PEL	4822 130 34197
V 9609	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9611	TRANSISTOR	BD435	PEL	4822 130 40982
V 9613	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9614	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9616	DIODE	BAW62	PEL	4822 130 30613
V 9617	DIODE	BAW62	PEL	4822 130 30613
V 9701	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9708	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9709	DIODE,REFERENCE	BZX79-C18	PEL	4822 130 31024
V 9716	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9717	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9718	DIODE	BAW62	PEL	4822 130 30613
V 9719	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9724	DIODE	BAW62	PEL	4822 130 30613
V 9801	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9816	TRANSISTOR	BC558B	PEL	4822 130 44197
V 9818	DIODE	BAW62	PEL	4822 130 30613
V 9819	TRANSISTOR	BC548C	PEL	4822 130 44196

15.5.5 MISCELLANEOUS

L 9351	COIL	2.2UH	TDK	4822 157 51757
L 9352	COIL	2.2UH	TDK	4822 157 51757

FINAL X/Z AMPLIFIER 16

CONTENTS

16. CIRCUIT DESCRIPTION OF FINAL X/Z AMPLIFIER.
16.1. Circuit description of intensity and focusing. 16-1
16.2. Circuit description of X-amplifier and CRT text part. 16-2
16.3. Parts list 16-11

FIGURES

16.1. Final X/Z amplifier, p.c.b. lay-out of chip unit 16-5
16.2. Final X/Z amplifier, p.c.b. lay-out. 16-5
16.3. Final X/Z amplifier, circuit diagram of intensity and focusing part. 16-8
16.4. Final X/Z amplifier, circuit diagram of X-amplifier and CRT text part. 16-9

16. CIRCUIT DESCRIPTION OF FINAL X/Z AMPLIFIER.

16.1. CIRCUIT DESCRIPTION OF INTENSITY AND FOCUSING (See fig.16.2.)

Z Amplifier

The Z amplifier consists of a text intensity pre-amplifier circuit in which the TEXT intensity signal from the TEXT Unit is controlled by the READ OUT potentiometer and passed to a Z pre-amplifier stage. This is the input stage for the Z signal from the time-base Z-logic and the Y CHOP blanking signal, and also an input for EXT Z modulation. The TEXT and Z signals are then routed to a switch selector stage, where the selected signal is then split between a focus amplifier and the final Z amplifier. The latter uses a modulator circuit to isolate the output (for d.c. and l.f. signals) from the very high c.r.t. potentials. This circuit is capacitively coupled to the c.r.t., the d.c. and low-frequency components of the signal being modulated for coupling purposes and then d.c. restored by a demodulator on the CRT Socket.

Text input circuit and Z Pre-amplifier

The TEXT signal from the TEXT Unit (CTU) is applied to pin 9 of D5801 at TTL level (0.8 V = L, 2.4 V = H). A high on pin 9 is applied to the base of one transistor of a long-tailed pair. This transistor switches on and the output transistor switches off. The high on its collector means that no current is drawn from R5858 (blanking).Conversely, a low on pin 9 switches off the input transistor and switches on the output transistor. The low on the collector (pin 6) means that current is drawn from R5858 (4 mA max.), which is the unblanking condition. This current is influenced by the position of the READ OUT (TEXT + CURSOR INTENSITY) control, which is applied on pin 14 via an emitter-follower to a transistor in the common-emitters of the long-tailed pair.
The TEXT output current via R5858 is applied to the emitter of common-base transistor V5851 and fed to the selector switch diode V5857.
The 0 and 4 mA Z signals and the CHOP blanking signals are also fed to a common-base transistor, V5852. In addition, the EXT Z-MOD input is routed via a long-tailed pair V5861/V5862 to the emitter of V5852. External blanking is achieved by a high input, unblanking by a low input. Transistor V5862 therefore draws less current at blanking. The Z signal on the collector of V5852 is fed to the selector switch diode V5856. The biasing of the transistors V5851 and V5852 is stabilised via operational amplifier N5803.

Selection between Text and Z signals

Z selection is determined by a signal from the CTU fed to the base of transistor V5858 of long-tailed pair V5858/V5859. The Z signal is low for selecting the time-base Z signal and high for the TEXT Z-signal.

When selecting time-base Z, the low input switches off V5858 and high on its collector switches on V5853. This short-circuits the TEXT Z-signal path and blocks diode V5857. With V5858 off, V5859 is on and the low on its collector switches off V5854. This allows the Z signal to flow via diode V5859 to the emitter of V5618.

When selecting TEXT-Z, the high input switches on V5858 and the low on its collector switches off V5853. The TEXT input is no longer short-circuited but flows via diode V5857 to the emitter of V5618. With V5858 on, V5859 is off and its high collector switches on V5854, which short-circuits the time-base Z signal and blocks V5856.

The current output from the common-base stage V5618 gives a voltage level across R5633, R5634, R5636, which is applied to active transistor V5619 of a long-tailed pair current-source, V5619/V5621. This supplies two similar voltage feedback amplifiers. Current is drawn either from the focus amplifier or from the final Z-amplifier.

Focus amplifier

Current is drawn by the cascode amplifier configuration V5629/V5631, used to speed-up the signal waveform. The additional emitter-follower V5623 is included for feedback. Bandwidth compensation is achieved by trimmers C5616 and C5618 in the feedback circuit. Positive slope speed-up is given by V5622, which draws current from the emitter of the current source V5624. The diodes V5626, V5627, V5628 reduce recovery time when V5624 is overloaded. The class B final amplifier consists of complementary pair V5632/V5633. The FOCUS OUT to the CRT Socket is taken from the mid-point of emitter resistors R5654, R5656. The test-point X27 is capacitively coupled to avoid loading the amplifier output. The gain of the focus amplifier is 0.74, which is smalller than that of the Z amplifier.

Final Z-amplifier

Current is drawn from the input transistor V5621 by the speed-up cascode circuit V5636/V5637. The extra emitter-follower V5638 is included for constant feedback. Capacitors C5627 and C5628 provide for bandwidth adjustment. Positive slope speed-up is achieved by the a.c. coupled transistor V5647, which draws current from the emitter of V5642. This gives fast switch-off of the cascode circuit. The diodes V5643, V5644, V5646 reduce the recovery time when current-source V5642 is overloaded. The class B final amplifier stage consists of complementary pair V5639/V5641. The Z OUT (the AC path) is taken from the mid-point of emitter resistors R5679, R5681.
The test-point X28 is capacitively coupled to avoid loading the amplifier output. Common-base transistor V5648 provides a constant load. Its collector is connected via a high-frequency filter C5637, R5687 to provide the l.f. and d.c. path. The pnp transistor V5651 and its associated components form the oscillator. The modulator consists of a oscillator with a frequency of 100 kHz for modulating the d.c. and l.f. signals. These signals are suplied via the emitter of V5652 of the cascode circuit V5652, V5657, which is capable of responding to fast high-voltage signals. The modulated output is fed via V5657 to the class B amplifier stage V5654 and V5656. The common emitter point feeds the 100 kHz modulated d.c. and l.f. signal to the CRT Socket. Preset R5696 allows for an output variation (-75 V...-125 V) for CRT-tolerance compensation.

16.2. CIRCUIT DESCRIPTION OF X AMPLIFIER AND CRT TEXT PART (See fig.16.3)

The selected inputs from the X pre-amplifier are fed as current waveforms via 50-ohm adaptation resistors to the balanced common-base circuit V5802 and V5803. The collector outputs are coupled to the transistors V5711, V5707 and V5719, V5714 in cascode configuration for signal speed-up.
Diodes V5709 and V5712 reduce the voltage levels during the negative signal slopes to prevent damage to the cascode transistors.

The voltages present at the outputs of the X-amplifier are taken off via voltage dividers R5701/R5730 and R5724/R5730 and are common mode compared with a voltage at the astigmatism electrodes of the CRT. This comparison is achieved via operational amplifier N5803/ 5, 6, 7.
During the time that text is written (signal OEN active and low via electronic switch D5802) is LF and DC drift compensated via the circuitry around the operational amplifiers N5801 and N5802.
Comparison of input and output signals is achieved via respectively R5803/R5807/R5806/R5804 and the feedback loops R5702/R5703/R5704 and R5711/R5712/R5716 and comparator N5801. N5802 functions as a 180 degree phase shifter that supplies both halves of the X-amplifier.

Transistor V5769 acts as a voltage to current converter to control the time-base.
When the output of multiplexer D5602(3) is low, the low on the comparator output blocks V5769 and V5771 conducts and draws current.
The ZERO ADJ. control R5779 and operational amplifier N5602 achieve symmetrical output to the time-base.
The gain preset R5784 is a balance control.

The output voltage of multiplexer D5603 is fed to test-point X46 on the positive input of comparator N5601.
When the output on the multiplexer is high, the high on the comparator output causes V5774 of long-tailed pair V5773/V5774 to conduct and draw current from the final Y amplifier via X5626.
The current source is V5776 in its emitter circuit, the U_{REF} being derived from the voltage source V5767 as before. With V5774 conducting, V5773 is blocked and no current is drawn from the final Y amplifier via the other output socket X5622. When the D5603 multiplexer output is low, V5774 blocks and V5773 conducts, current being drawn from the Final Y amplifier via X5622.

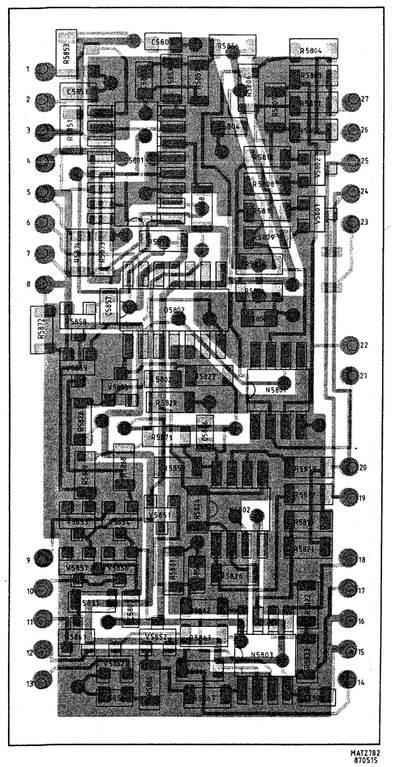


Fig. 16.1 Final X/Z amplifier, p.c.b. lay-out of chip unit

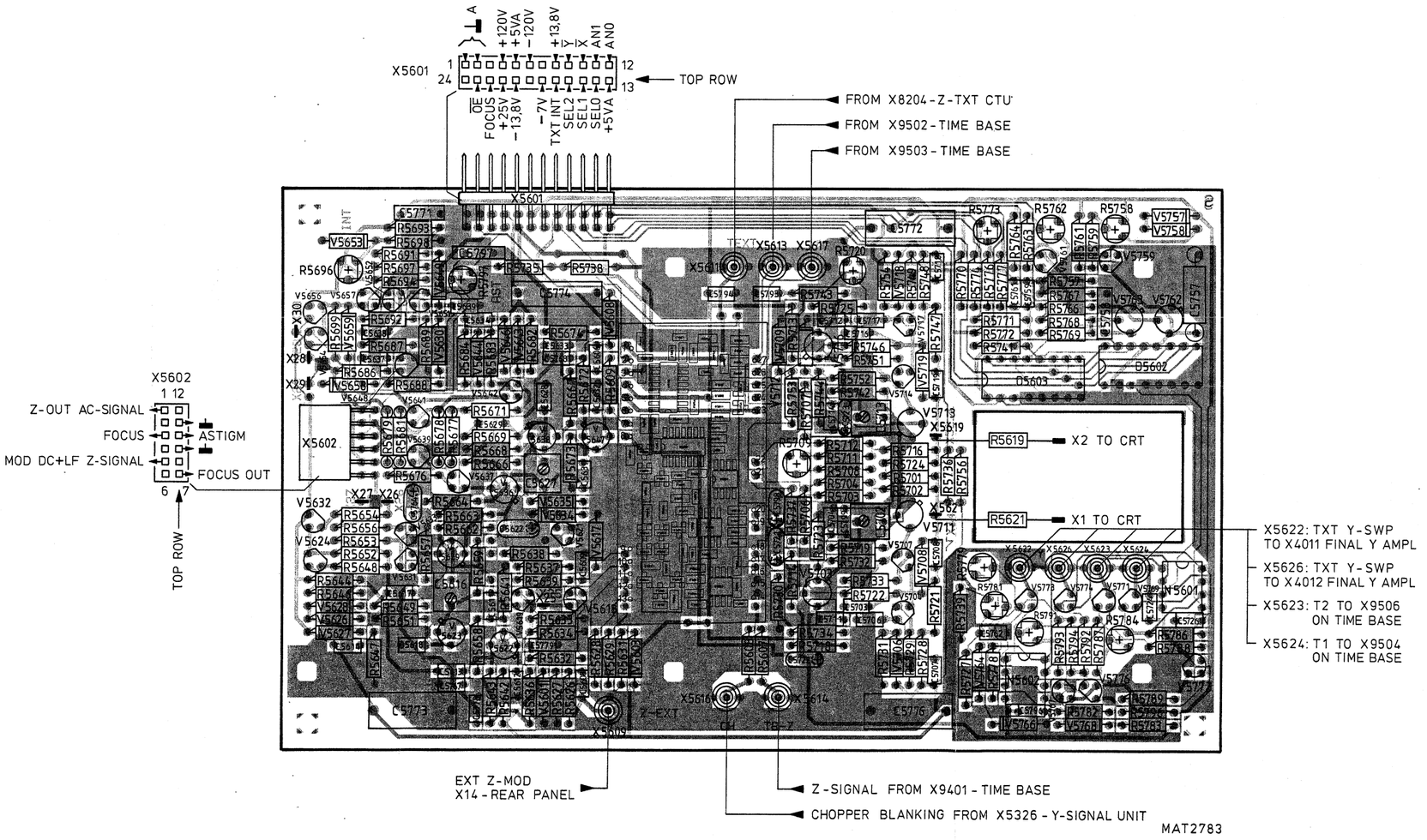


Fig.16.2. Final X/Z amplifier, p.c.b. lay-out.

Transistors V5704 and V5717 are current sources supplied by the +120 V and -120 V lines respectively, controlled via zener diodes V5706 and V5718 to ensure a fast positive slope.
Voltage feedback is via emitter-followers V5703 and V5716.
The output signal levels from the cascode amplifiers are +60 V and -60 V. These are level-adapted, the +60 V to +12 V by 47 V zener diode V5708, and the -60 V also to +12 V by 68 V zener diode V5719.

Text X-Y and cursor circuit

This circuit converts the digital TEXT X-Y and CURSOR information into analog signals for the time base and final Y amplifier.
Signal X- (coming from the CTU) is low to start the X sweep by switching V5762 off. Timing capacitor C5757 charges linearly, drawing current from the X sweep current source V5759. The X amplitude is adjustable by preset R5758 (AMPL X). The X sweep sawtooth takes care of the horizontal tracing of the text and is faster than the Y sweep. The X sweep is fed to multiplexers D5602 and D5603. These multiplexers are selection switches, controlled by three input signals SEL0, SEL1 and SEL2 coming from the CTU unit.

Similary, the Y-(coming from the CTU) signal is low to start the Y sweep by switchin V5763 off. Timing capacitor C5758 charges linearly via current source V5761 with its preset adjustment R5762 (AMPL Y). The Y sweep sawtooth (asymmetrial) takes care of the vertical tracing of the text. This is fed to multiplexer D5603.The other two inputs are d.c. levels AN0 and AN1 (0 to 10 V d.c.), which determine the position of the cursors on the screen. Both these are routed via voltage dividers to give 0 to 4.5 V to inputs on both multiplexers. In addition, the delta CURSOR input (AN1) has a preset, R5773, to compensate for resistor tolerances and to equalize the position of the cursors on the screen .

The selected multiplexer outputs provide a symmetrical current output for the time-base and an asymmetrical current output for the final Y amplifier.

The output voltage of mutliplexer D5602 is fed to test-point X45 on the positive input of comparator N5601. When the output on the multiplexer is high, it gives a high on the comparator output which causes V5769 of the long-tailed pair V5769/V5771 to conduct and draw current.
The current source is V5772 in its emitter circuit, the U_{REF} being derived from the voltage source V5767. This source is temperature stabilised by diode V5764.

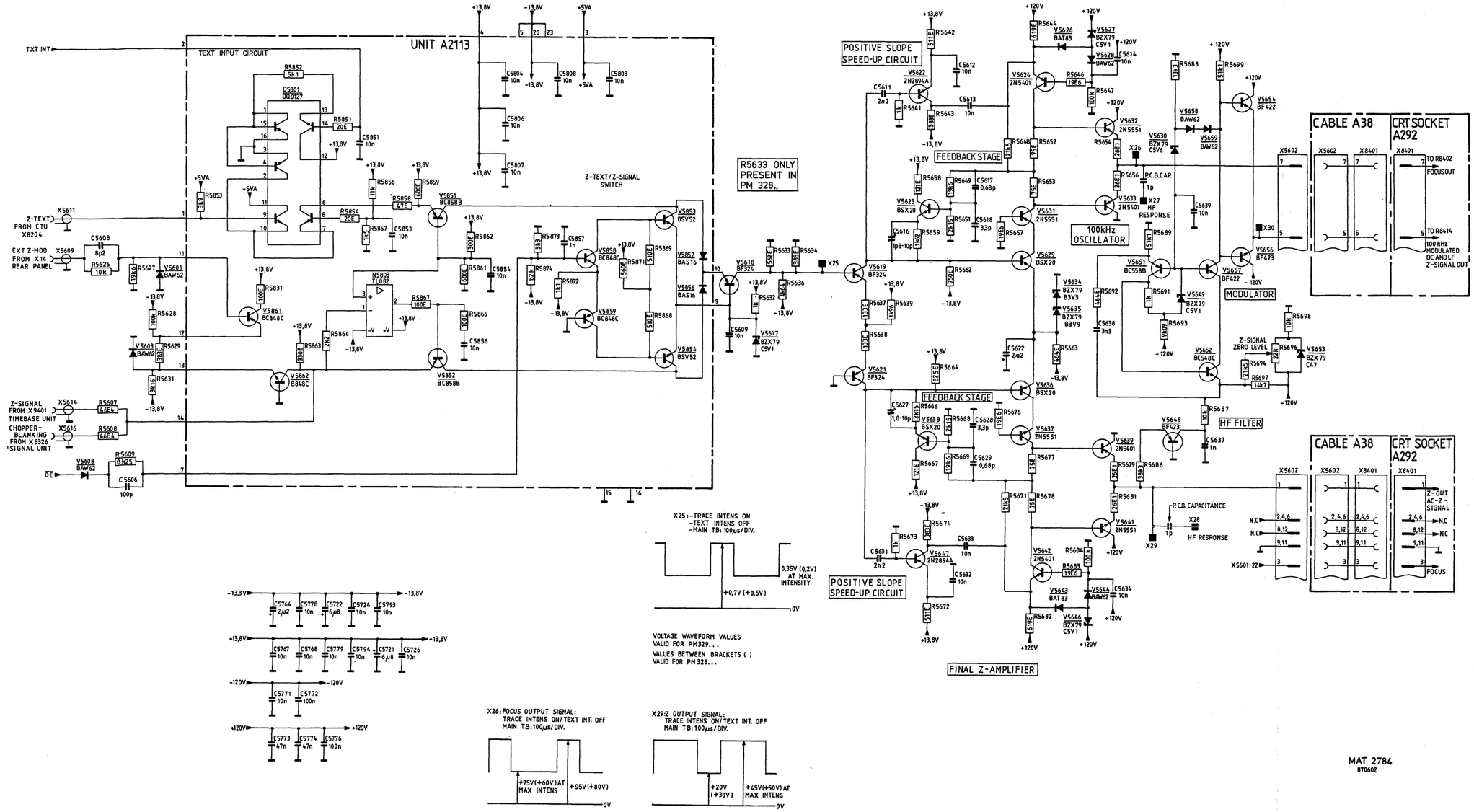


Fig.16.3. Final X/Z amplifier, circuit diagram of intensity and focusing part.

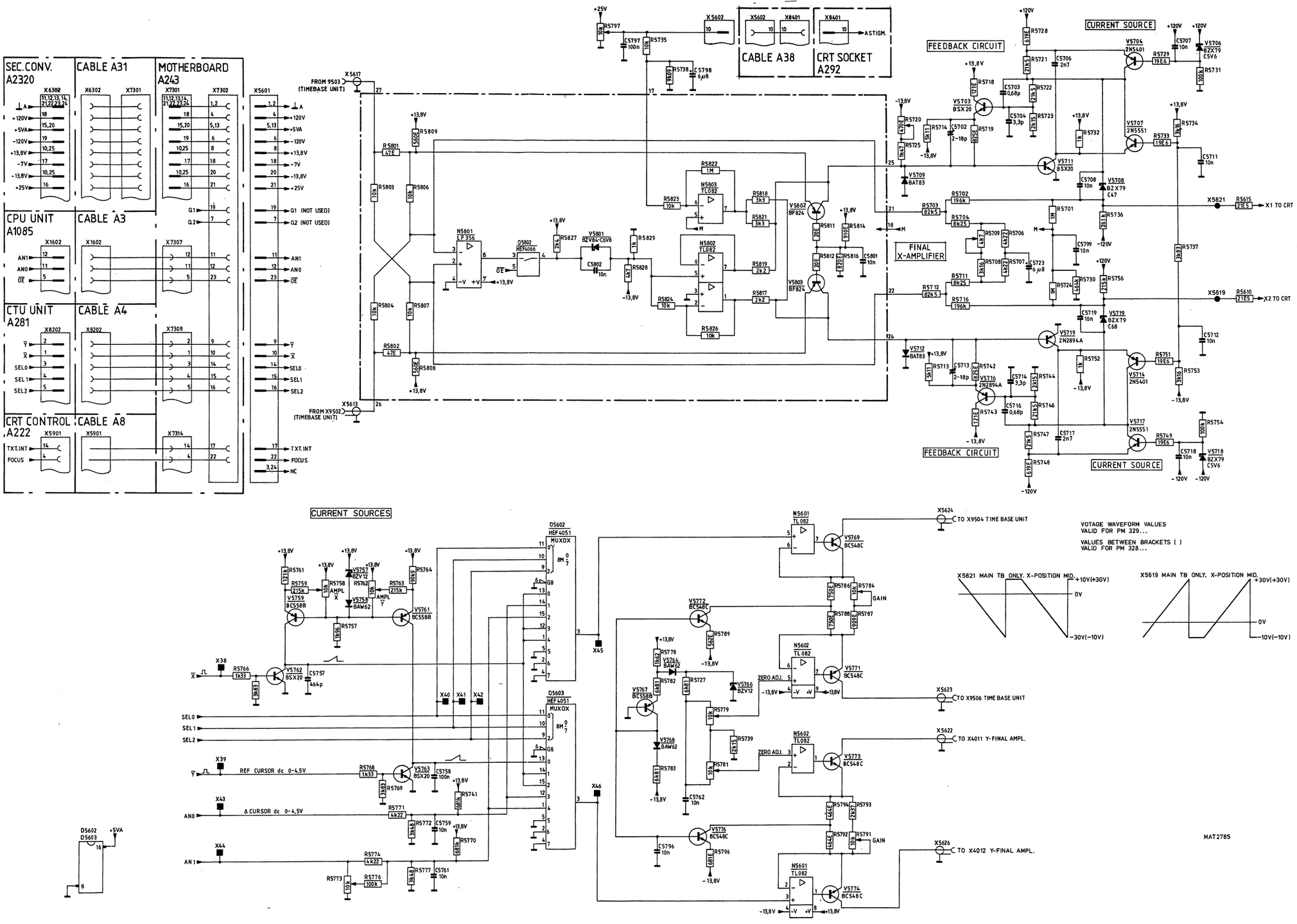


Fig.16.4. Final X/Z amplifier, circuit diagram of X-amplifier and CRT text part.

16.3 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

16.3.1 CAPACITORS

POSNR	DESCRIPTION	ORDERING CODE
C 5606	2% 33PF	5322 122 32072
C 5608	0.25PF 8.2PF	4822 122 31052
C 5609	-20+50% 10NF	4822 122 31414
C 5611	10% 2.2NF	4822 122 30114
C 5612	-20+50% 10NF	4822 122 31414
C 5613	-20+50% 10NF	4822 122 31414
C 5614	-20+50% 10NF	4822 122 31414
C 5616	300V 1.8/10PF	5322 125 50049
C 5617	0.25PF 0.68PF	4822 122 31215
C 5618	0.25PF 3.3PF	4822 122 31821
C 5622	16V 20% 2.2UF	4822 124 10204
C 5627	300V 1.8/10PF	5322 125 50049
C 5628	0.25PF 3.3PF	4822 122 31821
C 5629	0.25PF 0.68PF	4822 122 31215
C 5631	10% 2.2NF	4822 122 30114
C 5632	-20+50% 10NF	4822 122 31414
C 5633	-20+50% 10NF	4822 122 31414
C 5634	-20+50% 10NF	4822 122 31414
C 5637	10% 1NF	4822 122 30027
C 5638	10% 3.3NF	4822 122 30099
C 5639	-20+50% 10NF	4822 122 31414
C 5702	300V 2/18PF	5322 125 50051
C 5703	0.25PF 0.68PF	4822 122 31215
C 5704	0.25PF 3.3PF	4822 122 31821
C 5706	10% 2.7NF	5322 122 32338
C 5707	-20+50% 10NF	4822 122 31414
C 5708	-20+50% 10NF	4822 122 31414
C 5711	-20+50% 10NF	4822 122 31414
C 5712	-20+50% 10NF	4822 122 31414
C 5713	300V 2/18PF	5322 125 50051
C 5714	0.25PF 3.3PF	4822 122 31821
C 5716	0.25PF 0.68PF	4822 122 31215
C 5717	10% 2.7NF	5322 122 32338
C 5718	-20+50% 10NF	4822 122 31414
C 5719	-20+50% 10NF	4822 122 31414
C 5721	16V 20% 6.8UF	5322 124 14069
C 5722	16V 20% 6.8UF	5322 124 14069
C 5723	16V 20% 6.8UF	5322 124 14069
C 5724	-20+50% 10NF	4822 122 31414
C 5726	-20+50% 10NF	4822 122 31414
C 5757	630V 1% 464PF	5322 121 50982
C 5758	100V 10% 100NF	4822 121 41717
C 5759	-20+50% 10NF	4822 122 31414
C 5761	-20+50% 10NF	4822 122 31414
C 5762	-20+50% 10NF	4822 122 31414
C 5764	16V 20% 2.2UF	4822 124 10204
C 5767	-20+50% 10NF	4822 122 31414
C 5768	-20+50% 10NF	4822 122 31414
C 5771	400V 10% 10NF	5322 121 41977
C 5772	400V 10% 100NF	5322 121 44198

C 5773	400V 10%	47NF		5322 121 42486
C 5774	400V 10%	47NF		5322 121 42486
C 5776	400V 10%	100NF		5322 121 44198
C 5778	-20+50%	10NF		4822 122 31414
C 5779	-20+50%	10NF		4822 122 31414
C 5793	-20+50%	10NF		4822 122 31414
C 5794	-20+50%	10NF		4822 122 31414
C 5796	-20+50%	10NF		4822 122 31414
C 5797	63V 10%	100NF		5322 121 42492
C 5798	16V 20%	6.8UF		5322 124 14069
C 5799	-20+50%	10NF		4822 122 31414
C 5801	10NF10%X7R		50V	5322 122 34098
C 5802	10NF10%X7R		50V	5322 122 34098
C 5803	10NF10%X7R		50V	5322 122 34098
C 5804	10NF10%X7R		50V	5322 122 34098
C 5806	10NF10%X7R		50V	5322 122 34098
C 5807	10NF10%X7R		50V	5322 122 34098
C 5808	10NF10%X7R		50V	5322 122 34098
C 5851	10NF10%X7R		50V	5322 122 34098
C 5853	10NF10%X7R		50V	5322 122 34098
C 5854	10NF10%X7R		50V	5322 122 34098
C 5856	10NF10%X7R		50V	5322 122 34098
C 5857	50V 5%	1NF		5322 122 32531

16.3.2 INTEGRATED CIRCUITS

D 5602	HEF4051BP	PEL	4822 209 10262
D 5603	HEF4051BP	PEL	4822 209 10262
D 5802	HEF4066BT	PEL	5322 209 14542
N 5601	TL082CP	T.I	5322 209 86064
N 5602	TL082CP	T.I	5322 209 86064
N 5801	LF356M	NSC	5322 209 72003
N 5802	TL082CD	T.I	5322 209 72002
N 5803	TL082CD	T.I	5322 209 72002

6

16.3.3 RESISTORS

R 5607	MRS25	1%	46E4	5322 116 53248
R 5608	MRS25	1%	46E4	5322 116 53248
R 5609	MRS25	1%	38K3	4822 116 53526
R 5610	MRS25	1%	21E5	5322 116 53426
R 5615	MRS25	1%	21E5	5322 116 53426
R 5626	MRS25	1%	10K	4822 116 53022
R 5627	MRS25	1%	19K6	5322 116 53258
R 5628	MRS25	1%	100K	4822 116 52973
R 5629	MRS25	1%	383E	5322 116 53332
R 5631	MRS25	1%	3K16	4822 116 53021
R 5632	MRS25	1%	1K	4822 116 53108
R 5633	MRS25	1%	562E	5322 116 53214
R 5634	MRS25	1%	383E	5322 116 53332
R 5636	MRS25	1%	4K64	5322 116 53212
R 5637	MRS25	1%	133E	5322 116 53424
R 5638	MRS25	1%	133E	5322 116 53424
R 5639	MRS25	1%	1K96	5322 116 53237
R 5641	MRS25	1%	1K	4822 116 53108
R 5642	MRS25	1%	511E	5322 116 53135
R 5643	MRS25	1%	383E	5322 116 53332
R 5644	MRS25	1%	619E	5322 116 53337
R 5646	MRS25	1%	19E6	5322 116 53721
R 5647	MRS25	1%	100K	4822 116 52973
R 5648	MRS25	1%	21K5	5322 116 53241
R 5649	MRS25	1%	19K6	5322 116 53258
R 5651	MRS25	1%	2K15	5322 116 53239
R 5652	MRS25	1%	75E	5322 116 53339

R 5653	MRS25	1% 75E	5322 116 53339
R 5654	MRS25	1% 26E1	5322 116 53723
R 5656	MRS25	1% 26E1	5322 116 53723
R 5657	MRS25	1% 19E6	5322 116 53721
R 5658	MRS25	1% 121E	4822 116 52955
R 5659	MRS25	1% 1K62	5322 116 53257
R 5662	MRS25	1% 750E	5322 116 53265
R 5663	MRS25	1% 464E	5322 116 53232
R 5664	MRS25	1% 825E	5322 116 53541
R 5666	MRS25	1% 2K15	5322 116 53239
R 5667	MRS25	1% 121E	4822 116 52955
R 5668	MRS25	1% 2K15	5322 116 53239
R 5669	MRS25	1% 19K6	5322 116 53258
R 5671	MRS25	1% 21K5	5322 116 53241
R 5672	MRS25	1% 511E	5322 116 53135
R 5673	MRS25	1% 1K	4822 116 53108
R 5674	MRS25	1% 383E	5322 116 53332
R 5676	MRS25	1% 19E6	5322 116 53721
R 5677	MRS25	1% 75E	5322 116 53339
R 5678	MRS25	1% 75E	5322 116 53339
R 5679	MRS25	1% 26E1	5322 116 53723
R 5681	MRS25	1% 26E1	5322 116 53723
R 5682	MRS25	1% 619E	5322 116 53337
R 5683	MRS25	1% 19E6	5322 116 53721
R 5684	MRS25	1% 100K	4822 116 52973
R 5686	MRS25	1% 38K3	4822 116 53526
R 5687	MRS25	1% 10K	4822 116 53022
R 5688	MRS25	1% 13K3	5322 116 53489
R 5689	MRS25	1% 51K1	4822 116 53121
R 5691	MRS25	1% 1K	4822 116 53108
R 5692	MRS25	1% 464E	5322 116 53232
R 5693	MRS25	1% 9K09	5322 116 53253
R 5694	MRS25	1% 21K5	5322 116 53241
R 5696	0.3W 25%	10K	4822 105 10455
R 5697	MRS25	1% 14K7	4822 116 53531
R 5698	MRS25	1% 10K	4822 116 53022
R 5699	MRS25	1% 51K1	4822 116 53121
R 5701	MRS25	1% 1M	4822 116 52843
R 5702	MRS25	1% 196K	5322 116 53661
R 5703	MRS25	1% 82K5	5322 116 53581
R 5704	MRS25	1% 8K25	5322 116 53267
R 5706	MRS25	1% 4K22	5322 116 53246
R 5707	MRS25	1% 4K22	5322 116 53246
R 5708	MRS25	1% 3K16	4822 116 53021
R 5709	0.3W 25%	4K7	5322 105 20034
R 5711	MRS25	1% 8K25	5322 116 53267
R 5712	MRS25	1% 82K5	5322 116 53581
R 5713	MRS25	1% 5K11	5322 116 53494
R 5714	MRS25	1% 5K11	5322 116 53494
R 5716	MRS25	1% 196K	5322 116 53661
R 5718	MRS25	1% 121E	4822 116 52955
R 5719	MRS25	1% 825E	5322 116 53541
R 5720	0.3W 25%	470E	5322 105 20028
R 5721	MRS25	1% 21K5	5322 116 53241
R 5722	MRS25	1% 21K5	5322 116 53241
R 5723	MRS25	1% 2K15	5322 116 53239
R 5724	MRS25	1% 1M	4822 116 52843
R 5725	MRS25	1% 1K47	5322 116 53185
R 5727	MRS25	1% 6K81	5322 116 53252
R 5728	MRS25	1% 619E	5322 116 53337
R 5729	MRS25	1% 19E6	5322 116 53721
R 5730	MRS25	1% 464K	5322 116 53247
R 5731	MRS25	1% 100K	4822 116 52973
R 5732	MRS25	1% 1K	4822 116 53108
R 5733	MRS25	1% 19E6	5322 116 53721

1

R 5734	MRS25 1% 3K16	4822 116 53021
R 5735	MRS25 1% 10K	4822 116 53022
R 5736	MRS25 1% 261K	5322 116 53609
R 5737	MRS25 1% 3K83	4822 116 53079
R 5738	MRS25 1% 9K09	5322 116 53253
R 5739	MRS25 1% 2K15	5322 116 53239
R 5741	MRS25 1% 681K	5322 116 53593
R 5742	MRS25 1% 825E	5322 116 53541
R 5743	MRS25 1% 121E	4822 116 52955
R 5744	MRS25 1% 2K15	5322 116 53239
R 5746	MRS25 1% 21K5	5322 116 53241
R 5747	MRS25 1% 21K5	5322 116 53241
R 5748	MRS25 1% 619E	5322 116 53337
R 5749	MRS25 1% 19E6	5322 116 53721
R 5751	MRS25 1% 19E6	5322 116 53721
R 5752	MRS25 1% 1K	4822 116 53108
R 5753	MRS25 1% 3K16	4822 116 53021
R 5754	MRS25 1% 100K	4822 116 52973
R 5756	MRS25 1% 215K	5322 116 53425
R 5757	MRS25 1% 1K96	5322 116 53237
R 5758	0.3W 25% 10K	4822 105 10455
R 5759	MRS25 1% 215K	5322 116 53425
R 5761	MRS25 1% 75K	5322 116 53266
R 5762	0.3W 25% 10K	4822 105 10455
R 5763	MRS25 1% 215K	5322 116 53425
R 5764	MRS25 1% 56K2	5322 116 53222
R 5766	MRS25 1% 1K33	5322 116 53512
R 5767	MRS25 1% 3K83	4822 116 53079
R 5768	MRS25 1% 1K33	5322 116 53512
R 5769	MRS25 1% 3K83	4822 116 53079
R 5770	MRS25 1% 681K	5322 116 53593
R 5771	MRS25 1% 4K22	5322 116 53246
R 5772	MRS25 1% 3K48	4822 116 53315
R 5773	0.3W 25% 10K	4822 105 10455
R 5774	MRS25 1% 4K22	5322 116 53246
R 5776	MRS25 1% 100K	4822 116 52973
R 5777	MRS25 1% 3K48	4822 116 53315
R 5778	MRS25 1% 1K62	5322 116 53257
R 5779	0.3W 25% 10K	4822 105 10455
R 5781	0.3W 25% 10K	4822 105 10455
R 5782	MRS25 1% 6K81	5322 116 53252
R 5783	MRS25 1% 6K81	5322 116 53252
R 5784	0.3W 25% 10K	4822 105 10455
R 5786	MRS25 1% 750E	5322 116 53265
R 5787	MRS25 1% 909E	4822 116 53533
R 5788	MRS25 1% 750E	5322 116 53265
R 5789	MRS25 1% 562E	5322 116 53214
R 5791	0.3W 25% 10K	4822 105 10455
R 5792	MRS25 1% 464E	5322 116 53232
R 5793	MRS25 1% 2K37	5322 116 53536
R 5794	MRS25 1% 464E	5322 116 53232
R 5796	MRS25 1% 681E	4822 116 53123
R 5797	0.3W 25% 10K	4822 105 10455
R 5801	MCR18 1% 47E	4822 111 90217
R 5802	MCR18 1% 47E	4822 111 90217
R 5803	MCR18 1% 10K	4822 111 90249
R 5804	MCR18 1% 10K	4822 111 90249
R 5806	MCR18 1% 10K	4822 111 90249
R 5807	MCR18 1% 10K	4822 111 90249
R 5808	MCR18 1% 560E	5322 111 90113
R 5809	MCR18 1% 560E	5322 111 90113
R 5811	MCR18 1% 20E	4822 111 90352
R 5812	MCR18 1% 20E	4822 111 90352
R 5814	MCR18 1% 910E	5322 111 91472
R 5816	MCR18 1% 820E	4822 111 90171

R 5817	MCR18	1%	2K2	4822 111 90248
R 5818	MCR18	1%	3K3	4822 111 90157
R 5819	MCR18	1%	2K2	4822 111 90248
R 5821	MCR18	1%	3K3	4822 111 90157
R 5822	MCR18	1%	1M	5322 111 90094
R 5823	MCR18	1%	10K	4822 111 90249
R 5824	MCR18	1%	10K	4822 111 90249
R 5826	MCR18	1%	10K	4822 111 90249
R 5827	MCR18	1%	2K4	5322 111 91468
R 5828	MCR18	1%	4K7	5322 111 90111
R 5829	MCR18	1%	1K	5322 111 90092
R 5831	MCR18	1%	100E	5322 111 91134
R 5851	MCR18	1%	20E	4822 111 90352
R 5852	MCR18	1%	5K1	5322 111 91471
R 5853	MCR18	1%	3K9	5322 111 91135
R 5854	MCR18	1%	20E	4822 111 90352
R 5856	MCR18	1%	11K	5322 111 91467
R 5857	MCR18	1%	1K5	4822 111 90151
R 5858	MCR18	1%	47E	4822 111 90217
R 5859	MCR18	1%	680E	4822 111 90162
R 5861	MCR18	1%	680E	4822 111 90162
R 5862	MCR18	1%	300E	5322 111 91469
R 5863	MCR18	1%	330E	5322 111 90106
R 5864	MCR18	1%	2K2	4822 111 90248
R 5866	MCR18	1%	100E	5322 111 91134
R 5867	MCR18	1%	100E	5322 111 91134
R 5868	MCR18	1%	510E	4822 111 90245
R 5869	MCR18	1%	510E	4822 111 90245
R 5871	MCR18	1%	560E	5322 111 90113
R 5872	MCR18	1%	1K1	5322 111 91466
R 5873	MCR18	1%	1K2	5322 111 90096
R 5874	MCR18	1%	82K	4822 111 90575

16.3.4 SEMI CONDUCTORS

V 5601	BAW62	PEL	4822 130 30613
V 5603	BAW62	PEL	4822 130 30613
V 5608	BAW62	PEL	4822 130 30613
V 5617	BZX79-C5V1	PEL	4822 130 34233
V 5618	BF324	PEL	4822 130 41448
V 5619	BF324	PEL	4822 130 41448
V 5621	BF324	PEL	4822 130 41448
V 5622	2N2894A	PEL	5322 130 44127
V 5623	BSX20	PEL	4822 130 41705
V 5624	2N 5401		5322 130 42534
V 5624	2N5401	PEL	5322 130 42534
V 5626	BAT83	PEL	5322 130 32103
V 5627	BZX79-C5V1	PEL	4822 130 34233
V 5628	BAW62	PEL	4822 130 30613
V 5629	BSX20	PEL	4822 130 41705
V 5630	BZX79-C5V6	PEL	4822 130 34173
V 5631	2N5551	PEL	5322 130 44491
V 5632	2N5551	PEL	5322 130 44491
V 5633	2N 5401		5322 130 42534
V 5633	2N5401	PEL	5322 130 42534
V 5634	BZX79-B3V3	PEL	5322 130 31504
V 5635	BZX79-B3V9	PEL	4822 130 31981
V 5636	BSX20	PEL	4822 130 41705
V 5637	2N5551	PEL	5322 130 44491
V 5638	BSX20	PEL	4822 130 41705
V 5639	2N5401	PEL	5322 130 42534
V 5641	2N5551	PEL	5322 130 44491

V 5642	2N 5401		5322 130 42534
V 5642	2N5401	PEL	5322 130 42534
V 5643	BAT83	PEL	5322 130 32103
V 5644	BAW62	PEL	4822 130 30613
V 5646	BZX79-C5V1	PEL	4822 130 34233
V 5647	2N2894A	PEL	5322 130 44127
V 5648	BF423	PEL	4822 130 41646
V 5649	BZX79-C5V1	PEL	4822 130 34233
V 5651	BC558B	PEL	4822 130 44197
V 5652	BC548C	PEL	4822 130 44196
V 5653	BZX79-C47	PEL	4822 130 34383
V 5654	BF422	PEL	4822 130 41782
V 5656	BF423	PEL	4822 130 41646
V 5657	BF422	PEL	4822 130 41782
V 5658	BAW62	PEL	4822 130 30613
V 5659	BAW62	PEL	4822 130 30613
V 5703	BSX20	PEL	4822 130 41705
V 5704	2N5401	PEL	5322 130 42534
V 5706	BZX79-C5V6	PEL	4822 130 34173
V 5707	2N5551	PEL	5322 130 44491
V 5708	BZX79-C47	PEL	4822 130 34383
V 5709	BAT83	PEL	5322 130 32103
V 5711	BSX20	PEL	4822 130 41705
V 5712	BAT83	PEL	5322 130 32103
V 5713	2N2894A	PEL	5322 130 44127
V 5714	2N5401	PEL	5322 130 42534
V 5716	2N2894A	PEL	5322 130 44127
V 5717	2N5551	PEL	5322 130 44491
V 5718	BZX79-C5V6	PEL	4822 130 34173
V 5719	BZX79-C68	PEL	4822 130 30864
V 5757	BZV12	PEL	5322 130 34269
V 5758	BAW62	PEL	4822 130 30613
V 5759	BC558B	PEL	4822 130 44197
V 5761	BC558B	PEL	4822 130 44197
V 5762	BSX20	PEL	4822 130 41705

CRT SOCKET 17

CONTENTS

17. CIRCUIT DESCRIPTION OF CRT SOCKET 17-1
17.1 Parts list 17-6

FIGURES

17.1. CRT-socket, p.c.b. lay-out. 17-2
17.2. CRT-socket, circuit diagram. 17-4

17. CIRCUIT DESCRIPTION OF CRT SOCKET (See fig.17.2)

The CRT socket stage consists of the various circuit networks that are connected with the base of the c.r.t.
The circuit networks are the demodulators for the Z signal and focus signal.

The modulated d.c. and l.f. signal from the modulator circuit on the X-Z unit is applied on X8401-5 and forms two paths via R8414 and R8416. The Z demodulator path is via R8414 and the high-voltage blocking capacitor C8404. The Z signal is demodulated by a positive peak-peak detector consisting of diodes V8404, V8406 and C8406, R8407, R8404. The output consists of the d.c. and l.f. components of the Z signal superimposed on the -3.4 kV. The AC (Z) path is also added via R8401 and the high-voltage blocking capacitor C8401, to feed the c.r.t. control grid G1.

The zener diode V8401, Darlington pair V8402, V8403 and the resistance chain R8408, R8409, R8411, R8412 forms a 180 V zener circuit which provides the voltage difference between the K and G1 electrodes of the c.r.t. This bias voltage ensures blanking when there is no input signal.
Resistor R8403 maintains the filament at the same potential as the cathode.

The negative demodulation for focus control is via R8416 and the high-voltage blocking capacitor C8407. The Z signal is demodulated by a negative peak-peak detector V8407, V8408, C8408 with voltage divider R8417, R8418, and R8406. The d.c. and l.f. focus signal is recombined with the AC focus signal to feed the c.r.t. focus electrode G3. The AC focus signal is routed via h.f. blocking capacitor C8402.
This AC signal represents the dynamic focus signal which gives automatic adjustment of the level in the MTB INTENS mode. However, the static level is determined by the potential divider (R8413, R8419, R8421) from the -3.2 kV supply and the position of the manual FOCUS control potentiometer (R13).
The input on X8401-3 from the FOCUS control (static focus) is applied via R8426 to the base of V8411 to vary the current through the resistor chain in the collector of V8409.
With the FOCUS control at minimum (0 V) the transistors conduct and the collector voltage level on V8409 is -50 V.
With the FOCUS control at maximum (+13.8 V) the transistors block and V8409 collector stands at -600 V. However, the 200 V focus range from the negative focus demodulator (V8408-C) does not change. Resistors R8419 and R8421 are selected to compensate for c.r.t. tolerances (setting the -2 kV level).

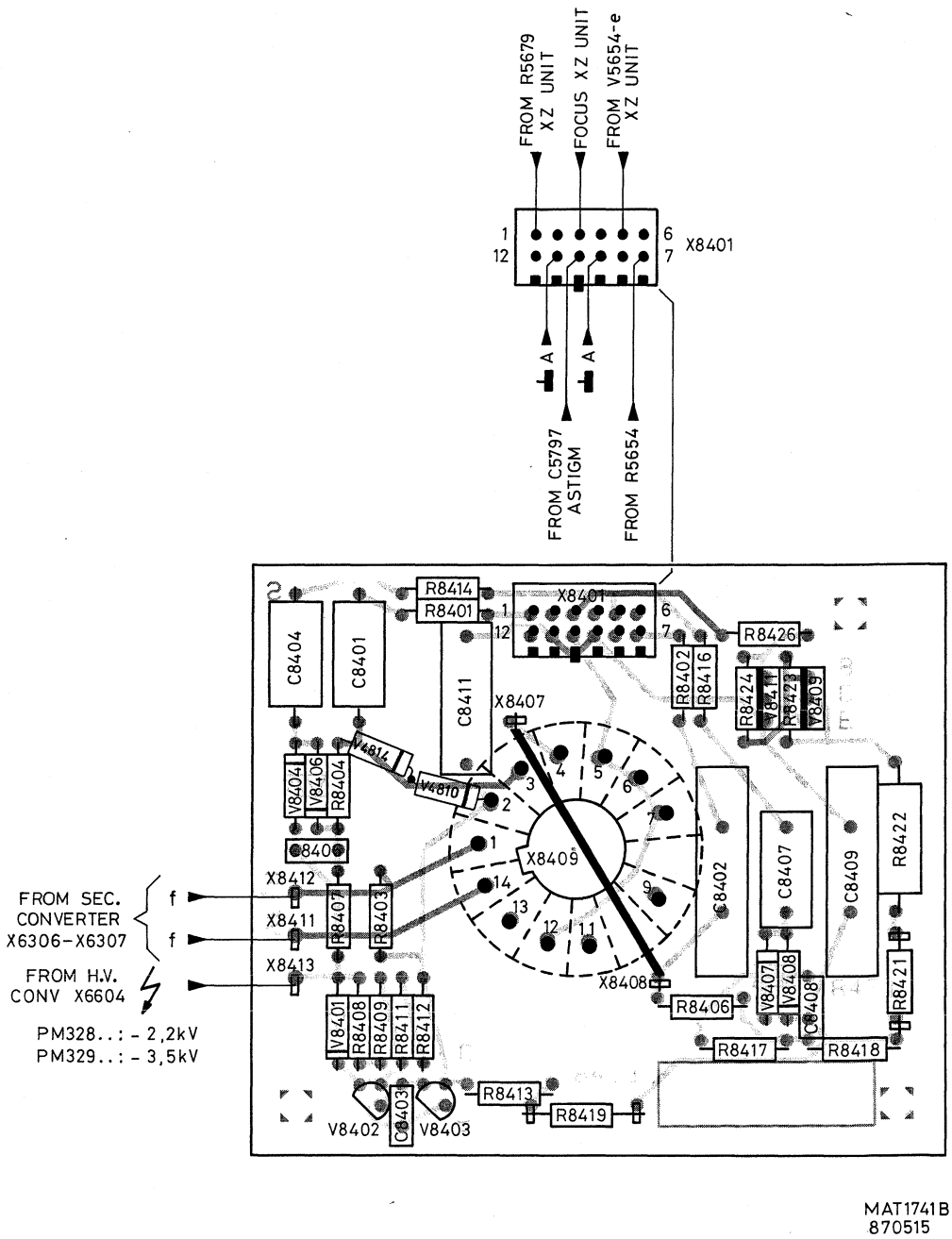


Fig.17.1. CRT-socket, p.c.b. lay-out.

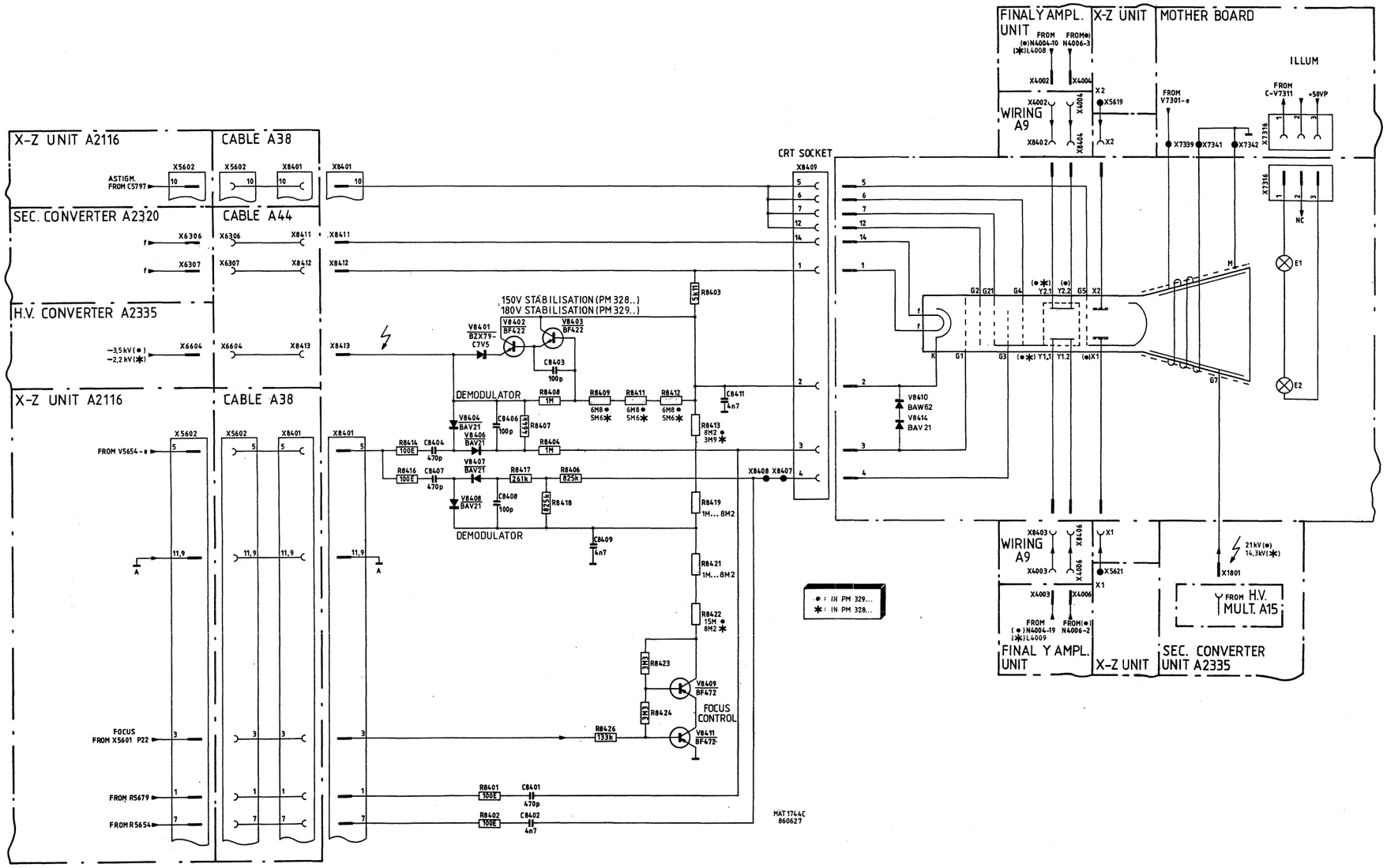


Fig.17.2. CRT-socket, circuit diagram.

18.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

18.1.1 CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE		CODE
C 6201	CAP.PAPER	250V 10% 220NF	5322 121 44142		50086
C 6202	CAP.PAPER	ME265 20% 2.2NF	5322 121 20232		50087
C 6203	CAP.PAPER	ME265 20% 2.2NF	5322 121 20232		32655
C 6204	CAP.CERAMIC	-20+50% 10NF	4822 122 31414		50086
C 6206	CAP.CERAMIC	-20+50% 10NF	4822 122 31414		32655
C 6207	CAP.CERAMIC	-20+50% 10NF	4822 122 31414		50086
C 6208	CAP.PAPER	ME265 20% 2.2NF	5322 121 20232		32655
C 6209	CAP.PAPER	ME265 20% 2.2NF	5322 121 20232	22	50087
C 6223	CAP.FOIL	100V 10% 10UF	5322 121 41727	22	50087

18.1.2 RESISTORS

R 6203	RES.METAL FILM MR25	1% 110K	5322 116 54701		55549
R 6219	RES.METAL FILM MR25	1% 51E1	5322 116 54442		55549
					54595
					55535

18.1.3 SEMI CONDUCTORS

V 6201	DIODE	BYW54	PEL	5322 130 34919	51398
V 6202	DIODE	BYW54	PEL	5322 130 34919	55207
V 6203	DIODE	BYW54	PEL	5322 130 34919	55535
V 6204	DIODE	BYW54	PEL	5322 130 34919	72209
					72209
V 6228	DIODE	BYV32-150	PEL	5322 130 31637	72209
V 6229	DIODE	BYV32-150	PEL	5322 130 31637	72212
V 6231	BZV85-C30 PEL			5322 130 32702	55549
V 6232	BYV19-45 PEL			5322 130 32703	55549
					54716
					51398
					72212
					72212
					42218
					72201

18.1.4 MISCELLANEOUS

L 6201	COIL	100UH	TDK	5322 157 52363	72201
F 6101	2.5A TZ			4822 253 30026	54708
					30861
					41782
					41782
					30842
					30842
					30842
					30842
					42535
					42535
					40502

PRIMARY CONVERTER UNIT 18

CONTENTS

18. CIRCUIT DESCRIPTION OF PRIMARY CONVERTER UNIT. 18-1
18.1 Parts list 18-6

FIGURES

18.1. Interconnections of primary converter. 18-1
18.2. Waveforms in primary converter. 18-3
18.3. Primary converter unit, p.c.b. lay-out. 18-4
18.4. Primary converter unit, circuit diagram. 18-5

18. CIRCUIT DESCRIPTION OF PRIMARY CONVERTER UNIT (See fig.18.4.)

WARNING : The complete circuit is at mains potential up to transformer T6201.

The block diagram, Fig.18.1, shows the connections of the primary converter within the power supply. In order to produce the 48V supply for the secondary converter, two identical standard 24 V units are used with outputs series-connected; primary converter I and primary converter II.

Each primary converter basically consists of:

- a mains filter and bridge rectifier circuit
- a forward converter (moulded part)
- a secondary rectifier circuit with over voltage protection.

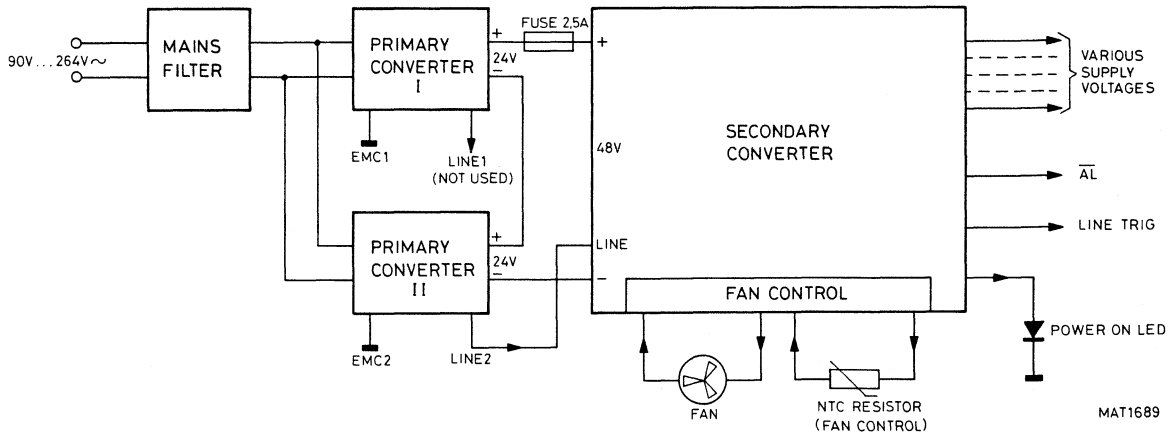


Fig.18.1. Interconnections of primary converters.

18

The mains filter and bridge recifier

The mains input (90 V...264 V ac) from the mains socket with filter and routed via double-pole switch S65, fuse F1 to connections X6204 and X6202. Resistor R6201 has a surge current limiting function.Capacitor C6201 across the input acts as an interference limiter.
At this point, the X6201 and X6203 connectors of the primary converters are paralleled with the X6202 and X6204 connectors.
A capacitive network C6202 ... C6209 across the input serves to reduce interference, the centre-point being coupled to earth to provide electromagnetic compatibility (EMC1).
In the primary converter II the other half of the capacitive network (C6206, R6203) is used as a trigger pick-off point for LINE triggering.
The full-wave diode bridge V6201 ... V6204 rectifies the input voltage, which is fed to forward converter.

The forward converter

Since the forward converter is a moulded part of the unit, the components are not accessible. Therefore, only a brief description of its operation is given.

The d.c. input from the bridge rectifier is smoothed in C6211, L6203, C6212 and C6213. To limit power surges at start-up, the base current (Ib) for V6222 of the converter Darlington circuit V6222/V6223 is initially blocked via the series diodes V6206, V6207, V6208, and Ib is only supplied via the limiting resistor R6213.

However, after start-up, V6206 ... V6208 conduct and constant base current is supplied via R6211, regulated by V6211. The constant base current is stabilized by the network R6211, C6217, V6218, V6219, V6221 and V6234.Zener diode V6212 provides a constant 7.5 V level on the base of series regulator V6211. This network, together with diode V6209 provides a voltage stabiliser to give 6.9 V on the emitter of V6211 independent of the mains voltage. In turn, this gives a constant base current via R6209, R6211 to V6222 as shown in fig.18.2.A. As a result, V6223 conducts and its collector current Ic increases linearly as shown in fig.18.2.B. This increase continues until the control voltage from the feedback winding (9 turns) (equal to the secondary voltage), rectified and stabilised by V6217, V6233 and V6216, is sufficient to fire thyristor V6213, which blocks the series regulator V6211.
The output feedback voltage accross V6214 determines the converter frequency (20 kHz approx.); -0.5 V ... +0.6 V gives an Ic of 0 A ... 2.2 A.
The NTC resistor R6214 gives temperature compensation for the thyristor V6213.
At high mains voltages, power limiting is achieved during the forward stroke by resistor R6207.
The maximum Ic of V6223 is also regulated by the current measuring resistors R6216 and R6217.
Capacitor C6217 charges during the forward stroke and provides a negative-voltage source for fast switch-off of V6222-V6223.
Chokes L6207, L6208 in series with the primary windings of T6201saturate (low-reactance) during normal operation, but have considerable reactance at start-up, thus limiting peak currents.
Snubbing circuits C6219, V6224, V6226; C6221, V6227 and the coil (8t),protect the Darlington transistors V6222/V6223 against fast positive peaks at the moment that they are switched-off.
During the forward stroke energy is build-up in the converter transformer T6201.
During the fly-back stroke this energy is discharged via the secondary winding over the secondary rectifier circuit.

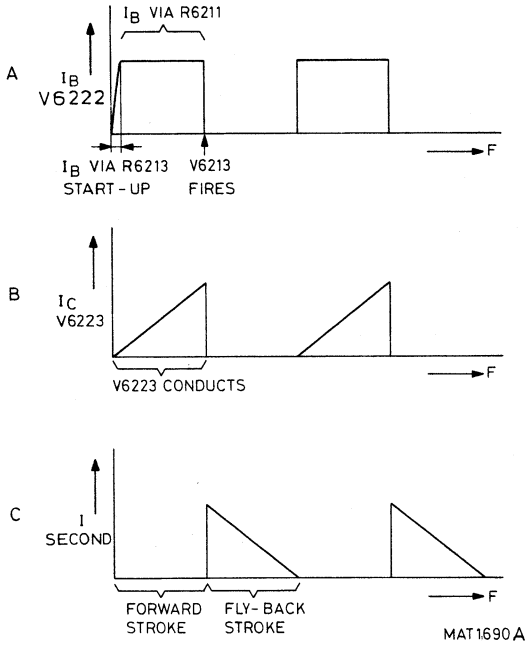
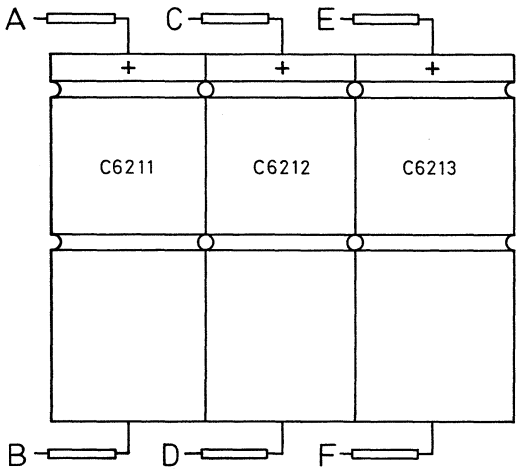


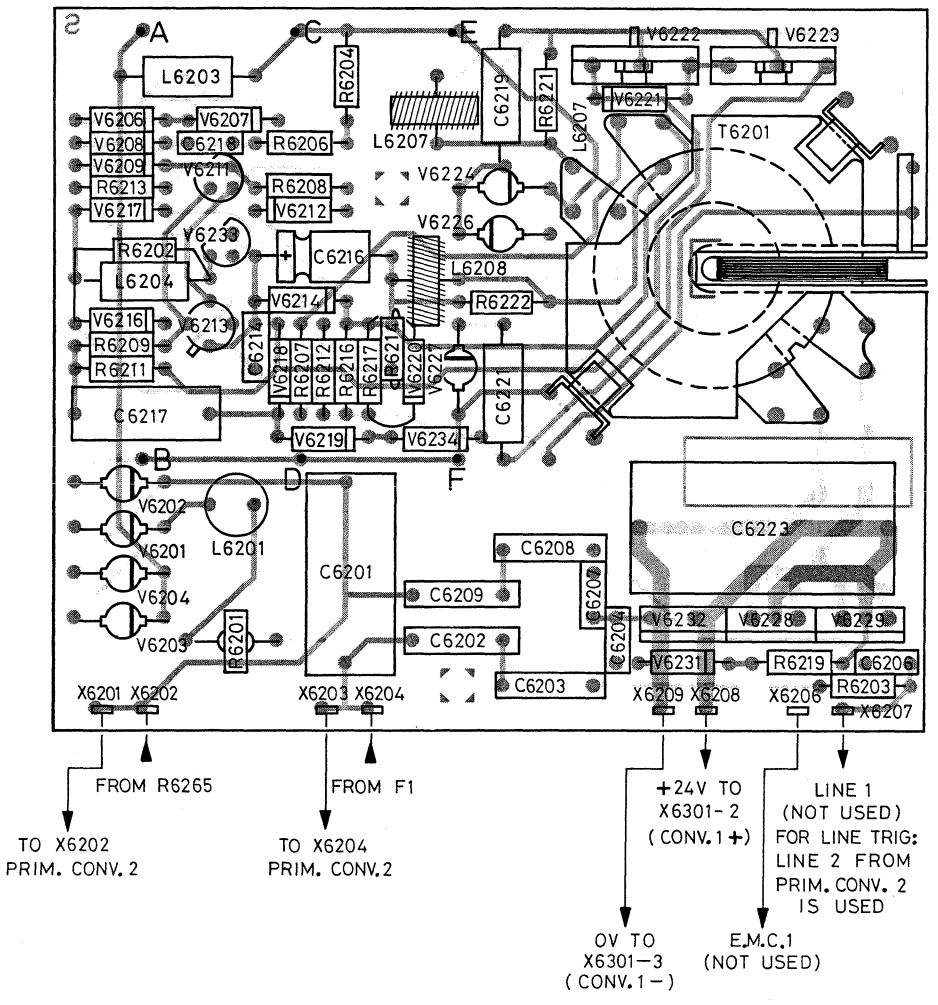
Fig.18.2. Waveforms in primary converter.

Secondary rectifier circuit

The current in the secondary winding of T6201 during the flyback stroke of the converter i.e. when V6223 blocks, decreases linearly as shown in fig.18.2.C. The current is half-wave rectified by diodes V6228, V6229 and smoothed by C6223. The flywheel diode V6232 prevents inverse currents appearing in the secondary winding.

Overvoltage protection is provided by zener diode V6231 in series with R6219 across the secondary output.
The secondary outputs of primary converter I and primary converter II are series connected to give a smoothed 48 V to the secondary converter unit.





MAT1745B
870515

Fig.18.3. Primary converter unit, p.c.b. lay-out.

SECONDARY CONVERTER UNIT 19

SECONDARY CONVERTER UNIT. 19

CONTENTS

19. CIRCUIT DESCRIPTION OF SECONDARY CONVERTER UNIT. 19-1
19.1. Parts list 19-12

FIGURES

19.1. Voltage waveforms in the flyback converter. 19-1
19.2. Voltage waveforms in the line trigger circuits. 19-3
19.3. Waveforms in fan control circuit. 19-4
19.4. Secondary converter unit, p.c.b. lay-out. 19-7
19.5. Secondary converter unit, circuit diagram. 19-10

19. CIRCUIT DESCRIPTION OF SECONDARY CONVERTER UNIT (See fig.19.5)

The secondary converter is similar in principle to the primary converter. It basically consists of:

- a flyback converter circuit
- a voltage regulator
- a control circuit
- a line trigger circuit
- a fan control circuit.

The flyback converter (V6306, V6342)
The flyback converter consists of transistors V6306 and V6342 and their associated components. The normal converter frequency is ≈ 25 kHz. For waveforms, see fig. 19.1.
Transistor V6342 conducts on the forward stroke and charges transformer T6301. The thyristor V6303 fires when the current measuring resistor R6309 has approximately 0.57 V accross it. Consequently, V6342 blocks (FET V6306 blocks) for the duration of the flyback stroke, during which the secondary windings discharge via the diode rectifiers into the smoothing capacitors.
The NTC resistor R6301 provides temperature compensation for the firing point of the thyristor. The zener diode V6341 gives over-voltage protection to prevent the cathode gate voltage of the thyristor exceeding 15.5.V.
The waveforms present on the gate (X29) and the drain (X28) of the FET V6306 and over R6309 (X27) are given in fig.19.1.

The CON-signal (X32) is according the output of comparator D6302-6-7-1 (open collector output) under normal conditions constantly high (27 V), but at the moment that the thyristor V6303 fires (every 40 us) this level is low for 4 us.

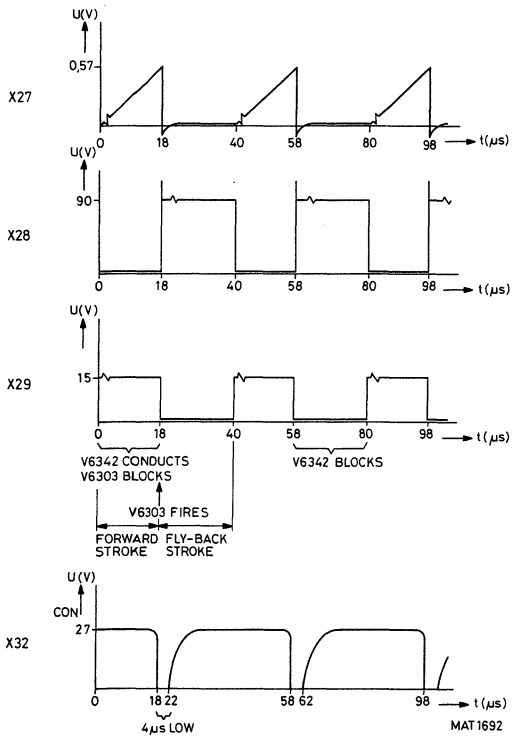


Fig.19.1. Voltage waveforms in the flyback converter.

Voltage regulator circuit (D6301)
The voltage regulator uses an integrated circuit D6301 to ensure a very constant output voltage.
The 5 V U REF voltage from the control circuit is applied to the positive input (pin 5) of a unity gain operational amplifier D6301 and provides the reference input (pin 2) for the comparator D6301. The other input is a +5 V feedback voltage from the rectified secondary of T6301. The resulting output voltage on pin 1 of D6301 is used to control the primary current through T6301. Its value is greater than 0.7 V, typicallly 1.5 V, and has a maximum of 12 V. If this voltage is negative, the converter is overloaded. The voltage is aplied via diode V6309 as the control voltage (CONTR) to the cathode gate of the thyristor V6303.
If the +5 VA feedback voltage is for instance too high, D6301-3 gets higher and D6301-1 will be higher than 1,5 V. As a result the thyristor V6303 will fire earlier (faster). This means that the forward stroke gets shorter, so the converter transformer T6301 will be less charged and the output voltages will decrease.

Control circuit (D6302)
The control supply voltages are derived from the +50 V [PRIM] supply. Fed via the two parallel resistors R6314, R6316, zener diode V6311 provides a +27 V for comparators D6302. Likewise, zener diode V6312 gives an output to a voltage divider that is adjustable by R6318 to give a 5 V U REF output on test-point X30.

The 5 V U REF output is also fed to input 10 of comparator D6302 where it is compared with a sampled potential on input 11, obtained from voltage divider R6323, R6324 across the +50 V [PRIM] supply. The circuit detects whether the supply is too low. A temperature compensation stage, V6339 controlled by a PTC resistor R6308 in its base circuit is also connected to input 11. At temperatures higher than 80 degrees C V6339 conducts and reduces the potential on input 11 of the comparator.
Therefore, is the 50 V [PRIM] input is low, or the circuit temperature is greater than 80 degrees C, output 13 of D6302 goes low, C6313 discharges in 50 us and output 2 of D6302 goes low (AL-). This alarm signal is routed to output connector X6302-32.
The low output from C6313 is also applied to the lower comparator in input 7. Since input 6 is at a lower potential than input 4 there is a delay of 1.5. ms after which the output on pin 1 goes low and switchesoff the converter by the low on the anode gate of the thyristor V6303 (CON: converter on signal).
The alarm signal AL-, routed via the motherboard to the CPU unit,thus saves the memory contents of the uP before the power is off.
At switch-on, AL- becomes high after 150 ms (the starting-up time determined by the charging time of C6313)

Line trigger circuit
The LINE 2 input from primary converter 2 is a mains-voltage related signal. To ensure that the line trigger signal has constant amplitude this circuit provides automatic gain control. The LINE 2 input is fed to a feedback operational amplifier D6301 with a gain of 1000 (R6341/R6339). The output on pin 14 is fed to a comparator input D6301-10. The other input carries the 5 V U REF. This stage operates as a top detector. The output on pin 8 is a rectangular waveform

(+14V ... -14 V) the pulse width being dependent on the amplitude of the sinewave input D6301-10 (see also fig.19.2). These pulses are rectified by diode V6313 and charge capacitor C6316 to give a negative control voltage on the base of FET V6314.This FET conducts to regulate the amplitude of the LINE 2 signal. If, for instance, the mains voltage increases, LINE 2 also increases. Than output D6301-14 also increases. As a result the pulse width of the square wave signal on D6301-8 will get wider (see fig.19.2). FET V6314 will conduct more, which decreases the sine wave signal on D6301-12. This results in a direct correction of the output sine wave on D6301-14. The output on D6301-14 provides the constant LINE TRIG signal on X34 (0.24 V eff), which is routed via the motherboard to the adaptation unit.

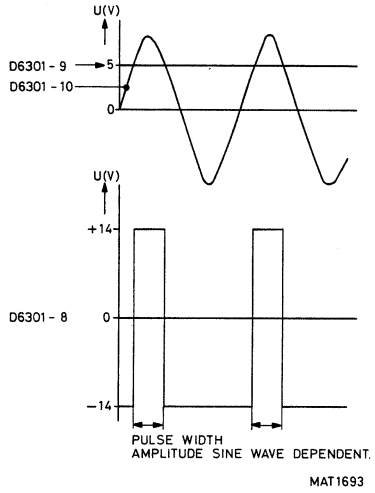


Fig.19.2. Voltage waveforms in the line trigger circuit.

Fan-control circuit

This consists of a highly-efficient switched series-regulator for determining the supply voltage to the fan, controlled by an NTC resistor on the Mother Board.
The sensing input NTC-1 is applied to the comparator positive input D6302-9. A U REF of 5.1 V derived from zener diode V6329 is applied to input D6302-8 together with the switch hysteresis input via R6351. For waveforms, see fig.19.3.
With input D6302-9 low (high temperature) output D6302-14 is low, which gives a low switch signal via zener diode V6332 to the base of the pnp series-regulator V6331. This conducts to provide a current (I) to charge L6317 and C6343. Output voltage U out is increased to the fan. With input D6302-9 high (normal temperature) output D6302-14 is high. Consequently, V6331 blocks and L6317 discharges (I_D) via diode V6333 in V6334 via R6357. Lower output voltage is supplied to the fan.

Current-limiting at switch-on is given by transistor V6334 (off before C6343 charges). It also provides short-circuit protection for V6331.

Overvoltage protection for the fan is given by V6337, V6338 at 33 V. Transistor V6338 conducts when the output voltage exceeds 33V and the output voltage will be reduced via the emitter of V6331. Resistor R6345 reduces the current which is fed through V6338.

At 25 degrees C the supply to the fan is ≈10 V. It increases at higher temperatures to a maximum of 28 V, when it is limited by zener diode V6336, which gives a feedback voltage to comparator input pin 9.

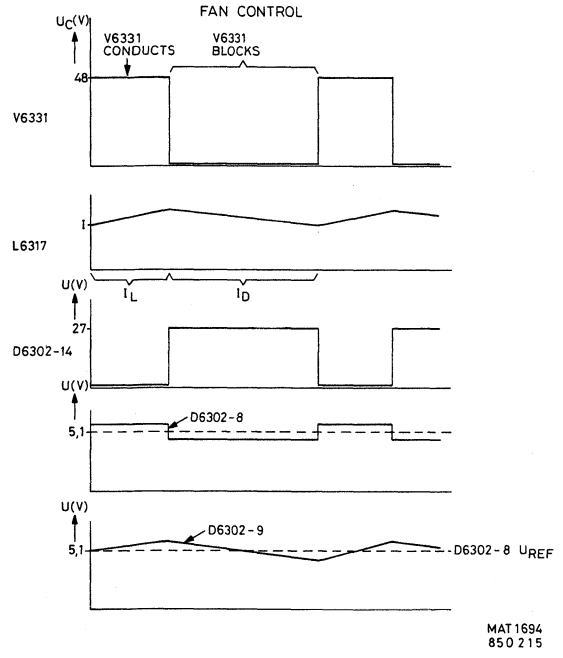


Fig.19.3. Waveforms in fan control circuit.

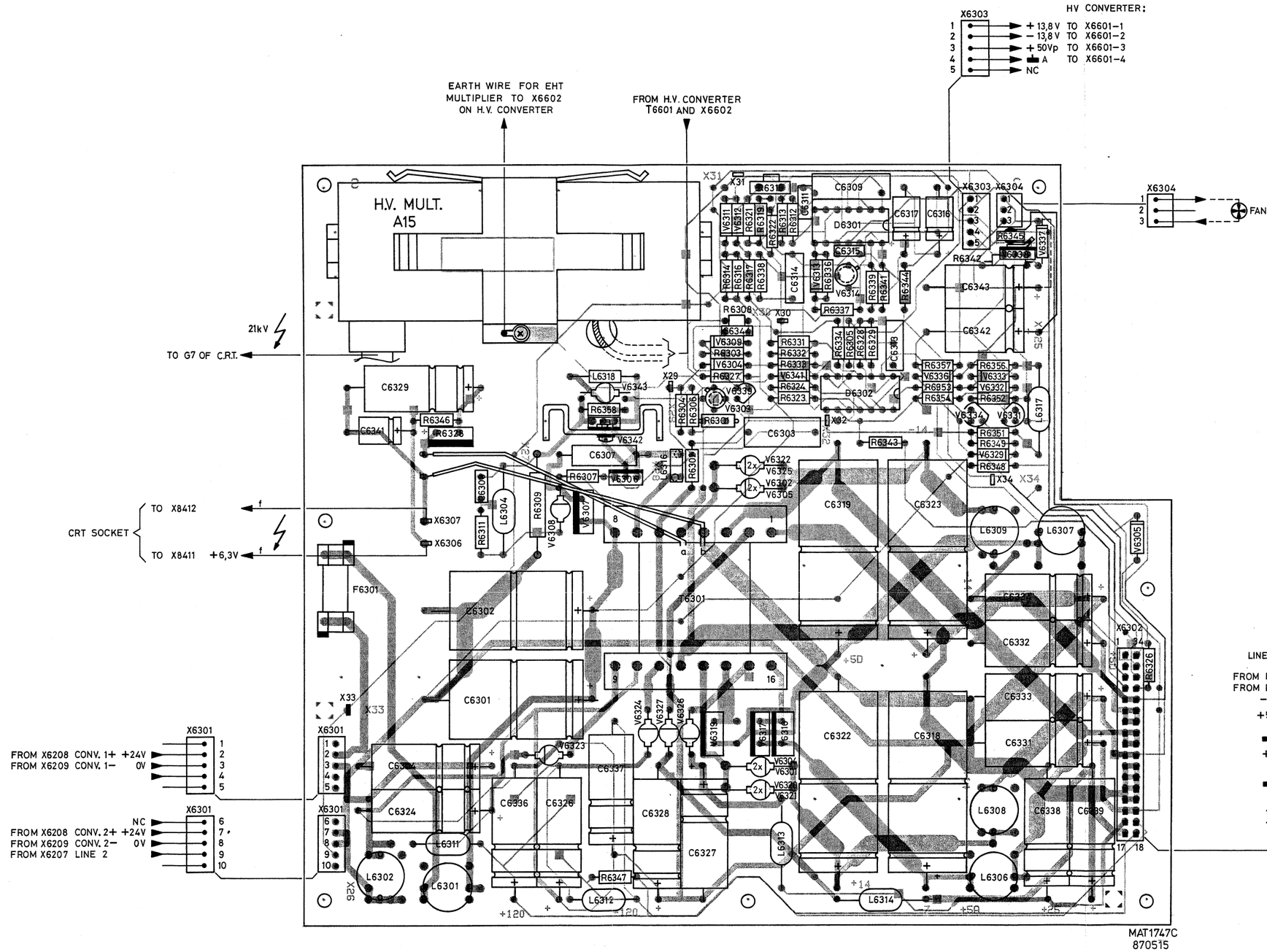


Fig.19.4. Secondary converter unit, p.c.b. lay-out.

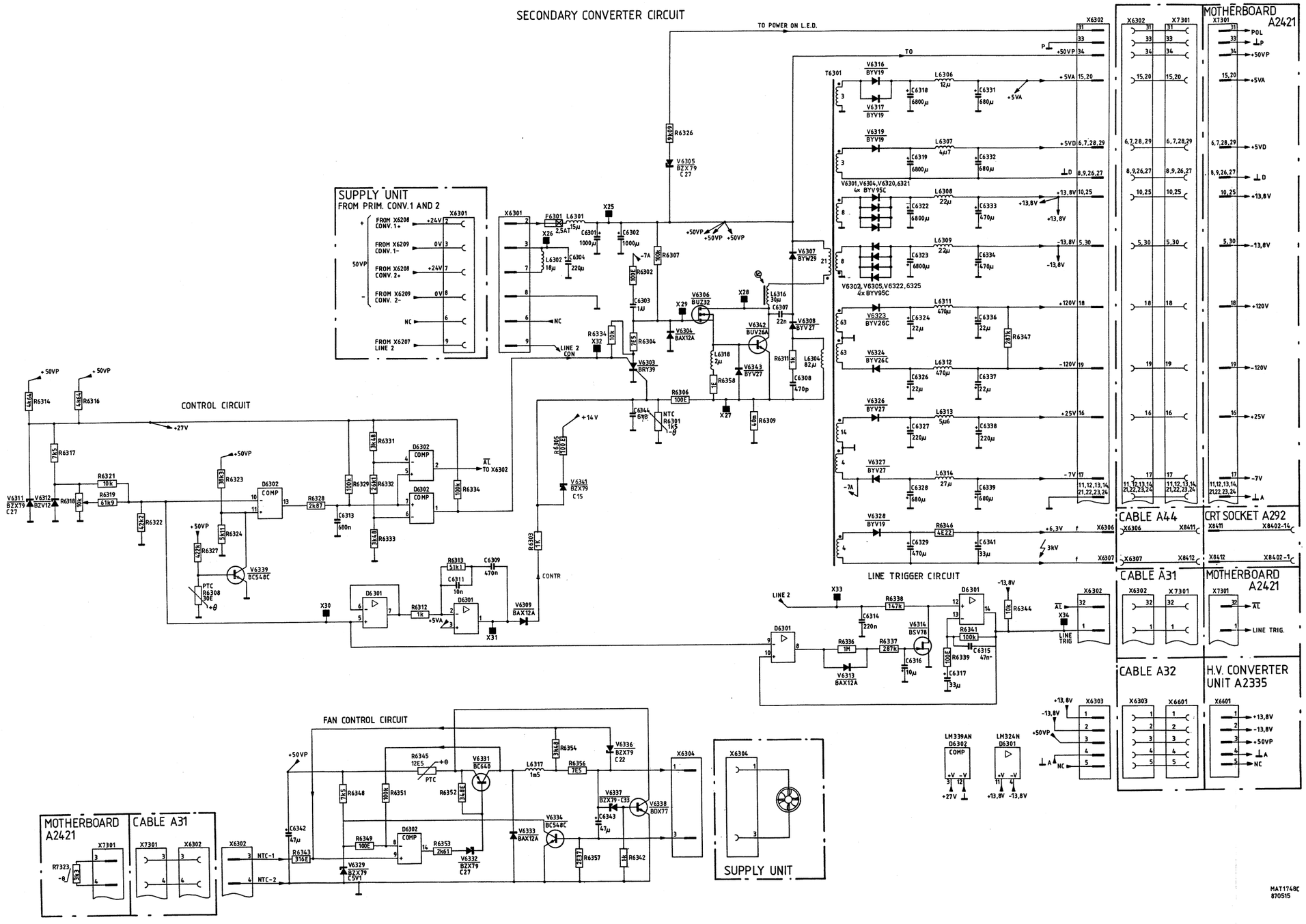


Fig.19.5. Secondary converter unit, circuit diagram.

19.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

19.1.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 6301	CAP.ELECTROLYT.	-20+20%	1000UF	5322 124 21541
C 6302	CAP.ELECTROLYT.	-20+20%	1000UF	5322 124 21541
C 6303	CAP.FOIL	100V 10%	1UF	5322 121 40197
C 6304	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20717
C 6307	CAP.FOIL	160V 5%	22NF	5322 121 50983
C 6308	CAP.CERAMIC	10%	470PF	4822 122 30034
C 6309	CAP.FOIL	100V 10%	470NF	5322 121 40175
C 6311	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 6313	CAP.FOIL	100V 10%	220NF	4822 121 40232
C 6314	CAP.FOIL	100V 10%	220NF	4822 121 40232
C 6315	CAP.FOIL	100V 10%	47NF	5322 121 42491
C 6316	CAP.ELECTROLYT.	-10+50%	10UF	4822 124 20728
C 6317	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 6318	CAP.ELECTROLYT.	-20+20%	6800UF	4822 124 20783
C 6319	CAP.ELECTROLYT.	-20+20%	6800UF	4822 124 20783
C 6322	CAP.ELECTROLYT.	-20+20%	6800UF	4822 124 20783
C 6323	CAP.ELECTROLYT.	-20+20%	6800UF	4822 124 20783
C 6324	CAP.ELECTROLYT.	-10+50%	22UF	5322 124 21768
C 6326	CAP.ELECTROLYT.	-10+50%	22UF	5322 124 21768
C 6327	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20717
C 6328	CAP.ELECTROLYT.	-10+50%	680UF	4822 124 20685
C 6329	CAP.ELECTROLYT.	-10+50%	470UF	4822 124 20695
C 6331	CAP.ELECTROLYT.	-10+50%	680UF	4822 124 20685
C 6332	CAP.ELECTROLYT.	-10+50%	680UF	4822 124 20685
C 6333	CAP.ELECTROLYT.	-10+50%	470UF	4822 124 20695
C 6334	CAP.ELECTROLYT.	-10+50%	470UF	4822 124 20695
C 6336	CAP.ELECTROLYT.	-10+50%	22UF	5322 124 21768
C 6337	CAP.ELECTROLYT.	-10+50%	22UF	5322 124 21768
C 6338	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20717
C 6339	CAP.ELECTROLYT.	-10+50%	680UF	4822 124 20685
C 6341	CAP.ELECTROLYT.	-10+50%	33UF	4822 124 20688
C 6342	CAP.ELECTROLYT.	-10+50%	47UF	4822 124 20733
C 6343	CAP.ELECTROLYT.	-10+50%	47UF	4822 124 20733
C 6344	CAP.CERAMIC	-20+50%	6.8NF	4822 122 31429

19.1.2 INTEGRATED CIRCUITS

N 6301	INTEGR.CIRCUIT	UA324PC	FSC	5322 209 82561
N 6302	INTEGR.CIRCUIT	LM339AN	N.S	4822 209 80631

19.1.3 RESISTORS

R 6301	RES.N.T.C.	0.5W	10%	1K5	4822 116 30248
R 6302	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6303	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 6304	RES.METAL FILM	MR25	1%	7E5	5322 116 54417
R 6305	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6306	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6307	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6308	RES.P.T.C.	70 DEG C			5322 116 40093
R 6309	RES.WIREWOUND		5%	0E04	5322 113 41159
R 6311	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 6312	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 6313	RES.METAL FILM	MR25	1%	51K1	5322 116 50672

R 6314	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 6316	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 6317	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 6318	POTM.TRIMMER	MTP10	20%	10K	5322 101 14066
R 6319	RES.METAL FILM	MR25	1%	61K9	4822 116 51265
R 6321	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 6322	RES.METAL FILM	MR25	1%	42K2	5322 116 50474
R 6323	RES.METAL FILM	MR25	1%	38K3	5322 116 55369
R 6324	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 6326	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 6327	RES.METAL FILM	MR25	1%	422K	5322 116 55247
R 6328	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 6329	RES.METAL FILM	MR25	1%	287K	5322 116 55463
R 6331	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 6332	RES.METAL FILM	MR25	1%	26K1	5322 116 54651
R 6333	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 6334	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6336	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 6337	RES.METAL FILM	MR25	1%	287K	5322 116 55463
R 6338	RES.METAL FILM	MR25	1%	147K	5322 116 54712
R 6339	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6341	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6342	1K				4822 116 51235
R 6343	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 6344	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 6345	12E5 PTC				5322 116 40099
R 6346	RES.METAL FILM	MR25	1%	4E22	5322 116 53181
R 6347	RES.METAL FILM	MR25	1%	287K	5322 116 55463
R 6348	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 6349	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6351	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6352	RES.METAL FILM	MR25	1%	348E	5322 116 54515
R 6353	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 6354	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 6356	RES.METAL FILM	MR25	1%	7E5	5322 116 54417
R 6357	RES.METAL FILM	MR25	1%	2E37	5322 116 52683
R 6358	RES.METAL FILM	MR25	1%	1E	4822 116 51179

19.1.4 SEMI CONDUCTORS

V 6301	DIODE	BYV 95 C		4822 130 41487
V 6304		BYV 95 C		4822 130 41487
V 6302	DIODE	BYV 95 C		4822 130 41487
V 6303	THYRISTOR	BRY39	PEL	5322 130 40482
V 6306	TRANSISTOR	BUZ32	PEL	5322 130 42721
V 6305		BYV 95 C		4822 130 41487
V 6307	DIODE	BYW29-150	PEL	5322 130 34711
V 6308	DIODE	BYV27-150	PEL	4822 130 31628
V 6309	DIODE	BAX12A	PEL	5322 130 34605
V 6311	DIODE,REFERENCE	BZX79-C27	PEL	4822 130 34379
V 6312	DIODE,REFERENCE	BZV12	PEL	5322 130 34269
V 6313	DIODE	BAX12A	PEL	5322 130 34605
V 6314	TRANSISTOR,FET	BSV78	PEL	5322 130 44093
V 6316	DIODE	BYV19-40	PEL	5322 130 32937
V 6317	DIODE	BYV19-40	PEL	5322 130 32937
V 6320		BYV 95 C		4822 130 41487
V 6319	DIODE	BYV19-40	PEL	5322 130 32937
V 6321	DIODE	BYW95A	PEL	5322 130 31925
V 6322	DIODE	BYW95A	PEL	5322 130 31925
V 6323	DIODE	BYV26C	PEL	4822 130 32343
V 6324	DIODE	BYV26C	PEL	4822 130 32343
V 6325		BYV 95 C		4822 130 41487
V 6326	DIODE	BYV27-150	PEL	4822 130 31628
V 6327	DIODE	BYV27-150	PEL	4822 130 31628
V 6328	DIODE	BYV19-40	PEL	5322 130 32937
V 6329	DIODE,REFERENCE	BZX79-C5V1	PEL	4822 130 34233
V 6331	TRANSISTOR	BC640	PEL	4822 130 41078

V 6332	DIODE,REFERENCE	BZX79-C27	PEL	4822 130 34379
V 6333	DIODE	BAX12A	PEL	5322 130 34605
V 6334	TRANSISTOR	BC548C	PEL	4822 130 44196
V 6336	DIODE,REFERENCE	BZX79-C22	PEL	4822 130 34441
V 6337	DIODE,REFERENCE	BZX79-C33	PEL	4822 130 34142
V 6338	TRANSISTOR	BDX77	PEL	5322 130 44553
V 6339	TRANSISTOR	BC548C	PEL	4822 130 44196
V 6341	DIODE,REFERENCE	BZX79-C15	PEL	4822 130 34281
V 6342	TRANSISTOR	BUV26A	PEL	5322 130 42722
V 6343	DIODE	BYV27-150	PEL	4822 130 31628

19.1.5 MISCELLANEOUS

F 6301	2.5A TZ			4822 253 30026
L 6304	COIL	82UH		4822 158 10563
L 6311	COIL	470UH	TDK	5322 157 52362
L 6312	COIL	470UH	TDK	5322 157 52362
L 6313	COIL	5.6UH		4822 157 52259
L 6314	COIL	27UH		4822 158 10551
L 6317	COIL	1500UH	TDK	4822 156 21293
L 6318	COIL	2.2UH	TDK	4822 157 51757

HIGH VOLTAGE CONVERTER UNIT 20

CONTENTS

20. CIRCUIT DESCRIPTION OF HIGH VOLTAGE CONVERTER UNIT. 20-1
20.1. Parts list 20-4

FIGURES

20.1. Waveforms in high voltage converter. 20-1
20.2. High voltage converter, p.c.b. lay-out. 20-2
20.3. High voltage converter, circuit diagram. 20-3

20. CIRCUIT DESCRIPTION OF HIGH VOLTAGE CONVERTER UNIT (See fig.20.3).

In principle, the HV converter circuit consists of a control circuit, driving a feedback oscillator. The secondary circuit feeds a voltage doubler to provide the -3.4 kV c.r.t. output and a voltage multiplier in the secondary converter to give the 21 kV final accelerator voltage. A protection circuit switches off the converter in the event of a secondary converter failure to prevent damage to V6603 and its output.

Protection circuit

The collector voltage of oscillator V6603 is supplied from the +50 V [PRIM] line controlled by a protection voltage (+13 V) derived from the secondary converter. This circuit switches off the 50 V [PRIM] supply to the oscillator if the secondary converter fails (when the +13V is not available e.g. in case of overload). The zener diode V6608 normally holds the base of V6609 at +4.8 V so that this transistor conducts. In turn, pnp transistor V6611 conducts and switches the +50 V supply via the primary winding of T6601 to the oscillator V6603. If the +13 V fails for any reason, V6609 and V6611 block and disconnect the collector supply to V6603.

Control circuit

When V6603 conducts, part of the negative output on the secondary winding (-3,4 kV) is fed back via the phase compensation capacitors C6616, C6617, and voltage divider R6626, R6627, R6628, R6611 to the + input of comparator N6601. Here, the feedback voltage is compared with the reference voltage adjusted by R6601 applied to the - input. The 21 kV output voltage is adjusted by R6601. The regulation sensitivity at the + input N6601-3 (test-point X26) is approximately 1 V/1 kV output. The overall resultant feedback builds up a negative voltage across the parallel capacitors C6603, C6604, which controls the base level of oscillator V6603 via the 3-turn winding. The oscillator thus works in class C operation. The control circuit influences the negative bias, which in turn controls the width of the collector current pulses (see fig.20.1)

The control action is as follows:

- If the secondary -3400 V output is too low (i.e. more positive) then the feedback voltage to N6601-3 is high.
- Output D6601-6 is therefore high (i.e. the negative charge on C6603, C6604 is lower), which tends to reduce the bias on V6603 base and consequently increases the Ic pulse-width.
- As a result the output voltage becomes higher (more negative).

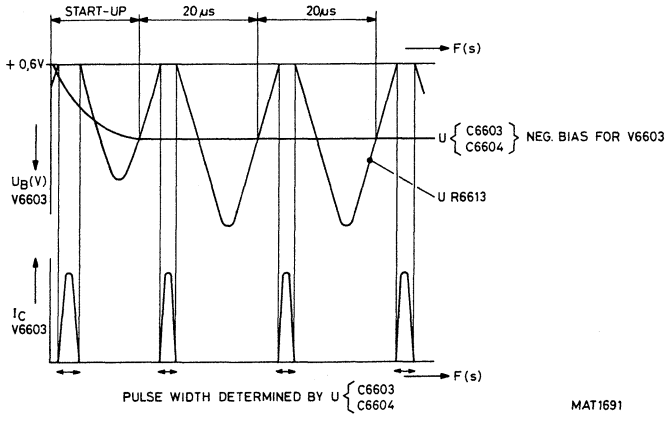


Fig.20.1. Waveforms in high-voltage converter.

Converter circuit

The converter consists of V6603 and transformer T6601 in a blocking oscillator circuit with the signal across the collector winding and base winding in phase. The collector current Ic starts the oscillator every 20 us, building up a 50 kHz sine-wave across the base winding connected to R6613 biased negatively by the feedback control. When the level of the sine-wave singal exceeds the 0.6 V base voltage then the transistor conducts to give the Ic pulses as described (see fig 19.4).

On the secondary windings two output voltages are available:

- 1700 V on 6609.
- 2500 V on the input of H.V. multiplier (A15 on the secondary converter)

The 1700 V is doubled by the negative voltage doubler V6604, V6606 and C6611, resulting in -3400 V.

The -3.4 kV can be adjusted independently of the 21 kV by R6622 (adjustment range 250 V) via emitter follower V6607, to compensate for tolerances in the c.r.t sensitivities

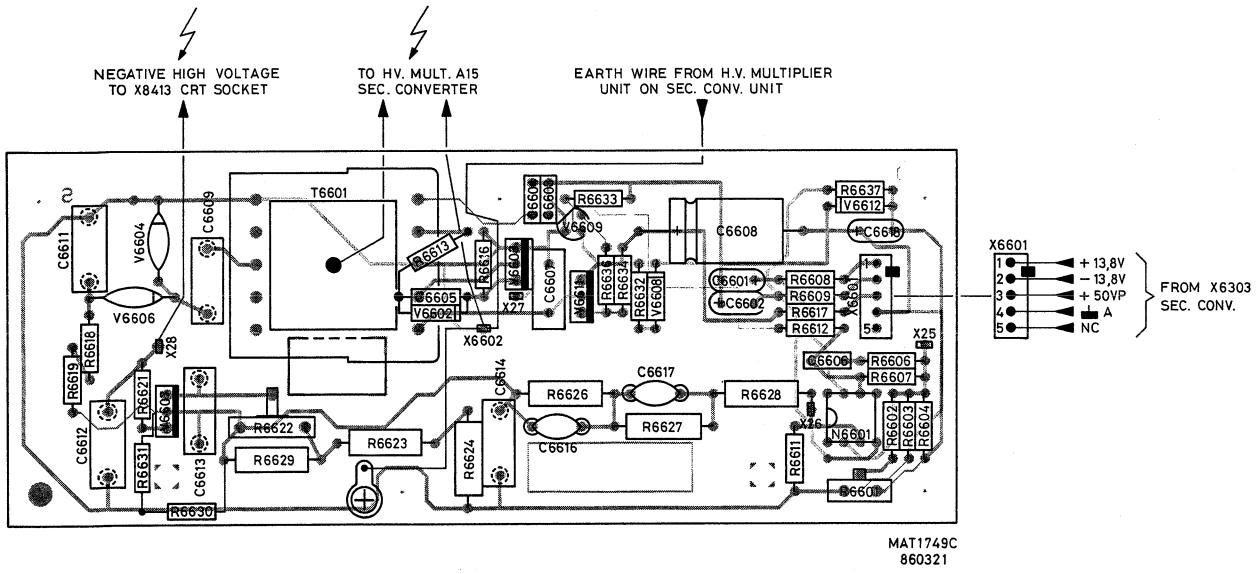


Fig.20.2. High-voltage converter, p.c.b. lay-out.

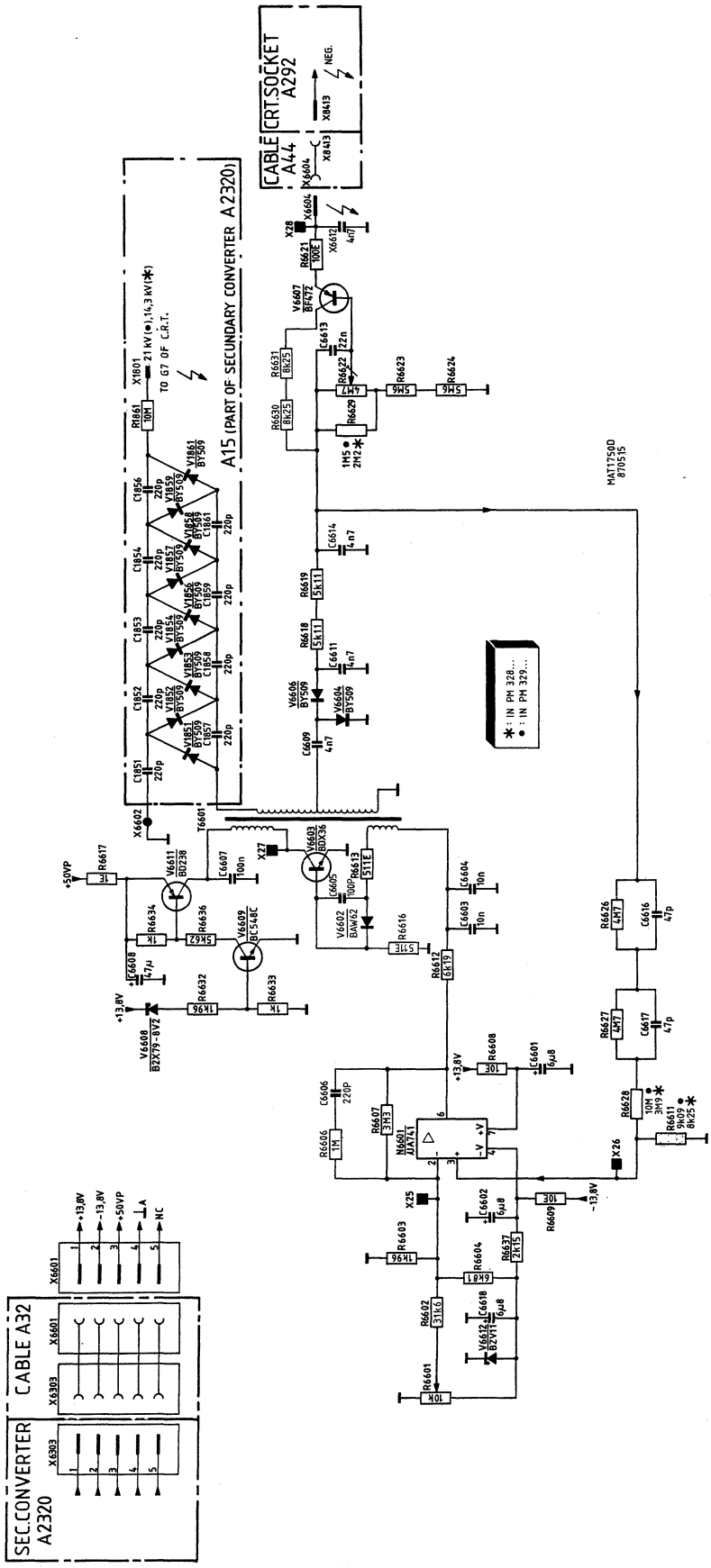


Fig.20.3. High-voltage converter, circuit diagram.

20.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

20.1.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 6601	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 6602	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 6603	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 6604	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 6605	100PF				4822 122 31316
C 6606	220PF				4822 122 30094
C 6607	CAP.	100V	10%	100NF	4822 121 41717
C 6608	CAP.ELECTROLYT.		-10+50%	47UF	4822 124 20733
C 6609	CAP.CERAMIC		20%	4.7NF	5322 122 50087
C 6611	CAP.CERAMIC		20%	4.7NF	5322 122 50087
C 6612	CAP.CERAMIC		20%	4.7NF	5322 122 50087
C 6613	CAP.FOIL	400V	10%	22NF	5322 121 40308
C 6614	CAP.CERAMIC		20%	4.7NF	5322 122 50087
C 6616	CAP.CERAMIC		10%	47PF	5322 122 50088
C 6617	CAP.CERAMIC		10%	47PF	5322 122 50088
C 6618	CAP.SOLID ALU.	25V	20%	6.8UF	5322 124 14081

20.1.2 INTEGRATED CIRCUITS

N 6601	INTEGR.CIRCUIT	UA741CN	SIG	5322 209 83267

20.1.3 RESISTORS

R 6601	POTM.TRIMMER	MTP10	20%	10K	5322 101 14066
R 6602	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 6603	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 6604	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 6606	1M				5322 116 55535
R 6607	RES.HI-TENSION	VR25	5%	3M3	4822 110 72201
R 6608	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 6609	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 6611	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 6612	RES.METAL FILM	MR25	1%	6.19K	5322 116 55426
R 6613	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 6616	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 6617	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 6618	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 6619	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 6621	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6622	POTM.TRIMMER	CTP14	20%	4M7	5322 101 10336
R 6623	RES.HI-TENSION	VR37	5%	5M6	4822 110 42207
R 6624	RES.HI-TENSION	VR37	5%	5M6	4822 110 42207
R 6626	RES.HI-TENSION	VR37	5%	4M7	4822 110 42205
R 6627	RES.HI-TENSION	VR37	5%	4M7	4822 110 42205
R 6630		MRS25	1%	8K25	5322 116 53267
R 6628	RES.HI-TENSION	VR37	5%	10M	4822 110 42214
R 6629	RES.HI-TENSION	VR37	5%	1M5	4822 110 42192
R 6632	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 6633	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 6634	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 6631		MRS25	1%	8K25	5322 116 53267
R 6636	RES.METAL FILM	MR25	1%	5K62	4822 116 51281
R 6637	RES.METAL FILM	MR25	1%	2K15	5322 116 50767

20.1.4 SEMI CONDUCTORS

V 6602	BAW62			4822 130 30613
V 6603	TRANSISTOR	BDX36	PEL	5322 130 44489
V 6604	DIODE	BY509	PEL	4822 130 41485
V 6606	DIODE	BY509	PEL	4822 130 41485
V 6607	TRANSISTOR	BF472	PEL	5322 130 42535
V 6608	DIODE,REFERENCE	BZX79-C8V2	PEL	4822 130 34382
V 6609	TRANSISTOR	BC548C	PEL	4822 130 44196
V 6611	TRANSISTOR	BD238	PEL	4822 130 40917
V 6612	DIODE,REFERENCE	BZV11	PEL	5322 130 34294

CONTENTS

21. CIRCUIT DESCRIPTION OF MOTHERBOARD 21-1
21.1. Parts list 21-10

FIGURES

21.1. Motherboard, p.c.b. lay-out. 21-5
21.2. Motherboard, circuit diagram and interconnections. 21-8

21. CIRCUIT DESCRIPTION OF MOTHERBOARD (See fig.21.2)

The mother board houses a number of miscellaneous circuit networks inter connections and connectors. These are now listed and briefly described.

Illumination circuit (V7312-V7311)
The slider potential of the ILLUM control R12, derived from the +50 V [PRIM] coming from the secondary converter, is fed to an emitter-follower driver V7312, to reduce the base current through the slider. The driver is followed by a further emitter-follower, power transistor V7311, which supplies the series-connected graticule lamps E1, E2 (28 V/80 mA)

Trace rotation (V7301-V7302)
The slider potential of the TRACE ROT control R16, derived from the +13.8 V and -13.8 V supplies, is fed to the bases of a complementary pair, V7301/V7302 also across these supplies. The common emitters of V7301/V7302 drive the trace rotation coil. If the slider of R16 goes positive then V7301 conducts to produce a positive-going current in the coil. Conversely, if the slider goes negative, V7301 blocks and V7302 conducts to produce a negative-going current in the coil.

HEF 4094 bus (serial data in, parallel data out/D7301)
The serial input data DATA1, coming from the CPU-unit, is applied to D7301-2 and comes out of D7301 (10) as serial data DATA2, which is fed via X7309-14, to the adaptation unit of the attenuators.
Integrated circuit D7301 on the HEF 4094 bus is controlled by the timing serial data lines SERCLK and ENSCP to give the parallel data outputs Q0 ...Q7.

Q0 drives the final Y amplifier unit via X7318-8 and X4001-8.
Q2 and Q6 are not used. Q1 is used to switch the LCD-illumination.
Q3 and Q4 are fed to the time base unit as Z control signals Z1 and Z2
Q5 is used to switch off the Hold off generator in Single mode and is fed to the time base (x9002-16)
Q7 is fed to the time base unit for Hold-off sawtooth control (H3).

Data jumpers (see Fig. 21.1)
These jumpers (X7334, X7336 and X7337) on the mother board serve to connect the serial data stream when printed circuit boards are removed.

50-ohm protection lines (INPROT A and INPROT B)
Resistors R7301 and R7302 are each part of a voltage divider for the A and B attenuator circuit. These resistors adapt the 12 V potential in the attenuator to the 5 V level of the uP to give a warning if the 50-ohm input signal is out of the window range of the window discriminator.

Fan NTC (R7323)
The NTC resistor R7323 on the mother board, fed from the secondary converter detects the temperature in the adjacency of the input attenuators.

Protection of OQ200 (V7313)
When the circuit boards XZ amplifier, time base or final Y amplifier are removed, the OE- line can go to low and OQ200 could be damaged. Diode V7313 protects OQ200 against this possibility.

Calibrator

The calibrator circuit consists of a divider circuit (D7302, D7303, D7304) to provide a 5 kHz square-wave followed by a controlled switched current source (V7304, V7306) to provide an accurate calibration voltage of 800 mV. Input signal for the divider circuit is a 3 MHz X-tal controlled sq.-wave.

The 5 kHz square-wave output at 5 V level is applied to the base of V7304. Diode V7309 serves as a slope improver to sharpen up the square wave.
Transistor V7304 acts as a switch for the current source transistor V7306, the emitter preset R7321 providing the current source adjustment (output amplitude).
A constant base voltage of 4.4 V for V7306 is achieved by two series-connected zener diodes V7307, V7308. This results in a 0,8 V square-wave output over the 50-ohm resistor R7318 at the collector of V7306, switched by V7304 at a frequency of 5 kHz.
The 0 V level of the output signal occurs when switch V7304 conducts; the 0,8 V output level occurs when V7304 is blocked and constant current flows through V7306.

Connectors on Mother Board.

The various connectors located on the mother board are given in Fig.21.2 together with their functional data.
A survey of signal names, which are present on the mother board, with their source and destinations (signal flow) is also given in fig.21.2.

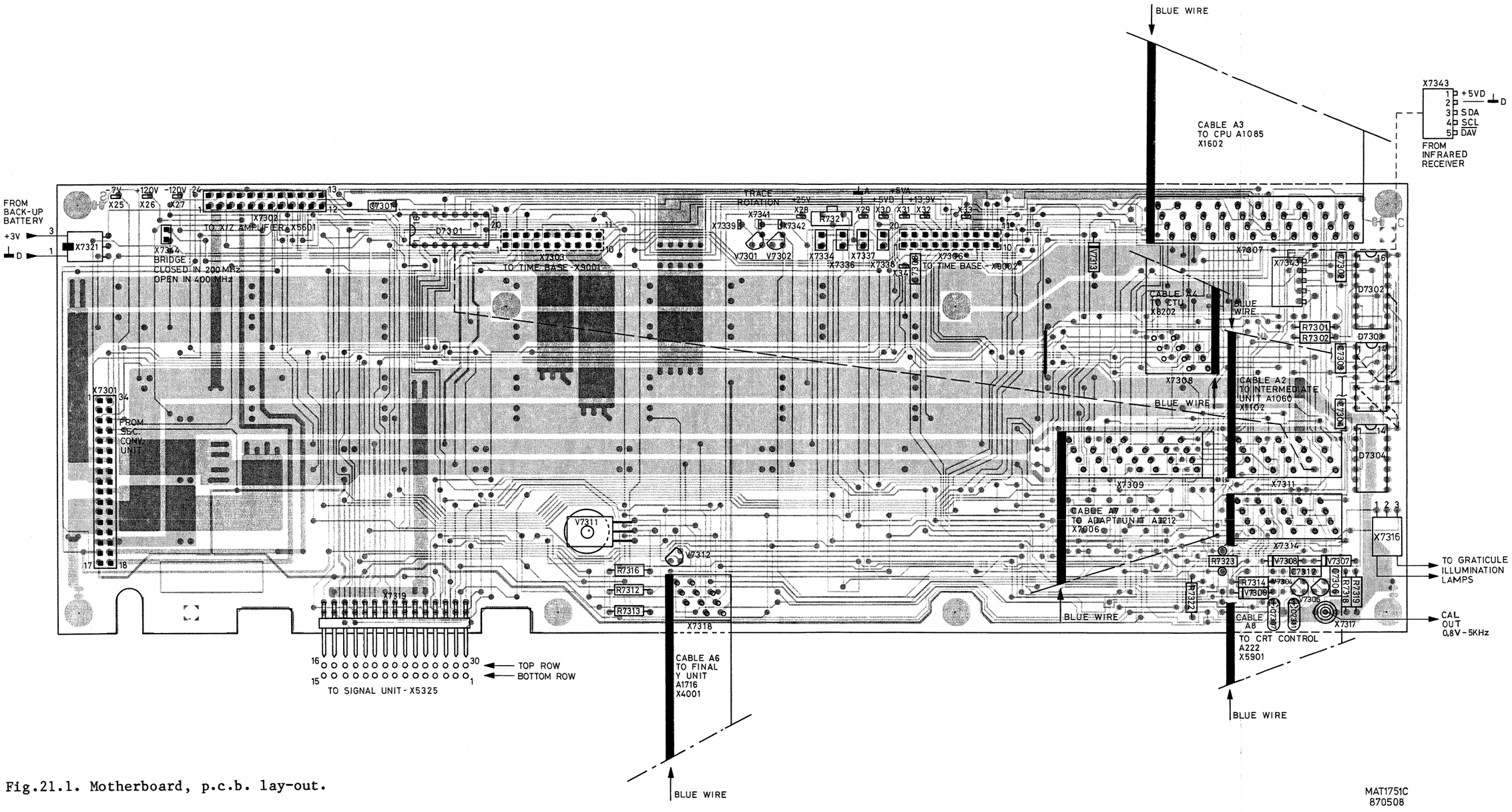
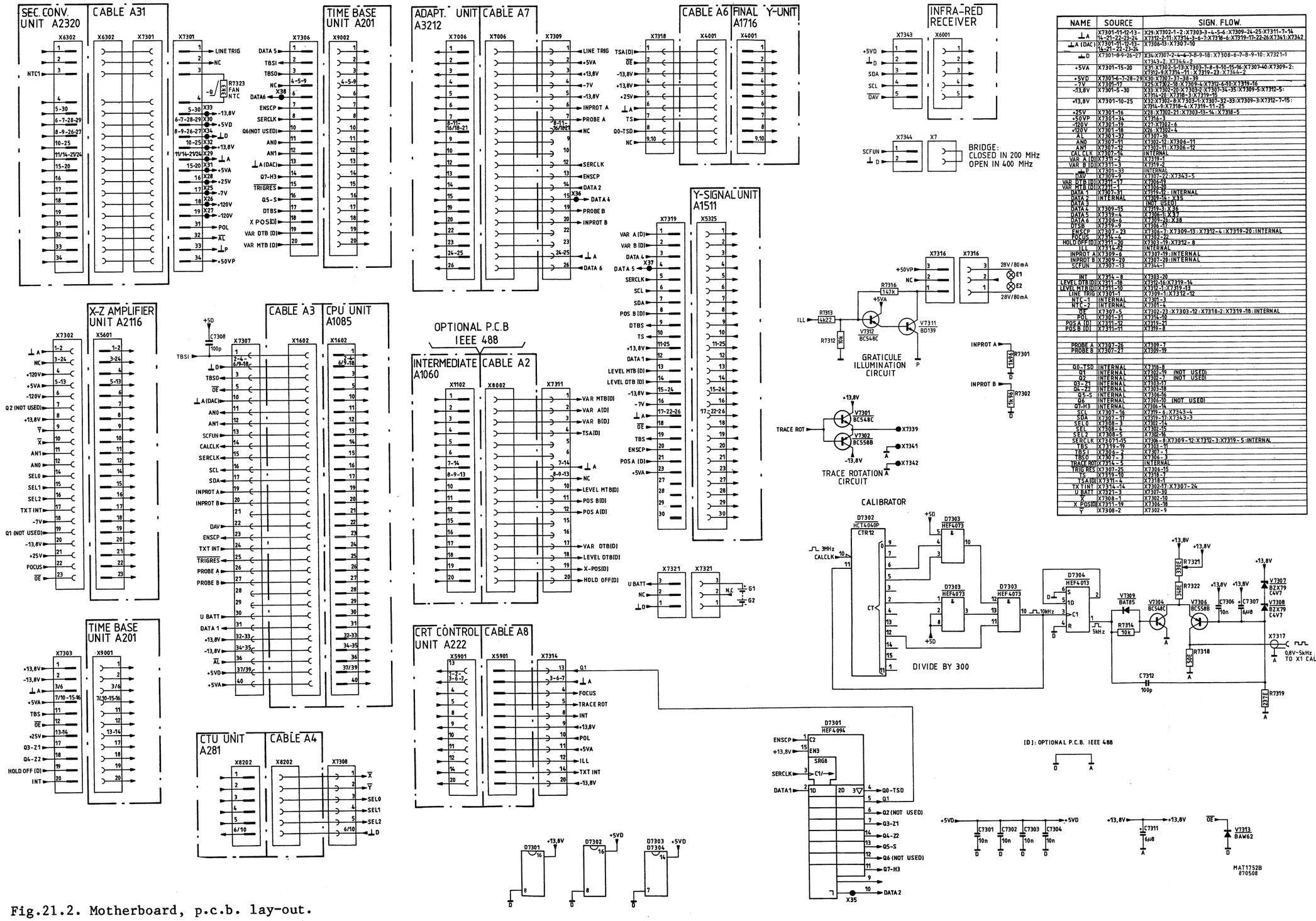


Fig.21.1. Motherboard, p.c.b. lay-out.

MAT1751C
870508



NAME	SOURCE	SIGN. FLOW.
⊥A	X7301-11-12-13-14-21-22-23-24	X29:X7302-1-2:X7303-3-4-5-6:X7309-24-25:X7311-7-14
⊥A (DAC)	X7301-11-12-13-14-21-22-23-24	X7312-2-11:X7314-3-6-7:X7318-6:X7319-17-22-26:X7341:X7342
⊥D	X7301-8-9-26-27	X9:X7306-13-X7307-10
+5VA	X7301-15-20	X3:X7303-2-4-6-7-8-9-18:X7308-6-7-8-9-10:X7321-1
+5VD	X7301-6-7-28-29	X7343-2, X7344-2
-7V	X7301-17	X30:X7302-26-X7309-1-X7312-6-10:X7319-16
-13,8V	X7301-5-30	X33:X7302-20:X7303-2:X7307-34-35:X7309-5:X7312-5:X7314-20:X7318-3:X7319-15
+13,8V	X7301-10-25	X32:X7302-8:X7303-1:X7307-32-33:X7309-3:X7312-7-15:X7314-9:X7318-4:X7319-11-25
+25V	X7301-16	X28:X7302-21:X7303-13-14:X7318-5
-50VP	X7301-34	X7314-3
-120V	X7301-19	X27:X7302-6
+120V	X7301-18	X26:X7302-4
A1	X7301-37	X7307-36
AN0	X7307-11	X7302-12:X7306-11
AN1	X7307-12	X7302-11:X7306-12
CALCLK	X7307-14	INTERNAL
VAR A (D)	X7311-2	X7319-1
VAR B (D)	X7311-3	X7319-2
⊥P	X7301-33	INTERNAL
DAV	X7309-9	X7307-22:X7343-5
VAR DTB (D)	X7311-17	X7306-19
VAR MTB (D)	X7311-1	X7306-20
DATA 1	X7307-31	X7316-12: INTERNAL
DATA 2	INTERNAL	X7309-25: X35
DATA 3		(NOT USED)
DATA 4	X7309-15	X7319-3: X36
DATA 5	X7319-4	X7306-5: X37
DATA 6	X7306-6	X7309-26: X38
DTSB	X7319-9	X7306-17
ENSCP	X7307-23	X7306-7: X7309-13: X7312-4: X7319-20: INTERNAL
FOCUS	X7314-4	X7302-22
HOLD OFF (D)	X7311-20	X7309-19: X7312-8
ILL	X7314-12	INTERNAL
INPROT A	X7309-6	X7307-19: INTERNAL
INPROT B	X7309-20	X7307-20: INTERNAL
SCFUN	X7307-13	X7344-1
INT	X7314-8	X7303-20
LEVEL DTB (D)	X7311-18	X7312-16:X7319-14
LEVEL MTB (D)	X7311-10	X7312-1:X7319-13
LINE TRIG	X7301-1	X7309-1:X7312-12
NTC-1	INTERNAL	X7301-3
NTC-2	INTERNAL	X7301-4
OE	X7307-5	X7302-23:X7303-12:X7318-2:X7319-18: INTERNAL
POL	X7301-31	X7314-10
POS A (D)	X7311-12	X7319-21
POS B (D)	X7311-11	X7319-8
PROBE A	X7307-26	X7309-7
PROBE B	X7307-27	X7309-19
Q0-TSD	INTERNAL	X7318-8
Q1	INTERNAL	X7302-19 (NOT USED)
Q2	INTERNAL	X7302-7 (NOT USED)
Q3-Z1	INTERNAL	X7303-11
Q4-Z2	INTERNAL	X7303-10
Q5-S	INTERNAL	X7306-16
Q6	INTERNAL	X7306-10 (NOT USED)
Q7-H3	INTERNAL	X7306-14
SCL	X7307-16	X7319-6: X7343-4
SDA	X7307-17	X7319-22: X7343-3
SEL0	X7308-3	X7302-14
SEL1	X7308-4	X7302-15
SEL2	X7308-5	X7302-16
SERCLK	X73071-15	X7306-8: X7309-12: X7312-3: X7319-5: INTERNAL
TBS	X7319-19	X7303-11
TBSI	X7306-2	X7307-1
TBSO	X7307-3	X7306-3
TRACE ROT	X7314-5	INTERNAL
TRIG RES	X7307-25	X7306-15
TS	X7319-10	X7318-7
TSA (D)	X7311-4	X7318-1
TX TINT	X7314-14	X7302-17: X7307-24
U BATT	X7321-3	X7307-30
$\overline{X}$	X7308-1	X7302-10
X POS (D)	X7311-19	X7306-18
$\overline{Y}$	X7308-2	X7302-9

Fig.21.2. Motherboard, p.c.b. lay-out.

21.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

21.1.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 7301	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 7302	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 7303	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 7304	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 7306	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 7307	CAP.SOLID ALU.	25V	20%	6.8UF	5322 124 14081
C 7308	CAP.CERAMIC		2%	100PF	4822 122 31316
C 7311	CAP.SOLID ALU.	25V	20%	6.8UF	5322 124 14081
C 7312	CAP.CERAMIC		2%	100PF	4822 122 31316

21.1.2 INTEGRATED CIRCUITS

				ORDERING CODE
D 7301	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7302	INTEGR.CIRCUIT	HEF4040BP	PEL	4822 209 10257
D 7303	INTEGR.CIRCUIT	HEF4073BP	PEL	4822 209 10266
D 7304	INTEGR.CIRCUIT	HEF4013BP	PEL	4822 209 10248

21.1.3 RESISTORS

						ORDERING CODE
R 7301	RES.METAL FILM	MR25	1%	1K96		5322 116 54571
R 7302	RES.METAL FILM	MR25	1%	1K96		5322 116 54571
R 7303	RES.METAL FILM	MR25	1%	1K96		5322 116 54571
R 7304	RES.METAL FILM	MR25	1%	1K96		5322 116 54571
R 7312	RES.METAL FILM	MR25	1%	10K		4822 116 51253
R 7313	RES.METAL FILM	MR25	1%	4K22		5322 116 50729
R 7314	RES.METAL FILM	MR25	1%	10K		4822 116 51253
R 7316	RES.METAL FILM	MR25	1%	147K		5322 116 54712
R 7318	RES.METAL FILM		0.1%	50E		5322 116 53165
R 7319	RES.METAL FILM	MR25	1%	237E		5322 116 50679
R 7321	POTM.TRIMMER	MTP10	20%	330E		5322 101 14244
R 7322	RES.METAL FILM	MR25	1%	287E		5322 116 53221
R 7323	RES.N.T.C.	0.5W	10%	3K3		5322 116 30234

21

21.1.4 SEMI CONDUCTORS

				ORDERING CODE
V 7301	TRANSISTOR	BC548C	PEL	4822 130 44196
V 7302	TRANSISTOR	BC558B	PEL	4822 130 44197
V 7304	TRANSISTOR	BC548C	PEL	4822 130 44196
V 7306	TRANSISTOR	BC558B	PEL	4822 130 44197
V 7307	DIODE,REFERENCE	BZX79-C4V7	PEL	4822 130 34174
V 7308	DIODE,REFERENCE	BZX79-C4V7	PEL	4822 130 34174
V 7309	DIODE	BAT85	PEL	4822 130 31983
V 7311	TRANSISTOR	BD139	PEL	4822 130 40823
V 7312	TRANSISTOR	BC548C	PEL	4822 130 44196
V 7313	DIODE	BAW62	PEL	4822 130 30613

CRT CONTROLS UNIT AND I.R.-RECEIVER 22

CONTENTS

22. DESCRIPTION OF THE CRT CONTROLS UNIT AND I.R.-RECEIVER 22-1
22.1. Parts list 22-4

FIGURES

22.1. CRT controls unit, p.c.b. lay-out. 22-1
22.2. CRT controls unit, circuit diagram. 22-2
22.3. Infra-red receiver, p.c.b. lay-out 22-2
22.4. Infra-red receiver, circuit diagram 22-3

22. DESCRIPTION OF CRT CONTROLS UNIT (See fig.22.2)

This unit incorporates the potentiometers that control the CRT functions and a 13,8 VDC into 300 VAC converter that supplies the LCD-illumination strip. These potentiometers are ILLUM (R12), FOCUS (R13), TRACE INTENSity (R14), READ OUT INTENSity (R15) and TRACE ROT (R16, screwdriver operated control). The way these potentiometers are influencing the connected circuit, is described together with the circuit description of the relevant circuitpart. The CRT controls unit is connected with the motherboard via a flat cable.

The 13,8 VDC/300 VAC generator consists of an oscillator V5901 that drives transformer T5901. Voltage stabilisation is achieved by means ofa feedback circuit with the (zener) diodes V5902, V5903 and V5904. The LCD illumination strip H101 is connected to the generator output via connector X5903.

DESCRIPTION OF INFRA-RED RECEIVER (See fig.22.4)

The command signals from the remote control box are picked up by photo-diode V6001 and applied to pin 2 and pin 15 of IC N6001. This IC converts the pulses from V6001 into a "RC5" code. This coded signal is applied to pin 12 of N6002. This IC converts the "RC5" code into the proper "I2C" bus information present on the lines SDA (serial data), SCL (serial clock) and DAV (data valid).

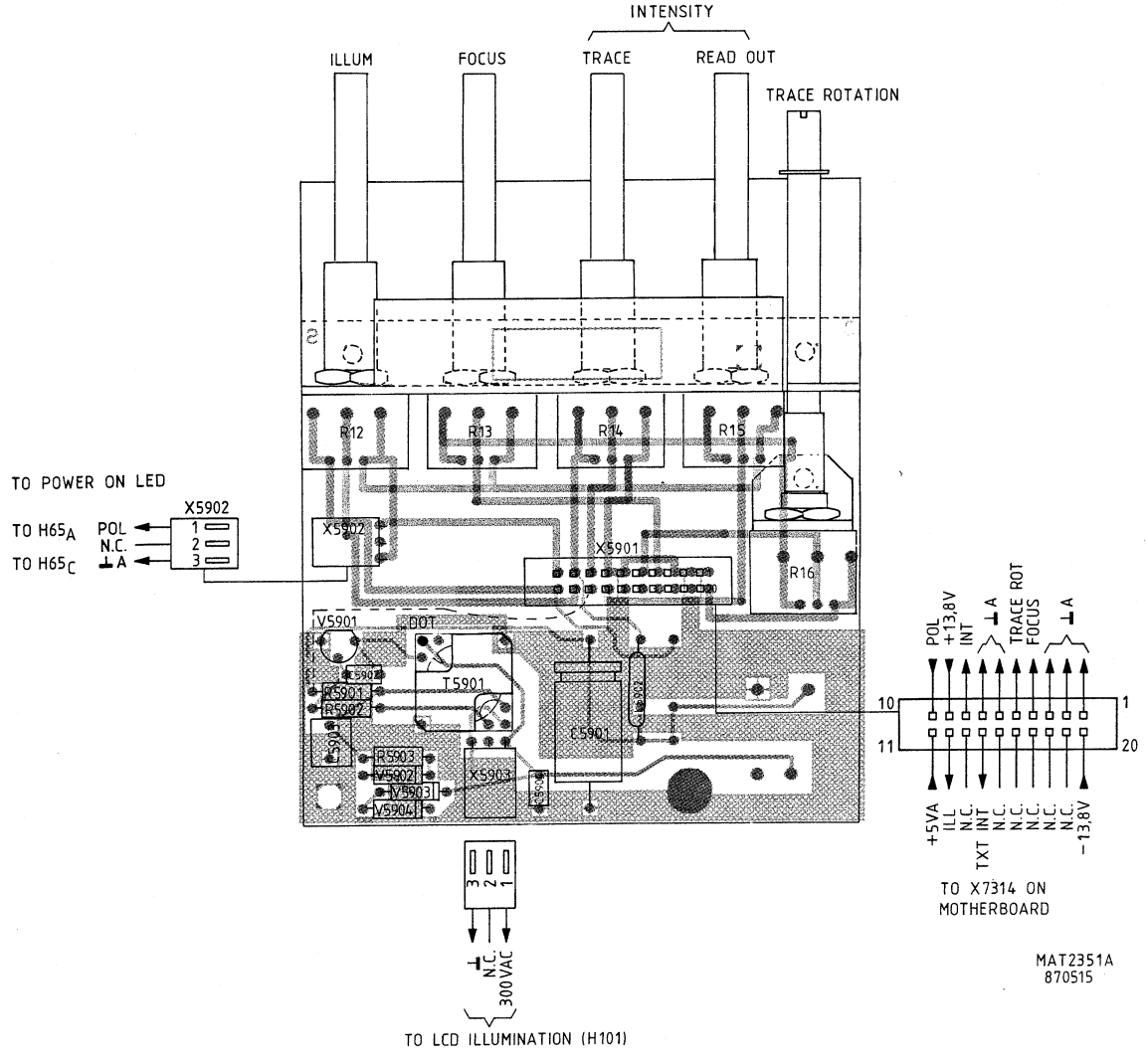


Fig.22.1. CRT controls unit, p.c.b. lay-out.

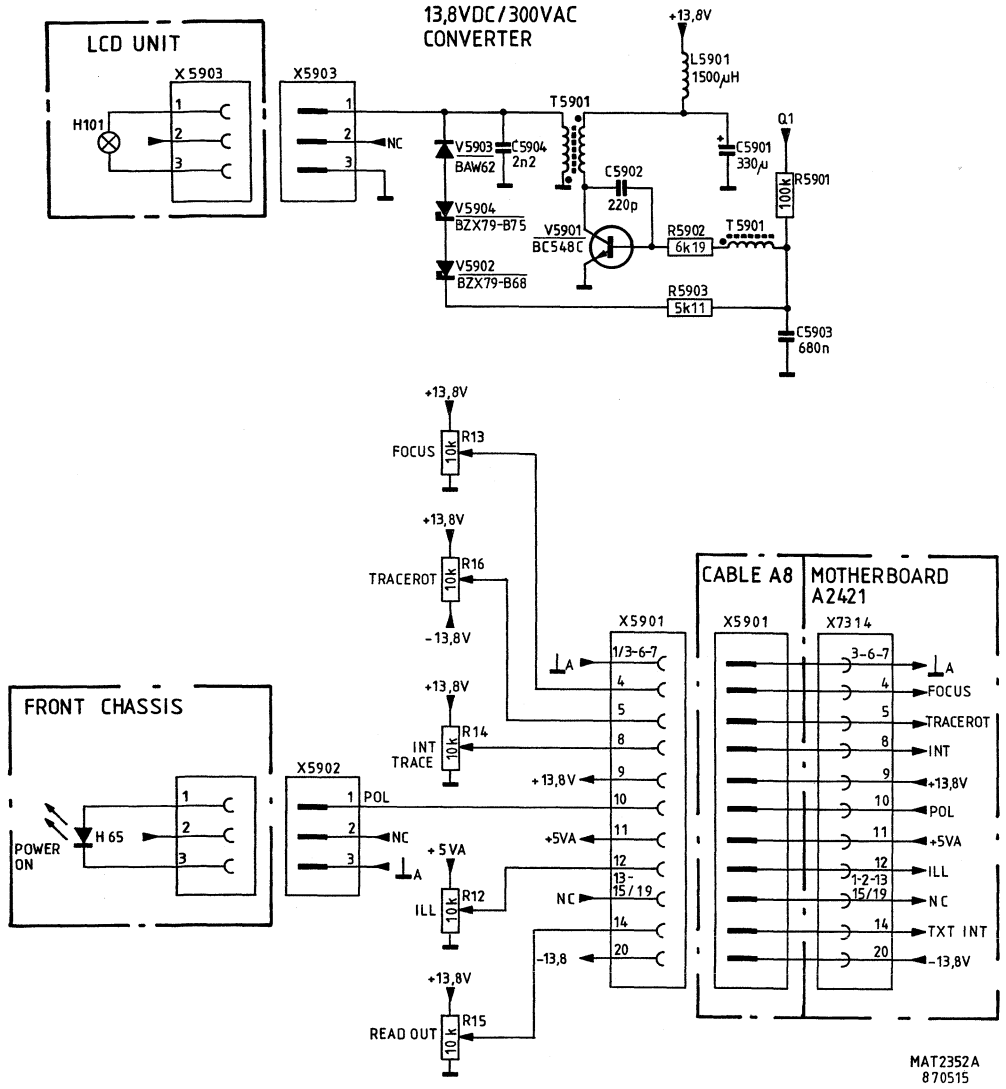


Fig.22.2 CRT controls unit, circuit diagram.

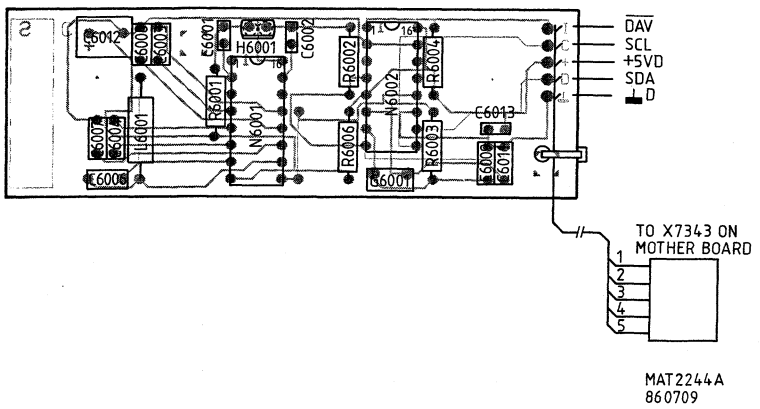


Fig.22.3 Infra red receiver, p.c.b. lay-out (PM3296A only)

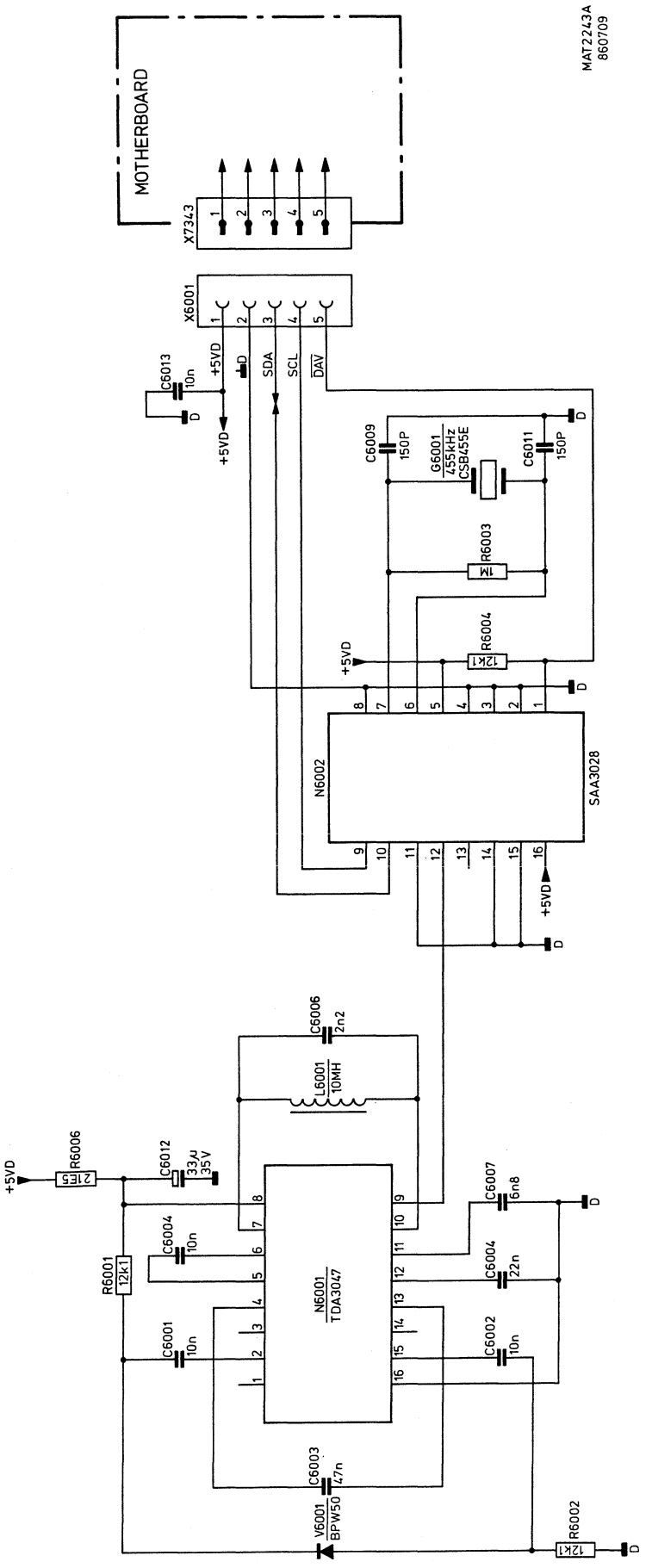


Fig.22.4 Infra red receiver, circuit diagram (PM3296A only)

22

22.1 PARTS LIST

In this section only electrical parts present on this unit are listed. Mechanical parts, including cables and connectors, are given in section 28.

SUBJECT TO ALTERATION WITHOUT NOTICE

RO012... 015	POTM.CARB.TRACK	0,1W 20% 10K	5322 101 20812
RO016	POTM.CARB.TRACK	0,1W 20% 10K	5322 101 20813

22.1.1 CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE
C 5901	-10+50% 330UF		4822 124 20694
C 5902	2% 220PF		4822 122 30094
C 5903	63V 10% 680NF		5322 121 42494
C 5904	10% 2.2NF		4822 122 30114
C 6001	-20+80% 10NF		4822 122 30043
C 6002	-20+80% 10NF		4822 122 30043
C 6003	47NF10%	63V	5322 121 42926
C 6004	-20+50% 10NF		4822 122 31414
C 6006	10% 2.2NF		4822 122 30114
C 6007	-20+50% 6.8NF		4822 122 31429
C 6008	-20+80% 22NF		4822 122 30103
C 6009	2% 150PF		4822 122 31413
C 6011	2% 150PF		4822 122 31413
C 6012	10V 20% 33UF		5322 124 21957
C 6013	-20+80% 10NF		4822 122 30043

22.1.2 RESISTORS

R 5901	MRS25 1% 100K		4822 116 52973
R 5902	MRS25 1% 11K		4822 116 52907
R 5903	MRS25 1% 5K11		5322 116 53494
R 6001	MRS25 1% 12K1		4822 116 52957
R 6002	MRS25 1% 12K1		4822 116 52957
R 6003	MRS25 1% 1M		4822 116 52843
R 6004	MRS25 1% 12K1		4822 116 52957
R 6006	MRS25 1% 21E5		5322 116 53426

22.1.3 MISCELLANEOUS

G 6001	CSB455E	MU	5322 242 70827
L 5901	1500UH	TDK	4822 156 21293
N 6001	TDA3047P	PEL	4822 209 83257
N 6002	SAA3028P	PEL	4822 209 10426
T 5901	TRANSFORMER		5322 146 21188
V 5901	BC548C	PEL	4822 130 44196
V 5902	BZX79-B68	PEL	4822 130 30864
V 5903	BAV21	PEL	4822 130 30842
V 5904	BZX79-B75	PEL	4822 130 34685
V 6001	BPW50		4822 130 32376
X 5901	20-P FEM POL		5322 265 54059
X 5902	3P ENKEL BUS		5322 268 40222
X 5902	2-167301-2 AMP		5322 268 20145
X 5902	1-POS		5322 268 90091
X 5902	3P SNG SQ 2.54		5322 265 30404
X 5903	3P SNG SQ 2.54		5322 265 30404
X 6001	CONN MOUSING		5322 267 40626
X 6001	CONN PIN		5322 268 20145

23 PERFORMANCE CHECK.

CONTENTS

23.1. General information	23-1
23.2. Preliminary settings	23-4
23.3. Recommended test equipment	23-4
23.4. Checking procedure	23-4

FIGURES

23.1. Preliminary settings	23-3
23.2. Pulse response	23-16
23.3. Phase difference	23-24

23 PERFORMANCE CHECK

23.1 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 instrument.
- 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.
Warming-up time under average conditions is 30 minutes.

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

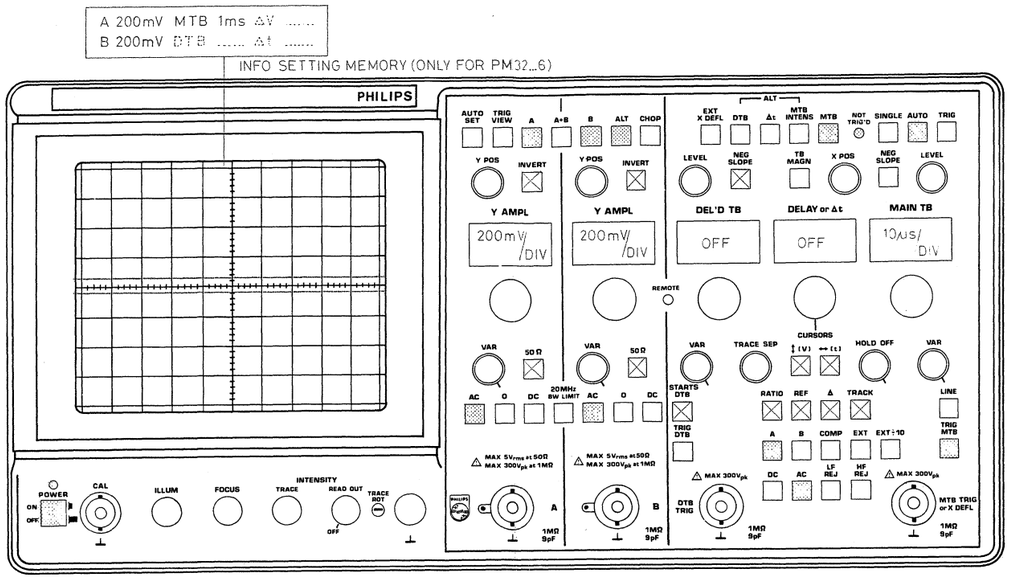
IMPORTANT:
NOTES
* At the start of every check, the controls always occupy the preliminary settings AUTO SET position, unless otherwise stated.

* The input voltage has to be supplied to the A-input; unless otherwise stated.
Set the TIME/DIV switches to a suitable position; unless otherwise stated.

* Tolerances given are for the instrument under test and do not include test equipment error.

* For some checks, we make use of the service routines. If you want additional information concerning these service routines refer to chapter 26.6.4. "description of service routines".

* In this chapter in some checks channel B is mentioned between brackets behind channel A. It is advised to perform first channel A checks. After that the checks for channel B can be done.



MAT2317A

IMPORTANT NOTE: ☒ These functions are only active after pressing AUTO SET, when they were active before AUTO SET was pressed!

fig. 23.1 Preliminary settings (AUTO SET)

23.2 Preliminary settings

- Switch-on the instrument (no input signal).
- Check if all leds and LCD´s are on for 1 sec. during the power up routine.
- Press AUTO SET.
- Check if the frontcontrols are set as indicated in fig. 23.1.
- Check if the Y POS controls of channel A and B are manually adjustable after turning them through their mid-positions.
- Check if with the READ OUT control the intensity of the setting information and cursors can be controlled.

23.3 Recommended test equipment

The test equipment that must be used for this performance check is as given in section 25.2, except:

7. Trimming tool kit
10. Oscilloscope
11. Digital multimeter

Additional equipment for this performance check:

- BNC T piece and 50 ohm T piece PM9584
- 50 ohm attenuators 10x (20dB) and 2x (6dB)
- 50 ohm terminator

23.4 Checking procedure

1		POWER SUPPLY (characteristics: 2.2.15)
1.1	SUBJECT	Mains voltage input
	TEST EQUIPMENT	Variable mains transformer
	MAINS VOLTAGE	Between 90 V and 264 V ac (r.m.s.) Frequency: 45 Hz...440 Hz
	SETTINGS	- Press POWER ON - Apply CAL signal to input A - Press AUTO SET
	REQUIREMENTS	- Starts at any mains voltage between 90 V...264 V ac (r.m.s.) - Instruments performance does not change over indicated mains voltage range; displayed CAL signal distortion-free and with equal intensity.
	MEASURING RESULTS	
1.2	SUBJECT	Power Consumption (ac source)
	TEST EQUIPMENT	Wattmeter
	MAINS VOLTAGE	Mains voltage between 100 V and 240 V ac (r.m.s.). Frequency 50 Hz...400 Hz.

	SETTINGS	Press POWER ON
	REQUIREMENTS	Options excluded : 135W (typical) PM8950 (IEEE 488) option included: 138W (maximum)
	MEASURING RESULTS	
1.3	SUBJECT	Setting retention (characteristics: 2.2.16)
	TEST EQUIPMENT	-
	INPUT VOLTAGE	Apply the CAL signal to input A
	SETTINGS	- Press AUTO SET, make a note of the front settings - Check if Memory Back Up batteries are installed. - Switch-off the instrument for approx. 15 min. - Switch-on the instrument
	REQUIREMENTS	- Check if the settings of the controls and the displayed signal are the same as at the moment of switching off.
	MEASURING RESULTS	
1.4	SUBJECT	Front Unit Test
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	- Press the INVERT buttons of channel A and B together to come into the Service Routine - Press vertical display mode A - Press vertical display mode TRIG VIEW - Press vertical display mode A - Press vertical display mode TRIG VIEW
	REQUIREMENT	- Check if all segments in the LCD´s are on
	SETTINGS	- Press AUTO SET - Press vertical display mode A + B - Press vertical display mode A
	REQUIREMENT	- Check if all push-button leds are on
	SETTINGS	- Press AUTO SET - Press vertical display mode B - Press vertical display mode TRIG VIEW
	REQUIREMENT	- Check if the Y POS controls of channels A and B are locked and can only be released by turning the controls through their mid-position.
	SETTINGS	- Press AUTO SET four times to leave the Service routine

	MEASURING RESULTS	
2.		DISPLAY (characteristics section 2.2.1)
2.1	SUBJECT	Illumination
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	Operate ILLUM control (fully clockwise)
	REQUIREMENTS	- Check if the graticule raster is equaly illuminated and if the intensity can be controlled continuously.
	MEASURING RESULTS	
2.2	SUBJECT	Trace Rotation
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	- Operate screwdriver adjustment: TRACE ROT
	REQUIREMENTS	Trace must be in parallel with the horizontal graticule line. Direction of screwdriver rotation same as direction of trace rotation.
	MEASURING RESULTS	

3		VERTICAL DEFLECTION OR Y-AXIS (characteristics section 2.2.2)
3.1	SUBJECT	Vertical Deflection Sources, Deflection modes and input coupling.
	TEST EQUIPMENT	LF Square wave generator
	INPUT VOLTAGE	Square wave signal 1 kHz to A
	SETTINGS AND REQUIREMENTS	- Set trace height to 5 div. - Press B; only channel A on - Check if one square wave signal of 5 div. is displayed. - Press B; channel A and B on - Check if a square wave signal (A) and line (B) is displayed and if A, B and ALT are on. - Press TRIG VIEW. - Check if two square wave signals (A and TRIG VIEW) and a line (B) are displayed and if TRIG VIEW, A, B and ALT are on. - Press TRIG VIEW; A, B and ALT on.
	MEASURING RESULTS	
	INPUT VOLTAGE	Square wave signal 100Hz to A and B
	SETTINGS AND REQUIREMENTS	- Press AUTO SET - Check if A, B and CHOP are on - Set trace height to 4 div. - Check if top and bottom lines of the two square waves are not flat (horizontal) due to AC coupling. - Press DC of A and B; check if correct square wave signals are displayed. - Press "0" of A and B, check if two lines are displayed. - Press DC of channel A and B. - Press A+B - Check if 3 square wave signals are displayed: channels A and B each 4 div. trace height and A+B with 8 div. trace height.
	MEASURING RESULTS	

3.2	SUBJECT	Visual Signal Delay
	TEST EQUIPMENT	Square wave calibration generator (PG506)
	INPUT VOLTAGE	Fast-rise input signal 1MHz, ≤1ns, 0,5 V to input A
	SETTINGS	- Apply fast-rise input signal to input A - Press AUTO SET - Press B (only A on) and 50 ohm (50 ohm on) - Set Y AMPL of A to 100 mV/div. - Set MAIN TB to 50 ns/div. - Press TB MAGN and turn X POS - Press TRIG and turn LEVEL MTB fully anti-clockw. - Turn LEVEL MTB slowly clockwise until instrument is just triggered - Set INTENSITY (TRACE) fully clock-wise
	REQUIREMENTS	- Check if visual signal delay is 20 ns (typical)
	MEASURING RESULTS	
3.3	SUBJECT	Delay Difference between input A (B) and ext.TRIG VIEW
	TEST EQUIPMENT	Square wave calibration generator. (PG506)- 50 ohm T piece PM9584 and 50 ohm terminator (for EXT)
	INPUT VOLTAGE	Fast-rise input signal 1MHz, 0,5V, ≤1ns via 50 ohm T piece to input A(B) and to MTB TRIG or X DEFL input via 50 ohm terminator
	SETTINGS	- Apply fast-rise input signal to input A and MTB TRIG or X DEFL. - Press AUTO SET and press B and TRIG VIEW - Press EXT - Set Y AMPL of A to 100mV - Press 50 ohm of A and TB MAGN - Set INTENSITY (TRACE) fully clock-wise - Set MAIN TB to 1ns
	REQUIREMENTS	- Check if delay difference between the two displayed signal slopes is ≤2 ns (typical) 2 div.
	MEASURING RESULTS	
3.4	SUBJECT	Channel isolation of Deselected Channel
	TEST EQUIPMENT	Sine-wave calibration generator (SG503)
	INPUT VOLTAGE	Sine-wave signal 100MHz, 4 V to input A(B)

	SETTINGS	- Apply sine-wave input signal to input A(B) - Press AUTO SET, and 50 Ohm on - Set the trace height to 8 div. (500 mV/div.) - Press B(A) (channel with input signal off). - Set Y AMPL of B(A) to 10 mV/DIV.
	REQUIREMENTS	- Check if trace height of channel without input signal B(A) is $\leq$ 4 div. (100:1)
	MEASURING RESULTS	
3.4.1	SUBJECT	Channel isolation between Selected Channels
	TEST EQUIPMENT	HF sine-wave generator (SG504)
	INPUT VOLTAGE	400 MHz sine-wave signal, 4 V to input A(B)
	SETTINGS	- Apply HF-sine wave signal to input A(B) - Press AUTO SET and 50 Ohm - Set the trace height to 8 div. (500 mV/div.) - Set the Y AMPL of both channels to 500 mV/div.
	REQUIREMENTS	- Check if trace height of channel without input signal B(A) is $\leq$ 0,16 div.
	MEASURING RESULTS	
3.5	SUBJECT	Y-Signal Output
	TEST EQUIPMENT	Fast-rise square-wave generator (PG506)
	INPUT VOLTAGE	Square-wave signal of 1 kHz (fast-rise)
	SETTINGS AND REQUIREMENTS	- Press AUTO SET - Connect the Y-output signal to the channel B(A) input socket. - Adjust channel B(A) to an input sensitivity of 10 mV/div. and 50 Ohm input impedance (DC coupled) - Press 50 ohm of A(B) (50 Ohm on) - Trigger the DEL´D TB on channel A(B) with AC-coupled filter. - Adjust the MAIN TB to a sweep of 200 us/div. - Trigger the MAIN TB on channel A(B) with AC-coupled filter - Apply a 1 kHz/6 div. square-wave signal to the channel A(B) input (DC-coupled) Y AMPL of A(B) to 100 mV/div. - Check if the amplitude of the square-wave displayed via channel B is equal to the channel A display (+or- 10%; or +or- 0,6 div.) - Set 50 Ohm of B(A) off. - Set Y AMPL of B(A) to 20 mV/div.

		- Check if the amplitude of the square-waves are equal (+or- 10%; or +or- 0,6 div.) - Increase the frequency of the square-wave signal applied to channel A(B) to 1 MHz (rise-time $\leq$ 1 ns) - Set 50 ohm of B(A) on - Set Y AMPL of B(A) to 10 mV/div. - Set MAIN TB to 200 ns/div. - Press TRIG DTB (DTB trigger coupling) - Press DC of DTB trigger coupling - Check if signal displayed via B(A) has a dc shift. - Press LF REJ of DTB trigger coupling - Check if the top of the square wave signal displayed via B(A) is not flat. - Press HF REJ; check if AC and HF REJ are on - Check if the signal displayed via B(A) is changed into a triangle shaped signal. - Press DC (DTB trigger coupling) twice (HF REJ off) - Connect the Y-output signal to the channel A input socket. - Adjust channel A to an input sensitivity of 10 mV/div. and 50 Ohm input impedance. - Select A as MTB trigger source. - Apply a 1 kHz/500 mV square-wave signal to the EXTernal trigger input of the DEL'D TB (DTB TRIG) - Select the EXTernal trigger input as DEL'D TB trigger source - Adjust the MAIN TB to a sweep speed of 500 us/div. - Check if a square-wave signal is displayed via A with an amplitude of 5 div. (+or- 10%; or +or- 0,5 div.) - Press EXT:10 (DTB trigger source) - Check if the trace height is reduced to 0,5 div. (+or- 10%; or +or- 0,05 div.)
MEASURING RESULTS		
3.5.1	SUBJECT	Frequency Response of Y signal output
	TEST EQUIPMENT	HF sine-wave generators (SG503 and SG504)
	INPUT VOLTAGE	Constant amplitude Sine-wave signal: dc...300 MHz
	SETTINGS AND REQUIREMENTS	- First the channel A bandwidth in 10 mV/div must be measured: adjust the amplitude of the 50 kHz sinewave to 6 div. Now increase the frequency to such a value that the signal amplitude at the screen decreases to 4,2 div. Now read the frequency of this signal (bandwidth of A = Fa) - Apply the Y OUT signal to input B. - Set Y AMPL of B to 10 mV/div (50 Ohm on and DC coupled).

- Trigger the DEL´D TB on channel A with AC-coupled filter.
- Set the MAIN TB to 200 us/div.
- Trigger the MAIN TB on channel B with AC-coupled filter.
- Apply a 50 kHz/6 div. sine-wave signal to input A
- Set the amplitude of the signal displayed via B to exactly 6 div. as reference.
- Check the overall bandwidth (channel A and Y OUT) by increasing the frequency of the input signal on A till the amplitude displayed via B is 4,2 div. (-3dB) (overall bandwidth = Fo)
- The bandwidth of the Y OUT-put can be calculated with the formula:

$$\frac{1}{\sqrt{\frac{1}{(Fo)^2} - \frac{1}{(Fa)^2}}} = \text{Y OUT bandwidth}$$

Y OUT bandwidth must be dc...typical 300 MHz (-3dB)

MEASURING RESULTS

3.6 SUBJECT: Vertical Deflection coefficients and input coupling of Channels A and B (characteristics section 2.2.3)

TEST EQUIPMENT: Square-wave calibration generator (PG506)

INPUT VOLTAGE: Square-wave signal 1 kHz to input A(B), amplitude 5 mVpp...20 Vpp in 1-2-5 steps

SETTINGS AND REQUIREMENTS:

- Apply a 1 kHz square wave signal of 5 mV to input A(B)
- Press DC and 50 ohm must be off (BW LIMIT on)
- Set the Y AMP to 1 mV/div.
- Check if the amplitude of the signal is 5 div. (+or- 2%)
- Increase the input amplitude and Y AMPL with the following steps:

Input voltage (pp)	Y AMPL setting	Requirements	Measuring results
10 mV	2 mV	5 div.(+or-2%)	
20 mV	5 mV	4 div.(+or-2%)	
50 mV	10 mV	5 div.(+or-2%)	
0,1 V	20 mV	5 div.(+or-2%)	
0,2 V	50 mV	4 div.(+or-2%)	
0,5 V	100 mV	5 div.(+or-2%)	
1 V	200 mV	5 div.(+or-2%)	
2 V	500 mV	4 div.(+or-2%)	
5 V	1 V	5 div.(+or-2%)	
10 V	2 V	5 div.(+or-2%)	
20 V	5 V	4 div.(+or-2%)	

3.6.1	SUBJECT	Vernier Ratio (continued procedure of 3.6) VAR
	SETTING	- Turn VAR control fully anti-clockwise
	REQUIREMENTS	- Check if displayed amplitude $\leq$1,6 div. (1:2,5)
	MEASURING RESULTS	
3.6.2	SUBJECT	Input coupling (continued procedure of 3.6.1)
	SETTINGS AND REQUIREMENTS	- Turn VAR control fully clockwise. - Press "0"; check if input signal is interrupted. - Press AC and then DC; check if the displayed signal is shifted upwards.
	MEASURING RESULTS	
3.7	SUBJECT	Input impedance and capacitance (1 Mohm and 50 Ohm)
	TEST EQUIPMENT	Calibrated square-wave signal 1 kHz (PG506) via input dummy to input A(B). Dummy for 1 Mohm input: 1 Mohm resistor in parallel with a capacitor of 9 pF.
		1 Mohm Input impedance
	INPUT VOLTAGE	Square-wave signal 1 kHz to input A(B) via dummy, amplitude 10 mVpp...50 Vpp in 1-2-5 steps
	SETTINGS AND REQUIREMENTS	- Apply calibrated square-wave signal of 10 mV via dummy to input A(B) (1 Mohm input) - Check the amplitude of the displayed signals according the table below:

Input voltage (pp) via dummy	Y AMPL setting	Requirements	Measuring results
10 mV	1 mV	5 div.(+or-2%)	
20 mV	2 mV	5 div.(+or-2%)	
50 mV	5 mV	5 div.(+or-2%)	
0,1 V	10 mV	5 div.(+or-2%)	
0,2 V	20 mV	5 div.(+or-2%)	
0,5 V	50 mV	5 div.(+or-2%)	
1 V	100 mV	5 div.(+or-2%)	
2 V	200 mV	5 div.(+or-2%)	
5 V	500 V	5 div.(+or-2%)	
10 V	1 V	5 div.(+or-2%)	
20 V	2 V	5 div.(+or-2%)	
50 V	5 V	5 div.(+or-2%)	

- Remove input signal.

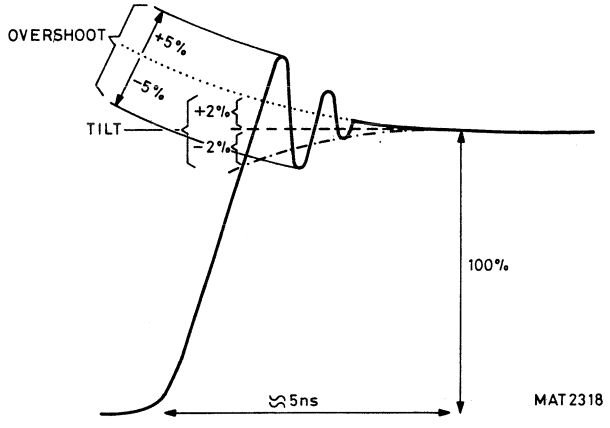
		50 Ohm input impedance
	INPUT VOLTAGE	Fast-rise square-wave signal to input A (50 Ohm output of PG506)
	SETTINGS	- Apply fast-rise signal of 0,5 V to input A(B) - Press AUTO SET; 50 Ohm off . - Set Y AMPL to 100 mV/div. - Set trace height to 5 div. - Press 50 Ohm (50 Ohm on)
	REQUIREMENTS	- Check that the displayed signal has a trace height of 2,5 div. +or- 1%.
	MEASURING RESULTS	
3.8	SUBJECT	Vertical Dynamic range
	TEST EQUIPMENT	Constant amplitude sine-wave generator
	INPUT VOLTAGE	Sine-wave signal of 100 MHz, 2,4 Vpp to input A(B)
	SETTINGS	- Apply sine-wave signal of 100 MHz, 2,4 Vpp to input A(B). - Set Y AMPL to 100 mV/div. - Shift with the Y POS control the sine-wave vertically over the screen.
	REQUIREMENT	- Check if the top and bottom of the sine-wave signal can be displayed distortion-free (24 div. trace height). Compression at limits: 7%
	INPUT VOLTAGE	Sine-wave signal of 350 MHz, 1,6 Vpp to input A(B)
	SETTINGS	- Set Y AMPL to 200 mV/div. - Increase the frequency of the input signal up to 350 MHz, trace height 8 div.
	REQUIREMENT	- Check if a sine-wave signal of 8 div. is displayed distortion-free. Compression at limits: 7%
	MEASURING RESULTS	
3.9	SUBJECT	LF linearity (vertical)
	TEST EQUIPMENT	LF square-wave generator
	INPUT VOLTAGE	Square-wave signal 50 kHz, 200 mV to input A(B)

	SETTINGS	- Set Y AMPL to 100 mV/div. - Set the square-wave signal in the vertical centre of the screen. - Adjust the square-wave signal to exactly 2 div. trace height. - Shift the signal with the Y POS control to the two upper and lower div. of the screen.
	REQUIREMENT	- Check if the trace height in the two upper and lower div. is 2 div. +or-0,1 div.
	MEASURING RESULTS	
3.10	SUBJECT	Shift range (vertical)
	TEST EQUIPMENT	LF Sine-wave generator
	INPUT VOLTAGE	Sine-wave signal of 1 kHz, 8 V to input A(B)
	SETTINGS	- Adjust the channel A (B) input sensitivity to 1 V/div. - Apply a sine-wave of 1 kHz/8 div. to the channel A (B) input. - Adjust the channel A (B) input sensitivity to 500 mV/div. - Rotate the channel A (B) Y POS control fully clockwise and anti-clockwise
	REQUIREMENT	- Check if the top and the bottom of the signal can be positioned on the vertical centre line of the screen.
	MEASURING RESULTS	
3.11	SUBJECT	Frequency response (in 50 Ohm and 1 Mohm position)
	TEST EQUIPMENT	Constant amplitude sine-wave generator (SG503, SG504) and PM5129 (for LF range 1 Hz...250 KHz)
	INPUT VOLTAGE	Constant amplitude sine-wave signal, 30 mV frequency 50 kHz...400 MHz to input A (B). Input impedance 50 Ohm
	SETTINGS AND REQUIREMENTS	- Set Y AMPL to 5 mV/div. - Apply 50 kHz sine-wave signal to A (B) via 26 dB att. - Adjust trace height to exactly 6 div. - Increase the frequency of the input signal up to 400 MHz. - Check if the vertical deflection is $\geq$ 4,2 div. (-3 dB) over the complete bandwidth range between 10 Hz and 400 MHz.

		- Reduce the amplitude of the input signal to 6 mV and the frequency to 50 kHz. - Set Y AMPL to 1 mV. - Adjust the trace height to exactly 6 div. - Increase the frequency up to 70 MHz. - Check if the vertical deflection is $\geq$ 4,2 div. (-3 dB) over the complete bandwidth range between 10 Hz and 70 MHz (typical) Input impedance 1 Mohm - Same procedure as for 50 Ohm (input voltage lower via 50 Ohm att.of 26 dB and external 50 Ohm terminator) - Check if the vertical deflection is $\geq$ 4,2 div. over the frequency range of 1 Hz up to 400 MHz in the setting 5 mV/div. - And check for the 1 mV/div. setting if the vertical deflection is $\geq$ 4,2 div. over the frequency range of 1 Hz up to 70 MHz.
	MEASURING RESULTS	
3.12	SUBJECT	Bandwidth limiter
	TEST EQUIPMENT	Constant amplitude sine-wave generator (SG503)
	INPUT VOLTAGE	- Sine-wave signal of 20 MHz, 30 mV to input A (B)
	SETTINGS	- Set Y AMPL to 5 mV/div. (50 Ohm on) - Adjust the trace heigt to exactly 6 div. - Press BW LIMIT 20 MHz
	REQUIREMENTS	- Check if the amplitude of the signal is $\geq$ 4,2 div. (-3 dB)
	MEASURING RESULTS	
3.13	SUBJECT	Pulse repsonse (in 50 Ohm and 1 Mohm position)
	TEST EQUIPMENT	Fast-rise square-wave generator (PG506)
	INPUT VOLTAGE	Fast-rise square-wave signal ($\leq$ 1 ns) to input A (B)
	SETTINGS AND REQUIREMENTS	Note: Take the pulse distortion of the calibration generator (2%) into account when performing the now following calibration steps. Check the calibration generator with a sampling oscilloscope. The pulse response of the signal at the output of the generator is optimal with max. pulse amplitude.

Pulse response (50 Ohm input impedance)

- The required fast rise-time square-wave must be obtained from the square-wave generator.
- Adjust channel A (B) to an input sensitivity of 20 mV/div.
- Select DC and 50 Ohm (generator termination) for channel A (B)
- Apply a 10 kHz/6 div. square-wave signal with 1 ns rise-time to input A (B)
- Set the MAIN TB to 20 us/div.
- Check the square-wave response; overshoot 5% or less.
- Apply a 100 kHz/6 div. square-wave signal with a 1 ns rise-time to input A(B)
- Set the MAIN TB to 2 us/div.
- Check the square-wave response; overshoot 5% or less.
- Apply a 1 MHz/6 div. square-wave signal with a rise-time of 1 ns to input A (B)
- Set the MAIN TB to 10 ns/div.
- Check the pulse response according the figure below; overshoot +or- 5% and tilt +or- 2%



Pulse response (1 M Ohm input impedance)

- As described for 50 Ohm input impedance, only input signal must be applied to input A (B) via an external 50 Ohm terminator (50 Ohm output of generator)
- Check the square-wave response; overshoot 6% or less (tilt is not specified for the 1 M Ohm position)

MEASURING RESULTS

3.14	SUBJECT	Rise-Time (in 50 Ohm and 1 M Ohm position)
	IMPORTANT	FOR BOTH INPUT IMPEDANCES, THE RISE TIME IS A CALCULATED VALUE, ACCORDING FORMULA: BANDWIDTH X RISE-TIME = 0,35
	TEST EQUIPMENT	Fast-rise square-wave generator (PG506)
	INPUT VOLTAGE	Fast-rise square-wave signal $\leq$ 1 ns to input A (B) frequency: 1MHz. - In 50 Ohm position: output of generator directly connected to input A (B) - In 1 M Ohm position: output of generator via 50 Ohm terminator to input A (B)
	SETTINGS	- Set Y AMPL to 50 mV/div (in setting 2 mV/div, input signal via 50 Ohm attenuator 100:1). - Set MAIN TB to 10 ns/div. - Adjust the trace height exactly between the dotted lines 0% and 100% (5 div.) - Press TB MAGN
	REQUIREMENTS	Important: $T_R(\text{measured}) = \sqrt{T_R(\text{input signal})^2 + T_R(\text{oscilloscope})^2}$ - Check the rise-time, measured between the 10% and 90% lines (4 div.). The now following rise-times are based upon a generator rise-time of 0,9 ns. If your generator differs from this value, you must recalculate with the above formula. * rise-time in 50 Ohm position (1 mV and 2 mV excluded): Ch. A(B): 1,25 ns or less Oscilloscope-only rise time: 0,88 ns * rise-time in 1 M.Ohm position (1 mV and 2 mV excluded): Ch. A(B): 1,25 ns or less Oscilloscope-only rise time: 0,88 ns * rise-time in 1 mV and 2 mV/div. settings: Ch. A(B): 5,1 ns or less Oscilloscope-only rise time: 5 ns
	MEASURING RESULTS	
3.15	SUBJECT	Base line instability (Jump)

		Attenuator balance between any V/div. setting
	SETTINGS AND REQUIREMENTS	- This adjustment is done in the service routine "attenuator unit test". Proceed as follows to come into this routine: depress the channel A and B INVERT pushbuttons together, then depress the vertical display mode switch A two times, then depress switch A. - Now the channel A input sensitivity switches automatically between 5 mV and 500 mV. - Check if the trace jump of channel A is $\leq$ 0,2 div. - Press AUTO SET (1 time) - Press B - Now the channel B sensitivity switches automatically between 5 mV and 500 mV. - Check if the trace jump of channel B is $\leq$ 0,2 div. - Press AUTO SET 4 times to leave the service routine.
	MEASURING RESULTS	
3.16	SUBJECT	Common Mode Rejection Ratio
	TEST EQUIPMENT	HF constant Amplitude sine-wave generator (SG503)
	INPUT VOLTAGE	Sine wave signal 1 MHz (50 MHz), 4 Vpp to inputs A and B (via 50 Ohm T-piece PM9584)
	SETTINGS	- Set Y AMPL of A and B to 500 mV/div. (8 div.) - Press DC of input coupling of channels A and B - Press INVERT of channel B - Adjust the VAR controls for minimum trace height difference of channel A and B - Press A+B
	REQUIREMENT	- Check if the trace height of the A+B signal is $\leq$ 0,08 div. with an input signal of 1 MHz and $\leq$ 0,4 div. with an input signal of 50 MHz.
	MEASURING RESULTS	
4.		TRIGGER VIEW (characteristics section 2.2.4)
4.1	SUBJECT	Deflection coefficient via A, B and EXT.
	TEST EQUIPMENT	Square-wave calibration generator (PG506)
	INPUT SIGNAL	Square-wave signal 1 kHz, amplitude given in table.

		TRIG VIEW via A(B)
	SETTINGS	- Apply the square-wave signal to input A(B) - Press TRIG VIEW (TRIG VIEW on) - Select A(B) as MTB trigger source - Select DC for MTB trigger coupling
	REQUIREMENT	- Check the amplitude of the TRIG VIEW signal according the table given in section 3.6 of this performance check. IMPORTANT: the error limit of the amplitudes displayed via TRIG VIEW is +or- 5%!!
	MEASURING RESULTS	
		TRIG VIEW via EXT and EXT:10
	INPUT SIGNAL	Square-wave signal 1 kHz, 500 mV to input MTB TRIG or X DEFL.
	SETTINGS	- Select EXT as MTB trigger source.
	REQUIREMENT	- Check if the square-wave signal displayed via TRIG VIEW has an amplitude of 5 div. (+or- 5%)
	MEASURING RESULTS	
	SETTINGS	- Select EXT:10 as MTB trigger source - Increase the amplitude of the input signal to 5 V.
	REQUIREMENT	- Check if the amplitude of the square-wave displayed via TRIG VIEW is 5 div. (+or- 5%)
	MEASURING RESULTS	
4.2	SUBJECT	Dynamic Range (TRIG VIEW)
	TEST EQUIPMENT	Constant amplitude sine-wave generator
	INPUT VOLTAGE	Sine-wave signal of 100 MHz, 2,4 Vpp to input A
	SETTINGS	- Press TRIG VIEW (TRIG VIEW on) and TRIG - Set Y AMPL to 100 mV/DIV. - Shift with the MTB LEVEL control the sine-wave signal displayed via TRIG VIEW vertically over the screen.
	REQUIREMENT	- Check if the top and bottom of the sine-wave signal can be displayed distortion free (24 div. trace height) Compression at limits: 7%
	MEASURING RESULTS	

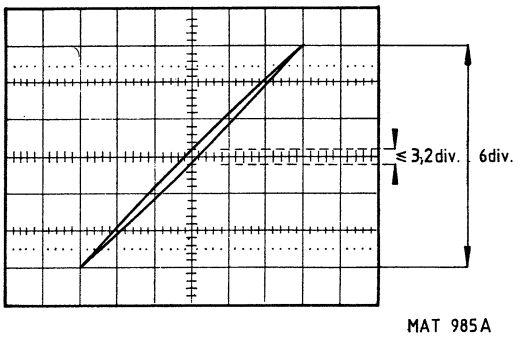
4.3	SUBJECT	Line deflection
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	- Select LINE as MTB trigger source - Press X DEFL.
	REQUIREMENT	- Check if horizontal deflection is 6 div. or more at mains frequency of 49 Hz...61 Hz.
	MEASURING RESULTS	
4.4	SUBJECT	Frequency response INT and EXT (TRIGGER VIEW)
	TEST EQUIPMENT	Constant amplitude sine-wave generator INT (via A and B)
	INPUT VOLTAGE	Constant amplitude sine-wave signal, 30 mV, freq. 50 kHz...350 MHz to input A(B)
	SETTINGS	- Set Y AMPL to 5 mV/div. - Adjust the trace height to exactly 6 div. - Press TRIG VIEW (only TRIG VIEW on) - Select A(B) as MTB trigger source and AC as MTB trigger coupling - Increase the frequency up to 350 MHz
	REQUIREMENTS	- Check if the vertical deflection via TRIG VIEW is $\geq$ 4,2 div.
	MEASURING RESULTS	
		EXT (via EXT and EXT:10)
	INPUT VOLTAGE	Constant amplitude sine-wave signal, 600 mV, freq. 50 kHz...370 MHz to input MTB TRIG or X DEFL.
	SETTINGS	- Select EXT as MTB trigger source - Adjust the trace height to exactly 6 div. - Increase the frequency up to 370 MHz.
	REQUIREMENT	- Check if the vertical deflection via TRIG VIEW is $\geq$ 4,2 div.

	MEASURING RESULTS	
4.5	SUBJECT	Rise-time (TRIG VIEW)
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	-
	REQUIREMENT	Rise time of trigger view is a calculated value according the formula: Bandwidth x rise-time = 0,35
	MEASURING RESULTS	
4.6	SUBJECT	Trigger point
	TEST EQUIPMENT	LF sine-wave generator
	INPUT VOLTAGE	Sine wave signal 50 kHz, 6 div trace height to input A
	SETTINGS	- Press AUTO SET - Set the trace height to 6 div. - Press TRIG of MTB trigger mode selector - Set the MAIN TB LEVEL control exactly in its mid position - Select TRIG VIEW for vertical deflection; A and B off.
	REQUIREMENTS	- Check if the sine wave signal is in the vertical mid-position of the screen
	MEASURING RESULTS	
5.		HORIZONTAL DEFLECTION OR X-AXIS (characteristics section 2.2.5)
	5.1 SUBJECT	Horizontal Deflection Sources and trace separation
	TEST EQUIPMENT	LF sine-wave generator
	INPUT VOLTAGE	Sine wave signal 2 kHz, 3 div. trace height to input A

	SETTINGS AND REQUIREMENTS	- Press AUTO SET, and press B; only A on - Set the trace height to 3 div. (MTB trace) - Set the MAIN TB to 500 us/div. - Press MTB INTENS - Set the DEL TB to 20 us/div. - Check if intensified part (DTB) is visible and if it can be shifted horizontally by the DELAY or delta t control - Press delta t - Check if MTB INTENS and delta t are on and if two intensified parts are visible and if the second intensified part can be horizontally shifted by the DELAY or delta t control - Press DTB - Check if DTB, delta t and MTB INTENS are on and if the MTB INTENS trace with two intensified parts and two DTB traces that cover each-other are displayed over the complete screen width - Set the TRACE SEP fully clockwise - Check if the MTB INTENS trace and the two DTB traces cover each other completely. - Set the trace in vertical mid-position - Set TRACE SEP fully anti-clockwise - Check if the traces are separated at least 4 div; MTB INTENS 2 div. upwards and the two DTB traces 2 div. downwards. - Press EXT X DEFL - Check if only EXT X DEFL is on of the horizontal deflection source selector. - Press A of MTB trigger source - Check if a line under an angle of 45° is displayed. - Remove input signal of A - Apply a sine wave signal 2 kHz, 600 mV to MTB TRIG or X DEFL input - Press EXT and EXT:10 and LINE - Check if a horizontal line is displayed.
	MEASURING RESULTS	
5.2	SUBJECT	Horizontal shift range
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal of 1 ms to input A.
	SETTINGS AND REQUIREMENTS	- Set MAIN TB to 100 us/div. - Set a marker pulse on the first and last vertical graticule line - Set X POS fully clockwise. - Check if the first marker pulse is at the right side of the horizontal centre line - Set X POS fully anti-clockwise - Check if the last marker pulse is at the left side of the horizontal centre line.

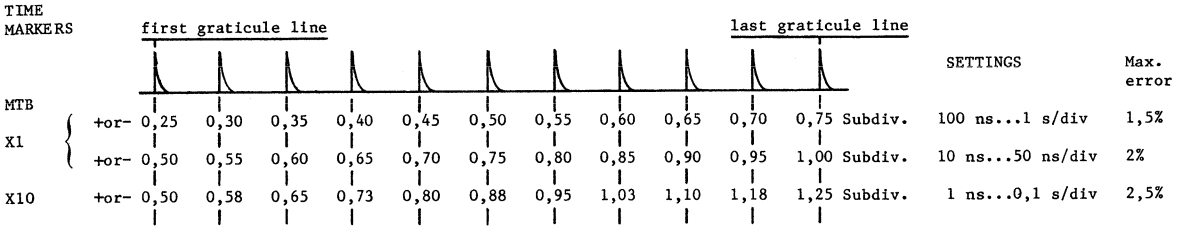
5.3	SUBJECT	Horizontal Deflection coefficients
	TEST EQUIPMENT	Sine wave generator
	INPUT VOLTAGE	Sine wave signal 2 kHz, 4 div. trace height to input A
	SETTINGS	- Press EXT X DEFL - Press A of vertical mode; only B on - Press A as X DEFL source
	REQUIREMENT	- Check if a horizontal line of 4 div. is displayed (+ or -2%)
	INPUT VOLTAGE	- Sine wave signal 2 kHz, 1 V to input MTB TRIG or X DEFL
	SETTINGS AND REQUIREMENTS	- Press EXT as X DEFL source - Check if a horizontal line of 10 div. (+or- 5%) is displayed. - Press EXT:10 - Check if a horizontal line of 1 div. (+or- 5%) is displayed.
	MEASURING RESULTS	
5.4	SUBJECT	Maximum linearity error and line deflection
	TEST EQUIPMENT	LF sine-wave generator
	INPUT VOLTAGE	Sine-wave signal, 1 kHz, 8 div. trace height to input A
	SETTINGS	- Set the Y AMPL of A to 200 mV/div. - Adjust the trace height to exactly 8 div. - Press EXT X DEFL - Press A of vertical display mode; only B on - Adjust the trace width to exactly 8 div. - Set Y APML of A to 2 V/div. - Turn the X POS control
	REQUIREMENTS	- Check if the horizontal deflection at the most lefthand side and righthand side of the screen is 0,8 div. (+or- 5%)
	SETTINGS	- Press LINE for horizontal deflection
	REQUIREMENT	- Check if the horizontal deflection if 7 div. +or- 1,5 div. (mains frequency: 49 Hz...61 Hz)
	MEASURING RESULTS	

5.5	SUBJECT	Frequency response (horizontal)
	TEST EQUIPMENT	Constant amplitude sine-wave generator (PG506)
	INPUT VOLTAGE	Constant amplitude sine-wave signal, 30 mV, 50 kHz...2 MHz to input A
	SETTINGS	- Set Y AMPL of A to 5 mV/div - Apply a 50 kHz sine-wave signal to input A - Adjust the trace height to exactly 6 div. - Press EXT X DEFL - Press A of vertical display mode; only B on - Press A as horizontal deflection source - Adjust the input voltage for exactly 6 div. horizontal deflection - Increase the frequency of the input signal up to 2 MHz
	REQUIREMENTS	- Check if the trace width is $\geq$ 4,2 div. (-3 dB) over the complete bandwidth range.
	MEASURING RESULTS	
5.6	SUBJECT	Maximum phase difference between horizontal and vertical deflection.
	TEST EQUIPMENT	LF sine-wave generator
	INPUT VOLTAGE	Sine wave signal, 2 kHz...100 kHz, trace height 6 div.
	SETTINGS	- Press EXT X DEFL - Press A for horizontal deflection - Set the trace height to exactly 6 div. - Increase the input frequency up to 100 kHz.
	REQUIREMENT	- Check if the phase shift $\leq 3^{o}$ (see Fig. below)
	MEASURING RESULTS	



MAT 985A

6.		MAIN TIME BASE (characteristics, section 2.2.6)
6.1	SUBJECT	Deflection coefficient (MTB)
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 10 ns...1 s
	SETTINGS	- Apply a time marker signal of 10 ns to input A - Press 50 Ohm of A (50 Ohm on) - Press AUTO SET
	REQUIREMENTS	- Check the deflection coefficients in TB MAGN OFF and TB MAGN ON according the table below: IMPORTANT: Time base accuracy must be measured according specification over 8 unmagnified or 80 magnified central divisions. The error limit is splitted up into two values (error of full scale and error of reading). The maximum deviation of the marker pulses with respect to the graticule lines may be as given in the figure below:

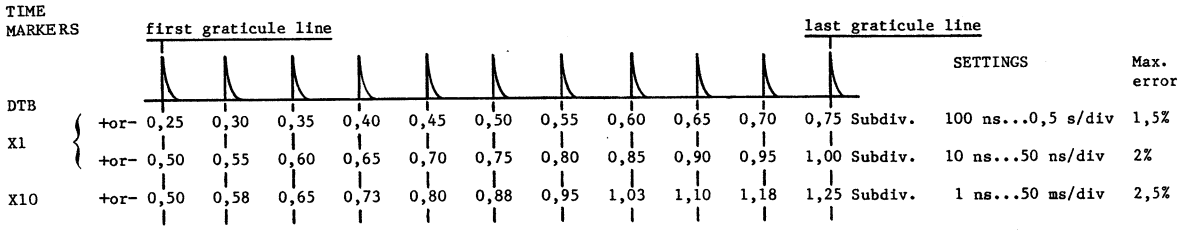


Time marker pulse	MAIN TB setting ../div	Max. coeff. error TB MAGN OFF (x1)	Max. coeff. error TB MAGN ON (x10)	Measuring results
10 ns	10 ns	2%	2,5%	
20 ns	20 ns	2%	2,5%	
50 ns	50 ns	2%	2,5%	
0,1 us	100 ns	1,5%	2,5%	
0,2 us	200 ns	1,5%	2,5%	
0,5 us	500 ns	1,5%	2,5%	
1 us	1 us	1,5%	2,5%	
2 us	2 us	1,5%	2,5%	
5 us	5 us	1,5%	2,5%	
10 us	10 us	1,5%	2,5%	
20 us	20 us	1,5%	2,5%	
50 us	50 us	1,5%	2,5%	
0,1 ms	100 us	1,5%	2,5%	
0,2 ms	200 us	1,5%	2,5%	
0,5 ms	500 us	1,5%	2,5%	

Time marker pulse	MAIN TB setting ../div	Max. coeff. error TB MAGN OFF (x1)	TB MAGN ON (x10)	Measuring results
1 ms	1 ms	1,5%	2,5%	
2 ms	2 ms	1,5%	2,5%	
5 ms	5 ms	1,5%	2,5%	
10 ms	10 ms	1,5%	2,5%	
20 ms	20 ms	1,5%	2,5%	
50 ms	50 ms	1,5%	2,5%	
0,1 s	100 ms	1,5%	2,5%	
0,2 s	200 ms	1,5%	-	
0,5 s	500 ms	1,5%	-	
1 s	1 ms	1,5%	-	

6.2	SUBJECT	Vernier Ratio (VAR MTB) and TB Magnification
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 1 us to input A
	SETTINGS	- Set MAIN TB to 200 ns/div; marker on first and sixth graticule line - Press B of vertical display mode; only A on - Set the MTB VAR fully anti-clockwise - Press 50 Ohm (50 Ohm on)
	REQUIREMENT	- Check if the VAR control range overlaps the time base steps 200 ns to 500 ns; first marker on first graticule line and second marker on the third graticule line or closer to the first marker (2,5:1)
	SETTINGS	- Set the MTB VAR control fully clockwise - Set the top of the second marker pulse exactly in the centre of the graticule - Press TB MAGN (on)
	REQUIREMENT	- Check if the top of the second marker pulse is not shifted more than +or- 0,4 div. (2 subdivisions)
	MEASURING RESULTS	
6.3	SUBJECT	Variable Hold Off
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 10 ns to input A
	SETTINGS	- Set Hold-off control fully clockwise - Turn Hold-off anti-clockwise
	REQUIREMENT	- Check if the trace intensity decreases (with in theory a factor of 6 times the minimum Hold Off)

	MEASURING RESULTS	
6.4	SUBJECT	Main Time Base Gate Out
	TEST EQUIPMENT	-
	INPUT VOLTAGE	MTB Gate Out (rear side) connected to input A
	SETTINGS	- Set MAIN TB to 10 us/div (AUTO triggering) - Set Y AMPL of A to 2 V/div. - Press DC of channel A input coupling
	REQUIREMENT	- Check if at the start of the sweep a leading edge is visible which if switching between 0 V and 5 V (time base running: level must be between 2,4 V...5 V)
	MEASURING RESULTS	
7.		DELAYED TIME BASE (characteristics section 2.2.7)
7.1	SUBJECT	Deflection Coefficients (DTB)
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 0,5 s...10 ns to input A
	SETTINGS	- Press 50 Ohm (50 Ohm on) - Press AUTO SET - Press DTB and MTB INTENS of horizontal display mode switches; only DTB on - Set MAIN TB to 500 ms/div. - Turn DELAY or delta t control fully anti-clockwise - Set DEL´D TB to 500 ms/div. - Press STARTS DTB (on)
	REQUIREMENTS	- Check the deflection coefficients in TB MAGN OFF and TB MAGN ON according the table below: IMPORTANT: Time base accuracy must be measured according specification over 8 unmagnified or 80 magnified central divisions. The error limit is splitted up into two values (error of full scale and error of reading). The maximum deviation of the marker pulses with respect to the graticule lines may be as given in the figure below:



Attention: To check the time coefficients according the table below the MAIN TB control must be operated (DTB setting is electrically coupled with MTB setting

MAIN TB setting	Time marker pulse	DEL'D TB setting ../div	Max.coeff.error TB MAGN OFF (x1)	TB MAGN ON (x10)	Measuring results
500 ms	0,5 s	500 ms	1,5%	-	
200 ms	0,2 s	200 ms	1,5%	-	
100 ms	0,1 s	100 ms	1,5%	-	
50 ms	50 ms	50 ms	1,5%	2,5%	
20 ms	20 ms	20 ms	1,5%	2,5%	
10 ms	10 ms	10 ms	1,5%	2,5%	
5 ms	5 ms	5 ms	1,5%	2,5%	
2 ms	2 ms	2 ms	1,5%	2,5%	
1 ms	1 ms	1 ms	1,5%	2,5%	
500 us	0,5 ms	500 us	1,5%	2,5%	
200 us	0,2 ms	200 us	1,5%	2,5%	
100 us	0,1 ms	100 us	1,5%	2,5%	
50 us	50 us	50 us	1,5%	2,5%	
20 us	20 us	20 us	1,5%	2,5%	
10 us	10 us	10 us	1,5%	2,5%	
5 us	5 us	5 us	1,5%	2,5%	
2 us	2 us	2 us	1,5%	2,5%	
1 us	1 us	1 us	1,5%	2,5%	
500 ns	0,5 us	500 ns	1,5%	2,5%	
200 ns	0,2 us	200 ns	1,5%	2,5%	
100 ns	0,1 us	100 ns	1,5%	2,5%	
50 ns	50 ns	50 ns	2%	2,5%	
20 ns	20 ns	20 ns	2%	2,5%	
10 ns	10 ns	10 ns	2%	2,5%	

23

7.2	SUBJECT	Vernier Ratio (VAR DTB) and TB magnifier
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 1 us to input A (50 Ohm on)
	SETTINGS	- Set MAIN TB to 200 ns/div. - Press B of vertical display mode; only A on - Press DTB of horizontal display mode; DTB and MTB INTENS on

		- Set with the DELAY or delta t control the intensified part (DTB) on the second marker pulse - Set the marker pulse displayed via the DTB on the first and the second marker on the sixth graticule line (X POS) - Set the DTB VAR control fully anti-clockwise.
	REQUIREMENT	- Check if the DTB VAR control shifts the second marker pulse displayed via the DTB to the third graticule line or closer to the first marker (2,5:1)
	SETTINGS	- Set the DTB VAR control fully clockwise - Set the top of the second marker pulse displayed via the DTB exactly in the centre of the graticule - Press TB MAGN (on)
	REQUIREMENT	- Check if the top of the second marker pulse displayed via the DTB is not shifted more than +or- 0,4 div. (2 subdivisions)
	MEASURING RESULTS	
7.3	SUBJECT	Delay Time and Time Difference (delta t)
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 10 us to input A via external 50 Ohm terminator
	SETTINGS AND REQUIREMENTS	- Press B of vertical display mode; only A on - Apply a time marker pulse of 10 us via a 50 terminator to input A - The now following adjustments must be done in te service routine "time base test". Proceed as follows to come into this routine: depress the channel A and B INVERT pushbuttons toghether, then depress vertical display mode switch A and then B. DELAY TIME - Press vertical display pushbutton TRIG VIEW - Set Y AMPL of A to 1 V/div. - Select a MAIN TB sweep speed of 10 microsec/div. - Select a DEL'D TB sweep speed of 1 microsec/div. - Adjust the control X POS so that the MAIN TB display starts exactly at the first vertical graticule line. - Check if the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and if the intensified part on the MAIN TB display starts after a delay of 2 div. (+or- 2,2%)

		- Press vertical display pushbutton A - Check if the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and if the intensified part on the MAIN TB display starts after a delay of 8 div. (+or- 2,2%) DELTA t - Press vertical display pushbutton A+B - Check if the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and if the intensified part on the MAIN TB display starts after a delay of 2 div. (0,6%) (Delay is 2 div.; delta T is Ø div.) - Press vertical display pushbutton B. - Check if the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and if the second intensified part on the MAIN TB display starts after a delay of 8 div. (0,6%) (Delay is 2 div.; delta T is 6 div.) - Press AUTO SET three times to leave the service routine.
	MEASURING RESULTS	
7.4	SUBJECT	DTB Position Range
	TEST EQUIPMENT	Time marker generator (TG501)
	INPUT VOLTAGE	Time marker signal 10 us to input A (50 Ohm on)
	SETTINGS AND REQUIREMENTS	- Press B of vertical display mode; only A on - Press DTB of horizontal display mode; MTB INTENS and DTB on - Set MAIN TB to 5 us/div - Set DEL'D TB to 500 ms/div. - Turn DELAY or delta t control fully anti-clockwise - Check if the first marker pulse displayed via the DTB is partly visible; more than 0,2 x MTB setting is 1 us (2 div.) and if the Delay Time in LCD is <1 us - Set the first marker displayed via the MTB exactly on the first graticule line - Turn DELAY or delta t fully clockwise - Check if the last marker pulse displayed via the DTB is completely visible and if the Delay Time displayed in the LCD is >49,5 us.
	MEASURING RESULTS	

7.5	SUBJECT	Maximum Jitter (DTB)
	TEST EQUIPMENT	Sine-wave generator
	INPUT SIGNAL	Sine-wave signal (1 MHz), 6 div. trace height to input A.
	SETTINGS	- Set the trace height to 6 div. - Press B of vertical display mode; only A on - Set MAIN TB to 1 ms - Press DTB of horizontal display mode. - Set DEL´D TB to 500 ns - Set the DELAY time to 5 ms - Press MTB INTENS; only DTB on
	REQUIREMENT	- Check if the jitter of the DTB trace is $\leq$ 1 div. (1 part per 20.000)
	MEASURING RESULTS	
7.6	SUBJECT	DTB Gate Out
	TEST EQUIPMENT	-
	INPUT SIGNAL	DTB Gate Out (rear side) to input A
	SETTINGS	- Press DC and B of verticl display mode, only A on - Set Y AMPL of A to 2 V/div. - Apply DTB gate out signal to input A - Set MAIN TB to 20 us/div. - Press MTB INTENS - Set DEL´D TB to 1 us/div. - Set the DELAY or delta t control to 100 us
	REQUIREMENT	- Check if the DTB gate out is visible and switches between 0 and 5 V (first 5 div. 0 V) DTB running: level must be between 2,4...5 V.
	MEASURING RESULTS	
8.		MTB TRIGGERING (characteristics, section 2.2.8)
8.1	SUBJECT	MTB Trigger Sources and trigger coupling
	TEST EQUIPMENT	Square-wave generator
	INPUT VOLTAGE	Square-wave signal 2 kHz, 4 div. trace height to input A(B) (EXT)

	SETTINGS AND REQUIREMENTS	- Press 20 MHz BW LIMIT (on) - Set the trace height to 4 div. - Press TRIG VIEW and A and B of vertical display mode; only TRIG VIEW on - Press DC of MTB trigger coupling - Check if a square wave signal is displayed of 4 div. - Press LF REJ of MTB trigger coupling - Check if a differentiated square wave is displayed - Press HF REJ of MTB trigger coupling - Check if a square-wave signal with slower slopes is displayed and if AC and HF REJ are on - Press AC of MTB trigger coupling - Connect CAL signal to input B - Set Y AMPL of B to 200 mV. - Press B of MTB trigger source - Check if a square wave of 5 div. is displayed - Increase the freq. of the square-wave signal to input A up to 20 kHz (CAL signal to B) - Press A and B of vertical display mode. - Press COMP of MTB trigger source. - Check if three well triggered traces are displayed; TRIG VIEW signal derived from A. - Remove input signals - Apply a square wave signal of 500 mV to input MTB TRIG - Press EXT of MTB trigger source - Check if a square wave signal is displayed via TRIG VIEW of 5 div. - Press EXT:10 of MTB trigger source - Check if a square wave signal of 0,5 div is displayed via TRIG VIEW. - Press LINE of MTB trigger source - Check if a sine-wave signal (mains frequency) is displayed.
	MEASURING RESULTS	
8.2	SUBJECT	Trigger Sensitivity (MTB)
	TEST EQUIPMENT	Sine-wave generator (SG503 and SG504)
	INPUT VOLTAGE	Sine-wave signal 100 MHz (400 MHz) to input A (B) (EXT)
	SETTINGS AND REQUIREMENTS	- Press DC (input coupling a A(B)) - Press 50 Ohm (50 Ohm on) - Press TRIG (MTB trigger mode) - Apply a sine-wave signal of 100 MHz approx. 250 mVpp to input A(B) - Set Y AMPL to 200 mV/div. - Decrease amplitude of input signal - Turn LEVEL MTB - Check if the signal is well-triggered at amplitudes $\geq$ 0,5 div. - Increase the frequency of the input signal up to 400 MHz.

		- Decrease amplitude of input signal - Turn LEVEL MTB - Check if the signal is well-triggered at amplitudes $\geq$ 2 div. - Remove input signal. - Apply a sine wave signal of 100 MHz, 50 mVpp to input MTB TRIG or X DEFL (via external 50 Ohm terminator) - Press EXT (MTB trigger source) - Press TRIG VIEW, A and B (only TRIG VIEW on) - Turn LEVEL MTB - Check if a well triggered sine-wave of 0,5 div. (50 mV) is displayed. - Decrease amplitude of input signal - Check if the signal is well triggered at amplitudes $\geq$ 50 mV (adjust LEVEL MTB) - Increase the amplitude of the input signal up to 500 mVpp - Press EXT:10 (MTB trigger source) - Check if the signal is well triggered at amplitudes $\geq$ 500 mV (adjust LEVEL MTB) - Increase the frequency of the input signal up to 400 MHz, 3 Vpp. - Check if the signal is well triggered at amplitudes $\geq$ 3 V (adjust LEVEL MTB) - Press EXT (MTB trigger source) - Decrease the amplitude of the input signal to 300 mV. - Check if the signal is well triggered at amplitudes $\geq$ 300 mV (adjust LEVEL MTB)
	MEASURING RESULTS	
8.3	SUBJECT	MTB Slope selection and Level control range.
	TEST EQUIPMENT	LF Sine-wave generator
	INPUT VOLTAGE	Sine-wave signal 2 kHz - 800 mV to input A(B) (EXT)
	SETTINGS AND REQUIREMENTS	- Set Y AMPL to 100 mV/div (DC input coupling) - Turn LEVEL MTB fully clockwise and fully anti-clockwise - Check if the signal is well triggered over the complete LEVEL range - Set the LEVEL MTB control in its mid-position - Start of signal display must be in the vertical centre - Press TRIG (MTB trigger mode) - Press NEG SLOPE MTB (on) - Check if the sine-wave signal is inverted and is triggered on the negative slope. - Press NEG SLOPE MTB (off) - Set Y AMPL to 50 mV/div (16 div. trace height)

		- Turn the LEVEL MTB - Check if the LEVEL range is ≥ +or- 8 div. and if the signal is triggered on the positive slope. - Set Y AMPL to 100 mV/div - Check if the NOT TRIG´D led is on, if the LEVEL control is set in its extreme positions - Remove input signal - Apply the sine-wave signal of 2 kHz, 1,6 Vpp to input MTB TRIG or X DEFL - Press EXT (MTB trigger source) - Press TRIG VIEW, A and B (only TRIG VIEW on) - Turn the LEVEL MTB - Check if the LEVEL range is ≥ +or- 0,8 V (+or- 8 div) - Press EXT : 10 (MTB trigger source) - Increase the input signal to 16 Vpp - Turn the LEVEL MTB - Check if the LEVEL range is ≥ +or- 8 V (+or- 8 div.)
	MEASURING RESULTS	
8.4	SUBJECT	Frequency response MTB trigger filters.
	TEST EQUIPMENT	LF Sine-wave generator
	INPUT VOLTAGE	Sine-wave signal 10 Hz...100 kHz, 0,5 div. trace height to input A(B)
	SETTINGS AND REQUIREMENTS	- Press DC of input coupling A(B) - Apply a sine-wave signal of 10 Hz, 0,5 div. to input A(B) - Press DC (MTB trigger coupling) - Check if the sine-wave signal is well triggered - Press AC (MTB trigger coupling) - Frequency of input signal 10 Hz (-3 dB) (0,5 div) - Check if the sine-wave signal is well triggered (NOT TRIG´D led off) - Press LF REJ (MTB trigger coupling) - Check if the signal is not triggered (NOT TRIG´D led on) - Increase the frequency of the input signal up to 20 kHz (-3 dB) - Check if the signal is well triggered (NOT TRIG´D led off) - Press HF REJ (HF REJ and AC on) - Increase the input frequency up to 50 kHz (-3 dB) - Check if the signal is well triggered - Increase the frequency of the input signal up to 100 kHz - Check if the signal is not triggered
	MEASURING RESULTS	

9.		DTB TRIGGERING (characteristics, section 2.2.9)
9.1	SUBJECT	DTB Trigger sources and trigger coupling (see also "Y-Signal Output" section 3.5)
	TEST EQUIPMENT	Square-wave generator
	INPUT VOLTAGE	Square-wave signal 2 kHz, 4 div. trace height to input A(B) (EXT)
	SETTINGS AND REQUIREMENTS	- Press B of vertical display mode (only A on) - Press 20 MHz BW LIMIT (on) - Press START DTB (on) - Press A (DTB trigger source) - Press DC (DTB trigger coupling) - Press MTB INTENS - Set MAIN TB to 100 us - Set DEL´D TB to 10 us - Check if an intensified part is displayed - Press TRIG DTB - Turn LEVEL DTB to get a triggered intensified part - Check the DTB trigger sources and trigger coupling via channel A according the procedure given in section 3.5 "Y signal output">
	MEASURING RESULTS	
9.2	SUBJECT	DTB Trigger Sensitivity
	TEST EQUIPMENT	Sine-wave generator (SG503 and SG504)
	INPUT VOLTAGE	Sine-wave signal 100 MHz (400 MHz) to input A(B) (EXT)
	SETTINGS AND REQUIREMENTS	- Press TRIG DTB (on) - Press A as DTB trigger source and DC as DTB trigger coupling. - Press MTB INTENS - Set MAIN B to 10 ns/div - Set DEL´D TB to 10 ns/div - Turn LEVEL DTB to get a well triggered intensified part - Check the DTB trigger sensitivity according the procedure given in section 8.2 * The EXT trigger sensitivity must be checked via channel A (input signal to EXT and A) * Read DTB instead of MTB
	MEASURING RESULTS	

9.3	SUBJECT DTB	Slope selection and Level control range
	TEST EQUIPMENT	LF Sine-wave generator
	INPUT VOLTAGE	Sine-wave signal 2 kHz - 800 mVpp to input A(B) (EXT)
	SETTINGS AND REQUIREMENTS	- Set Y AMPL to 100 mV/div (8 div) - Set MAIN TB to 200 us /div and DEL´D TB to 5 us/div. - Press MTB INTENS - Press TRIG DTB: source A(B) coupling DC - Turn LEVEL DTB for a well triggered intensified part. - Press NEG SLOPE DTB - Check if the intensified part is on the negative slope. - Press NEG SLOPE DTB (positive triggering) - Set DEL´D TB to 100 us/div. - Set Y AMPL to 50 mV/div. - Turn LEVEL DTB - Check if the LEVEL DTB range is $\geq$ +or- 8 div. - Apply a sine-wave signal of 2 kHz, 800 mVpp to input DTB TRIG and to input A - Press EXT as DTB trigger source - Check if the LEVEL DTB range is $\geq$ +or- 0,8 V (+or- 8 div) - Press EXT : 10 as DTB trigger source - Set Y AMPL to 1 V/div. - Increase the input signal to 8 Vpp (8 div.) - Set Y AMPL to 500 mV/div. (16 div. trace height) - Check if the LEVEL DTB range is $\geq$ +or- 8 V. (+or- 8 div).
9.4	SUBJECT	Frequency response DTB trigger filters.
	TEST EQUIPMENT	LF Sine-wave generator
	INPUT VOLTAGE	Sine-wave signal 10 Hz...100 kHz, 0,5 div. trace height to input A(B)
	SETTINGS AND REQUIREMENTS	- Press DC of input coupling A(B) - Apply a sine-wave signal of 10 Hz, 0,5 div to input A(B) - Press DC of MTB trigger coupling - Press TRIG DTB : DTB trigger source A(B), coupling DC - Press MTB INTENS of horizontal display mode - Set MAIN TB to 50 ms/div. - Set DEL´D TB to 10 ms/div. - Turn LEVEL DTB for a triggered intensified part. - Check if the intensified part is well triggered - Press AC of DTB trigger coupling - Check if the intensified part is well triggered at 10 Hz (-3 dB) 0,5 div. trace height. - Press LF REJ of DTB trigger coupling - Check if the intensified part is not triggered

		- Increase the frequency of the input signal up to 20 kHz (-3 dB) - Set MAIN TB to 50 us/div - Set DEL´D TB to 10 us/div - Turn LEVEL DTB - Check if the intensified part is well-triggered - Press HF REJ of DTB trigger coupling - Increase the frequency of the input signal up to 50 kHz (-3 dB) - Check if the intensified part is well triggered - Increase the frequency up to 100 kHz - Check if the intensified part is not triggered.
	MEASURING RESULTS	
10.		BLANKING OR Z-AXIS (characteristics, section 2.2.10)
10.1	SUBJECT	Sensitivity
	TEST EQUIPMENT	Square-wave generator
	INPUT VOLTAGE	Square-wave signal, 1 kHz, duty cycle 50%, amplitude 0...5 Vpp to input A and Z-in (rear side)
	SETTINGS AND REQUIREMENTS	- Press B of vertical display model; only A on - Set MAIN TB to 500 us/div. - Press 0 of channel A input coupling - Set the trace of A in mid-position - Press DC of channel A Input coupling - Apply square-wave signal of 2,5 Vpp, 1 kHz to input A and Z-in. - Check if only the bottom half of the square wave signal is displayed (500 us blanking and 500 us unblanking) - Decrease the amplitude of the input signal to 0,5 Vpp. - Set Y AMPL of A to 200 mV - Increase the screen intensity (turn INTENSITY TRACE clockwise) - Check if the top half of the square-wave signal is visible with a lower intensity and will be unblanked at an input voltage of 0 V or less.
	MEASURING RESULTS	

11.		CURSORS AND CRT TEXT (characteristics, section 2.2.12 and 2.2.13)
11.1	SUBJECT	Cursor intensity and cursor modes
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS AND REQUIREMENTS	- Turn READ OUT control clockwise for a well readable setting text (setting information of channel A, channel B and MTB) - Press MTB INTENS (on) - Check if also the setting information of the DTB is indicated. - Press MTB; MTB INTENS off - Press VOLT cursors on; VOLT= ↕ (V) - Check if the setting information of the VOLT cursors and two horizontal cursor lines are displayed. - Press TIME cursors on; TIME=↔(t) - Check if the setting information of the TIME cursors and two vertical cursor lines are displayed. - Press TIME button two times - Check if only the setting information of the TIME cursor is indicated (not the settings of the vertical and horizontal channels) - Press REF - Turn CURSOR control - Check if the REF cursor line (dashed line) can be shifted horizontally and if the delta T value changes - Press DELTA - Turn CURSOR control - Check if the DELTA cursor (dotted line) can be shifted horizontally and if the delta T value changes. - Press TRACK - Turn CURSOR control - Check if the delta T window shifts horizontally over the screen. - Press RATIO (RATIO and TRACK are on) - Check if the delta T value is indicated in % (100%) - Press REF (RATIO and REF are on) - Turn CURSOR control - Check if the REF cursor (dashed line) moves and if the delta T value changes (in %) - Press TIME (cursor off)
11.2	SUBJECT	Voltage cursors - Error limit
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-

	SETTINGS AND REQUIREMENTS	- Switch on the READ ON intensity and the TRACE intensity off. - The following must be done in the Service Routine "X- and Z-amplifier test". Proceed as follows to come into this routine: press the channel A and B INVERT buttons together, then press vertical display mode button A, then ALT and then B. - Check if one cursor is in the centre of the screen. - Check if the other cursor is 3,5 div downwards from the vertical mid of graticule. - Depress vertical display mode ALT - Check if the cursor lines are respectively 3,5 div downwards and upwards from the vertical mid of graticule. - Depress vertical display mode CHOP - Check if the illuminated area lies symmetrically inside the graticule - Press AUTO SET three times to leave the service routine.
	MEASURING RESULTS	
	MEASURING RESULTS	
11.3	SUBJECT	Voltage cursors - Minimum Cursor range and Read Out range
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS AND REQUIREMENTS	- Read Out intensity on - Press VOLT cursors on - Press REF (only REF on) - Turn CURSOR control anti-clockwise (dashed line as low as possible) - Press DELTA - Turn CURSOR control anti-clockwise (dotted line as low as possible) - Check if both CURSOR lines cover each other and are in the lower part of the graticule. (make a note of this position). - Press TRACK - Turn CURSOR control clockwise, set both CURSOR lines as high as possible. - Check if both CURSOR lines are in such a position that the CURSOR range, with respect to lowest position, is at least 7 div. around the centre of screen. - Press REF - Turn CURSOR control, set REF cursor as low as possible. - Press DELTA and set the DELTA cursor as high as possible.

		- Check if delta V value is + 7X V/div. setting if channel A (VAR A in uncal: +7div.) - Set both CURSOR lines exactly in the screen centre (delta V = 0) - Press RATIO (DELTA and RATIO on) - Turn CURSOR control - Check if delta V range is between +999% and -999% - Press RATIO (only delta on) - Set the DELTA cursor on 3,5 div. above the centre of the screen. - Press RATIO (RATIO and DELTA on) - Turn CURSOR control anti clockwise - Check if the smallest RATIO step is 0,1%
	MEASURING RESULTS	
11.4	SUBJECT	Voltage Course Reference
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS AND REQUIREMENTS	- Read Out intensity on - Press VOLT cursors on and RATIO off - Press A as MTB trigger source - Check if delta V value is indicated for channel A. - Press B as MTB trigger source. - Check if delta V value is indicated for channel B. - Press COMP, EXT and EXT:10 - Check if delta V value is indicated for channel A. - Press A as MTB trigger source. - Set VAR control of A in UNCAL - Check if delta V value is indicated in div. - Set VAR control fully clockwise - Press TRIG VIEW, A and B of vertical display mode (only TRIG VIEW on) - Check if delta V value is indicated in div. - Press AUTO SET - Press EXT X DEFL of horizontal display mode - Check if delta V value is indicated in div.
	MEASURING RESULTS	
11.5	SUBJECT	Time cursors - Error Limit
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-

	SETTINGS AND REQUIREMENTS	- Switch the READ OUT INTENSITY on and the TRACE INTENSITY off. - The now following "X- and Z-amplifier test" must be done in the service routine. Proceed as follows to come into this routine: press the channel A and B INVERT pushbuttons together, then press vertical display mode switch A, then ALT and then TRIG VIEW. - Check if both cursor lines are in the right-hand side of the graticule (4,5 div from mid of the screen) (both cursor lines must cover each other) - Press vertical display mode pushbutton A - Check if the reference cursor covers the graticule line in the mid of the screen - Check if the delta cursor is in the right-hand side of the graticule (4,5 div from mid of screen) - Depress vertical display mode pushbutton A+B - Check if the cursor lines are respectively in the left-hand and right-hand side of the graticule (both cursors 4,5 div from mid of screen) - Press AUTO SET three times to leave the Service Routine.
	MEASURING RESULTS	
11.6	SUBJECT	Time cursors - Minimum Cursor range and Read Out range.
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS AND REQUIREMENTS	- Read Out intensity on - Press TIME cursors on TIME = ◄► (t) - Press REF (only REF on) - Turn CURSOR control anti-clockwise (dashed lines as left as possible.) - Press DELTA - Turn the CURSOR control anti-clockwise (dotted line as left as possible) - Check if both CURSOR lines cover each other and are positioned in the left-hand side of the graticule (4,5 div from mid of screen) - Press TRACK - Turn CURSOR control clockwise, set both CURSOR lines as right as possible. - Check if both CURSOR lines are in such a position that the CURSOR range, with respect to the most left position, is at least 9 div. - Press REF - Turn CURSOR control; set REF cursor as left as possible. - Press DELTA and set the DELTA cursor as right as possible. - Check if the delta T value is + 9x s/div. setting of MTB (VAR MTB in uncal: +9 div.)

		- Set both CURSOR lines exactly in the centre of the screen (delta T value = 0) - Press RATIO (DELTA and RATIO on) - Turn CURSOR control - Check if delta T range is between +999% and -999% - Press RATIO (only delta on) - Set the DELTA cursor on the most left handside of the screen. - Press RATIO (RATIO and DELTA on) - Turn CURSOR control clockwise - Check if the smallest RATIO step is 0,1% - Press RATIO (only DELTA on) - Press EXT X DEFL - Check if delta T value is indicated in div.
	MEASURING RESULTS	
12.		CALIBRATOR (characteristics, section 2.2.14)
12.1	SUBJECT	Frequency and output voltage
	TEST EQUIPMENT	Digital multimeter
	INPUT VOLTAGE	CAL output signal to input A
	SETTINGS	- Press 0 of A input coupling - Set trace of A on 1 div. from the bottom of the screen - Press DC of A input coupling
	REQUIREMENTS	- Check if a positive going square wave signal is displayed of 0,8Vpp (+or- 1%). frequency 5 kHz (+or- 0,1%). This results in a read-out of 400 mV on a digital AC-millivoltmeter (duty cycle of CAL voltage is 50%)
	MEASURING RESULTS	
		ONLY FOR PM3296A
13.		REMOTE CONTROL FUNCTIONS
13.1	SUBJECT	Settings and Special commands
	TEST EQUIPMENT	-
	INPUT VOLTAGE	CAL output to input A and B

SETTINGS AND REQUIREMENTS

The buttons that must be pressed in the following procedure are located on the Setting Memory Remote control

- Press AUTO SET
- Check if this action has the same result as the AUTO SET button on the oscilloscope and if two square wave signals that cover each other are displayed:
  Y AMPL setting: 200 mV/div (5 div. trace height)
  MAIN TB setting: 100 us/div (5 div. repetition time)
- Change the vertical and horizontal settings to get different information for the following checks.

* SAVE
- Select a frontnumber (1...75)
- Press SAVE
- Check if the actual frontsettings are stored under the selected frontnumber, by pressing selected frontnumber and RECALL

* INSERT
- Select a frontnumber (1...75)
- Press INSERT
- Check if the actual frontsettings are stored under the selected frontnumber (in between two already stored frontnumbers), by pressing frontnumber and RECALL.

* DELETE
- Select a frontnumber (1...75)
- Press DELETE
- Check if the selected frontnumber is erased by pressing selected frontnumber and RECALL (on screen is indicated: CANCELLED)

* RECALL
- Select a frontnumber (1...75)
- Press RECALL
- Check if the selected frontnumber is displayed. (if a frontnumber is selected that was not stored or erased, on screen is indicated: CANCELLED)

* NEXT
- Press NEXT
- Check if the front settings of the next frontnumber are displayed.
  If a frontnumber is erased it will be skipped.

* PREVIOUS
- Press PREVIOUS
- Check if the front settings of the previous frontnumber are displayed.
  If a frontnumber is erased it will be skipped

		* FCN - Switch the oscilloscope off and on (memory back-up batteries must be present) - Check if the stored front settings are WRITE PROTECTED and can only be RECALLED (PREVIOUS, NEXT). - Press 3 - Press FCN - Check if the stored front settings are NOT WRITE PROTECTED, and can be changed with the commands SAVE, DELETE and INSERT Programming IDENTIFICATION NUMBER (ID) - Select ID Number (0...9) - Press 2 - Press FCN - Check if the ID number is programmed and is displayed on the right upper part of the crt screen. Cancel IDENTIFICATION NUMBER (ID) - Select the ID number that must be cancelled (0...9) - Press 1 - Press FCN - Check if the ID number is cancelled.
13.2	SUBJECT	Maximum Transmission distance and angle
	TEST EQUIPMENT	-
	INPUT VOLTAGE	-
	SETTINGS	- Press AUTO SET (of remote control)
	REQUIREMENTS	- Check if the oscilloscope reacts at a distance of typical 3,5 m at an angle of max. 5° off axis. - Check if the oscilloscope reacts at a distance of 0,5 m on axis at a vertical angle of +or- 45° off axis and at a horizontal angle of +or- 35° off axis

CONTENTS

24. DISMANTLING THE INSTRUMENT. 24-1
24.1. General information. 24-1
24.2. Removing the instrument´s covers. 24-1
24.3. Access to parts for the checking and adjusting procedures. 24-1

24. DISMANTLING THE INSTRUMENT.

24.1. GENERAL INFORMATION

This section provides the dismantling procedures required for the removal of components during repair operations.
All circuit boards removed from the instrument must 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 so 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.

24.2. REMOVING THE INSTRUMENT'S COVERS

The instrument is protected by three covers: a front-panel protection cover, a cabinet with carrying handle and a rear panel. To facilitate the removal of the instrument's cabinet and rear panel, first put the front-panel protection cover in position.
Then proceed as follows:
- Hinge the carrying handle clear of the front protection cover.
- Stand the instrument on its protective front cover on a flat surface.
- Slacken the four screws present in the feet at the rear panel.
- Slacken the four smaller screws that are also present in the rear panel: the rear panel can now be lifted.
- Remove one screw from the bottom side of the instrument.
- The instrument's cabinet (with carrying handle) can be removed by lifting it clear of the instrument.

NOTE: If necessary bend out the cabinet at the side of the rubber feet so that the feet do not catch behind the frame parts. When reinstalling the cabinet again, take care that the wiring (coaxial cables and flat cables) is not damaged.

24.3. ACCESS TO PARTS FOR THE CHECKING AND ADJUSTING PROCEDURES

After the actions performed in chapter 24.2. almost all adjustment points are accessible. However for the access to a minority of the adjustments, some additional actions are necessary. These actions are mentioned in the chapter "checking and adjusting".

CONTENTS

25. CHECKING AND ADJUSTING.	25-1
25.1. General information.	25-1
25.2. Recommended test and calibration equipment.	25-2
25.3. Checking and adjusting procedure.	25-8

FIGURES

25.1. Adjustment points, top view.	25-6
25.2. Adjustment points, bottom view.	25-7

25. CHECKING AND ADJUSTING

25.1. GENERAL INFORMATION

The following information provides the complete checking and adjusting procedure for the instrument. As various control functions are interdependent, a certain order of adjustment is 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.

- Warming-up time under average conditions is 30 minutes.
- Where possible, instrument performance should be checked before any adjustment is made.
- 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 Section 2.2.
- Tolerances given are for the instrument under test and do not include test equipment error.
- The most accurate display adjustment are made with a stable, wellfocused low intensity display.
- All controls which are mentioned without item numbers are located on the outside of the instrument.

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

25.2. RECOMMENDED TEST AND CALIBRATION EQUIPMENT

Type of instrument	Specification	Used for	Example of required instruments
1. Constant amplitude sine-wave generator.	Freq. 50kHz.. 400MHz Voltage 10mV.. 5Volt	Bandwidth check of vertical channels and triggering	Tektronix SG503 + SG504
2. Time marker generator	Repetition rate 1sec ... 1ns	Checking and adjusting of time base sweep rates including MAGN X10.	Tektronix TG501.
3. Square-wave calibration generator	Rise-time faster then 500psec Voltage 10mV up to (for preference) 30V Duty cycle 50%	Checking and adjusting of square-wave response of vertical channels and triggering	Generator with additional attenuators partly PG506. For check of rise time PG506 and belonging tunnel diode pulser (type 067/0681/01).
4. LF sine-wave /sq.-wave generator	Sine-wave Freq.: 1Hz... 1MHz Voltage: 0... 30Volt	Checking the trigger sensitivity	Philips PM5131
	Square-wave Freq.: 1Hz... 1MHz Voltage: 0... 30Volt Rise time: faster then 100ns	Checking and adjusting sq.-wave response of for instance-attenuator unit	
5. Cables, T-piece, terminations and attenuators for the generators	General Radio types for fast rise-time sq.-wave and high frequency sine-wave.	see point 1 and 3	
	BNC-type for other applications.	see point 2 and 4	
6. Dummy probe 2:1	1 M.Ohm ±0,1%//9pF	Check of input capacitance	

7. Trimming tool kit	--	Adjustments	Philips SBC317 (ord. number 4822 310 50095)
8. Variable mains transformer.	Well-insulated Output voltage 90...264VAC	Checking influence of mains voltage variations and adjustment of power supply.	Philips ord. number 2422 529 00005
9. Wattmeter		Checking the power consumption of the instrument	
10.Oscilloscope	The bandwidth must be the same or higher than the bandwidth of the instrument under test.	Checking the instrument under test	Philips PM3295A
11.Digital multimeter	Wide voltage, current and resistance ranges. Required accuracy 0,1%	Checking the instrument under test.	Philips PM2718 and high-voltage probe PM9246/03

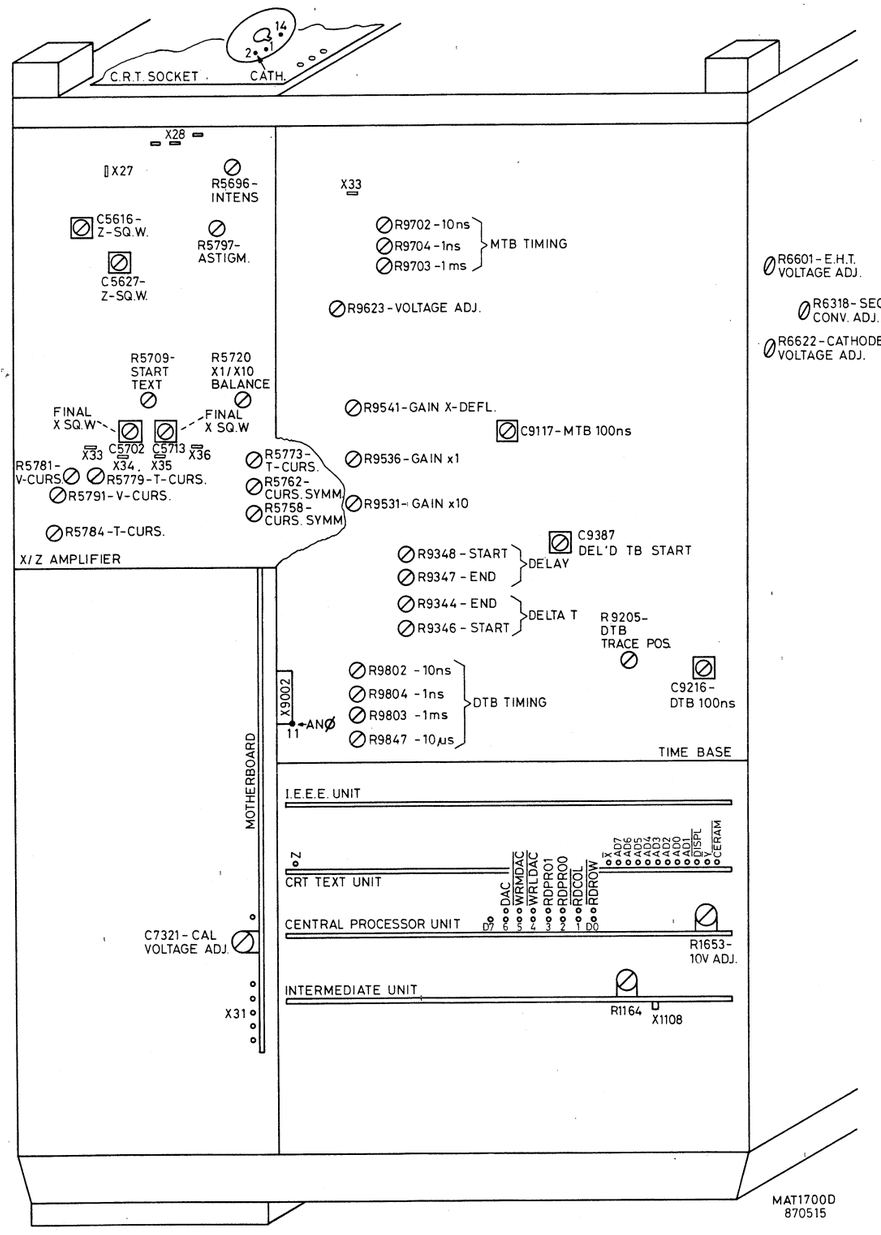


Fig. 25.1. Adjustment points, top view.

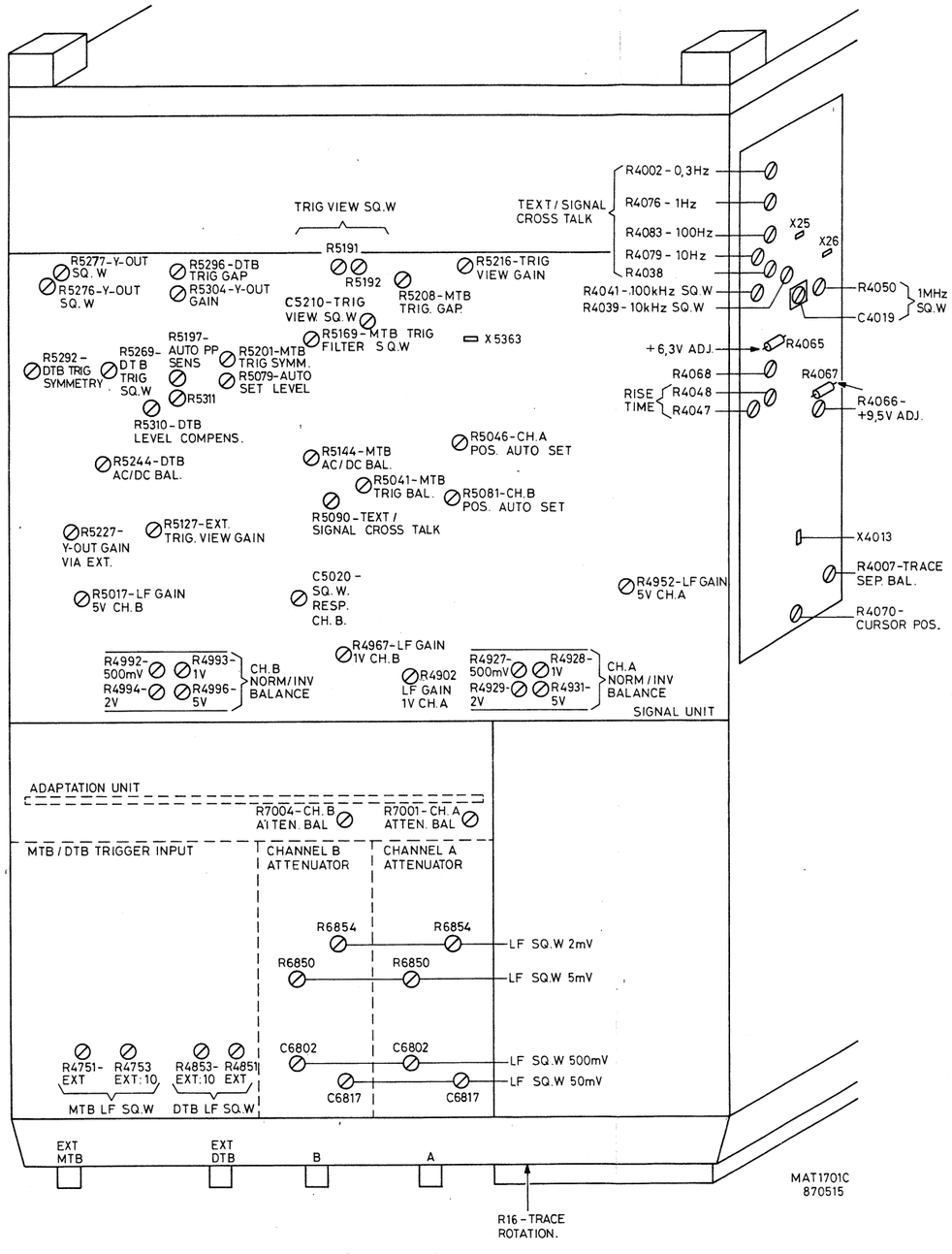


Fig. 25.2. Adjustment points, bottom view.

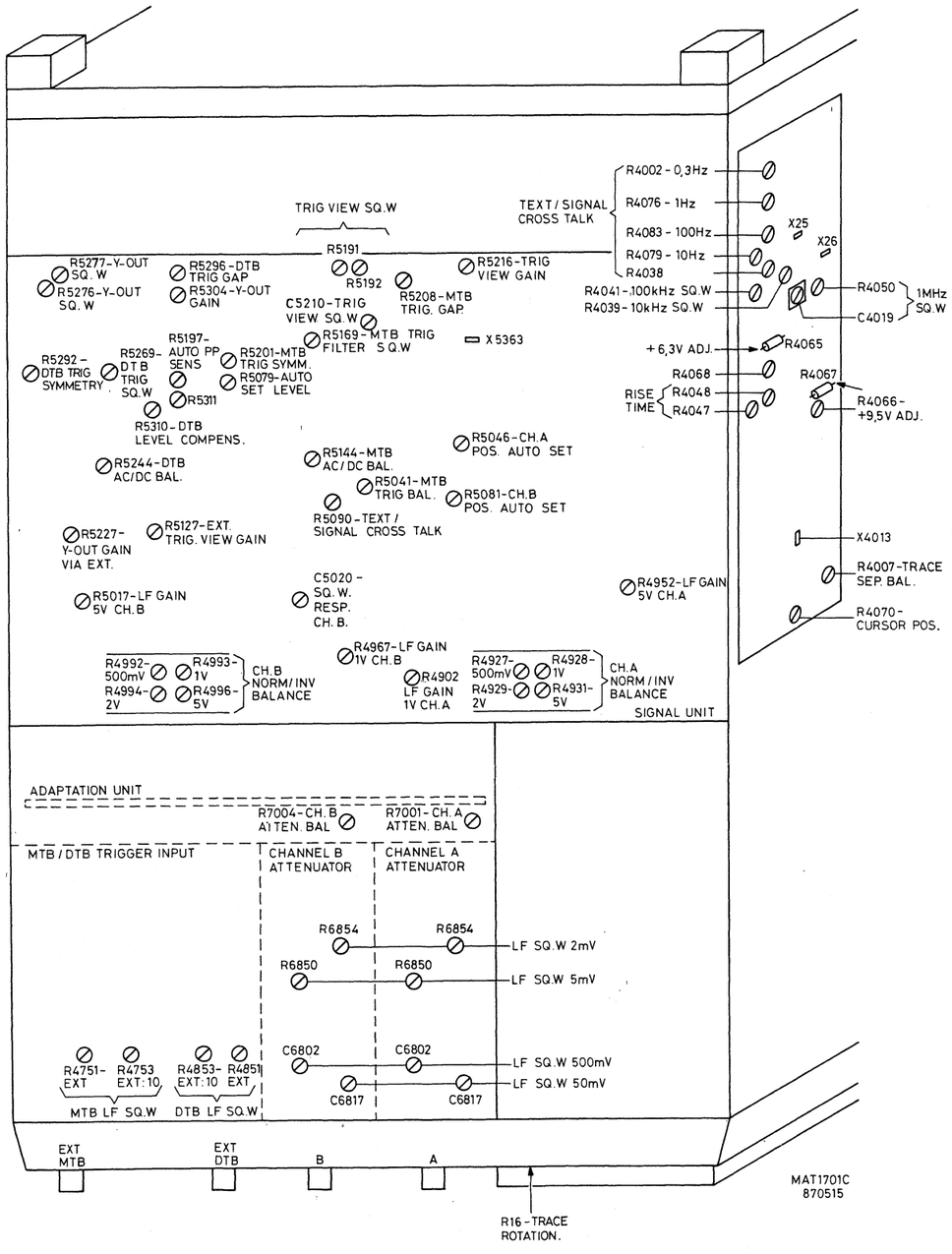


Fig. 25.2. Adjustment points, bottom view.

25.3. CHECKING AND ADJUSTING PROCEDURE

The adjusting elements and measuring points are given in fig. 25.1 and fig. 25.2.

NOTE: Use always an isolated adjustment tool.

25.3.1. Preparation

Before starting the checking and adjusting procedure, it is necessary to take notice of the following.
- For some adjustments, we make use of the service routines. If you want additional information concerning these service routines refer to chapter 26.6.4. "description of service routines".
- Unless otherwise indicated, the MAIN TB must be triggered on the channel that is selected for vertical display and the trigger path is AC coupled. The MAIN TB must function in the AUTO mode and its sweep speed must be adjusted to a good visibility of the phenomena of interest. The DEL'D TB is not used. The INTENS and FOCUS controls must be adjusted to a well-defined trace and text display.
- The various adjustment steps in this procedure must be carried out in the given sequence. Within a certain chapter (e.g. adjustment of CRT-display section), the knob settings belonging to a certain adjustment are based upon the settings done in the preceeding adjustment step.

25.3.2. Power supplies, supply voltages on various printed circuit boards and astigmatism.

Secondary power supply (R6318).

The output voltages can be adjusted with R6318.
This adjustment point is attainable via a hole in the right side panel of the instrument. Now proceed as follows:
- Connect a digital voltmeter to tag X31 on the motherboard. The tag carries the supply voltage + 5 Volt for the analog circuits.
- Check if the voltage is + 5 Volt exactly.
- If not readjust R6318.

Supply voltages on final Y-amplifier (R4066, R4068)

- Connect a digital voltmeter between the instrument's measuring earth and R4067.
- Adjust R4066 to a supply voltage of + 9,5 Volt.
- Connect a digital voltmeter between the instrument's measuring earth and R4065.
- Adjust R4068 to a supply voltage of + 6,3 Volt.

High voltage converter (R6601).

The two adjustment points on this unit can be adjusted via holes present in the right side panel of the instrument. During the adjustment of R6601 the -3,05 kVolt present at the cathode of CRT must be monitored with a digital multimeter via a high-voltage probe. The measuring point can be reached after removal (4 screws) of the rear plate that covers the CRT-socket: the cathode is pin 2 of the CRT-socket.

ATTENTION: Be aware that after removal of the rear plate, several points can be touched that carry dangerous live voltages.

Now proceed as follows:
- Set R6622 completely anti-clockwise (maximum negative voltage level on cathode of CRT).
- Adjust R6601 to -3050 Volt (or slightly smaller if the adjustment of R6622 is not possible) present at the cathode of the CRT.
- Reinstall the rear plate again.

Astigmatism (R5797, X/Z-amplifier).

- This adjustment is done in the service routine "CRT text unit test". Proceed as follows to come into this routine: depress the channel A and B INVERT pushbuttons together, depress the vertical display mode switches A, then TRIG VIEW, then CHOP and finally ALT.
- Turn the TRACE INTENSITY off.
- Turn the READ OUT INTENSITY on (normal Intensity) and a grid with equidistantial horizontal and vertical lines is displayed.
- Adjust R5797 to maximum sharpness of all the lines of the grid. The adjustment can also be done with a number of periods of a 8 div. peak-to-peak sine-wave on the screen.
- Depress AUTO SET four times to leave the service routine.

Alternative way of astigmatism adjustment (R5797, X/Z-amplifier)

- Apply a 10 kHz sinewave to the channel A input and display approx. 3 periods of it at an amplitude of 6 div.
- Switch the bandwidth limiter on.
- Adjust R5797 so that the sharpness of the sinewave is equal across the screen at normal Intensity.
- Switch the bandwidth limiter off again.

High voltage converter (R6622).

- The now following adjustment of the CRT-cathode voltage (R6622) is based upon the fact that the CRT sensitivity is influenced by this cathode voltage.
- Apply a 10kHz sine-wave signal to the channel A input socket and display this signal on the screen.
- Adjust the sine-wave amplitude at the generator so that the R.M.S. value of the voltage measured with a digital voltmeter between pin X25 and X26 at the final Y-amplifier is exactly 201,5 mV.
- Adjust R6622 so that a vertical display of 6 div. is present on the screen.

* READJUST THE ASTIGMATISM (R 5797) AS INDICATED ABOVE!!!

Trace rotation (R16, front panel)

Adjust the trace exactly in parallel with the horizontal graticule lines.

Potentiometer supply voltage on intermediate unit (R1164).

- Remove the metal plate that covers the compartment of the front unit: the plate is fixed with six screws. This action is not necessary in newer instruments where the top cover plate is provided with holes through which the adjustment can be done.
- Connect the digital voltmeter between the instrument's chassis and tag X1108.
- Adjust R1164 so that the voltage across X1108 is exactly 10 Volt.

DAC supply voltage on central processor unit (R1653).

- Select MTB INTENS for horizontal display.
- Select 1 µsec/div for DEL'D TB and 10 µsec/div for MAIN TB.
- Select the maximal delay time (100 µsec).
- Connect a digital voltmeter between X9002/11 on the time base and the instrument's chassis.
- Adjust R1653 on the central processor unit to a voltmeter read-out of 10 volt.

Supply voltage on time base unit (R9623)

- Connect a digital voltmeter between the instrument's measuring earth and measuring point X33 on the time base.
- Adjust R9623 to a supply voltage read-out of 15,03 Volt.

25.3.3. Adjustment of CRT display section.

Intensity (R5696, X/Z amplifier)

- Select EXT X DEFL for horizontal display.
- Position the displayed point in the mid of the screen and adjust the FOCUS control for a well-focused display.
- Turn the TRACE INTENSITY and READ OUT INTENSITY control fully anti-clockwise.
- Adjust R5696 so that the point is just invisible.

Square-wave response of Z-amplifier (C5616, C5627, X/Z-amplifier)

- Apply a sine-wave with a frequency of at least 1MHz to the channel A input
- Trigger the MAIN TB on channel A.
- Select X-deflection by the MAIN TB.
- Select AUTO mode for the MAIN TB.
- Select the MAIN TB sweep time of 20 n.sec/div.
- Switch the TRACE INTENSITY on and the READ OUT INTENSITY off.
- Connect your measuring oscilloscope to tag X27 (X28) on the X/Z amplifier. Trigger the measuring scope on the sine-wave signal.
- Adjust C5616 and C5627 for a straight pulse top and a good square-wave response. Adjust the main time base sweep time of your measuring oscilloscope for a good read-out of the pulse response on X27 (X28).
- Remove the probes.

Text adjustment on final Y-amplifier (R4002, R4038, R4076, R4079, R4083, R5090/signal unit).

- Remove jumper X4013.
- Switch the TRACE and READ OUT INTENSITY on.
- Apply a 100Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 10 msec/div.
- Adjust R4083 so that the bottom side of the text display is not affected (does not move) by the signal display.
- Apply a 10Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 20 msec/div.
- Adjust R4079 so that the bottom side of the text display is not affected (does not move) by the signal display.
- Apply a 1Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 200 msec/div.
- Adjust R4076 so that the bottom side of the text display does not move.
- Apply a 0,3Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 500 msec/div.
- Adjust R4002 so that the bottom side of the text display does not move.
- Apply a 100Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 10 m.sec/div.
- Adjust R4083 so that the bottom side of the text display is not affected (does not move) by the signal display.
- Apply a 10Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 20 msec/div.
- Adjust R4079 so that the bottom side of the text display is not affected (does not move) by the signal display.
- Adjust R4038 so that the top side of the text display is not affected (does not move) by the signal display.
- Apply a 1Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 200 msec/div.
- Adjust R4076 so that the bottom side of the text dipslay does not move.
- Apply a 0,3Hz/8 div. sine-wave to the channel A input.
- Select the MAIN TB sweep time of 500 msec/div.
- Adjust R4002 so that the bottom side of the text display does not move.
- Remove the input signal.
- Select MTB for horizontal display and adjust the MAIN TB to a sweep speed of 10 ms/div.
- Select channel A and B in ALTernate mode for vertical display.
- Shift the channel A trace upon the top graticule line.
- Shift the channel B trace upon the bottom graticule line.
- Adjust R5090 on the signal unit so that the text display does not move.

25.3.4. Chopper cross talk (R4039, final Y amplifier)

- Switch channel A and B on in CHOP mode.
- Apply a 10 kHz/8div square wave to channel A.
- Shift channel B in the vertical mid of the screen and select an input sensitivity of 20mV/div.
- Trigger the MAIN TB on channel A and select a sweep speed of 20 microsec/div.
- Adjust R4039 so that the crosstalk from channel A on channel B is minimal.

25.3.5. Adjustment of balances and gain of channel A (B) on signal unit.

NOTE: In this chapter the adjustments of channel B are mentioned between brackets behind those of channel A. It is advised to perform first the channel A adjustments in this chapter. After that the adjustments for channel B must be done.

Channel A (B) attenuator balance (R7001 R7004, adaptation unit).

- This adjustment is done in the service routine "attenuator unit test". Proceed as follows to come into this routine:

* Depress the channel A and B INVERT pushbuttons together in order to come in the service routine.
* Depress pushbutton A two times.
* Depress pushbutton A(B) for adjustment of channel A(B). The change between A and B must be done via AUTO SET. The input sensitivity in the selected channel switches automatically between 5 and 500 mV/div.

- Adjust R7001 (R7004) so that the trace jump is minimal.
- Depress AUTO SET four times to leave the service routine

Gain adjustments channel A (B) (R4902, R4952, R4967, R5017, signal unit).

- Apply a 1kHz/2 Volt calibrated square-wave signal to the channel A (B) input. Trigger the instrument on channel A (B).
- Adjust the MAIN TB sweep time to 500 microsec/div.
- Adjust the vertical input sensitivity to 500 mV/div.
- Adjust R4902 (R4967) to a vertical display of exactly 4 divisions.
- Increase the generator output voltage to 20 Volt.
- Adjust the vertical input sensitivity to 5 Volt/div.
- Adjust R4952 (R5017) to a vertical display of exactly 4 divisions.

Normal/Invert balances channel A (B) (R4927, R4928, R4929, R4931, R4992, R4993, R4994, R4996, signal unit).

- Switch channel A (B) on for vertical display.
- This adjustment is done in the service routine "Y-preamplifier test". Proceed as follows to come into this routine:

* Depress the channel A and B INVERT pushbuttons together in order to come into the service routine.
* Depress pushbutton A.
* Depress pushbutton A + B
* Depress pushbutton A(B) for adjustment of channel A(B). The change between A and B must be done via AUTO SET. The selected channel is switched continuously between normal and invert position.

- Adjust the channel A (B) input sensitivity to 500mV/div.
- Adjust R4927 (R4992) for minimal trace jump.
- Adjust the channel A (B) input sensitivity to 1V/div.
- Adjust R4928 (R4993) for minimal trace jump.
- Adjust the channel A (B) input sensitivity to 2V/div.

- Adjust R4929 (R4994) for minimal trace jump.
- Adjust the channel A (B) input sensitivity to 5V/div.
- Adjust R4931 (R4996) for minimal trace jump.
- Depress AUTO SET three times to leave the service routine.

Auto Set position channel A (B) (R5046, R5081 signal unit).

- Put the channel A and B position controls in their fully (anti) clockwise positions.
- Disconnect all input signals.
- Depress AUTO SET.
- Position channel A 0,2 div above the vertical mid of the screen with R5046.
- Position channel B 0,2 div under the vertical mid of the screen with R5081.

25.3.6. Adjustment of low-frequency square-wave response of vertical attenuator unit of channel A (R6854, R6850, C6817, C6802).

NOTE: In this chapter the adjustments of channel B are mentioned between brackets behind those of channel A. It is advised to perform first the channel A adjustments. After that the adjustments for channel B must be done.

- Adjust the channel A (B) input sensitivity to 5 mV/div.
- Apply a calibrated square-wave signal of 1kHz/20 mV to the channel A (B) input.
- Adjust R6850A (B) for a straight pulse top.
- Adjust the channel A (B) input sensitivity to 2 mV/div.
- Apply a calibrated square-wave signal 1kHz/10 mV to the channel A (B) input.
- Adjust R6854A (B) for a straight pulse top.
- Adjust the channel A (B) input sensitivity to 50 mV/div.
- Apply a calibrated square-wave signal of 1kHz/200 mV to the channel A (B) input.
- Adjust C6817A (B) for a straight pulse top.
- Adjust the channel A (B) input sensitivity to 500 mV/div.
- Apply a calibrated square-wave signal of 1kHz/2 Volt to the channel A (B) input.
- Adjust C6802A (B) for a straight pulse top.

25.3.7. Adjustment of time-base and final X-amplifier.

IMPORTANT: In order to minimise temperature effects, it is recommended for the time base and X-ampl. adjustments to position the instrument flat in the normal working position on your bench.

Final X-amplifier MAGN ON/OFF balance (R5720).

- Select MTB for X-deflection and AUTO mode.
- Apply a 1 msec time marker signal. MAIN TB sweep speed 200 microsec/div.
- Adjust the second time marker to the horizontal mid of the screen.
- Switch the TB MAGN off and check that the second time marker shows a minimal shift. If this is not obtained, readjust R5720 a little.

Main time base sweep times (R9536, R9531, R9703, C9117, R9702).

- Put the MAIN TB continuous control in the CAL position.
- Select MTB for horizontal deflection and AUTO mode.
- Select a MAIN TB sweep time of 10 microsec/div.
- Apply a 10 microsec. time marker pulse to input A. Select channel A for vertical display.
- Trigger the MAIN TB on channel A (AC-coupled).
- The function TB MAGN must be off.
- Adjust R9536 and the control X POS so that the 3rd and 9th marker pulse coincide exactly with the 3rd and 9th graticule line.
- Switch function TB MAGN on.
- Apply a 1 microsec. time marker pulse to input A.
- Adjust R9531 and control X POS so that the 3rd and 9th marker pulse coincide exactly with the 3rd and 9th graticule line. This must be valid over the total X-deflection range.
- Switch the function TB MAGN off.
- Apply 1 m.sec time marker pulse to input A.
- Select a MAIN TB sweep time of 1 m.sec/div.
- Adjust R9703 and the control X POS so that the 3rd and 9th time marker pulse coincide exactly with the 3rd and 9th graticule line.
- Apply a 100 n.sec time marker pulse to input A.
- Select a MAIN TB sweep time of 100 n.sec.
- Adjust C9117 and the control X POS so that the 3rd and 9th marker pulse coincide exactly with the 3rd and 9th graticule line.
- Select a MAIN TB sweep speed of 10 ns/div.
- Apply a 10 n.sec time marker signal to input A.
- Adjust R9702 and control X POS so that the 3rd and the 9th marker pulse coincide exactly with the 3rd and 9th graticule line.

Final X-amplifier linearity (C5702, C5713).

- Switch the function TB MAGN on.
- Select a MAIN TB sweep time of 2 n.sec/div.
- Adjust X POS so that the centre of the magnified sweep is in the centre of the screen.
- Apply a 2 n.sec time marker pulse to channel A.
- Check the linearity: the marker pulse in the horizontal mid of the screen must not deviate more than 0,18 div. if the marker at the begin deviates not more than 0.1 div and the marker at the end deviates not more than 0,25 div. If this is not obtained it may be corrected by readjusting C5702 and C5713 to a somewhat higher capacitance value. Both trimming capacitors must be increased with the same amount (must be turned over the same angle).

Main time base sweep times (R9702, R9704).

- Switch the TB MAGN function off.
- Select a MAIN TB sweep speed of 10 ns/div.
- Apply a 10 n.sec time marker signal to input A.
- Readjust -if necessary- R9702 and control X POS so that the 3rd and the 9th marker pulse coincide exactly with the 3rd and 9th graticule line.
- Select a MAIN TB sweep speed of 2 n.sec/div.
- Apply a 2 n.sec time marker signal to input A.
- Readjust -if necessary- R9704 and control X POS so that the 3rd and the 9th marker pulse coincide exactly with the 3rd and the 9th graticule line.

Delayed time base sweep times and X-deflection gain (R9847, R9803, C9216, R9802, R9804, R9541).

- Select DTB and MTB INTENS for horizontal display.
- Select function STARTS DTB.
- Put the DEL'D TB continuous control in the CAL position.
- Adjust the DELAY time to minimal: turn the control anti-clockwise until the value in the LCD does not change any longer.
- Select a MAIN TB sweep speed of 20 microsec/div.
- Select a DEL'D TB sweep speed of 10 microsec/div.
- Apply a 10 microsec time marker signal.
- Separate the MAIN TB and DEL'D TB displays with the TRACE SEP control so that they don't cover each other.
- Adjust R9847 and control X POS so that the 3rd and 9th marker pulse of the DEL'D TB display (bottom of screen) coincide exactly with the 3rd and 9th graticule line.
- Select a MAIN TB sweep speed of 2 m.sec/div.
- Select a DEL'D TB sweep speed of 1 m.sec/div.
- Apply a 1 m.sec time marker signal to input A.
- Adjust R9803 and control X POS so that the 3rd and 9th marker pulse of the DEL'D TB display coincide exactly with the 3rd and 9th graticule line.
- Select a MAIN TB sweep speed of 200 n.sec/div.
- Select a DEL'D TB sweep speed of 100 n.sec/div.
- Apply a 100 n.sec time marker signal to input A.
- Adjust C9216 and control X POS so that the 3rd and 9th marker pulse of the DEL'D TB display coincide exactly with the 3rd and 9th graticule line.
- Select a MAIN TB sweep speed of 20 n.sec/div.
- Select a DEL'D TB sweep speed of 10 n.sec/div.
- Apply a 10 n.sec time marker signal to input A.
- Adjust R9802 and control X POS so that the 3rd and 9th marker pulse of the DEL'D TB display coincide exactly with the 3rd and 9th graticule line.
- Switch the TB MAGN function on.
- Select a MAIN TB sweep time of 2 n.sec/div.
- Select a DEL'D TB sweep time of 1 n.sec/div.
- Apply a 1 n.sec time marker signal to input A.
- Adjust R9804 and control X POS so that the 3rd and 9th marker pulse of the DEL'D TB display coincide exactly with the 3rd and 9th graticule line.
- Switch function TB MAGN off.
- Select MTB for horizontal display.
- Select a MAIN TB sweep speed of 20 microsec/div.
- Select channel A for vertical display.
- Select a channel A input sensitivity of 20 mV/div.
- Select channel A and AC-coupling for MAIN TB triggering.
- Apply a 10 kHz/120 mV calibrated sine-wave to channel A.
- Switch channel B on and channel A off.
- Select EXT X DEFL for horizontal display.
- Adjust R9541 for a horizontal deflection of 6 div.

DTB trace position adjustment (R9205/time base)

- Disconnect the input signal.
- Select MTB INTENTS and DTB for horizontal display.
- Adjust the DEL'D TB to a sweep speed of 10 us/div.
- Adjust the MAIN TB to a sweep speed of 10 us/div.
- Put the TRACE SEP control in its anti-clockwise position.
- Adjust R9205 to equal starting points of MTB INTENTS and DTB traces.

Delayed time base delay and delta T adjustments (R9348, R9347, R9346, R9344).

- Switch the READ OUT INTENSITY and the TRACE INTENSITY on.
- The now following adjustments must be done in the service routine "time base test". Proceed as follows to come into this routine:

* Depress the channel A and B INVERT pushbuttons together.
* Depress pushbutton A.
* Depress pushbutton B.

- Switch the READ OUT INTENSITY off.
- Apply a 10us time marker signal to channel A.
- Depress vertical display pushbutton TRIG VIEW.
- Select a MAIN TB sweep speed of 10 microsec/div.
- Select a DEL'D TB sweep speed of 1 microsec/div.
- Adjust the control X POS so that the MAIN TB display starts exactly at the first vertical graticule line.
- Adjust R9348 so that the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and that the intensified part on the MAIN TB display starts after a delay of 2 div.
- Depress vertical display pushbutton A.
- Adjust R9347 so that the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and that the intensified part on the MAIN TB display starts after a delay of 8 div.
- Repeat the adjustments of R9348 (TRIG VIEW depressed) and R9347 (A depressed) a couple of times since they are interdependent.
- Depress vertical display pushbutton A+B.
- Adjust R9346 so that the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and that the intensified part on the MAIN TB display starts after a delay of 2 div. (Delay is 2 div; delta T is 0 div.)
- Depress vertical display pushbutton B.
- Adjust R9344 so that the first marker pulse of the DEL'D TB display coincides with the first vertical graticule line and that the 2nd intensified part on the MAIN TB display starts after a delay of 8 div. (Delay is 2 div.; delta T is 6 div.)
- Repeat the adjustments of R9346 (A+B depressed) and R9344 (B depressed) a couple of times since they are interdependent.
- Depress AUTO SET three times.

25.3.8. Adjustment of TRACE SEP balance on final Y amplifier (R4007)

- Select channel A for vertical display.
- Select "0" input coupling and an input sensitivity of 5 Volt/div for channel A.
- Select MTB INTENS and DTB for horizontal display.
- Select AUTO mode for MAIN TB.
- Adjust a MAIN TB sweep speed of 10 microsec/div.
- Adjust a DEL'D TB sweep speed of 1 microsec/div.
- Adjust a delay time of 050,00 microsec.
- Turn the TRACE SEP control fully clockwise.
- Adjust R 4007 so that the MAIN TB and DEL'D TB displays cover each other.

25.3.9. DEL'D TB start adjustment (C9387)

- Select channel A for vertical display and MAIN TB trigger source.
- Apply time marker pulses with a repetition rate of 100ns.
- Select ALT TB mode.
- Adjust X POS so that the MAIN TB display starts at the first vertical line of the graticule (in the MAIN TB sweep speed position of 1ms/div.)
- Select a MAIN TB sweep speed of 20ns/div.
- Select a DEL'D TB sweep speed of 10ns/div.
- Select TRIGered mode for MAIN TB.
- Turn the MAIN TB LEVEL control fully anti-clockwise. After this turn it slowly clockwise until the instrument is just triggered.
- Adjust the delay time in the LCD to 90n.sec. (allowed deviation +or- 12 nsec).
- Adjust C9387 so that on the DEL'D TB display the beginning of the rising edge of the time marker pulse coincides with the 2nd vertical graticule line.

25.3.10. Cursor adjustment (R5784, R5791, R5779, R5781, R5758, R5762, R5773, R4070).

- Switch the READ OUT INTENSITY on and the TRACE INTENSITIY off.
- The now following adjustments must be done in the service routine "final X/Z-amplifier test". Proceed as follows to come into this routine: depress the channel A and B INVERT pushbuttons together, then depress vertical display mode switch A, then ALT and then TRIG VIEW.
- Adjust R5779 so that both cursor lines are inside the screen area.
- Adjust R5773 so that both cursor lines cover each other.
- Depress vertical display mode pushbutton A.
- Adjust R5779 so that the left-hand cursor covers the graticule line in the mid of the screen.
- Adjust R5784 so that right-hand delta cursor covers the last right-hand graticule line. If necessary repeat the previous and this step.
- Depress vertical display mode pushbutton A+B.
- check if the cursor lines cover exactly the last left-hand graticule line and the last right-hand graticule line.
  Readjust R5779 and R5784 if required.
- Depress vertical display mode pushbutton B.
- Adjust R5781 so that the upper cursor covers the graticule line in the vertical mid of the screen.
- Adjust R5791 so that the lower cursor covers the last graticule line in the bottom of the screen. If necessary repeat the previous and this step.
- Install jumper X4013 again on the final Y-amplifier.
- Adjust R4070 onthe final Y-amplifier so that the upper cursor covers the graticule line in the vertical mid of the screen.
- Depress vertical display mode pushbutton ALT.
- Check if the cursor lines cover the last graticule line in the top and the bottom of the screen. If necessary readjust R5781 and R5791.
- Depress vertical display mode pushbutton CHOP.
- Adjust R5758 and R5762 so that the illuminated area lies symmetrically inside the graticule.
- Adjust 5709 so that the start of the first line of text (left top corner) coincides exactly with the other lines of text.

25.3.11. Square-wave response of final Y-amplifier (R4041, R4050, C4019, R4047, R4048, C5020/C5210/signal unit).

IMPORTANT:
In this part of the adjusting procedure the square-wave response of the instrument must be adjusted to minimal pulse distortion (aberrations) at maximal rise-time and bandwidth. Before starting the adjustment it is important to be aware of the following:

- The aberrations specification is only valid if the rise-time of the input pulse is 1 nsec. As a rule, the pulse aberrations displayed on the CRT screen will increase if the rise-time of the input pulse is faster than 1 nsec. Consult the specification of the generator that you use and if necessary measure its rise-time. Only if the generator's rise-time is close to 1 nsec it may be used for checking oscilloscope's pulse aberrations specification.
- The adjustments are done via channel A. If the square-wave adjustments via channel A are completed, channel B must be checked. The adjustments via A are located on the final Y amplifier and thus also influencing the channel B performance. To compensate for this, channel B has one additional adjustment point C5020 on the signal unit. However, in some cases it is necessary to average between the response of channel A and B. The response of the TRIG VIEW channel can be adjusted with C5210 on the signal unit. In series with C5020 in channel B there is a resistor R5020 with a factory-selected value. Selection is done for obtaining equal pulse response in the vertical channels. During this adjustment procedure it is not necessary to change the value of R5020; this can only be necessary after replacement of one of the film circuits N4903 or N4967.
- The fast-rise output of the square-wave generator recommended in chapter 25.2./3 is able to deliver 1 Volt amplitude into 50 Ohm input impedance of the oscilloscope: this results in 5 div. signal in the 200 mV/div position of the attenuator. The adjustments are done in 200 mV/div. Afterwards it must be checked if the pulse aberration specification of + and - 5% can be obtained in 20 mV/div. For this the generator's output signal must be attenuated with an external 10:1 attenuator. The use of the amplitude control on the generator is not recommended since the aberrations in the output signal increase if this control is moved out of its max. position. Bear also in mind that the aberrations in the generator's output signal must be added to the aberrations of the oscilloscope if you judge the result on the CRT-screen.

Now proceed as follows:

- Adjust channel A to an input sensitivity of 200 mV/div.
- Select DC and 50 Ohm (generator termination) input coupling for channel A.
- Apply a 100 kHz/6 div. square-wave signal with a rise-time of 1 nsec. to the channel A input.
- Adjust the MAIN TB sweep speed to 2 us/div.
- Adjust the square-wave response with R4041.
- Apply a 1 MHz/6 div. square-wave signal with a rise-time of 1 nsec. to the channel A input.
- Adjust the MAIN TB sweep speed to 10 ns/div.
- Adjust the square-wave response with R4050 and C4019.
- Adjust the rise-time of the signal slope with R4047 and R4048.
- Now apply the generator signal to channel B (200 mV/div and selected as trigger source). Input switched to 50 Ohm and DC coupling.
- Try to optimise the square-wave response via channel B with C5020 on the signal unit. Do the same with C5210 for TRIG VIEW via the EXTernal trigger input.

- Check that the pulse aberrations via channel A and B in 20 mV/div do not exceed + and - 5%.
  The generator's output signal must be attenuated with an external 10:1 attenuator piece.
- Now the bandwidth of channel A (B) must be checked with a constant amplitude sine-wave generator.
- Apply a 50kHz/6 div. sine-wave signal to the channel A (B) input. The 6 divisions signal amplitude function as a reference.
- Check if the amplitude displayed on the screen does not become smaller than 4,3 div. over the frequency range from 250kHz up to 400 MHz. Check also that there are no dips in the frequency reponse.

NOTE: Two generators are required to cover the complete frequency range (see list of recommended test and calibration equipment). The amplitude of each generator must be adjusted to 6 div. at 50 kHz.

25.3.12. Adjustment of gain, square-wave responses and balances of MAIN TB triggering on signal unit and MTB/DTB trigger input.

Trigger filter gain (R5191, R5192, R5169, R5216, C5210, signal unit)

- Apply a 2kHz/6 div. square wave signal to the channel A input (DC coupled). Input sensitivity: 200mV/div.
- Adjust the MAIN TB to a sweep speed of 200 us/div.
- Select channel A and TRIG VIEW for vertical display.
- Select DC for the MAIN TB triggering.
- Adjust the MAIN TB LEVEL control to a triggered display. Triggering on channel A.
- Adjust R5169 so that the shape of the square-wave displayed via TRIG VIEW is equal to the channel A display.
- Adjust R5216 so that the amplitude of the square-wave displayed via TRIG VIEW is equal to the channel A display.
- Increase the frequency of the square-wave signal applied to channel A to 1 MHz (rise-time $\leq$ 1 ns).
- Adjust the MAIN TB to a sweep speed of 20 ns/div.
- Adjust R5191 so that the shape of the square-wave displayed via TRIG VIEW is equal to the channel A display.
- Adjust the MAIN TB to a sweep speed of 10 ns/div.
- Adjust R5192 and C5210 so that the shape of the square-wave displayed via TRIG VIEW is equal to the channel A display.

Trigger view gain via external input (R5127, signal unit).

- Select EXT as MAIN TB trigger source together with DC-coupling.
- Switch the BW LIMIT function on.
- Apply a 2 kHz/0,5 Volt calibrated square-wave signal to the MTB TRIG or X DEFL input.
- Adjust the MAIN TB sweep speed to 200 microsec/div.
- Adjust the signal amplitude to 5 div. with R5127.

LF-square-wave response MTB/DTB trigger input (R4751, R4753).

- Adjust the square-wave response to minimal overshoot with R4751.
- Increase the generator output voltage from 0,5 to 5 Volt.
- Select EXT:10 as MAIN TB trigger source.
- Adjust the square-wave response to minimal overshoot with R4753.

MTB trigger filter offset (R5144, signal unit).

- Adjust the channel B input sensitivity to 20mV/div.
- Apply a 1 kHz/0,1 Volt square-wave signal to the channel B input.
- Select AC input coupling for channel B.
- Switch BW LIMIT on.
- Select TRIG VIEW for vertical deflection.
- Select B as MAIN TB trigger source.
- Select TRIG mode (adjust MAIN TB LEVEL) for the MAIN TB and a sweep time of 200 microsec/div.
- Adjust R5144 to minimal trace jump when switching between AC and DC trigger coupling.

MTB AUTO peak-peak sensitivity (R5197, signal unit).

- Depress input coupling pushbutton "0" of channel B.
- Select AUTO mode for the MAIN TB.
- Select DC trigger coupling for the MAIN TB.
- Adjust R5197 so that the trace does not move when operating the MAIN TB LEVEL control between its extreme positions.

MAIN TB SLOPE, trigger gap and AUTO SET (R5208, R5201, R5079 signal unit).

- Select channel A for vertical display.
- Apply a 2 kHz/6 div. sine-wave signal to the channel A input (DC-coupled).
- Trigger the MAIN TB on channel A. Filter section must be DC-coupled.
- Depress AUTO of the MAIN TB mode selector.
- Put the MAIN TB LEVEL control exactly in its mid position.
- Operate the SLOPE switch continuously and adjust R5208 to a vertical distance of 0,2 div. between the start of the positive and negative slope.
- Decrease the signal amplitude to 2 div.
- Operate the SLOPE switch continuously and adjust R5201 to the situation that the trigger points of the positive and negative slope are symmetrical around the vertical mid of the screen.
- Repeat the adjustment of R5201 also with a signal amplitude of 0,8 div.
- Decrease the signal amplitude to 0,4 div.
- Operate the SLOPE switch continuously and readjust R5208 and R5201 so that the signal stays triggered.
- Depress AUTO SET.
- Readjust -if necessary- the MAIN TB sweep speed and channel A Y AMPL to a well-visible waveform on the screen.
- Depress pushbutton TRIG of the MAIN TB mode selector.
- Adjust R5079 to a starting point of the signal at 1,2 div. above the vertical mid of the screen.

Trigger view balance (R5041, signal unit).

- Select "0" input coupling for channel B.
- Select TRIG VIEW for vertical deflection.
- Position the trace in the vertical mid of screen by means of R5041.

25.3.13. Adjustment of gain, square-wave responses and balances of DEL'D TB triggering on signal unit and MTB/DTB trigger input.

Y-out filter gain (R5276, R5304, R5269)

- Connect the Y-output signal to the channel B input socket.
- Adjust channel B to an input sensitivity of 10mV/div. and 50 Ohm input impedance.
- Select channel A and B for vertical display.
- Depress pushbutton AUTO of the MAIN TB mode selector.
- Trigger the DEL'D TB on channel A with AC-coupled filter.
- Adjust the MAIN TB to a sweep of 100us/div.
- Trigger the MAIN TB on channel A with AC-coupled filter.
- Apply a 2 kHz/6 div. square-wave signal to the channel A input (DC-coupled).
- Adjust R5269 so that the shape of the square-wave displayed via channel B is equal to the channel A display.
- Adjust R5304 so that the amplitude of the square-wave displayed via channel B is equal to the channel A display.
- Increase the frequency of the square-wave signal applied to channel A to 1 MHz (rise-time $\leq$ 1ns).
- Adjust the MAIN TB to a sweep speed of 20 ns/div.
- Adjust R5276 so that the shape of the square-wave (pulse top) displayed via channel B is equal to the channel A display.
- Connect the Y-output signal to the channel A input socket.
- Adjust channel A to an input sensitivity of 10 mV/div. and 50 Ohm input impedance.
- Select channel A for vertical display.
- Apply a 2 kHz/500 mV square-wave signal to the EXTernal trigger input of the DEL'D TB.
- Select the EXTernal trigger input as DEL'D TB trigger source.
- Adjust the MAIN TB to a sweep speed of 200 us/div.
- Adjust R5227 so that 5 div. of amplitude are displayed.

LF-square-wave response MTB/DTB trigger unit (R4851, R4853)

- Adjust the square-wave response to minimal overshoot with R4851.
- Increase the generator output voltage from 0,5 to 5 Volt.
- Select EXT:10 as DEL'D TB trigger source.
- Adjust the square-wave response to minimal overshoot with R4853.

DTB trigger filter offset (R5244, signal unit).

- Adjust the channel B input sensitivity to 20mV/div.
- Apply a 1 kHz/0,1 Volt square-wave signal to the channel B input.
- Select AC input coupling for channel B and switch the 50 Ohm off.
- Switch BW LIMIT on.
- Select B as DEL'D TB trigger source.
- Select TRIG mode (adjust MAIN TB LEVEL) for the MAIN TB and a sweep time of 200 microsec/div.
- Adjust R5244 to minimal trace jump when switching between AC and DC trigger coupling of the DEL'D TB triggering.

DEL'D TB SLOPE and trigger gap (R5292, R5296 signal unit).

- Put the DEL'D TB LEVEL control in its mid position: check that the voltage tag X5363 is +5 Volt.
- Select AUTO mode for the MAIN TB (sweep speed 200 us/div).
- Select channel B for vertical deflection (channel A off).
- Select input coupling mode "0" for channel B.
- Position the channel B trace in the vertical mid of the screen.
- Select input coupling mode "DC" for channel B and apply a 1 kHz/6 div. sine-wave signal to the channel B input.
- Connect the Y output signal to the channel A input (10 mV/div).
- Select channel A for vertical display. Switch channel B off.
- Select the channel A DC and 50 Ohm input coupling.
- Switch the BW LIMIT function on.
- Select MAIN TB triggering on channel A (DC coupled).
- Select TRIG DTB and select DEL'D TB triggering via channel B (DC-coupled).
- Operate the DEL'D TB SLOPE switch constantly and adjust the starting point of the trace symmetrically around the screen mid with R5292.
- Operate the MAIN TB SLOPE switch constantly and adjust R5296 so that the vertical distance between the start of the signal at positive and negative SLOPE is + or - 0,3 div.

LEVEL compensation adjustment Y-out (R5310, signal unit).

- Adjust R5310 for minimal trace jump when operating the DEL'D TB LEVEL control.

LEVEL offset adjustment Y-out (R5311, signal unit).

- Select channel B for vertical display. Switch channel A off.
- Select "0" input coupling for channel B and position the channel B trace in the vertical mid of the screen.
- connect the Y-output signal to channel B.
- Select DC and 50 Ohm input coupling for channel B.
- Select TRIG DTB and select DEL'D TB triggering via channel A (DC coupled).
- Select "0" input coupling for channel A.
- Position the trace in the vertical mid of the screen with R5311.

25.3.14. Calibration voltage adjustment (R7321, mother board)

Check that the amplitude of the calibration signal lies between 0 Volt and +0,8 Volt (+/- 1%). This results in a read-out of 400 mV on a digital AC-millivoltmeter (duty-cycle of cal. voltage is 50%).
If not, readjust R7321.

CONTENTS

26.	CORRECTIVE MAINTENANCE.	26-1
26.1.	Replacements.	26-1
26.1.1.	Standard parts.	26-1
26.1.2.	Special parts.	26-1
26.1.3.	Transistors and integrated circuits.	26-1
26.1.4.	Static sensitive components.	26-1
26.1.5.	Handling MOS-devices.	26-6
26.1.6.	Replacing knobs.	26-7
26.1.7.	Removing printed circuit boards, mounting plates and the CRT.	26-7
26.2.	Soldering techniques.	26-23
26.3.	Special tools.	26-26
26.4.	Recalibration after repair.	26-26
26.5.	Instrument repacking.	26-27
26.6.	Trouble shooting.	26-27
26.6.1.	Introduction.	26-27
26.6.2.	Trouble shooting techniques.	26-27
26.6.3.	Trouble shooting of the power supplies.	26-28
26.6.4.	Explanation of the service routines.	26-29

FIGURES

26.1.	Exploded view of front unit.	26-4
26.2.	Measuring the front unit and power supplies under working conditions.	26-8
26.3.	Dimensional drawing of tool for slotted nut.	26-9
26.4.	Exploded view of vertical attenuator unit.	26-15
26.5.	Dimensional drawing of tool for BNC input sockets.	26-17
26.6.	Exploded view of CRT and belonging mechanical parts.	26-19
26.7.	Arrangement of working area for S.M.D. exchange.	26-24
26.8.	Trimming tool kit.	26-26
26.9.	LCD with all elements activated.	26-33

26. CORRECTIVE MAINTENANCE

26.1 REPLACEMENTS

WARNING: The EHT cable is unbreakably connected to the CRT. When the EHT cable to the post acceleration anode is disconnected, the cable must be discharged by shortening the terminal to the instrument´s earth.

26.1.1. Standard parts

Electrical and mechanical replacement parts can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

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

26.1.2. 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 of representative.

26.1.3. Transistors and Integrated 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 lenght 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.

26.1.4. Static sensitive components

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.

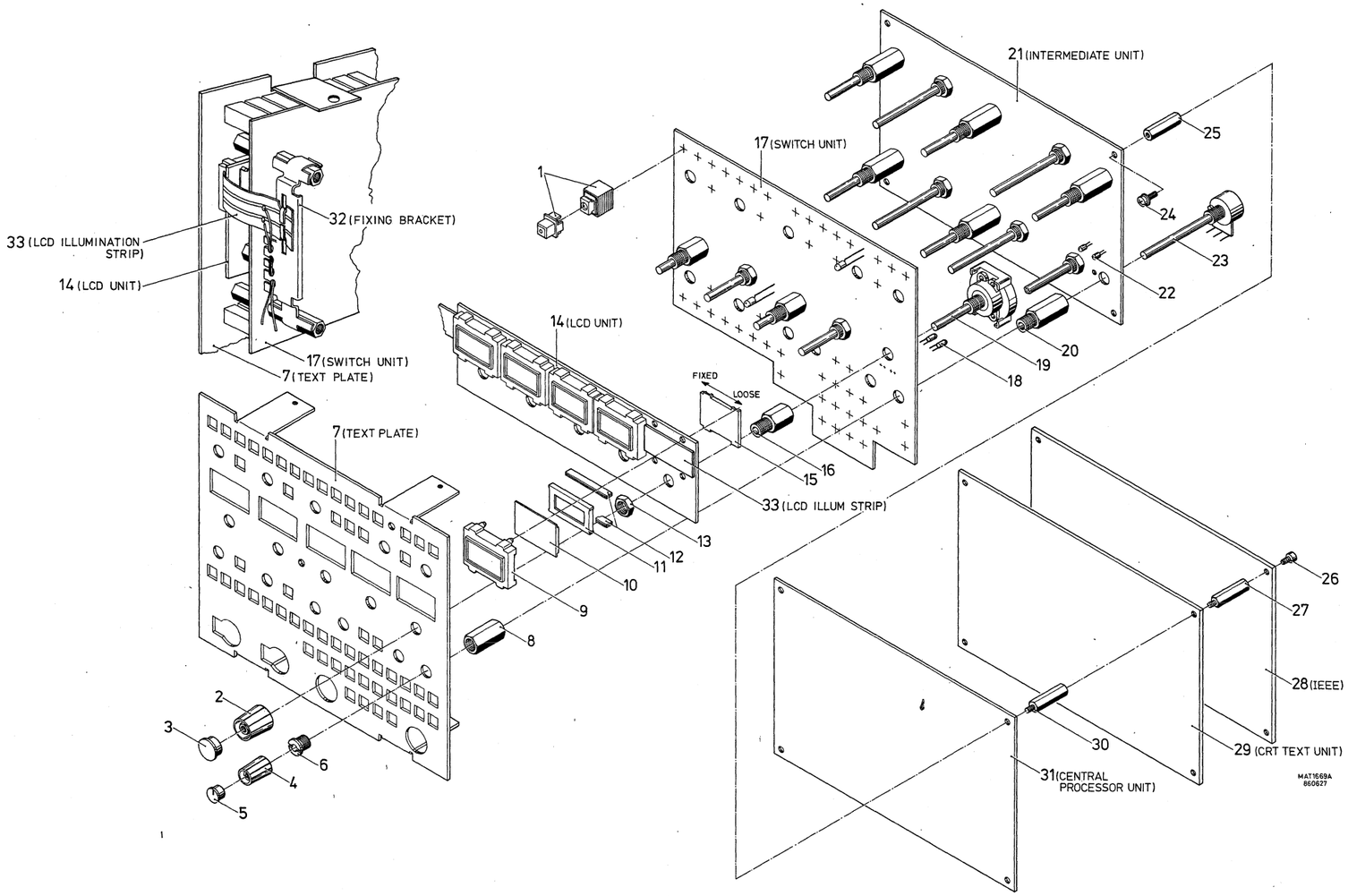


Fig.26.1.Exploded view of front unit.

26.1.5. Handling MOS devices

Through all our MOS integrate electostatic discharges, they accidental over-voltages. In precautions are recommended.

CAUTION: Testing or handling to personal safety normally be connec

26.1.5.1 Storage and transport

Store and transport the circu Alternatively, use may be mad IC carrier that either short- external contact.

26.1.5.2 Testing or handling

Work on a conductive surface circuits or transfering them connect the person doing the surface, for example by a met chain. Connect all testing an surface. Signals should not b should not be applied to the off. All unused input leads s voltage or to ground.

26.1.5.3 Mounting

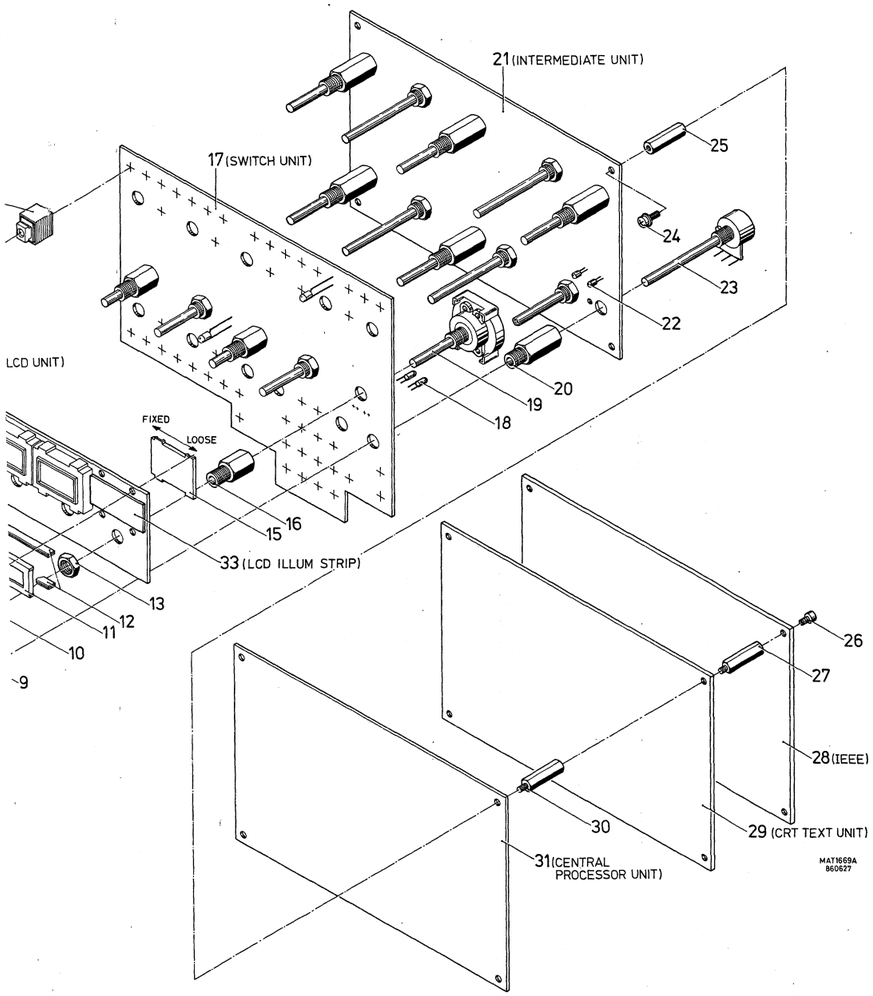
Mount MOS integrated circuits other components have been mo themselves, metal parts of th doing the mounting are kept a If it is impossible to ground mounting the circuits should t circuits into contact with it

26.1.5.4 Soldering

Soldering iron tips, includin soldering baths should also b circuits and the board.

26.1.5.5 Static charges

Dress personnel in clothing o silk or synthetic fibres). Aft the proper handling precautio Until the sub-assemblies are i which the proper voltages are extension of the leads of the static charges from being tra device it is recommended that put on the circuit board termi



26.1.5. Handling MOS devices

Through all our MOS integrated circuits incorporate protection against electostatic 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.

26.1.5.1 Storage and transport

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

26.1.5.2 Testing or handling

Work on a conductive surface (e.g. metal table top) when testing the circuits or transfering them from one carrier to another. Electrically connect the person doing the testing or handling to the conductive surface, for example by a metal bracelet and a conductive cord to a chain. Connect all testing and handling equipment to the same surface. Signals should not be applied to the 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.

26.1.5.3 Mounting

Mount MOS integrated circuits 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.

26.1.5.4 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.

26.1.5.5 Static charges

Dress personnel in clothing of non-electrostatic material (no wool, silk or synthetic fibres). After the MOS circuits have been mounted, 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 not 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.

26.1.5.6 Transient voltages

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

26.1.5.7 Voltage surges

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

26.1.6. Replacing knobs

NOTE: fig.26.1. shows the exploded view of the front unit. The numbers mentioned between brackets in this text refer to the itemnumbers given in the exploded view.

- take off the knob covers (3,5). When reinstalling knob covers with a dashed line take care that the dashed line is in its correct position.
- the internal fixation screw in the small knobs (4) can be slackened with a screwdriver: after this the knob can be taken off.
- the bigger knobs (2) have an internal fixation nut that can be slackened with a pair of pliers: after this the knob can be taken off.

26.1.7. Removing the printed circuit boards and their mountig plates and the CRT.

NOTE: during installation, work in reversed sequence.

26.1.7.1 Printed circuit boards of the front unit and text plate.

Fig.26.1. shows the exploded view of the front unit. The numbers mentioned between brackets in this text refer to the itemnumbers given in the exploded view.

Front unit

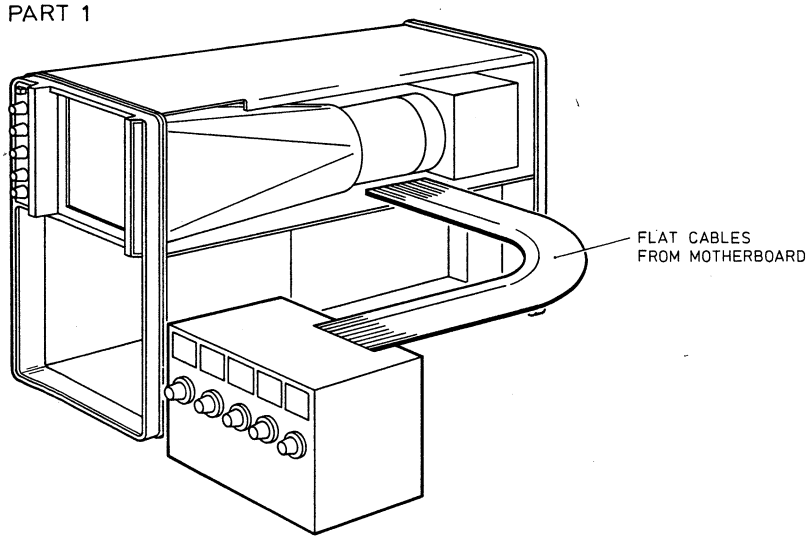
- Remove the six screws in the top cover plate of the unit. The removal of this top cover plate is necessary to reach the flatcables that are plugged on to the unit.
- Remove the two screws that fix the front unit to the bottom side of the front profile.
- Unplug the flatcables at the central processor unit, CRT text unit and the IEEE-unit and the two-wire connection between LCD illumination strip and CRT controls unit.
- Unplug a coaxial cable from the text unit.
- Now the unit can be slided out of the front profile of the instrument.

IMPORTANT: after the above actions, the front unit can be connected again in order to measure it under wording conditions. The best way to do this (see fig.26.2. part 1) is to put the instrument on its left side panel and to put the front unit in its normal position close to the instrument:
now the flatcables and the coaxial cable are just long enough to reach their connectors at the front unit.

IEEE unit (unit A271, Optional)

- Take the front unit out of the instrument
- Unplug the flatcable coming from the intermediate unit
- Remove 2 screws (26) and 2 hexagonal spacers (bottom side).
- The IEEE unit can now be separated from the CRT text unit. This must be done very carefully in order to prevent that the interconnecting contact pins are bent. Also the installation of the unit must be done very carefully.

PART 1



PART 2

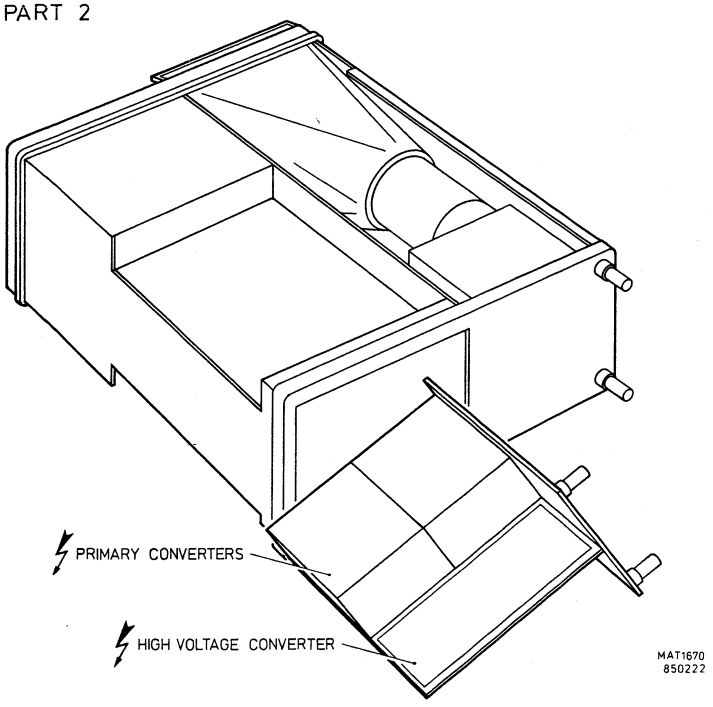


Fig.26.2. Measuring the front unit and power supplies under working conditions.

NOTE: after this action the component side of the CRT text unit is visible.

CRT text unit (unit A281, Optional)
- Take the frontunit out of the instrument.
- Remove the IEEE unit.
- Remove four hexagonal spacers (27).
- The CRT text unit can now be separated from the central processor unit. This must be done very carefully in order to prevent that the interconnecting contact pins are bent. Also the installation of the unit must be done very carefully.

NOTE: after this action the component side of the central processor unit is visible.

Central processor unit (unit A 1085)
- Take the front unit out of the instrument.
- Remove the IEEE unit.
- Remove the CRT unit.
- Remove four hexagonal spacers (30).
- The central processor unit can now be separated from the intermediate unit. This must be done very carefully in order to prevent that the interconnecting contact pins are bent. Also the installation of the unit must be done very carefully.

Text plate
- Remove the front unit.
- Take off the knob covers (3,5). When reinstalling knob covers with dashed line take care that the dashed line is in its correct position!
- The internal fixation screw in the small knobs (4) can be slackened with a screwdriver: after this the knob can be taken off.
- The bigger knobs (2) have and internal fixation nut that can be slackened with a pair of pliers: after this the knob can be taken off.
- The text plate (7) can be removed after having removed six slotted nuts (6) behind the knobs Ch.A position, level MTB, level DTB, var Ch.A, var MTB and var DTB. For this job a special tool is available under service code number 5322 395 54024. For those who want to make this tool in a local workshop, a dimensional drawing is given in fig. 26.3.

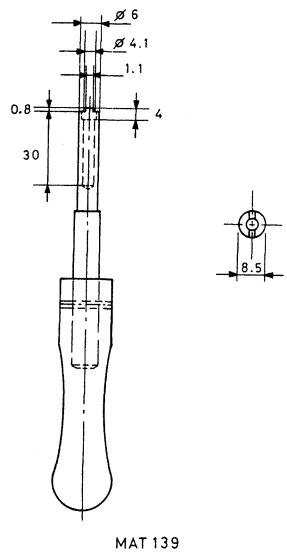


Fig.26.3. Dimensional drawing of tool for slotted nut.

LCD unit (unit A 1011) and LCD illumination strip

- Take front unit out of instrument.
- Remove text plate and knobs.
- The LCD-unit can be separated from the front unit after having removed three nuts (13) under the controls Ch.A Y-ampl., DEL'D TB and MAIN TB and after having loosened the bracket (34) that attaches the LCD illumination (33) to the front unit. This must be done very carefully in order to prevent that the interconnecting contact pins are bent. Also the installation of the unit must be done very carefully.

Removal of an LCD (and LCD illumination strip):

- Slide the plastic plate (15) off at the rear side of the p.c.b.(14).
- Now the transparant box (9) can be separated from the p.c.b. This box contains two contact rubbers (12), a plastic spacer (11) and the LC-display (10). The rubbers and the LCD must be handled very carefully and must be kept away from dirt (such as grease) in order to assure good contact capabilities. After removal of all LCD's, the LCD illumination (33) together with its fixing bracket (32) can be separated from the front unit.

NOTE: after the removal of the LCD-unit, the component side of the intermediate unit is visible.

Switch unit (unit A 1031)

- Remove the knobs and text plate.
- Remove six hexagonal spacers (8) that are present around the shafts of the potentiometers Ch.A pos, level MTB, level DTB, var. Ch. A, var MTB and var DTB.
- Now the switch unit (17) together with the LCD unit (14) can be removed. The LCD-unit can be separated from the switch unit after having removed three nuts (13) that are present around the shafts of the controls Ch. A Y ampl., DEL'D TB and MAIN TB.

NOTE: the pushbutton switches (1) with incorporated LED must be replaced as a complete unit.

removal of an impulse switch (19) and infra-red LED (18):

- Remove the LCD-unit (see description above).
- Remove the hexagonal (spacer) nut (16) that fixes the impulse switch unit to the p.c.b.
- Now the impulse switch unit can be taken backwards out of the unit.
- Now the two infra-red LED's (18) of the switch can be reached for replacement.

NOTE: when reinstalling a new infra-red LED, take care of the correct position of this device compared with the impulse switch unit. For this it is advised first to mount the LED without soldering it. Then the impulse switch must be installed. Now check that the LED fits correctly in the impulse switch and solder it.

Intermediate unit (unit A 1061)

- Remove the knobs and text plate.
- Remove the switch unit (together with LCD unit).
- Remove four screws (24) and the unit can be separated from the central processor unit.
- Potentiometers (23) can be interchanged after removal of its hexagonal (spacer) nut (20). After installation of a new potentiometer it is advised first to fix it with the nut. After this its pins must be soldered to the unit: this assures correct positioning.

NOTE: when reinstalling a new photo-sensitive transistor (22), take care of the correct position of this device compared with the impulse switch unit on the switch unit. Therefore it is advised to solder the photo-transistor to the p.c.b. after having checked its position compared with the impulse switch unit. For this it is necessary to fix the intermediate unit and the switch unit together.

26.1.7.2 Time base unit (unit A201)

- Unplug all the coaxial cables.
- Remove the small p.c.b. from time base unit and also the underlaying spacer. When reinstalling the small p.c.b., take care that its contact pins fit correctly in the connectors at the time base unit so that these pins are not bent.
- Remove the fixation screws of the unit.
- Slide the unit sidewards out of the connectors at the motherboard.

26.1.7.3 X/Z amplifier (unit A 2116)

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.

- Unplug very carefully the two output wires from the X/Z amplifier. These wires have small connectors that fit on the side connection pins of the CRT.- Unplug the coaxial cables.
- Remove the six screws that mount the unit to its mounting plate.
- Slide the p.c.b. carefully out of its connector on the motherboard.
- Unplug the multipole connector that comes from the CRT-socket.

NOTE: the mounting plate of this p.c.b. can be removed after having removed the two screws that fix it to the instrument´s rear panel.

26.1.7.4 Final Y amplifier (unit A1716)

- Unscrew the earth and signal clamps of the delay line cable.
- Unplug a coaxial cable.
- Unplug the flatcable coming from the motherboard.
- Remove the three nuts that attach the film circuits of the p.c.b. to the underlaying mounting plate.
- Remove the X/Z amplifier together with its mounting plate (see chapter 26.1.7.3).

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 of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.

- Unplug very carefully the four output wires from the final Y amplifier. These wires have small connectors that fit on the side connection pins of the CRT.
- Remove the two remaining screws that attach the p.c.b. to its mounting plate.

NOTE: the mounting plate for this p.c.b. can be separated from the chassis after having removed its four mounting screws.

26.1.7.5 Signal unit (unit A1511)
- Remove all the coaxial cables from their sockets.
- Unscrew the earth and signal clamps of the delay line cable.
- Remove the screws that fix the p.c.b. to the instrument´s chassis.
- Lift the p.c.b. upwards from the instrument. This is necessary because the unit has contact pins that fit into a connector at the mother board. In order to protect these contact pins, the mother board is equipped with guidance pins.

26.1.7.6 CRT control unit (unit A222)
- Unplug a connector with flat-cable.
- Unplug a three-pole connector.
- The complete unit can be taken out of instrument after having removed two screws in the front-profile of instrument.

For exchange of a potentiometer proceed as follows:
- Remove the four nuts that attach the potentiometer to the bracket.
- Separate bracket from p.c.b. by removing 2 screws.
- Solder potentiometer out of p.c.b.
- Put the new potentiometer in the p.c.b. (without soldering it).
- Mount the bracket to the p.c.b. (with two screws and four potentiometer nuts)
- Now the potentiometer is positioned correctly, it can be soldered on to the p.c.b.

26.1.7.7 Graticule illumination lamps
- Can be reached after removal of the CRT control unit (see chapter 26.1.7.6.)
- The two lamps are fixed in plastic lamp holders. Every lampholder fits in a plastic light-conductor with two clamping springs. These clamping springs are parts of the lampholder.

26.1.7.8 Delay line cable
- Remove the front unit (see chapter 26.1.7.1.)
- Unscrew the earth and signal clamps at both ends of the cable at the signal unit and the final Y amplifier.
- Unscrew the plastic clamps that fix the cable to the instrument´s chassis.
- Remove the two nuts that fix the cable holder to the power supply compartment; these nuts can be reached via the space in which the front unit fits.

26.1.7.9 Power supplies

Opening the power supply compartment

WARNING: inside the power supply compartment there are many parts that carry dangerous high voltages. Some of these voltages stay some time after disconnecting the instrument from the mains. Therefore it is recommended to wait at least five minutes after having disconnected the instrument from the mains, before opening the compartment. If working on the power supplies under working condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved.

now proceed as follows:
- Switch the instrument off and disconnect it from the mains voltage.
- Remove the screws from the rear panel with mounting plate for the power supplies. Some of these screws have spring washers that assure a good interconnection of the safety earth to the instrument´s chassis. Don´t forget to remount them in their original position!
- Remove the rear panel that covers the CRT-socket.
- Remove the support for the EHT-cable. This support is located close to the final Y-amplifier.
- Unplug the multipole connector from the motherboard.
- Unplug three single wire connectors from the CRT socket p.c.b.. Remember the position of the wires for correct reinstallation.
- Now the unit can be slided out of the instrument.

NOTE: The power supplies can be measured under working condition if the mounting plate with the power supplies is positioned behind the instrument according to figure 26.2/part 2. In the positions indicated in the figure, the wiring is long enough to be reconnected to mother board and CRT-socket. The figure gives the position for access to primary converters and high voltage converter. With the instrument and the mounting plate upside down, the secondary converter is accessible.

Primary converter units (unit A2315)
- Unsolder the wires from the unit that has to be exchanged. Remember the position of these wires in order to assure correct reinstallation.
- Remove two screws per converter unit and it can be slided out of its mounting plate.

High voltage converter (unit A2350)
- Unsolder the two wires that are going to the EHT multiplier unit.
- Unplug one single-wire connector going to the CRT-socket.
- Unplug one multipin socket.
- Remove six mounting screws and the p.c.b. can be separated from its mounting plate.

Secondary converter unit (unit A2320)
- Unplug four multipole connectors.
- Unplug two single-pole connectors going to the CRT-sockets. Remember the position of these wires in order to assure correct reinstallation.
- Unsolder the two wires from the EHT-multiplier unit at the high voltage converter (unit A2350).
- Unscrew the bracket for the EHT-cable.
- Remove the two hexagonal spacers under this bracket.

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

- Unscrew the plastic nut from the EHT multiplier unit, pull the EHT-cable out of the EHT mutliplier unit and short-circuit its end to the instrument´s earth.
- Unscrew the fixation screws of the p.c.b., after this the unit can be separated from its mounting plate.

NOTE: the EHT-multiplier unit can be separated from the secondary converter p.c.b.. The unit is fixed with a metal bracket; this bracket is fixed with one screw.

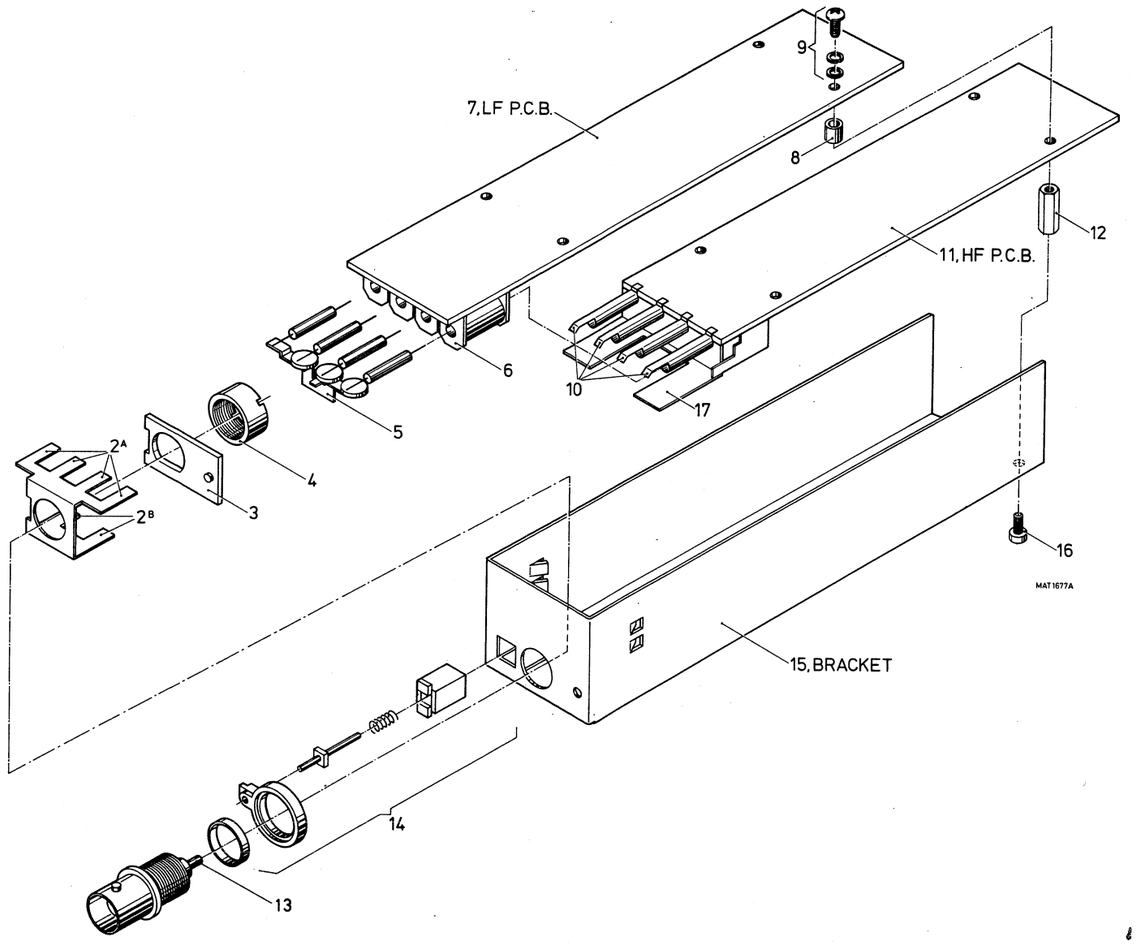


Fig 26.4.Exploded view of attenuator unit.

26.1.7.10 Mother Board (unit A2421)

- Remove the X/Z amplifier together with its mounting plate. See chapter 26.1.7.3.

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 very carefully the four side connections coming from the final Y-amplifier. These side connection wires have small connectors that fit on the side connection pins of the CRT.
- Unplug the flatcable from the final Y-amplifier.
- Remove the left side panel from the instrument: it is fixed with seven screws.
- Remove the screw in the spacer of the EHT-cable situated in the vicinity of the final Y-amplifier.
- Now the side panel can be moved so that the eight screws in the mother board (for screws at the top side and four at the bottom side) can be reached with a screwdriver with a long shaft.
- Remove the nut and spring-washer from power transistor V7311.

NOTE: for replacement of V7311 it is not necessary to remove the mother board. It is required then to remove the X/Z amplifier and its mounting plate and the nut and spring washer in V7311. Then its pins can be desoldered one by one. For mounting of the new transistor you have to work in reversed sequence: the pins of the new transistor must be cut to the required length.

- Remove the time base unit (see chapter 26.1.7.2.)
- Remove the top cover plate from the front unit and unplug the flatcables.
- Unsolder three leads coming from the CRT (trace rotation).
- Unplug the connectors coming from the power supply and the battery holder.
- Unplug the flatcable that comes from the CRT control unit.
- Unplug the flatcable from the adaptation unit.
- Unplug the coaxial cable for the calibration voltage.
- Unplug the connector for the graticule illumination lamps.
- Slide the motherboard upwards out of the connector on the signal unit.

26.1.7.11 Vertical attenuator, external MTB/DTB trigger input and adaptation unit.

Removal of mounting plate.

On this mounting plate the channel A and B attenuators, the MTB/DTB external trigger input and the adaptation unit are mounted. The plate can be separated from the instrument as follows:

- Unplug the flatcable coming from the motherboard.
- Unplug four coaxial cables.
- Unscrew six screws of which there are two present in the left and two in the right side panel of the front compartment. The remaining two screws are also used to fix the front unit to the instrument´s front profile.

IMPORTANT: after the above actions, the units can be separated from their mounting plate. Every input unit is fixed to the mounting plate with a pair of small screws that are present in holes in the plate. After reinstallation of an input unit it is recommended not to tighten its two mounting screws until the BNC input socket fits again into the text plate: this assures a correct positioning of the unit.

Removal and dismantling of external trigger input (unit A1311)

- Remove two small screws that fix the unit to its mounting plate.
- Slide the unit out of its connector on the adaptation unit: this must be done very carefully in order to prevent that the contact pins of the unit are bent. Also the installation of the unit must be done very carefully.
- The screening can be slided from the unit after removal of one screw.
- The p.c.b. is mounted in its holder with four screws: before removing the p.c.b., the earth tags (four per BNC) of the BNC´s must be unsoldered from the p.c.b.. Also the wire between the BNC signal tag and the bracket with the input capacitors must be unsoldered: this must be done very quickly and close to the BNC in order to avoid that the input capacitors get too hot. The BNC-socket can be separated from the bracket with a special tool that fits on the slotted nut of the BNC. This tool is available under service code number 5322 395 54023. For those who want to make this tool in a local workshop, a dimensional drawing is given in fig.26.5.

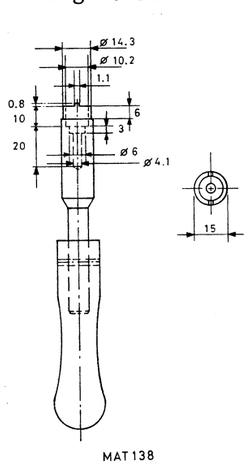


Fig.26.5. Dimensional drawing of tool for BNC input sockets.

Removal and dismantling of vertical attenuator

- Remove two small screws that fix the unit to its mounting plate.
- Slide the unit out of its connector on the adaptation unit: this must be done very carefully in order to prevent that the contact pins of the unit are bent. Also the installation of the unit must be done very carefully.
- Slide the screening can from the unit. The unit can be plugged into its connector on the adaptation unit again. The LF-p.c.b. (unit A1116) can be measured now under working conditions if the wiring is reconnected again.

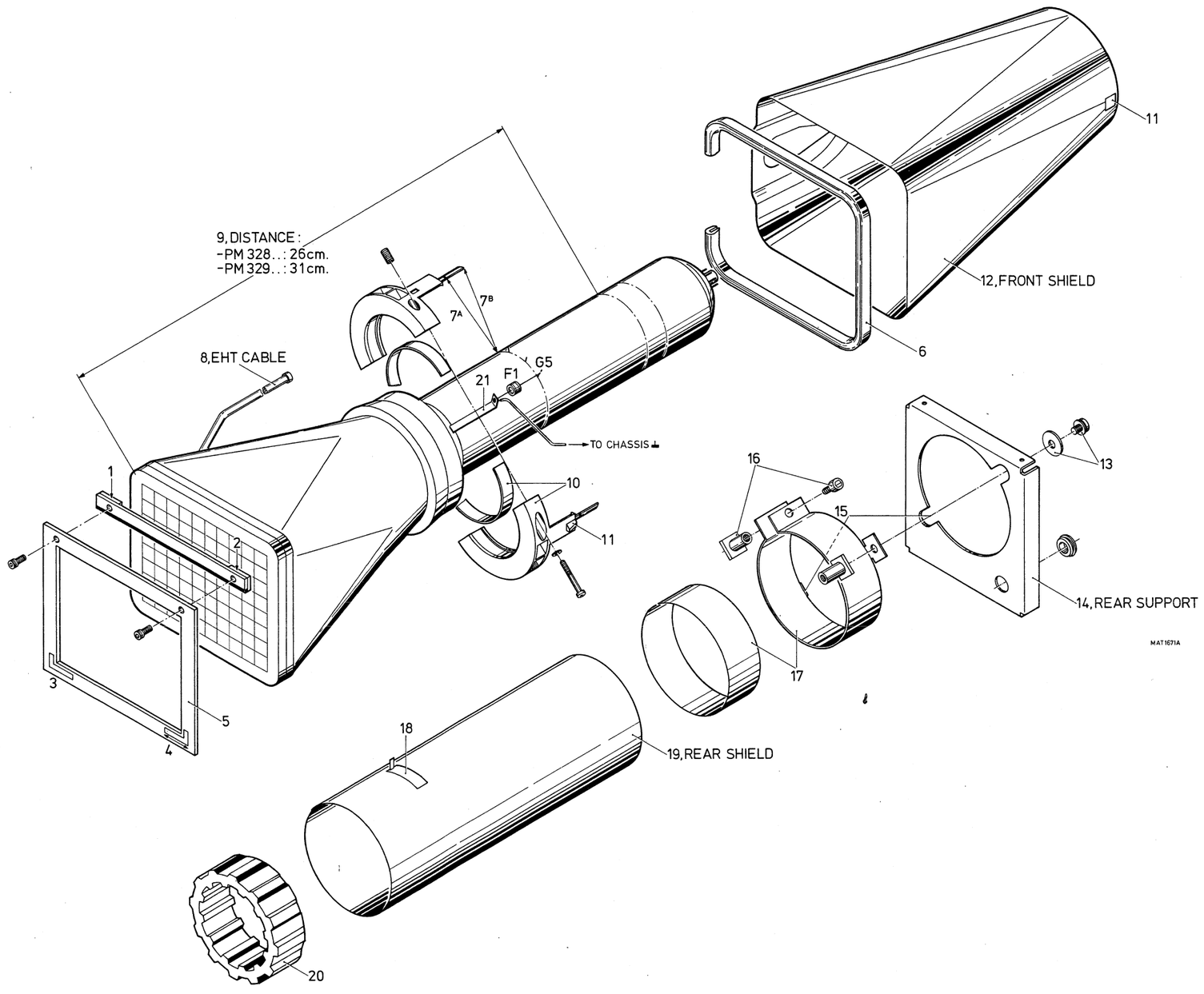


Fig.26.6. Exploded view of CRT and belonging mechanical parts.

IMPORTANT: it is strongly recc
and belonging figur

- Put the unit on your bench v
the four screening cans (10)
- Unsolder the wire of the prc
the LF-p.c.b.
- Remove two screws that attac
bracket.
- Put the unit on your bench v
the BNC-signal tag (13) from
(5): this must be done very
avoid that the input capacit
- The subassembly consisting c
of the mounting bracket.

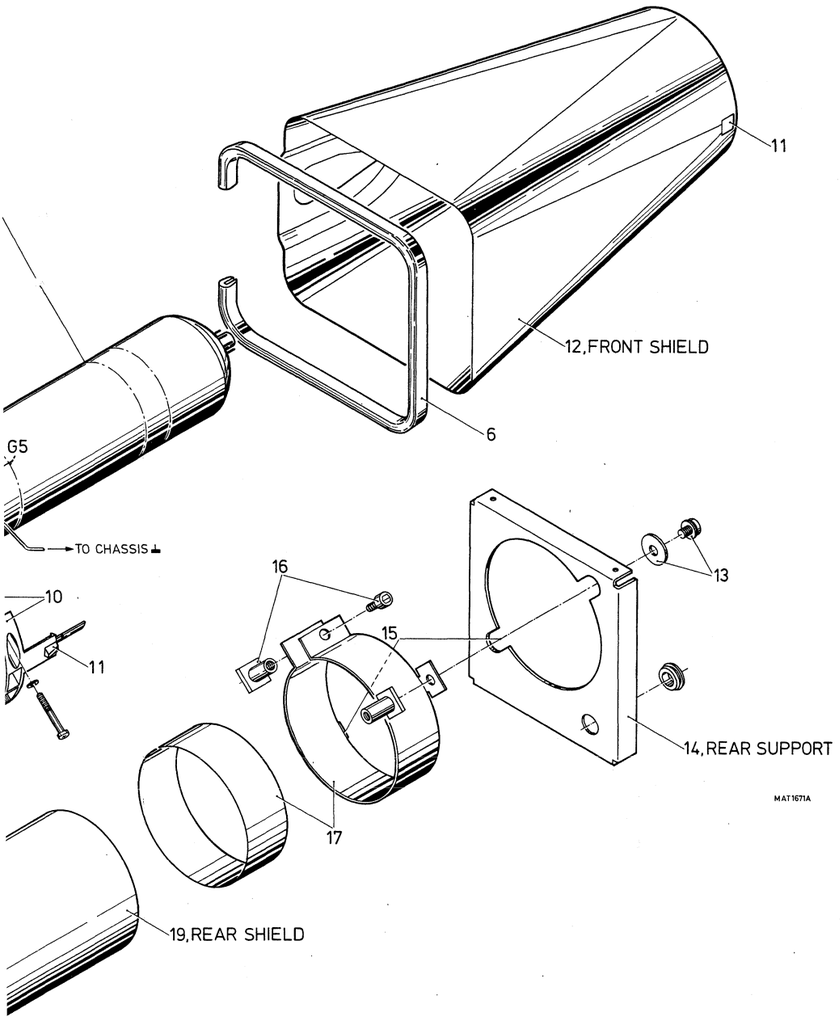
NOTE: after the above actions,
on the HF-p.c.b. can be

- The BNC-socket can be separa
that fits on the slotted nut
under service code number 53
this tool in a local worksho
fig. 7.4. Together with the
parts (2), (3), (4), (13), a
- If you want to separate the
necessary to remove the glas
For this purpose the bracket
unsoldered from the reed rel
After this the other side of
the HF-p.c.b. and it can be
resistor between the bracket
the LF-p.c.b. Now the hardwa
together (9,8,12) can be rem
four screening cans (10) can
(6) on the LF-p.c.b. (7).

Removal of adaptation unit (un

- Remove the two vertical atte
- Remove the external trigger
- Remove the three screws that
plate.
- The unit can now be separate

IMPORTANT: All sides of the in
condition. For this
their mounting plat
be removed. After t
adaptation unit aga
wiring (flatcable a
function again.



cal parts.

IMPORTANT: it is strongly recommended to take notice of this chapter and belonging figure 26.4. before starting the job.

- Put the unit on your bench with the LF-p.c.b upwards and unsolder the four screening cans (10) from the tags of the earth bracket (2).
- Unsolder the wire of the probe indicator from the soldering tag on the LF-p.c.b.
- Remove two screws that attack the p.c.b.´s to their mounting bracket.
- Put the unit on your bench with the HF-p.c.b. upwards and unsolder the BNC-signal tag (13) from the bracket with the input capacitors (5): this must be done very quickly and close to the BNC in order to avoid that the input capacitors get too hot.
- The subassembly consisting of the LF and HF p.c.b. can be slided out of the mounting bracket.

NOTE: after the above actions, the 50 Ohm termination resistor array on the HF-p.c.b. can be interchanged.

- The BNC-socket can be separated from the bracket with a special tool that fits on the slotted nut (4) of the BNC. This tool is available under service code number 5322 395 54023. For those who want to make this tool in a local workshop, a dimensional drawing is given in fig. 7.4. Together with the removal of the BNC all the separate parts (2), (3), (4), (13), and (14) can be taken apart.
- If you want to separate the HF (11) and LF (7) p.c.b´s, it is necessary to remove the glass reed switches from their coils. For this purpose the bracket with the input capacitors (5) must be unsoldered from the reed relays. After this the other side of the reed relay can be unsoldered from the HF-p.c.b. and it can be slided out of the coil. Also the resistor between the bracket and the LF-p.c.b. must be unsoldered at the LF-p.c.b. Now the hardware (4x) that fixes the HF and LF p.c.b. together (9,8,12) can be removed and the HF-p.c.b. (11) with its four screening cans (10) can be slided out of the reed relay coils (6) on the LF-p.c.b. (7).

Removal of adaptation unit (unit A2312).

- Remove the two vertical attenuator units.
- Remove the external trigger input unit.
- Remove the three screws that fix the adaptation unit to its mounting plate.
- The unit can now be separated from the mounting plate.

IMPORTANT: All sides of the input units can be measured under working condition. For this all four units must be removed from their mounting plate. The shield of the suspected unit must be removed. After this, the units can be plugged into the adaptation unit again and after reinstallation of the wiring (flatcable and four coaxial cables) the units function again.

26.1.7.12 Replacement of CRT (cathode ray tube).

IMPORTANT: It is strongly recommended to take notice of this chapter and belonging figure 26.6. before starting the job. Bear in mind that there are slight differences between PM328.. and PM329.. Where it happens, it is indicated.

Removing the CRT from the instrument.

- Remove the X/Z-amplifier together with its mounting plate. See chapter 26.1.7.3.

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 very carefully the side connections coming from the final Y-amplifier. These connection wires have small connectors that fit on the side connection pins of the CRT.
- Remove the earth connection wires from the front and rear CRT shields
- Remove the rear plate that covers the CRT socket and take the p.c.b. at the CRT socket off.
- Open the power supply compartment. In PM329.. the EHT-cable can only be removed at the EHT multiplier. This part is present in the power supply compartment that must be opened for CRT removal. In PM328.. however the EHT-cable can also be removed at the CRT-side. Therefore it is not necessary to open the power supply compartment when exchanging a CRT. See chapter 26.1.7.9.

WARNING: When the EHT-cable is disconnected from the EHT multiplier unit or the CRT in PM328.., the end of the cable must be discharged immediately by shorting it to the instruments earth.

- Remove the EHT-cable from the bracket on the secondary converter unit, disconnect it from the EHT multiplier unit and discharge it.
- Take the bezel and contrast filter off: for this grip the left and right hand side between each thumb and fore finger and pull it gently forward (if necessary, insert the finger-nails in slots to ease it free).
- Slacken the hexagon screws (1), (2) and (4) that position the CRT-screen. Screws (1) and (2) attach the pressure bar on top of the screen.
- Remove the two screws that attach the rear support (14) of the CRT to the instrument's chassis. For this you have to use a screwdriver with a long shaft.
- Now the CRT can be lifted upwards out of the instrument.
- Remove the mounting material (13) and (15) that attaches the rear support (14) to the clamping bracelet (17).
- Remove the clamping bracelet.

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.

- Slide the rear shield (19) backwards from the CRT and be careful not to hit the CRT side connections.
- Remove the rubber ring (20) from the CRT.
- Click the front shield (12) out of its two plastic clamping springs (11).

- Now the CRT and its plastic positioning ring (10) are left. The position of this ring is very important since it determines the position of front and rear shield. So before taking the ring off from the CRT you have to look very carefully how it is mounted in order to be able to remount it correctly on the new CRT. The ring can be removed with two screws (7A=PM328. and 7B=PM329. situation).

Installing the new CRT.

- Install the positioning ring (10) so that the end of the positioning tags (7B, PM329.) or the indication line on the tags (7A, PM328.) are at the same level as the side connection pins of the CRT (see fig 26.6.). The position of the clamping springs (11) must be so, that the front shield (12) fits correctly into them. When doing this, take care of the correct positioning of the EHT-cable (8) and the trace rotation wires and mount the plastic rim (6). For PM329. the earthing bracket (21) for protection tube F1 must be positioned under ring (10). This bracket also earthens the CRT.
- Put the rubber ring (20) around the CRT. The distance (9) between the ring and the end of the CRT-screen must be 31 cm for PM329. and 26 cm for PM328..

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.

- Slide the rear shield (19) into the front shield until it touches the positioning ring. The position of the rear shield must be so that all the CRT's side connections are visible through the square holes (18) in the shield.
- Put the bracelet (17) and the CRT rear support (14) around the rear shield and mount the fixing material in hole (15) of the rear support without tightening it. The result is that the bracelet and rear support can be slided along the rear shield.
- Now the CRT can be put into the instrument. The screen must touch the front plate (5). The horizontal positioning part (4) and the top positioning parts (1) and (2) must be fixed (with their hexagon screws) so that the CRT is pressed into the fixed positioning part (3). The variable positioning parts can be pressed with a screwdriver via the belonging holes in the front plate; after that they are secured with the belonging hexagon screw.
- Now the CRT rear support can be positioned and fixed to the chassis (2 screws).
- After this the bracelet can be fixed with the mounting material (13), (15) and (16).
- Now the steps mentioned under "removing the CRT ..." must be completed in reversed sequence in order to complete the job.

Removal of carrying handle

See fig. 28.3 for location and itemnumber of parts.

- Remove both fixing rings and washers (7) and the handle can be separated from the cabinet. When installing the handle again, the fixing pin (8) can be pulled out of the handle arm with a screw with M4-thread (e.g. 4822 502 10054, M4x35mm). This screw can be fixed in fixing pin (8) because this part has M4-thread.
- Remove both handle covers (outer part, 5) by removing 4 screws (6).
- Remove both handle arms (inner part, 4) by removing 2 hexagonal screws (2).
- The text strip (3) can be slided out of the grip (1).

26.2. SOLDERING TECHNIQUES

Working method:
- Carefully unsolder one after the other the soldering tags of the semi-conductor.
- Remove all superfluous soldering material. Use a sucking iron or sucking 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 semi-conductor (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 PLATO pin-point tip type 0-569.
- ERSA miniature soldering iron, type minor 040 B, voltage 6V.
- Low Voltage Mini Soldering Iron, type 800/12 W-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.

26.2.1. Soldering and desoldering of surface mounted devices.

Introduction .
This description gives you a method for replacing surface mounted devices (S.M.D.´s) and incorporates subjects such as:
- required tools and materials.
- how to arrange the S.M.D.-workshop. (see fig.26.7.)
- general hints for S.M.D.-handling.
- interchanging S.M.D.´s with two or three connections.
- interchanging S.M.D.´s with four or more connectionss.

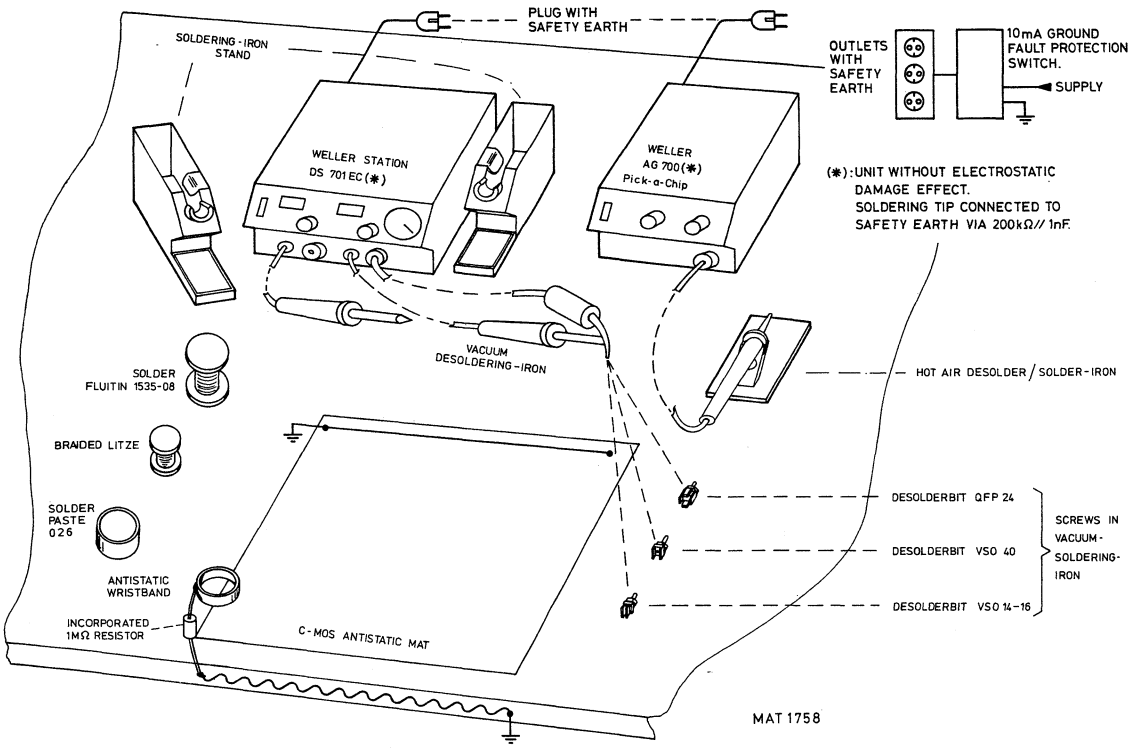


Fig.26.7. Arrangement of working area for S.M.D. exchange.

Required tools and materials

The following tools are necessary:
- A hot-air soldering/desoldering station for components with two or three leads: Weller AG 700 pick-a-chip.
- A vacuum, temperature controlled, soldering/desoldering station for components with four or more connections: Weller DS 701 EC.
- Desoldering accessories that can be attached to the Weller DS 701 EC-equipment: for dual-in-line S.M.D.'s VSO 14 and VSO 16 (with 14 and 16 connections such as used on the HF-attenuator p.c.b.) the types with Weller ordering code 587 13 701 and 587 13 702. For dual-in-line S.M.D.'s VSO 40 (with 40 connections such as used on the LCD-unit) the type with Weller ordering code 587 13 703. For QFP 24 S.M.D.'s (such as used on the time base chip unit) the type with Weller ordering code 587 13 704.
- A working area that has been secured against electro static discharge (E.S.D.).
- A pair of tweezers.

NOTE: The Weller equipment can be ordered via your local Weller-dealer.

The following material is necessary:
- "Fluittin" solder diameter of 0,8mm, 15/35, Sn Pb 60.
- Solder paste 026.
- Components. Since not all the components are marked, they must be kept in their original packing in order to avoid interchanging them.
- Desoldering braided wire.

General hints for S.M.D.-mounting.

- Protection against E.S.D.: since the working area must be suitable for repair of MOS-devices, some precautions must be taken (see fig.26.7),
  All repairs must be done earthened which means that the repair surface, the soldering iron and the technician must be connected to the earth potential. This is achived by using a C-MOS antistatic mat that must be connected to earth. The service-technician is connected to earth by wearing an antistatic wristband.
- Components: desoldered components cannot be used again since desoldering is done at a temperature of 350 degrees Celcius while they can only whitstand 240 degrees Celcius for max. 10 sec.
  Keep the new components as long as possible in their original packing in order to avoid damage and mixing up new and old S.M.D.'s.
- For an optimal supply of heat a working area must be used that does not lead away the heat: the antistatic mat in fig.26.7. meets this requirement.

Interchanging S.M.D.'s with two or three connections.

IMPORTANT: before removing the component, observe very carefully its position in order to avoid that the new component is installed upside-down. This is especially important for capacitors where the metalisation at both ends is longer at the p.c.b. side than at the top side.

Use the equipment Weller AG 700 pick-a-chip and proceed as follows:

- Heat the component up equably with hot air of 350 degrees Celcius.
- Remove the component with a pair of tweezers.
- Clean the p.c.b. tracks, on which the new component has to be soldered, with braided wire or with the use of the vacuum desoldering equipment DS 701 EC.
- Put solder paste on the connections of the new component and position it on the p.c.b.
- Solder the component on to the p.c.b. with the solder described in the materials list. Soldering temperature must be 240 degrees Celsius, soldering time must not exceed 3 sec. per connection.
  The tip of your soldering iron must not touch the component, but must touch the p.c.b. track close to the component.

Interchanging S.M.D.'s with four or more connections.

Use the equipment Weller DS 701 EC and attach a suitable desoldering piece (VSO 14, VSO 16, VSO 40 or OFP 24). Then proceed as follows:

- Adjust the desoldering temperature to 350 degrees Celcius and place the desoldering piece on the IC that has to be removed. Take care that all connections of the IC are equally heated up).
- Switch the vacuum on and lift the component from the p.c.b.
- Clean the p.c.b. tracks, on which the new component has to be soldered, with braided wire or with the use of the vacuum desoldering equipment DS 701 EC.
- Put solder paste on the connections of the new component and position it on the p.c.b.
- Position the component by soldering first the outside connections in a crosswise manner. Soldering temperature must be 240 degrees Celcius. Keep the soldering time as short as possible.
- Solder now the other connections.

- If necessary you must remove superfluons rests of solder with the use of braided wire.

26.3. SPECIAL TOOLS

Special tools are available for removal of the slotted nuts behind some potentiometer knobs (service ordering code 5322 395 54024) and the nuts that secure the input BNC-connectors (service ordering code 5322 395 540243). Information how to use these tools is given in chapter 26.1.7.1. and 26.1.7.11. For those who want to make such a tool, sketches are given with dimensions in mm in the figures 26.3. and 26.5. The material is silversteel N094, tempered 40-45 RC.

Trimming Kit SBC 317 4822 310 50095
The SBC 317 Trimming Kit matches every current trimming requirement on all products. The set contains 27 pieces (22 different bits, plus 3 bit holders and 2 extension pieces). The insulated holders and exension pieces make it easy to reach into a chassis and make accurate adjustments, without wasting time or risking shocks.
The SBC 317 Trimming Kit is packed in a flat transparent case. Several of the most commonly required bits re duplicated. In addition, a spare set of 8 bits is separately available as replacement (4822 310 50016)

For an easy exchange of dual-in-line IC's there is a lay cutter available under service code 5322 395 71004. After having removed the IC, the pins can be soldered one by one out of the p.c.b.

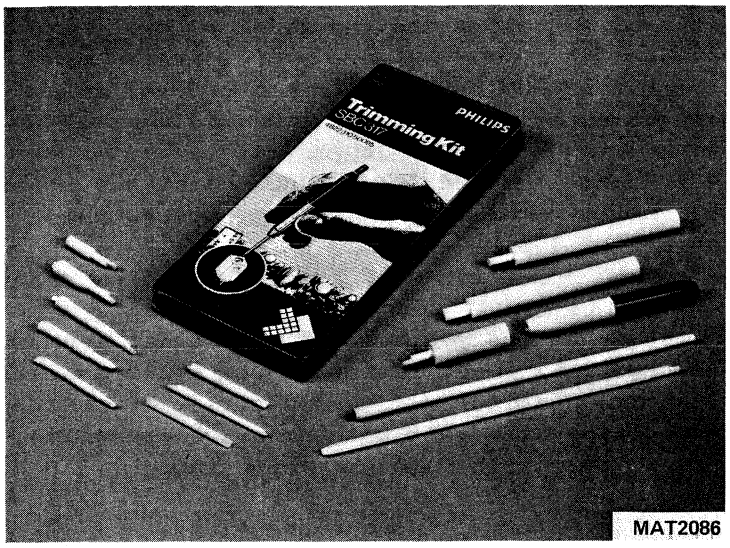


Fig. 26.8 Trimming tool kit

26.4. RECALIBRATION AFTER REPAIR

After any electrical component has been renewed 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 in the power supply or if the transformer has been renewed.

26.5.INSTRUMENT REPACKING

If the instrument is to be shipped to a Service Centre for service or repair, attach a tag showing the full address and the name of the individual at the users firm that can be contacted. The Service Centre needs the complete instrument, its serial number and a fault description. If the original packing is not available, repack the instrument in such a way that no damage occurs during transport.

26.6. TROUBLE SHOOTING

26.6.1. Introduction

The following information is provided to facilitate trouble shooting. Information contained in other sections of the manual should also be used to locate the defect. An understanding of the circuit is helpful in locating troubles, particularly where integrated circuits are used. Refer to the circuit description for this information.

26.6.2. Trouble shooting techniques

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

- Check if the settings of the controls of the oscilloscope are correct. Consult the Operating Instructions.
- 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 25. "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 (0,7V approx. in conductive state) and the voltage between collector and emitter (0,2V approx. in saturation) with a voltmeter or an oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the 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 condition that the new component will be damaged.
- Integrated circuits. In circuit testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore first read the circuit descriptions in Section 3...22.

- Capacitors. Leakage can be traced with an ohmmeter adjusted to its 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 the 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 the 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 respones when HF signals are passed through the circuit. Also an inductance meter can be used.
- Data latches. To measure on inputs and outputs of data latches a measuring oscilloscope can be triggered by the clock signal which is connected to the clock input of the data latch.
  Check the input data lines one by one during the active edge of the clock signal.
  This measurement can only be done in this way when there is an acceptable repetition time of the clock signal. A too low clock pulse repetition time results in a low intensity of the trace on the measuring oscilloscope screen.
  The outputs can easily be checked by a voltmeter or oscilloscope.

26.6.3. Trouble shooting the power supplies.

Information for an easy access to the power supplies and for safe working conditions can be found in chapter 26.1.7.9. This chapter also explains how to measure the power supplies in working condition.

Primary converter units.
Since these units are almost completely sealed, they must be replaced by a new unit if they are defective. Only a limited number of components in the primary and secondary circuit of a unit can be interchanged. What components are interchangeable and what not can be found in the circuit diagram. If a unit is suspected to be defective, its output voltage can be substitued by a bench-type power supply. This power supply must be capable of delivering at least 2,3 Amp. at 24 Volt DC: the Philips type PE1540 is a suitable type.

Secondary converter unit.
It must be borne in mind that this unit does not work if the input supply voltage is lower than 43 Volt DC. So if one of the primary converter units does not function, also the secondary converter unit is dead. In order to be able to determine whether a certain fault condition is initiated by the secondary power supply itself or by the connected oscilloscope circuits, a dummy load is listed in the table below. The table gives also an example of the resistor types that can be used to compose the dummy load: the resistors can be ordered at Concern Service.

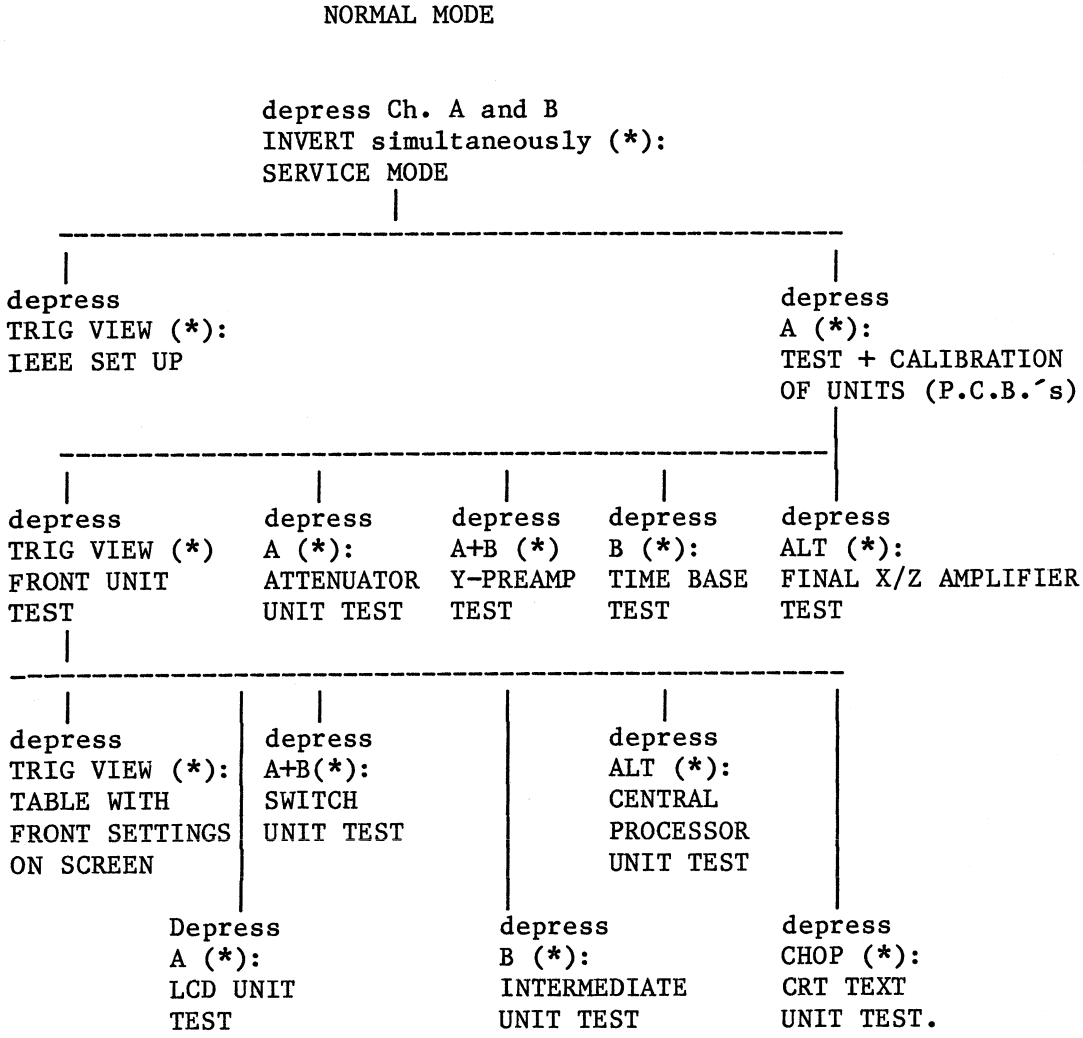
Supply voltage	Output Current	Dissipated Power	Dummy resistance and their service ordering code.
+13,8 Volt	1,7 Amp.	23 Watt	8,2 Ohm: 15 Ohm (4822 112 31058) and 18 Ohm (4822 112 31061) in parallel.
-13,8 Volt	1,7 Amp.	23 Watt	8,2 Ohm: 15 Ohm (4822 112 31058) and 18 Ohm (4822 112 31061) in parallel.
+5 Volt digital	2 Amp.	10 Watt	2,5 Ohm: 4,7 Ohm (4322 112 21045) and 5,6 Ohm (4822 112 21047) in parallel.
+5 Volt analog	1,3 Amp.	6,5 Watt	3,7 Ohm: 6,8 Ohm (4822 112 21049) and 8,2 Ohm (4822 112 21052) in parallel.
+25 Volt	0,16 Amp.	4 Watt	150 Ohm (4822 112 21085)
+120 Volt	0,03 Amp.	3,6 Watt	3,9k.Ohm (4822 112 21123)
-120 Volt	0,03 Amp.	3,6 Watt	3,9k.Ohm (4822 112 21123)
-7 Volt	0,33 Amp.	2,3 Watt	22 Ohm (4822 112 21063)

26.6.4. Description of service routines.

Introduction

If you depress the channel A and B INVERT pushbuttons simultaneously, the instrument jumps to the service routine. The service routine consists of a big number of separate routines that are logically arranged in a tree-structure. If you are at a certain level in this tree, you can select different branches: the branches that can be selected at a certain level are indicated in a menu that is visible on the CRT-screen if the text display is on.
The branches are selectable with the vertical display mode switches TRIG VIEW, A, A+B, B, ALT and CHOP.
If you want to jump back in the tree you must depress pushbutton AUTO SET. During the service routine the controls of the instrument are mostly out of order (except the vertical display mode switches). The LED'S in the pushbuttons and the LCD's represent the momentary setting of the instrument: this setting is fixed and depends on the part of the service routine you are working in. The new following scheme gives you the tree-structure with selectable programs and their names and the vertical display mode switches that select the programs. This scheme is followed by a description of every program.

Structure of service routines:



(*) means: depress AUTO SET to move upwards in the tree-structure.

Explanation of the service routines.

IEEE SET UP.
Function of pushbuttons is arranged as follows:
depress TRIG VIEW: listen only
depress A : talk and listen
depress A + B : software release in LCD-A
The device address can be selected between 00 and 30 with the Ch. A attenuator switch. The IEEE set-up data is also displayed in the Ch. A LCD.

ATTENUATOR TEST.
This routine helps to check and adjust the attenuator balances for channel A (A depressed) and channel B (B depressed). In this routine the vertical input attenuator of the selected channel is automatically switched between 5 and 500mV/div. (indicated in belonging LCD): now the balance adjustment can be checked/adjusted for minimal trace jump. Changing from channel A to B must be done via operation of the AUTO SET pushbutton.

Y-PREAMPLIFIER TEST.
This routine helps to check and adjust the normal/invert balances for channel A (A depressed) and B (B depressed). In this routine the selected channel is automatically switched between normal and inverted display (indicated by LED in belonging pushbutton): now the balance adjustment can be checked/adjusted for minimal trace jump. Changing from channel A to B must be done via operation of the AUTO SET pushbutton. In this mode, the input sensitivity of the channel can be adjusted to the desired value.

TIME BASE TEST.
This routine helps to check and adjust the delay and delta T times on the time base. The MAIN TB LCD always shows 10 microsec./div. The following modes can be selected:

depress TRIG VIEW:	the DTB start (= intensified part) at the 3rd division can be adjusted. The DELAY LCD shows 020.00 microsec.
depress A:	the DTB start at the 9th division can be adjusted. The DELAY LCD shows 080.00 microsec.
depress A+B:	the DTB start after DELAY + DELTA T at the 3rd division can be adjusted. The DELAY + DELTA T LCD shows 000.00 microsec.
depress B:	the DTB start after DELAY + DELTA T at the 9th division can be adjusted. The DELAY + DELTA T LCD shows 060.00 microsec.

NOTE: Changing the modes can be done directly; operation of the AUTO SET pushbutton is not necessary.

FINAL X/Z-AMPLIFIER TEST.
This routine helps to check and adjust the position of the cursor line. The following modes can be selected:

depress TRIG VIEW:	two vertical cursor lines on the right side of the screen must be postioned upon each other. The LED in the "time" cursor pushbutton is on.
depress A:	the reference cursor must be positioned in the mid of the graticule. The delta cursor must be positioned upon the last right-hand graticule line. The LED in the "time" cursor pushbutton is on.
depress A+B:	check that the reference cursor is upon the first left-hand graticule line and that the delta cursor is upon the last right-hand graticule line. The LED in the "time" cursor pushbutton is on.
depress B:	two horizontal cursor lines are visible on the screen. The reference cursor line must be positioned upon the graticule line in the mid of the screen. The delta cursor line must be positioned upon the last graticule line in the bottom of the screen. The LED in the "voltage" cursor pushbutton is on.
depress ALT:	check that the reference cursor line is upon the last graticule line in the bottom of the screen and that the delta cursor line is upon the first graticule line in the top of the screen. The LED in the "voltage" cursor pushbutton is on.
depress CHOP:	adjust the instrument so that the green area fits inside the outside graticule lines of the screen.

TABLE WITH FRONT SETTINGS ON SCREEN (SETTING MONITOR).
With this service-routine you are able to check if the signals from the pushbutton switches, rotary switches and potentiometers (CAL/UNCAL) are taken in correctly by the central processor unit. The table consists of 24 rows of 8 bits of information. The bits represent the actual position of the controls: for instance if Ch. A is switched on, the belonging bit is 1.
All the controls except AUTO SET can be activated in this routine: if a control is operated the contents of the table changes. The eight-bit binary value is also represented as a hexadecimal number under the column "hex". The 24 rows represent the following information (if a bit is not used this is indicated with N):

row 00: N/N/N/N/trig view/Ch. B/A+B/Ch. A.
row 01: N/N/N/BW LIMIT off/N/N/N/ALT.
row 02: N/N/N/Ch. A 50 Ohm/N/Ch. A DC/Ch. A 0/Ch. A AC.
row 03: Ch.A UNCAL/Ch.A INVERT/2 bits for Ch.A probe type: 00 = 1:1 probe. 01 = 10:1 probe, 10 = 100:1 probe/4 bits for Ch.A sensitivities: bit pattern carrying from 0000 (5V/div.) till 1011 (1mV/div.)
row 04: N/N/N/Ch.B 50 Ohm/N/Ch.B DC/CH.B 0/Ch.B AC.
row 05: Ch.B UNCAL/Ch.B INVERT/2 bits for CH.B probe type: bit pattern identical to Ch.A (see row 03)/4 bits for Ch.B sensitivities: identical to Ch.A (see row 03).
row 06: row 07, row 08, row 09: all bits not used.
row 0A: N/N/N/TB MAGN on/N/3 bits for horizontal display source: 000 = MAIN TB/001 = MTB intensified/010 = MTB intensified and DTB/011 = DTB/100 = MTB intensified and delta T/101 = MTB intensified, DTB and delta T/110 = DTB and delta T/111 = EXT X DEFL.
row 0B: N/SINGLE/AUTO/TRIG/N/N/N/MTB NEG SLOPE.
row 0C: 4 bits for MTB trigger coupling: 0000 = DC coupling/0001 = LF reject/ 0010 = AC/ 0011 = HF reject/ 0100 = HF reject and DC/4 bits for MTB trigger source: 0000 = Ch.A/ 0001 = Ch.B/ 0010 = COMP/ 0011 = EXT/ 0100 = EXT ÷10/0101 = LINE.
row 0D: MTB UNCAL /N/N/5 bits for MTB sweep speeds: bit pattern varying from 00000 (1 sec/div.) till 11000 (10n.sec./div)
row 0E: N/N/N/N/N/N/N/DTB NEG SLOPE on.
row 0F: 4 bits for DTB trigger coupling: bit pattern identical to MTB (see row 0C)/4 bits for DTB trigger source: bit pattern identical to MTB (see row 0C) except for 0101 (STARTS).
row 10: DTB UNCAL /N/N/5 bits for DTB sweep speeds: bit pattern varying from 00000 (500 m.sec/div) till 10111 (10 n.sec/div).
row 11,12: 16 bits for the delay time; row 11 incorporates the least significant bits, row 12 the most significant bits.
row 13,14: 16 bits for the delta T time; row 13 incorporates the least significant bits, row 14 the most significant bits.
row 15: delta T hor./reference hor./delta T vert./reference vert./N/TRACK/RATIO/CURSORS.
row 16,17: 16 bits for the time reference cursor position; row 16 incorporates the least significant bits, row 17 the most significant bits.
row 18,19: 16 bits for the time delta cursor position; row 18 incorporates the least significant bits, row 19 the most significant bits.

row 1A, 1B:16 bits for the voltage reference cursor position; row 1A incorporates the least significant bits, row 1B the most significant bits.
row 1C, 1D:16 bits for the voltage delta cursor position; row 1C incorporates the least significant bits, row 1D the most significant bits.
row 1E, 1F:16 bits for the reference value after operation of the RATIO-pushbutton; row 1E incorporates the least significant bits, row 1F the most significant bits.

LCD UNIT TEST.
In this service routine you are able to check the pathes between central processor unit and the LCD's. If pushbutton TRIG VIEW is depressed, all the segments in the LCD's are on: every LCD shows a pattern as indicated in fig.26.9.
If pushbutton A is depressed, all segments in the LCD's are off.
Selection between both modes can be done directly: operation of the AUTO SET is not necessary.

MAT 2157
840928

Fig.26.9. LCD with all elements activated.

SWITCH UNIT TEST

NOTE: in the circuit and p.c.b. lay-out you can find several signal names. Some of them have a line on top which means that the signal is low if the related function is on. In this description the line on top of the signal name is not present; it is replaced by the addition "-" directly behind the signal name.

In this service routine you are able to test if the central processor unit controls the LED's in the pushbutton switches correctly. For this purpose you can depress either pushbutton A (all LED's switched on) or pushbutton A+B (all LED's off).
Another important feature of this test routine is the possibility to check if the information from the pushbutton switches (depressed or not) is present on the databus of the central processor unit. This part of the test routine is active after operation of the TRIG VIEW pushbutton. The pushbutton switches are grouped in a matrix structure (see circuit diagram of switch unit): this means that every switch is located at the crossing of two wires (see table below). One wire is the "column" wire, the other is the "row" wire. There are 8 column wires numbered column 0 ... 7 and 8 row wires numbered row 0 ... 7. The logic levels from column 0 ... 7 are applied to the databus lines D0 ... 7 if the signal RDCOL- is low. The logic levels from row 0 ... 7 are applied on the databus lines D0 ... 7 if the signal RDROW- is low. The lines RDCOL-, RDROW- and D0 ...7 have soldering tags to which a measuring probe can be connected:

for their position refer to the p.c.b. lay-out of the central processor unit. Normally the row and column wires are at a logic high (+5V) level. However, if a switch (e.g. CHOP) is depressed the column wire (column 1) and the row wire (row 2) of the switch are low (0 Volt).
Now the databus information (e.g. from pushbutton CHOP) can be measured with a standard 2 channel oscilloscope:
- Connect channel A to the signal RDCOL- and adjust the input sensitivity to a suitable value.
- Trigger the measuring oscilloscope on channel A and on the negative slope of the RDCOL- signal.
- Connect channel B to the databus line D1 (see table).
- Now the signal on channel B must be low (0 Volt) during the time that RDCOL- is low if pushbutton CHOP is depressed.
  For a well-defined read-out the main time base of the measuring oscilloscope must be set to 0,1 microsec/div.
- Connect channel A to the signal RDROW-.
- Connect the channel B to the databus line D2 (see table).
- Now the signal on channel B must be low (0 Volt) during the time that RDROW- is low if pushbutton CHOP is depressed.

COLUMNS (trigger measuring oscilloscope on RDCOL-)

		0	1	2	3	4	5	6	7
ROW	0	SLOPE MTB	B ON	-	-	-	TIME CURS.	-	TRIG MTB
ROW	1	AUTO	ALT	INVERT CH.A	-	-	VOLT CURS.	START DTB	-
ROW	2	SINGLE	CHOP	INVERT CH.B	50 OHM B	AC CH.A	MTB	LINE	EXT /10
ROW	3	TRIG	-	TRIG VIEW	RATIO	DC CH.B	TB MAGN	-	EXT
ROW	4	0 CH.B	EXT.X DEFL	AUTO SET	REF	0 CH.A	-	-	TRACK
ROW	5	AC CH.A	MTB INTENS	A ON	DELTA CURS.	-	TRIG DTB	COMP	LF REJ
ROW	6	BW LIMIT	DELTA T	A+B	50 OHM A	-	-	B TRIG	AC TRIG
ROW	7	DC CH.A	DTB	-	HF REJ.	SLOPE DTB	-	A TRIG	DC TRIG

ROWS: trigger measuring oscilloscope on RDROW-.

INTERMEDIATE UNIT TEST.
In this service routine the position of the controls Y POS Channel A, Y POS channel B and LEVEL MAIN TB becomes fixed in their mid position after the operation of the TRIG VIEW pushbutton.
The controls can be released again by turning them through their mid position.

CENTRAL PROCESSOR UNIT (CPU) TEST.
In this servie routine five different functions can be selected. These functions can be used either for checking and adjusting the instrument or they can be used for checking the correct functioning of the central processor unit. The following can be selected: depress TRIG VIEW: the LCD of channel A shows you the release of the software of the instrument. This is represented in a two digit number.

NOTE: In correspondance concerning this instrument it is recommended to mention the software-release number if you expect a fault in the central processor unit.

depress A: now you can check if the probe indicator IC D1628 functions correctly. This measurement must be done in the same way as the pushbutton test of the switch unit test. If the signal RDRR0 is high, the databus lines D0 ... 7 represent a bit pattern that depends on the type of probe connected to the vertical inputs A and B. Only probes with an identification ring function correctly: the ring incorporates a resistor and its resistance value tells D1628 what probe is connected.
The lines RDPR0 and D0 ... 7 have tags to which a measuring probe can be connected: for their position refer to the p.c.b. lay out of the central processor unit. Channel A of a standard oscilloscope can be connected to the RDPR0 signal. The oscilloscope must be triggered on channel A and on the positive slope of the signal. With channel B the databus line D0 ... 7 can be checked: for this refer to the table below. In the table it is assumed that channel A and B have the same probe type connected to their input.

probe type connected to Ch.A and B	indicator resistor in probe	bit pattern on databus lines Channel A D0	D1	D2	D3	Channel B D4	D5	D6	D7
no probe	-	1	1	1	1	1	1	1	1
1:1 probe	10 k.Ohm	1	1	1	1	1	1	1	1
10:1 probe	2,32k.Ohm	0	0	0	1	0	0	0	1
10:1 probe 50 Ohm	4,12k.Ohm	1	0	0	1	1	0	0	1
100:1 probe	6,98k.Ohm	1	0	1	1	1	0	1	1
100:1 probe 50 Ohm	6,34k.Ohm	0	0	1	1	0	0	1	1

Depress A+B: in this mode the DC voltage present at the tag "DAC" (for location see p.c.b. lay-out of central processor unit) must be 10 Volt.
Depress B: in this mode the 8 most significant bits for the digital to analog converter (DAC) are always 0000 0000: the 8 least significant bits are stepwise increased between 0000 0000 and 1111 1111.
The result is a sawtooth signal on the tag "DAC" with a value between 0 and 39 m.Volt.
If you want to leave this mode, you have to depress AUTO SET.
Depress ALT: in this mode the 16 bits of the DAC are stepwise increased between 0000 0000 0000 0000 and 1111 1111 1111 1111. The result is a sawtooth signal on the tag "DAC" with a value between 0 and 10 Volt.
If you want to leave this mode you have to depress AUTO SET.

CRT TEXT UNIT (CTU) TEST
In this service routine six different patterns can be selected on the screen. These patterns can be used either for checking and adjusting or they can be used to check the correct functioning of the CRT text unit and its control signal exchange with the central processor unit.
The following test patterns can be selected:
depress TRIG VIEW: the whole screen is white now.
depress A: a fine-grained grid is displayed.
depress A+B: on the CRT screen, alternatly two points are on, two points are off, two points are on, and so on. This is done both in horizontal and vertical deflection.
depress B: on the CRT screen, alternately one point is on, one point is off, one point is on, and so on.
This is done both in horizontal and vertical direction.
depress ALT: a grid consisting of equidistantial horizontal and vertical lines is displayed.
depress CHOP: the complete character set is displayed.

NOTE: Changing from one pattern to another can be done directly, so operation of the AUTO SET pushbutton is not necessary.

SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT. 27

CONTENTS

27. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT. 27-1
27.1. General directives. 27-1
27.2. Safety components. 27-1
27.3. Checking the protective earth connection. 27-1
27.4. Checking the isolation resistance. 27-1
27.5. Checking the leakage current. 27-1
27.6. Voltage test. 27-2

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

27.1. 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 be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

27.2. SAFETY COMPONENTS

Components in the primary circuit may only be renewed by components selected by Philips, see also clause 26.1.2.

27.3. CHECKING THE PROTECTIVE EARTH CONNECTION

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 Ohm. During measurement the mains cable should be removed from the mains. Resistance variations indicate a defect.

27.4. 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 2 M.Ohm.

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

27.5 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 does not exceed 0,5 mA rms.

27.6. 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 1500 V 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.

CONTENTS

28. PARTS LISTS 28-1
28.1. Mechanical parts. 28-1
28.2. Units 28-10
28.3. Cables and connectors 28-11
28.4. Miscellaneous 28-14

FIGURES

28.1. Mechanical parts FRONT SIDE 28-2
28.2. Mechanical parts REAR SIDE 28-5
28.3. Carrying handle and housing 28-3
28.4. General FRAME parts 28-8
28.5. Survey of UNITS 28-9

28. PARTS LISTS

SUBJECT TO ALTERATION WITHOUT NOTICE.

In this chapter the mechanical parts are listed, including: cables and connectors.

The electrical parts of the various units are given in the corresponding chapters, section: PARTS LIST.

The item numbers of the parts are indicated in the figures of chapter 26 or in the figures of this chapter.

28.1 MECHANICAL PARTS

FRONTSIDE (figure 28.1)

Item	Qty/instr.	Description	Ordering number
1	1	Blue contrast filter	5322 480 30181
2	1	Bezel (window for contrast filter)	5322 459 20305
3	1	Green pushbutton cover (Auto Set)	5322 414 60115
4	47	Brown pushbutton cover	5322 414 60038
5	15	Knob dia 10 mm.	5322 414 30044
6	15	Brown cover with dash	5322 414 70016
7	5	Knob dia 14 mm	5322 414 30062
8	5	Brown cover (for 14 mm knob)	5322 414 70015
9	1	Power on knob	5322 414 60142
10	1	Knurled nut (earth connector)	5322 505 14178
		Thread end (earth connector)	5322 535 84446
11	4	BNC input socket	5322 267 10173
12	1	BNC output socket	5322 267 10004
13	1	Front plate and text plate	5322 447 90605
14	1	Text plate under c.r.t (adhesive backside)	5322 455 81042
15a	1	Text strip above c.r.t (adhesive backside) PM3295A	5322 455 81047
15b	1	Text strip above c.r.t. (adhesive backside) PM3296A	5322 455 81049
16	1	Plastic front frame	5322 447 90608
-	1	Front cover (without inner plate)	5322 447 90518
-	1	Inner plate of front cover	5322 466 81585

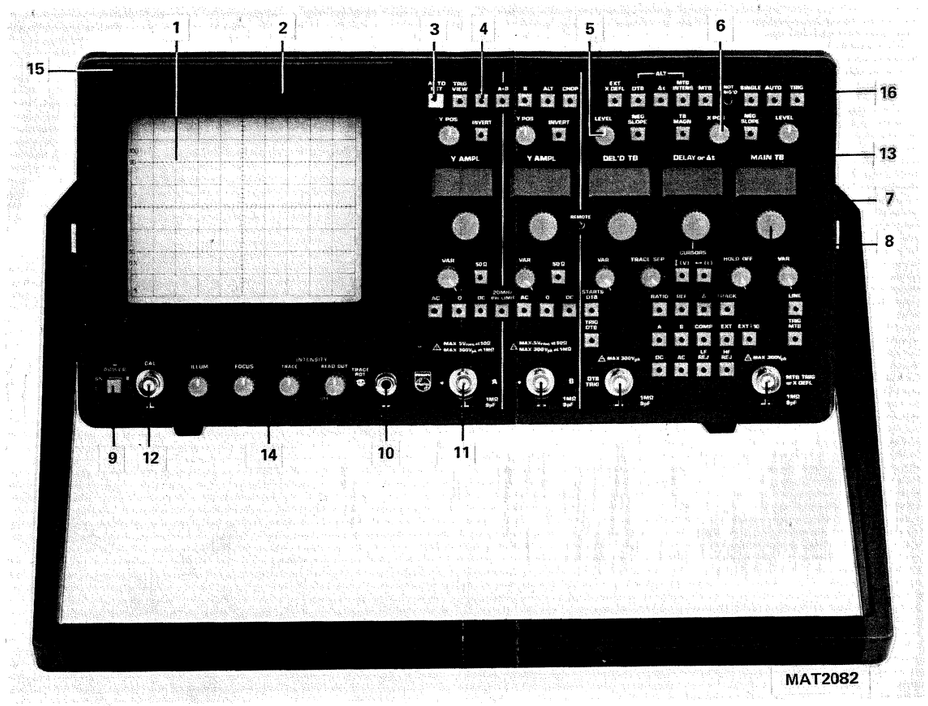


Fig.28.1. Mechanical parts FRONT SIDE

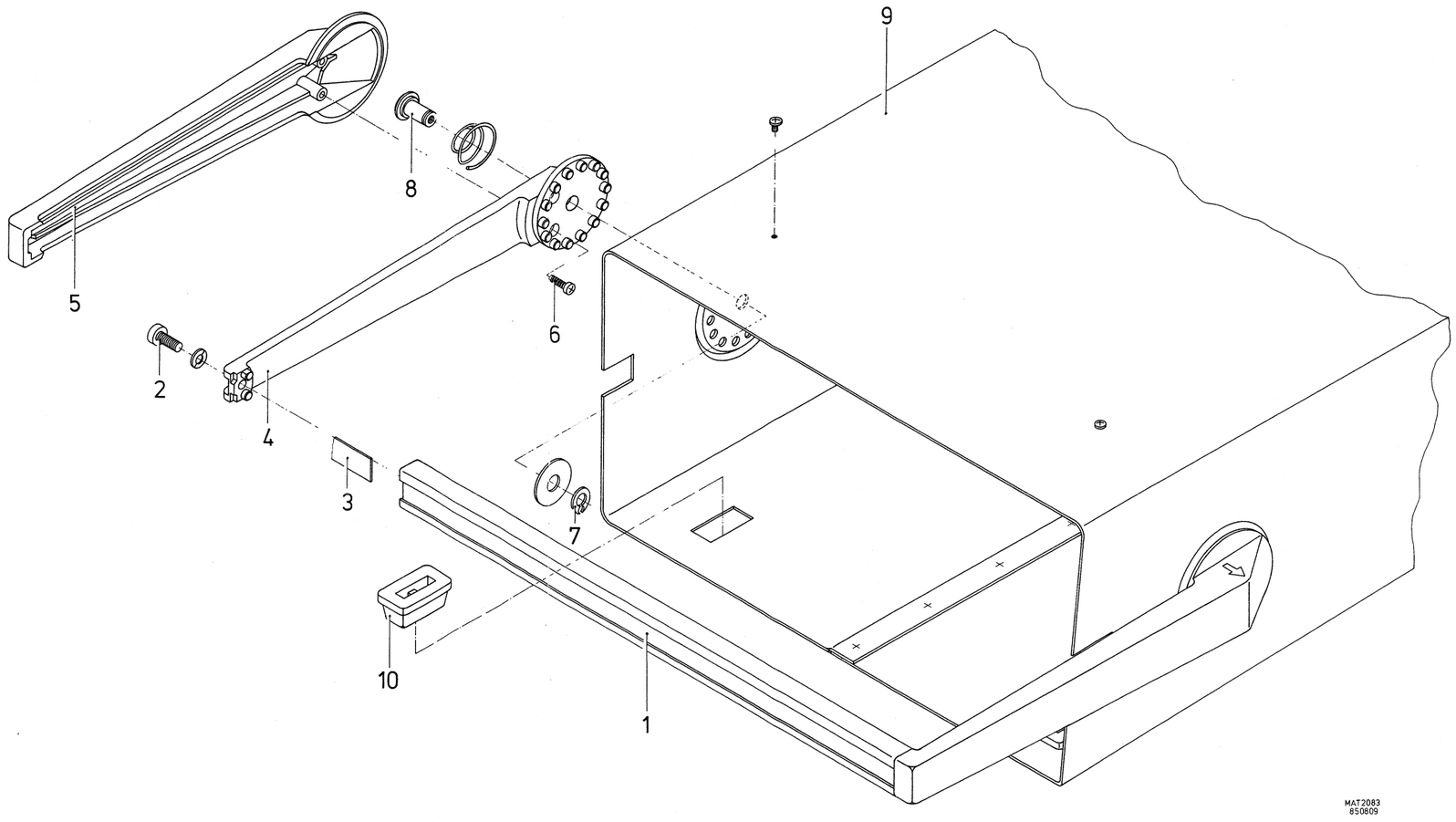


Fig. 28.3 CARRYING HANDLE and HOUSING

REAR SIDE (fig. 28.2)

Item	Qty/instr.	Description	Ordering number
1	4	Rear foot	5322 462 40765
2	1	Battery cover	5322 462 40766
3	2	Battery holder	5322 256 64014
4	1	Rear plate	5322 466 81646
5	4	BNC socket (also CAL socket)	5322 267 10004
6	1	Rear plate	5322 466 81647
7	1	Fuse holder	5322 256 30242
8	1	Mains input socket and filter	5322 267 40627
9	1	Rear rim	5322 447 90517
10	1	Fan. 24V d.c.	5322 361 10326
11	1	IEEE-488 connector (option) X16	5322 265 51116

CARRYING HANDLE and HOUSING (fig. 28.3)

Item	Qty/instr.	Description	Ordering number
1	1	Carrying profile	5322 498 50192
2	2	Screw	4822 502 10075
3a	1	Textstrip PM 3295A	5322 455 81048
3b	1	Textstrip PM 3296A	5322 455 81051
4	2	Handle arm (inner part)	5322 498 50189
5	2	Handle cover (outer part)	5322 498 50191
6	4	Screw	4822 502 30054
7	2	Fixing ring	4822 530 70126
8	2	Fixing pin	5322 535 91903
9	1	Housing complete (without carrying handle)	5322 447 90612
10	4	Foot (bottom side)	5322 462 44297

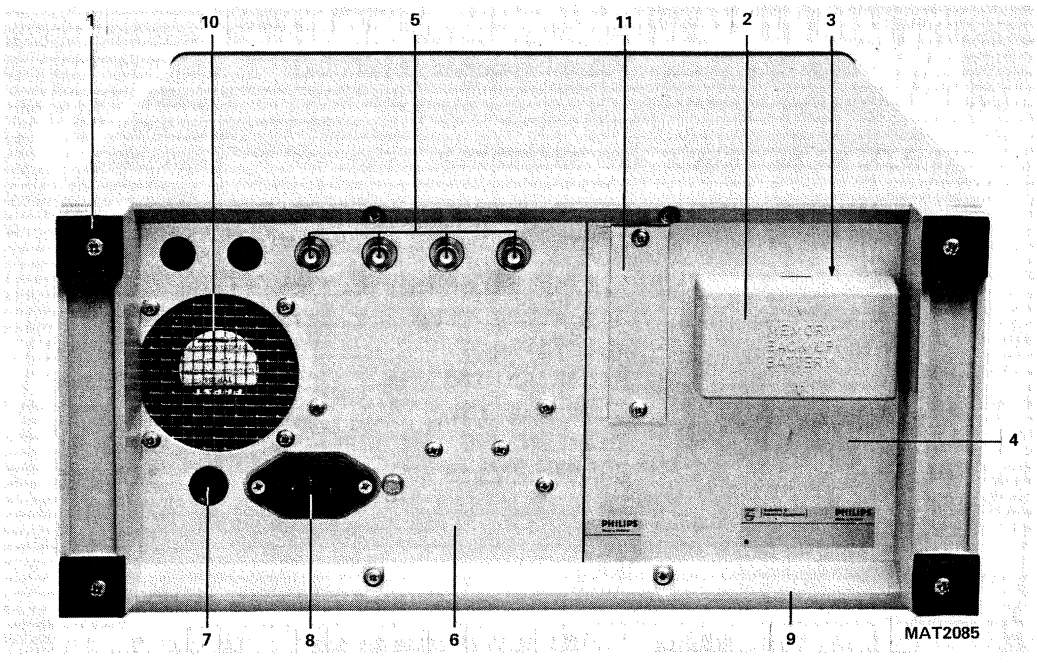


Fig. 28.2 Mechanical parts REAR SIDE

General FRAME parts (fig. 28.4)

Item	Qty/instr.	Description	Ordering number
1	1	Spring for power on switch	5322 492 41354
2	1	BNC CAL output socket	5322 267 10004
-	-	Adapter BNC/probe	5322 263 50022
3	1	Extension bush for CAL socket	5322 532 21075
4	2	Front cover lock	5322 526 40481
5	1	Alluminium front frame	5322 447 90609
6	1	Alluminium rear frame	5322 447 90611
7	2	Splitpen for power on shaft	5322 535 14015
8	1	Light reflector for illumination	5322 380 10021
9	2	Lamp holder	5322 255 24015
10	1	Plastic front frame	5322 447 90608

FRONT UNIT (fig. 26.1, page 26-3)

Item	Qty/instr.	Description	Ordering number
1a	48 (42)	Pushbutton switch (red led) S1...S64 (without cover, for cover see item 4 fig 28.1)	5322 276 11459
1b	48 (42)	Pushbutton switch green LED S1...S64 (without cover, for cover see item 4 fig. 28.1)	5322 276 11883
9	5	Window for LCD	5322 459 20304
10	5	LCD Display H24...H28	5322 130 90374
11	5	Spacer for LCD	5322 532 51626
12	10	Interconnector for LCD-pcb	5322 267 70146
15	5	Spring clip for LCD	5322 535 91824
34	1	Fixing bracket for LCD illum	5322 401 10986
33	1	LCD illumination strip	5322 290 80687
19	4	Shaft encoder for Y AMPL A (S24) } Y AMPL B (S25) } DEL'D TB (S26) } MAIN TB (S28) }	5322 535 91822
		DELAY or delta t (S27)	5322 535 91823
23	11	Potentiometer R1...R11	5322 103 50018

CRT FIXING MATERIALS and SHIELDINGS (fig. 26.6, page 26-17)

Item	Qty/instr.	Description	Ordering number
3 and 4	2	Fixing piece crt bottom side	5322 401 10909
11	2	Adjusting ring for crt shielding	5322 532 80784
12	1	Front shield crt	5322 447 90606
17	1	Clamping ring	5322 532 21074
18	1	Rear shield crt	5322 447 90607
20	1	Buffer (rear side crt)	5322 462 40826

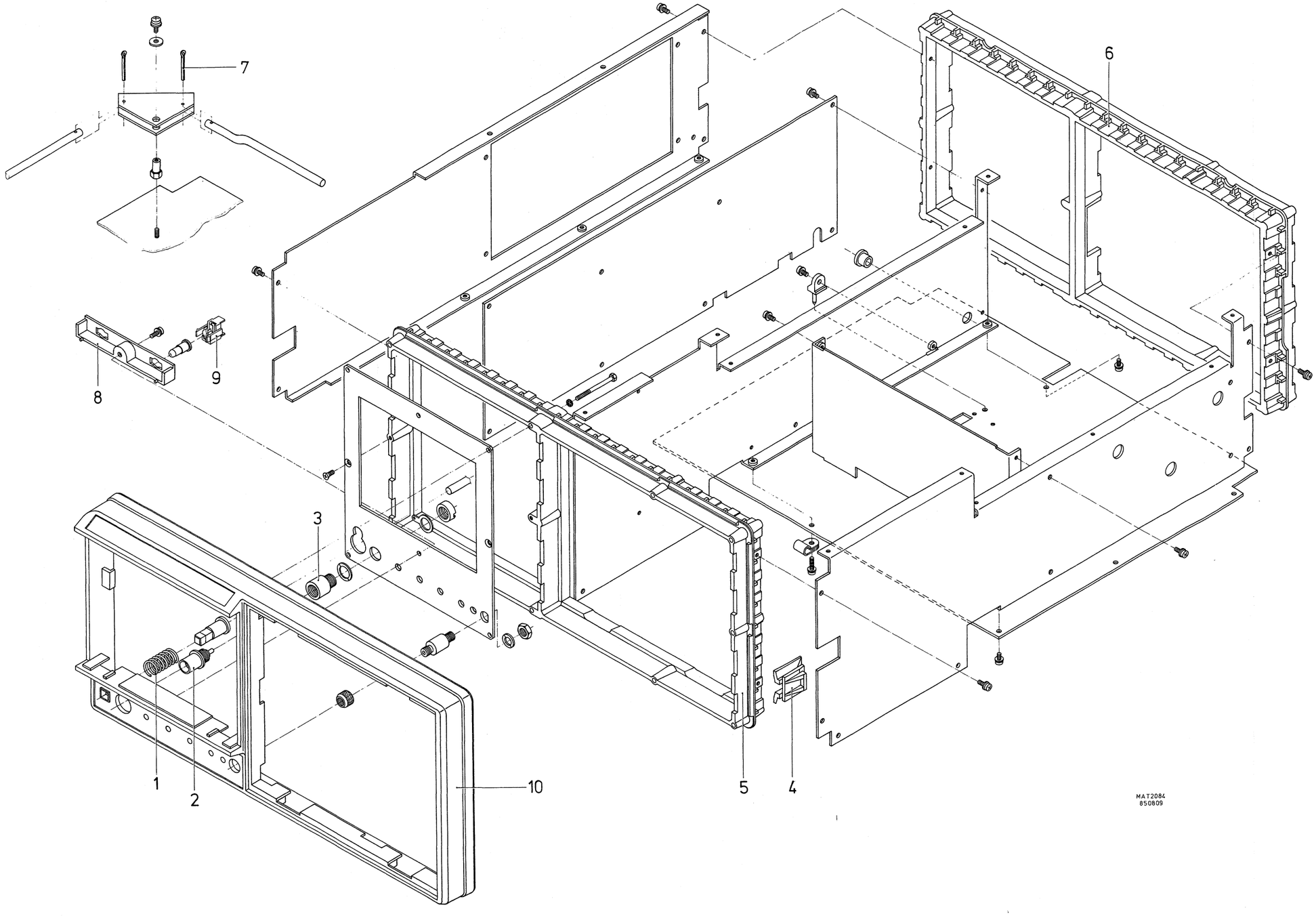


Fig. 28.4 General FRAME parts

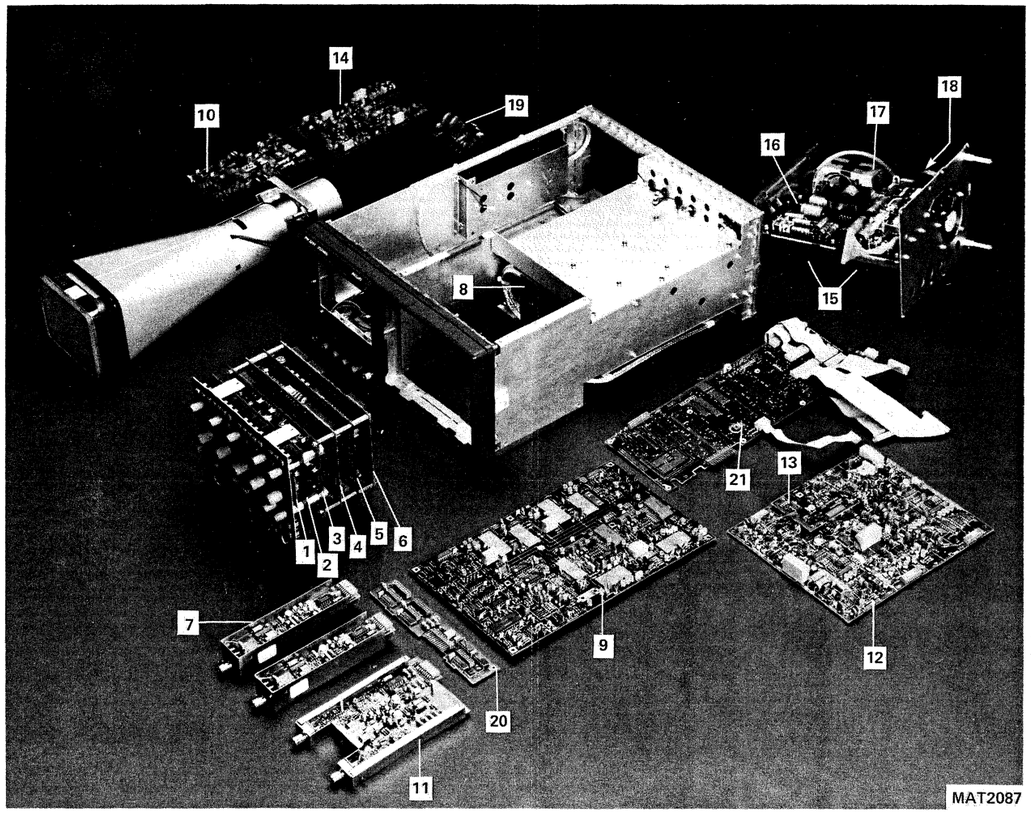


Fig. 28.5 Survey of UNITS

28.2 UNITS (fig. 28.5, unless otherwise stated)

- Front unit

Item	Description	Ordering number
1	LCD unit A1011	5322 216 51138
2	Switch unit A1031	5322 216 51098
3	Intermediate unit A1061	5322 216 51099
4	Central processor unit A1086	5322 216 51101
5	CRT Text unit A281	5322 216 51194
6	IEEE-488 bus unit A271 (option)	5322 217 51106

28.2.1 Vertical deflection

Item	Description	Ordering number
7	Attenuator module A113	5322 216 51102
5 - Fig. 26.4	Attenuator relay unit A1121	5322 218 41015
7 - Fig. 26.4	LF attenuator unit A1116	5322 218 41021
11 - Fig. 26.4	HF attenuator unit A1111	5322 216 51081
8	Delay line unit A162	5322 216 51104
9	Y Signal unit A1511	5322 216 51103
10	Final Y amplifier unit A1716	5322 216 51191

28.2.2 Horizontal deflection:

Item	Description	Ordering number
11	Trigger unit A1311	5322 216 51084
12	Time base unit A2011 (excl. A2016)	5322 216 51091
13	Time base logic unit A2016	5322 216 51087
14	X-Z amplifier unit A2116 (remove R5633 for PM329..)	5322 216 51193

28.2.3 Power supply units and Z units

Item	Description	Ordering number
15	Primary converter unit A2315	5322 216 51086
16	Secondary converter unit A2320 (incl. unit A15)	5322 216 51083
17	EHT unit A15	5322 216 51096
18	High voltage converter A2335	5322 216 51093

28.2.4 Additional units:

Item	Description	Ordering number
19	CRT socket unit A292	5322 255 40503
20	Adaptation unit A3211	5322 216 51094
21	Motherboard unit A2421	5322 216 51095
-	Infra-red transmitter complete (PM3296A)	5322 218 41022
-	Infra-red receiver complete (PM3296A)	5322 216 51139
-	CRT controls unit	5322 216 51132

28.3 CABLES AND CONNECTORS

28.3.1 Flatcables and connectors

For the flatcables used in this oscilloscope, the required version must be made by yourself with the following parts:

- Universal flatcable, 40 wires, length 60 cm 5322 323 50112

To get the required number of wires the flat cable must be split by means of a pair of scissors or a knife.
The cable must be cut on the required length.

- Flatcable connectors

The connectors can be mounted on the flatcable by means of a pair of pliers or in a bench-vice.
Attention: check the position of the flatcable in the connector before pressing the connector together.

The following connectors are available:

10 pole cable connector X8202-X4001	5322 265 51117
20 pole cable connector X1102-X5901-X8001-X8002	5322 265 54059
24 pole cable connector X8003	5322 265 51114
26 pole cable connector X7006	5322 267 60164
34 pole cable connector X6302,X7301	5322 267 70163
40 pole cable connector X1602	5322 267 70162

28.3.2 AMP cable connectors

- Single row cable connectors (without bus-contact)

  X5902, X7316, X7321, X6304
  3 pole female type 5322 268 40222

  X6301, X6601, X6603, X6303
  5 pole female type 5322 267 40626

- Double row cable connectors (without bus-contact)
  X5602, X8401
  6 pole female type 5322 268 40223

- Bus contact for female type 5322 268 20145

- Lock for AMP connectors 5322 268 90091

28.3.3 50 ohm Cables

The 50 Ohm coax-cables are standerdized, so some cables are a little bit too long.
The tules around the cable ends can have the different colour, but if necessary it can be replaced by the original one.

Connectors	Ordering number	Remarks
X5613-X9502 X5617-X9503 X5622-X4011 X5626-X4012	5322 321 21291	Cable length: 20 cm
X5614-X9401 X5616-X5326	5322 321 21292	Cable length: 31 cm
X5623-X9506 X5624-X9504	5322 321 21293	Cable length: 26 cm
X5327-X9009 X5127-X9501 X5128-X9102	5322 321 21294	Cable length: 51 cm
X5228- - X9011- - X9201- - X7317- - X5609- -	5322 321 21294	The cable must be cut on the required length with a connector at one side. Cable length: 51 cm
X5227-X9202 X5611-X8202	5322 321 21297	Cable length: 40 cm
X5126-X4701 X5226-X4801	5322 321 21295	Cable length: 31 cm Cable with ferrite bead (from Trigger outputs to Y-signal unit)
X6801-X4966 X6801-X4901	5322 321 21296	Cable length: 20 cm Cable with ferrite bead (att. outputs A and B to Y-signal unit)

Holder for the bead around the cables X5126-X4701, X5226-X4801, X6801-X4966, X6801-X4901 — 5322 462 40825

28.3.4 P.c.b. conntectors

Male headers:

Item	Description	Remarks	Ordering number
X1101,X8000,X1603	25 pole-dbl	long contact pins	5322 265 51115
X1103	22 pole-dbl	long contact pins, must be sawn on the required width	5322 265 51115
X1602	20 pole-dbl	short contact pins	5322 265 61061
X502	6 pole-dbl	Must be sawn on the required width	5322 265 61061
X1102,X5901,X7303			
X7306,X8001,X8002	10 pole-dbl		
X4001,X8202	5 pole-dbl		
X5601,X8003	12 pole-dbl		
X6302,X7301	17 pole-dbl		
X8401	6 pole-dbl		
X9003,X9004			
X9006,X9007	8 pole-single		5322 265 40483
S8001,S8201		Must be sawn on the required width	5322 265 40483
X6304	3 pole-single		
X6301,X6303	5 pole-single		
X6601	5 pole-single		5322 265 30405
X7319	15 pole-dbl	90° type	5322 265 40484
X4703,X6903	9 pole-dbl	90° type	
X6802	7 pole-dbl	Must be sawn on the required width	5322 265 40484
X7006	13 pole-dbl		
X5902,X7316			
X7321	3 pole-single		5322 265 30404

P.C.B. connectors

Item	Description	Remarks	Ordering number
X1601,X8201,X8203	25 pole-dbl		5322 267 60165
X501	22 pole-dbl	Must be sawn on the required width	5322 267 60165
X101	6 pole-dbl		
X7001,X7003	7 pole-dbl		
X7002,X7004,X7007	9 pole-dbl		
X7302	12 pole-dbl		
X5325	15 pole-dbl		
X7343	5 pole		5322 265 30448
X7344	2 pole		5322 265 20281
X9001,X9002	10 pole-dbl	Horizontal input type	5322 265 40482

X9003,X9004,X9006 X9007	8 pole-single		5322 267 50589
X5602	6 pole-dbl	Horizontal input type	5322 265 30403
X7308,X7318	10 pole-4 row	Flat cable connector	5322 265 40458
X7307	40 pole-4 row	Flat cable connector	5322 265 61057
X7309	26 pole-4 row	Flat cable connector	5322 265 51031
X7311,X7314	20 pole-4 row	Flat cable connector	5322 265 54058

50 Ohm Coax-connector socket (36 connectors per instrument)

Outer part (bush)	5322 268 24116
Inner part (pin)	5322 268 14141

28.4 MISCELLANEOUS

Fuse F6101 and F6301 2,5A TZ	4822 253 30026
Power on switch S65	5322 276 11574
Power on led CQW54 H65	5322 130 32704
NOT TRIG'D LED CQW54 H14	5322 130 32704
REMOTE LED CQW54 H54	5322 130 32704
C.r.t. D14-400GH/123	5322 131 20145
Illumination lamp E1 and E2 28V 80mA	5322 134 40534
Delay line connector X5032/signal unit	5322 290 60475
PROM set D1633, D8204, D8241,D8004 (latest version)	5322 310 10202

MAINS CORDS:

	Last digit 12nc of oscilloscope (on packing)	
European version	1	5322 321 21616
U.S.A. version	3	5322 321 10446
U.K. version	4	5322 321 21617
Swiss version	5	5322 321 21618
Australian version	8	5322 321 21781

CONTENTS

29.1. Accessoires supplied with the instrument 29-1
29.1.1. Passive probe PM8929/19 with automatic range indication 29-1
29.1.1.1. Introduction 29-1
29.1.1.2. Characteristics 29-1
29.1.1.3. Adjustments 29-5
29.1.1.4. Dismantling 29-6
29.1.1.5. Parts list 29-7
29.2. Optional accessories 29-7
29.2.1. IEEE 488/IEC 625 bus interface PM8950 29-7

FIGURES

29.1. Input impedance-reactance and voltage versus frequency. 29-4
29.2. Probe LF compensation. 29-5
29.3. Probe HF compensation. 29-6
29.4. Adjusting elements versus HF step response 29-6
29.5. Probe with accessories 29-7

29.1 ACCESSORIES SUPPLIED WITH THE INSTRUMENT

29.1.1 Passive probe PM 8929/19 with automatic range indication

29.1.1.1 Introduction

This 10x attenuator modular is provided with a special BNC plug for automatic range indication, designed for HF oscilloscopes.

The probe consists of 3 separate units:
- the compensation box having a BNC male connector output, with automatic range indication possibility.
- the cable assembly (cable length of PM8929/19 is 1 m).
- the probe body including probe tip and RC assy.

At delivery, the probe is adjusted to an oscilloscope with an input capacitance of 9pF.
The attenuator range is selected by a resistor, mounted in the holder of the BNC-connector.

29.1.1.2 Characteristics

- Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.
- Numerical values without tolerances are typical and represent the characteristics of an average probe.
- These characteristics are valid with a termination of 1 M.Ohm oscilloscope input, unless otherwise stated.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
ATTENUATION:		
Attenuation at d.c.	10x + or -2%	
INPUT IMPEDANCE:		
Parallel resistance at d.c.	10M.Ohm + or - 1,5%	
at a.c.	See fig. 29.1.	
Parallel capacitance up to 100kHz	12pF	Termination: 1M.Ohm Oscilloscope input. For parallel cap. as function of freq. see fig. 29.1
COMPENSATION RANGE:		
Input Capacitance of Oscilloscope	5pF...20pF	

BANDWIDTH:

Probe only Bandwidth At Osc. Input Cap:		
-10pF or less	d.c...500MHz(-3dB)	
->10pF	d.c...400MHz(-3dB)	
-Max. useful system bandwidth at osc, input cap. of 10pF	d.c...350MHz(-3dB)	Note: up to these freq. the system (probe + scope) bandwidth is $\geq$95% of the "scope only" bandwidth.
PULSE RESPONSE		Aberations in addition to Oscillscope aberrations. Oscilloscope Bandwidth equal to or less then Usefull Bandwidth.
-Overshoot	<6%	
-Ringing during first 30ns after leading edge	+or- (5% or less) 7% or less (pk to pk)	
thereafter	+or- (2% or less)	
-Tilt	2% or less	
SIGNAL DELAY	5,2ns +or- 150ps	Measured between tip to BNC-output connector.
MAXIMUM VOLTAGE		
-max.non destructive input voltage (d.c. + a.c. peak)	500V	0...2MHz approx; for derating see fig. 29.1
-test voltage (d.c):		
type test	2,42kV	During 1min (resistance value adapted to test)
performance check	2,42kV	During 1sec

Mechanincal

-Dimensions	length	width	height	
probe body	57mm	14mm(max)		
cable assy	1000mm	9mm(max)		
compensation box	38mm	16mm	15mm	BNC excluded
pouch	275mm	195mm		

-Mass	143g	for PM8929/19 Standard probe with accesories in pouch

Environmental

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by PHILIPS INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEM DIVISION, EINDHOVEN, THE NETHERLANDS.

- Operating temperature	$-10^{o}C...+55^{o}C$
- Storage temperature	$-62^{o}C...+85^{o}C$
- Maximum humidity	95% relative humidity
- Altitude *operating	To 4500m
*non-operating	To 12000m
- Vibration (operating)	
* freq. 5 ... 15Hz	7 min each axis, excursion 1,5mm (p-p) and $7m/s^2$ (0,7g) acceleration at 15Hz.
* freq. 15 ... 25Hz	3 min each axis, excursion 1mm (p-p) and $13m/s^2$ (1,3g) acceleration at 25Hz.
* freq. 25 ... 55Hz	5 min each axis, excursion 0,5mm (p-p) and $30m/s^2$ (3g) acceleration at 55 Hz.
- Resonance dwell	10min at each resonance freq.
- Shock (operating)	$300m/s^2$ (30g) half sine-wave shock, duration is 11ms. (3 shocks per direction for a total of 18 shocks)

Accessories

-Accessory kit, contents:
- Earth cable
- Spring-loaded test clip
- Set marking rings
- Probe tip (2x)
- Insulating cap
- DIL cap
- Wrap pin adapter
- Earth bus

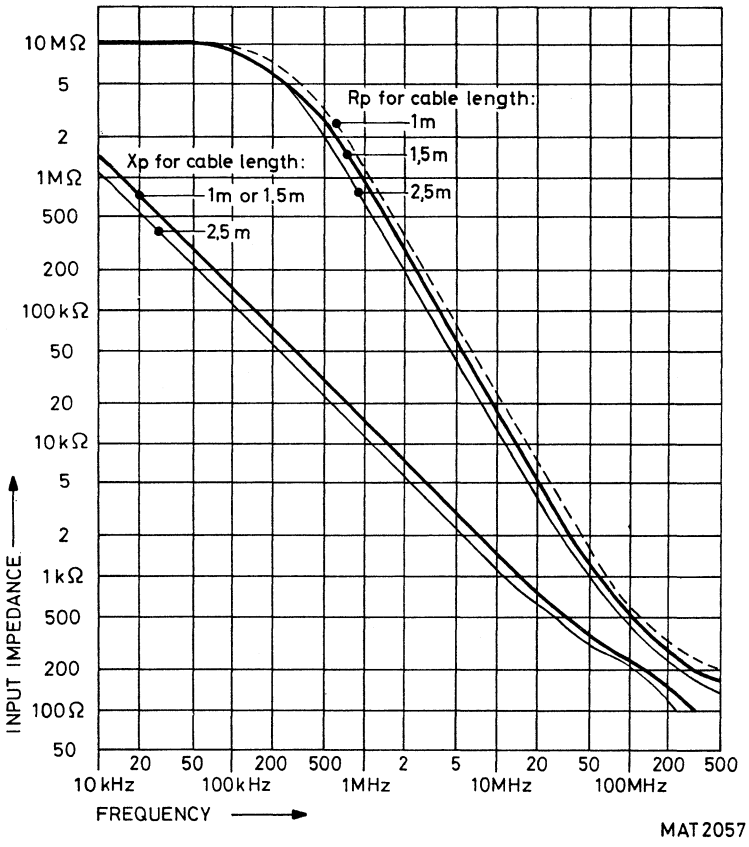


Fig. 29.1.a Input impedance versus frequency

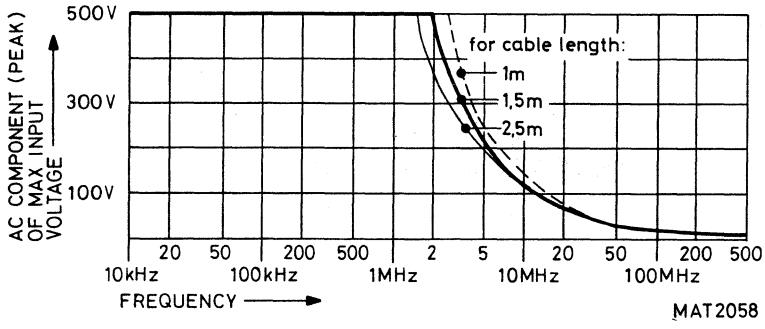


Fig. 29.1.b AC-component (pk) of max. input voltage versus frequency

DESCRIPTION OF ACCESSORIES

Earth cable: To minimize ringing on a signal, an earth cable is provided. This cable must first be plugged into the probe body and then be connected to the nearest earth point of the circuit to be measured.

Spring-loaded test clip: This is a provision for hands-free connection to a test point or component lead.

Marking rings: At delivery a set of 3 different coloured marking rings (red, white and blue) are provided. This can be used to help identify the specific probes when using more than one probe.

Probe tip: A spare set of 2 probe tips are standard supplied with the probe. When a probe tip is damaged it can be pulled out by means of a pair of pliers. Then a new tip must be firmly pushed in.

Insulating cap: An insulating cap is provided to cover the metal part of the probe during measurements in densely wired circuits.

D.I.L.cap: This is a cap facilitating measurements on dual-in-line integrated circuits.

Wrap pin adapter: the wrap pin adapter is a provision to make hands-free connection to a wired wrap pin circuit.

Earth bus: This is a provision to minimize ringing in VHF signals, when earthing must be as short as possible.

29.1.1.3 Adjustments

Checking the range indicator.
Check when the BNC plug of the probe with range indication is connected on the oscilloscope input (PM329..), that the LCD indication (AMPL/DIV) is increased by a factor of 10.

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to the match the probe to your oscilloscope, the following further adjustment is necessary.
- Connect the measuring pin to the CAL socket of the oscilloscope.
- A trimmer C2, can be adjusted through a hole in the compensation box to obtain optimum square-wave response (see Fig. 29.2).

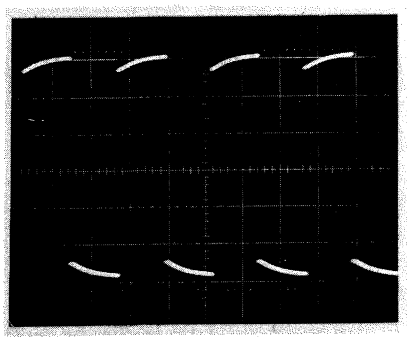


Fig.29.2a Over-compensation

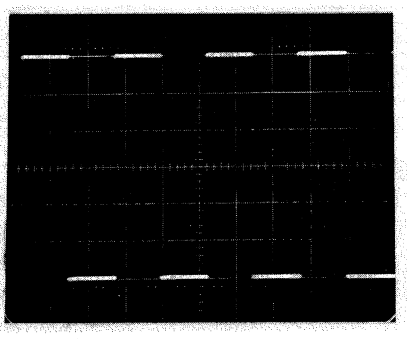


Fig.29.2.b Correct compensation

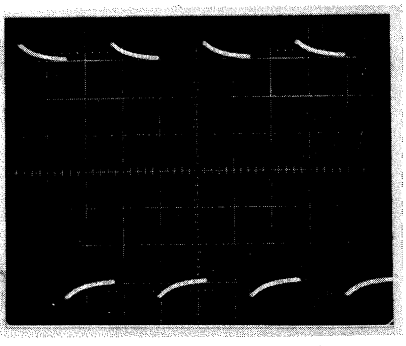


Fig.29.2.c Under compensation

Adjusting the h.f. step response

WARNING: If adjustments of the h.f controls is inevitable, it must be carried out only by a qualified person who is aware of the hazards involved.

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
- after replacement of a separate unit or an electrical component.

For adjustment, proceed as follows:

- Dismantle the compensation box, see Section 29.1.1.4.
- Connect the probe to a fast pulse generator (rise-time out exceeding 1ns) which is terminated by its characteristic impedance.
- Adjust the generator for a 6 div/100 kHz pulse.
- Set all potentiometers fully clockwise and both trimmers C2 and C4 for minimum capacity.
- Adjust the adjusting elements according to fig. 29.4.

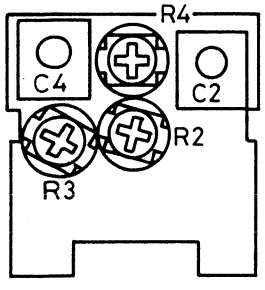


Fig. 29.3 Adjusting elements

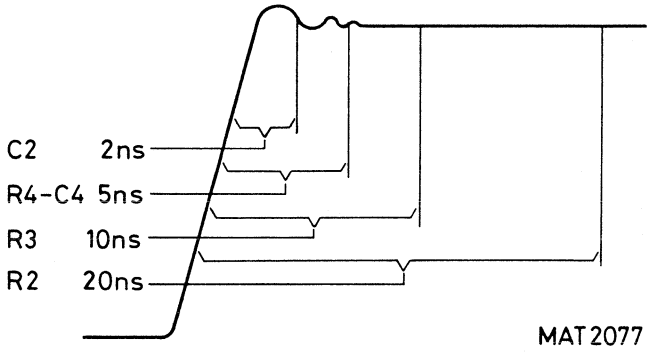


Fig. 29.4 Adjusting elements v.s. h.f step response

29.1.1.4 Dismantling (see fig. 29.4)

WARNING: The probe shall be disconnected from all voltage sources before any unit separation, replacement or maintenance will be carried out.

Dismantling the probe body

The probe body can be removed by sliding the probe body from the cable assembly.

Dismantling the compensation box

- Unscrew the knurled nut in a counter-clockwise direction.
- Remove the compensation box by sliding it from the cable assy.
- Slid the cap sideways off the compensation box.
- The h.f adjustment controls are then accessible.

Replacing 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.

29.1.1.5 Parts list

For ease of handling some spare parts are delivered in larger quantities as a set.
(see fig. 29.6)

Item	Q.ty	Ordering number	Description
1	1	5322 264 20062	Probe body
2	1	5322 321 21224	Cable assy-1mm
3	1	5322 219 80647	Compensation box
4	1	5322 321 20223	Earth cable
5	1	5322 264 24019	Spring-loaded test clip
6	6	5322 310 30624	Set of probe tips
7	6	5322 310 30623	Set of insulating caps
8	6	5322 310 30626	Set of DIL caps
9	4	5322 310 30627	Set of WRAP-pin adapters
10	6	5322 267 10043	Set of earth busses

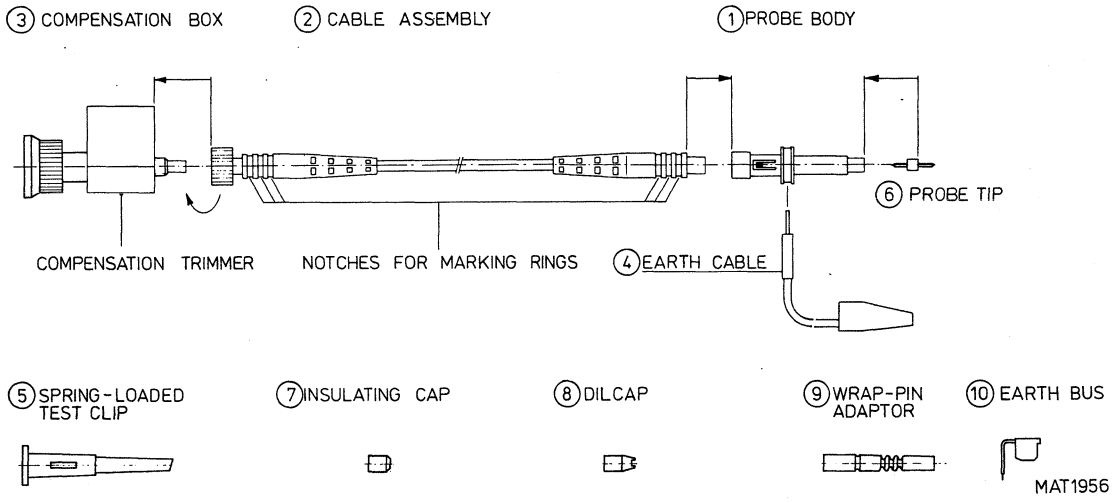


Fig. 29.5 Probe with accessories

29.2. OPTIONAL ACCESSORIES

29.2.1. IEEE 488/IEC 625 bus interface PM8950

The IEEE 488/IEC 625 is a general-purpose bus interface designed according to the IEEE 488/IEC 625 standard. This option can be either retrofitted or factory installed. It enables the oscilloscope to be used in a measuring system together with other IEEE 488/IEC 625 bus compatible instruments.
For more detailed operating information concerning this facility, refer to the separate booklet:

IEEE 488/IEC 625 BUS INTERFACE PM8950

For installation instructions, see information delivered with the option.

SALES AND SERVICE ALL OVER THE WORLD

Alger: Bureau de Liaison Philips,
24 bis, Rue Bougainville,
El Mouradia, Alger; tel.:213-601405

Antilles: see Ned. Antillen

Argentina: Philips Argentina S.A.,
Vedia 3892, Casilla de Correo 3479,
1430 Buenos Aires; tel.:54-1-5414106/
54-1-5417141/5422411

Austria: see Oesterreich

Australia: Philips Scientific & Industrial,
25-27 Paul Street, P.O. Box 119, North Ryde/
NSW 2113; tel.: 61-2-8888222
Service Centre:
PCS Service,
2 Greenhills Avenue,
Moorebank, P.O. Box 269,
Liverpool/NSW 2170;
tel.: 61-2-6022000

Bangla Desh: Philips Bangla Desh Ltd.,
16/17 Kawran Bazar C/A
P.O. Box 62; Ramna, N.V. Dhaka;
tel.: 325081/5, 411976
Service Centre:
50 New Eskaton Road
Maghbazar, Dhaka; tel.: 403047

België/Belgique: Philips & MBLE associated S.A.,
Scientific and Industrial Equipment Division,
80 Rue des Deux Gares, 1070 Bruxelles;
tel.: 32-2-5256111

Bolivia: E.P.T.A.
Industrias Bolivianas Philips S.A.,
Calle Mercado no. 1046,
Cajón Postal 2964, La Paz,
tel.: 341453/350029

Brasil: Philips do Brasil Ltda.,
Av. Eng. Luiz Carlos Berrini, 3009,Caixa Postal 8681,
CEP 04571-Sao Paulo (S.P.);
tel.: 55-11-2411611
Service Centre:
Sistemas Profissionais,
Rua Anton Philips 1,
Caixa Postal 7018,
07000 Guarulhos-S.P.;
tel.: 55-11-2090111

Canada: Philips Electronics Ltd.,
Test and Measurement Dept.,
1001 Ellesmere Road,
Scarborough (Ontario) M1P-2W7,
tel.: 1-416-292 82000

Chile: Philips Chiléna S.A.,
Division Professional, Avenida Santa Maria 0670,
Casilla 2687, Santiago de Chile; tel.:56-2-770038

Colombia: Industrias Philips de Columbia S.A.,
Calle 13 no. 51-39, Apartado Aereo 4282
Bogota; tel.: 57-1-2600600

Danmark:Philips Industri og Handels A/S,
Prags Boulevard 80, P.O. Box 1919,
DK-2300 København S; tel.: 45-1-572222

Deutschland (Bundesrepublik): Philips GmbH,
Unternehmensbereich Elektronik für
Wissenschaft und Industrie, Miramstrasse 87,
Postfach 310 320, 3500 Kassel-Bettenhausen;
tel.: 49-561-5010

Ecuador: Philips Ecuador C.A.,
Páez 118 y Avenida Patria, Casilla 343,
Quito; tel.: 593-2-546100/564601

Egypt: Philips Egypt Branch of Philips Midden Oosten N.V.,
10, Abdel Rahman El Rafei Street -Dokki-, Cairo;
tel.: 20-2-3490922/3490926/3490928/3492237

Eire: Philips Electrical (Ireland) Ltd.,
Newstead, Clonskeagh, Dublin 14; tel.: 353-1-693355

España: Philips Ibérica S.A.E.,
Martinez Villergas 2, Apartado 2065,
Madrid 28027; tel.: 34-1-4042200
Service Centre:
Euroservice S.A.
Calle de Albasanz 75, Madrid 28017;
tel.: 34-1-2045940/2047025/2047105

Ethiopia: Philips Ethiopia (Priv. Ltd. Co.),
Ras Abebe Areguay Avenua, P.O.B. 2565,
Addis Ababa; tel.: 448300/157441

Finland: see Suomi

France: S.A. Philips Industrielle et Commerciale,
Division Science et Industrie,
105 Rue de Paris, B-P.62, 93 002 Bobigny Cedex,
tel.: 33-1-4830111

Germany: see Deutschland

Hellas (Greece): Philips S.A. Hellénique,
15, 25th March Street, P.O. Box 3153,
Athens 10210; tel.: 30-1-4894911

Hong Kong: Philips Hong Kong Ltd.,
29/F Hopewell Centre,
17 Kennedy Road, G.P.O. Box 2108,
Hong Kong; tel.: 852-5-283298

Ireland: see Eire

India: Peico Electronics & Electricals Ltd.,
I&E Equipment, Shivsagar Estate, Block "A"
Dr. Annie Besant Road, P.O.B. 6598, Worli,
Bombay 400 018 (WB); tel.: 91-22-4921500

Indonesia: P.T. Philips Development Corporation,
Jalan Gatot Subroto Kav. 35/36,
P.O. Box 785/KBY, Jakarta 12950;
tel.: 62-21-517900/5781977

Iran: Philips Iran Ltd., P.O.B. 11365-3891,
Tehran; tel.: 98-21-674138/675158

Iraq: Philips Midden Oosten B.V., Baghdad Branch,
Hai Al Whida (district), Area No. 902, Street No. 12
Building No. 141/10, P.O. Box 5749, Baghdad;
tel.: 7187181

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

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

Japan: see Nippon

Kenya: Philips (Kenya) Ltd.,
01 Kalou Road, Industrial Area,
P.O.B. 30554, Nairobi; tel.: 254-2-557999

Lebanon: Philips Middle East S.A.R.L.,
P.O. Box 11-670, Beyrouth; tel.: 392320/1

Malaysia: Philips Malaysia Sendirian Berhad,
Wisna Philips, No. 3, Jalan SS15/2A,
47500 Petaling Jaya, Selangor, G.P.O.B. 12163,
50768 Kuala Lumpur; tel.: 60-3-7345511/7554234
Service Centre:
Lot 51, Jalan University, Section 13,
46200 Petaling Jaya; tel.: 60-3-7562144

México: Telecommunicaciones y Sistemas
Professionales S.A. de C.V.,
Goldsmith No. 40, Col. Polanco,
11560 México, D.F.; tel.: 52-5-5406875

Morocco: Philips Maroc S.A., 304-Boulevard Mohammed V,
B.P. 10896, Bandoeng, Casablanca 05;
tel.: 212-302092/303192/308051

Nederland: Philips Nederland B.V.
Boschdijk 525, Gebouw VB,
5600 PD Eindhoven; tel.: 31-40-793333

Ned. Antillen: Philips Antillana N.V.,
Schottegatweg Oost 146, Postbus 3523,
Willemstad, Curaçao;
tel.: 599-9-615277/612799 (service)

New Zealand: Philips New Zealand Ltd.,
Scientific and Industrial Equipment Division,
68-86 Jervois Quay, G.P.O. Box 2097,
Wellington C1; tel.: 64-4-735735

Nigeria: Associated Electronic Products (Nigeria) Ltd.,
KM16, Ikorodu Road, Ojota, P.O.B. 1921, Lagos;
tel.: 234-1-900160/69

Nippon: NF Trading Co. Ltd.,
3-20 Tsunashima Higashi 6 - Chome, Kohoku-ku,
Yokohama-Shi

Norge (Norway): Norsk A.S. Philips,
Dept. Industry and Telecommunication,
Sandstuveien 70, Postboks 1, Manglerud N 0612,
Oslo 6; tel.: 47-2-680200

Oesterreich: Oesterreichische Philips Industrie GmbH,
Abteilung Industrie Elektronik,
Triesterstrasse 64, Postfach 217, A 1100 Wien;
tel.: 43-222-645521
Service Centre:
Oesterreichische Philips Industrie GmbH
Ketzergasse 120-122, A 1232 Wien;
tel.: 43-222-8662

Pakistan: Philips Electrical Co. of Pakistan Ltd.,
P.O.B. 7101, Karachi 3;
tel.: 92-21-725772

Paraguay: Philips del Paraguay S.A.,
Avenida Artigas 1519, Casilla de Correo 605,
Asunción; tel.: 595-21-291924/291934

Péru: Philips Peruana S.A.,
Av. Alfonso Ugarte 1268, Lima 5,
Apartado Aereo 1841, Lima 100; tel.: 51-14-326070

Philippines: Philips Industrial Development Inc.,
2246 Pasong Tamo, Makati, Metro Manila;
tel.: 63-2-868951/868959

Portugal: Philips Portuguesa S.A.R.L.,
1009 Lisboa Codex, Av. Eng. Duarte Pacheco 6,
1000 Lisboa; tel.: 351-1-683121/9
Service Centre:
Servicos Técnicos Profissionais, Outorela 7/Carnaxide,
2795 Linda-a-Velha; tel.: 351-1-2180071

Saoudi Arabia: Delegate Office of Philips Industries,
P.O. Box 9844, Riyadh 11423; tel.: 966-1-4777808

Schweiz-Suisse-Svizzera: Philips A.G., S&I Equipment,
Allmendstrasse 140, Postfach 670, CH-8027 Zürich;
tel.: 41-1-4882211

Singapore: Philips Singapore Private Limited,
Lorong 1, Toa Payoh, Singapore 1231,
P.O. Box 340 - Toa Payoh Central Post Office,
Singapore 9131; tel.: 65-3502000 (N.O.)

South Africa: South African Philips (Pty) Ltd.,
2 Herb Street, P.O.B. 7703, New Doornfontein,
Johannesburg 2000; tel.: 27-11-6179111

South Korea: Philips Electronics (Korea) Ltd.,
260-199 Itaewon-dong, Yongsan-ku, Philips House
C.P.O. Box 3680, Seoul, Korea 140;
tel.: 82-2-794-5011/5

Spain: see España

Suomi: Oy Philips AB, Kaivokatu 8,
P.O. Box 255, SF-00101 Helsinki;
tel.: 358-0-17271
Service Centre:
Sinikallionte 1-3, P.O. Box 11,
SF-02630 Espoo; tel.: 358-0-52571

Sverige (Sweden): Philips Försäljning AB,
Div. Industrielektronik, Tegeluddsvägen 1,
S 115 84 Stockholm; tel.: 46-8-7821000

Syria: Philips Moyen-Orient S.A.R.L.,
Rue Fardoss 79, B.P. 2442, Damas;
tel.: 218605/221650/228003/221025

Taiwan: Philips Taiwan Ltd.,
150, Tun Hua North Road,
P.O. Box 22978, Taipei;
tel.: 886-2-712-0500

Tanzania: Philips (Tanzania) Ltd.,
T.D.F.L. Building (1st floor), Ohio/Upanga Road
P.O. Box 20104, Dar es Salaam; tel.: 29571/4

Thailand: Philips Electrical Co. of Thailand Ltd.,
283 Silom Road, P.O. Box 961, Bangkok 10500;
tel.: 66-2-233 6330.9/2355 665.8
Service Centre:
29/1 Sanpavud Road, Bangna, Prakanong,
Bangkok 10110; tel.: 66-2-396-1639/393 8772-6/
66-2-396-1437

Tunisia: S.T.I.E.T., 32 bis, Rue Ben Ghedhahem,
Tunis; tel.: 216-1-348666

Türkiye: Türk Philips Ticaret A.S.,
Inönü Caddesi 78/80, Posta Kutusu 504,
80074 Beyoglu, Istanbul; tel.: 90-1-1435910

United Arab Emirates: Philips Middle East B.V.,
Dubai International Trade Centre, 11th floor,
P.O. Box 9269, Dubai; tel.: 971-4-37700

United Kingdom: Pye Unicam Ltd., York Street,
Cambridge CB1-2PX; tel.: 44-223-358866
Service Centre:
Pye Unicam Ltd., Service Division,
Beddington Lane, Croydon CR9-4EN;
tel.: 44-1-6843670

Uruguay: Industrias Philips del Uruguay S.A.,
Avda Uruguay 1287, Casilla de Correo 294,
Montevideo; tel.: 915641/2/3/4-919009
Service : 387777-387878-388484

U.S.A.:
Philips Test and Measurement Department Inc.,
California: Garden Grove 92645
12882 Valley View Street, Suite 9;
tel.: (213) 594-8741 / (714) 898-5000
California: Milpitas 95035
477 Valley Way;
tel.: (408) 946-6722
Florida: Winter Park 32789
1850 Lee Road, Suite 229;
tel.: (305) 628-1717
Illinois: Itasca 60143
500 Park Blvd., Suite 1170;
tel.: (312) 773-0616
Massachusetts: Woburn 01801
21 Olympia Avenue;
tel.: (617) 935-3972
Minnesota: Minneapolis 55420
7851 Metro Parkway, Suite 302;
tel.: (612) 854-2426
New Jersey: Mahwah 07430
85 McKee Drive;
tel.: 1-201-5293800 (Toll-free 800-6317172)

Venezuela: Industrias Venezolanas Philips S.A.,
Apartado Aereo 1167, Caracas 1010-A;
tel.: 58-2-203.7111

Zaire: S.A.M.E./s.a.r.l., 137, Boulevard du 30 juin,
B.P. 16636, Kinshasa; tel.: 31887-31888-31921

Zambia: Philips Electrical Zambia Ltd.,
Mwembeshi Road, P.O.B. 31878, Lusaka;
tel.: 218511/218701/218321

Zimbabwe: Philips Electrical (Pvt) Ltd.,
62 Mutare Road, P.O. Box 994, Harare;
tel.: 47211/48031

For information on change of address:
Philips Export B.V.,
Industrial & Electro-acoustic Systems Division,
Test & Measurement, Building TQ III - 4, P.O. Box 218,
5600 MD Eindhoven - The Netherlands
Tel. 31-40-788476

T&M/870415