350 MHz VHF Dual Channel, Dual Time Base Oscilloscope

PM3295

Service Manual

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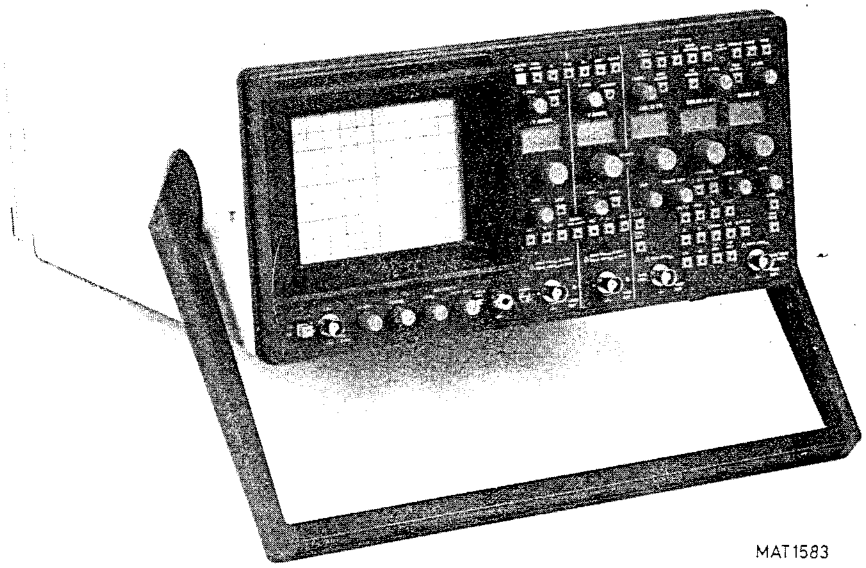

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1. SAFETY INSTRUCTIONS

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.

2. GENERAL INFORMATION

2.1. INTRODUCTION TO THE PM 3295 OSCILLOSCOPE.

This compact V.H.F. oscilloscope features an extensive bandwidth of 350 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.

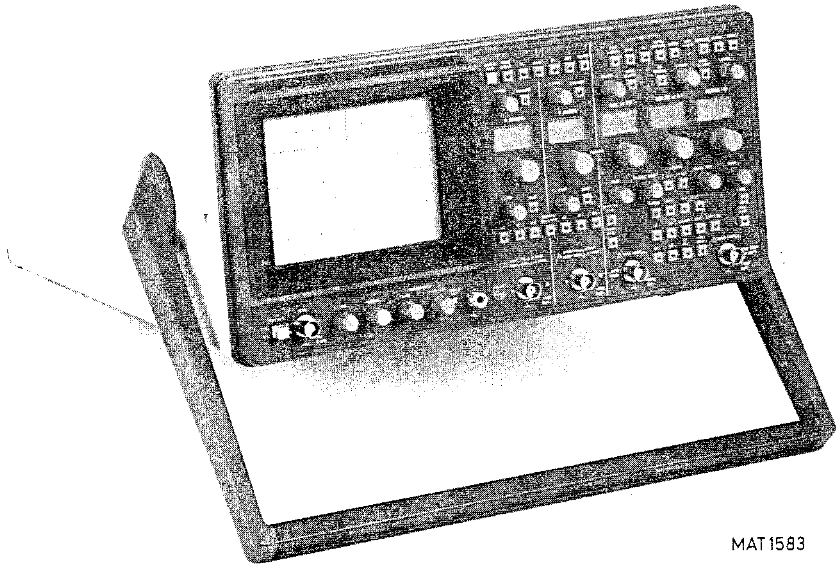

Fig. 2.1. 350 MHz V.H.F. oscilloscope PM3295.

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 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)	
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

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATIION
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)	GH (P31)	
	(optional)	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	

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- 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.
Orthogonality	90 + or -0,5°	Measured at centre of screen. (Angle between X and Y axes, when traces are written in X and Y direction alternately; deflection frequency: 50...60Hz)
Trace Rotation:		Screwdriver adjustment; direction of screwdriver rotation same as direction of trace rotation.
Min. Range	12°	Either X- or Y trace can be aligned with graticule, when environmental magnetic field is within 0,1mT.

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 and Ch.B~~	~~max. 120ps~~	~~Channels at same position of input impedance selector.~~
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 350MHz; channels with equal V/div settings; input to either channel equivalent to 8 divisions 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)

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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 350MHz 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%	(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 (-3dB)	Input Coupling in DC position. Input Coupling in AC position.
- Upper Transition Point of BW (Ambient:5...40°C)	350MHz (-3dB)	1mV and 2mV/div positions excluded (see 2.2.3.)
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 (Ambient:5...40°C)	350MHz (-3dB)	1mV and 2mV/div positions excluded (see 2.2.3.).
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

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: 5...40°C)	1ns or less	1mV and 2mV/div excluded, (see 2.2.3.) (Calculated from Bandwidth x Rise Time = 0,35)
- Pulse Aberrations: overshoot	5% or less	Tested with a 1ns Rise Time pulse at 20 mV/div.
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: 5...40°C)	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 (Ambient 5...40°C)		
when switching to added mode	0,5 div or 3 mV}	
between any V/div positions	0,2 div or 1 mV}	
when using INVertor switch	0,4 div or 2 mV}	Whichever is greater
between AC and DC position	0,1 div or 1 mV}	
between DC and 0 position	0,1 div or 1 mV	Whichever is greater; Input externally grounded
when rotating vernier	0,8 div or 1,2mV	Whichever is greater
Drift	0,1div/h	Measured in 20mV/div position.
Temperature coefficient	0,05div/K	
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 (Ambient:5...40°C)	+ or - 5%	For all sources except LINE
Dynamic Range:		Compression at limits of Dynamic Range: 7%
up to 100MHz	24div	
up to 350MHz	8div	

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: 5.. .40°C)	d.c...300MHz	Channel A or B in 50 Ohm position. Z of Signal Source: 50 Ohm.
Trigger source:EXT (Ambient:5...40°C)	d.c...350MHz	Z of Signal Source: 25 Ohm.
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 (Ambient :5.. .40°C)		(Calculated from Bandwidth x Rise Time = 0,35).
Trigger source: INT	1,2 ns	Z of Signal Source: 50 Ohm
Trigger source: EXT	1 ns	Z of Signal Source: 25 Ohm
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°	Up to 100kHz
Max. Horizontal Display Instability		
- Drift	0,1 div/h	
- Temp. Coefficient	0.05div/K	

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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
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)	
- Vernier Ratio	2,5:1	Uncalibrated, contin. variable between steps.
TB Magnification (Hor. Expansion):	1ox	
Max. Expansion Unbalance	+ or - 0,4 unexpand. div	When switching from x10 to xl, the center display will not shift more than stated value.
Minimum Visual Display Length	10 unexpanded div	At Normal Intensity.
Variable Hold Off:		
Minimum	lus 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), 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)	+ oκ - (0,5% of full scale + 1% of reading)	Add 0,5 % of full scale for 10 ns/div...50 ns/div
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)	
- Vernier Ratio	2,5:1	Uncalibrated continuously variable between steps.
TB Magnification (Hor. Expansion): Max. Expansion	10x	
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 + 6ns)	MTB Vernier in CAL position

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- 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 T:		Dual DTB method.
Range	10ns...10 x MTB time/div setting	
Error Limit (Ambient:5...40 C)	+ or - (0,025% of full scale + 1%of reading + 2ns)	Add 0,05% of full scale for first and last 10%of available range
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)	up to 100MHz | up to 400MHz	
Ch.A and Ch.B	0,5div | 2div	In TRIG mode
EXT	50mV | 300mV	
EXT/10	0,5V | 3V	
Slope Selection	positive going (+); negative going (-)	
Level Control Range:		NOT TRIG'D led is **lit** unless triggered.
Ch. A and Ch.B EXT EXT:10	+ or - 8 div + or -0,8V + or -8V	In TRIG and SINGLE positions of Mode Selector.
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.

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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
C parallel	9pF	In AC position of Input Coupling: 18 nF in series with R parallel and C parallel
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
EXT	50mV	300mV
EXT: 10	0,5V	3v

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 0,4...2,5V, otherwise >10k. Ohm
Input Coupling	d.c.	
Maximum Input Voltage	+ or - 10V	
Sensitivity:		
Unblanked at	+ 0,4V or less	Half tones are possible at input voltages between +0,4V 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).

2.2.11. 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	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	
MTB Trigger LEVEL	1,2 div above center of screen	NEG SLOPE Selection not affected by AUTO SET: LEVEL control remains "dead", until setting of knob (when turning) represents actual trigger level.
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	

2.2.12. 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 A cursor are tracking
Hor. and Vert. Resolution	0,02mm or better	
Read Out Resolution	3 digits	
Voltage Cursors		
- Error Limit (Ambient:0 ...40 C)	+or- 2%	Referred to input at BNC,error of probes etc. excluded.
- Minimum Cursor Range	central 7,6 div	
- Read Out Range:		(with positive or negative sign)
Absolute	8x V/div setting	Probe factor included, when probe is provided with probe read out.
Relative	8 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.
	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.
	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 (Ambient:0...40^{o}C)	+or- 3%	
- Minimum Cursor Range:	central 9,6 div	
- Read Out Range:		(With positive or negative sign)
Absolute	10x s/div setting	
Relative	10 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) 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	} Incl. Cursor Readings
	Cursors only	}
	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	Ch.A deflect. coefficient.	When channel A is displayed.
	Ch.B deflect. coefficient.	When channel B is displayed.
Horizontal Settings	MTB deflection coefficient.	In MTB, MTB-INTENS and alternate sweep mode.
	DTB deflection coefficient.	In DTB and alternate sweep mode.

2.2.14. CALIBRATOR

Wave Form: Shape	square wave	
Internal Impedance	50 Ohm + or - 1%	
Output Voltage (peak to peak)	1V + or - 1% pos. going with respect to ground	Open Voltage: halves when terminated into 50 Ohm.
Output Current (peak to peak)	20mA + or - 2%	When output short circuited; halves when terminated into 50 Ohm.
Frequency	2kHz + 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%	
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	130W	Options excluded
Limits of Operation	136W	PM8950 (IEEE 488) option included

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^{o}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^{o}C, with recommended (fresh) batteries.
Temperature Range	-30^{o}C...+70^{o}	At -40^{o}C...-30^{o}C Settings Retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer periods (>24h) below -30^{o}C or above 60^{o}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

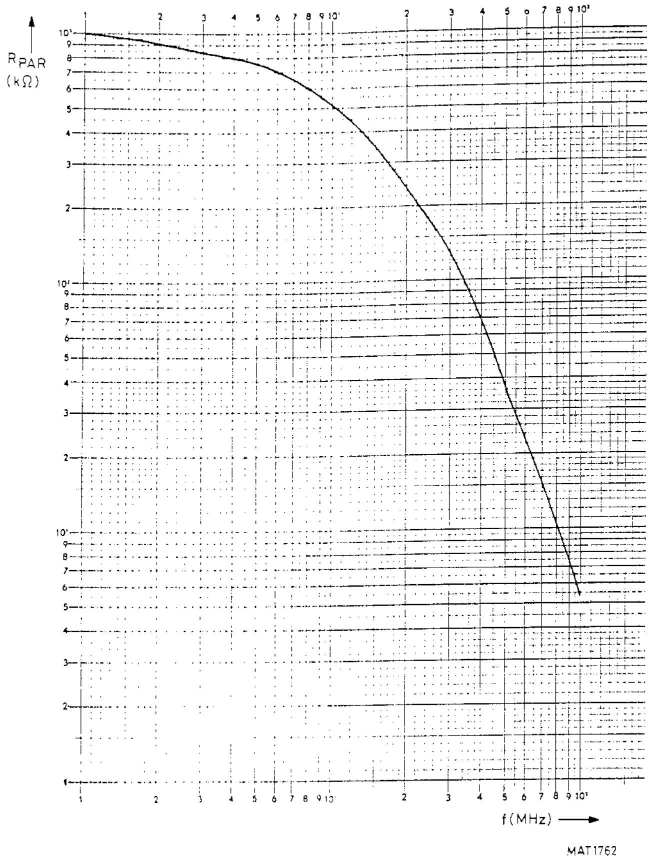
Structural parts meet requirements of	MIL-STD-810 method 509, proced. I salt solution 20%	
EMI (Electro Magnetic Interference) meets requirements of	MIL-STD-461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS02, RS03.
	VDE 0871 and VDE 0875 Grenz-wertklasse B	
Magnetic 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

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	



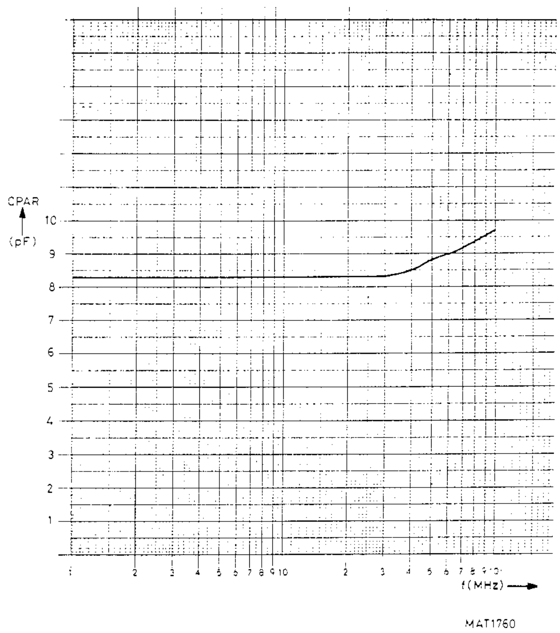


fig. 2.2 Input resistance R par. and capacitance C par. versus frequency.

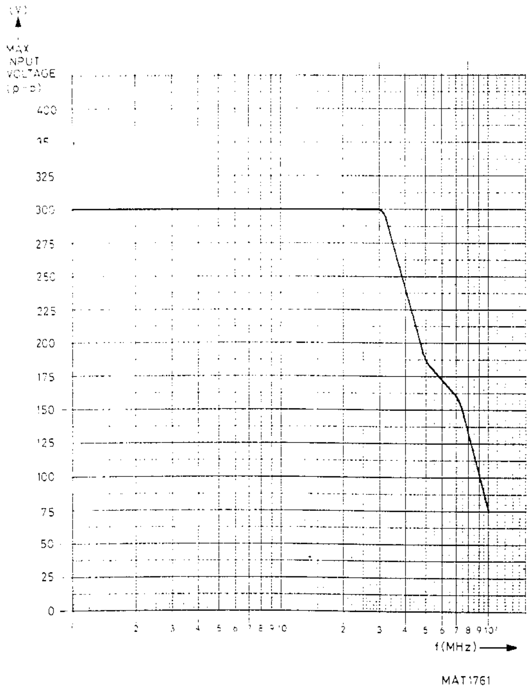


fig.2.3. Maximum input voltage (peak to peak) derating versus frequency.

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
5601-5799	X/Z amplifier	16.1, 16.2, 16.3
5901-5999	CRT-controls unit	22.1, 22.2
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.

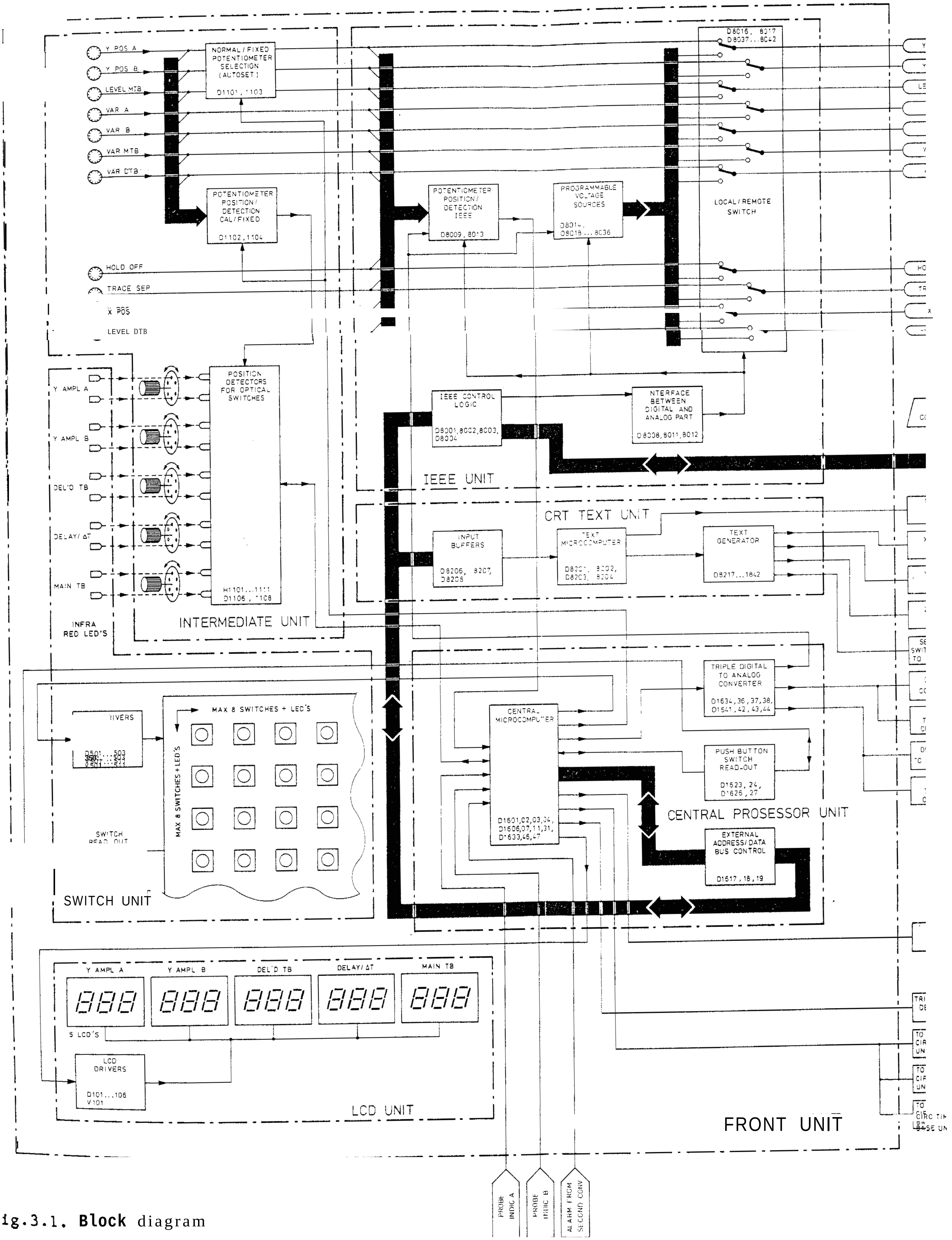
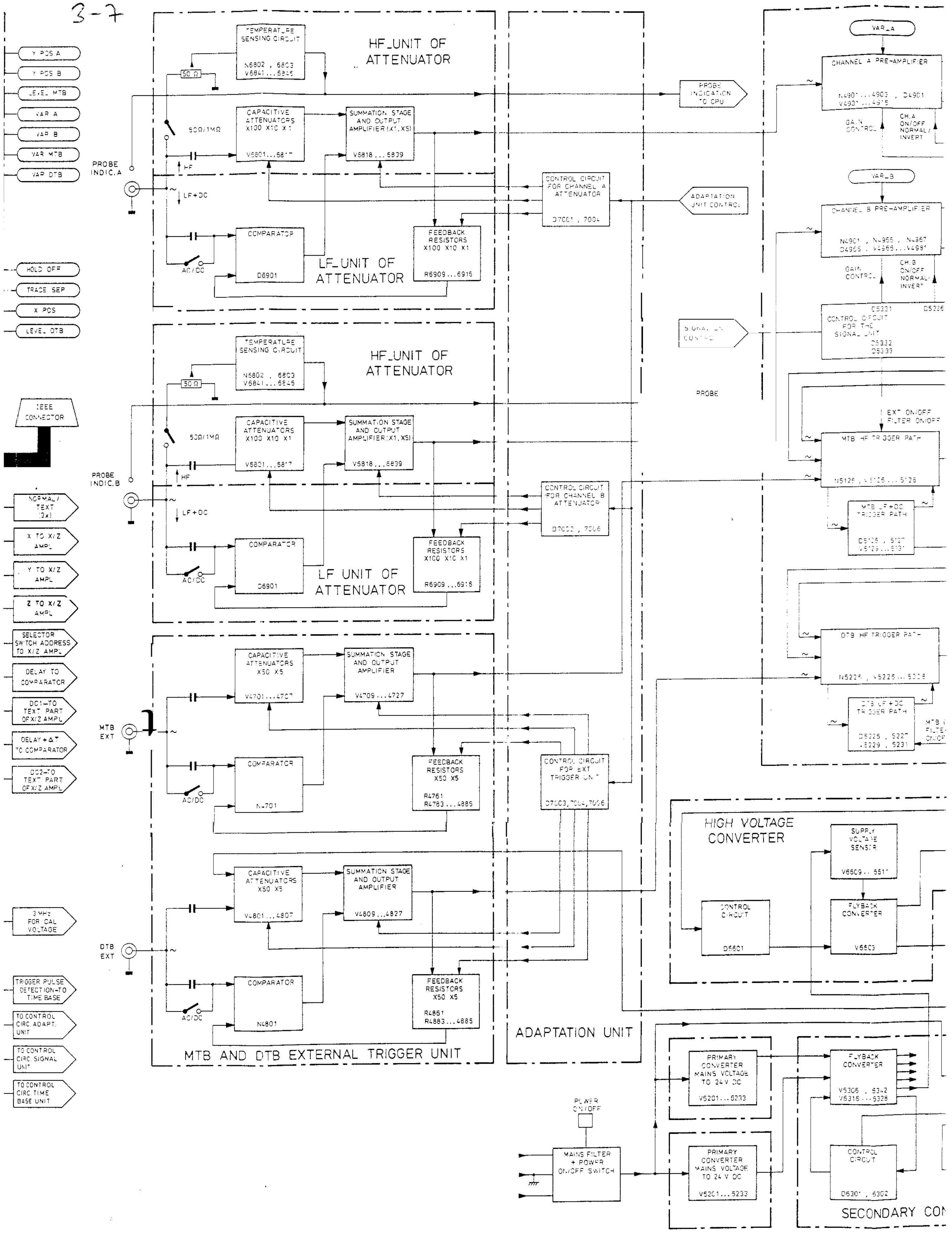
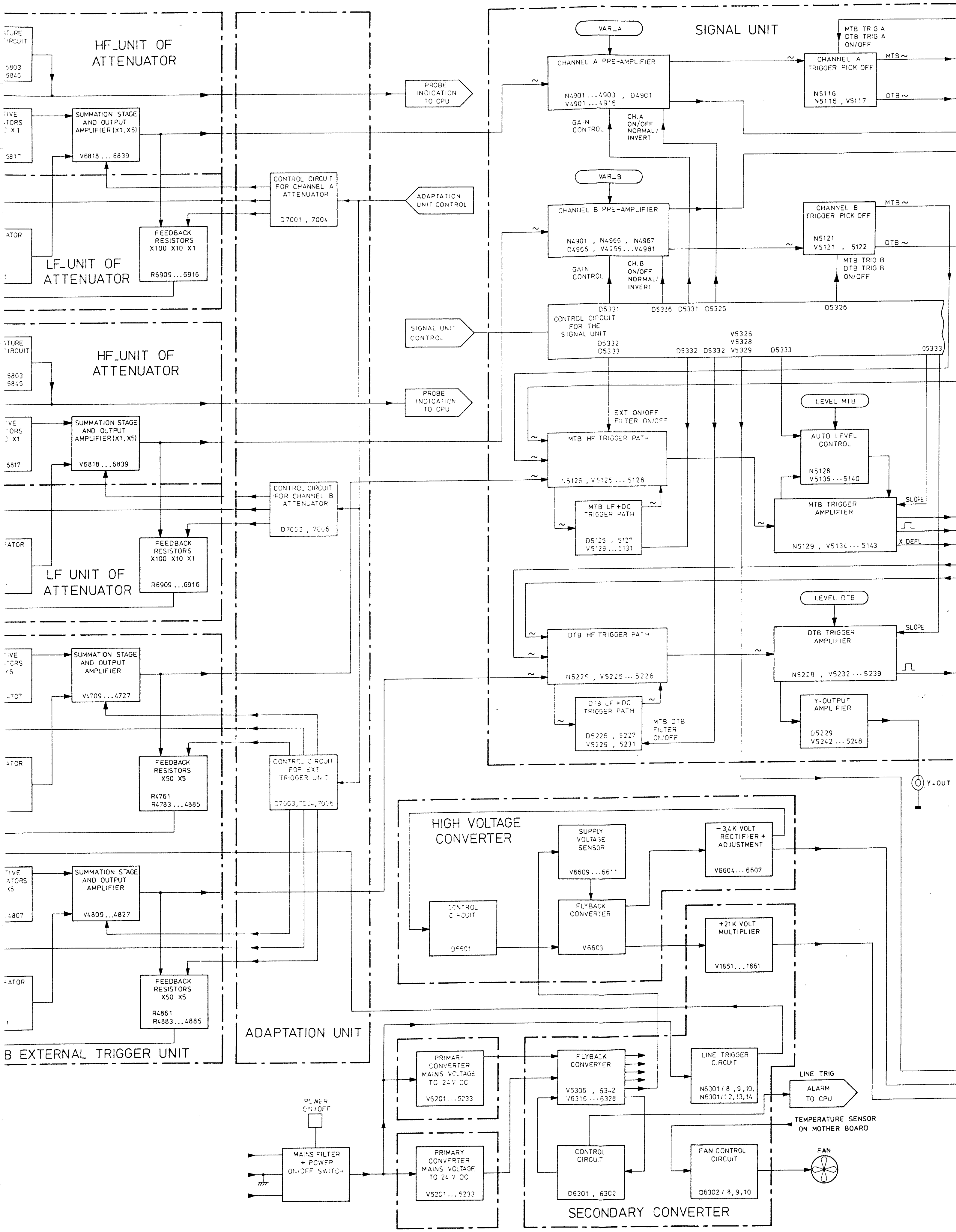


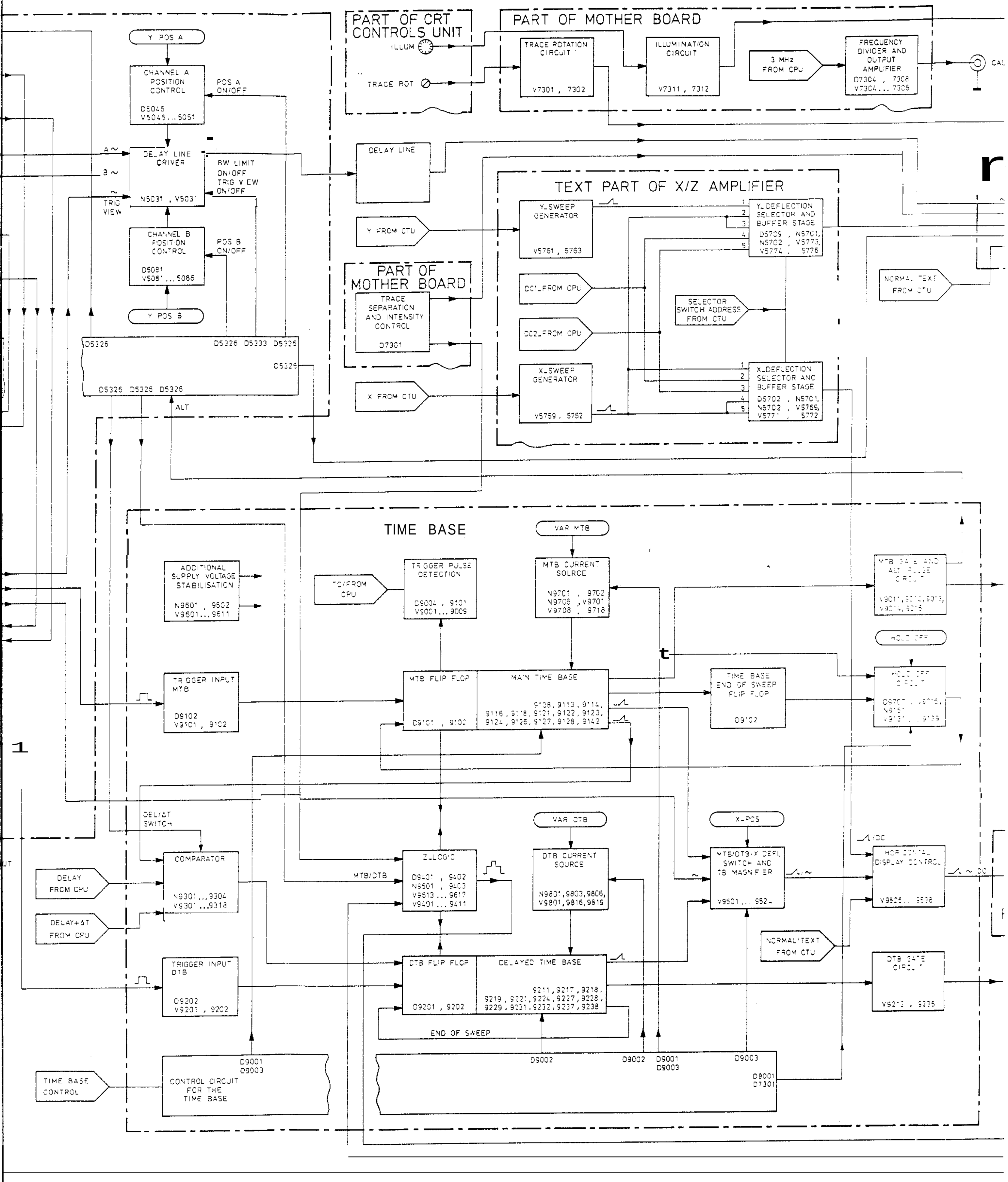
Fig.3.1. **Block** diagram



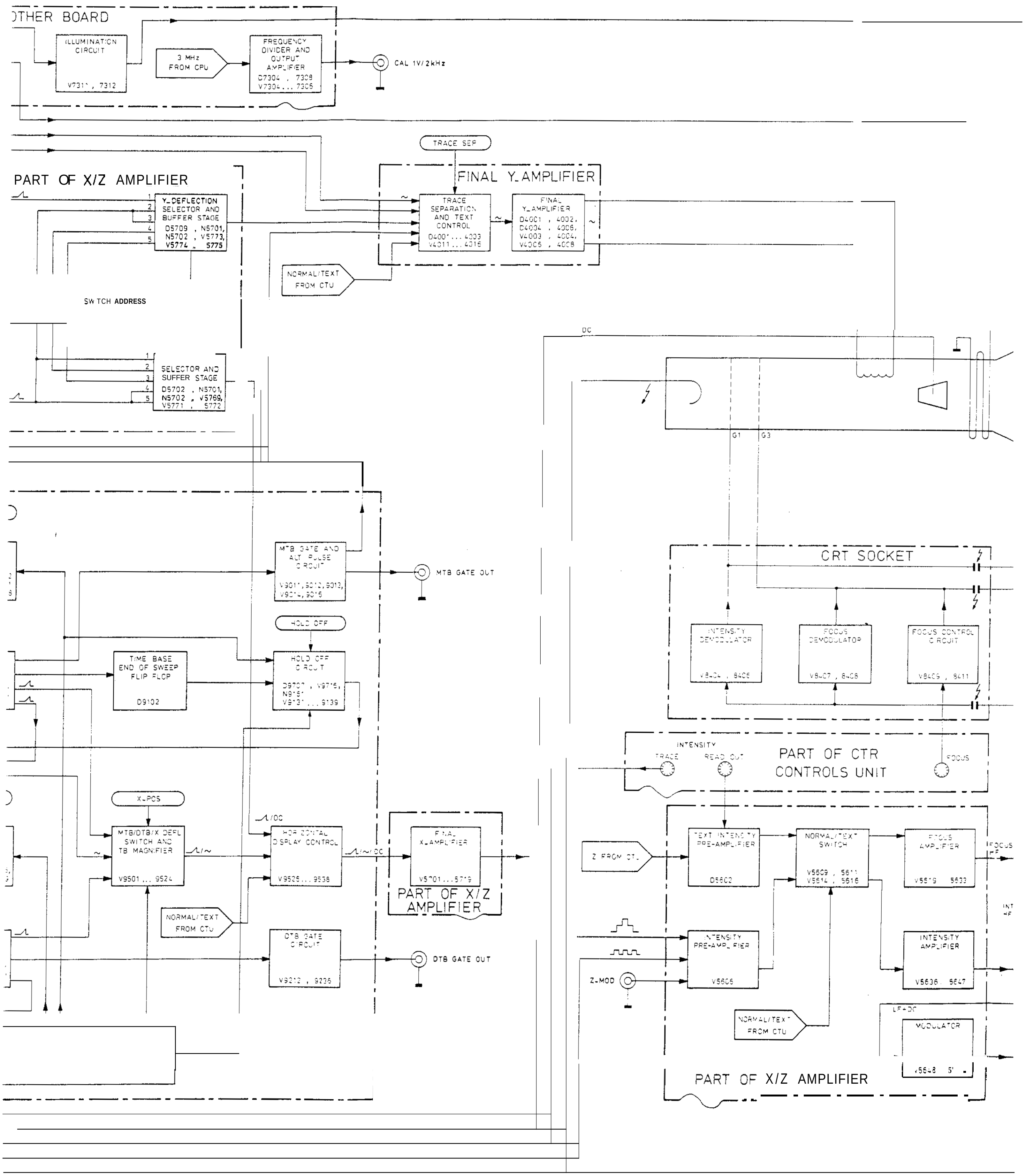
HF_UNIT OF ATTENUATOR
TEMPERATURE SENSING CIRCUIT N6802 , 6803 V6841...6845
CAPACITIVE ATTENUATORS X100 X10 X1 V6801...6817
SUMMATION STAGE AND OUTPUT AMPLIFIER (X1, X5) V6818...6839
50Ω/1MΩ
HF
LF+DC
PROBE INDIC.A
PROBE INDIC.B
COMPARATOR D6901
FEEDBACK RESISTORS X100 X10 X1 R6909...6915
LF_UNIT OF ATTENUATOR
LF UNIT OF ATTENUATOR
AC/DC
CONTROL CIRCUIT FOR CHANNEL A ATTENUATOR D7001 , 7004
CONTROL CIRCUIT FOR CHANNEL B ATTENUATOR D7002 , 7006
CONTROL CIRCUIT FOR EXT TRIGGER UNIT D7003, 7004, 7006
ADAPTATION UNIT CONTROL
PROBE INDICATION TO CPU
ADAPTATION UNIT
MTB AND DTB EXTERNAL TRIGGER UNIT
CAPACITIVE ATTENUATORS X50 X5 V4701...4707
SUMMATION STAGE AND OUTPUT AMPLIFIER V4709...4727
COMPARATOR N4701
FEEDBACK RESISTORS X50 X5 R4761 R4783...4885
CAPACITIVE ATTENUATORS X50 X5 V4801...4807
SUMMATION STAGE AND OUTPUT AMPLIFIER V4809...4827
COMPARATOR N4801
FEEDBACK RESISTORS X50 X5 R4861 R4883...4885
MTB EXT
DTB EXT
Y POS A
Y POS B
LEVEL MTB
VAR A
VAR B
VAR MTB
VAR DTB
HOLD OFF
TRACE SEP
X POS
LEVEL DTB
IEEE CONNECTOR
NORMAL/ TEXT (3x)
X TO X/Z AMPL
Y TO X/Z AMPL
Z TO X/Z AMPL
SELECTOR SWITCH ADDRESS TO X/Z AMPL
DELAY TO COMPARATOR
DC1-TO TEXT PART OF X/Z AMPL
DELAY + ΔT TO COMPARATOR
DC2-TO TEXT PART OF X/Z AMPL
3 MHz FOR CAL VOLTAGE
TRIGGER PULSE DETECTION-TO TIME BASE
TO CONTROL CIRC ADAPT. UNIT
TO CONTROL CIRC SIGNAL UNIT
TO CONTROL CIRC TIME BASE UNIT
VAR_A
CHANNEL A PRE-AMPLIFIER N4901...4903 , D4901 V4901...4916
GAIN CONTROL
CH.A ON/OFF NORMAL/ INVERT
VAR_B
CHANNEL B PRE-AMPLIFIER N4901 , N4955 , N4967 D4955 , V4955...V4981
CH.B ON/OFF NORMAL/ INVERT
CONTROL CIRCUIT FOR THE SIGNAL UNIT D5331 D5332 D5333
D5226
PROBE
EXT ON/OFF FILTER ON/OFF
MTB HF TRIGGER PATH N5126 , V5126...5126
MTB LF+DC TRIGGER PATH
DTB HF TRIGGER PATH N5225 , V5225...5228
DTB LF+DC TRIGGER PATH D5225 , 5227 , 5229 , 5231
HIGH VOLTAGE CONVERTER
SUPPLY VOLTAGE SENSOR V6509...6511
CONTROL CIRCUIT D6601
FLYBACK CONVERTER V6603
PRIMARY CONVERTER MAINS VOLTAGE TO 24 V DC V5201...5233
FLYBACK CONVERTER V5306 , 5312 V5315...5328
CONTROL CIRCUIT D6301 , 6302
POWER ON/OFF
MAINS FILTER + POWER ON/OFF SWITCH
SECONDARY CON


HF_UNIT OF ATTENUATOR
SUMMATION STAGE AND OUTPUT AMPLIFIER (X1, X5)
V6818 ... 6839
FEEDBACK RESISTORS X100 X10 X1
R6909 ... 6916
LF_UNIT OF ATTENUATOR
PROBE INDICATION TO CPU
CONTROL CIRCUIT FOR CHANNEL A ATTENUATOR
D7001 , 7004
ADAPTATION UNIT CONTROL
CONTROL CIRCUIT FOR CHANNEL B ATTENUATOR
D7002 , 7005
SIGNAL UNIT CONTROL
SUMMATION STAGE AND OUTPUT AMPLIFIER
V4709 ... 4727
FEEDBACK RESISTORS X50 X5
R4761
R4783 ... 4885
CONTROL CIRCUIT FOR EXT TRIGGER UNIT
V4809 ... 4827
R4861
R4883 ... 4885
B EXTERNAL TRIGGER UNIT
ADAPTATION UNIT
SIGNAL UNIT
VAR_A
CHANNEL A PRE-AMPLIFIER
N4901 ... 4903 , D4901
V4901 ... 4915
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 , N4965 , N4967
D4965 , V4965 ... V4981
CH.B ON/OFF NORMAL/INVERT
CHANNEL B TRIGGER PICK OFF
N5121
V5121 , 5122
MTB TRIG B
DTB TRIG B
ON/OFF
CONTROL CIRCUIT FOR THE SIGNAL UNIT
D5331
D5326
D5332
D5333
V5326
V5328
V5329
EXT ON/OFF
FILTER ON/OFF
MTB HF TRIGGER PATH
N5126 , V5125 ... 5128
MTB LF+DC TRIGGER PATH
D5125 , 5127
V5129 ... 5131
LEVEL MTB
AUTO LEVEL CONTROL
N5128
V5135 ... 5140
MTB TRIGGER AMPLIFIER
N5129 , V5134 ... 5143
SLOPE
X DEFL
LEVEL DTB
DTB HF TRIGGER PATH
N5225 , V5225 ... 5228
DTB LF+DC TRIGGER PATH
D5226 , 5227
V5229 , 5231
MTB DTB FILTER ON/OFF
DTB TRIGGER AMPLIFIER
N5228 , V5232 ... 5239
Y-OUTPUT AMPLIFIER
D5229
V5242 ... 5248
Y-OUT
HIGH VOLTAGE CONVERTER
SUPPLY VOLTAGE SENSOR
V6609 ... 6611
-3,4K VOLT RECTIFIER + ADJUSTMENT
V6604 ... 6607
CONTROL CIRCUIT
D6601
FLYBACK CONVERTER
V6603
+21K VOLT MULTIPLIER
V1851 ... 1861
POWER ON/OFF
MAINS FILTER + POWER ON/OFF SWITCH
PRIMARY CONVERTER MAINS VOLTAGE TO 24 V DC
V5201 ... 5233
FLYBACK CONVERTER
V6306 , 63-2
V6316 ... 6328
LINE TRIGGER CIRCUIT
N6301 / 8 , 9 , 10,
N6301 / 12 , 13 , 14
LINE TRIG
ALARM TO CPU
TEMPERATURE SENSOR ON MOTHER BOARD
CONTROL CIRCUIT
D6301 , 6302
FAN CONTROL CIRCUIT
D6302 / 8 , 9 , 10
FAN
SECONDARY CONVERTER

3 - 9

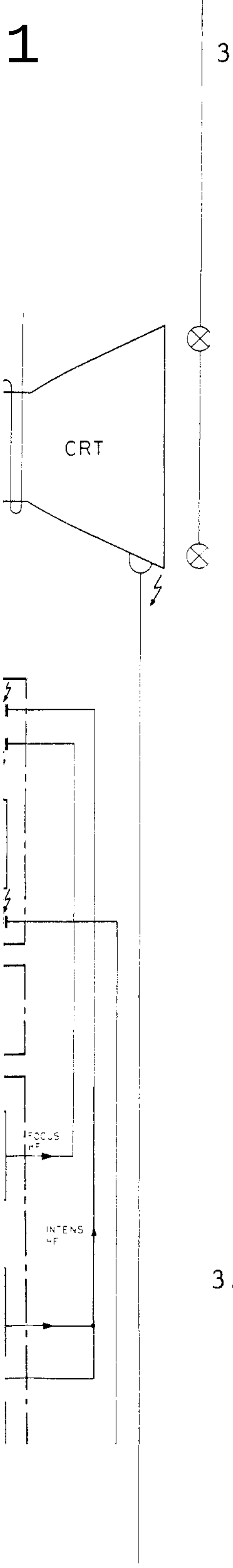


PART OF CRT CONTROLS UNIT
ILLUM
TRACE ROT
PART OF MOTHER BOARD
TRACE ROTATION CIRCUIT
V7301 , 7302
ILLUMINATION CIRCUIT
V7311 , 7312
3 MHz FROM CPU
FREQUENCY DIVIDER AND OUTPUT AMPLIFIER
D7304 , 7308
V7304 ... 7306
CAL
Y POS A
CHANNEL A POSITION CONTROL
D5045
V5046 ... 5051
POS A ON/OFF
A ~
B ~
TRIG VIEW
DELAY LINE DRIVER
N5031 , V5031
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 D5325
D5326
D5326 D5325 D5326
ALT
DELAY LINE
TEXT PART OF X/Z AMPLIFIER
Y FROM CTU
Y-SWEEP GENERATOR
V5761 , 5763
Y-DEFLECTION SELECTOR AND BUFFER STAGE
D5709 , N5701,
N5702 , V5773,
V5774 , 5776
PART OF MOTHER BOARD
TRACE SEPARATION AND INTENSITY CONTROL
D7301
DC1-FROM CPU
DC2-FROM CPU
SELECTOR SWITCH ADDRESS FROM CTU
X FROM CTU
X-SWEEP GENERATOR
V5759 , 5762
X-DEFLECTION SELECTOR AND BUFFER STAGE
D5702 , N5701,
N5702 , V5769,
V5771 , 5772
NORMAL TEXT FROM CTU
TIME BASE
VAR MTB
ADDITIONAL SUPPLY VOLTAGE STABILISATION
N9601 , 9602
V9501 ... 9611
TO/FROM CPU
TRIGGER PULSE DETECTION
D9004 , 9101
V9001 ... 9009
MTB CURRENT SOURCE
N9701 , 9702
N9705 , V9701
V9708 , 9718
MTB GATE AND ALT PULSE CIRCUIT
HOLD OFF
HOLD OFF CIRCUIT
TRIGGER INPUT MTB
D9102
V9101 , 9102
MTB FLIP FLOP
D9101 , 9102
MAIN TIME BASE
9108, 9113, 9114,
9116, 9118, 9121, 9122, 9123,
9124, 9125, 9127, 9128, 9142
TIME BASE END OF SWEEP FLIP FLOP
D9102
DEL/ΔT SWITCH
COMPARATOR
N9301 ... 9304
V9301 ... 9318
DELAY FROM CPU
DELAY+ΔT FROM CPU
Z-LOGIC
D9401 , 9402
N9501 , 9403
V9613 ... 9617
V9401 ... 9411
MTB/DTB
VAR DTB
DTB CURRENT SOURCE
N9801, 9803, 9806,
V9801, 9816, 9819
X-POS
MTB/DTB/X DEFL SWITCH AND TB MAGNIFIER
V9501 ... 9524
HORIZONTAL DISPLAY CONTROL
V9525 ... 9538
NORMAL/TEXT FROM CTU
TRIGGER INPUT DTB
D9202
V9201 , 9202
DTB FLIP FLOP
D9201 , 9202
DELAYED TIME BASE
9211, 9217, 9218,
9219, 9221, 9224, 9227, 9228,
9229, 9231, 9232, 9237, 9238
DTB GATE CIRCUIT
END OF SWEEP
TIME BASE CONTROL
CONTROL CIRCUIT FOR THE TIME BASE
D9001
D9003
D9002
D9002
D9001
D9003
D9003
D9001
D7301



)THER BOARD
ILLUMINATION CIRCUIT
V7311 , 7312
3 MHz FROM CPU
FREQUENCY DIVIDER AND OUTPUT AMPLIFIER
D7304 , 7309
V7304 ... 7306
CAL 1V/2kHz
TRACE SEP
FINAL Y_AMPLIFIER
PART OF X/Z AMPLIFIER
Y_DEFLECTION SELECTOR AND BUFFER STAGE
D5709 , N5701,
N5702 , V5773,
V5774 , 5775
TRACE SEPARATION AND TEXT CONTROL
D4001 ... 4003
V4011 ... 4016
FINAL Y_AMPLIFIER
D4001 , 4002,
D4004 , 4006,
V4003 , 4004,
V4005 , 4008
NORMAL/TEXT FROM CTU
SWITCH ADDRESS
DC
SELECTOR AND SUFFER STAGE
D5702 , N5701,
N5702 , V5769,
V5771 , 5772
G1
G3
CRT SOCKET
MTB GATE AND ALT PULSE CIRCUIT
V9011, 9012, 9013,
V9014, 9015
MTB GATE OUT
HOLD OFF
HOLD OFF CIRCUIT
D9707 , V9716,
N9151
V9131 ... 9139
TIME BASE END OF SWEEP FLIP FLOP
D9102
INTENSITY DEMODULATOR
V8404 , 8405
FOCUS DEMODULATOR
V8407 , 8408
FOCUS CONTROL CIRCUIT
V8409 , 8411
INTENSITY
TRACE
READ OUT
PART OF CTR CONTROLS UNIT
FOCUS
X_POS
MTB/DTB/X DEFL SWITCH AND TB MAGNIFIER
V9501 ... 9524
HOR ZONTAL DISPLAY CONTROL
V9525 ... 9538
FINAL X_AMPLIFIER
V5701 ... 5719
PART OF X/Z AMPLIFIER
NORMAL/TEXT FROM CTU
DTB GATE CIRCUIT
V9212 , 9236
DTB GATE OUT
Z FROM CT.
TEXT INTENSITY PRE-AMPLIFIER
D5602
NORMAL/TEXT SWITCH
V5609 , 5611
V5614 , 5616
FOCUS AMPLIFIER
INTENSITY PRE-AMPLIFIER
V5605
INTENSITY AMPLIFIER
V5636 , 5647
Z-MOD
NORMAL/TEXT FROM CTU
LF+DC
MODULATOR
V5648
PART OF X/Z AMPLIFIER

3.2 BLOCK DIAGRAM DESCRIPTION (see fig. 3.1.)



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; in this event, the front-panel controls are inactive. Via the IEEE-bus the controller can also take-in a complete front panel setting data.
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:

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- 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 2 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 EXTERSAL 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 (optional)

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 co-efficients 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 ADAPTATIOS 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.

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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 immediately (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.

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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 f21 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 2 KHz square-wave. This square-wave signal is amplified and stabilised to give a 1 V output on the CAL voltage output socket.

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.

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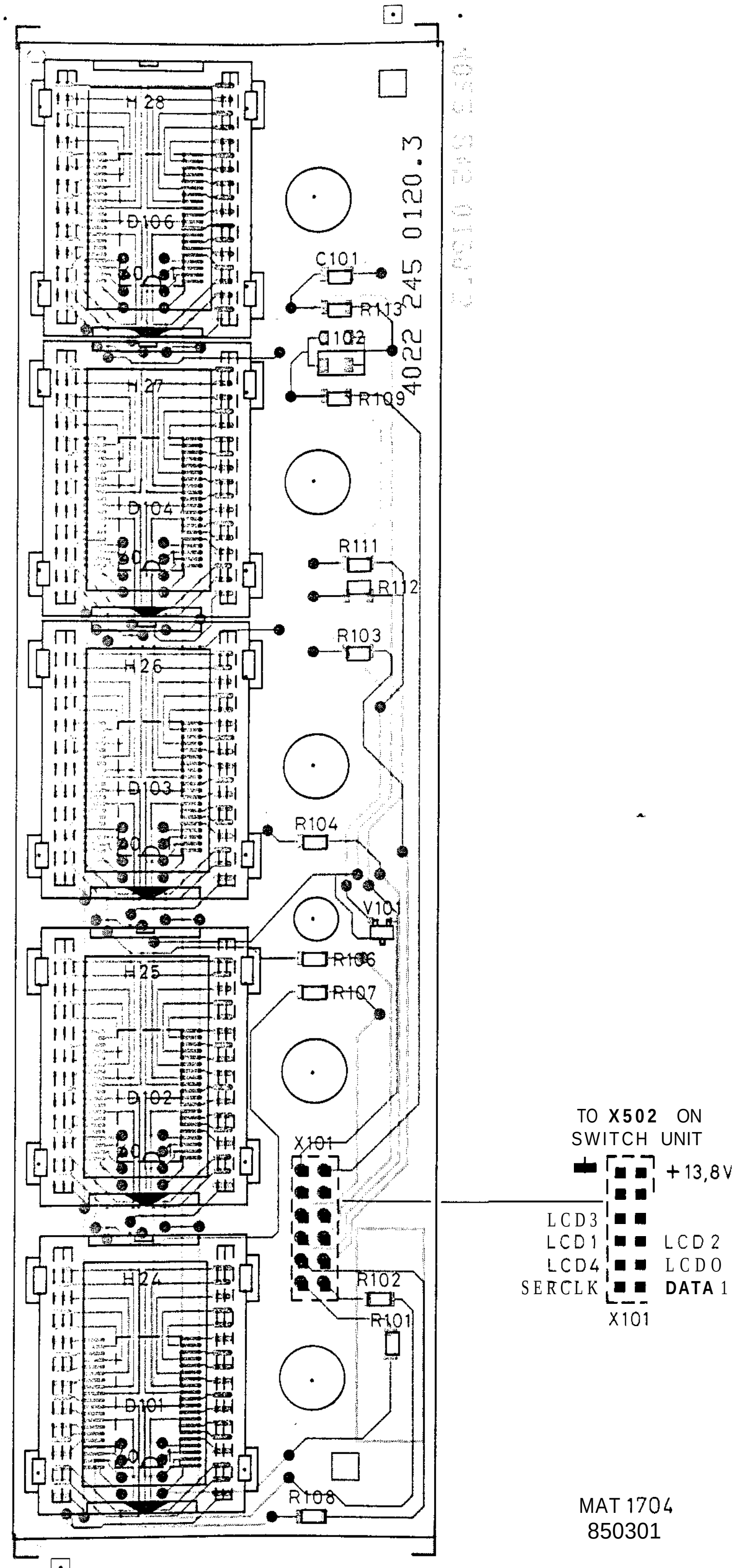
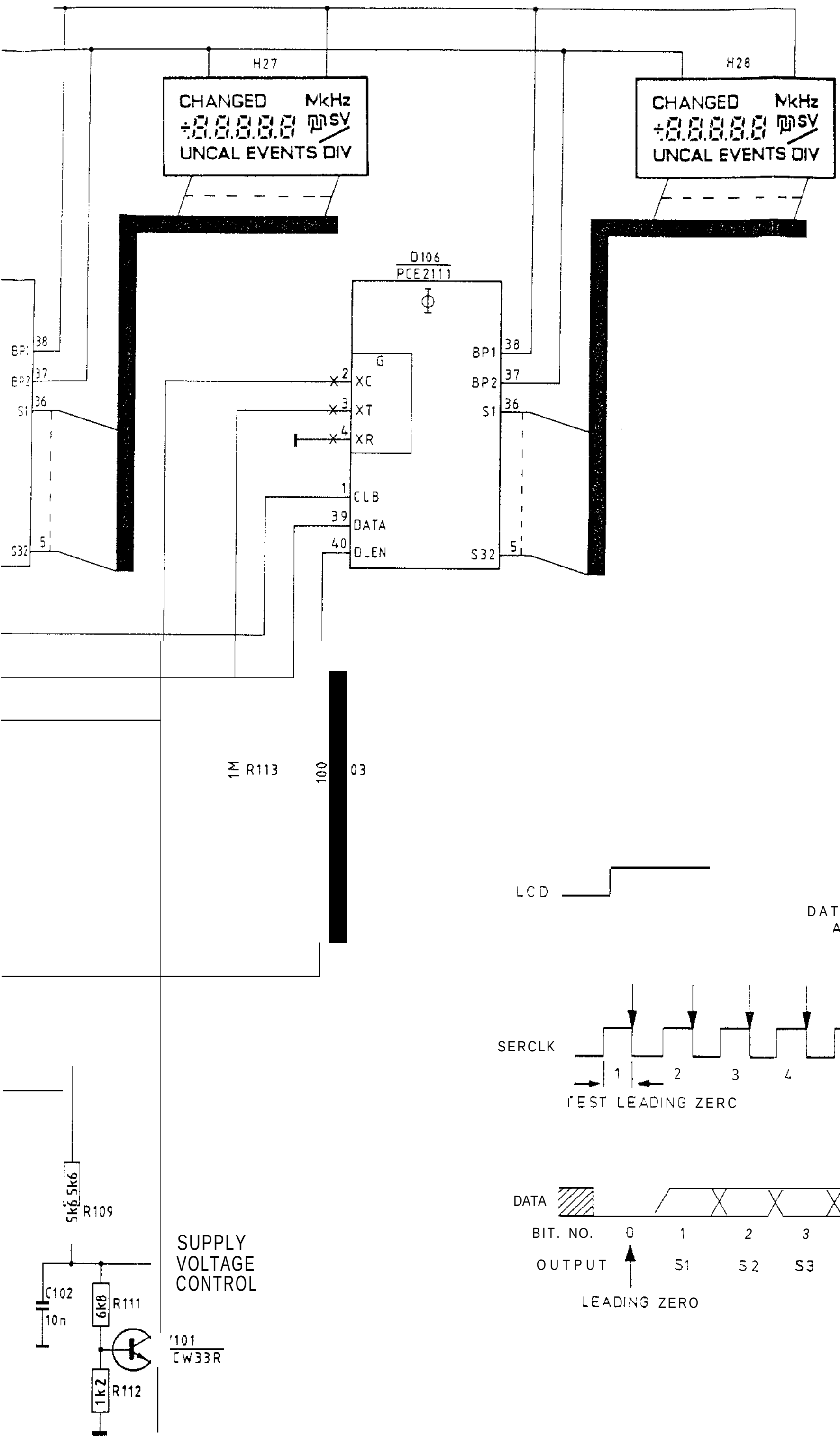


Fig.4.1. **LCD-unit**, p.c.b. lay-out.



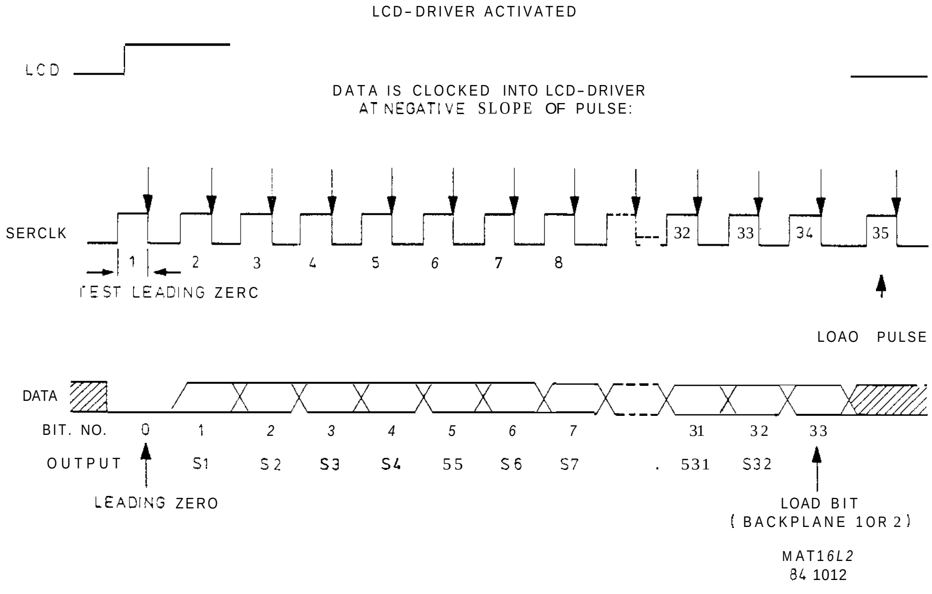


Fig.4.3. Time relation of input signals of LCD-drivers

4-5

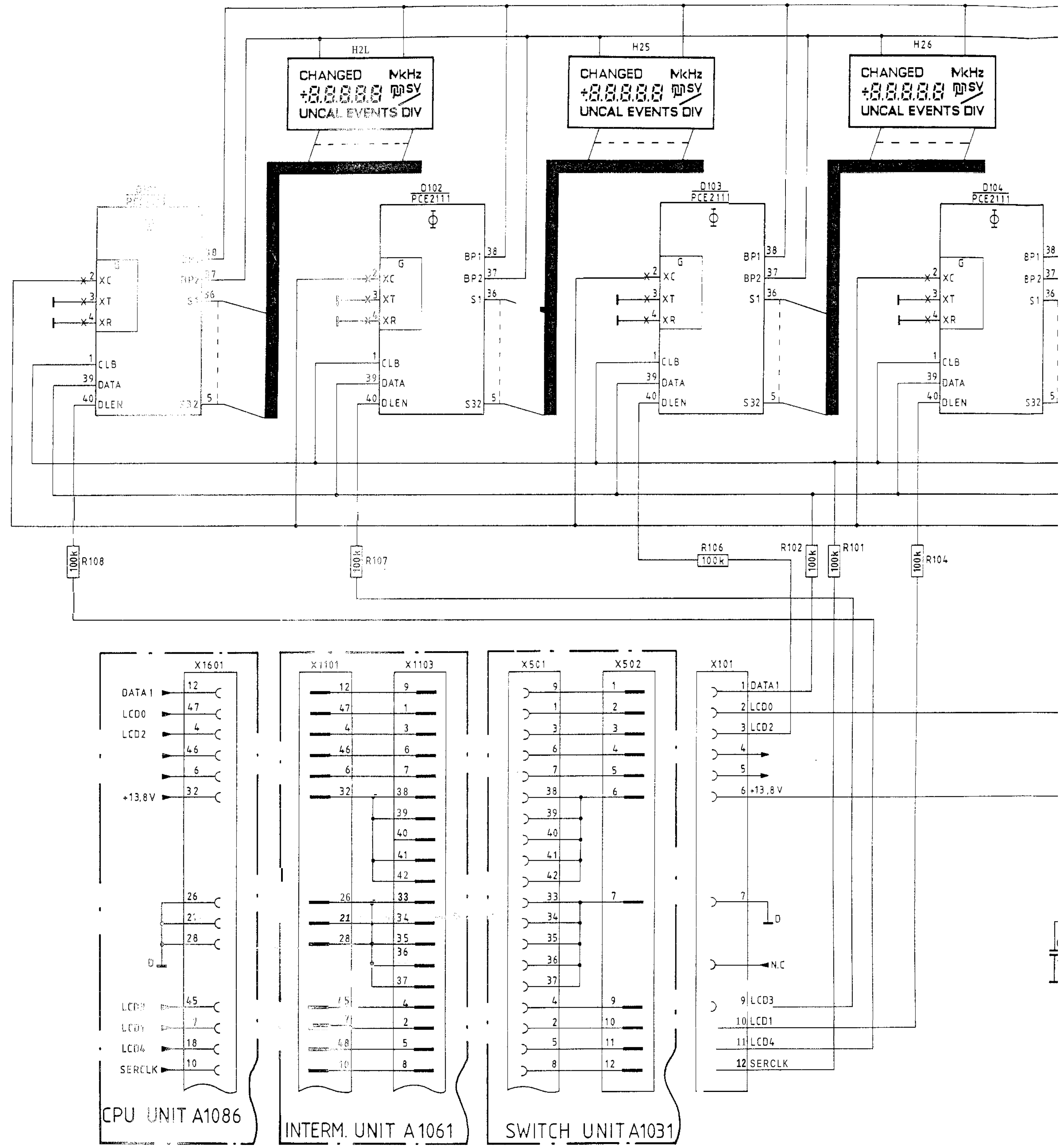


Fig.4.2. LCD-unit, circuit **diagram**.

4

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	CAP.CHIP	50V 5%	680PF	4822 122 31775
C 0102	CAP.CHIP	50V 10%	10NF	4822 122 31728
C 0507	CAP.ELECTROLYT.	-10+50%	1000UF	4822 124 20768
C 0508	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

4.1.2 INTEGRATED CIRCUITS

POSNR	DESCRIPTION			ORDERING CODE
D 0101	INTEGR.CIRCUIT	PCE2111T	PEL	5322 209 82942
D 0102	INTEGR.CIRCUIT	PCE2111T	PEL	5322 209 82942
D 0103	INTEGR.CIRCUIT	PCE2111T	PEL	5322 209 82942
D 0104	INTEGR.CIRCUIT	PCE2111T	PEL	5322 209 82942
D 0106	INTEGR.CIRCUIT	PCE2111T	PEL	5322 209 82942

4.1.3 RESISTORS

R 0101	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0102	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0103	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0104	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0106	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0107	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0108	RES.CHIP	RC-01	5%	100K	4822 111 90214
R 0109	RES.CHIP	RC-01	5%	5K6	4822 111 90572
R 0111	RES.CHIP	RC-01	5%	6K8	4822 111 90544
R 0112	RES.CHIP	RC-01	5%	1K2	5322 111 90096
R 0113	RES.CHIP	RC-01	5%	1M	5322 111 90094

4.1.4 SEMI CONDUCTORS

V 0101	TRANSISTOR	BCW33R	PEL	5322 130 44342

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.

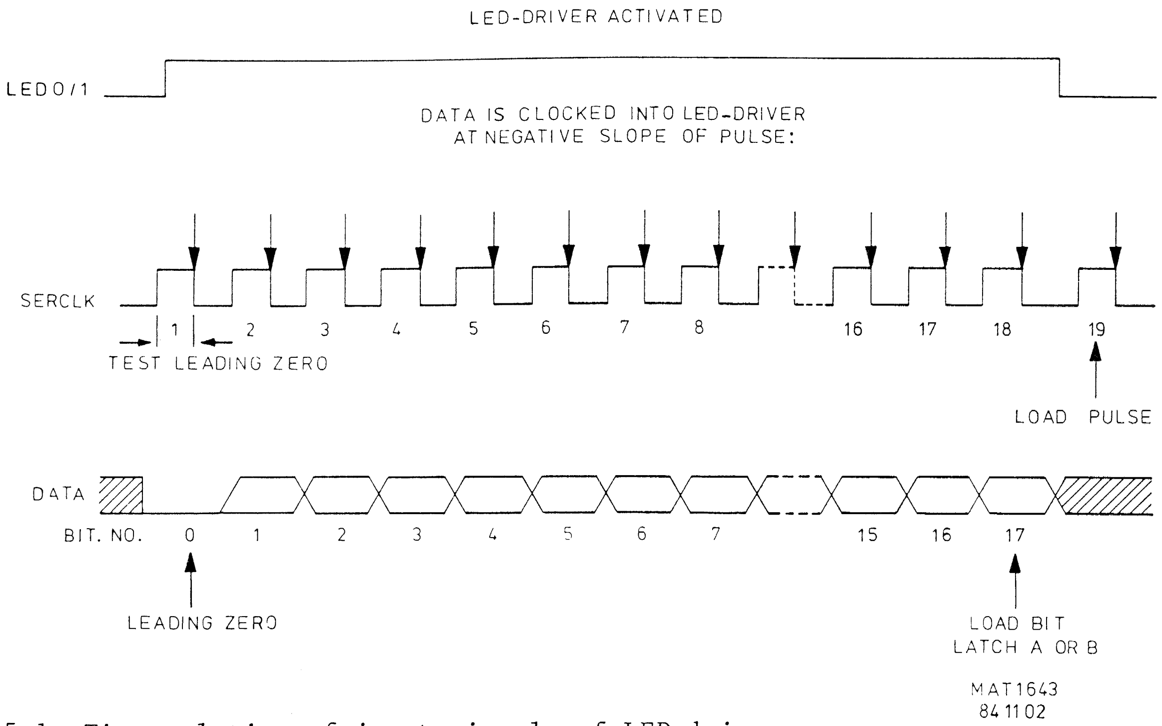


Fig.5.1. Time relation of input signals of LED drivers

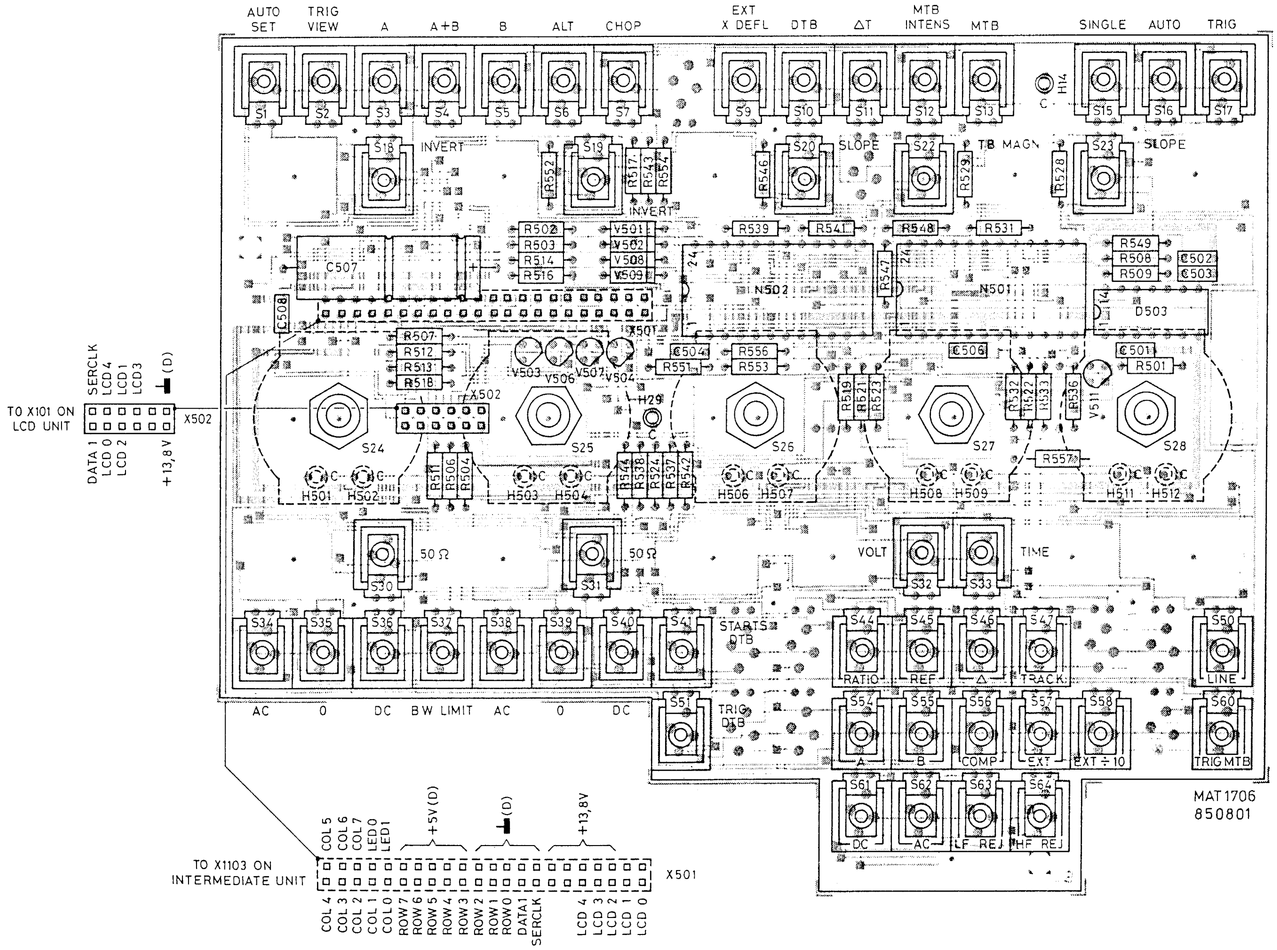
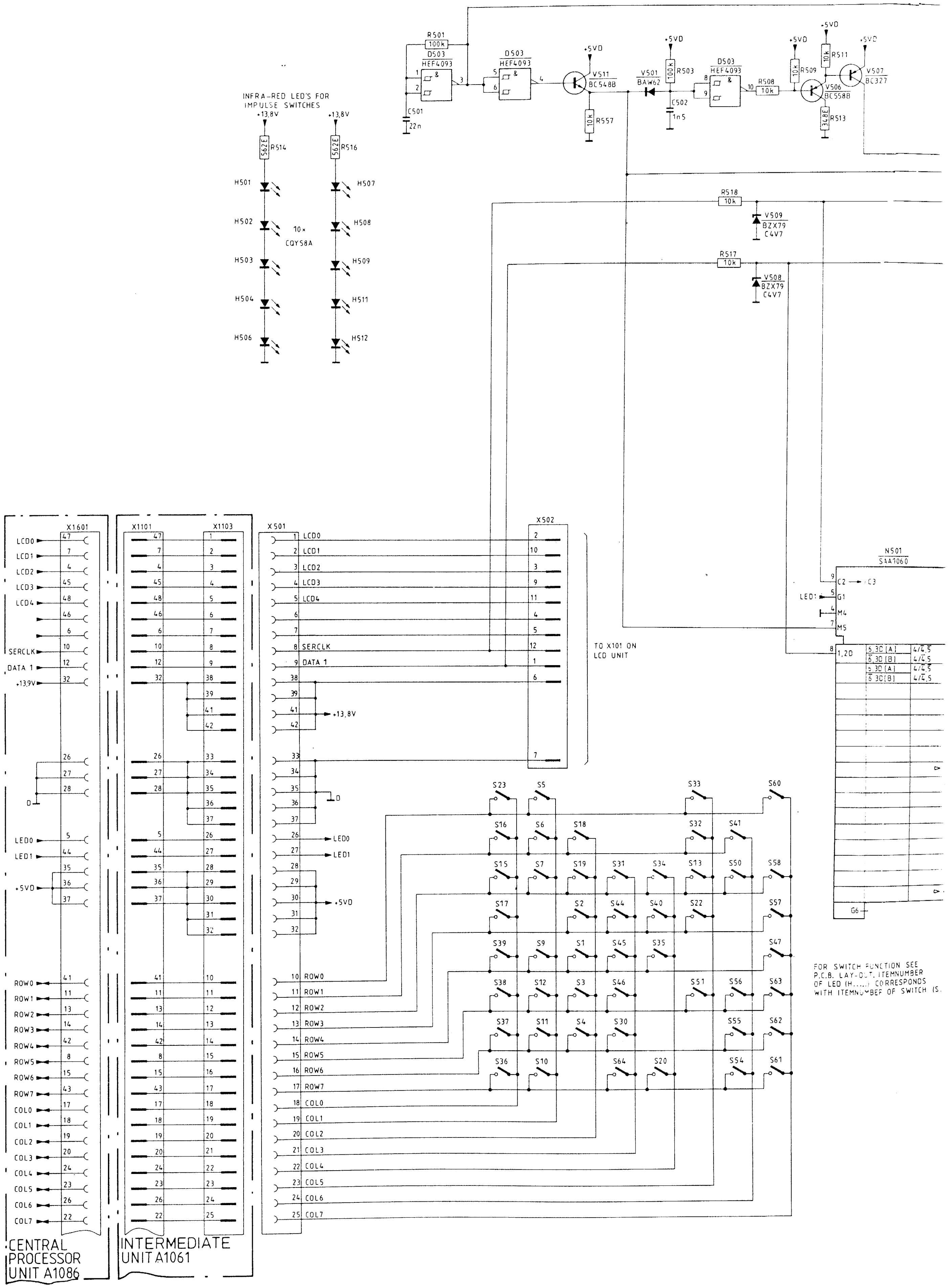
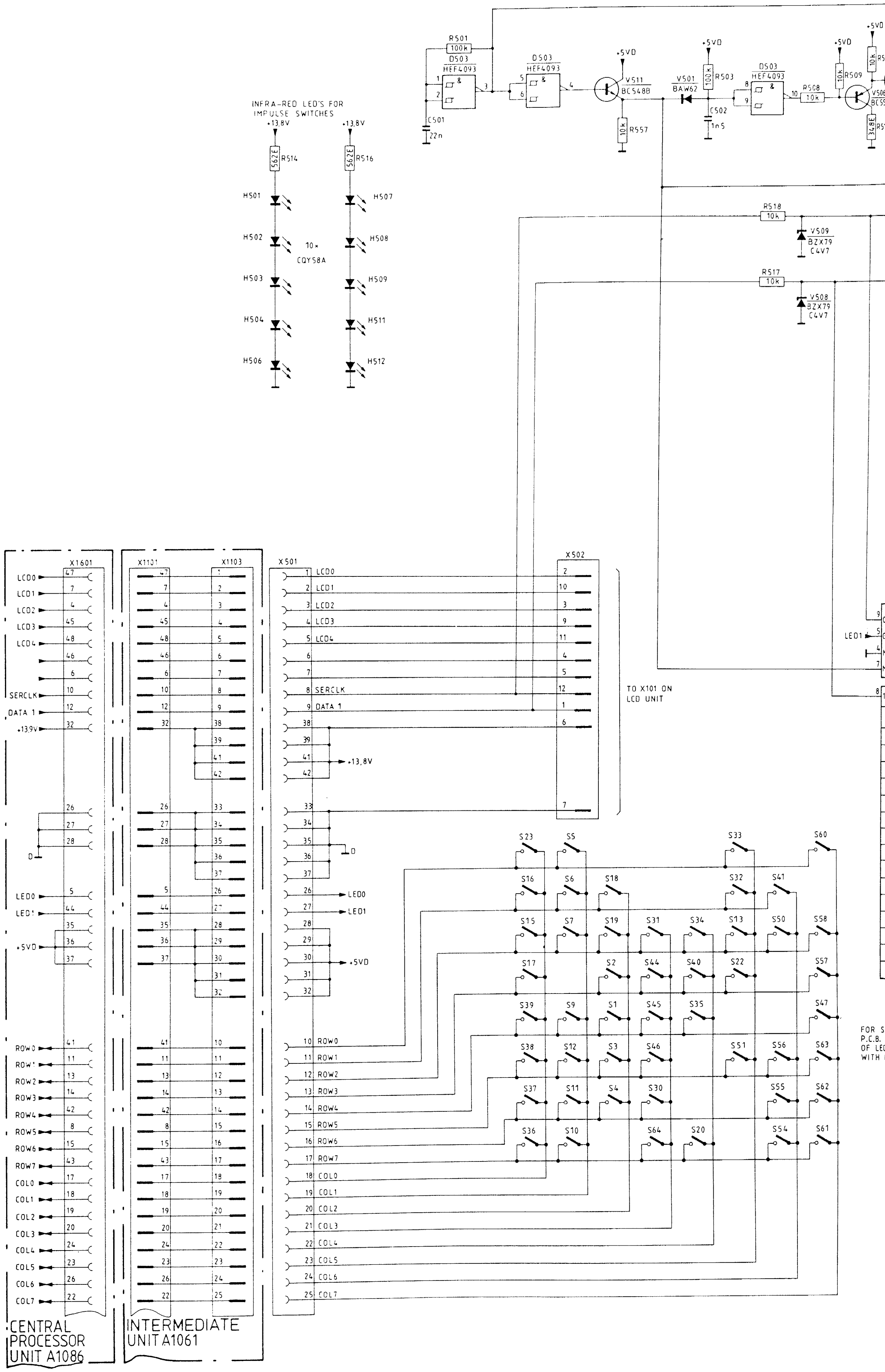
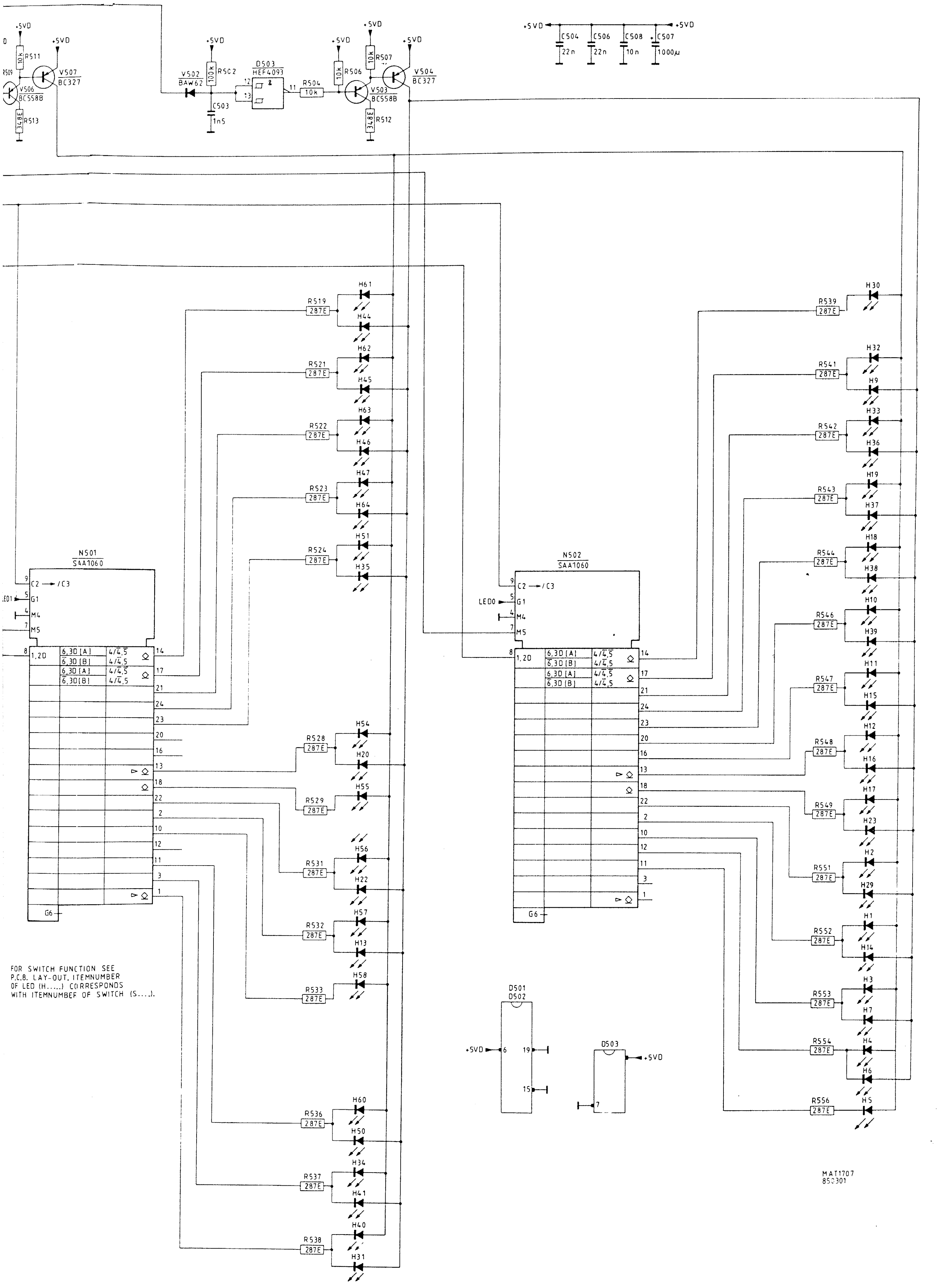


Fig.5.2. Switch unit, p.c.b. lay-out.


INFRA-RED LED'S FOR IMPULSE SWITCHES
+13,8V
R514
R516
562E
H501
H502
H503
H504
H506
H507
H508
H509
H511
H512
10× CQY58A
R501 100k
D503 HEF4093
C501 22n
V511 BC548B
R557 10k
+5VD
V501 BAW62
R503 100k
C502 1n5
R508 10k
R509 10k
R511 10k
R513 348E
V506 BC558B
V507 BC327
R518 10k
V509 BZX79 C4V7
R517 10k
V508 BZX79 C4V7
X1601
X1101
X1103
X501
X502
LCD0
LCD1
LCD2
LCD3
LCD4
SERCLK
DATA 1
+13,9V
+13,8V
LED0
LED1
+5VD
ROW0
ROW1
ROW2
ROW3
ROW4
ROW5
ROW6
ROW7
COL0
COL1
COL2
COL3
COL4
COL5
COL6
COL7
TO X101 ON LCD UNIT
N501 SAA1060
C2
C3
G1
M4
M5
1,20
G6
CENTRAL PROCESSOR UNIT A1086
INTERMEDIATE UNIT A1061
FOR SWITCH FUNCTION SEE P.C.B. LAY-OUT. ITEMNUMBER OF LED (H.....) CORRESPONDS WITH ITEMNUMBER OF SWITCH (S.


INFRA-RED LED'S FOR IMPULSE SWITCHES
10× CQY58A
R501 100k
D503 HEF4093
V511 BC548B
V501 BAW62
C501 22n
C502 1n5
R557
R503
R508 10k
R509
R518 10k
R517 10k
V509 BZX79 C4V7
V508 BZX79 C4V7
X1601
X1101
X1103
X501
X502
TO X101 ON LCD UNIT
LCD0
LCD1
LCD2
LCD3
LCD4
SERCLK
DATA 1
+13,8V
+5VD
LED0
LED1
ROW0
ROW1
ROW2
ROW3
ROW4
ROW5
ROW6
ROW7
COL0
COL1
COL2
COL3
COL4
COL5
COL6
COL7
CENTRAL PROCESSOR UNIT A1086
INTERMEDIATE UNIT A1061



FOR SWITCH FUNCTION SEE
P.C.B. LAY-OUT. ITEMNUMBER
OF LED (H.....) CORRESPONDS
WITH ITEMNUMBER OF SWITCH (S.....).

MAT1707
850301

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

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

5.1.4 SEMI CONDUCTORS

H 0501	DIODE	CQY58A-II	PEL	5322 130 32158
H 0502	DIODE	CQY58A-II	PEL	5322 130 32158
H 0503	DIODE	CQY58A-II	PEL	5322 130 32158
H 0504	DIODE	CQY58A-II	PEL	5322 130 32158
H 0506	DIODE	CQY58A-II	PEL	5322 130 32158
H 0507	DIODE	CQY58A-II	PEL	5322 130 32158
H 0508	DIODE	CQY58A-II	PEL	5322 130 32158
H 0509	DIODE	CQY58A-II	PEL	5322 130 32158
H 0511	DIODE	CQY58A-II	PEL	5322 130 32158
H 0512	DIODE	CQY58A-II	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

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.

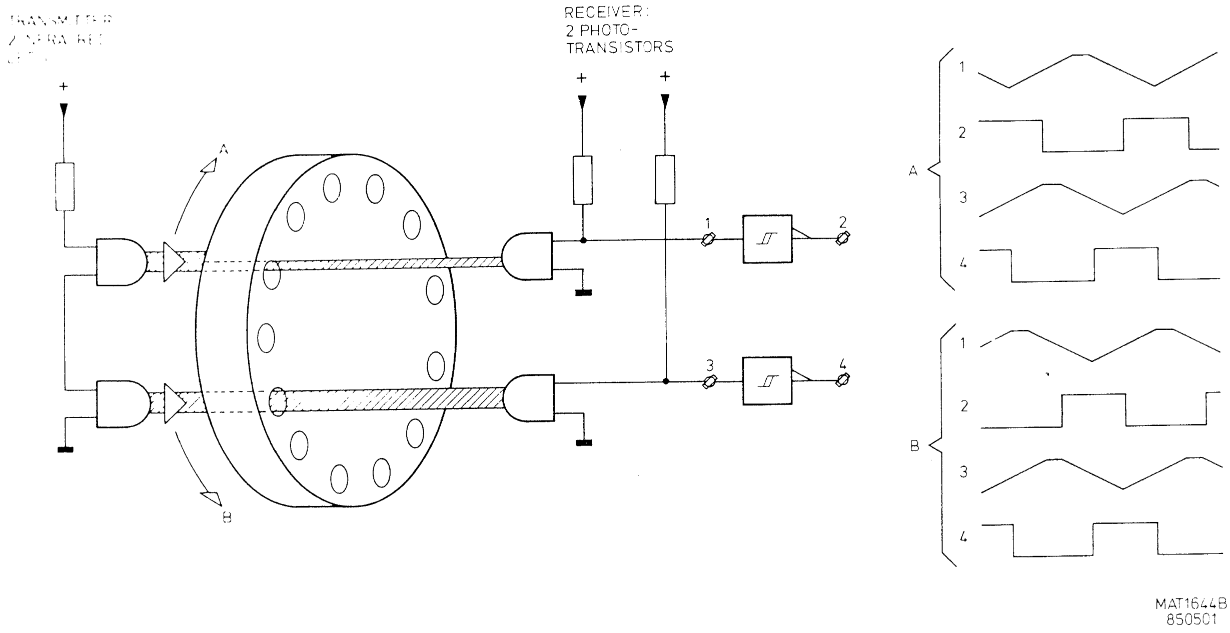


Fig.6.1. Mechanical lay-out of an optical switch.

6

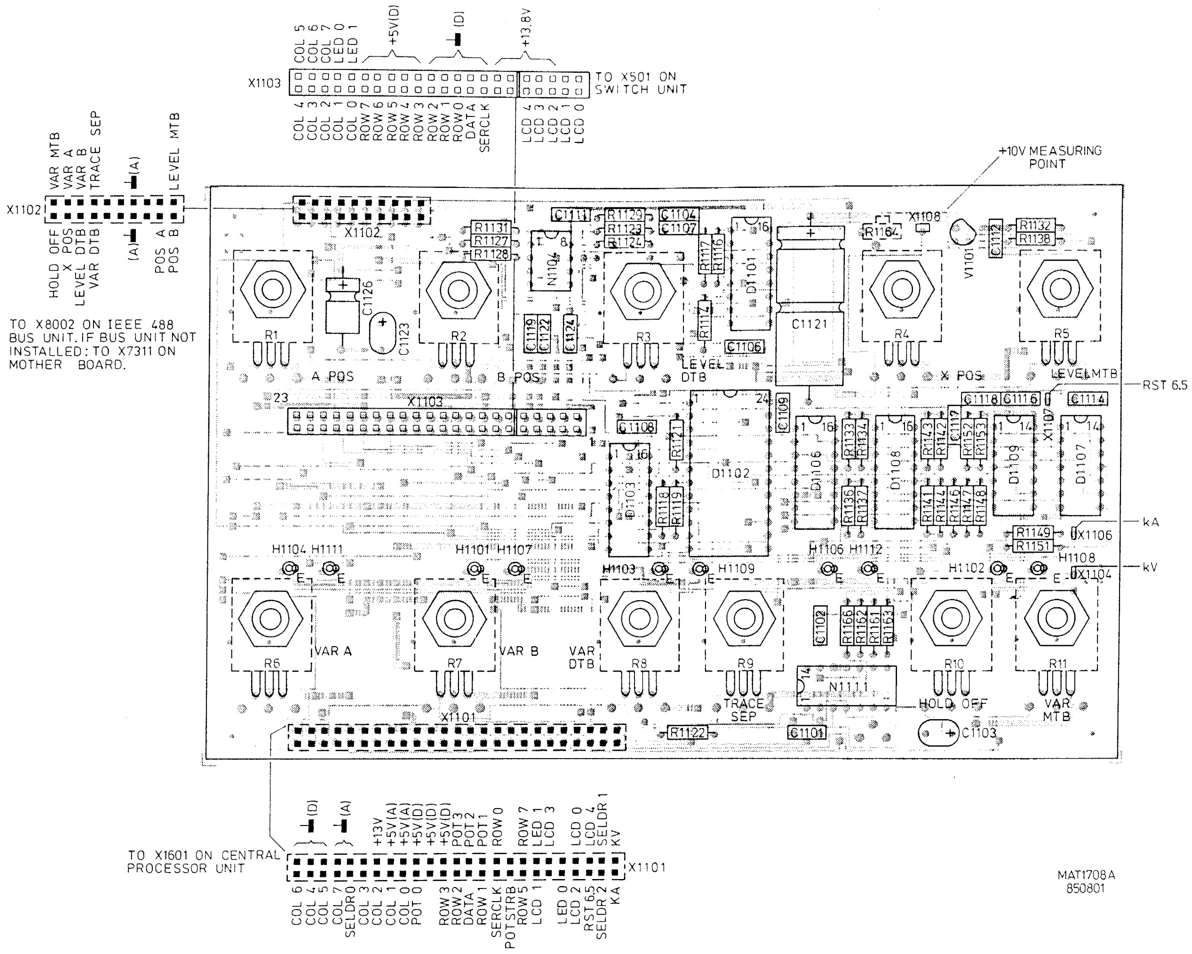
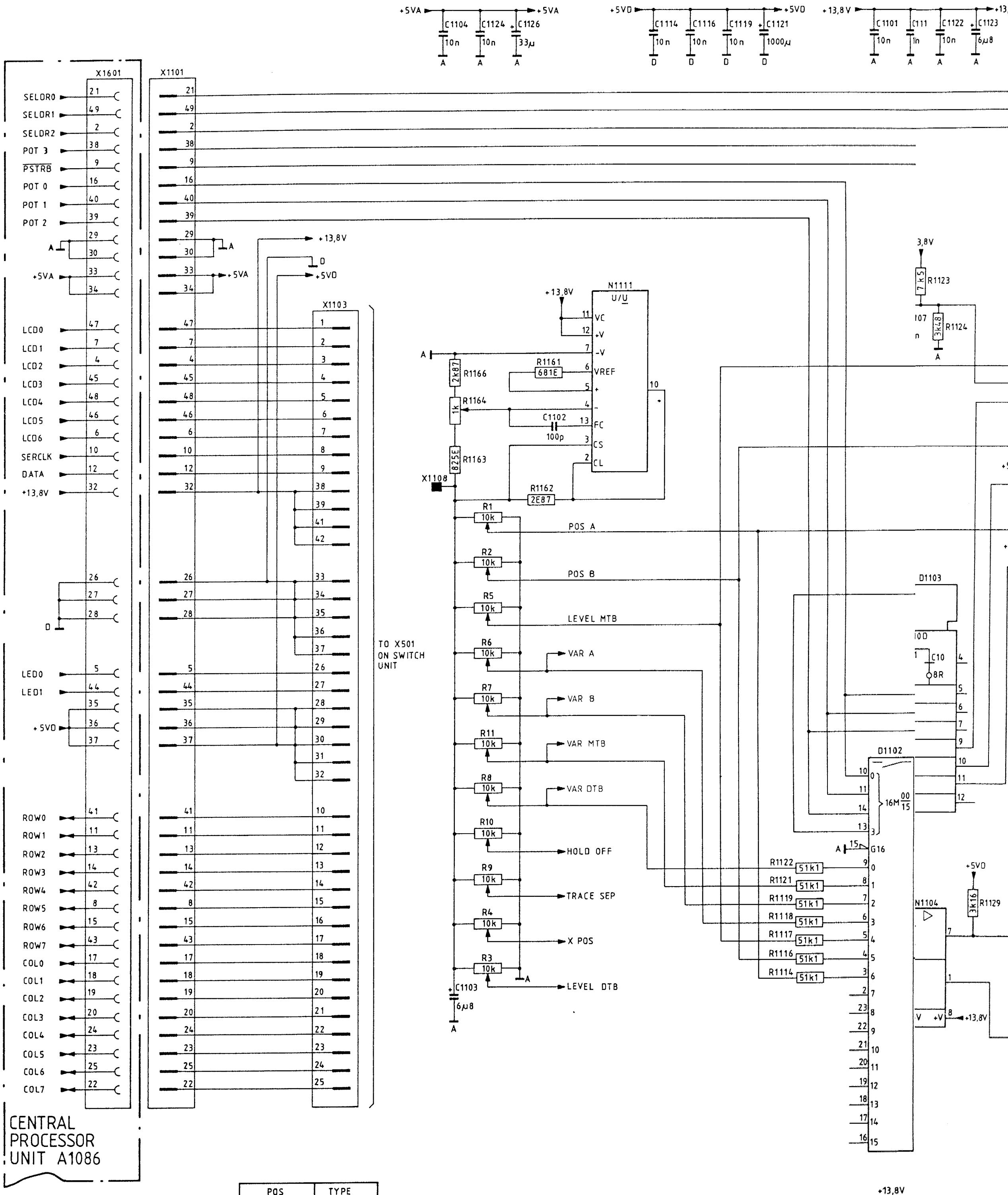
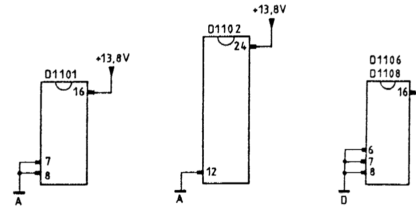


Fig.6.2. Intermediate unit, p.c.b. lay-out.

6-5



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



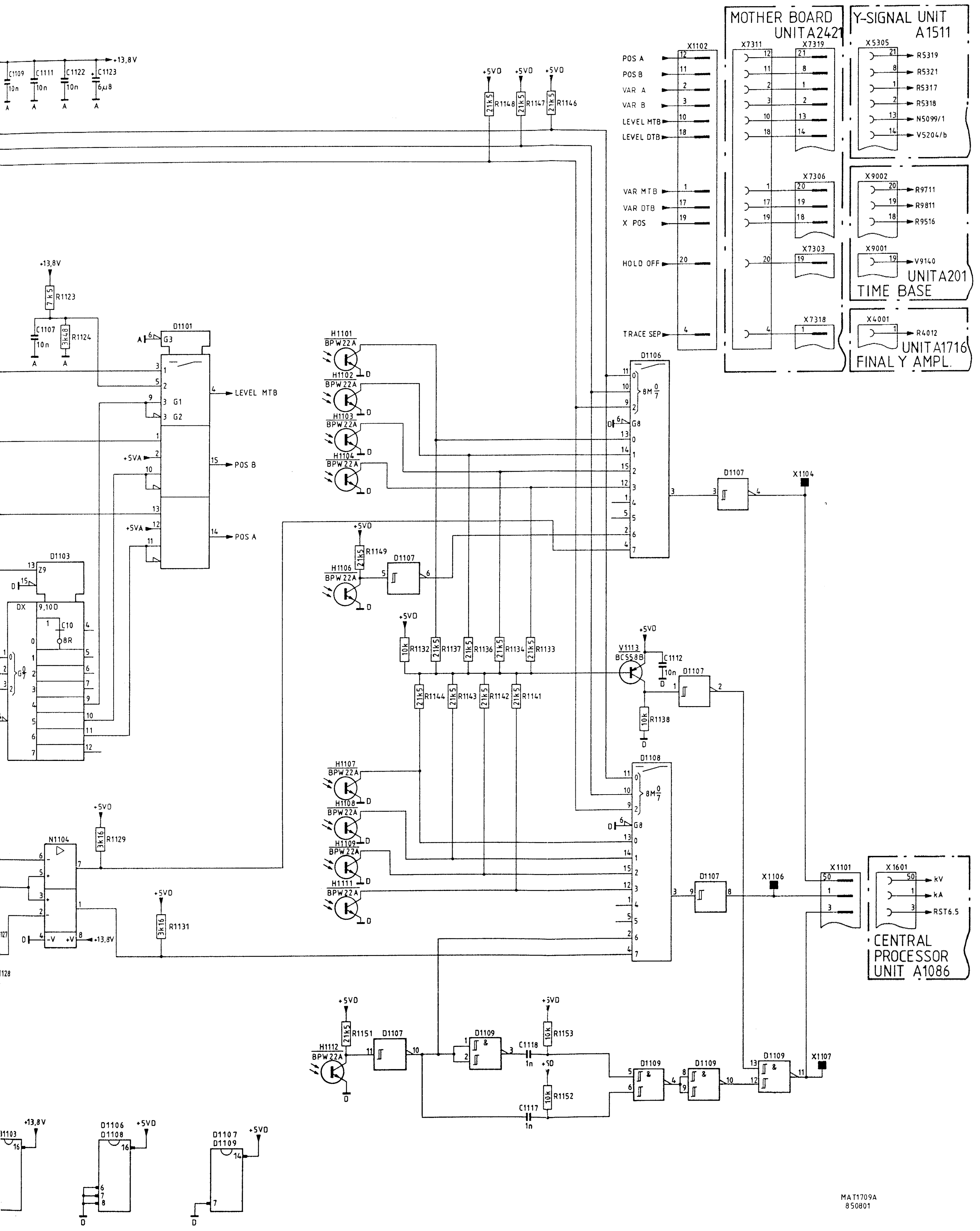


Fig.6.3. Intermediate unit, circuit diagram.

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 1111	INTEGR.CIRCUIT	UA723CN	SIG	5322 209 85889

6

6.1.3 RESISTORS

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%	3K48	5322 116 55367
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

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 fdr CTU/IEEE communication via latch D1617.
- CEROM-, a chip enable signal for the program memory on CPU2.
- Enable signal applied to D1613/15 for decoding address lines A11, A12 to give a further four output ambinations 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

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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.
- TBSO-,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 (optionally, 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.

7

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 reqularly 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 earhts to all the columns; the column pull-up resistors are provided by resistdr 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 earths 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.

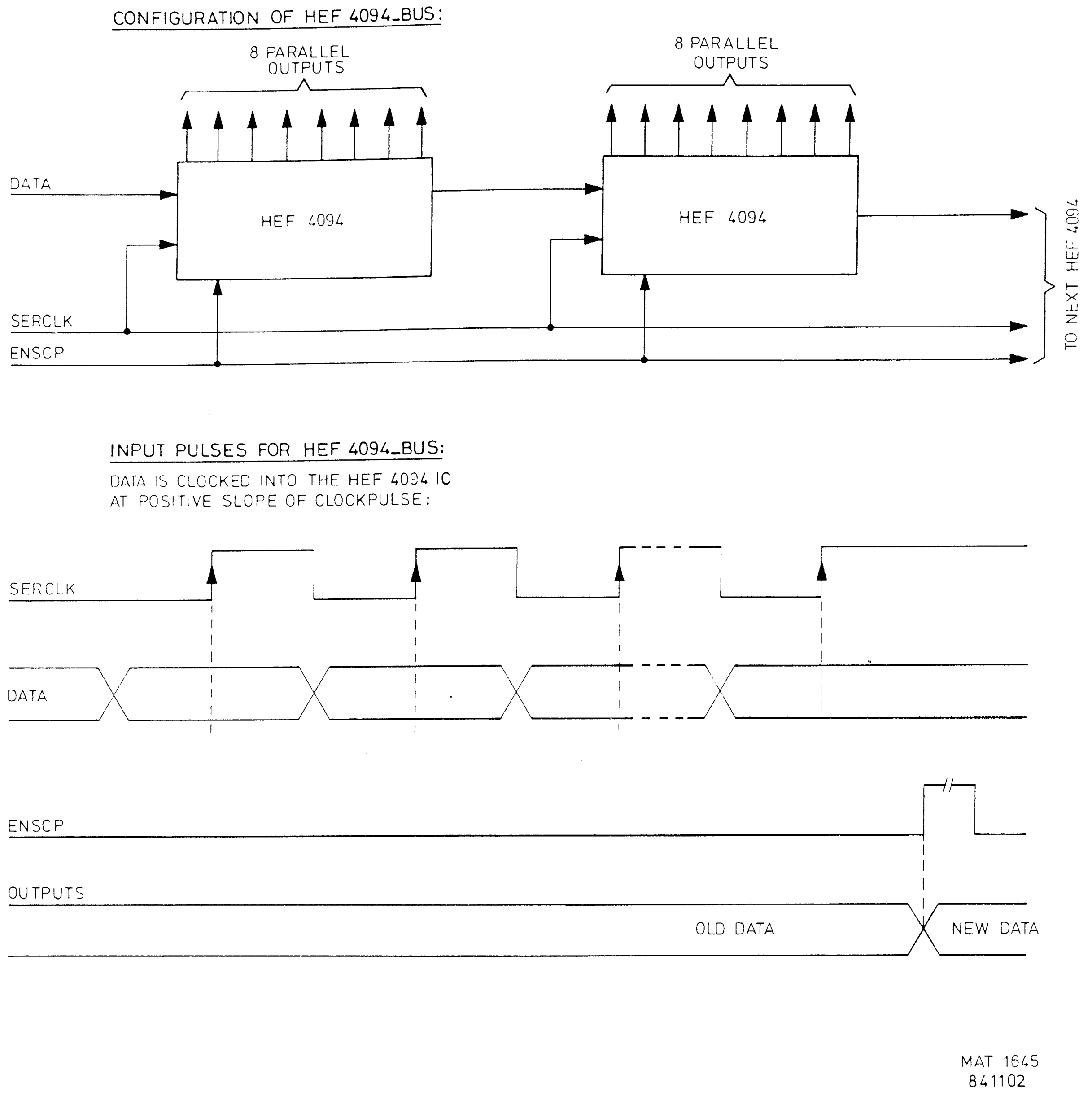

Fig.7.1. HEF 4094-bus: configuration and input pulses.

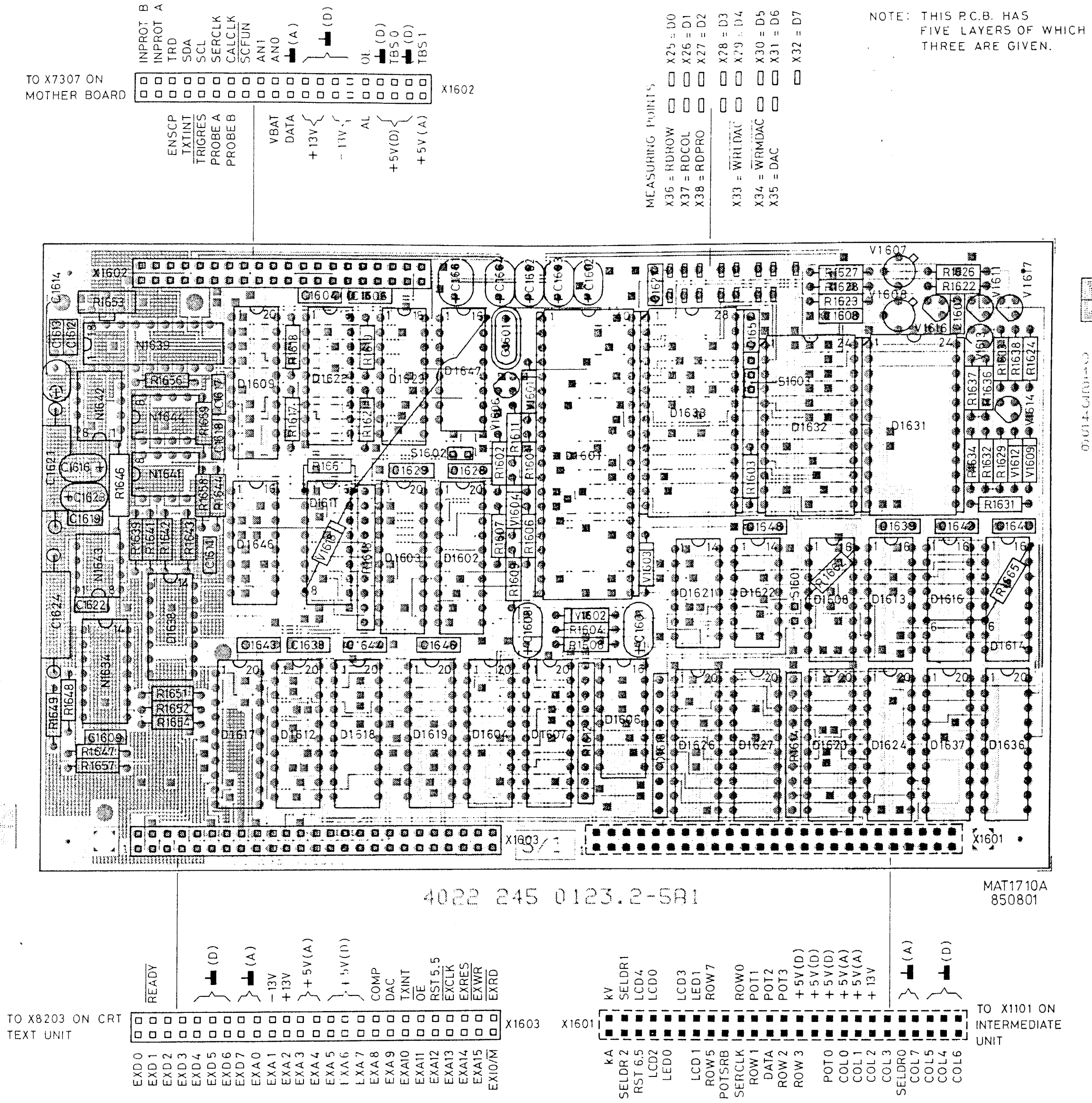

Fig.7.2. Central processor unit, p.c.b. lay-out.

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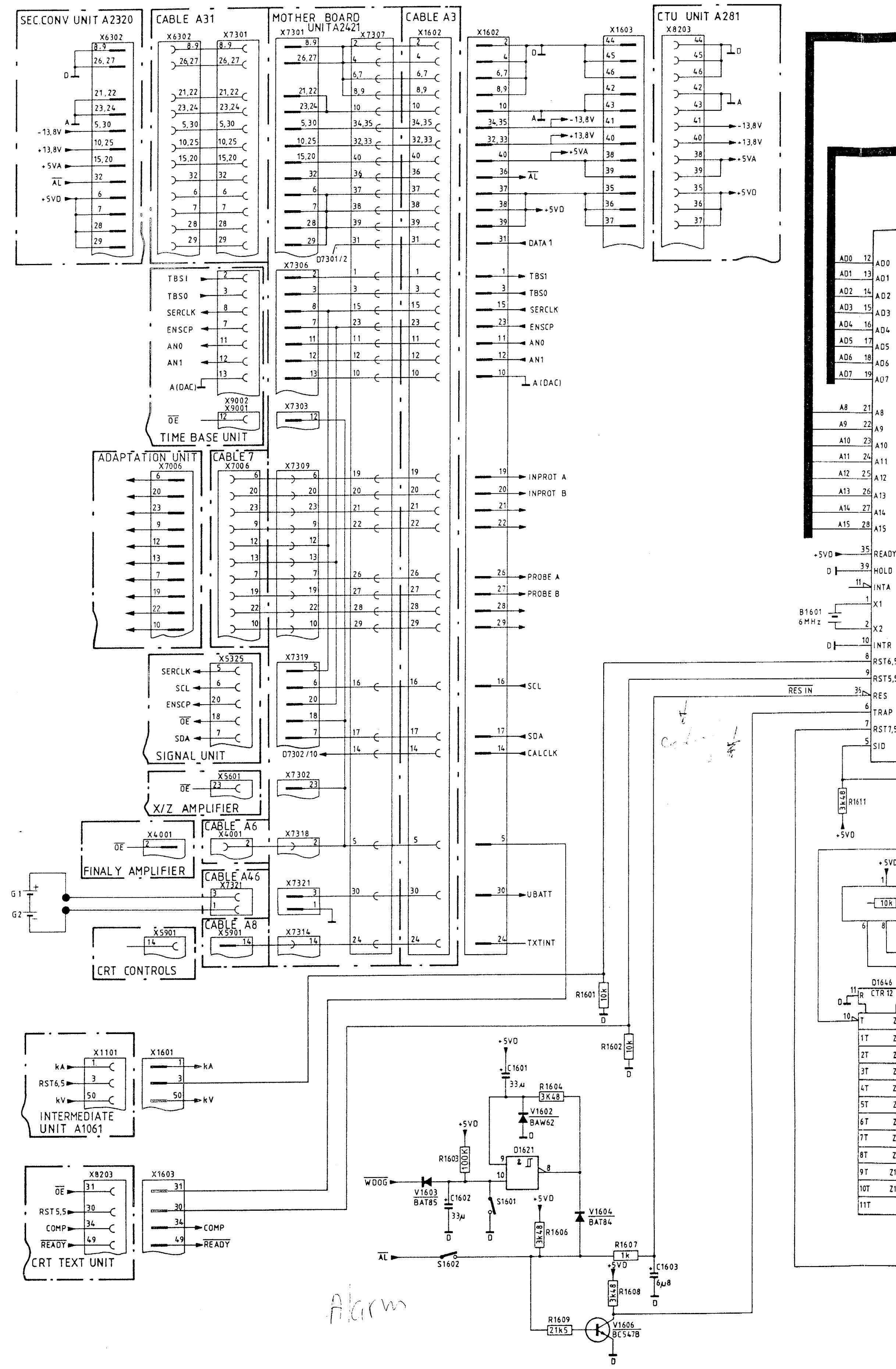

SEC.CONV UNIT A2320
CABLE A31
MOTHER BOARD UNIT A2421
CABLE A3
CTU UNIT A281
TIME BASE UNIT
ADAPTATION UNIT
CABLE 7
SIGNAL UNIT
X/Z AMPLIFIER
FINALY AMPLIFIER
CABLE A6
CABLE A46
CABLE A8
CRT CONTROLS
INTERMEDIATE UNIT A1061
CRT TEXT UNIT
DATA 1
TBS1
TBS0
SERCLK
ENSCP
AN0
AN1
A(DAC)
INPROT A
INPROT B
PROBE A
PROBE B
SCL
SDA
CALCLK
UBATT
TXTINT
WDOG
COMP
READY
RES IN
Alarm

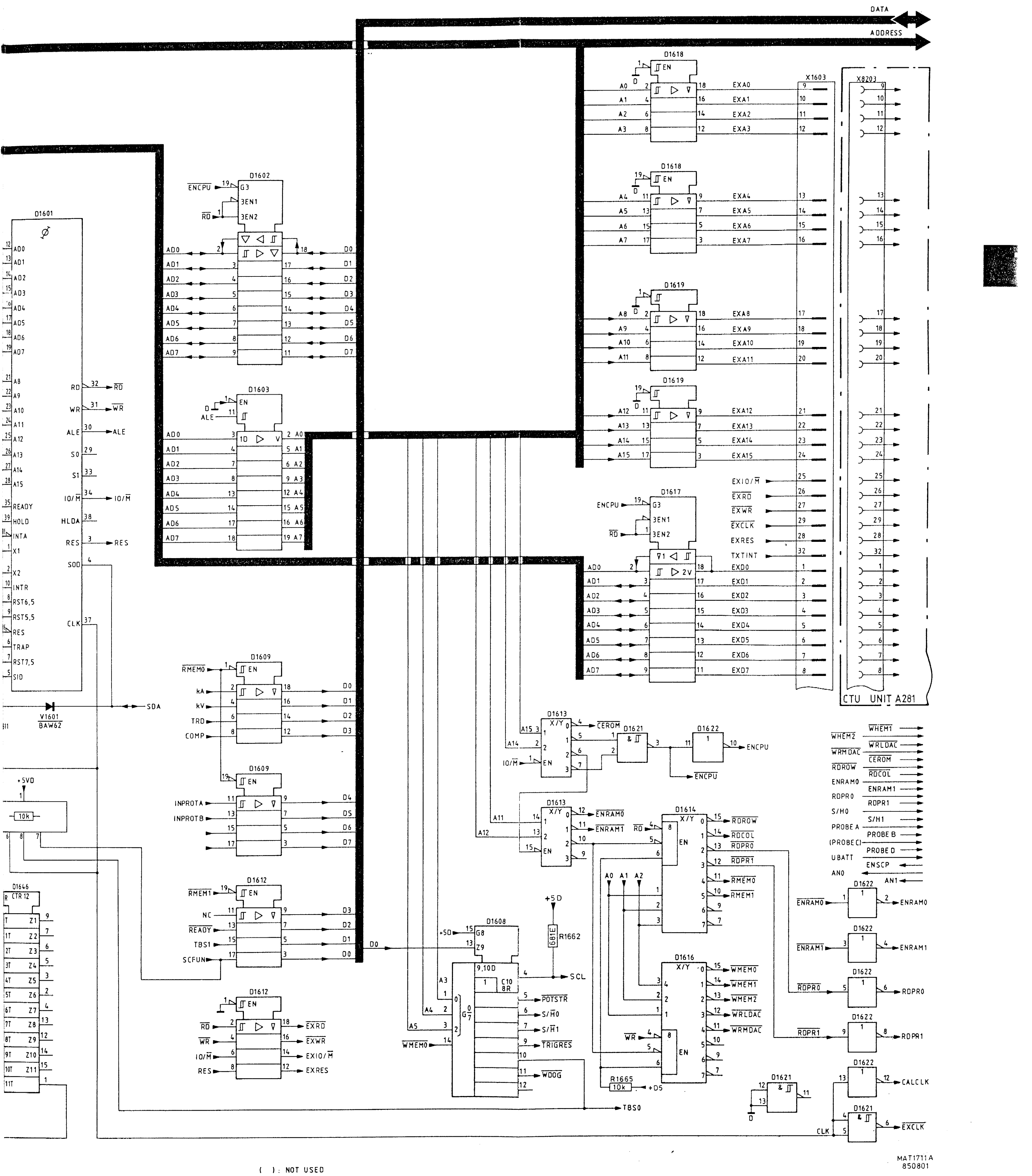
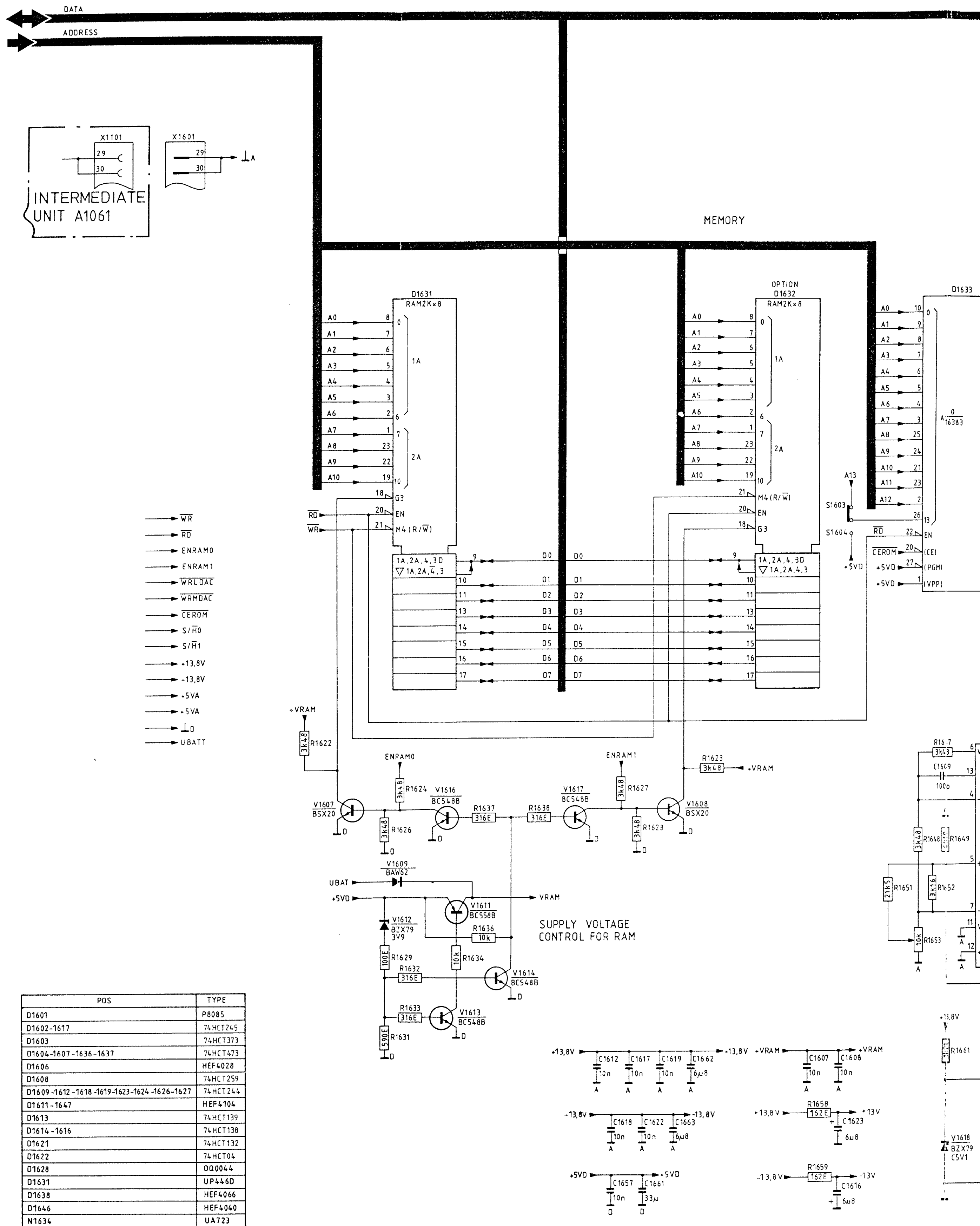


Fig.7.3. Central processor unit, circuit diagram 1.



POS	TYPE
D1601	P8085
D1602-1617	74HCT245
D1603	74HCT373
D1604-1607-1636-1637	74HCT473
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	0Q0044
D1631	UP446D
D1638	HEF4066
D1646	HEF4040
N1634	UA723
N1639	AD7541
N1641-1644	UA741
N1642-1643	NE5537
D1633	D27128

Fig.7.4. Central processor unit, circuit diagram 2.

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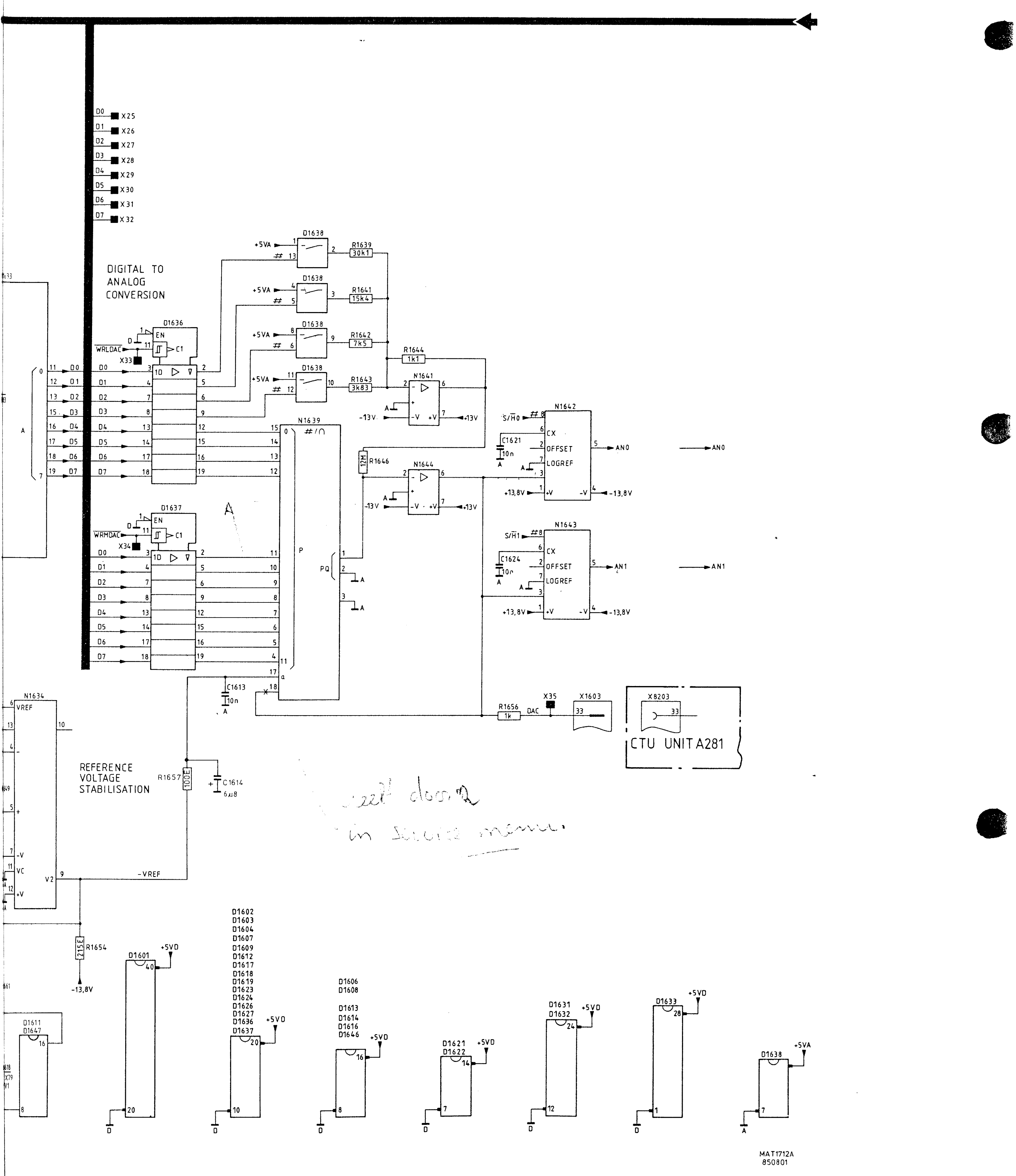
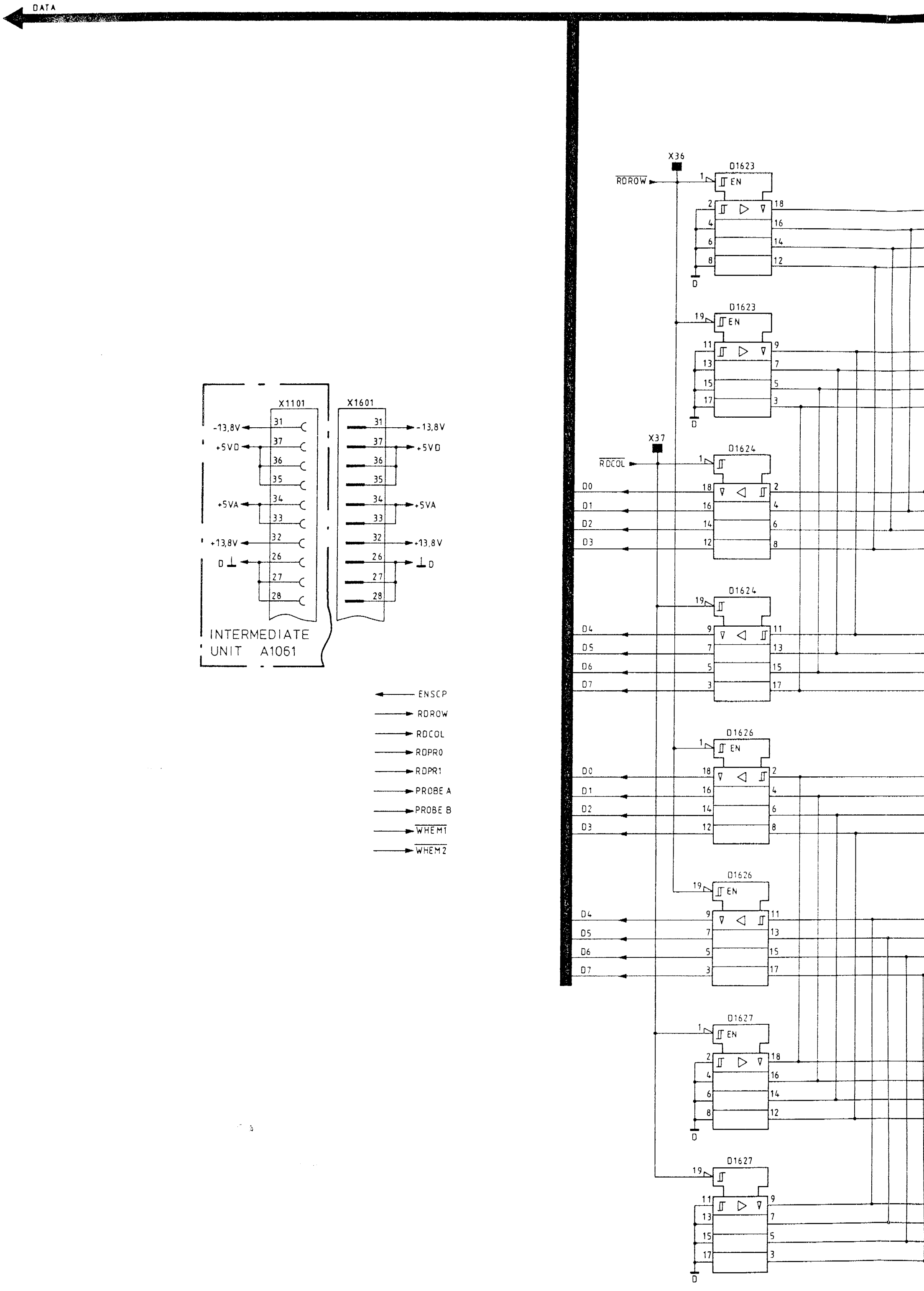

DIGITAL TO
ANALOG
CONVERSION
REFERENCE
VOLTAGE
STABILISATION
D1636
D1637
D1638
N1639
N1641
N1642
N1643
N1644
N1634
R1639 30k1
R1641 15k4
R1642 7k5
R1643 3k83
R1644 1k1
R1646 12M
R1656 1k
R1657 100E
R1654 215E
C1613 10n
C1614 6µ8
C1621 10n
C1624 10n
WRLDAC
WRMDAC
X33
X34
X35
X1603
X8203
CTU UNIT A281
DAC
-VREF
AN0
AN1
S/H0
S/H1
CX
OFFSET
LOGREF
+5VA
+5VD
-13V
+13V
+13,8V
-13,8V
X25
X26
X27
X28
X29
X30
X31
X32
D1601
D1602
D1603
D1604
D1607
D1609
D1612
D1617
D1618
D1619
D1623
D1624
D1626
D1627
D1636
D1637
D1606
D1608
D1613
D1614
D1616
D1646
D1611
D1647
D1621
D1622
D1631
D1632
D1633
D1638
MAT1712A
850801


DATA
X36
RDROW
D1623
EN
X37
RDCOL
D1624
D1626
D1627
D0
D1
D2
D3
D4
D5
D6
D7
X1101
X1601
-13,8V
+5VD
+5VA
+13,8V
INTERMEDIATE UNIT A1061
ENSCP
RDROW
RDCOL
RDPR0
RDPR1
PROBE A
PROBE B
WHEM1
WHEM2

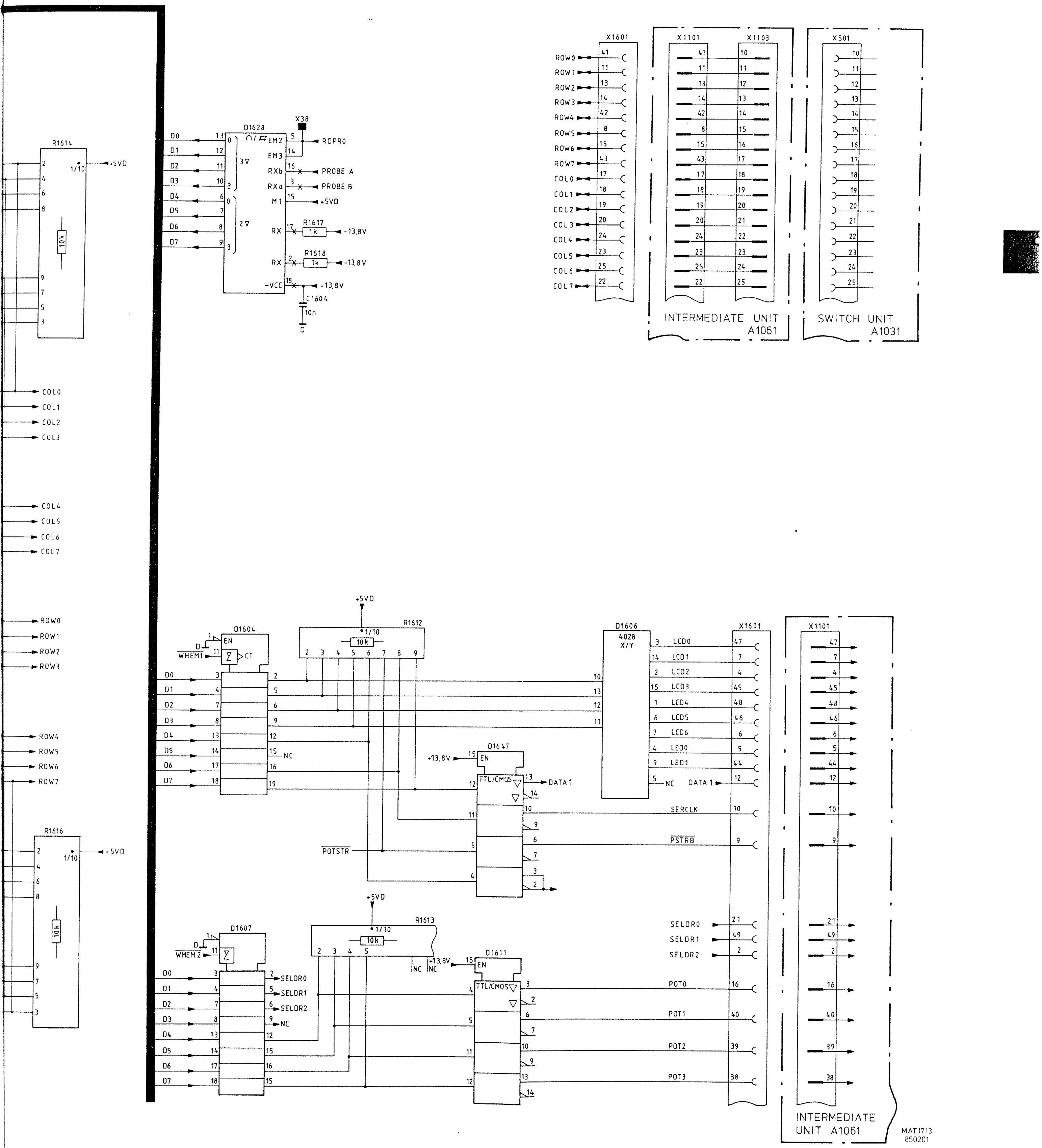


Fig.7.5. Central processor unit, circuit diagram 3.

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

7.5.1 CAPACITORS

POSNR	DESCRIPTION				ORDERING CODE
C 1601	CAP.SOLID ALU.	10V	20%	33UF	4822 124 20945
C 1602	CAP.SOLID ALU.	10V	20%	33UF	4322 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	4622 122 31315
C 1611	CAP. CERAMIC		-20+50%	10NF	4822 122 31414
C 3612	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	4322 122 31414
C 1619	CAP. CERAMIC		-20+50%	10NF	4822 122 31114
C 1621	CAP. FOIL	63V	1%	10NF	5322 121 54154
C 1622	CAP. CERAMIC		-20+50%	10NF	4822 122 31414

7.5.2 INTEGEUTED 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 2C9 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	P174HCT132P	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 1633	I.C. ROM	D27128-3-PROG		5322 209 50542
D 1636	INTEGR.CIRCUIT	PC74HCT374P	PEL	5322 209 11119
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 2U9 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	4322 116 51253
R 1603	RES.METAL FILM	MR25	1%100K	4822 116 51268
R 1604	RES.METAL FILM	MR25	1% 3K48	5322 116 55367
R 1606	RES.METAL FILM	MR25	1% 3K48	5322 116 55357
R 1607	RES.METAL FILM	MR25	1% 1K	4822 116 51235
R 1608	RES.METAL FILM	MR25	1% 3K48	5322 116 55357
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 90373
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 1613	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 1529	RES.METAL FILM	MR25	1% 100E	5322 116 55549
R 1631	RES.METAL FILM	MR25	1% 590E	5322 116 53561
R 1632	RES.METAL FILM	MR25	1% 316E	5322 116 56511
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 1635	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 1643	RES.METAL FILM	MR25	1% 3K48	5322 116 55367
R 1649	RES.METAL FILM	MR25	1%6K19	5322 116 55426
R 1651	RES.METAL FJLM	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 1559	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

7.5.4 SEMI CONDUCTORS

V 1601	DIODE	BAW62	PEL	4822 130 30613
V 1602	DIODE	BAW62	PEL	4822 130 30613
V 1603	DIODE	BAT85	PEL	4522 130 31983

V 1604	DIODE	RAT85	PEL	4822 130 31963
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 30513
V 1611	TRANSISTOR	BC558B	PEL	4822 130 44197
V 1612	DIODE	BZX79-C3V9	PEL	4822 130 31981
V 1613	TRANSISTOR	BC548B	PEL	4822 130 40337
V 1614	TRANSISTO!?	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

7.5.5 MISCELLANEOUS

S 1501	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	4322 242 70392

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.
An 8.2 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.

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.
An 8.2 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 t restart the Y sweep.

The text X sweep
The DSPL- signal also makes D8217-2 output high, which starts the 8.2 MHz oscillator D8218. 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 120 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 24 "characters lines" (i.e. 2048 x 24 = 49152 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 24 "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 RAY 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 8.2 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 o'f the signal is cut-off and the light intensity is somewhat reduced.

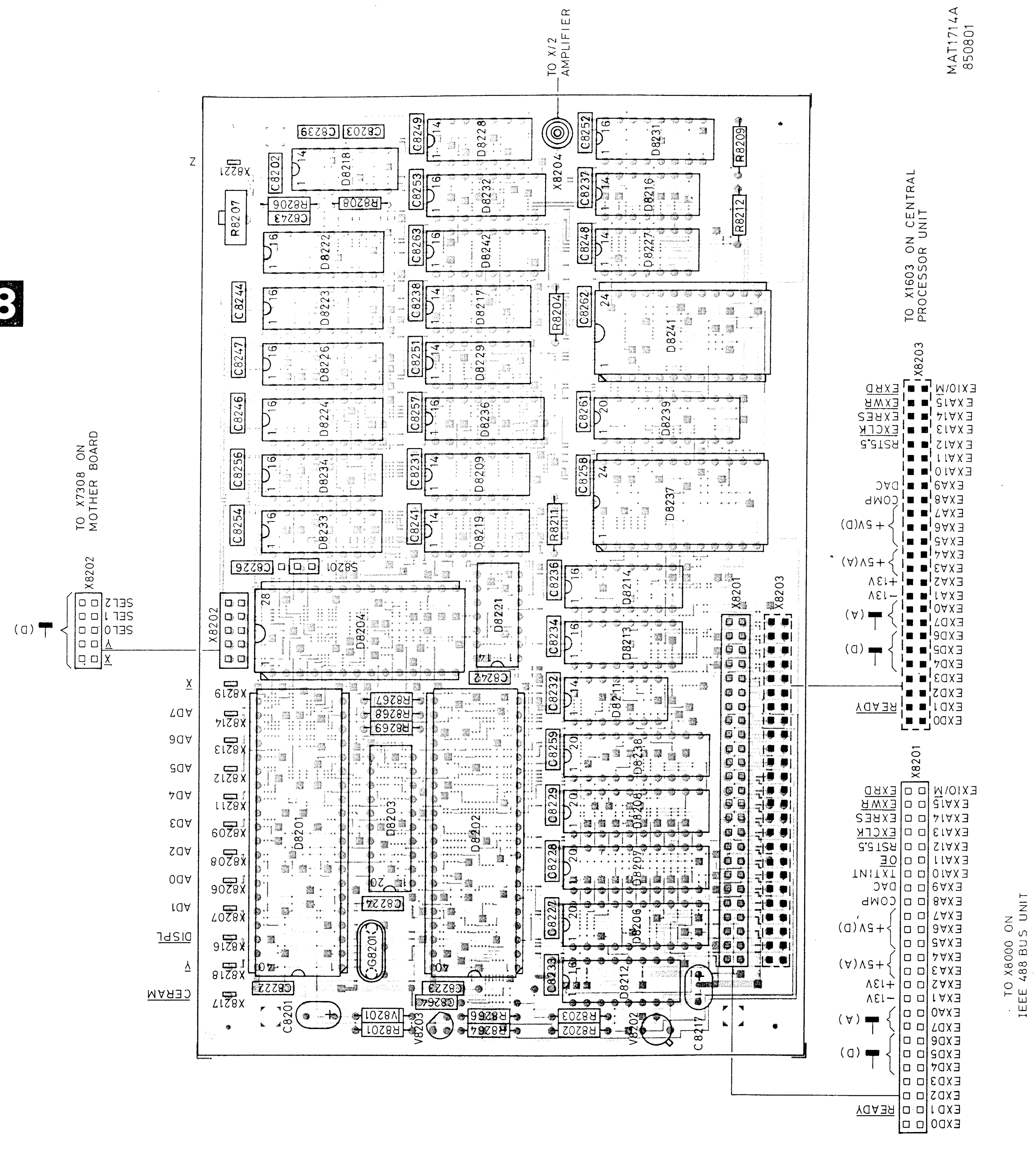


Fig.8.1. CRT text unit, p.c.b. lay-out.

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	4322 122 31414
C 8224	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8226	CAP.CERAMIC		-20+50%	10NF	4822 12% 31414
C 8227	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8228	CAP.CERAMIC		-20+50%	10NF	4822 122 51414
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 If2 31414
C 8252	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8253	CAP.CERAMIC		-20+50%	10NF	4822 122 31414
C 8254	CAP.CERAMIC		-20+50%	10NF	4322 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 12.2 31414
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

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 8204	I.C. ROM	2764A-4-PROG		5322 209 50543
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 2C9 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	fEL	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	FEL	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 6237	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 8241	I.C. ROM	AM2732DC-PROG		5322 209 50544
D 8242	INTEGR.CIRCUIT	PC74HCT166P	FEL	5322 209 11113

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 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	4522 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

8.3.4 SEMI CONDUCTORS

V 3201	DIODE	BAW62	PEL	4822 130 30613
V 8202	TRANSISTOR	BSX20	FEL	4822 130 41705
V 8203	TRANSISTOR	BC548B	PEL	4822 130 40937

8.3.5 MISCELLANEOUS

G8201 Crystal 6000kHz 4822 242 70392

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 64-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 SL4 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.

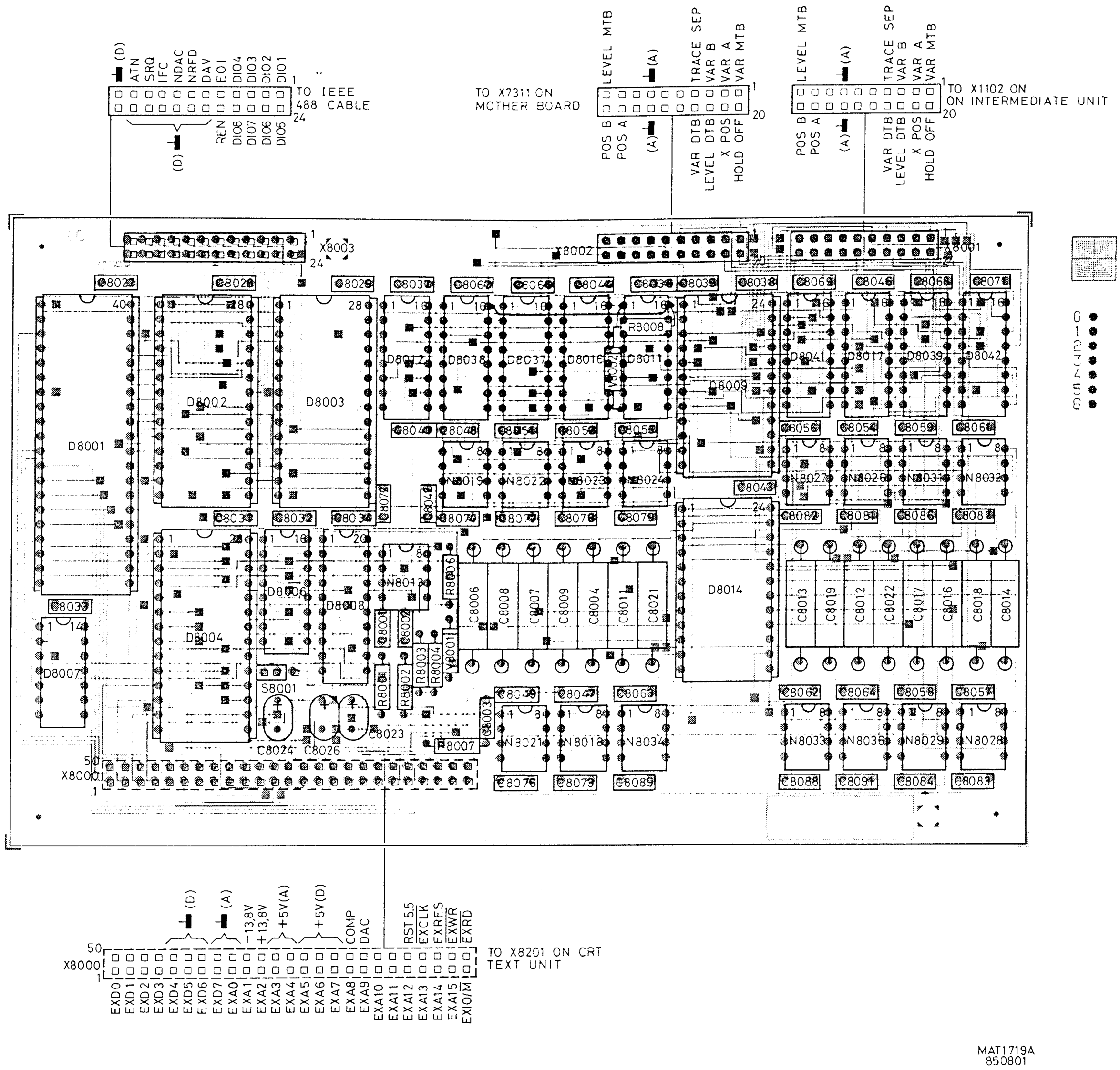
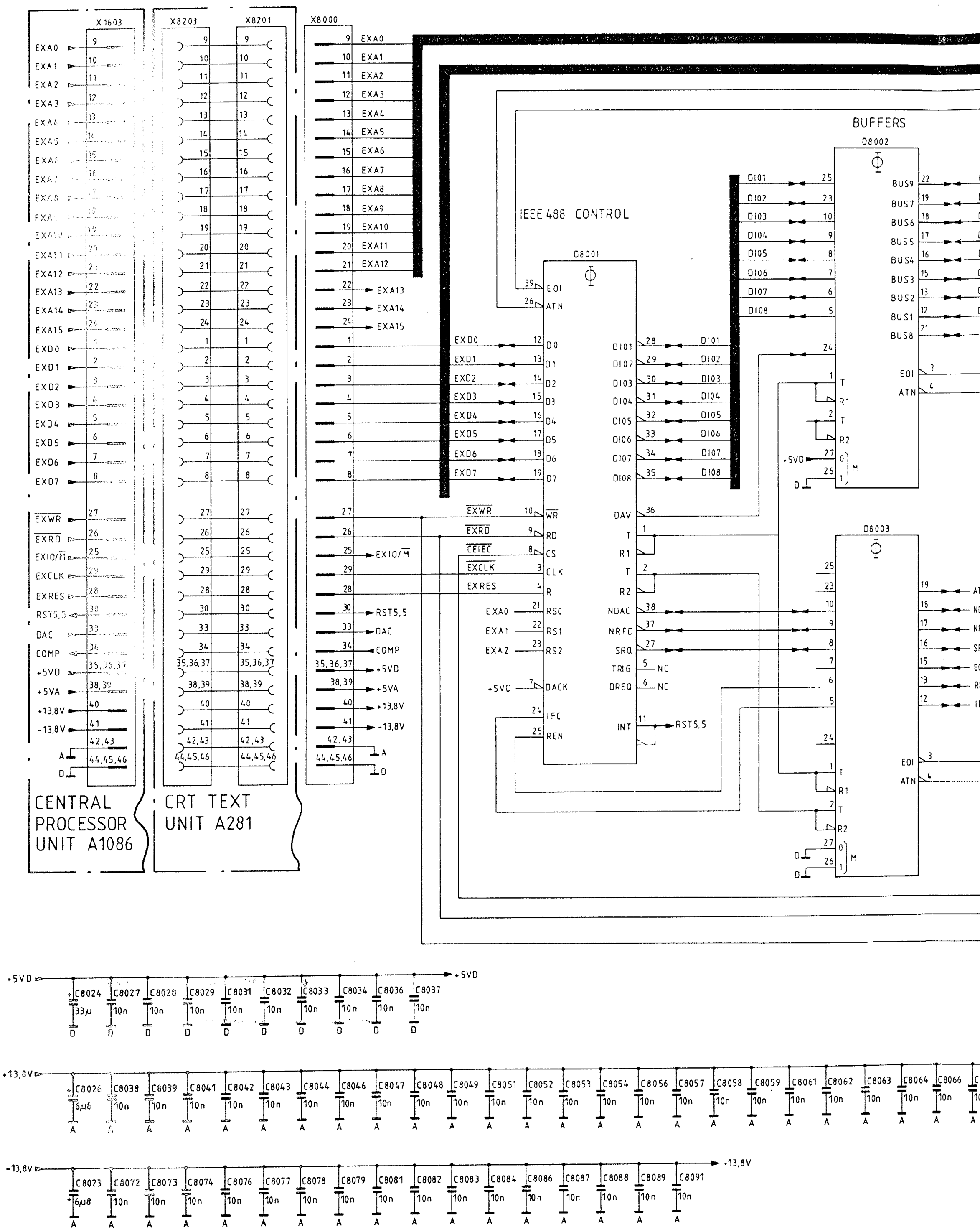


Fig.9.1. IEEE 488 bus unit, p.c.b. lay-out.

9-6-1


X1603
X8203
X8201
X8000
EXA0
EXA1
EXA2
EXA3
EXA4
EXA5
EXA6
EXA7
EXA8
EXA9
EXA10
EXA11
EXA12
EXA13
EXA14
EXA15
EXD0
EXD1
EXD2
EXD3
EXD4
EXD5
EXD6
EXD7
EXWR
EXRD
EXIO/M
EXCLK
EXRES
RST5,5
DAC
COMP
+5VD
+5VA
+13,8V
-13,8V
CEIEC
BUFFERS
D8002
D8001
D8003
IEEE 488 CONTROL
EOI
ATN
DIO1
DIO2
DIO3
DIO4
DIO5
DIO6
DIO7
DIO8
BUS1
BUS2
BUS3
BUS4
BUS5
BUS6
BUS7
BUS8
BUS9
WR
RD
CS
CLK
R
RS0
RS1
RS2
DACK
IFC
REN
DAV
NDAC
NRFD
SRQ
TRIG
DREQ
INT
NC
CENTRAL PROCESSOR UNIT A1086
CRT TEXT UNIT A281
C8024
C8027
C8028
C8029
C8031
C8032
C8033
C8034
C8036
C8037
33µ
10n
C8026
C8038
C8039
C8041
C8042
C8043
C8044
C8046
C8047
C8048
C8049
C8051
C8052
C8053
C8054
C8056
C8057
C8058
C8059
C8061
C8062
C8063
C8064
C8066
6µ8
C8023
C8072
C8073
C8074
C8076
C8077
C8078
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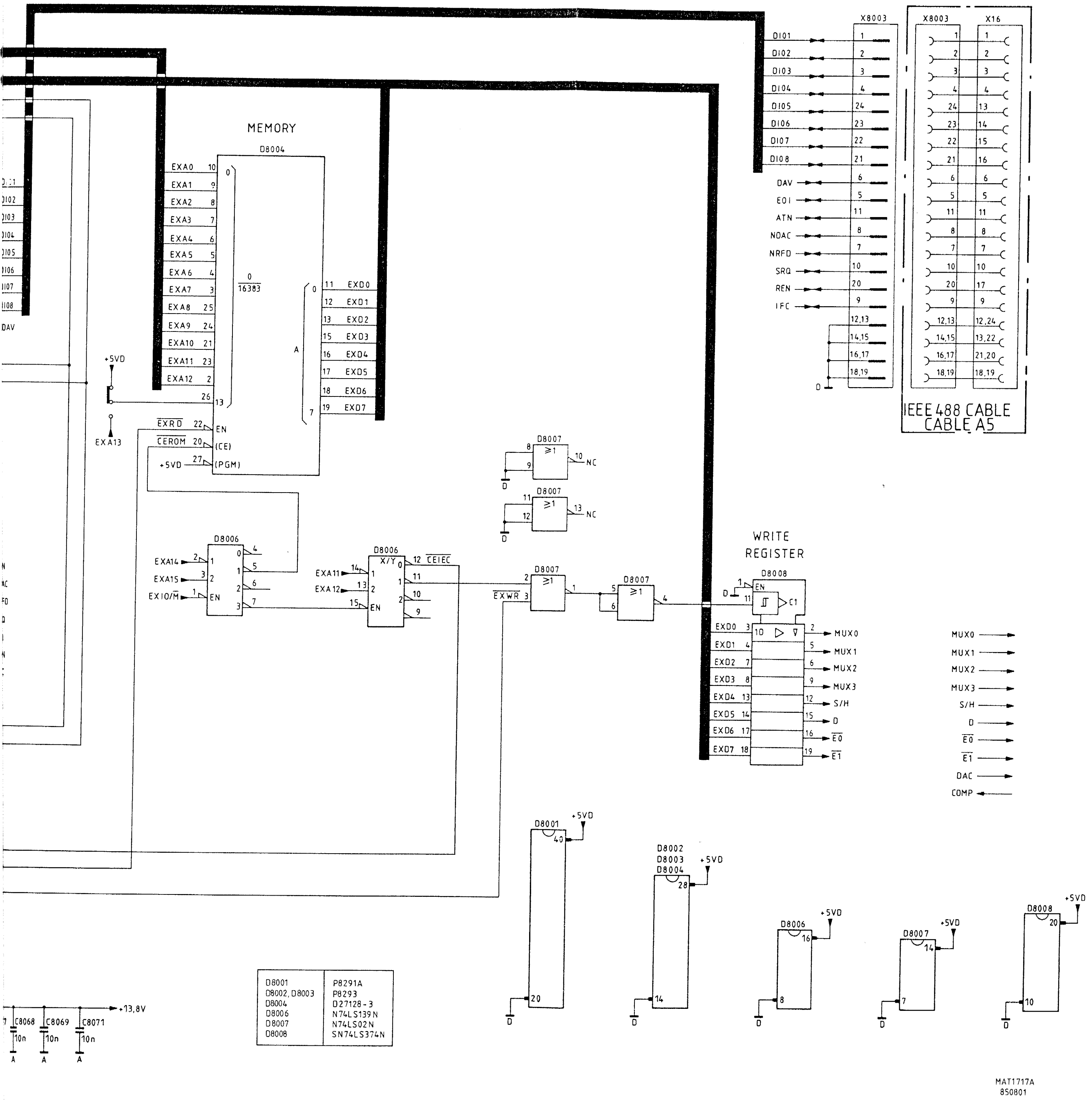
C8081
C8082
C8083
C8084
C8086
C8087
C8088
C8089
C8091



D8001	P8291A
D8002, D8003	P8293
D8004	D27128-3
D8006	N74LS139N
D8007	N74LS02N
D8008	SN74LS374N

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

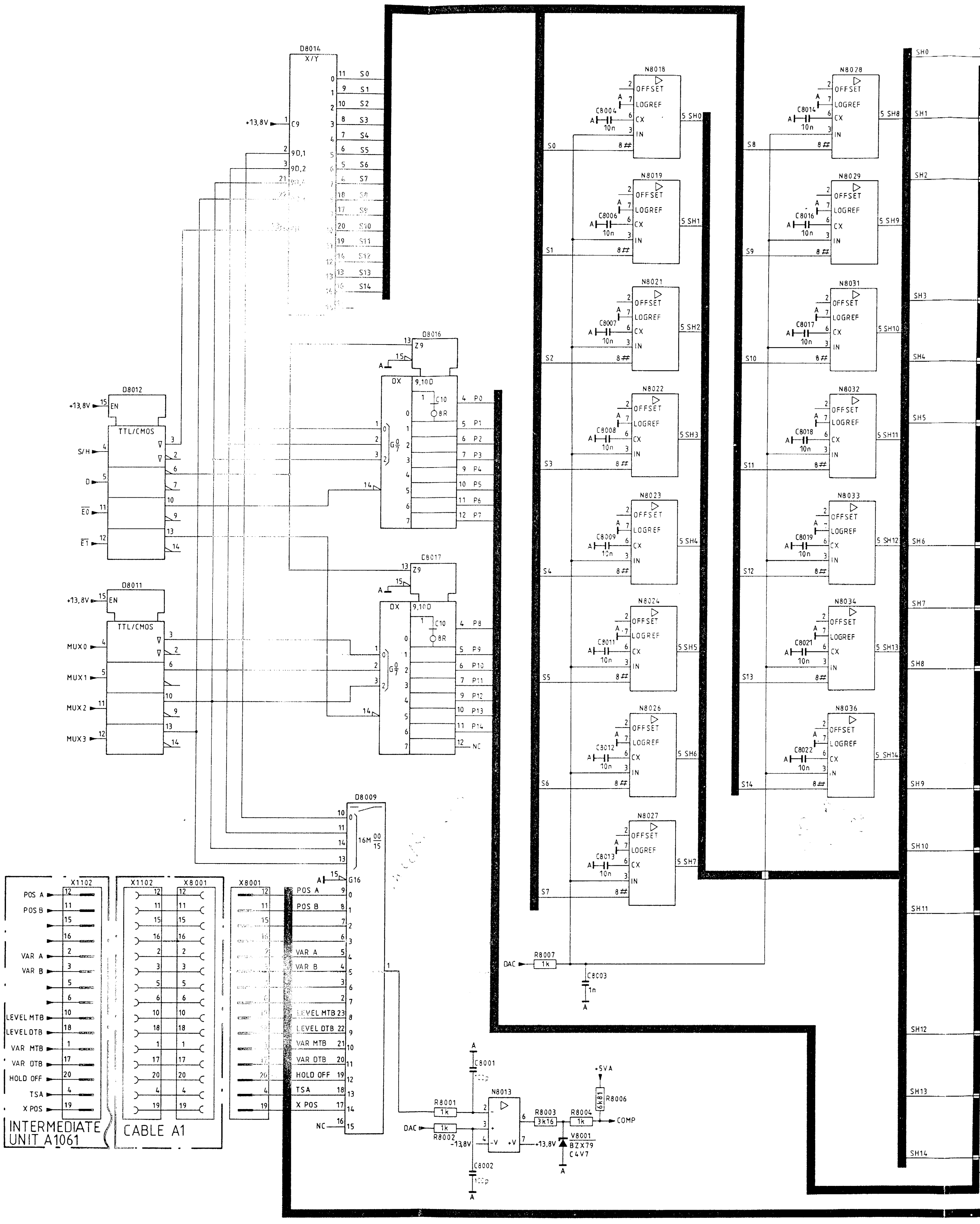
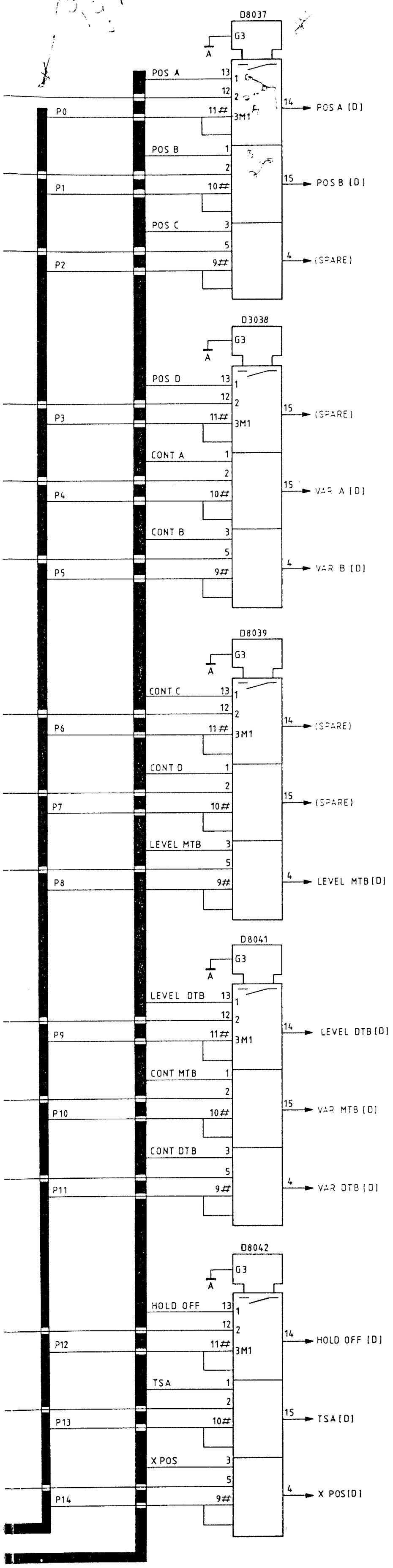
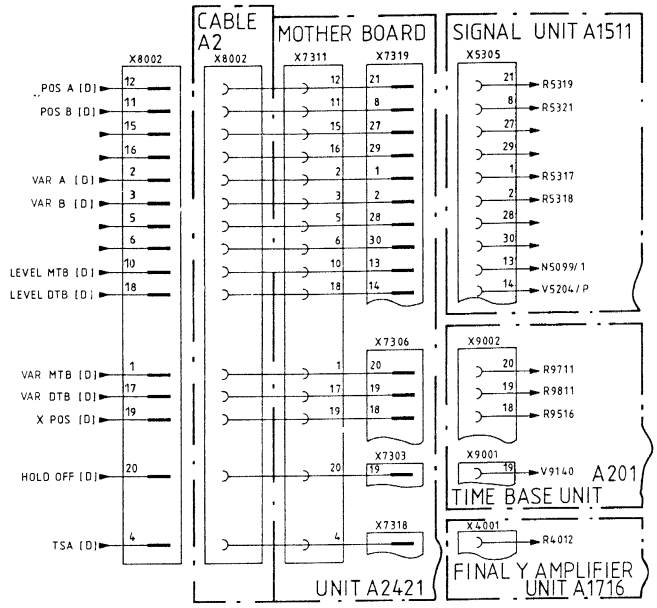


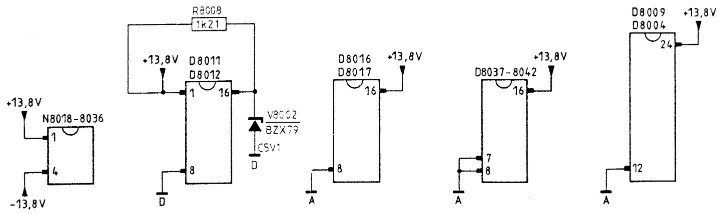
Fig.9.3. IEEE 488 bus unit, circuit diagram 2 (analog part)

9-7-2





D8009 D8011 - D8012 N8013 D8014 D8016 - D8017 N8018 T/M N8036 D8037 T/M D8042	HEF 4067 HEF 4104 μA 741 HEF 4514 HEF 4724 NE 5537 HEF 4053



[D]: OPTIONAL IEEE 488 BUS

MAT1718A
850801

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 8033	CAP.CERAMIC	10%	1NF	4822 122 30027
C 8004	CAP.FOIL	63V 1%	10NF	5522 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 PO12	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	5722 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	1322 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	4622 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	4322 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	4322 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	4322 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 8053	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 8377	CAP.CERAMIC	-20+50%	10NF	4822 122 3141%
C 8078	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5079	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8081	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8082	CAP.CERAMIC	-20+50%	10NF	4822 122 3141.4
C 8083	CAP.CERAMIC	-20+50%	10NF	4822 122 31416
C 8084	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8085	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8087	CAP,CERAMIC	-20+50%	10NF	4822 122 31414
C 8088	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8089	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 8091	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

9.3.2 INTEGRATED CIRCUITS

D 8001	INTEGR.CIRCUIT	P8291A	INT	5322 209 81254
D 8002	INTEGR.CIRCUIT	P8293	INT	5322 209 81265
D 8003	INTEGR.CIRCUIT	P8293	INT	5322 209 81265
D 8004	I.C. ROM	D27128-3-PROG		5322 209 50545
D 3005	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 85669
D 8009	INTEGR.CIRCUIT	HEF4067BP	PEL	5322 209 14513
D 8011	INTEGR.CIRCUIT	HEF4104BP	PEL	4822 209 10273
D 8012	INTEGR.CIRCUIT	HEF4104BP	PEL	4522 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 8057	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 16121
N 6013	INTEGR.CIRCUIT	UA741CN	SIG	5322 209 83257
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 01729
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 8333	INTEGR.CIRCUIT	NE5537N	SIG	5322 209 81729
N 8034	INTEGR.CIRCUIT	NE5537H	SIG	5322 209 81'729
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 8133	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%	1x21	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

10. CIRCUIT DESCRIPTION OF VERTICAL ATTENUATOR UNIT.

10.1. INTRODUCTION.

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

The h.f. signal paths and the 50-ohm termination are selected by the contacts of reed relays mounted on the l.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 (on the h.f. unit) 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 l.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 R6863 + (R6850//R6851), 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 l.f. attenuator unit.

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

The l.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 compared in the operational amplifier D6901 with the d.c. output.
Any difference in the comparator is applied to the summation stage consisting of V6836, V6833 and V6829. Note that when added, the h.f. signal and the l.f. signal shown at the summation stage form a reconstituted version of the square-wave applied to the input.
Feedback capacitors in the operational amplifier 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 D6901 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 : R6914 + R6909 (always in circuit)
x0.1 : (R6914 + R6909)//(R6911//R6912) switched by V6911
x0.01: (R6914 + R6909)//(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
- Temperature sensing circuit for 50-ohm input termination.

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 resectively. These pins are connected with V6807/base, V6818/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 R6872.

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 double operational amplifier D6803. The temperature of the 50 ohm termination resistor is measured by a 1 k.Ohm resistor 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 FET 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 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 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.

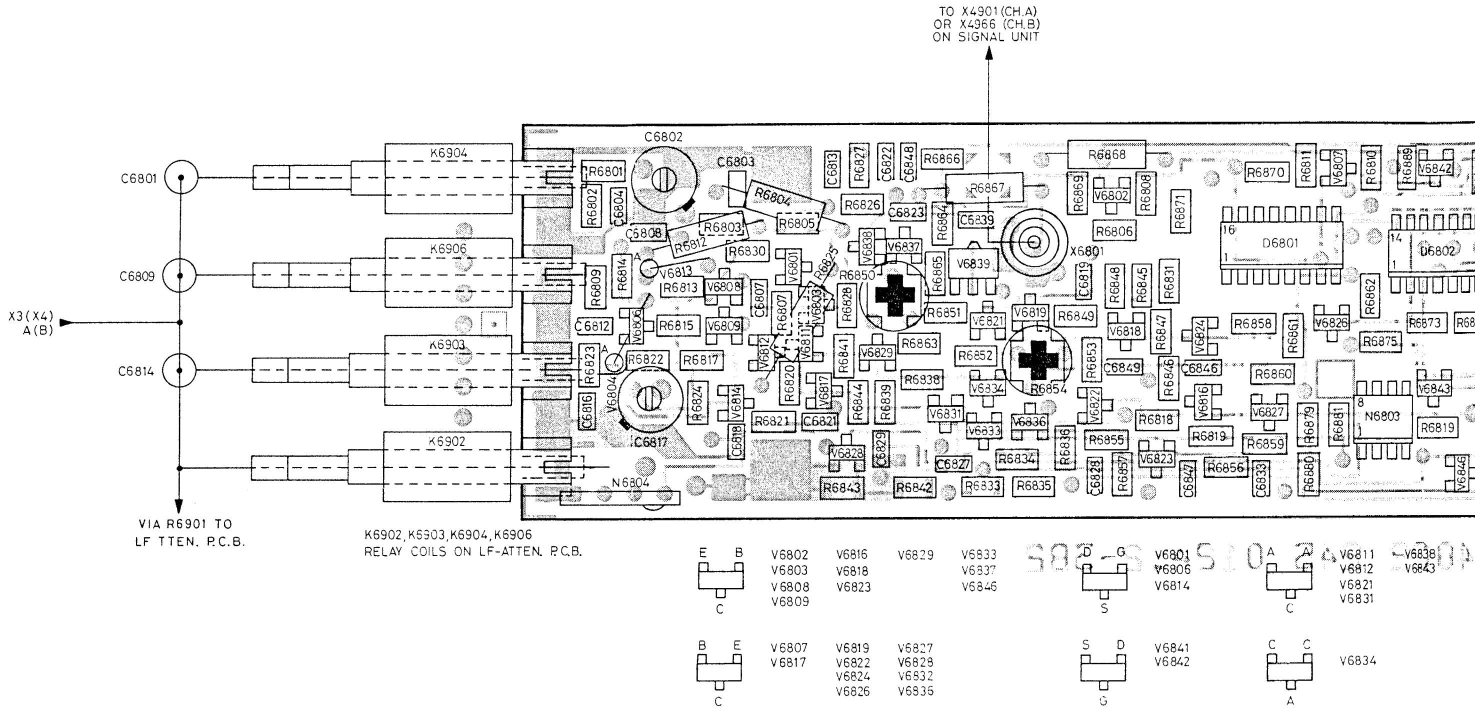
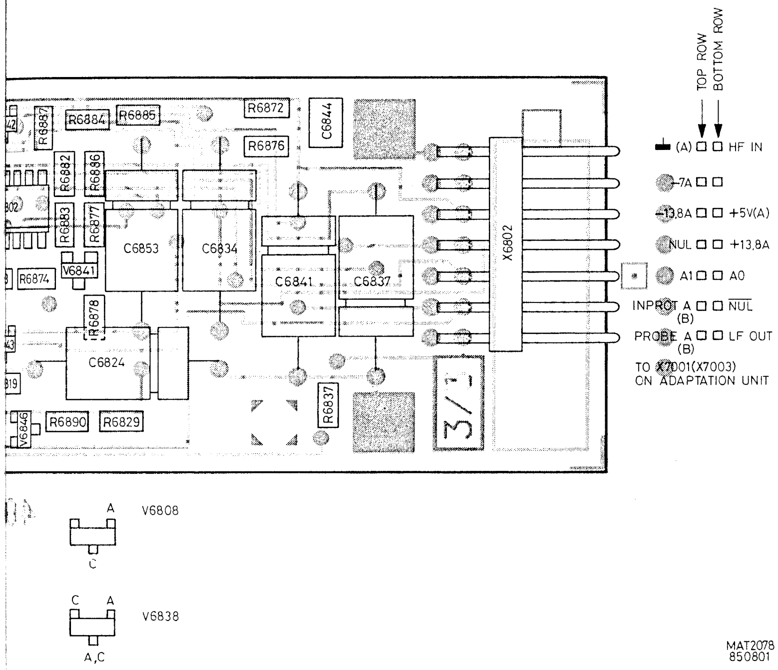
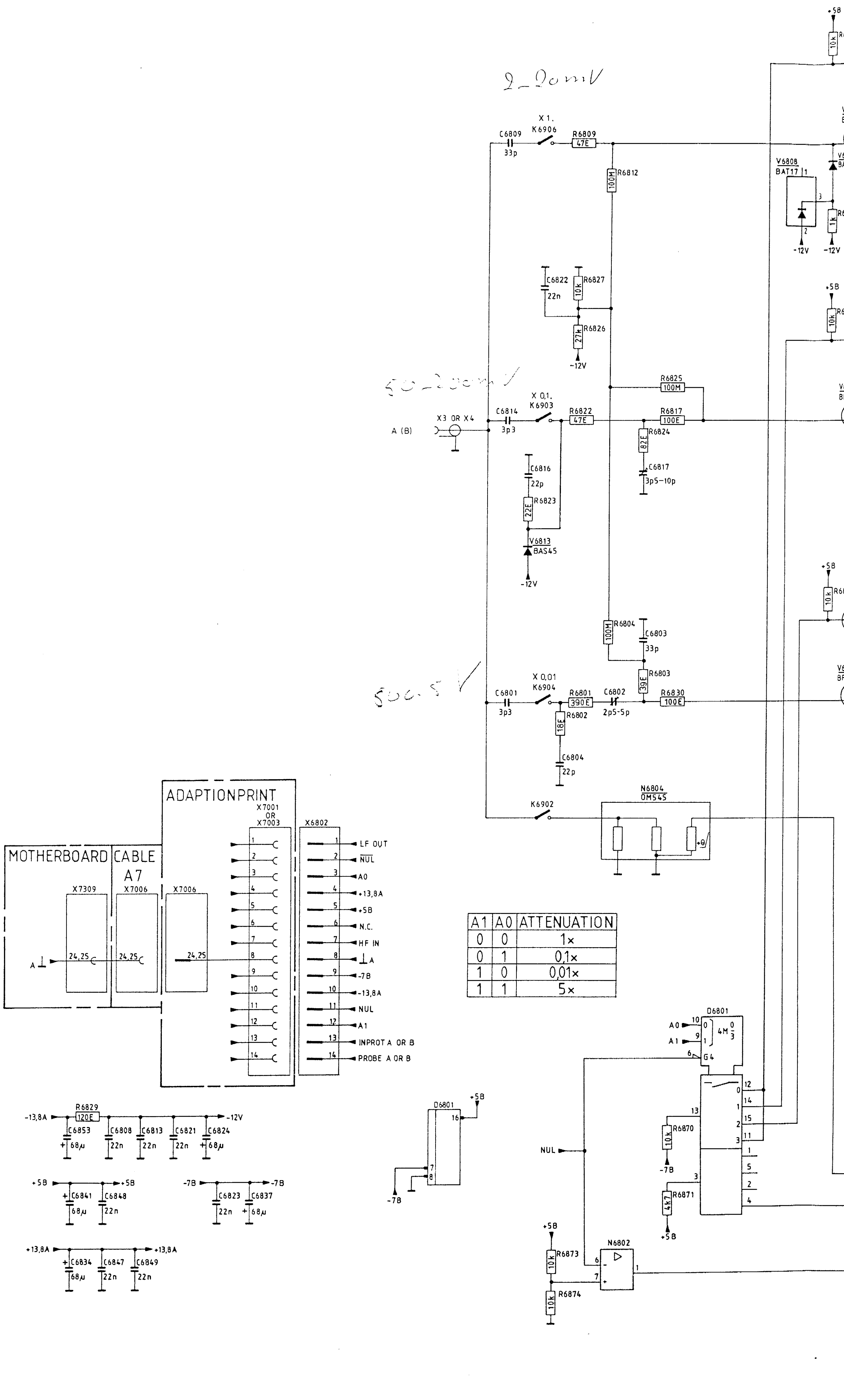
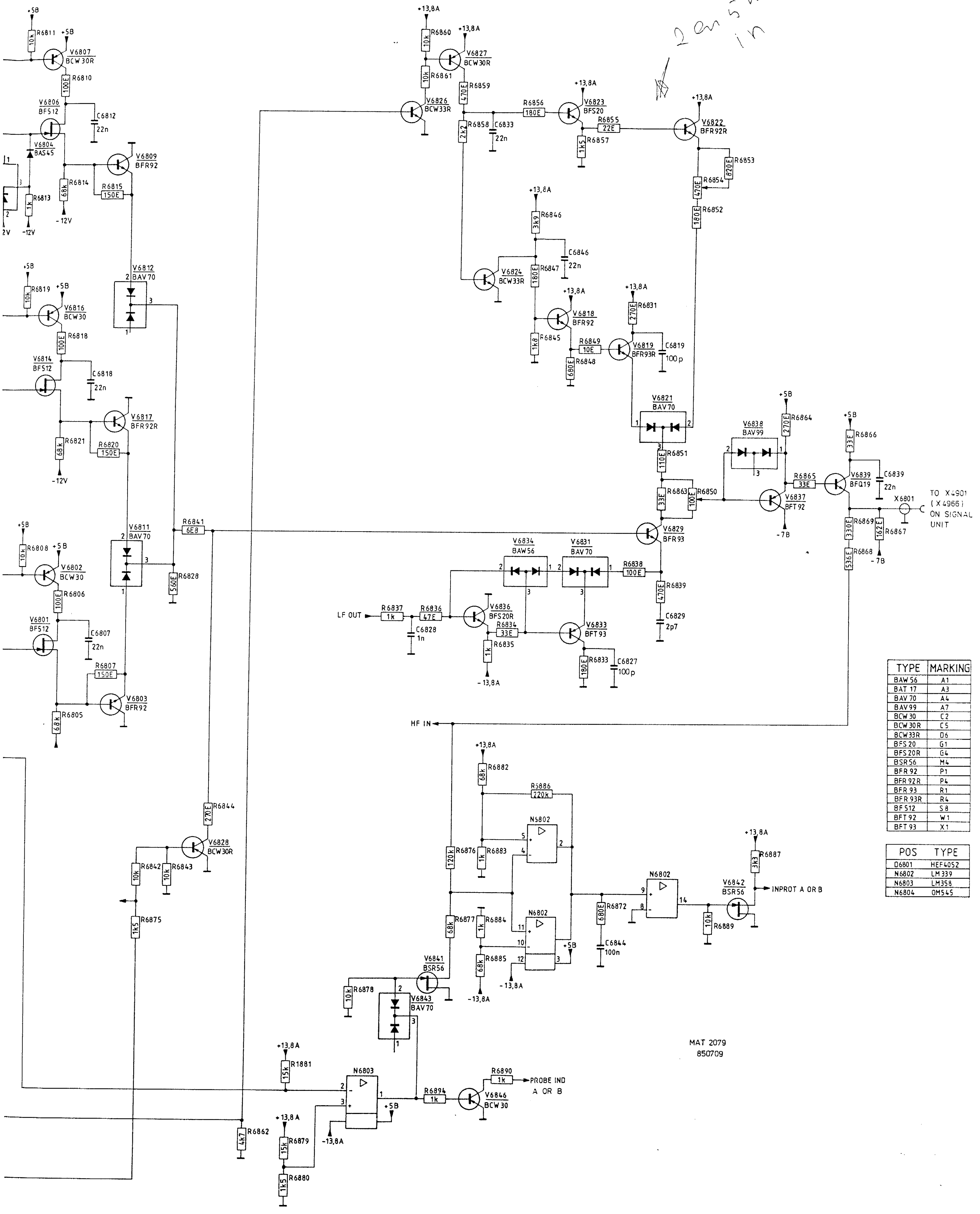


Fig.10.1. HF attenuator unit, p.c.b. lay-out.


TOP ROW
BOTTOM ROW
(A) HF IN
-7A
-13,8A +5V(A)
NUL +13,8A
A1 A0
INPROT A NUL
(B)
PROBE A LF OUT
(B)
TO X7001(X7003)
ON ADAPTATION UNIT
R6884
R6885
R6872
C6844
R6876
R6882
R6836
R6883
R6877
C6853
C6834
C6841
C6837
X6802
R6874
V6841
R6878
C6824
R6837
R6890
R6829
V6808
V6838
MAT2078
850801



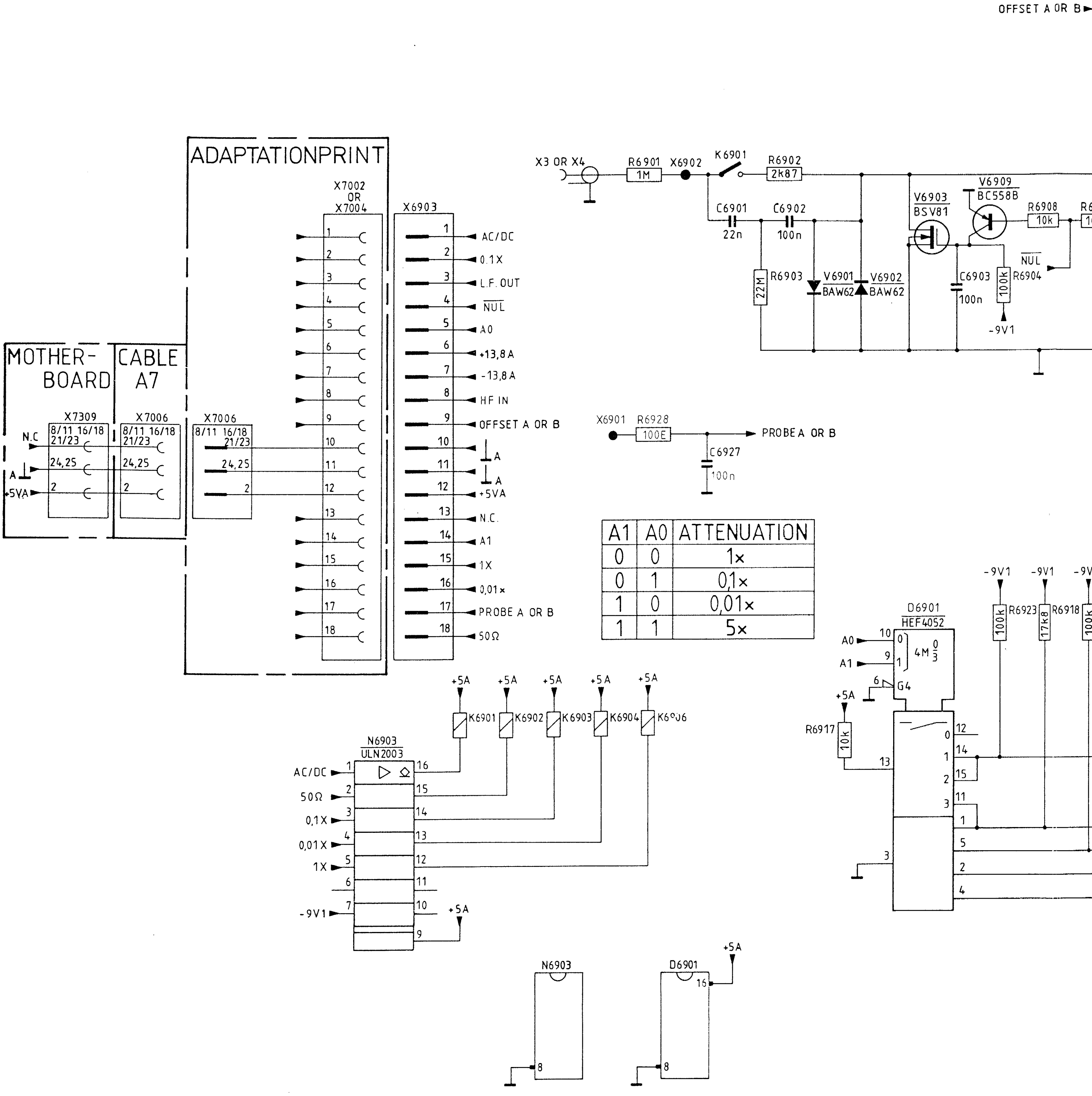
A1	A0	ATTENUATION
0	0	1×
0	1	0,1×
1	0	0,01×
1	1	5×



TYPE	MARKING
BAW 56	A1
BAT 17	A3
BAV 70	A4
BAV99	A7
BCW 30	C2
BCW 30R	C5
BCW33R	D6
BFS 20	G1
BFS 20R	G4
BSR56	M4
BFR 92	P1
BFR 92R	P4
BFR 93	R1
BFR 93R	R4
BF512	S8
BFT 92	W1
BFT 93	X1

POS	TYPE
D6801	HEF4052
N6802	LM339
N6803	LM358
N6804	OM545

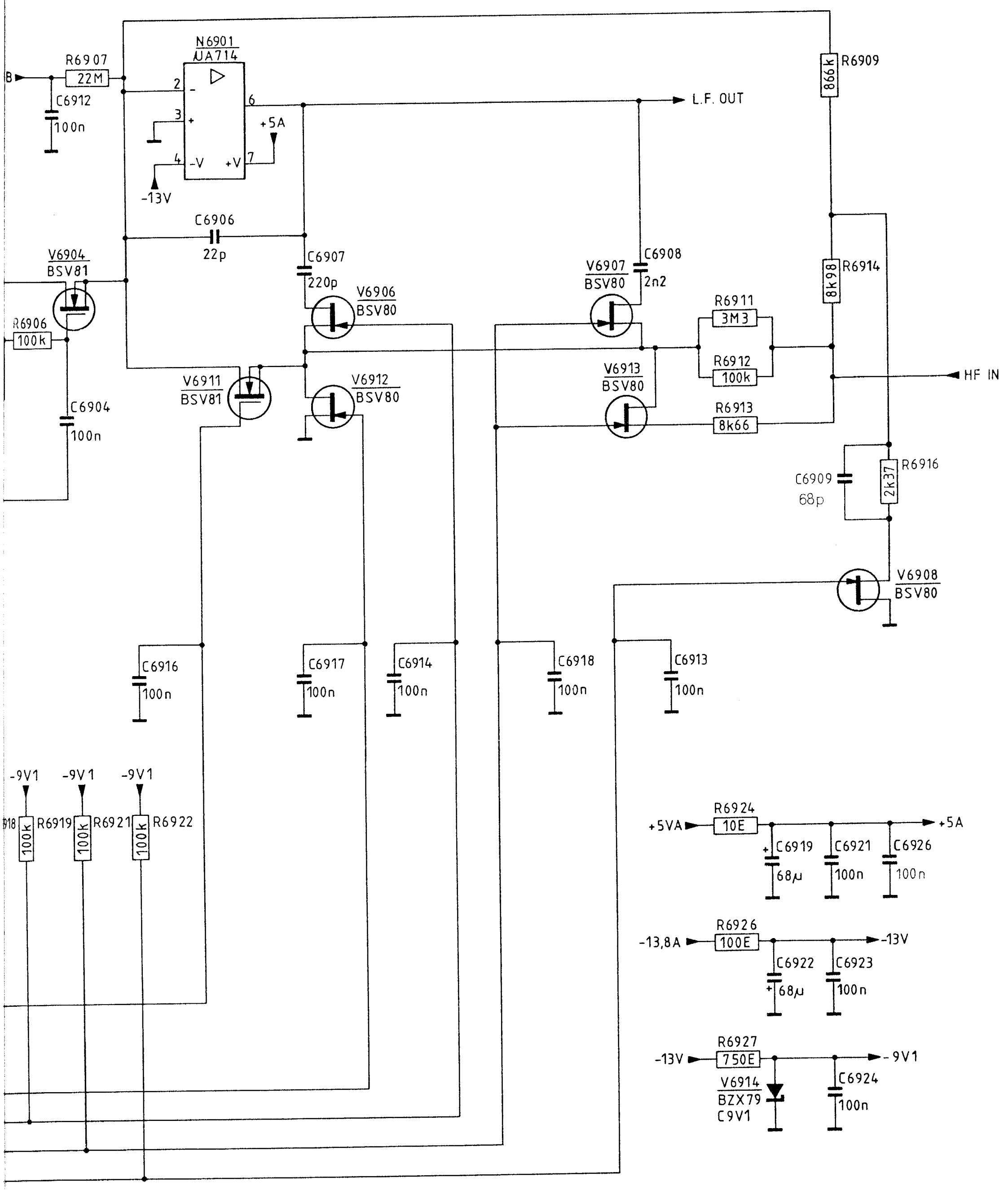
Fig.10.2. HF attenuator unit, circuit diagram



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

Fig.10.3. LF attenuator unit, circuit diagram.

10-10



MAT 1723A
850801

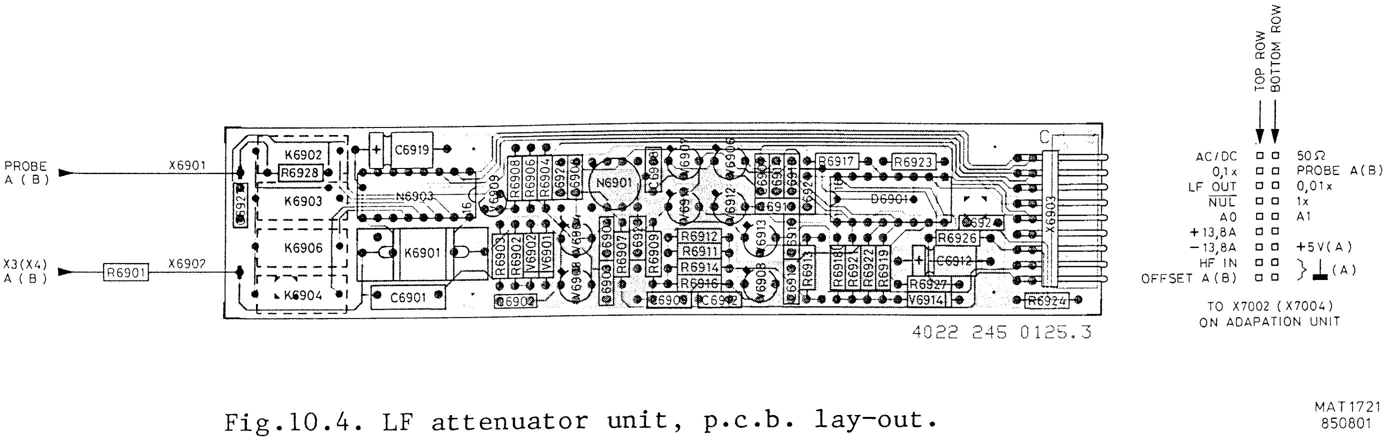


Fig.10.4. LF attenuator unit, p.c.b. lay-out.

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 20.

SUBJECT TO ALTERATION WITHOUT NOTICE

10.5.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 6802	CAP.TRIMMER	63V	2.5-5PF	5322 125 50288
C 6803	CAP.CHIP	50V 5%	33PF	5322 122 32659
C 6804	CAP.CHIP	50V 5%	22PF	5322 122 32658
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 32556
C 6816	CAP.CHIP	50V 5%	22PF	5322 122 32658
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 20669
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	5GV 10%	100NF	5322 122 32657
C 6833	CAP.CHIP	50v 10%	22NF	5322 122 32656
C 6834	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20589
C 6537	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	5c9 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 6353	CAP.ELECTROLYT.	-10+50%	68UF	4822 124 20689
C 6901	CAP.FOIL	400V 10%	22NF	5322 121 40308
C 6902	CAP.FOIL	631' 10%	100NF	5322 121 42386
C 6903	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 6904	CAP.FOIL	G3V 10%	100NF	5322 121 42386
C 6904	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 42356
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 20487
C 6923	CAP.FOIL	63V 10%	100NF	5522 121 42336
C 6924	CAP.FOIL	63V 10%	100NF	5322 121 42356
C 6926	CAP.FOIL	63V 10%	100NF	5322 121 42356
C 6927	CAP.FOIL	c3v 10%	100NF	5322 121 42385

10.5.2 INTEGRATED CIRCUITS

D 6801	INTEGR.CIRCUIT	HEF4052BT	F'EL	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%	470E	5322 111 90109
R	6302	RES.CHIP	RC-01	5%	33E	4822 111 90357
R	6803	RES.CHIP	RC-01	5%	47E	4822 111 90217
R	6804	RES.CARBON	0,125W	5%	100M	5322 111 30376
R	6805	RES.CHIP	RC-01	5%	6SK	4522 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	6610	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 30375
R	6313	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%	100E	5322 111 90091
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%	47E	4822 111 90217
R	6823	RES. CHIP	RC-01	5%	27E	5322 111 90105
R	6824	RES.CHIP	RC-01	5%	82E	4822 111 90124
R	6825	RES.CARBON	0,125W	5%	100M	5322 111 30376
R	6826	RES. CHIP	RC-01	5%	27K	4822 111 93542
R	6627	RES.CHIP	RC-01	5%	10K	4822 111 90249
R	6828	RES. CHIP	RC-01	5%	560E	5322 111 90113
R	6329	RES.CHIP	RC-01	5%	120E	4822 111 90339
R	6830	RES.CHIP	RC-01	5%	100E	5322 111 90091
R	6531	RES. CHIP	RC-01	5%	270E	4822 111 90154
R	6833	EES.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	6335	RES.CHIP	RC-01	5%	47E	4822 111 $0217
R	6837	RES.CHIP	RC-01	5%	1K	5322 111 90092
R	6838	RES. CHIP	RC-OX	5%	100E	5322 111 90091
R	6839	RES. CHIP	RC-31	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-51	5%	180E	5322 111 90242
R	6848	RES. CHIP	RC-01	5%	680E	4322 111 90162
R	6349	RES.CHIP	RC-01	5%	10E	5322 111 90095
R	6850	FOTM.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%	180E	5322 111 90242
R	6853	RES. CHIP	RC-01	5%	820E	4822 111 90171
R	6854	POTM.SLIDE	0.3W	25%	470E	5322 105 20023
R	6855	RES. CHIP	RC-01	5%	22E	4522 111 90186
R	6854	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. CHI?	RC-01	5%	10K	4822 111 90249
R	6861	RES. CHIP	RC-01	5X	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-51	5%	270E	4822 111 90154
R 6365	RES.CHIP	KC-01	5%	33E	4822 111 90357
R 6366	RES.CHIP	RC-01	5%	33E	4522 111 90357
R 6367	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 6363	RES.METAh FILM	Mi725	1%	536E	5322 116 50521
R 6869	RES.CHIP	RC-01	5%	330E	5322 111 90106
R 6870	RES.CHIP	RC-01	5%	10K	4822 111 96249
R 6371	RES.CHIP	RC-01	5%	4K7	5322 111 90111
R 6872	RES.CHIP	RC-01	5%	680E	4822 111 90162
R 6573	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6874	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6875	EES.CHIP	RC-01	5%	1K5	4822 111 90151
R 6876	RES.CHIP	RC-01	5%	120K	4822 111 90568
R 6377	RES.CHIP	RC-01	5%	68K	4322 111 90202
R 6878	RES.CHIP	RC-01	5%	10K	4822 111 90249
R 6879	RES.CHIP	RC-01	5%	15K	4522 111 30196
R 6880	RES.CHIP	RC-01	5%	1K8	5322 111 90101
R 6381	RES.CHIP	RC-01	5%	15K	4822 111 90196
R 6832	RES.CHIP	RC-01	5%	68K	4822 111 30202
R 6363	RES.CHIP	RC-01	5%	1K	5322 111 90092
R 6884	RES.CHIP	RC-01	5%	1K	5322 111 90692
R 6885	RES.CHIP	RC-01	5%	68K	4822 111 95202
R 6886	RES.CHIP	RC-01	5%	220K	4822 111 90197
R 6887	RES.CHIP	RC-01	5%	3K3	4522 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 6931	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 6901	RES.METAL FILM	MR30	1%	1M	4322 116 51279
R 6902	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 6933	RES.METAL FILM	VR25	10%	22M	5322 116 51785
R 6904	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6906	RES.METAL FILM	MR25	1%	100K	4322 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%	2K37	5322 116 53171
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 114 51268
R 6921	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 6922	RES.METAL FILM	MR25	1%	100K	4822 116 51265
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

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 44575
V 6807	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
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		FEL	5322 130 32256
V 6814	TRANSISTOR,FET	BF512		PEL	5322 130 44875
V 6616	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 6821	DIODE	BAV70	TAPE	FEL	5322 130 34331
V 6322	TRANSISTOR	BFR92R		PEL	5322 130 44606
V 6823	TRANSISTOR	BFS20		PEL	5322 130 42718
V 6824	TRANSISTOR	BCW33R	TAPE	FEL	5322 130 44342
V 6826	TRANSISTOR	BCW33R	TGFE	PEL	5322 130 44342
V 6827	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 6828	TRANSISTOR	BCW30R	TAPE	PEL	5322 130 44341
V 6831	DIODE	BAV70	TAPE	PEL	5322 130 34331
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 6830	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 6981	DIODE	BAW62		PEL	4822 130 30613
V 6902	DIODE	BAW62		PEL	4822 130 30613
V 6983	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	4522 130 44197
V 6911	TRANSISTOR, FET	BSV81		PEL	5322 130 44'041
V 6912	TRANSISTOR, FET	BSV80		FEL	5322 130 34044
V 6913	TRANSISTOR, FET	BSV80		FEL	5322 130 34044
V 6914	DIODE, REFERENCE	BZX79-C9V1		PEL	4822 130 30862

10.5.5 MISCELLANEOUS

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
K 6902..K6906	reed relay coil 5V		5322 280 10175
K 6901			5322 280 20145

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 reconsitated 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.

1

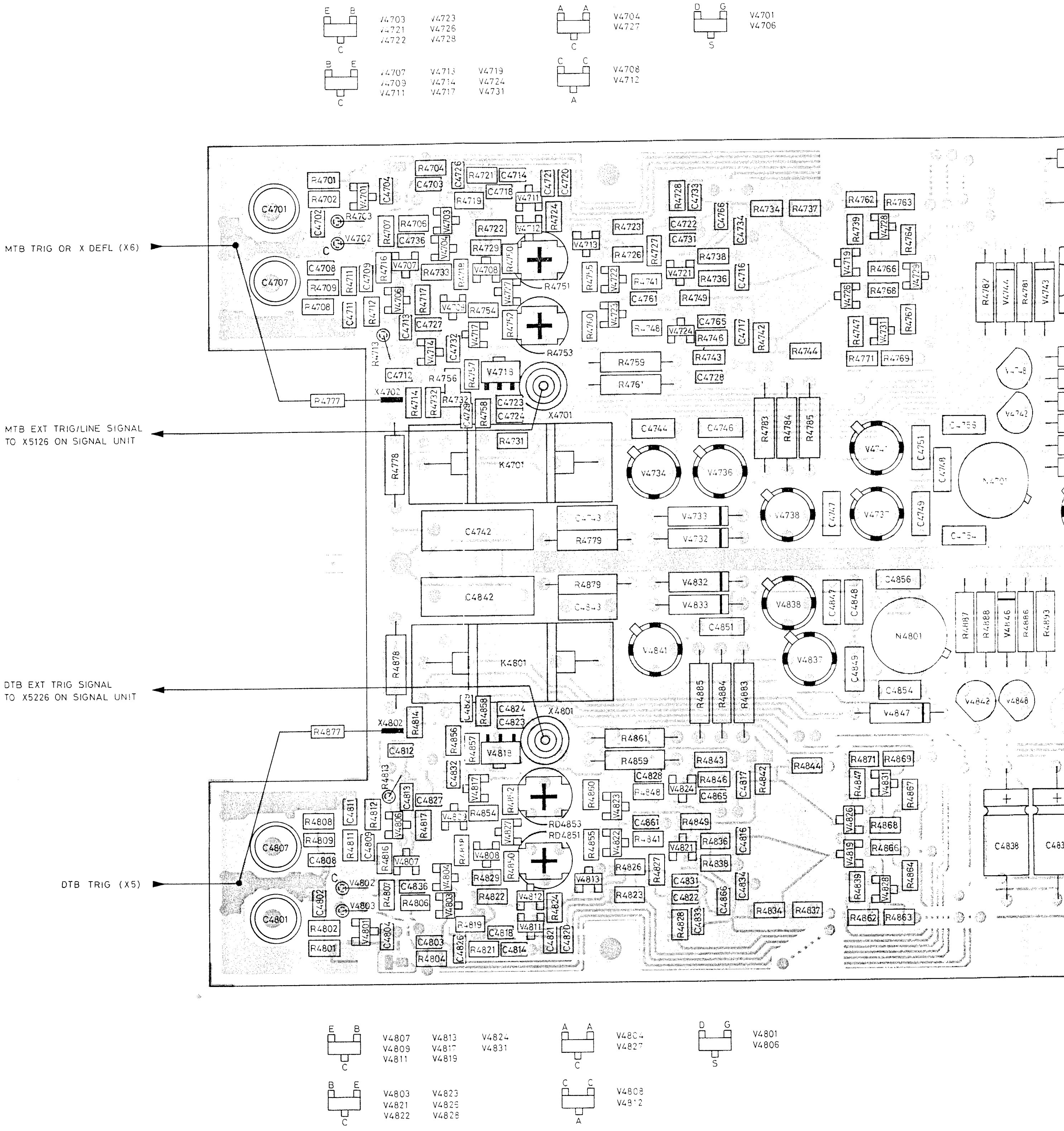
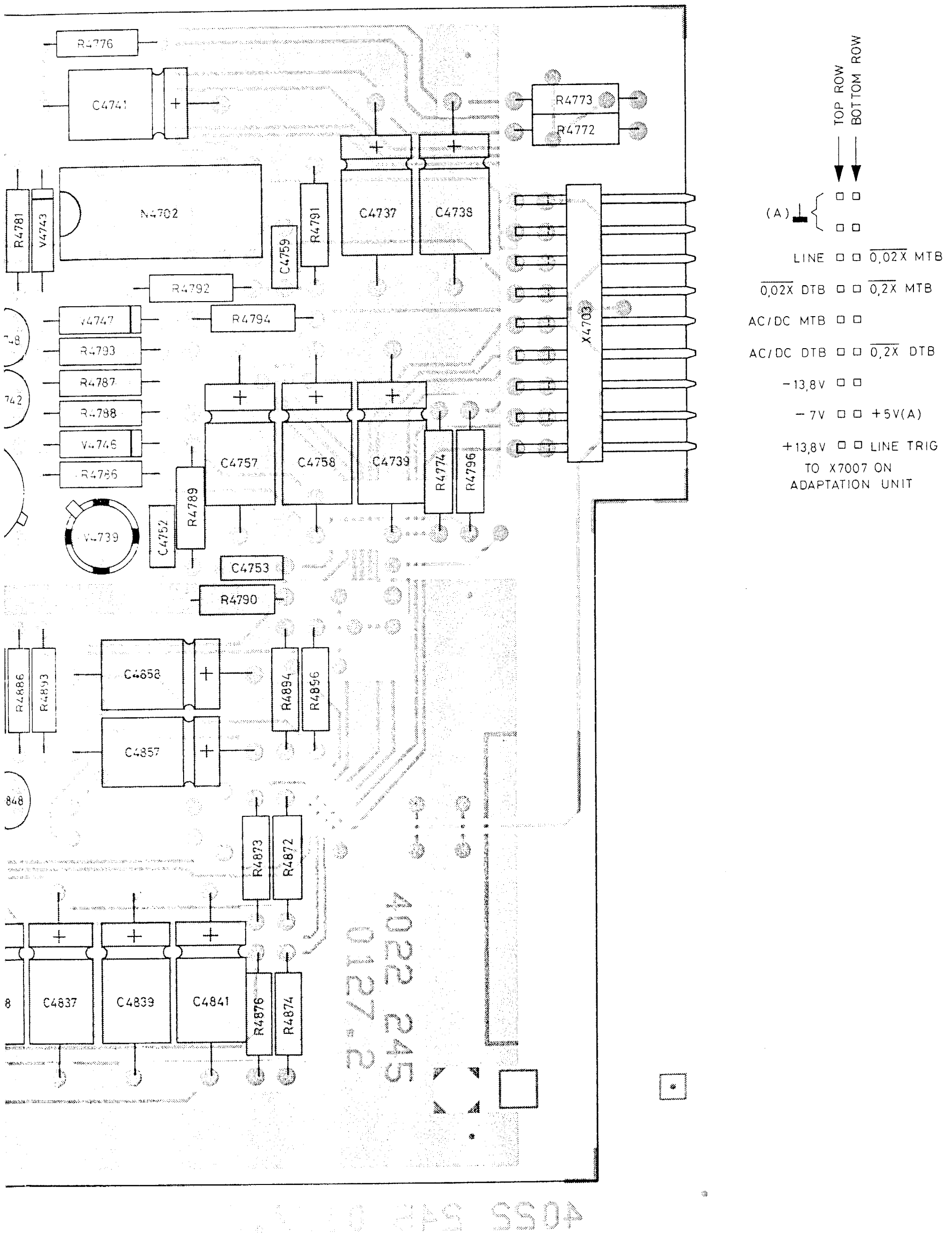
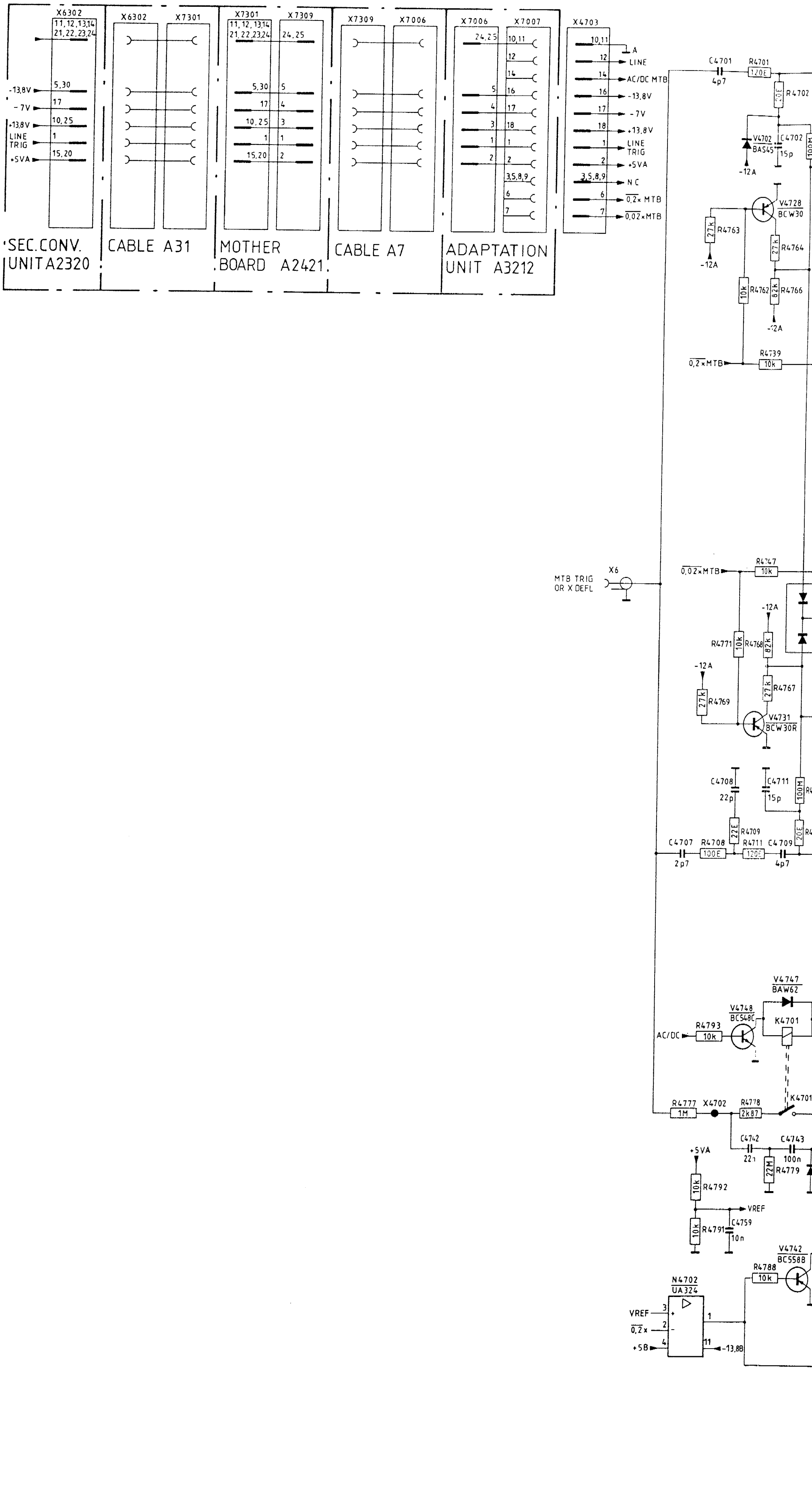


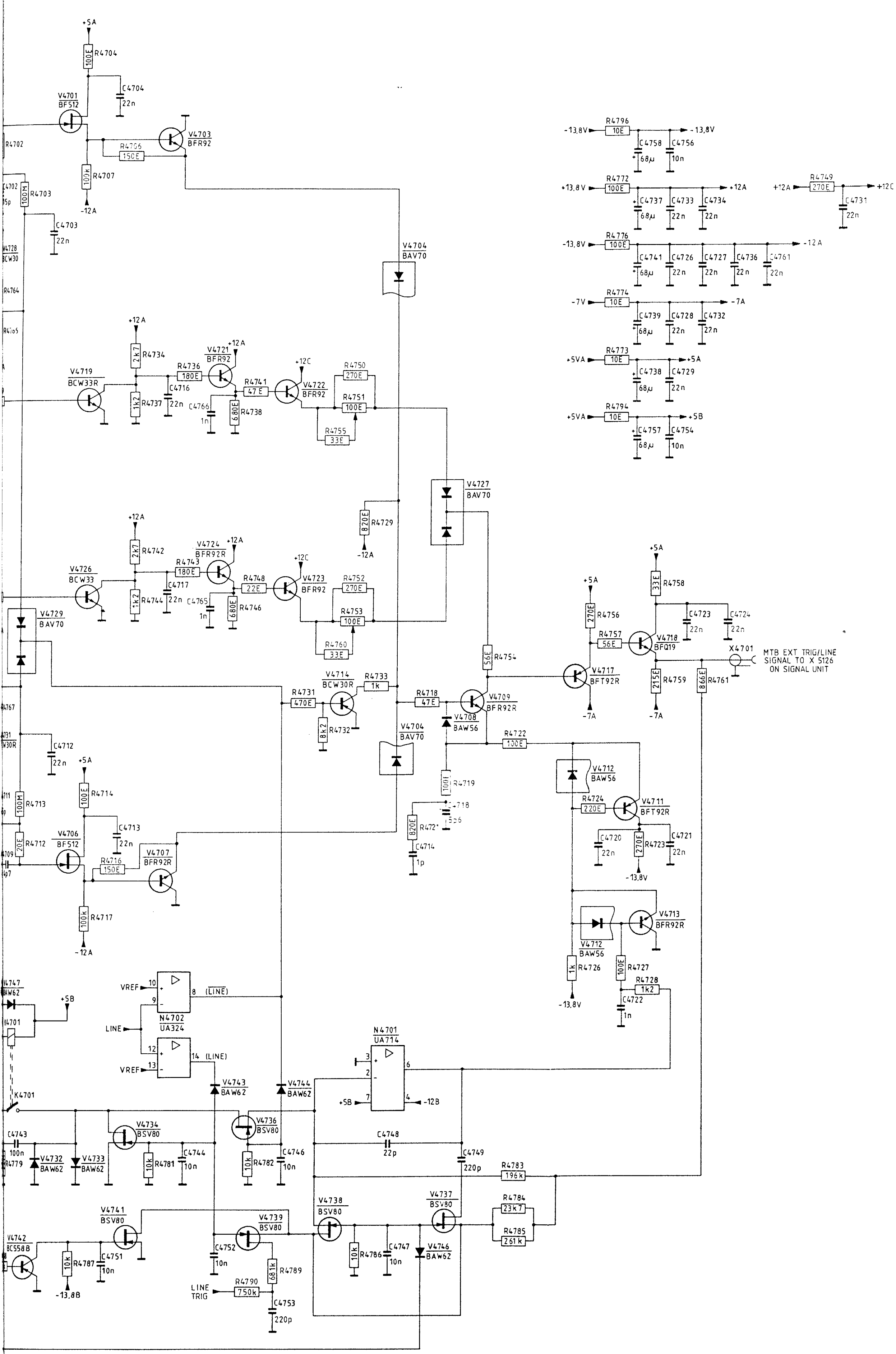
Fig.11.1. External MTB/DTB trigger unit, p.c.b. lay-out.



MAT 2076
850801



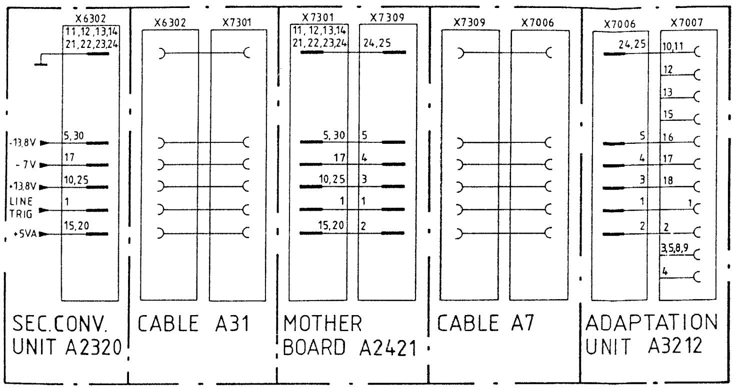
X6302
11,12,13,14
21,22,23,24
-13,8V
-7V
+13,8V
LINE TRIG
+5VA
5,30
17
10,25
1
15,20
X7301
X7309
24,25
X7006
X7007
X4703
10,11
A
LINE
AC/DC MTB
-13,8V
-7V
+13,8V
+5VA
N C
0,2× MTB
0,02×MTB
SEC.CONV. UNIT A2320
CABLE A31
MOTHER BOARD A2421
CABLE A7
ADAPTATION UNIT A3212
C4701
4p7
R4701
120E
R4702
V4702
BAS45
C4702
15p
-12A
V4728
BCW30
R4763
27k
R4764
R4762
10k
82k
R4766
R4739
10k
MTB TRIG OR X DEFL
X6
R4747
R4771
R4768
R4769
R4767
V4731
BCW30R
C4708
22p
C4711
15p
100M
R4709
C4707
2p7
R4708
100E
R4711
C4709
4p7
V4747
BAW62
V4748
BC548C
K4701
AC/DC
R4793
R4777
1M
X4702
R4778
2k87
C4742
C4743
100n
+5VA
22M
R4779
R4792
VREF
R4791
C4759
10n
V4742
BC558B
R4788
N4702
UA324
0,2×
+5B
-13,8B



TYPE	MARKING CODE
BAV 70	A4
BAW 56	A1
BCW 30	C2
BCW 30R	C5
BCW 33	D3
BCW 33R	D6
BF512	S8
BFQ 19	BFQ19
BFR 92	P1
BFR 92R	P4
BFT 92R	W4

MAT1724A
850801

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



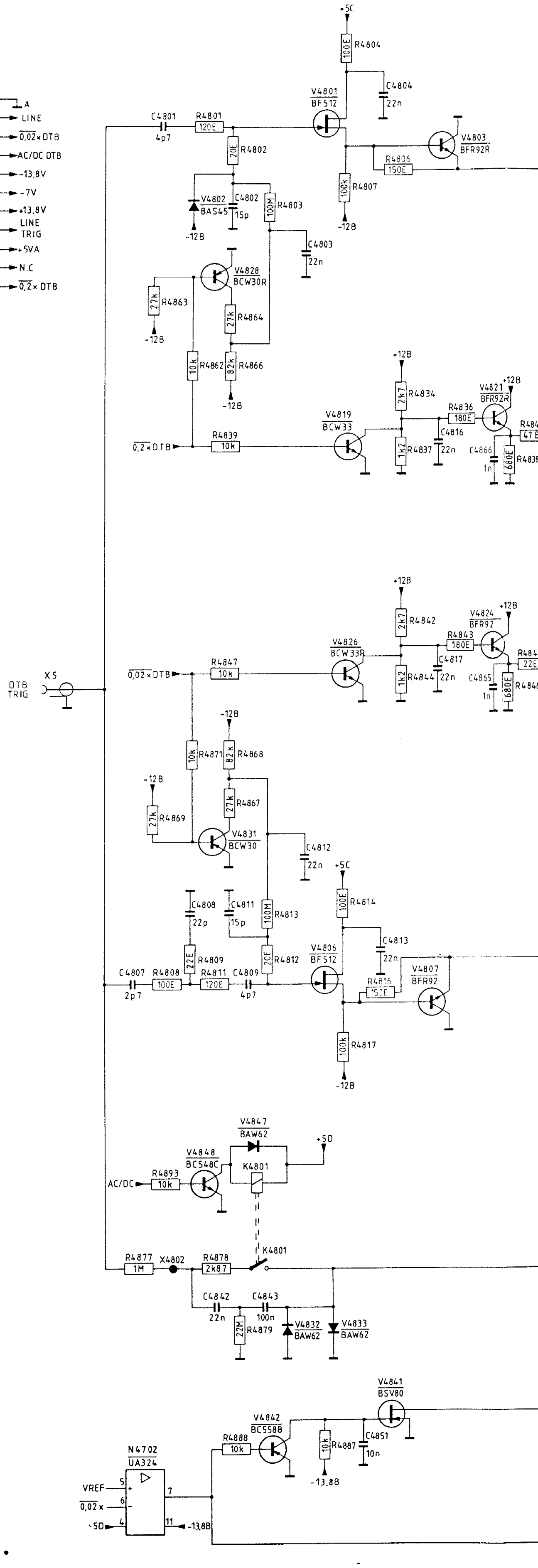
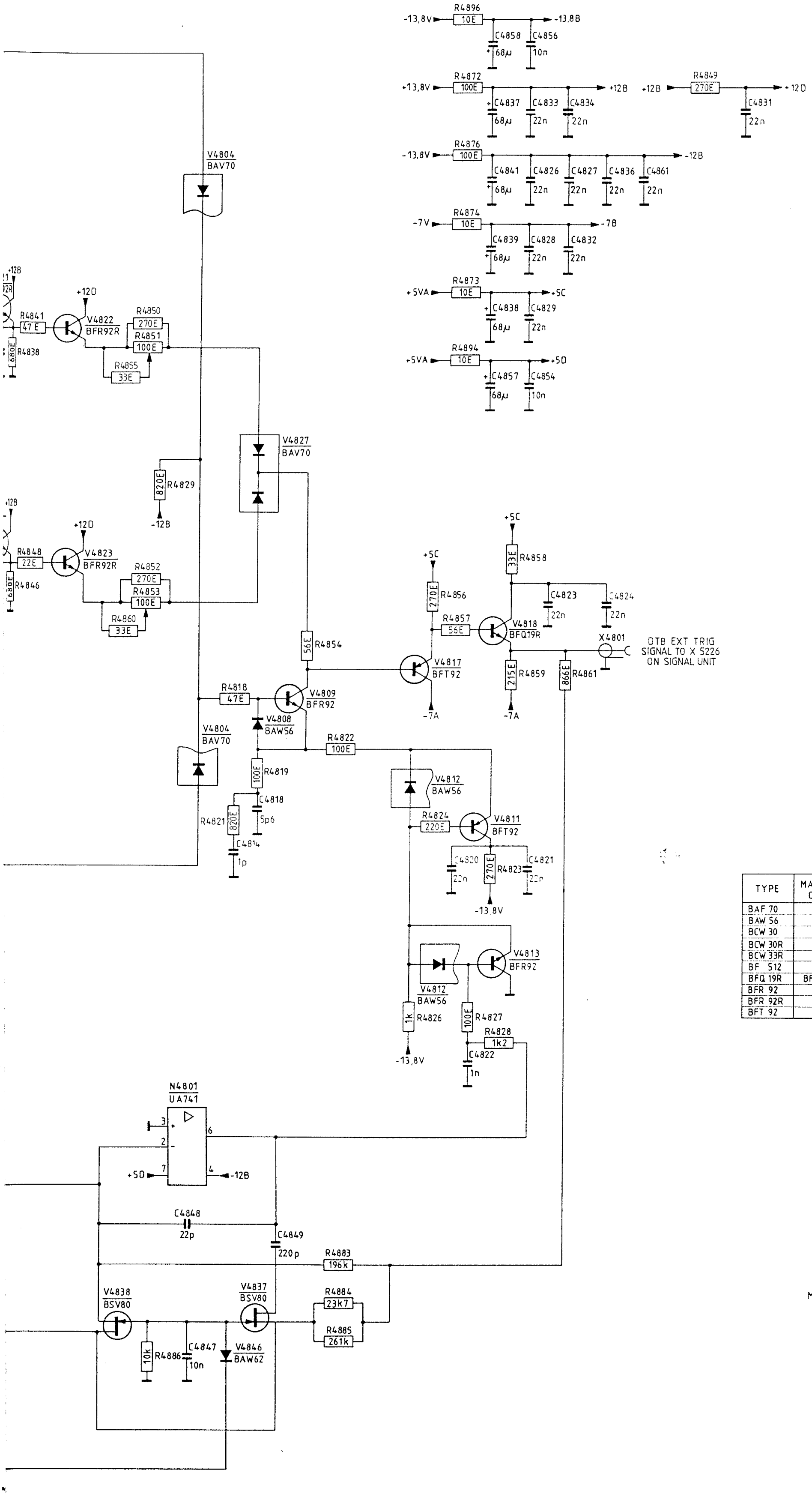


Fig.11.3. External DTB trigger input, circuit diagram.

11 - 10



TYPE	MARKING CODE
BAF 70	A4
BAW 56	A1
BCW 30	C2
BCW 30R	C5
BCW 33R	D6
BF 512	S8
BFQ 19R	BFQ19R
BFR 92	P1
BFR 92R	P4
BFT 92	W1

MAT1725A
850801

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.

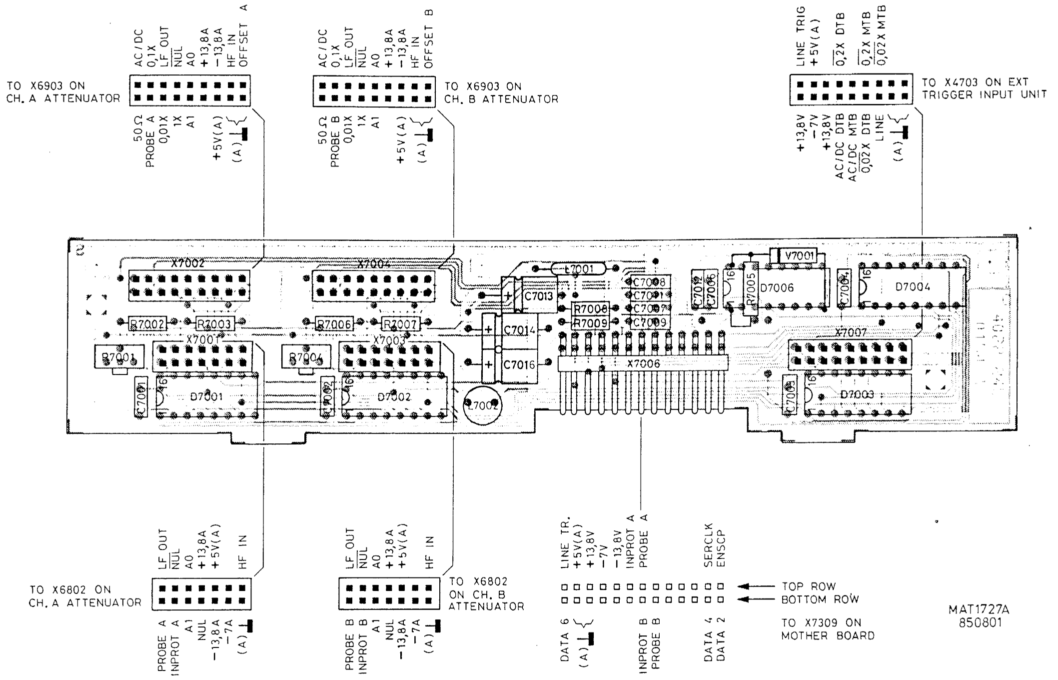
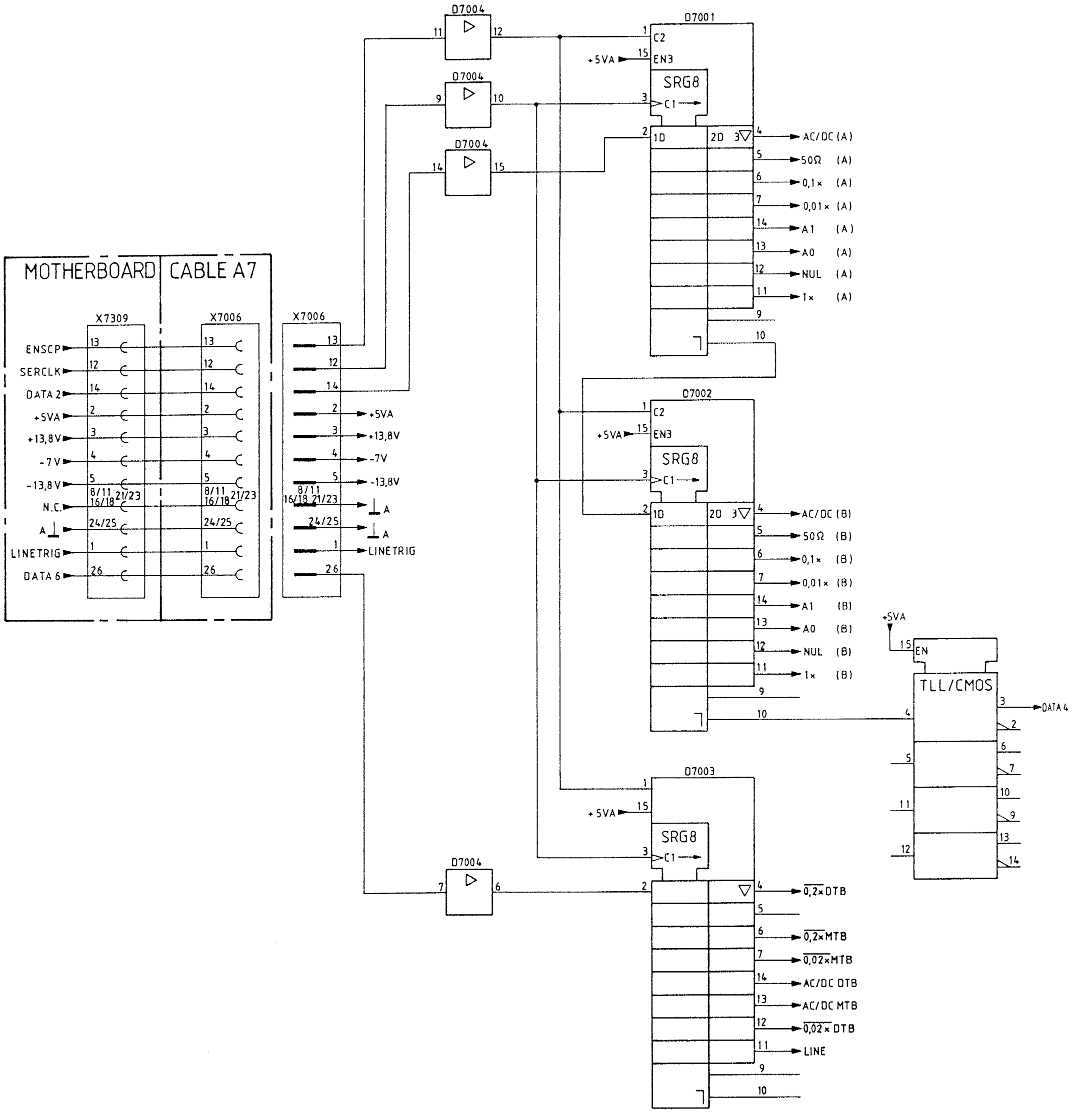
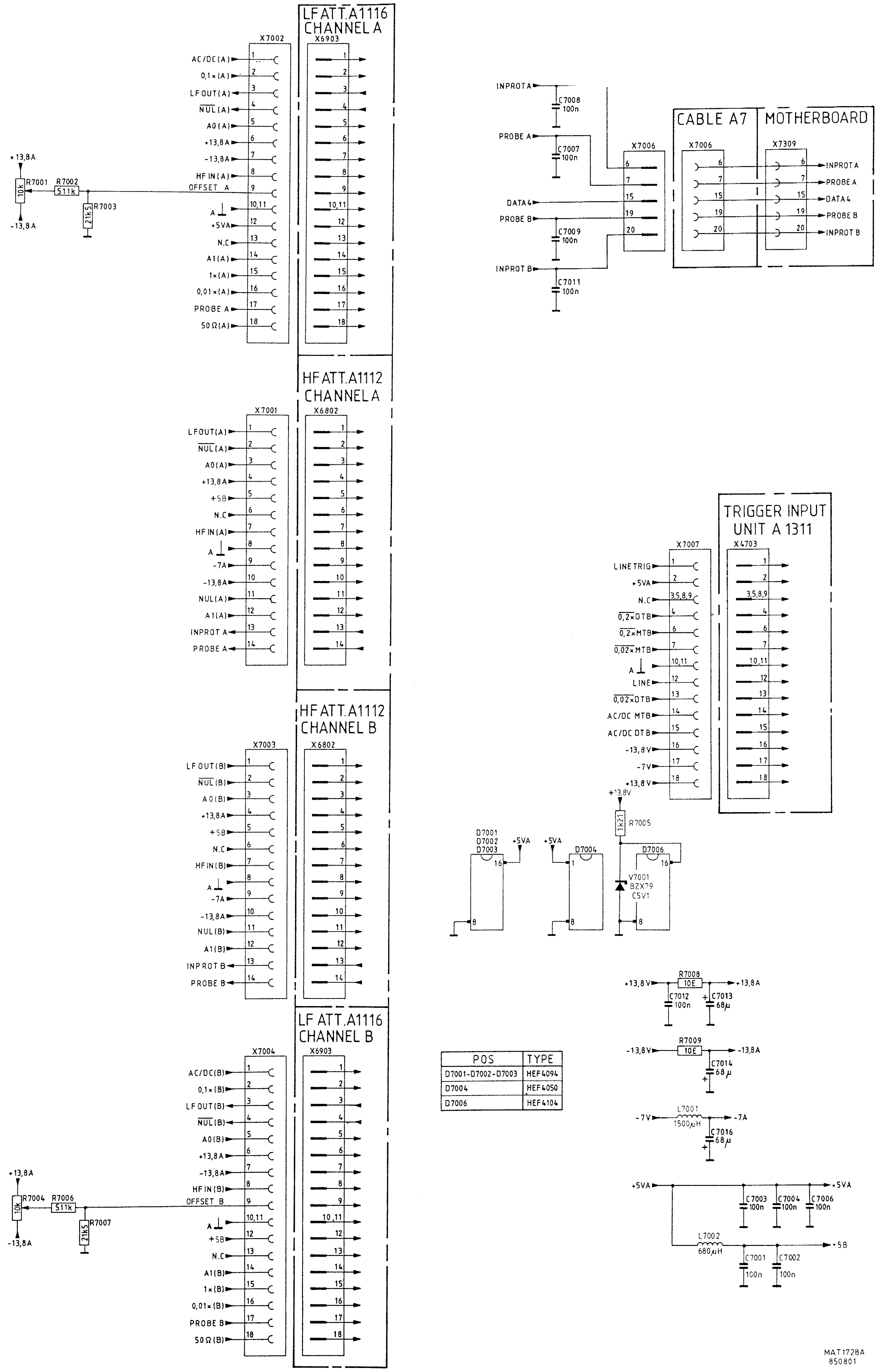


Fig.12.1. Adaptation unit, p.c.b. lay-out.

12-3



MOTHERBOARD
CABLE A7
X7309
X7006
X7006
ENSCP
SERCLK
DATA 2
+5VA
+13,8V
-7V
-13,8V
N.C.
A
LINETRIG
DATA 6
LINETRIG
D7004
D7001
D7002
D7003
SRG8
C2
EN3
C1
1D
2D
AC/DC (A)
50Ω (A)
0,1× (A)
0,01× (A)
A1 (A)
A0 (A)
NUL (A)
1× (A)
AC/DC (B)
50Ω (B)
0,1× (B)
0,01× (B)
A1 (B)
A0 (B)
NUL (B)
1× (B)
TLL/CMOS
EN
DATA 4
0,2×DTB
0,2×MTB
0,02×MTB
AC/DC DTB
AC/DC MTB
0,02× DTB
LINE



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

Fig.12.2. Adaptation unit, circuit diagram.

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				OEDERING 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 42356
C 7005	CAP.FOIL	63V	10%	100NF	5322 121 42366
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	4622 124 20689
C 7014	CAP.ELECTROLYT.		-10+50%	68UF	4822 124 20689
C 7016	CAP.ELECTROLYT.		-10+50%	68UF	4822 124 20689

2

12.1.2 INTEGRATED CIRCUITS

D 7001	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7002	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14455
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%	21K5	5322 116 50451
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%	21K5	5322 116 50451
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

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.

The CONT A signal input range is from 0 V to +10 V. However, the first few degrees of rotation of the control have no influence on the output of V4916 because of the base-emitter junction voltage which has to be overcome. As the control has no mechanical OFF switch, this "dead-angle" allows it to be a few degrees off the fully anticlockwise position without giving an UNCAL error; i.e. V4916 is still non-conducting. As CONT A (VAR) is rotated further clockwise (UNCAL) V4916 conducts to give variable control between the calibrated positions. In all other gain positions except 5 V/div, V4914 conducts (divided by 2.5- signal on its base) and diode V4913 switches the control signal via the output of operational amplifier N4902 to the base of V4914. In this case, preset R4952 is not effective as it is in the feedback loop, and only the CONT A input is active.

- The trigger pick-off signals are fed from a balanced emitter-follower stage behind the multiplier (pins 21, 23) and these are routed to circuit diagram 2.
- This emitter-follower stage feeds a series feedback amplifier with an RC compensation network connected between pins 9 and 10 to speed-up the amplification at high frequencies.
- Finally, there are three identical common-base output circuits for the 3 output (pin 14 and 16) modes:
  - channel A output signal in normal mode
  - channel A output signal in inverted mode
  - no output signal in channel A off mode. Only the DC biasing current is coming from pin 14 and 16

3

The balanced 50-ohm output is applied to integrated circuit N5031 (OM547), the delay line driver. Here, the A and B channel inputs and the TRIG VIEW input from circuit diagram 2 combine.
Position control
Control of vertical position (and symmetry) is effected on common-base circuits internally connected to pins 1 and 30 of N5031.

Consider channel B is active:
A +12 V command signal at ON/OFF POS B switched on V5082 of long-tailed pair V5081/V5082. Current source V5083 suplies 14 mA to the collector of V5082. This current divides to provide the emitter currents of balanced amplifier D5081. The current division depends on the setting of the Y POS B potentiometer and the SYM B preset, which control the stage via emitter-followers D5081 (1, 2, 3) and D5081 (11, 12, 13). Position changes for channel B therefore infuence the current applied the N5031/pin 1 and 30.
Consider the TRIG VIEW channel is active:
When TRIG VIEW is selected a +12 V signal via diode V5032 is applied to the slider of R5041 to give trace position control of the trigger view signal.

Consider channel A is active:
The circuit is identical to that of channel B as previously descibed. A +12 V command signal at ON/OFF POS A switches on V5047 of long-tailed pair V5046/V5047. Current source V5048 supplies 14 mA to the collector of V5047 which divides to provide the emitter currents of differential amplifier D5046. As for the channel B circuit, this division is influenced by the position of the Y POS A control (and SYM A control R5046).
Position changes again influence the current applied to N5031/pin 1 and 30.

The N5031 switching stage incorporates an h.f. compensation network between pins 21 and 22 and provides bandwidth-limiting, controlled by a +12 V signal BWL on pin 11.

13.2. CIRCUIT DESCRIPTION OF DIAGRAM 2 (See fig.13.3.)

The A trigger pick-off signal from diagram 1 is received on pins 7 and 9 of the A selection integrated circuit N5116 (OM611). Voltage adaptors V5116 and V5117 apply the supply voltages +2 V on pin 22 and -10 V on pin 3 respectively. Trigger source control signals MTBA (pin 15) and DTBA (pin 24) are switching the DTB and MTB trigger source signals from channel A. A control signal of +12 V switches the signal through; 0 Volt blocks the signal. Similary, the B trigger pick-off from diagram 1 is received on pins 7 and 9 of the B selection integrated circuit N5121.

The MTB trigger signals from channel A or B and the EXT MTB trigger input signals, all at 50-ohm, are combined in a common-base input stage of the MTB filter integrated circuit N5126 (OM612). The EXT MTB is activated by a +12 V signal on the base of V5128, which switches the transistor off. In turn, this causes V5127 to conduct so that the EXT GAIN control R5127 on its base is operative. This varies the current to pin 28 to compensate for the magnitude of the externally applied signal.
The amplifier in the MTB filter is capacitively-coupled so that only the h.f. components are fed directly to the output (pin 17 and 19).
The d.c. and l.f. components are blocked and taken out on pins 10 and 11 to a common-base amplifier V5129, V5131 and emitter-followers D5127.
The d.c. and l.f. components are the applied by switches D5126 via three paths of different bandwidths (two l.f. and one d.c.) to a series-feedback amplifier D5127 with adjustable gain preset R5169.The switching conditions for these paths are:

DC	=	two D5126 switches on (contacts 8,9 and 10,11)
LF REJ	=	D5126 switches off (range: 20 kHz - 50 kHz) The signal path consists of C5129/R5156 and C5131/R5157.
AC	=	two D5126 switches on (contacts 1,2 and 3,4): the range is 7 Hz-50 kHz.

The overall l.f. path gain, representing the 0 - 50 kHz range, has to match the internal D5126 signal path gain (for 50 kHz to full bandwidth).
The paths combine on pins 13 and 14 to provide the reconstituted signal output on pins 17 and 19.
These outputs are applied to pins 28 and 3 of the MTB trigger amplifier integrated circuit N5129 (OM613).

The filter section of the DTB is identical to that described for the MTB.
However, the DTB trigger amplifier N5228 (OM 613) has simpler associated circuits than the MTB trigger amplifier and is therefore described first.
Supply voltage adaptation is provided by transistor V5232 (+2 V) and V5241 (-10 V).
Transistors V5234, V5237 are connected as a balanced amplifier.
The balanced amplifier is influenced by the LEVEL DTB control signal. Normally, pins 24 and 6 of N5228 are at equal current division, but the LEVEL control disturbs the balance. Preset R5292 provides the +/- SLOPE balance.
Pins 11 and 13 provide a balanced output. The offset adjustment R5211 is adjusted to a no-signal zero at the Y output socket.
Preset R5310 provides level compensation to make the d.c. output voltage independent of the LEVEL control position. The current source V5248 is controlled by N5229

The DTB SLOPE control signals are applied to pin 16 of D5228. Negative slope is activated by a +12 V signal: positive slope is acivated by a 0 V, which also switches on inverter V5239 and applies a positive signal to pin 21 The trigger signal can be shifted with the LEVEL DTB control. This shiftable signal is applied to a Schmitt-trigger input inside D5228. The output pulse from the Schmitt-trigger is available at pin 19 of D5228. The trigger pulses to start the DTB are fed via output pin 19 and connector X5227 to the time-base logic.
The MTB trigger amplifier has similar circuits to the DTB, but in this case, it is necesarry to adjust the trigger level between the peak-to-peak level of the signal. A peak detector circuit N5128 (OQ0128) is therefore included.
This circuit is supplied with a voltage (0 ... 10 Volt) from the MTB LEVEL control and with output signals from pins 25 and 26 of the MTB trigger amplifier in order to detect the peak-to-peak level. These signals are routed to inputs 3 and 7 of the peak detector N5128.
If AUTO is selected (+12 V applied to pin 13), the trigger can never exceed the peak-to-peak level of the signal. The input signal from N5129 pins 25 and 26 is also used to provide the EXT X DEFL output via V5134. This signal is routed to the X-deflection selector on the time base unit. Adjustable RC networks for trigger view square-wave compensation are connected across pin 25 and 26 of D5129.

The TRIG VIEW outputs on pins 11 and 13 are routed to the vertical channel switch on diagram 1.
3 The TRIG VIEW ON/OFF signal switches the TRIG VIEW display mode on via the circuit with V5143 and incorporated gain adjustment R5216. When the TRIG VIEW signal in ON (logic high), V5143 is switched off and the GAIN TRIG VIEW control R5116 can influence the base current of V5141 and hence its collector current (between 0...0,2 mA) applied to pin 15 of N5129.
When the TRIG VIEW signal is OFF (logic low), V5143 is switched on (current of 5,5 mA applied to pin 15) and V5141 is switched off.

The trigger pulses to start the MTB are fed via output pin 19 (4 mA/div) and connector X5128 to the time-base logic.

13.3. CIRCUIT DESCRIPTION OF DIAGRAM 3 (see fig.13.4.)

Most of the signal display functions are controlled by:
- a two-line bus system, serial clock (SCL) and serial data (SDA) from the CENTRAL PROCESSOR UNIT
- output enable (OE-) from the CRT Text Unit
- alternate clock (ALT CLK-) from the TB generator
- a CHOP CLOCK- derived from a 2 MHz chop oscillator formed by D5327 pins 8 to 12 with feedback via V5328. The output to D5326-7 is via transistor V5329.

The output control signals from D5326 are as follows:
- output pin 5 provides a direct output for the ON/OFF POS A control signal on diagram 1. It also provides CHAN A OFF, CHAN A INVERT and CHAN A NORMAL commands to diagram 1. An output via the emitter-follower level adaptor V5332 switches on channel A (+5 V on D5328-9 inverter input gives a low output on D5328-8). The +5 V on AND-gate inputs D5329-5 and D5329-9 also conditions the CHAN A INVERT and CHAN A normal signals. A parallel output signal from D5333-14 of the HEF-bus is fed via the emitter-follower level adaptor V5333 to provide the other gate inputs to select CHAN A INVERT or CHAN A NORMAL. A logic high input from D5333-14 switches via V5333 to give a CHAN A NORMAL signal via D5329-8 (output remains high). At the same time, the inverter output D5328-6 gives a logic low input to D5329-4 which inhibits the CHAN A INVERT signal (low on D5329-6).

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.

	OUTPUT SIGNALS TO CHANNEL A SWITCH N4903:		
MODES SELECTED	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:

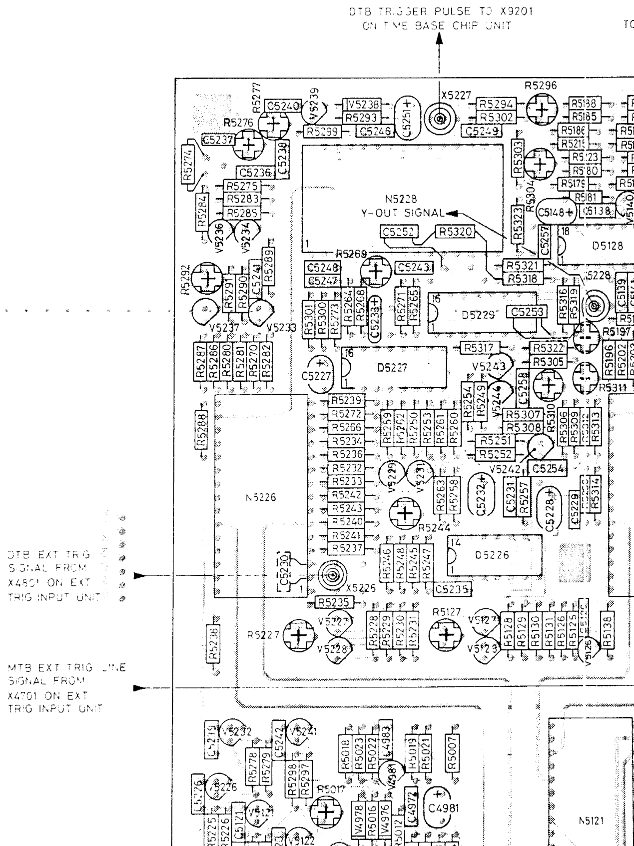
	OUTPUT SIGNALS TO CHANNEL B SWITCH N4967:		
MODES SELECTED	CHAN B OFF	CHAN B INVERT	CHAN B NORMAL
CHAN B OFF	H	L	L
CHAN B INVERT	L	H	L
CHAN V NORMAL	L	L	H

- 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.

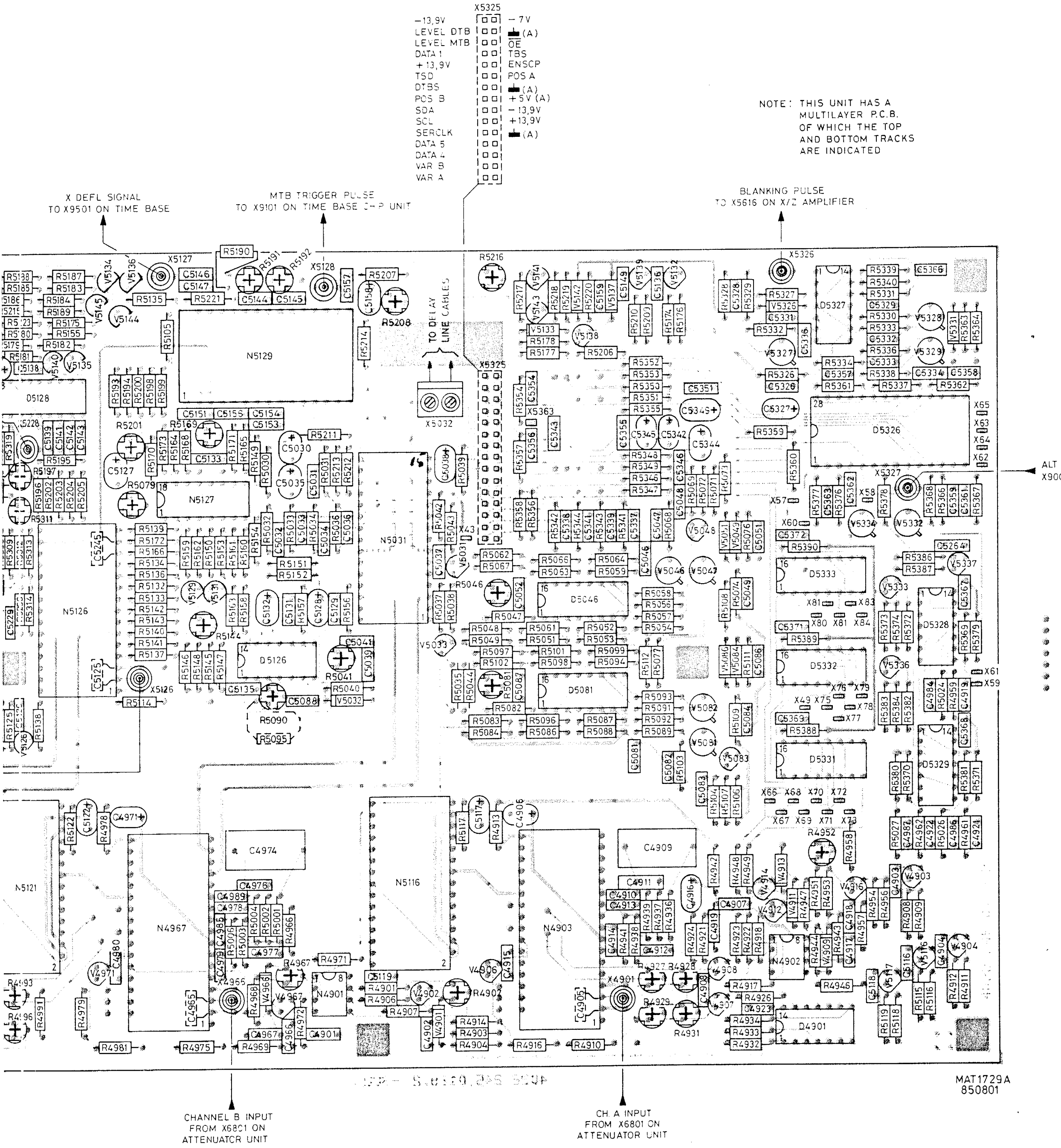
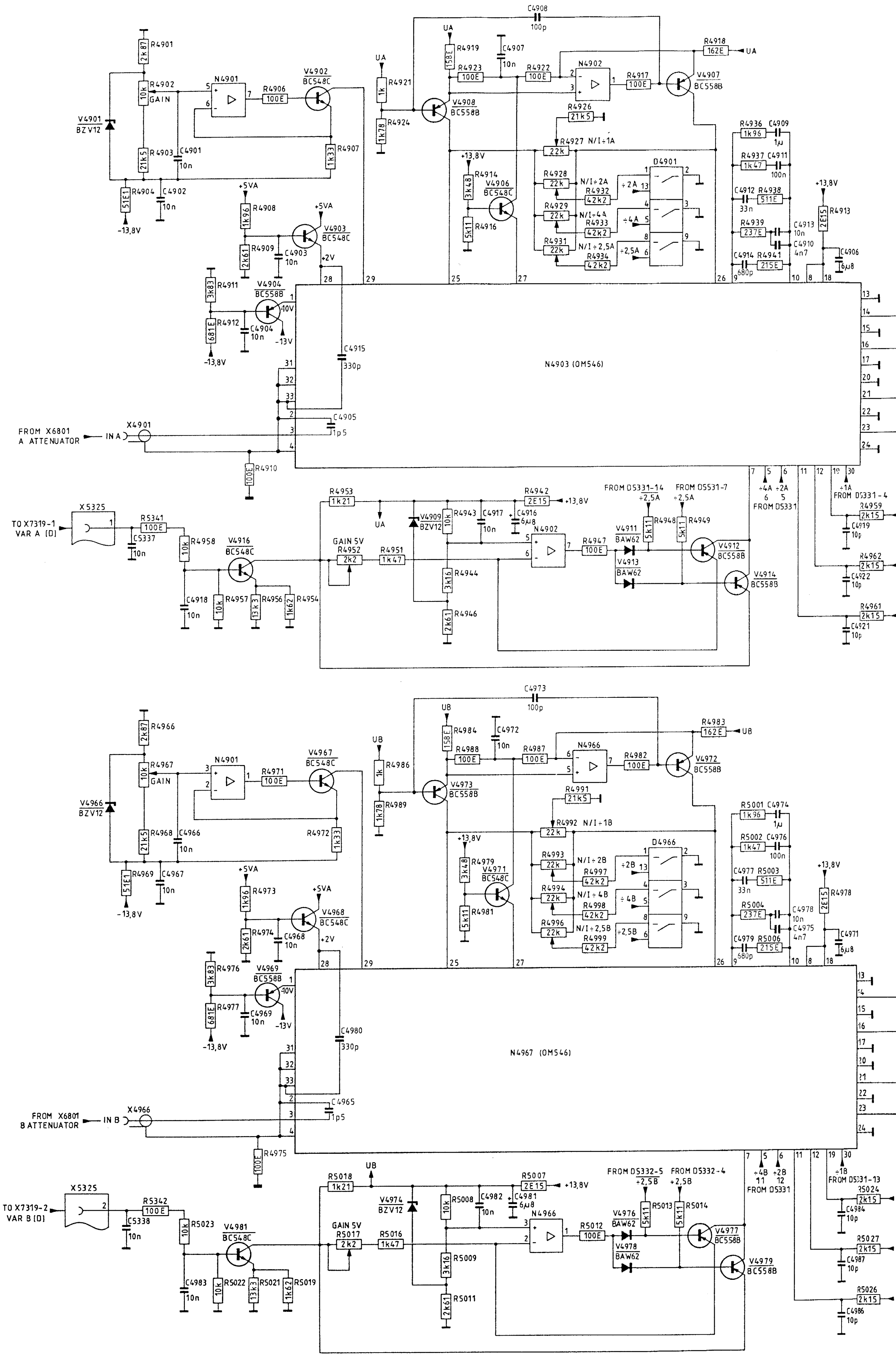


Fig.13.1. Signal unit, p.c.b. lay-out.

13-10-1



C4908
100p
R4901
2k87
R4902
10k
GAIN
N4901
R4906
100E
V4902
BC548C
V4901
BZV12
R4903
21k5
C4901
10n
R4907
1k33
R4904
51E1
C4902
10n
-13,8V
UA
R4921
1k
R4924
1k78
R4919
158E
C4907
10n
R4923
100E
R4922
100E
N4902
R4917
100E
R4918
162E
V4907
BC558B
V4908
BC558B
R4926
21k5
R4927 N/I÷1A
22k
+13,8V
R4914
3k48
V4906
BC548C
R4916
5k11
D4901
R4928
22k
N/I÷2A
R4932
42k2
÷2A
R4929
22k
N/I÷4A
R4933
42k2
÷4A
R4931
22k
N/I÷2,5A
R4934
42k2
÷2,5A
R4936
1k96
C4909
1µ
R4937
1k47
C4911
100n
C4912
33n
R4938
511E
R4939
237E
C4913
10n
C4910
4n7
C4914
680p
R4941
215E
+13,8V
R4913
2E15
C4906
6µ8
+5VA
R4908
1k96
V4903
BC548C
R4909
2k61
C4903
10n
+2V
R4911
3k83
V4904
BC558B
10V
R4912
681E
C4904
10n
-13V
-13,8V
C4915
330p
N4903 (OM546)
C4905
1p5
FROM X6801
A ATTENUATOR
INA
X4901
R4910
100E
÷4A
÷2A
6
5
FROM D5331
÷1A
FROM D5331-4
R4959
2k15
C4919
10p
R4962
2k15
C4922
10p
R4961
2k15
C4921
10p
R4953
1k21
R4942
2E15
+13,8V
FROM D5331-14
÷2,5A
FROM D5531-7
÷2,5A
TO X7319-1
VAR A (D)
X5325
R5341
100E
C5337
10n
R4958
10k
V4916
BC548C
GAIN 5V
R4952
2k2
R4951
1k47
V4909
BZV12
R4943
10k
C4917
10n
C4916
6µ8
N4902
R4947
100E
V4911
BAW62
R4948
5k11
R4949
5k11
V4912
BC558B
V4913
BAW62
V4914
BC558B
R4944
3k16
R4946
2k61
C4918
10n
R4957
10k
13k3
R4956
1k62
R4954
C4973
100p
UB
R4966
2k87
R4967
10k
GAIN
N4901
R4971
100E
V4967
BC548C
V4966
BZV12
R4968
21k5
C4966
10n
R4972
1k33
R4969
51E1
C4967
10n
-13,8V
R4984
158E
C4972
10n
R4988
100E
R4987
100E
N4966
R4982
100E
R4983
162E
V4972
BC558B
R4986
1k
R4989
1k78
V4973
BC558B
R4991
21k5
R4992 N/I÷1B
22k
+13,8V
R4979
3k48
V4971
BC548C
R4981
5k11
D4966
R4993
22k
N/I÷2B
R4997
42k2
÷2B
R4994
22k
N/I÷4B
R4998
42k2
÷4B
R4996
22k
N/I÷2,5B
R4999
42k2
÷2,5B
R5001
1k96
C4974
1µ
R5002
1k47
C4976
100n
C4977
33n
R5003
511E
R5004
237E
C4978
10n
C4975
4n7
C4979
680p
R5006
215E
+13,8V
R4978
2E15
C4971
6µ8
+5VA
R4973
1k96
V4968
BC548C
R4974
2k61
C4968
10n
+2V
R4976
3k83
V4969
BC558B
10V
R4977
681E
C4969
10n
-13V
-13,8V
C4980
330p
N4967 (OM546)
C4965
1p5
FROM X6801
B ATTENUATOR
IN B
X4966
R4975
100E
÷4B
11
÷2B
12
FROM D5331
÷1B
FROM D5331-13
R5024
2k15
C4984
10p
R5027
2k15
C4987
10p
R5026
2k15
C4986
10p
R5018
1k21
R5007
2E15
+13,8V
FROM D5332-5
÷2,5B
FROM D5332-4
÷2,5B
TO X7319-2
VAR B (D)
X5325
R5342
100E
C5338
10n
R5023
10k
V4981
BC548C
GAIN 5V
R5017
2k2
R5016
1k47
V4974
BZV12
R5008
10k
C4982
10n
C4981
6µ8
N4966
R5012
100E
V4976
BAW62
R5013
5k11
R5014
5k11
V4977
BC558B
V4978
BAW62
V4979
BC558B
R5009
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R5011
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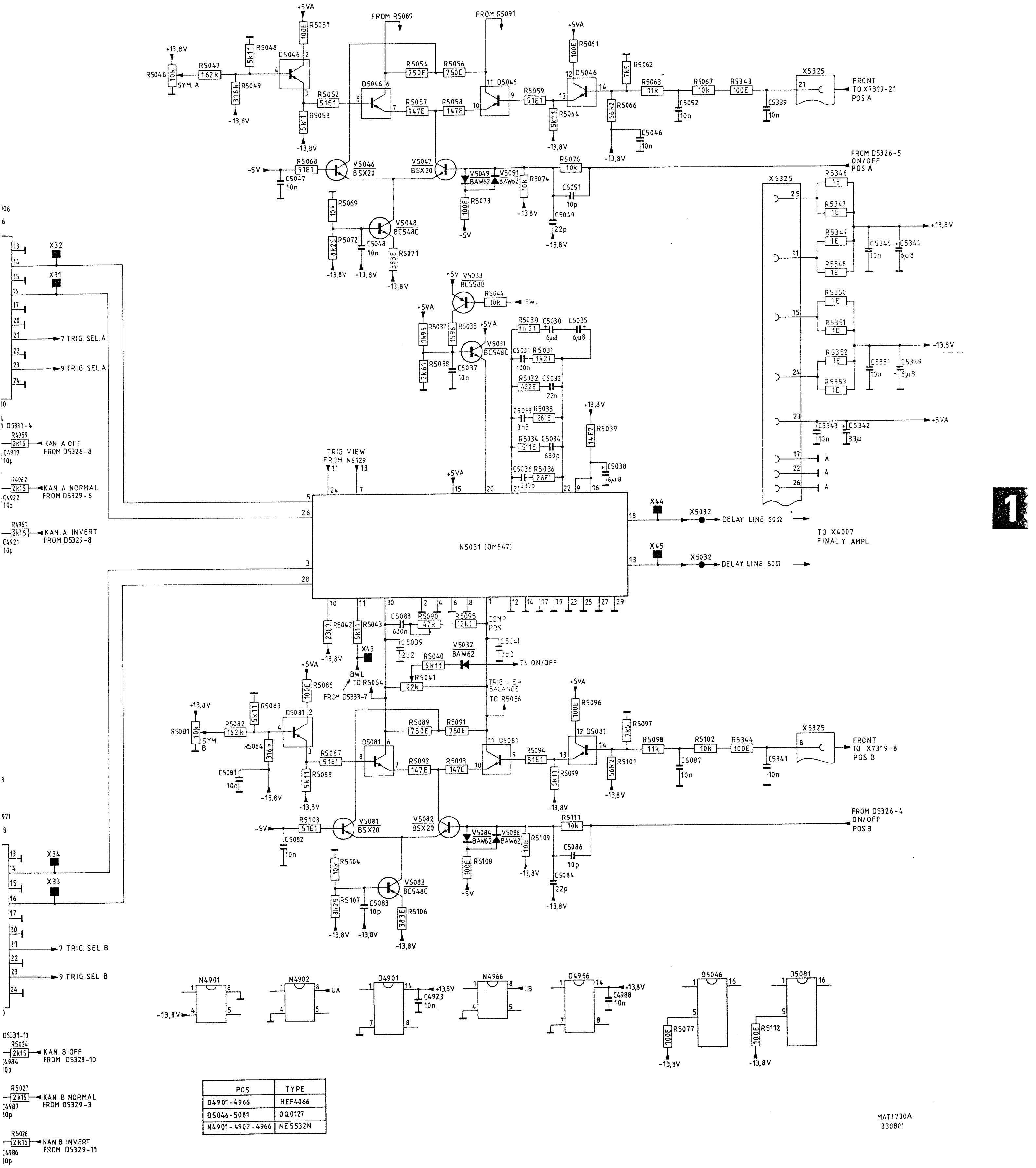
C4983
10n
R5022
10k
13k3
R5021
1k62
R5019



POS	TYPE
D4901-4966	HEF4066
D5046-5081	OQ0127
N4901-4902-4966	NE5532N

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

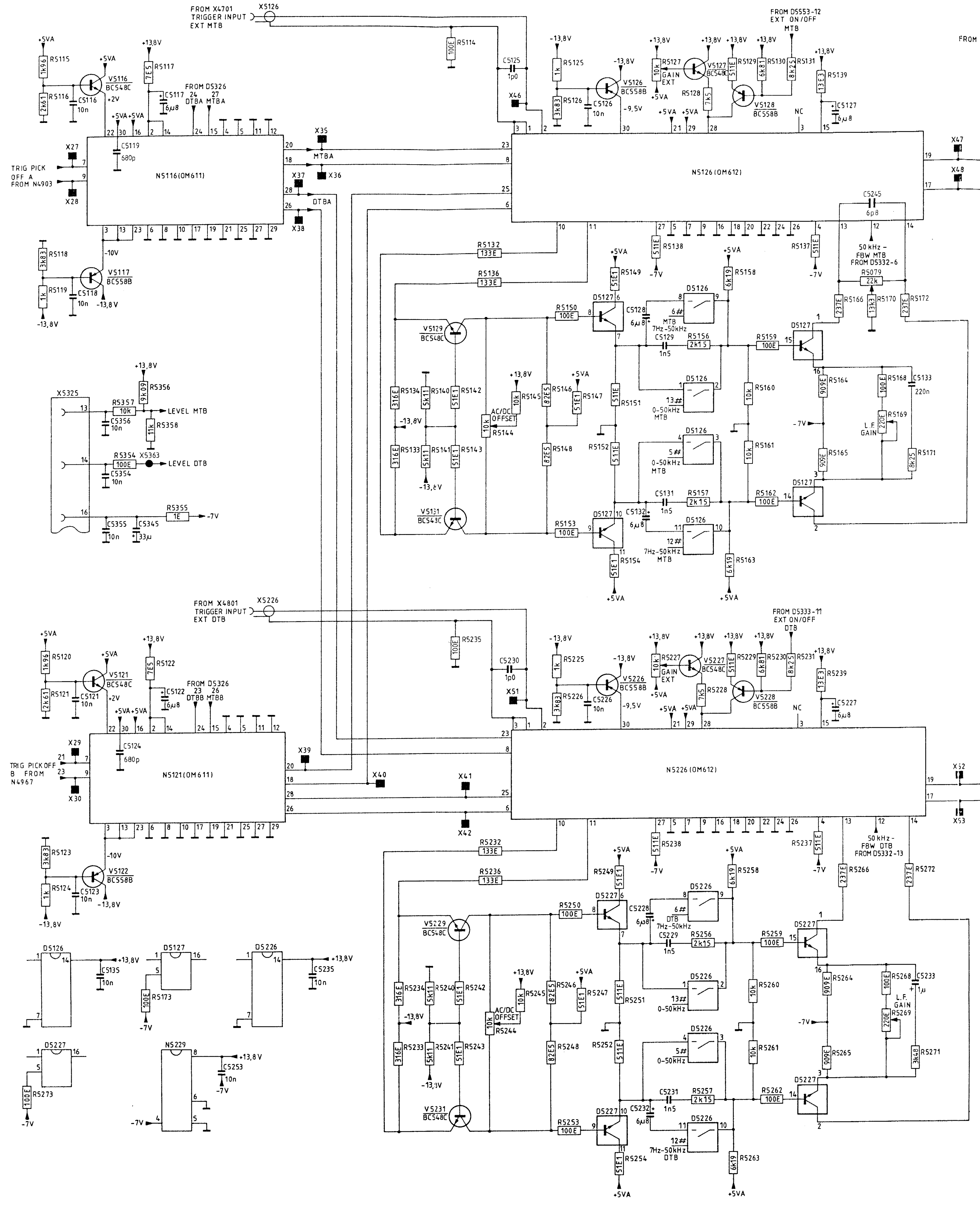
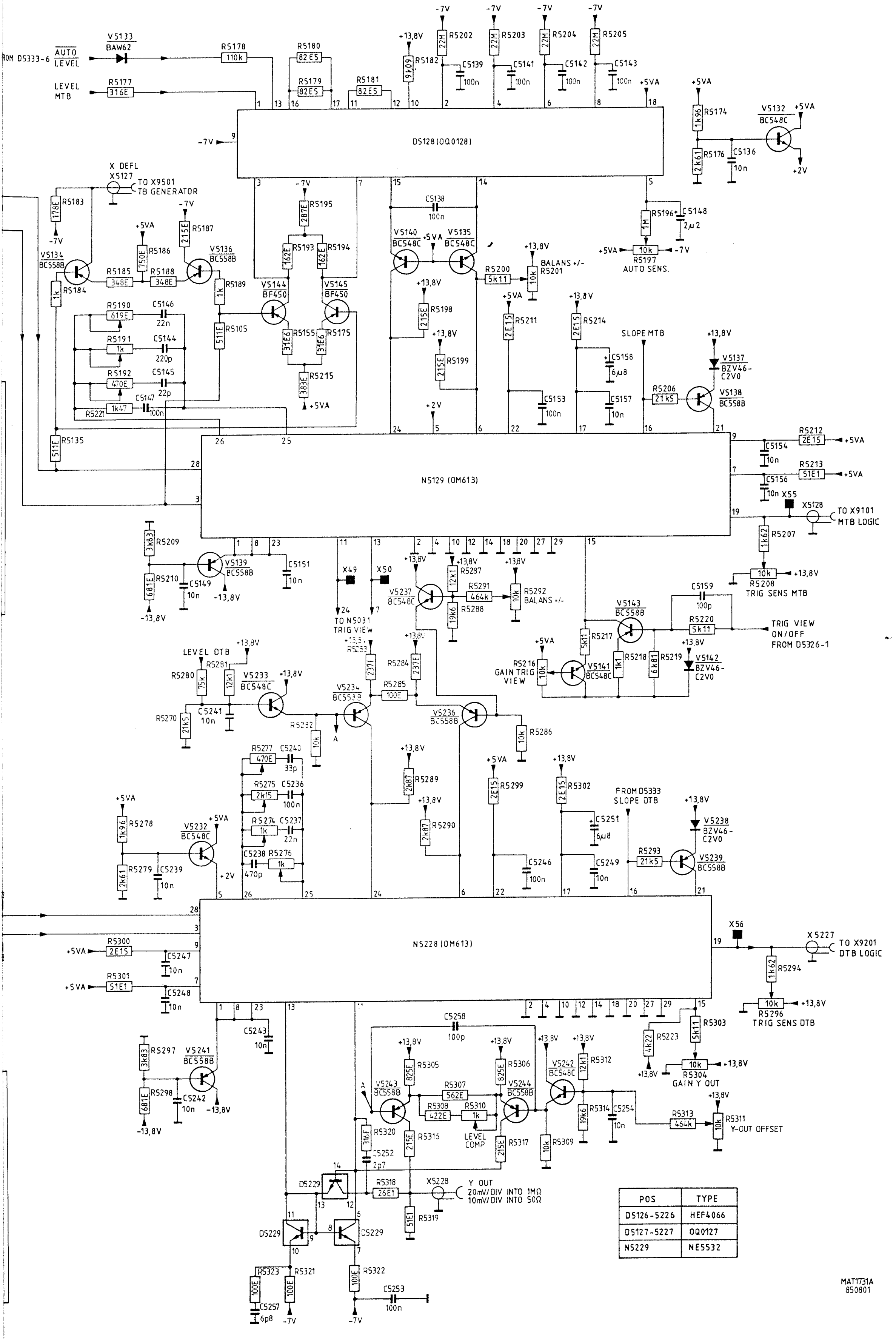


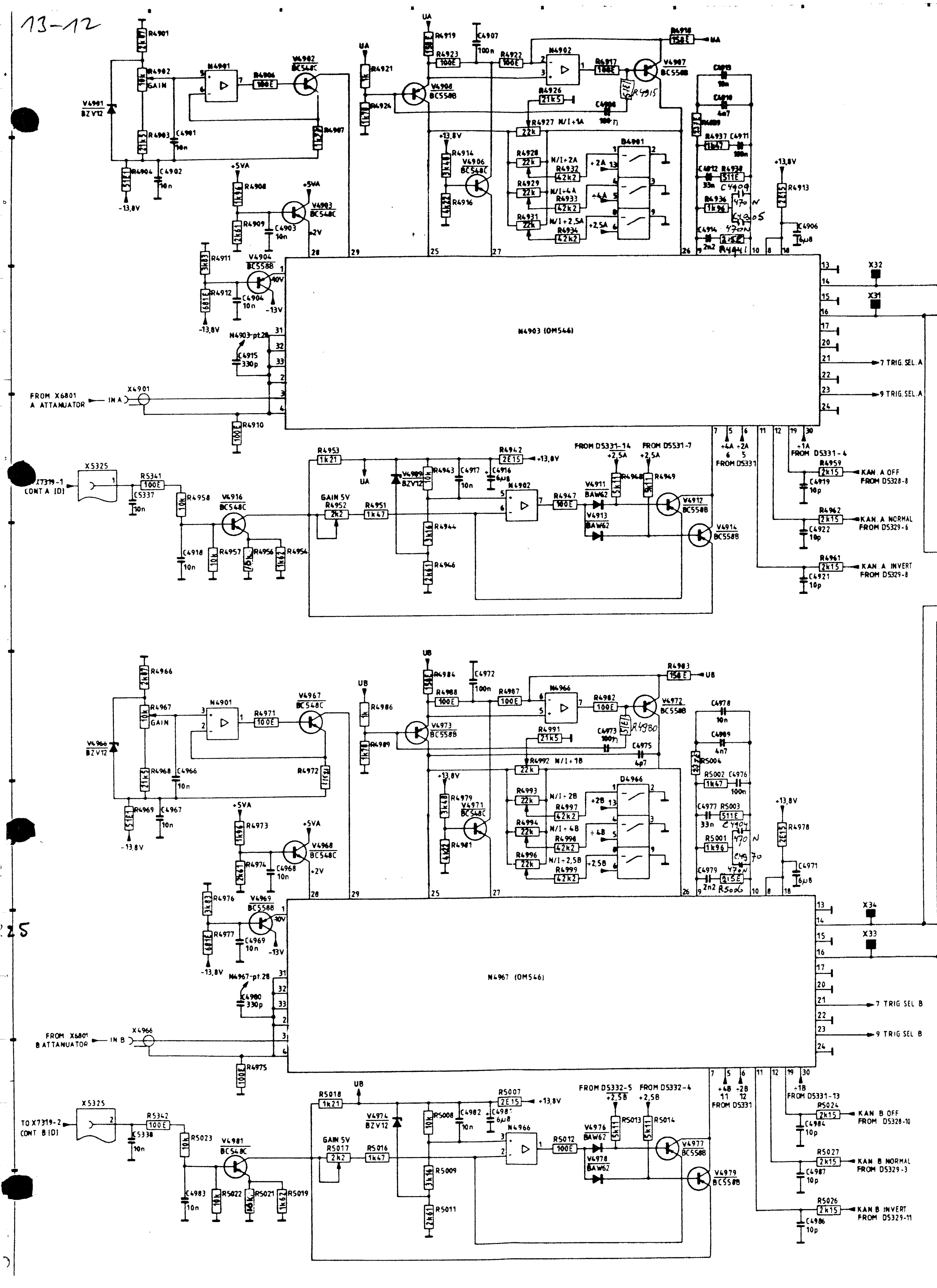
Fig.13.3. Signal unit, circuit diagram 2 (MTB/DTB triggering)

13-11-2

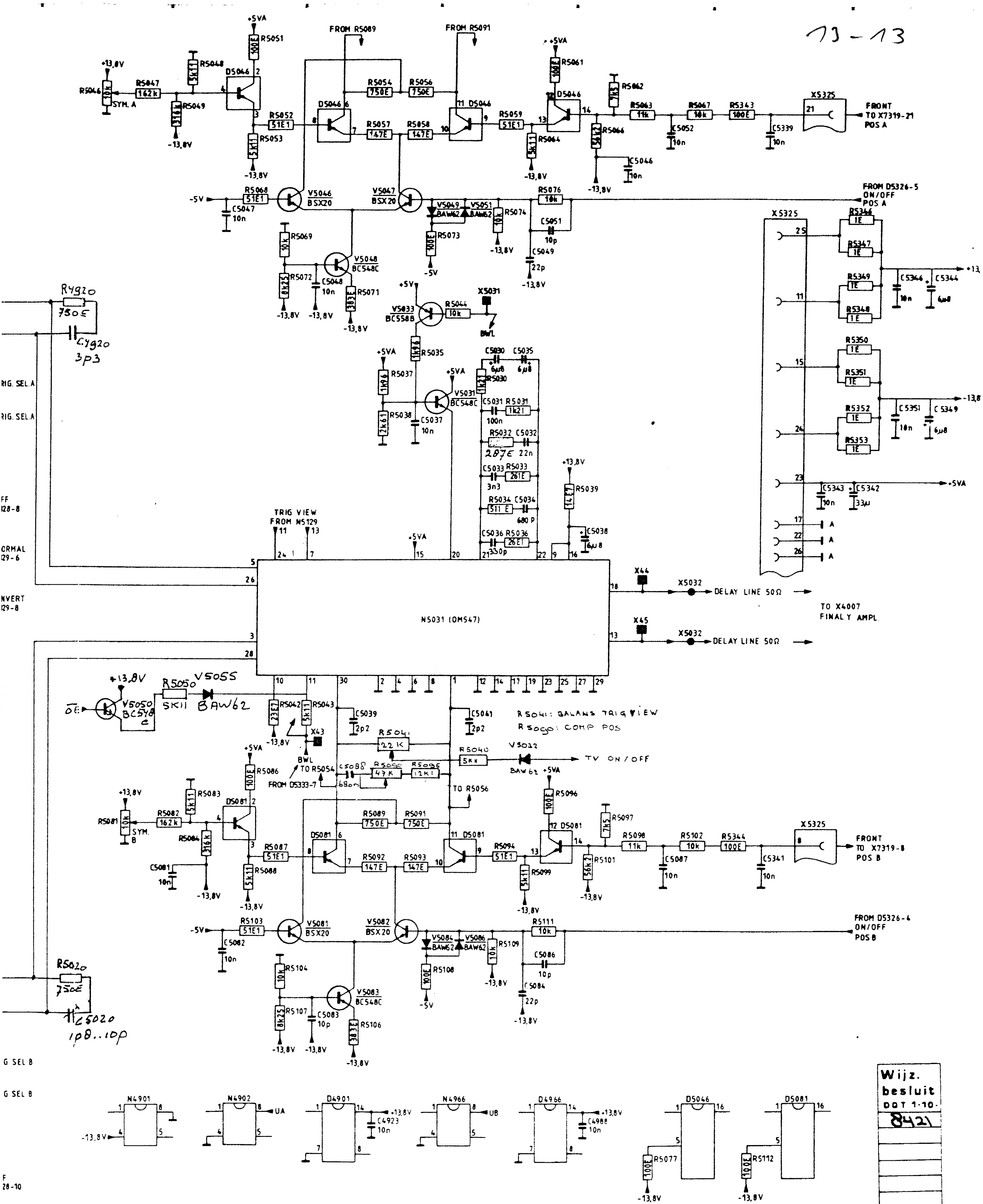


POS	TYPE
D5126-5226	HEF4066
D5127-5227	0Q0127
N5229	NE5532

13-12


N4903 (OM546)
N4967 (OM546)
FROM X6801 A ATTANUATOR
FROM X6801 B ATTANUATOR
IN A
IN B
7 TRIG. SEL. A
9 TRIG. SEL. A
7 TRIG SEL B
9 TRIG SEL B
KAN. A OFF FROM D5328-8
KAN. A NORMAL FROM D5329-6
KAN. A INVERT FROM D5329-8
KAN B OFF FROM D5328-10
KAN B NORMAL FROM D5329-3
KAN B INVERT FROM D5329-11
TO X7319-1 CONT A (D)
TO X7319-2 CONT B (D)
FROM D5331-14
FROM D5331-7
FROM D5332-5
FROM D5332-4
FROM D5331-4
FROM D5331-13
FROM D5331
GAIN 5V
X5325
X32
X31
X34
X33
B4901
D4966

11-13



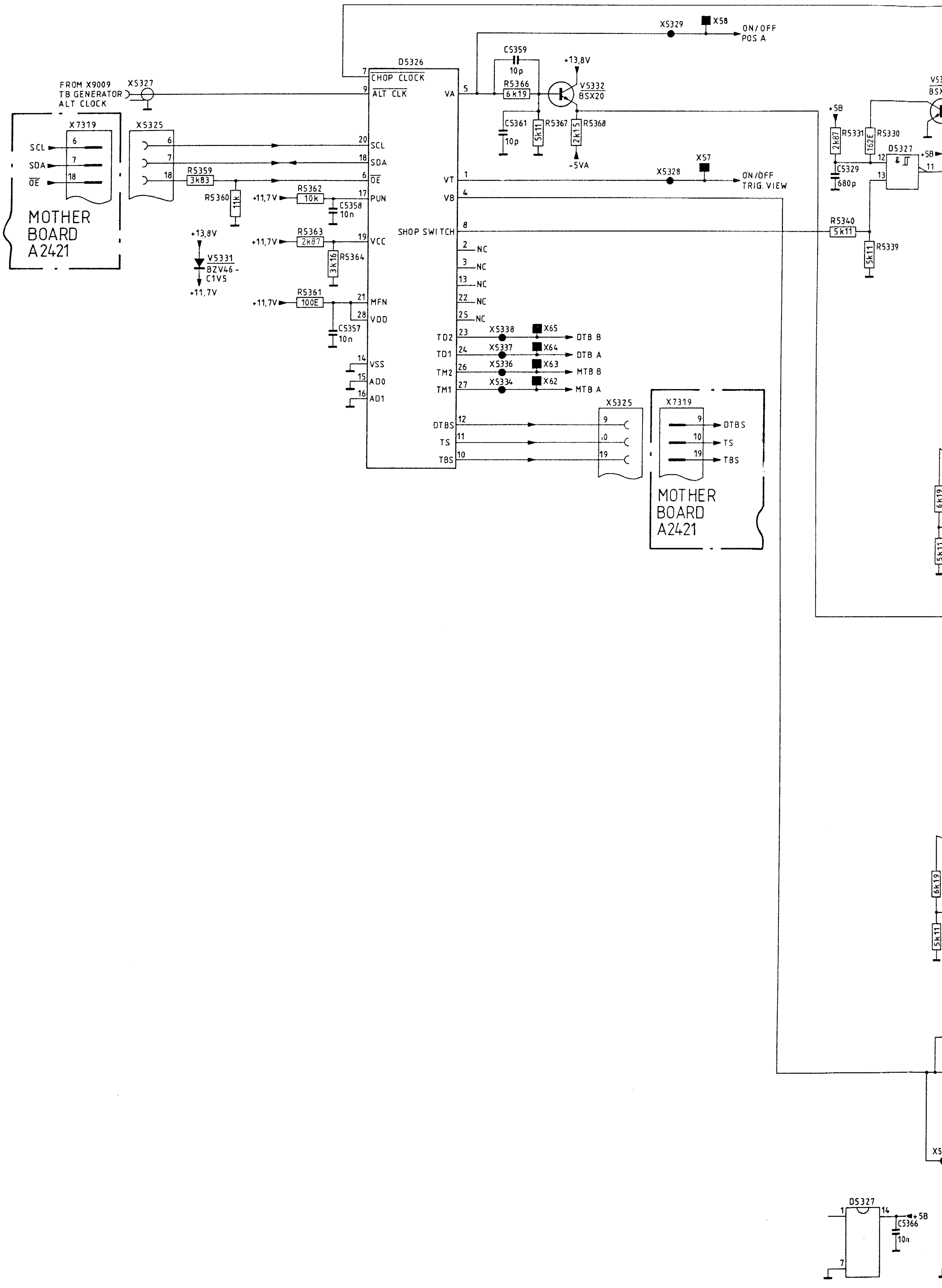
POS	TYPE
D4901-4966	HEF4066
D5046-5081	OQ0127
N4901-4902-4966	NE5532N

344.0793

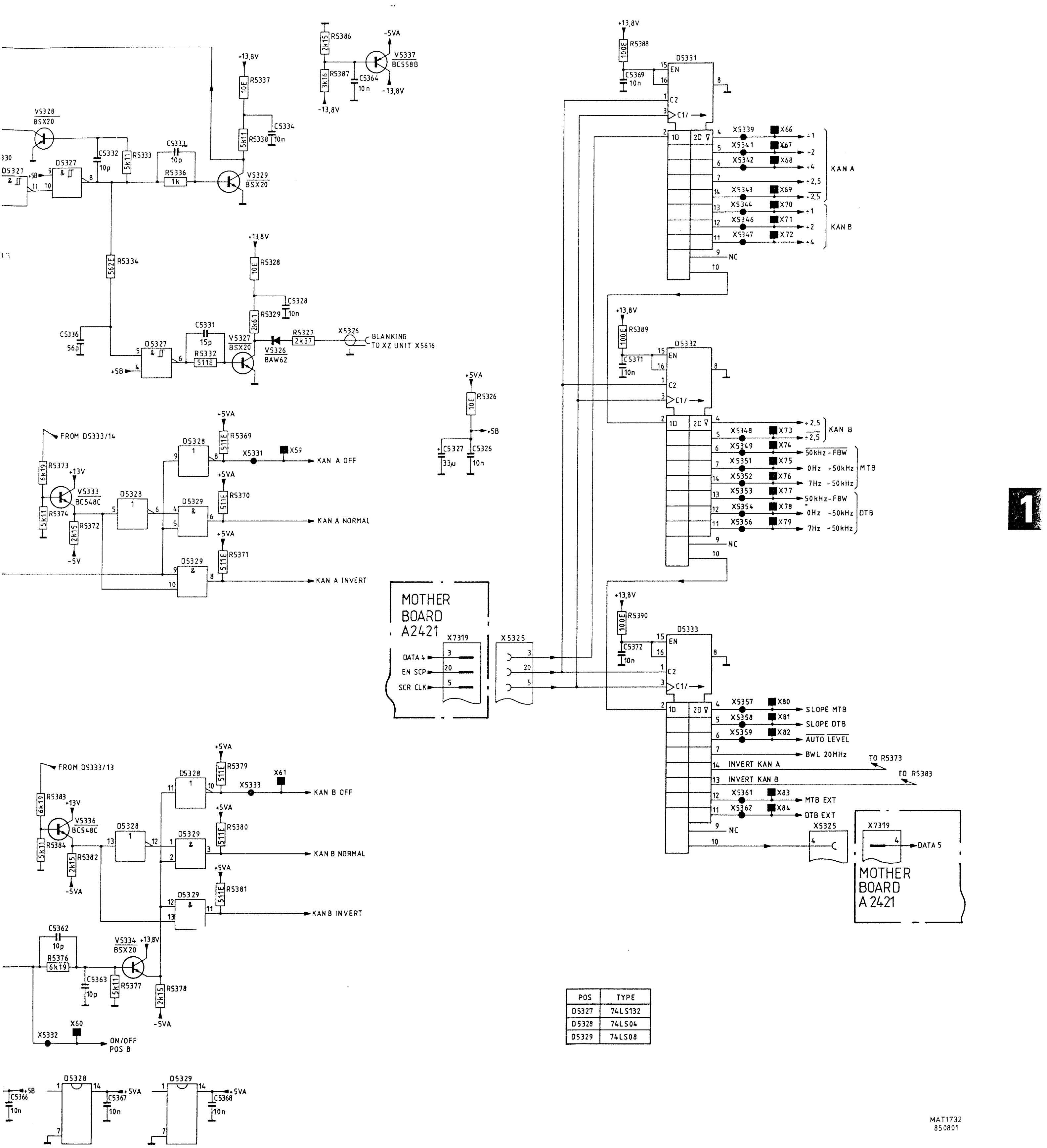
Y-SIGNAL
UNIT A1511

4022 246 0648

13-13



FROM X9009
TB GENERATOR
ALT CLOCK
X5327
D5326
CHOP CLOCK
ALT CLK
VA
X7319
X5325
SCL
SDA
OE
MOTHER BOARD A2421
R5359
3k83
R5360
11k
+11,7V
R5362
10k
C5358
10n
PUN
R5363
2k87
VCC
R5364
3k16
+13,8V
V5331
BZV46-C1V5
+11,7V
R5361
100E
MFN
VDD
C5357
10n
VSS
AD0
AD1
X5329
X58
ON/OFF
POS A
C5359
10p
R5366
6k19
+13,8V
V5332
BSX20
C5361
10p
R5367
5k11
R5368
2k15
-5VA
VT
VB
X5328
X57
ON/OFF
TRIG. VIEW
SHOP SWITCH
NC
TD2
TD1
TM2
TM1
X5338
X5337
X5336
X5334
X65
X64
X63
X62
DTB B
DTB A
MTB B
MTB A
DTBS
TS
TBS
+5B
R5331
2k87
R5330
162E
D5327
C5329
680p
R5340
5k11
R5339
5k11
6k19
C5366
10n



POS	TYPE
D5327	74LS132
D5328	74LS04
D5329	74LS08

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

13.4 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

13.4.1 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%	100PF	4822 122 31316
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 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%	100PF	4822 122 31316
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 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 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 5241	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5242	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

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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 5254	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
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

13.4.2 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 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
N 4901	INTEGR.CIRCUIT	NE5532N	SIG	5322 209 86234
N 4902	INTEGR.CIRCUIT	NE5532N	SIG	5322 209 86234
N 4966	INTEGR.CIRCUIT	NE5532N	SIG	5322 209 86234

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13.4.3 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%	1K33	5322 116 55422
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 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 4921	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4922	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4923	RES.METAL FILM	MR25	1%	100E	5322 116 55549
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	5322 116 55276
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%	1K33	5322 116 55422
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 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		1%	100E	5322 116 55549
R 4988	RES.METAL FILM	MR25		1%	100E	5322 116 55549
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 5021	RES.METAL FILM	MR25		1%	13K3	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%	422E	5322 116 50459
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%	7K5	5322 116 54608
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%	13K3	5322 116 55276
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%	110K	5322 116 54701
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%	82E5	4822 116 52814
R 5182	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 5183	RES.METAL FILM	MR25	1%	178E	5322 116 54492
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%	750E	4822 116 51234
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%	1K47	5322 116 50635
R 5223	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
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%	7K5	5322 116 54608
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 5277	POTM.SLIDE	0.3W	25%	470E	5322 105 20028
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%	10K	4822 116 51253
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
F 5390	RES.METAL FILM	MR25	1%	100E	5322 116 55549

13.4.4 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

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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

Integrated circuits

D5128	OQ0128	5322 209 82925
N5031	OM547	5322 209 82928
N4903	OM546	5322 209 82926
N4967	OM546	5322 209 82926
N5126	OM612	5322 209 82929
N5226	OM612	5322 209 82929
N5129	OM613	5322 209 82931
N5228	OM613	5322 209 82931
N5116	OM611	5322 209 82927
N5121	OM611	5322 209 82927

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

The Final Y Amplifier accepts the analog Y signal from the delay line, and the text/cursor Y sawtooth for driving the deflection coils. It also provides trace separation for the various display modes and frequency compensation to reduce signal distortion.

The Y signal from the delay line is applied at 50-ohm impedance on pins 3 and 24 to the bases of a series feedback amplifier. The emitter circuit contains an adjustable h.f. square-wave compensation network. The high frequency components are blocked by chokes L4003, L4004 so that the l.f. components 0 - 10 kHz are routed via two low-pass filters R4029, C4008, R4027 and R4031, C4007, R4028 to an operational amplifier. A square-wave adjustment network on the output feeds a second operational amplifier. The l.f. path is then balanced again by differential amplifier V4003/V4004 (fed from current source V4006) and coupled to the main signal path in the emitter circuit of the series feedback amplifier. In this way, the circuit is compensated against pulse distortion.

The amplifier drives the c.r.t. via a common-base circuit and an emitter-follower series feedback amplifier with external current source V4008. The c.r.t. has 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 D4006.

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 an 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 an OR-gate to D4003-11.

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 by the 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.

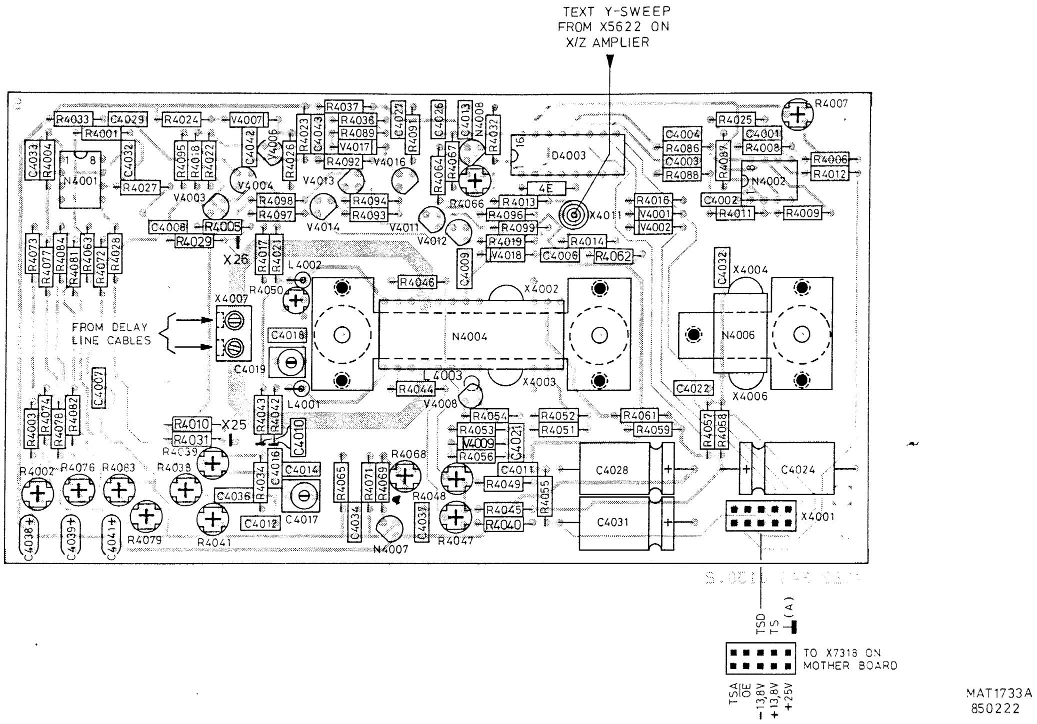
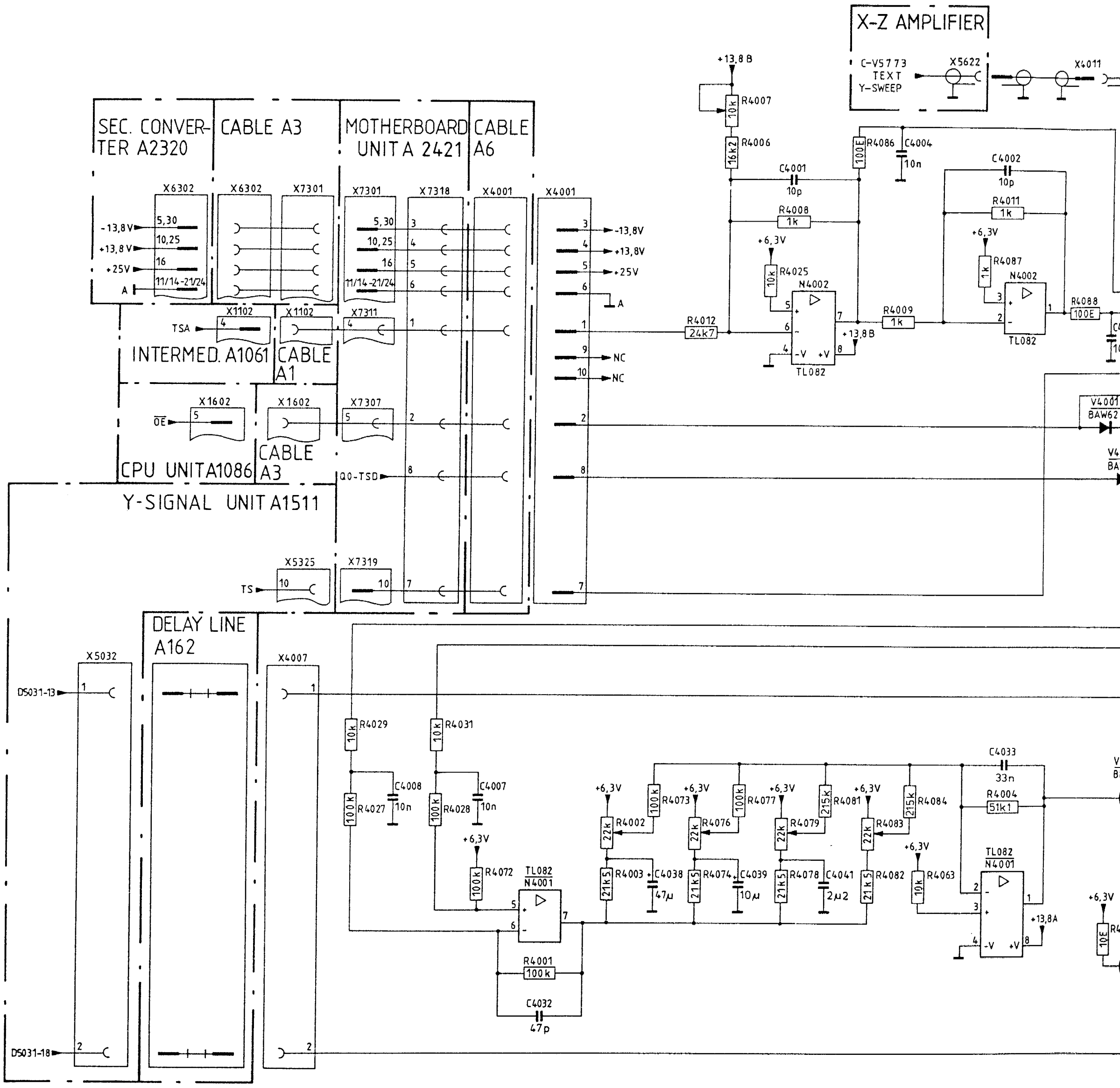


Fig.14.1. Final Y amplifier, p.c.b. lay-out.

14-3


X-Z AMPLIFIER
C-V5773
TEXT
Y-SWEEP
X5622
X4011
SEC. CONVER-TER A2320
CABLE A3
MOTHERBOARD UNIT A 2421
CABLE A6
X6302
X7301
X7318
X4001
-13,8V
+13,8V
+25V
A
TSA
INTERMED. A1061
CABLE A1
X1102
X7311
X1602
X7307
OE
CPU UNIT A1086
CABLE A3
Q0-TSD
Y-SIGNAL UNIT A1511
X5325
X7319
TS
NC
DELAY LINE A162
X5032
X4007
D5031-13
D5031-18
R4007
R4006
C4001
10p
R4008
1k
R4086
C4004
10n
C4002
R4011
R4087
R4025
N4002
TL082
R4012
24k7
R4009
R4088
100E
V4001
BAW62
+13,8B
+6,3V
R4029
R4031
C4008
C4007
R4027
R4028
R4072
N4001
R4001
100k
C4032
47p
R4002
R4073
R4076
R4077
R4079
R4081
R4083
R4084
R4003
C4038
47μ
R4074
C4039
10μ
R4078
C4041
2μ2
R4082
R4063
C4033
33n
R4004
51k1
+13,8A

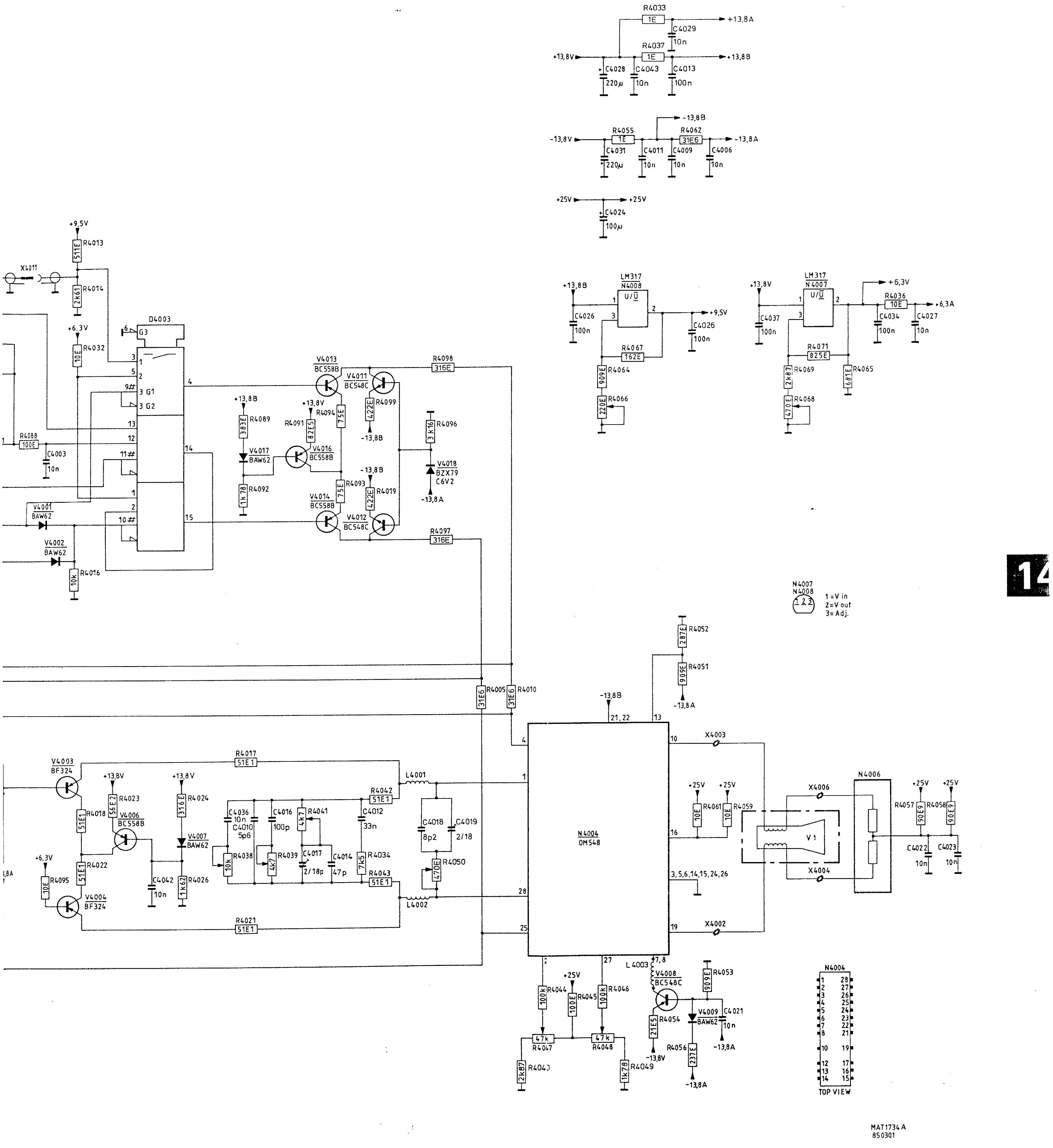


Fig.14.2. Final Y amplifier circuit diagram.

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	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4002	CAP.CERAMIC	2%	10PF	4822 122 32185
C 4003	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4004	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4006	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4007	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4008	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4009	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4011	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4012	CAP.FOIL	100V 10%	33NF	5322 121 42489
C 4013	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 4014	CAP.CERAMIC	2%	47PF	4822 122 31072
C 4016	CAP.CERAMIC	2%	100PF	4822 122 31316
C 4017	CAP.TRIMMER	300V	2/18PF	5322 125 50051
C 4018	CAP.CERAMIC	0.25PF	8.2PF	4822 122 31052
C 4019	CAP.TRIMMER	300V	2/18PF	5322 125 50051
C 4021	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4022	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4023	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4024	CAP.ELECTROLYT.	-10+50%	100UF	4822 124 20715
C 4026	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 4027	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4028	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20693
C 4029	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4031	CAP.ELECTROLYT.	-10+50%	220UF	4822 124 20693
C 4032	CAP.CERAMIC	2%	47PF	4822 122 31072
C 4033	CAP.FOIL	100V 10%	33NF	5322 121 42489
C 4034	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 4036	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4037	CAP.FOIL	63V 10%	100NF	5322 121 42386
C 4038	CAP.TANTAL	6.3V 20%	47UF	4822 124 10197
C 4039	CAP.SOLID ALU.	6.3V 20%	10UF	5322 124 14066
C 4041	CAP.TANTAL	16V 20%	2.2UF	4822 124 10204
C 4042	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 4043	CAP.CERAMIC	-20+50%	10NF	4822 122 31414

14.1.2 INTEGRATED CIRCUITS

D 4003	INTEGR.CIRCUIT	HEF4053BP	PEL	5322 209 14121
D 4901	INTEGR.CIRCUIT	HEF4066BP	PEL	5322 209 14104
N 4001	INTEGR.CIRCUIT	TL082CP	T.I	5322 209 86064
N 4002	INTEGR.CIRCUIT	TL082CP	T.I	5322 209 86064
N 4007	INTEGR.CIRCUIT	LM317LZ	MOT	5322 209 82943
N 4008	INTEGR.CIRCUIT	LM317LZ	MOT	5322 209 82943

14.1.3 RESISTORS

R 4001	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4002	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4003	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4004	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 4005	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 4006	RES.METAL FILM	MR25	1%	16K2	5322 116 55361

R 4007	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 4008	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4009	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4010	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 4011	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4012	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 4013	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 4014	RES.METAL FILM	MR25	1%	2K61	5322 116 50671
R 4016	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4017	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4018	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4019	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 4021	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4022	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4023	RES.METAL FILM	MR25	1%	56E2	5322 116 54446
R 4024	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 4025	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4026	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 4027	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4028	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4029	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4031	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4032	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4033	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 4034	RES.METAL FILM	MR25	1%	7K5	5322 116 54608
R 4036	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4037	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 4038	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 4039	POTM.SLIDE	0.3W	25%	4K7	5322 105 20034
R 4040	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 4041	POTM.SLIDE	0.3W	25%	4K7	5322 105 20034
R 4042	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4043	RES.METAL FILM	MR25	1%	51E1	5322 116 54442
R 4044	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4045	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4046	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4047	POTM.SLIDE	0.3W	25%	47K	5322 105 20036
R 4048	POTM.SLIDE	0.3W	25%	47K	5322 105 20036
R 4049	RES.METAL FILM	MR25	1%	1K78	5322 116 50515
R 4050	POTM.SLIDE	0.3W	25%	470E	5322 105 20028
R 4051	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 4052	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 4053	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 4054	RES.METAL FILM	MR25	1%	21E5	5322 116 50677
R 4055	RES.METAL FILM	MR25	1%	1E	4822 116 51179
R 4056	RES.METAL FILM	MR25	1%	237E	5322 116 50679
R 4057	RES.METAL FILM	MR25	1%	90E9	5322 116 54466
R 4058	RES.METAL FILM	MR25	1%	90E9	5322 116 54466
R 4059	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4061	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4062	RES.METAL FILM	MR25	1%	31E6	5322 116 54034
R 4063	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 4064	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 4065	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 4066	POTM.SLIDE	0.3W	25%	220E	5322 105 20031
R 4067	RES.METAL FILM	MR25	1%	162E	5322 116 50417
R 4068	POTM.SLIDE	0.3W	25%	470E	5322 105 20028
R 4069	RES.METAL FILM	MR25	1%	2K87	5322 116 55279
R 4071	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 4072	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4073	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4074	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4076	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4077	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 4078	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4079	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4081	RES.METAL FILM	MR25	1%	215K	5322 116 54728

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R 4082	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 4083	POTM.SLIDE	0.3W	25%	22K	5322 105 20035
R 4084	RES.METAL FILM	MR25	1%	215K	5322 116 54728
R 4086	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4087	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 4088	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 4089	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 4091	RES.METAL FILM	MR25	1%	82E5	4822 116 52814
R 4092	RES.METAL FILM	MR25	1%	1K78	5322 116 50515
R 4093	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 4094	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 4095	RES.METAL FILM	MR25	1%	10E	5322 116 50452
R 4096	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 4097	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 4098	RES.METAL FILM	MR25	1%	316E	5322 116 54511
R 4099	RES.METAL FILM	MR25	1%	422E	5322 116 50459

14.1.4 SEMI CONDUCTORS

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

Integrated circuits

N4004	OM548	5322 209 82932
N4006	OM549	5322 209 82933

4

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 lns 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.

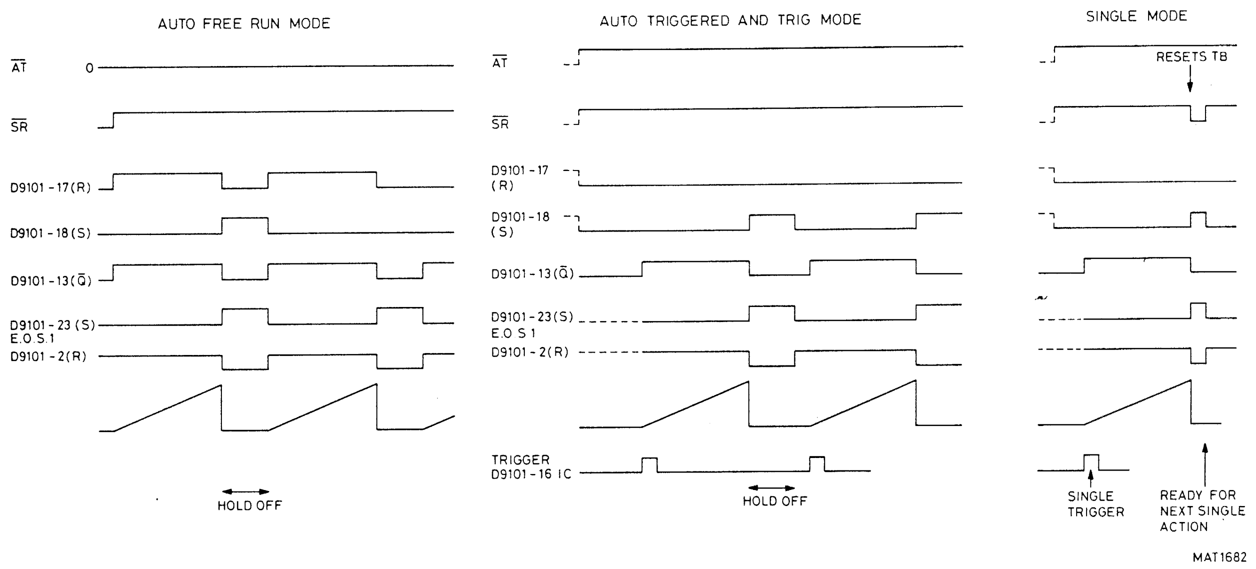
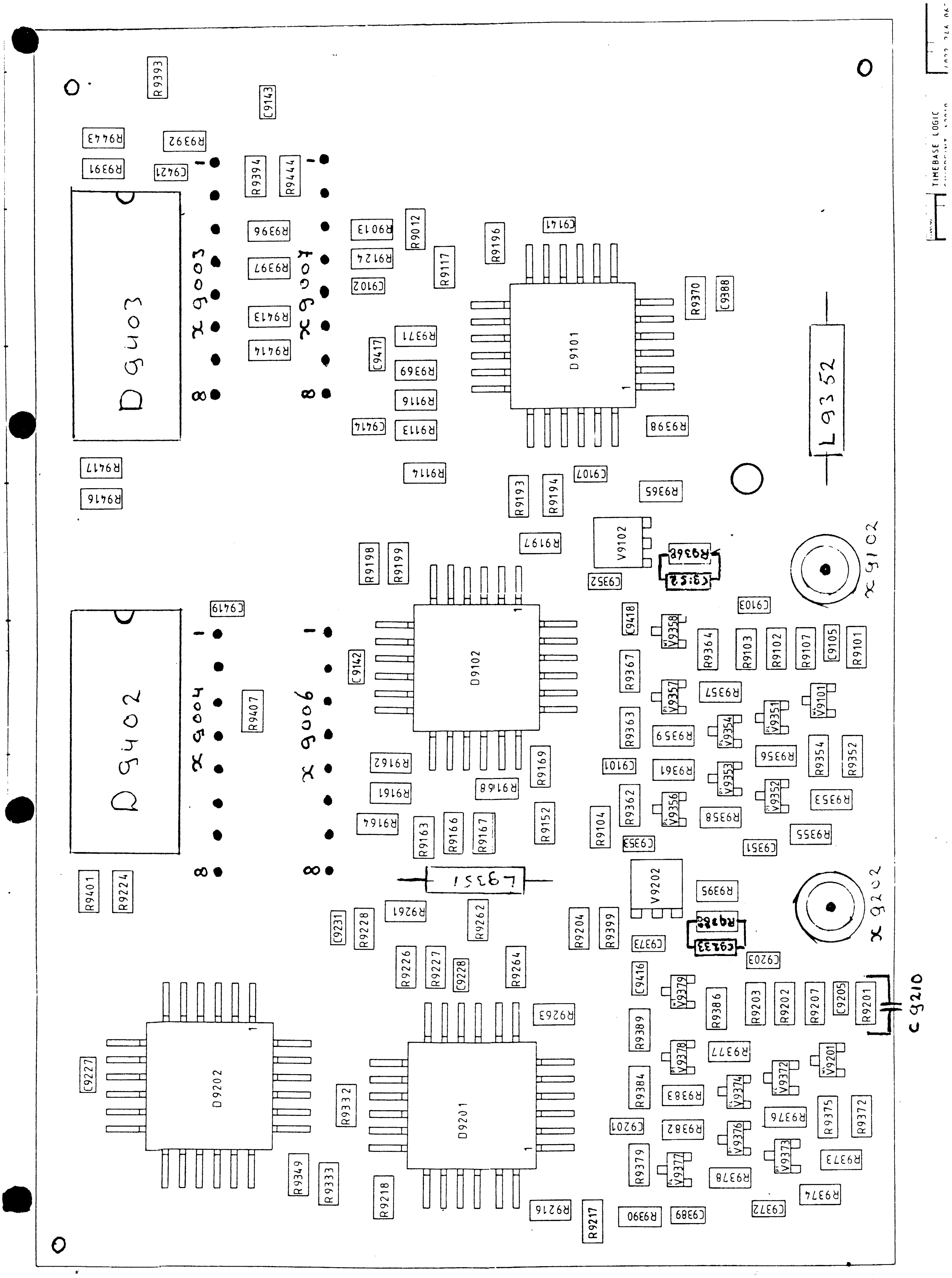


Fig.15.1.Voltage wave forms in MTB circuits

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).

K-2-1



TIMEBASE LOGIC
D9403
D9402
D9101
D9102
D9201
D9202
X9003
X9004
X9006
X9007
X9102
X9202
L9352
L9351
V9102
V9202
V9358
V9357
V9354
V9351
V9101
V9353
V9356
V9352
V9379
V9378
V9374
V9372
V9201
V9376
V9373
V9377
C9210
R9393
C9143
R9443
R9392
R9391
C9421
R9394
R9444
R9396
R9397
R9413
R9414
R9013
R9012
R9124
C9102
R9117
R9196
C9141
R9370
C9388
C9417
R9371
R9369
R9116
C9414
R9113
R9398
R9417
R9416
R9114
R9193
R9194
C9107
R9365
R9197
R9198
R9199
C9352
C9419
C9418
C9103
C9142
R9364
R9103
R9102
R9107
C9105
R9101
R9367
R9357
R9407
R9363
R9359
R9356
R9354
R9352
C9101
R9361
R9162
R9169
R9161
R9168
R9362
R9353
R9164
R9163
R9166
R9167
R9152
R9104
R9358
R9355
C9353
C9351
R9401
R9224
R9395
C9231
R9228
R9261
R9262
R9204
R9399
C9373
C9233
C9203
R9226
R9227
C9228
R9264
C9416
R9386
R9203
R9202
R9207
C9205
R9201
R9263
R9389
R9377
C9227
R9384
R9383
R9332
R9375
R9372
R9376
C9201
R9382
R9379
R9373
R9378
R9349
R9333
R9218
R9216
R9217
R9390
C9389
C9372
R9374

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.

<u>SINGLE mode (see fig.15.1)</u>
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 TBSO 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 TBSO 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.

1

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

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 }
- C9132 by V9137, controlled by H3 from the HEF-bus.} See fig. 15.2

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

	MAIN TIME BASE								H.OFF		DELAYED TIME BASE							
	CURRENT SOURCE						SWEEP		SWEEP		CURRENT SOURCE						SWEEP	
SET-TINGS	S2	S1	S0	M100	COM-1nsM	10nsM	M2	M3	H2	H3	02	01	00	D100	1nsD	10nsD	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	0	1	1	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 diode V9209 blocks . 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 D9202-18 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 (pin12) 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

<u>End of sweep</u> 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.

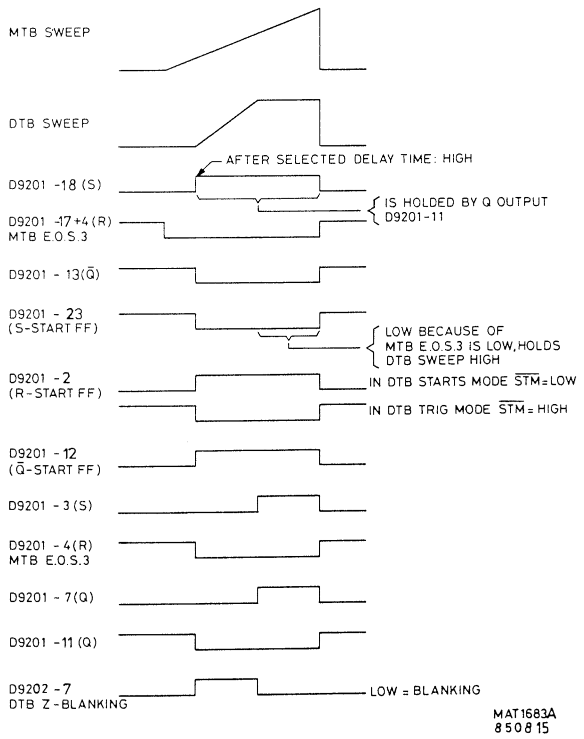


Fig.15.3. Voltage waveforms in the DTB circuits.

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.

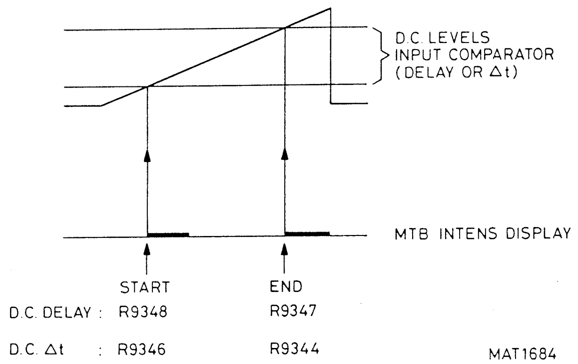


Fig.15.4. Start of the DELAY and delta t sweep at the lefthand side and the righthand side of the screen.

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.

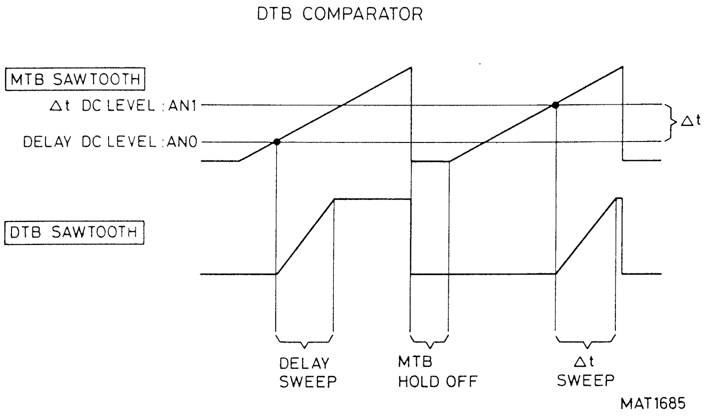


Fig.15.5. DTB display sequence.

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 OQ 0200); MTB ON is high, DTB ON is low.

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-(5). The other input is also high during the MTB sweep (Z MTB) so via the output, the high is fed to input 5 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 D9402-7 so the input 11 of the DTB NOR-gate D9403 is high. With one input (pin 11) 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 high)
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 10 of AND-gate D9402. During the DTB sweep the other input (11) is high (Z DTB), so the output (14) 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 13 of the DTB NOR-gate D9403 is low because the X-DEFL is low. The low Z MTB is applied to input 6 of AND-gate D9402, the output (3) of which gives a low to the input 11 of the DTB NOR-gate D9403. Finally, the high D OFF input gives a low output on D9401-3, which in turn gives a low input 12 of AND-gate D9402. This results in a low to input 12 of the DTB NOR-gate D9403. With all inputs low, the output to the base of V9418 is high. V9418 conducts, as a result V9417 blocks, so current is only drawn via V9416 by V9422.

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. One part, MTB and DTB on together, is described. At the moment that the MTB and DTB are on, both Z MTB and Z DTB are high. With Z MTB and TBS (MTB on) both high, the inputs of AND-gate D9402-(4 and 5) are high. This gives a high output (2) which is fed to input 5 of MTB NOR-gate D9403. Therefore a low output is supplied to the base of V9414 (X52).

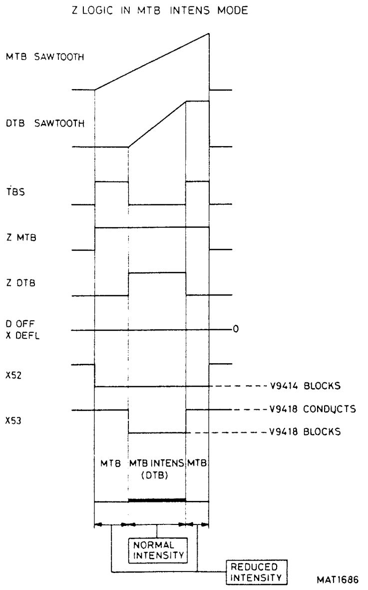


Fig.15.6. Voltage waveforms in Z logic in MTB INTENSified mode.

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	0
0.1	0	1	0	1	0	1	0	0
50 us	0	1	0	1	0	1	0	0
20	0	1	0	1	0	0	0	0
10	0	1	0	1	0	0	0	0
5	0	1	0	1	0	0	0	0
2	0	1	0	1	0	0	0	0
1	0	1	0	1	0	0	0	0
0.5	0	1	0	0	0	0	0	0
0.2	0	1	0	0	0	0	0	0
0.1	0	1	0	0	0	0	0	0
50 ns	0	1	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 1.3 V 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 3.63 V then diode V9616 conducts and reduces the intensity range as shown, via the input buffer.

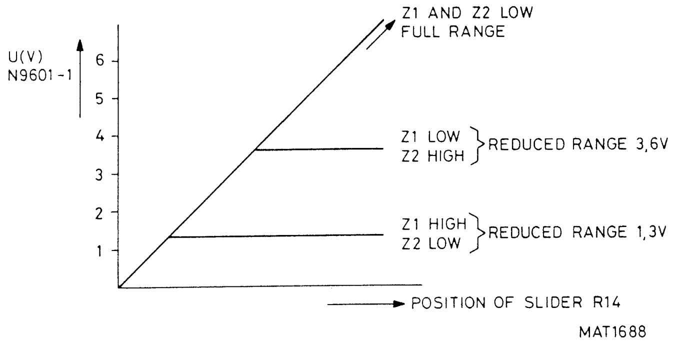


Fig.15.8. Graph of range of INTENSity control circuit as a function of the HEF 4094 bus signals Z1 and Z2.

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 from a reference voltage divider R9428/R9427. The current drawn from the Z pre-amplifier normally increases with increased INTENS control setting. However, up to 4.7 V of the potentiometer control no intensity output is produced by current source V9421 because it is biased off by zener diode V9419. After this dead angle, the slope is determined by R9429 and R9431.
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)

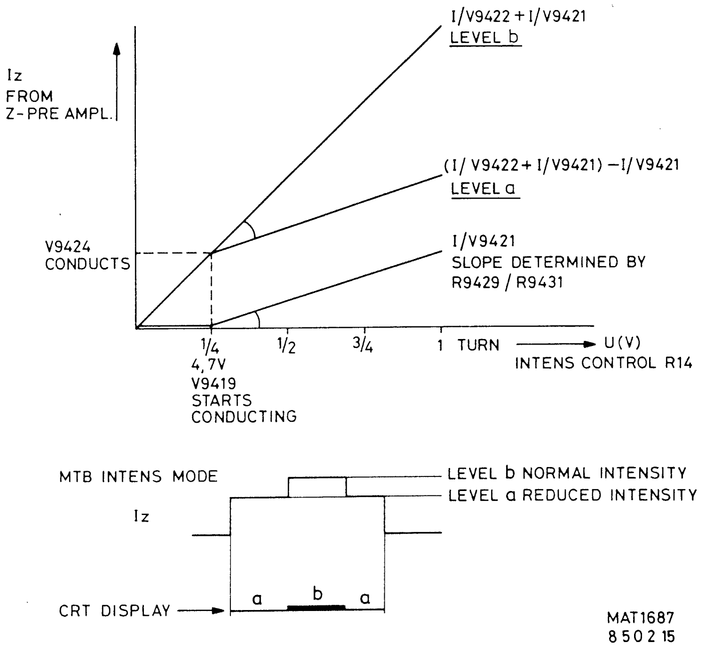


Fig.15.9. Graph of range of INTENSity control circuit.

At the potentiometer level when diode V9424 conducts the slope is determined by R9421 in parallel with R9431. In this 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.

When both the MTB and the DTB are on,(Z MTB and Z DTB high) V9414 and V9418 are switched off, so current is drawn by V9422 via V9416, and also by V9421 via V9417, from the Z 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

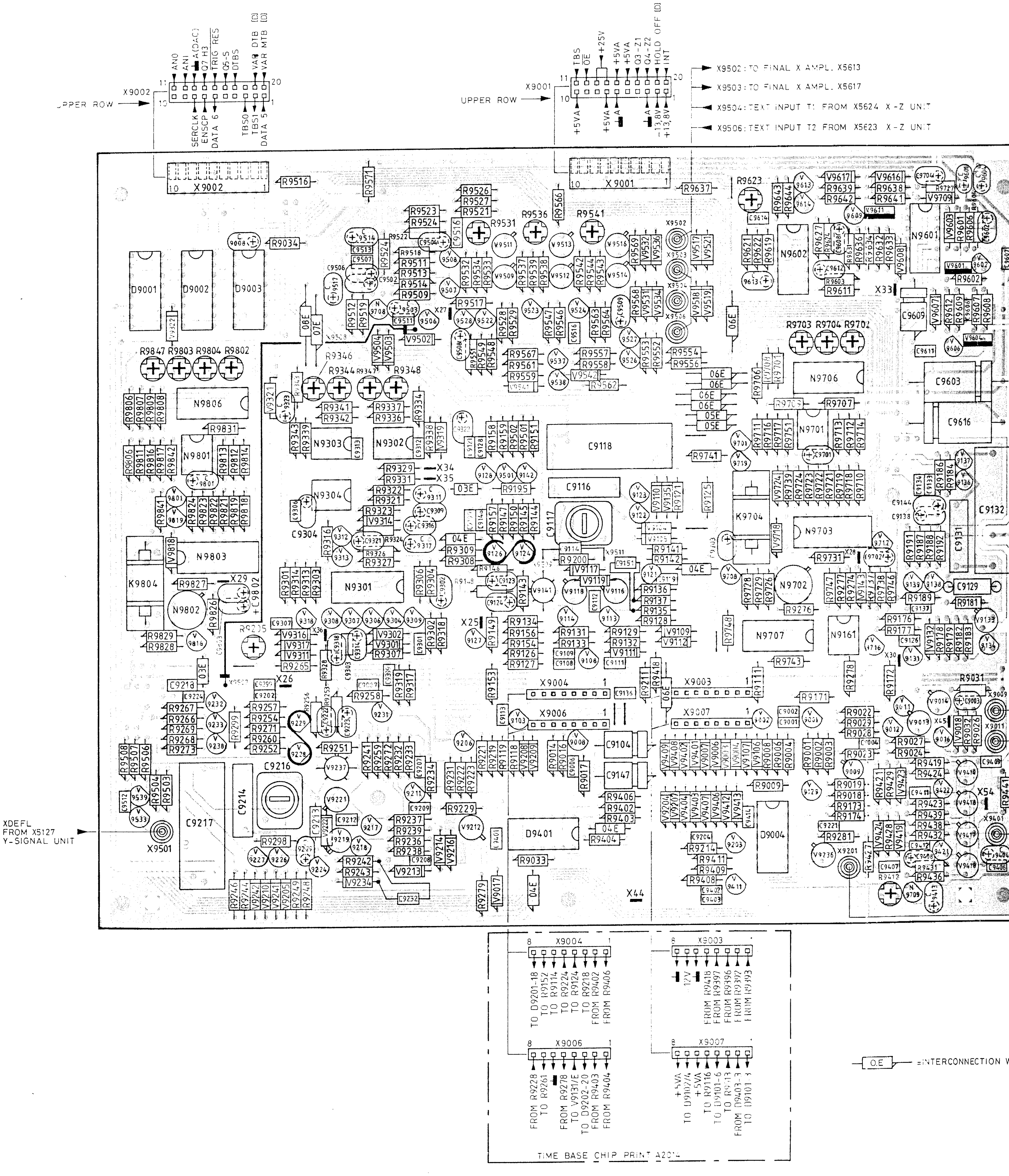


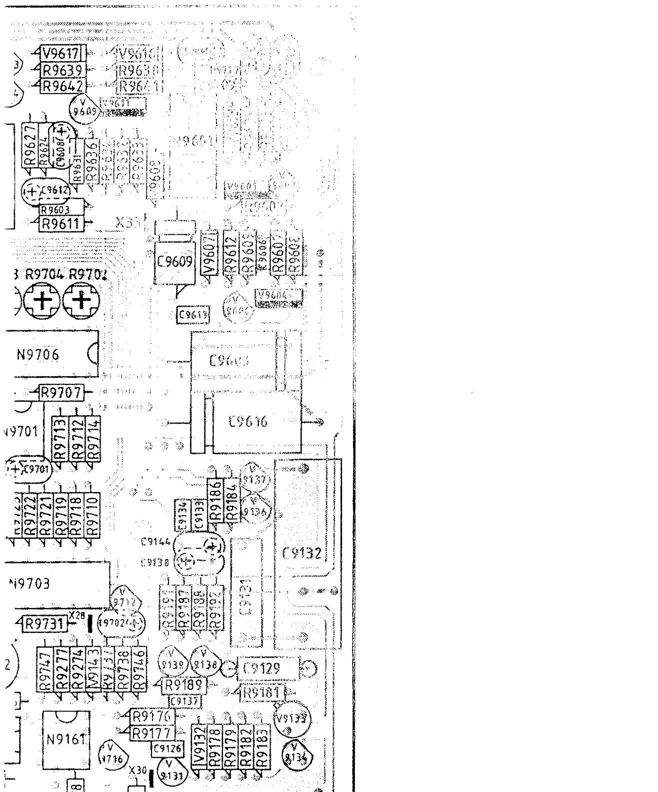
Fig.15.10 Time base unit, p.c.b. lay-out.

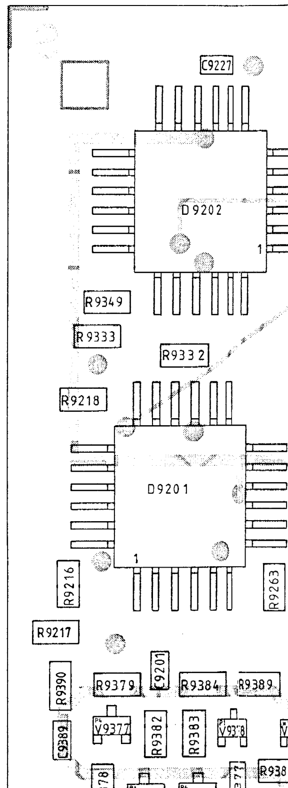
AMPL. X5613

AMPL. X5617

T1 FROM X5624 X-Z UNIT

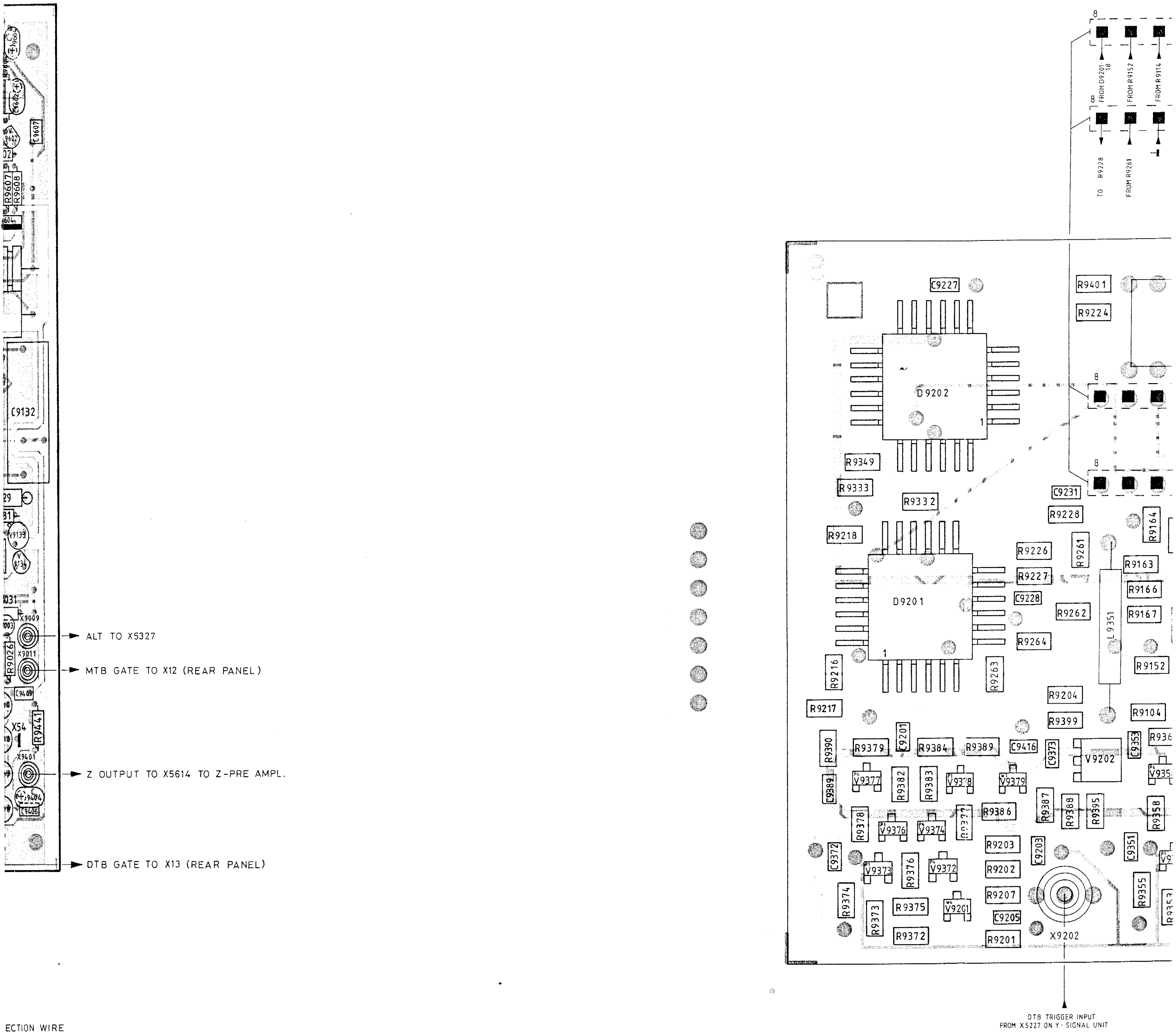
T2 FROM X5623 X-Z UNIT





O.E =INTERCONNECTION WIRE

MAT1735A
850801



MAT1735A
850801

Fig.15.

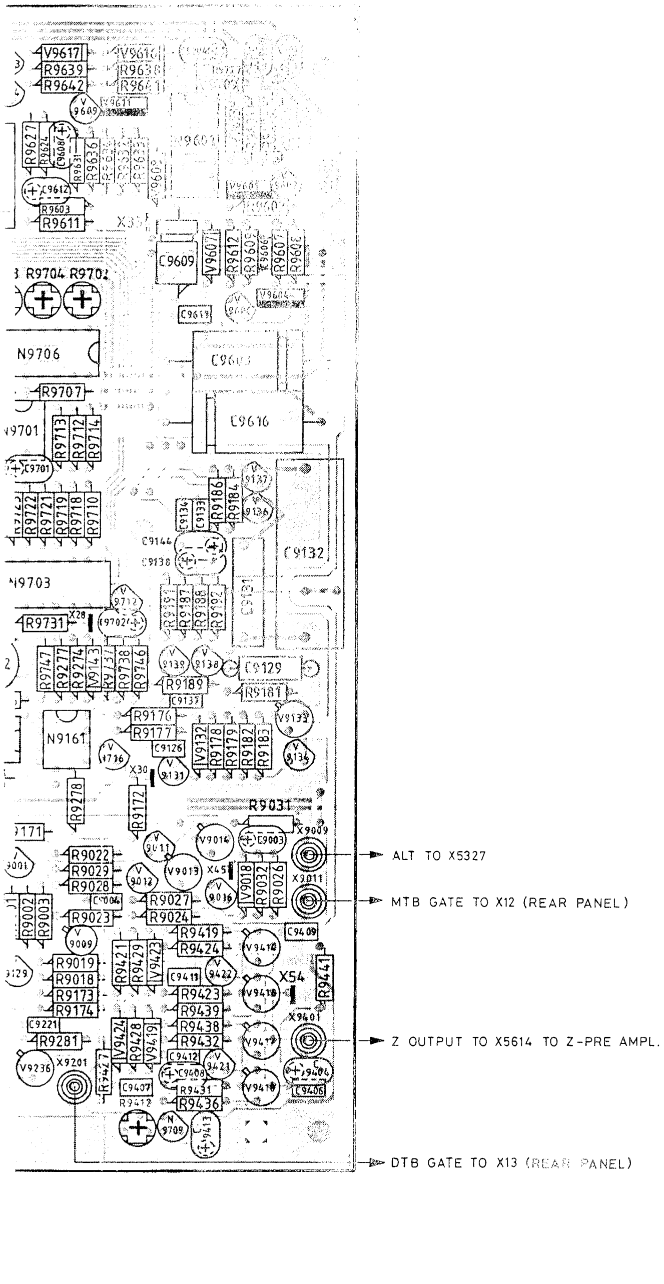
15-26-1

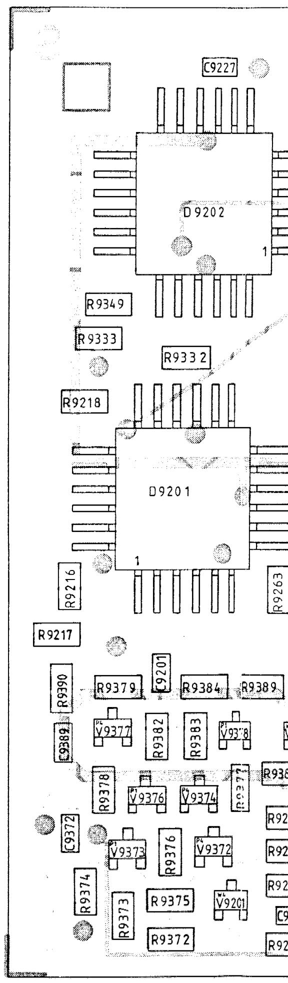
AMPL. X5613

AMPL. X5617

T1 FROM X5624 X-Z UNIT

T2 FROM X5623 X-Z UNIT





O.E =INTERCONNECTION WIRE

MAT1735A
850801

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 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 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 9404	CAP.TANTAL	16V	20%	6.8UF	5322 124 14069
C 9406	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 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

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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 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

15.4.2 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	TL082CP	T.I	5322 209 86064
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

15.4.3 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%	3K48	5322 116 55367
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%	10E	5322 111 90095
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	10%	8E2	5322 111 90876
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

1

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

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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 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%	110E	5322 111 90877
R 9366	RES.CHIP	RC-01	5%	120E	4822 111 90339
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 9384	RES.CHIP	RC-01	5%	10E	5322 111 90095
R 9386	RES.CHIP	RC-01	5%	47E	4822 111 90217
R 9387	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9388	RES.CHIP	RC-01	5%	47E	4822 111 90217
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%	110E	5322 111 90877
R 9396	RES.CHIP	RC-01	5%	120E	4822 111 90339
R 9397	RES.CHIP	RC-01	5%	120E	4822 111 90339
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%	26K1	5322 116 54651
R 9423	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 9424	RES.METAL FILM	MR25	1%	422E	5322 116 50459
R 9427	RES.METAL FILM	MR25	1%	1K33	5322 116 55422
R 9428	RES.METAL FILM	MR25	1%	2K37	5322 116 54576
R 9429	RES.METAL FILM	MR25	1%	31K6	5322 116 54657
R 9431	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 9432	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 9436	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9438	RES.METAL FILM	MR25	1%	100E	5322 116 55549

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R 9439	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 9441	RES.METAL FILM	MR25	1%	10E	5322 116 50452
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 9502	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 9503	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
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 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%	3K83	5322 116 54589
R 9522	RES.METAL FILM	MR25	1%	100E	5322 116 55549
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%	13K3	5322 116 55276
R 9527	RES.METAL FILM	MR25	1%	12K1	5322 116 50572
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%	470E	5322 105 20028
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%	13K3	5322 116 55276
R 9639	RES.METAL FILM	MR25		1%	464E	5322 116 50536
R 9641	RES.METAL FILM	MR25		1%	4K22	5322 116 50729
R 9642	RES.METAL FILM	MR25		1%	1K33	5322 116 55422
R 9643	RES.METAL FILM	MR25		1%	10K	4822 116 51253
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%	316K	5322 116 55268
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

15.4.4 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-C6V2	PEL	4822 130 34167
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

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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 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-C4V7	PEL	4822 130 34174
V 9421	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9422	TRANSISTOR	BC548C	PEL	4822 130 44196
V 9423	DIODE	BZX79-C4V3	PEL	4822 130 31554
V 9424	DIODE	BAW62	PEL	4822 130 30613
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

15.4.5 MISCELLANEOUS

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

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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 D5601 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 R5616 (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 R5616 (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 R5616 is applied to the emitter of common-base transistor V5606 and fed to the selector switch diode V5614.
The 0 and 4 mA Z signals and the CHOP blanking signals are also fed to a common-base transistor, V5607. In addition, the EXT Z-MOD input is routed via a long-tailed pair V5602/V5604 to the emitter of V5607. External blanking is achieved by a high input, unblanking by a low input. Transistor V5604 therefore draws less current at blanking. The Z signal on the collector of V5607 is fed to the selector switch diode V5616.

Selection between Text and Z signals

Z selection is determined by a signal from the CTU fed to the base of transistor V5612 of long-tailed pair V5612/V5613. 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 V5612 and high on its collector switches on V5609. This short-circuits the TEXT Z-signal path and blocks diode V5614.
With V5612 off, V5613 is on and the low on its collector switches off V5611. This allows the Z signal to flow via diode V5616 to the emitter of V5618.

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When selecting TEXT-Z, the high input switches on V5612 and the low on its collector switches off V5609. The TEXT input is no longer short-circuited but flows via diode V5614 to the emitter of V5618. With V5612 on, V5613 is off and its high collector switches on V5611, which short-circuits the time-base Z signal and blocks V5616.

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 V5701 and V5702. The collector outputs are coupled to the transistors V5711, V5707 and V5713, 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. Two NTC resistors R5717, R5712 provide drift compensation. The x1 and x10 balance and the zero level on +12 V output is obtained by preset R5726 and R5738 on the collectors of V5701 and V5702.

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.

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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.

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.

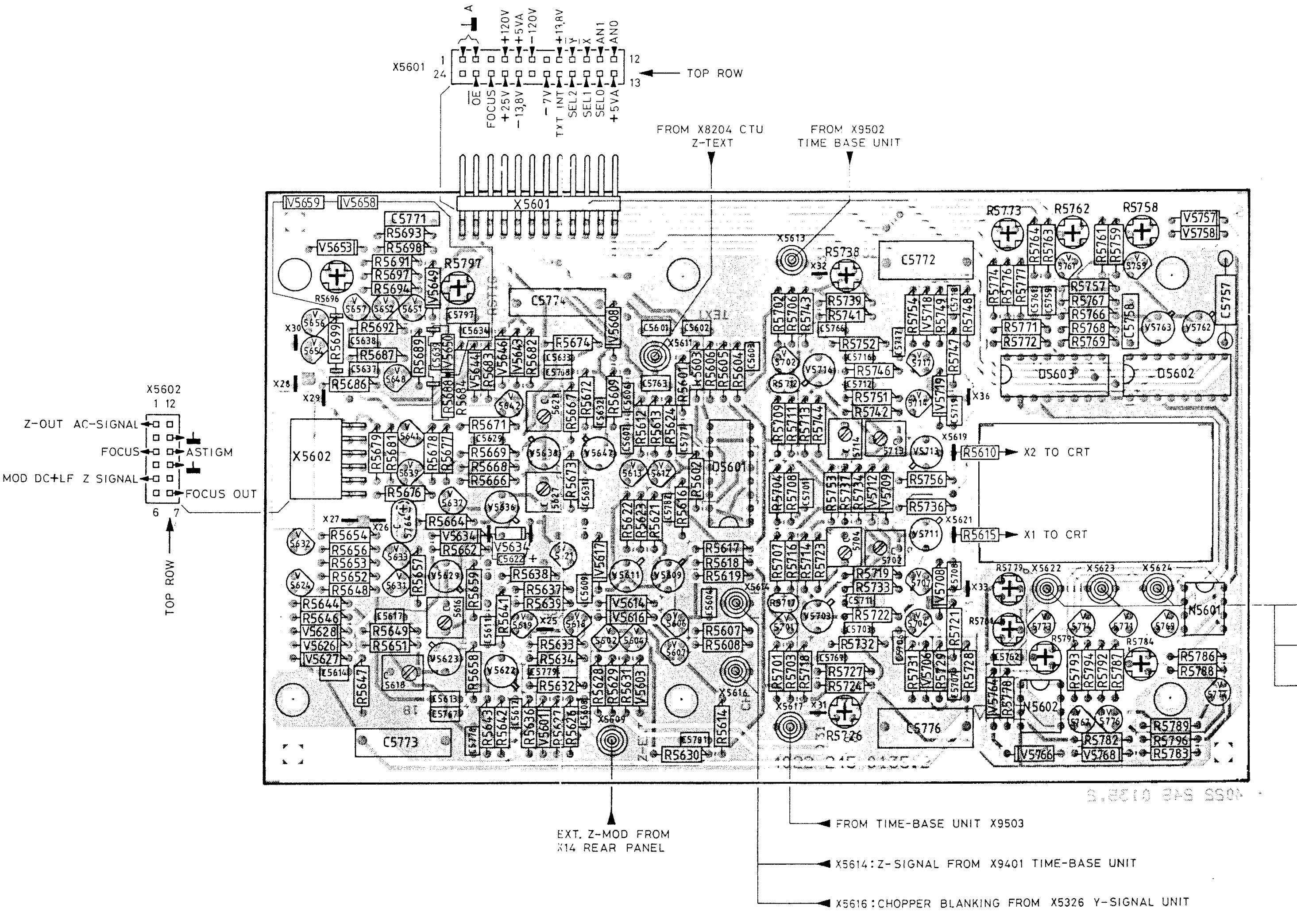
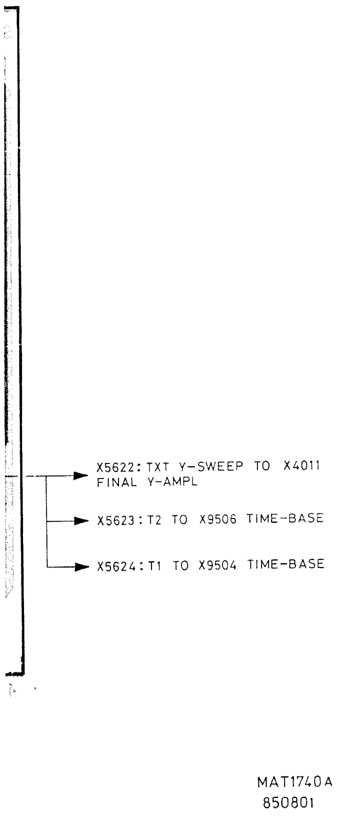
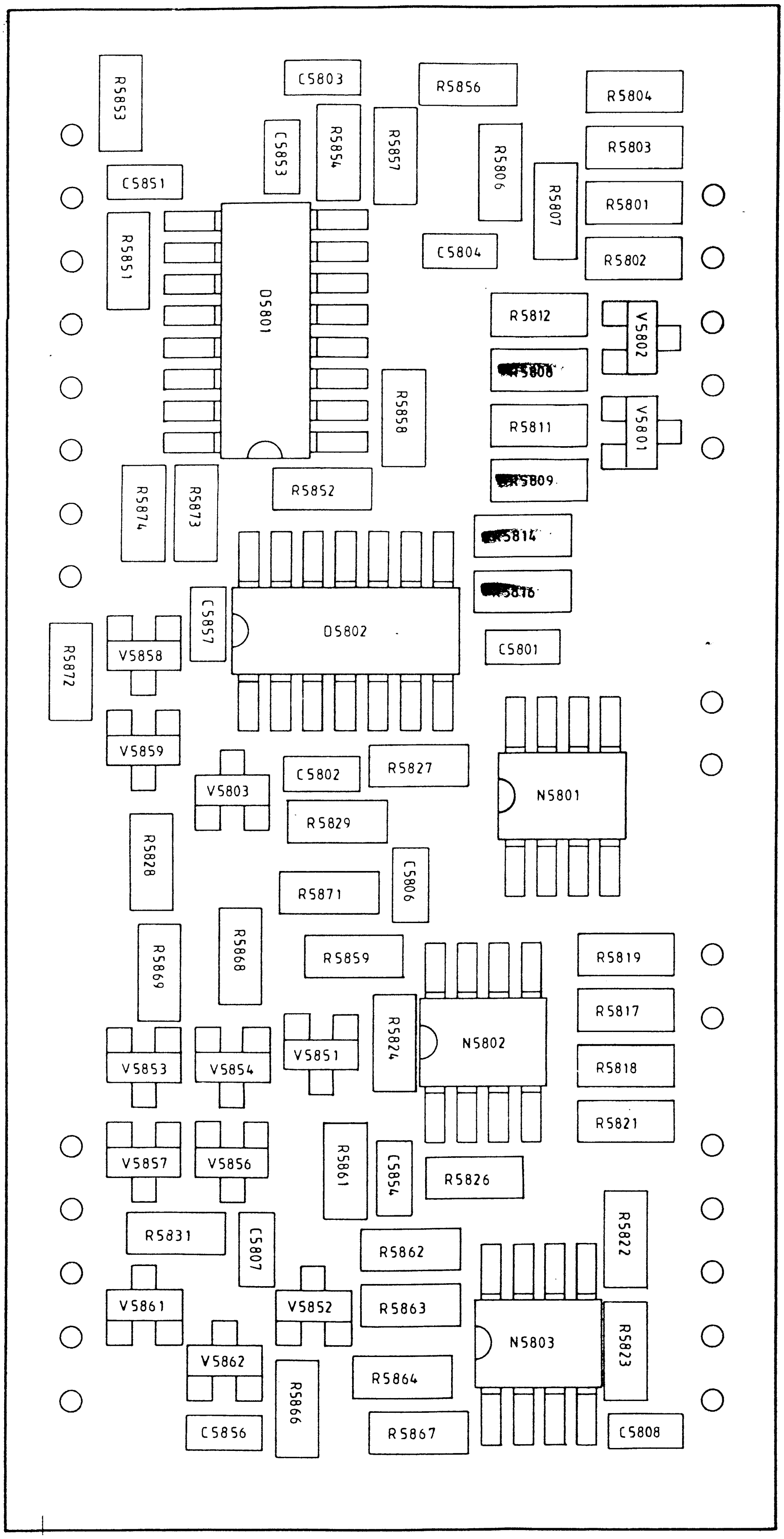


Fig.16.1. Final X/Z amplifier p.c.b. lay-out.

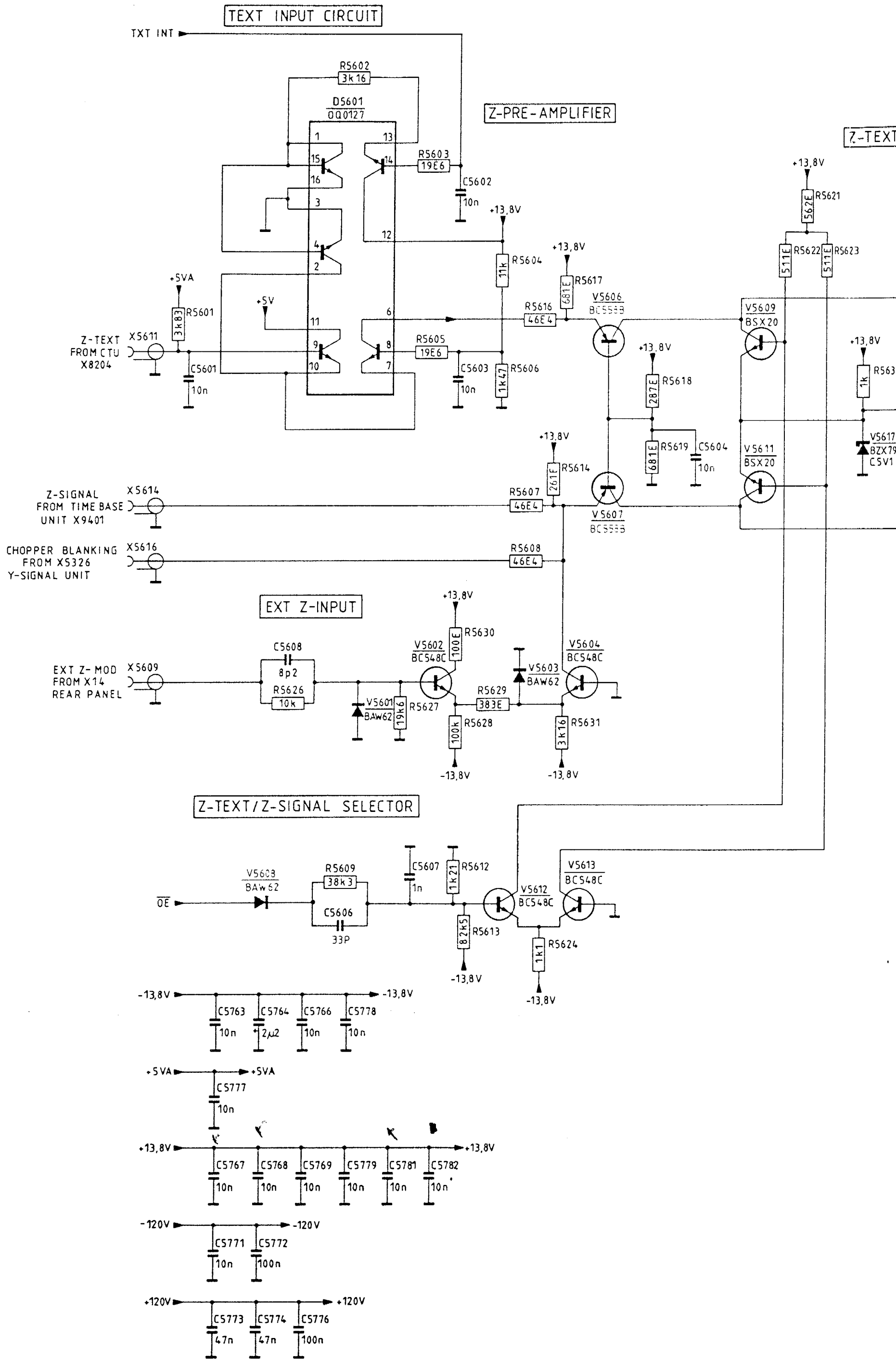
The output voltage of multiplexer D5603 is fed to test-point X46 on the positive input of comparator N5601.
When the output on the multiplexer is high, the high on the comparator output causes V5774 of long-tailed pair V5773/V5774 to conduct and draw current.
The current source is V5776 in its emitter 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. When the D5603 multiplexer output is low, V5774 blocks and V5773 conducts, current being drawn from the Final Y amplifier.



16-6


R5853
C5803
R5856
R5804
C5853
R5854
R5857
R5806
R5803
C5851
R5807
R5801
R5851
C5804
R5802
D5801
R5812
V5802
R5808
R5858
R5811
V5801
R5874
R5873
R5852
R5809
R5814
R5816
C5857
D5802
R5872
V5858
C5801
V5859
C5802
R5827
V5803
N5801
R5829
R5828
C5806
R5871
R5869
R5868
R5859
R5819
R5817
R5824
N5802
V5853
V5854
V5851
R5818
R5821
V5857
V5856
R5861
C5854
R5826
R5822
R5831
C5807
R5862
V5861
V5852
R5863
N5803
R5823
V5862
R5864
R5866
C5856
R5867
C5808

16-7


TEXT INPUT CIRCUIT
TXT INT
Z-PRE-AMPLIFIER
Z-TEXT
D5601
OQ0127
R5602
3k16
R5603
19E6
C5602
10n
R5601
3k83
+5VA
+5V
Z-TEXT FROM CTU X8204
X5611
C5601
10n
R5605
19E6
C5603
10n
R5606
1k47
R5604
11k
+13,8V
R5616
46E4
R5617
681E
V5606
BC559B
R5618
287E
R5619
681E
C5604
10n
V5609
BSX20
V5611
BSX20
R5621
562E
R5622
511E
R5623
511E
V5617
BZX79
C5V1
Z-SIGNAL FROM TIME BASE UNIT X9401
X5614
R5607
46E4
R5614
261E
V5607
BC559B
CHOPPER BLANKING FROM X5326 Y-SIGNAL UNIT
X5616
R5608
46E4
EXT Z-INPUT
EXT Z-MOD FROM X14 REAR PANEL
X5609
C5608
8p2
R5626
10k
V5601
BAW62
R5627
19k6
V5602
BC548C
R5630
100E
R5628
100k
R5629
383E
V5603
BAW62
V5604
BC548C
R5631
3k16
-13,8V
Z-TEXT/Z-SIGNAL SELECTOR
OE
V5603
BAW62
R5609
38k3
C5606
33P
C5607
1n
R5612
1k21
R5613
82k5
V5612
BC548C
V5613
BC548C
R5624
1k1
-13,8V
C5763
10n
C5764
2μ2
C5766
10n
C5778
10n
+5VA
C5777
10n
+13,8V
C5767
10n
C5768
10n
C5769
10n
C5779
10n
C5781
10n
C5782
10n
-120V
C5771
10n
C5772
100n
+120V
C5773
47n
C5774
47n
C5776
100n

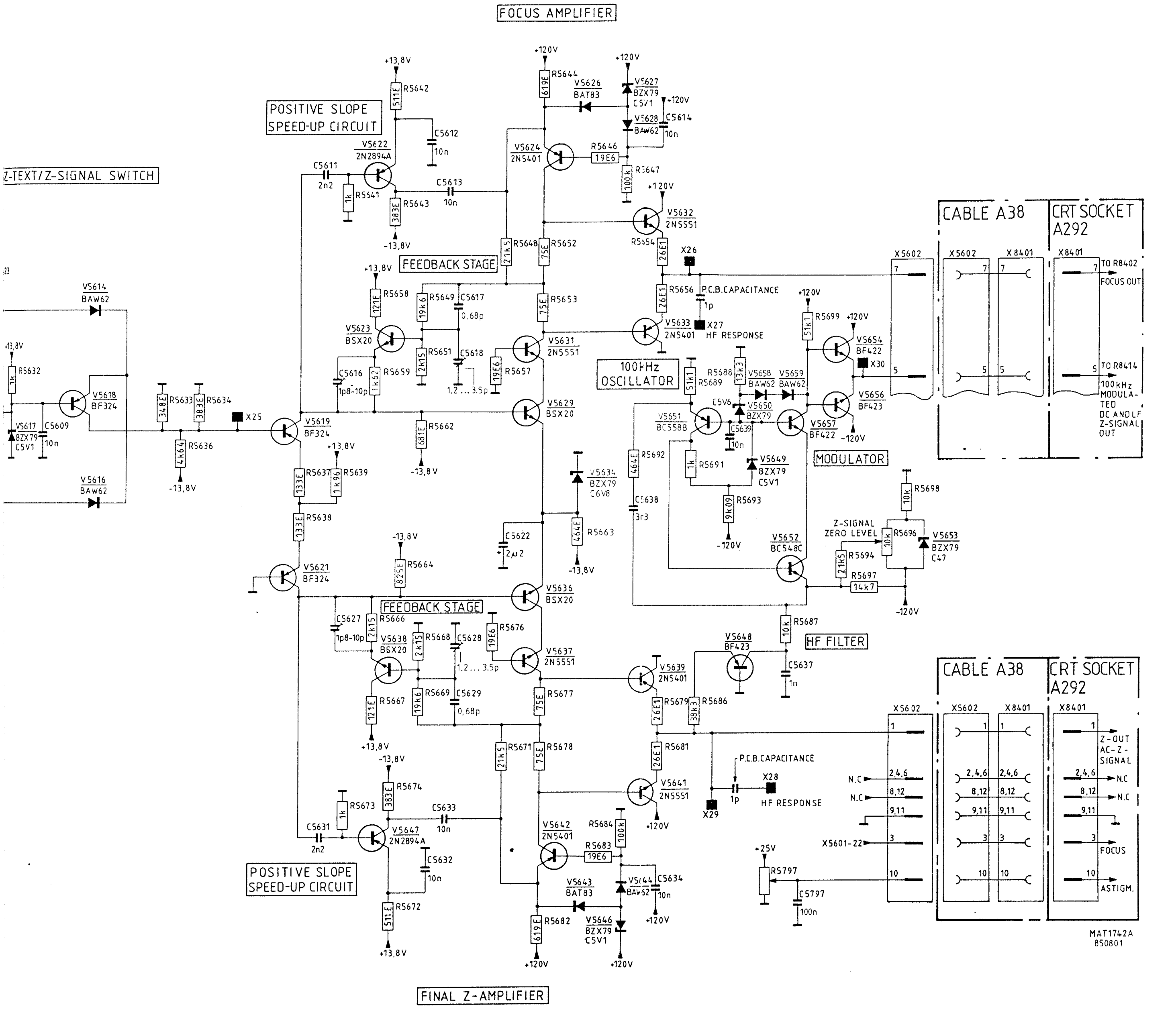


Fig.16.2. Final X/Z amplifier, circuit diagram of intensity and focusing part.

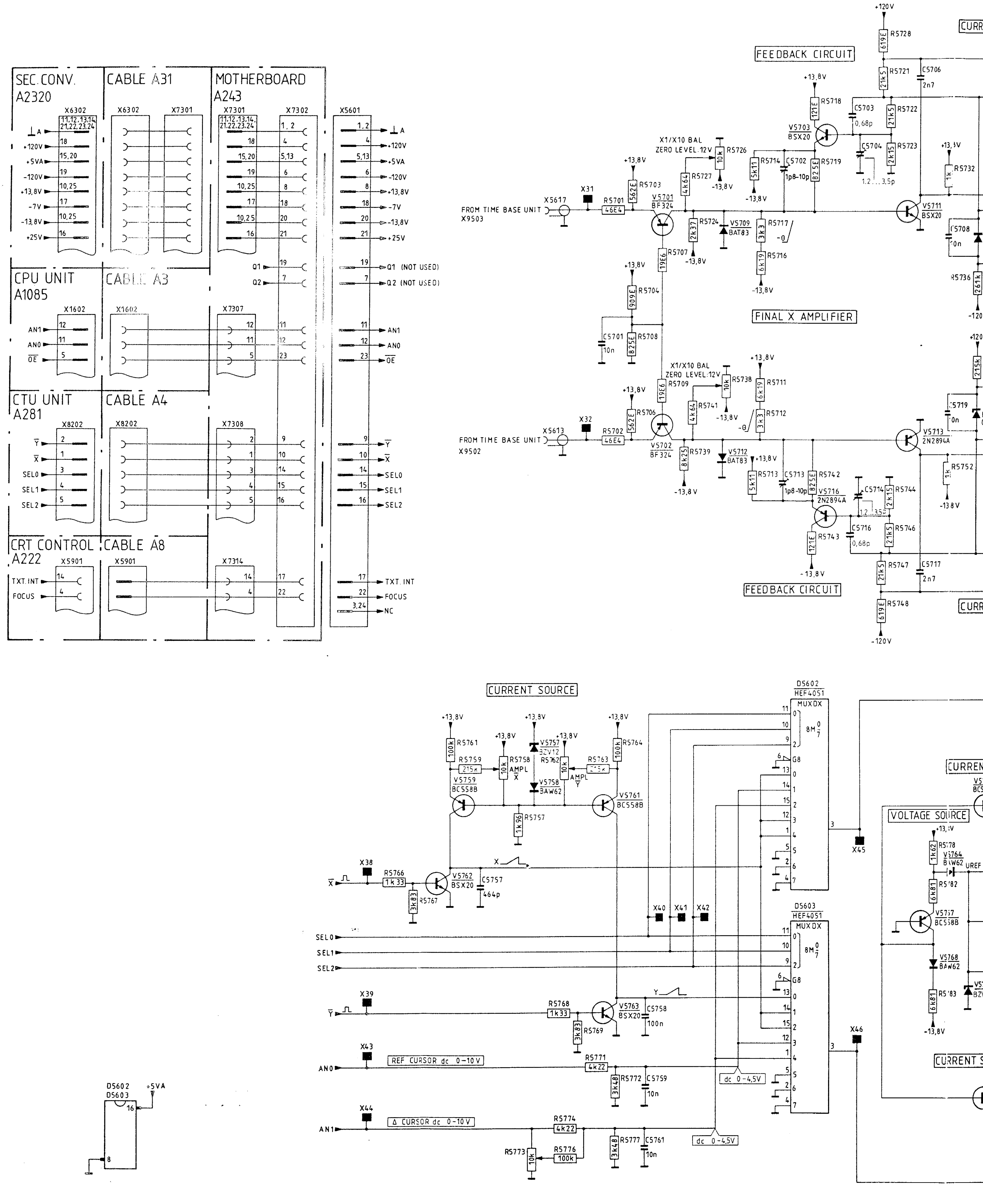
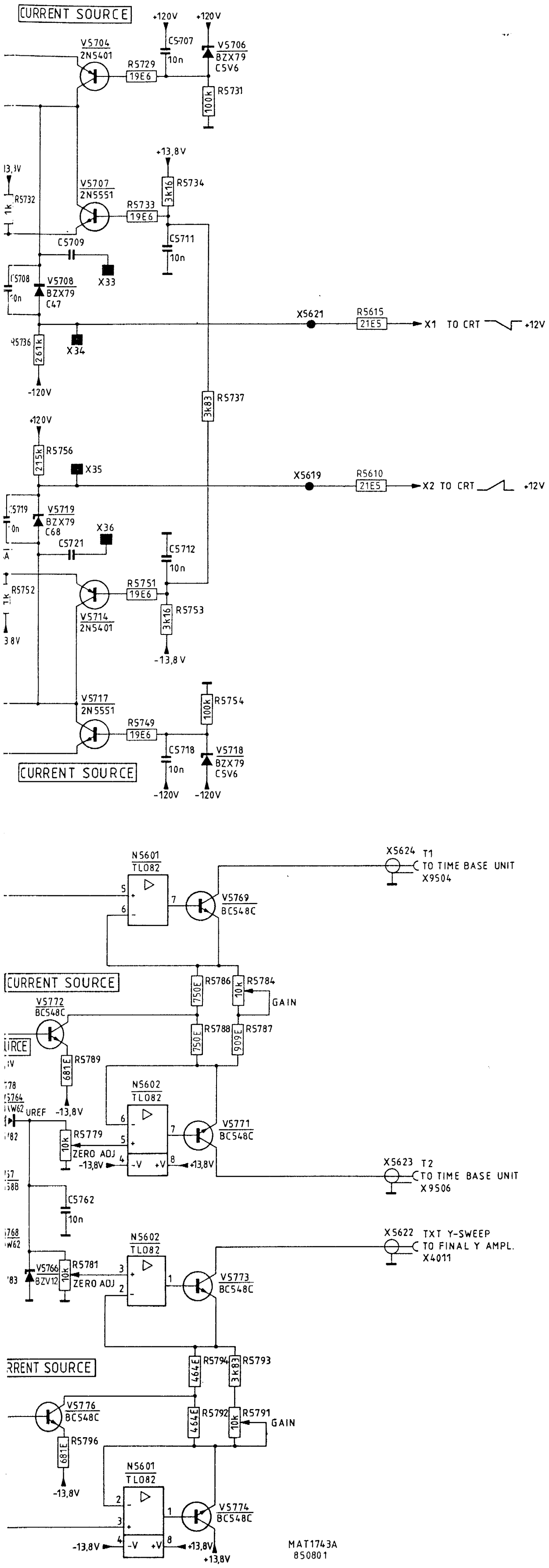


Fig.16.3. Final X/Z amplifier, circuit diagram of X-amplifier and CRT text part.



CURRENT SOURCE
V5704 2N5401
R5729 19E6
C5707 10n
V5706 BZX79 C5V6
R5731 100k
+120V
+13,8V
R5734 3k16
V5707 2N5551
R5733 19E6
C5711 10n
C5709
X33
V5708 BZX79 C47
R5736 261k
X34
-120V
X5621
R5615 21E5
X1 TO CRT +12V
R5737 3k83
R5756 215k
X35
X5619
R5610 21E5
X2 TO CRT +12V
V5719 BZX79 C68
C5721
X36
C5712 10n
R5751 19E6
R5753 3k16
V5714 2N5401
-13,8V
V5717 2N5551
R5754 100k
R5749 19E6
C5718 10n
V5718 BZX79 C5V6
CURRENT SOURCE
N5601 TL082
V5769 BC548C
X5624 T1 TO TIME BASE UNIT X9504
CURRENT SOURCE
R5786 750E
R5784 10k
GAIN
V5772 BC548C
R5788 750E
R5787 909E
R5789 681E
N5602 TL082
V5771 BC548C
UREF
R5779 10k
ZERO ADJ
X5623 T2 TO TIME BASE UNIT X9506
C5762 10n
X5622 TXT Y-SWEEP TO FINAL Y AMPL. X4011
V5766 BZV12
R5781 10k
ZERO ADJ
V5773 BC548C
RRENT SOURCE
R5794 464E
R5793 3k83
V5776 BC548C
R5792 464E
R5791 10k
GAIN
R5796 681E
V5774 BC548C
MAT1743A
850801

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 5601	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5602	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5603	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5604	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5606	CAP.CERAMIC	2%	33PF	5322 122 32072
C 5607	CAP.CERAMIC	10%	1NF	4822 122 30027
C 5608	CAP.CERAMIC	0.25PF	8.2PF	4822 122 31052
C 5609	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5611	CAP.CERAMIC	10%	2.2NF	4822 122 30114
C 5612	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5613	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5614	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5616	CAP.TRIMMER	300V	1.8/10PF	5322 125 50049
C 5617	CAP.CERAMIC	0.25PF	0.68PF	4822 122 31215
C 5618	CAP.TRIMMER	300V	1.2/3.5PF	5322 125 50048
C 5622	CAP.TANTAL	16V 20%	2.2UF	4822 124 10204
C 5627	CAP.TRIMMER	300V	1.8/10PF	5322 125 50049
C 5628	CAP.TRIMMER	300V	1.2/3.5PF	5322 125 50048
C 5629	CAP.CERAMIC	0.25PF	0.68PF	4822 122 31215
C 5631	CAP.CERAMIC	10%	2.2NF	4822 122 30114
C 5632	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5633	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5634	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5637	CAP.CERAMIC	10%	1NF	4822 122 30027
C 5638	CAP.CERAMIC	10%	3.3NF	4822 122 30099
C 5639	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5701	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5702	CAP.TRIMMER	300V	1.8/10PF	5322 125 50049
C 5703	CAP.CERAMIC	0.25PF	0.68PF	4822 122 31215
C 5704	CAP.TRIMMER	300V	1.2/3.5PF	5322 125 50048
C 5706	CAP.CERAMIC	10%	2.7NF	5322 122 32338
C 5707	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5708	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5711	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5712	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5713	CAP.TRIMMER	300V	1.8/10PF	5322 125 50049
C 5714	CAP.TRIMMER	300V	1.2/3.5PF	5322 125 50048
C 5716	CAP.CERAMIC	0.25PF	0.68PF	4822 122 31215
C 5717	CAP.CERAMIC	10%	2.7NF	5322 122 32338
C 5718	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5719	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5757	CAP.FOIL	630V 1%	464PF	5322 121 50982
C 5758	CAP.	100V 10%	100NF	4822 121 41717
C 5759	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5761	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5762	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5763	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5764	CAP.TANTAL	16V 20%	2.2UF	4822 124 10204
C 5766	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5767	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5768	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5769	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5771	CAP.FOIL	400V 10%	10NF	5322 121 41977

C 5772	CAP.FOIL	400V 10%	100NF	5322 121 44198
C 5773	CAP.FOIL	400V 10%	47NF	5322 121 42486
C 5774	CAP.FOIL	400V 10%	47NF	5322 121 42486
C 5776	CAP.FOIL	400V 10%	100NF	5322 121 44198
C 5777	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5778	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5779	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5781	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5782	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 5797	CAP.FOIL	63V 10%	100NF	5322 121 42492

16.3.2 INTEGRATED CIRCUITS

D 5601	INTEGR.CIRCUIT	ARRAY OQ 0127		5322 209 80992
D 5602	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
D 5603	INTEGR.CIRCUIT	HEF4051BP	PEL	4822 209 10262
N 5601	INTEGR.CIRCUIT	TL082CP	T.I	5322 209 86064
N 5602	INTEGR.CIRCUIT	TL082CP	T.I	5322 209 86064

16.3.3 RESISTORS

R 5601	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5602	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5603	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5604	RES.METAL FILM	MR25	1%	11K	5322 116 54623
R 5605	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5606	RES.METAL FILM	MR25	1%	1K47	5322 116 50635
R 5607	RES.METAL FILM	MR25	1%	46E4	5322 116 50492
R 5608	RES.METAL FILM	MR25	1%	46E4	5322 116 50492
R 5609	RES.METAL FILM	MR25	1%	38K3	5322 116 55369
R 5610	RES.METAL FILM	MR25	1%	21E5	5322 116 50677
R 5612	RES.METAL FILM	MR25	1%	1K21	5322 116 54557
R 5613	RES.METAL FILM	MR25	1%	82K5	5322 116 55374
R 5614	RES.METAL FILM	MR25	1%	261E	5322 116 54502
R 5615	RES.METAL FILM	MR25	1%	21E5	5322 116 50677
R 5616	RES.METAL FILM	MR25	1%	46E4	5322 116 50492
R 5617	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5618	RES.METAL FILM	MR25	1%	287E	5322 116 54506
R 5619	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5621	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 5622	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5623	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5624	RES.METAL FILM	MR25	1%	1K1	4822 116 51236
R 5626	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5627	RES.METAL FILM	MR25	1%	19K6	5322 116 54641
R 5628	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5629	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5630	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 5631	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5632	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5633	RES.METAL FILM	MR25	1%	348E	5322 116 54515
R 5634	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5636	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 5637	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 5638	RES.METAL FILM	MR25	1%	133E	5322 116 54482
R 5639	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5641	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5642	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5643	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5644	RES.METAL FILM	MR25	1%	619E	4822 116 51232
R 5646	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5647	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5648	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5649	RES.METAL FILM	MR25	1%	19K6	5322 116 54641
R 5651	RES.METAL FILM	MR25	1%	2K15	5322 116 50767

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R 5652	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 5653	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 5654	RES.METAL FILM	MR25	1%	26E1	5322 116 50876
R 5656	RES.METAL FILM	MR25	1%	26E1	5322 116 50876
R 5657	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5658	RES.METAL FILM	MR25	1%	121E	5322 116 54426
R 5659	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 5662	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5663	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 5664	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 5666	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5667	RES.METAL FILM	MR25	1%	121E	5322 116 54426
R 5668	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5669	RES.METAL FILM	MR25	1%	19K6	5322 116 54641
R 5671	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5672	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 5673	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5674	RES.METAL FILM	MR25	1%	383E	5322 116 55368
R 5676	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5677	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 5678	RES.METAL FILM	MR25	1%	75E	5322 116 54459
R 5679	RES.METAL FILM	MR25	1%	26E1	5322 116 50876
R 5681	RES.METAL FILM	MR25	1%	26E1	5322 116 50876
R 5682	RES.METAL FILM	MR25	1%	619E	4822 116 51232
R 5683	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5684	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5686	RES.METAL FILM	MR25	1%	38K3	5322 116 55369
R 5687	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5688	RES.METAL FILM	MR25	1%	13K3	5322 116 55276
R 5689	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 5691	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5692	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 5693	RES.METAL FILM	MR25	1%	9K09	4822 116 51284
R 5694	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5696	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5697	RES.METAL FILM	MR25	1%	14K7	5322 116 54632
R 5698	RES.METAL FILM	MR25	1%	10K	4822 116 51253
R 5699	RES.METAL FILM	MR25	1%	51K1	5322 116 50672
R 5701	RES.METAL FILM	MR25	1%	46E4	5322 116 50492
R 5702	RES.METAL FILM	MR25	1%	46E4	5322 116 50492
R 5703	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 5704	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 5706	RES.METAL FILM	MR25	1%	562E	4822 116 51231
R 5707	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5708	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 5709	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5711	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5712	RES.N.T.C.	0.5W	10%	3K3	5322 116 30234
R 5713	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5714	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 5716	RES.METAL FILM	MR25	1%	6K19	5322 116 55426
R 5717	RES.N.T.C.	0.5W	10%	3K3	5322 116 30234
R 5718	RES.METAL FILM	MR25	1%	121E	5322 116 54426
R 5719	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 5721	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5722	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5723	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5724	RES.METAL FILM	MR25	1%	2K37	5322 116 54576
R 5726	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5727	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 5728	RES.METAL FILM	MR25	1%	619E	4822 116 51232
R 5729	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5731	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5732	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5733	RES.METAL FILM	MR25	1%	19E6	5322 116 50473

R 5734	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5736	RES.METAL FILM	MR25	1%	261K	5322 116 54736
R 5737	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5738	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5739	RES.METAL FILM	MR25	1%	8K25	5322 116 51498
R 5741	RES.METAL FILM	MR25	1%	4K64	5322 116 50484
R 5742	RES.METAL FILM	MR25	1%	825E	5322 116 54541
R 5743	RES.METAL FILM	MR25	1%	121E	5322 116 54426
R 5744	RES.METAL FILM	MR25	1%	2K15	5322 116 50767
R 5746	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5747	RES.METAL FILM	MR25	1%	21K5	5322 116 50451
R 5748	RES.METAL FILM	MR25	1%	619E	4822 116 51232
R 5749	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5751	RES.METAL FILM	MR25	1%	19E6	5322 116 50473
R 5752	RES.METAL FILM	MR25	1%	1K	4822 116 51235
R 5753	RES.METAL FILM	MR25	1%	3K16	5322 116 50579
R 5754	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5756	RES.METAL FILM	MR25	1%	215K	5322 116 54728
R 5757	RES.METAL FILM	MR25	1%	1K96	5322 116 54571
R 5758	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5759	RES.METAL FILM	MR25	1%	215K	5322 116 54728
R 5761	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5762	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5763	RES.METAL FILM	MR25	1%	215K	5322 116 54728
R 5764	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5766	RES.METAL FILM	MR25	1%	1K33	5322 116 55422
R 5767	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5768	RES.METAL FILM	MR25	1%	1K33	5322 116 55422
R 5769	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5771	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 5772	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 5773	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5774	RES.METAL FILM	MR25	1%	4K22	5322 116 50729
R 5776	RES.METAL FILM	MR25	1%	100K	4822 116 51268
R 5777	RES.METAL FILM	MR25	1%	3K48	5322 116 55367
R 5778	RES.METAL FILM	MR25	1%	1K62	5322 116 55359
R 5779	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5781	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5782	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 5783	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
R 5784	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5786	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5787	RES.METAL FILM	MR25	1%	909E	5322 116 55278
R 5788	RES.METAL FILM	MR25	1%	750E	4822 116 51234
R 5789	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5791	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455
R 5792	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 5793	RES.METAL FILM	MR25	1%	3K83	5322 116 54589
R 5794	RES.METAL FILM	MR25	1%	464E	5322 116 50536
R 5796	RES.METAL FILM	MR25	1%	681E	4822 116 51233
R 5797	POTM.TRIMMER	0.3W	25%	10K	4822 105 10455

16.3.4 SEMI CONDUCTORS

V 5601	DIODE	BAW62	PEL	4822 130 30613
V 5602	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5603	DIODE	BAW62	PEL	4822 130 30613
V 5604	TRANSISTOR	BC548C	PEL	4822 130 44196
V 5606	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5607	TRANSISTOR	BC558B	PEL	4822 130 44197
V 5608	DIODE	BAW62	PEL	4822 130 30613
V 5609	TRANSISTOR	BSX20	PEL	4822 130 41705
V 5611	TRANSISTOR	BSX20	PEL	4822 130 41705

V 5612	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5613	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5614	DIODE	BAW62	PEL	4822	130	30613
V 5616	DIODE	BAW62	PEL	4822	130	30613
V 5617	DIODE,REFERENCE	BZX79-C5V1	PEL	4822	130	34233
V 5618	TRANSISTOR	BF324	PEL	4822	130	41448
V 5619	TRANSISTOR	BF324	PEL	4822	130	41448
V 5621	TRANSISTOR	BF324	PEL	4822	130	41448
V 5622	TRANSISTOR	2N2894A	PEL	5322	130	44127
V 5623	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5626	DIODE	BAT83	PEL	5322	130	32103
V 5627	DIODE,REFERENCE	BZX79-C5V1	PEL	4822	130	34233
V 5628	DIODE	BAW62	PEL	4822	130	30613
V 5629	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5631	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5632	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5634	DIODE,REFERENCE	BZX79-C6V8	PEL	4822	130	34278
V 5636	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5637	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5638	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5641	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5643	DIODE	BAT83	PEL	5322	130	32103
V 5644	DIODE	BAW62	PEL	4822	130	30613
V 5646	DIODE,REFERENCE	BZX79-C5V1	PEL	4822	130	34233
V 5647	TRANSISTOR	2N2894A	PEL	5322	130	44127
V 5648	TRANSISTOR	BF423	PEL	4822	130	41646
V 5649	DIODE,REFERENCE	BZX79-C5V1	PEL	4822	130	34233
V 5650	DIODE,REFERENCE	BZX79-C5V6	PEL	4822	130	34173
V 5651	TRANSISTOR	BC558B	PEL	4822	130	44197
V 5652	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5653	DIODE,REFERENCE	BZX79-C47	PEL	4822	130	34383
V 5654	TRANSISTOR	BF422	PEL	4822	130	41782
V 5656	TRANSISTOR	BF423	PEL	4822	130	41646
V 5657	TRANSISTOR	BF422	PEL	4822	130	41782
V 5658	DIODE	BAW62	PEL	4822	130	30613
V 5659	DIODE	BAW62	PEL	4822	130	30613
V 5701	TRANSISTOR	BF324	PEL	4822	130	41448
V 5702	TRANSISTOR	BF324	PEL	4822	130	41448
V 5703	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5706	DIODE,REFERENCE	BZX79-C5V6	PEL	4822	130	34173
V 5707	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5708	DIODE,REFERENCE	BZX79-C47	PEL	4822	130	34383
V 5709	DIODE	BAT83	PEL	5322	130	32103
V 5711	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5712	DIODE	BAT83	PEL	5322	130	32103
V 5713	TRANSISTOR	2N2894A	PEL	5322	130	44127
V 5716	TRANSISTOR	2N2894A	PEL	5322	130	44127
V 5717	TRANSISTOR	2N5551	PEL	5322	130	44491
V 5718	DIODE,REFERENCE	BZX79-C5V6	PEL	4822	130	34173
V 5719	DIODE,REFERENCE	BZX79-C68	PEL	4822	130	30864
V 5757	DIODE,REFERENCE	BZV12	PEL	5322	130	34269
V 5758	DIODE	BAW62	PEL	4822	130	30613
V 5759	TRANSISTOR	BC558B	PEL	4822	130	44197
V 5761	TRANSISTOR	BC558B	PEL	4822	130	44197
V 5762	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5763	TRANSISTOR	BSX20	PEL	4822	130	41705
V 5764	DIODE	BAW62	PEL	4822	130	30613
V 5766	DIODE,REFERENCE	BZV12	PEL	5322	130	34269
V 5767	TRANSISTOR	BC558B	PEL	4822	130	44197
V 5768	DIODE	BAW62	PEL	4822	130	30613
V 5769	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5771	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5772	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5773	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5774	TRANSISTOR	BC548C	PEL	4822	130	44196
V 5776	TRANSISTOR	BC548C	PEL	4822	130	44196

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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).

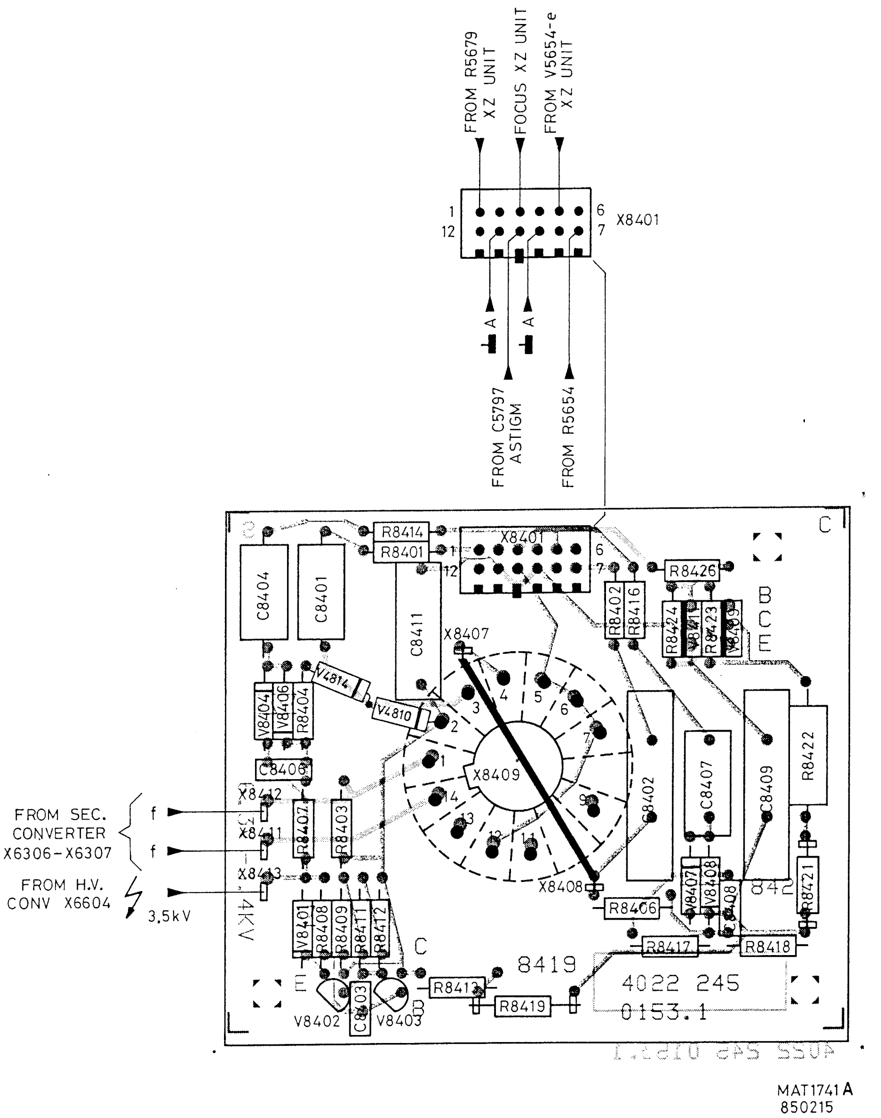
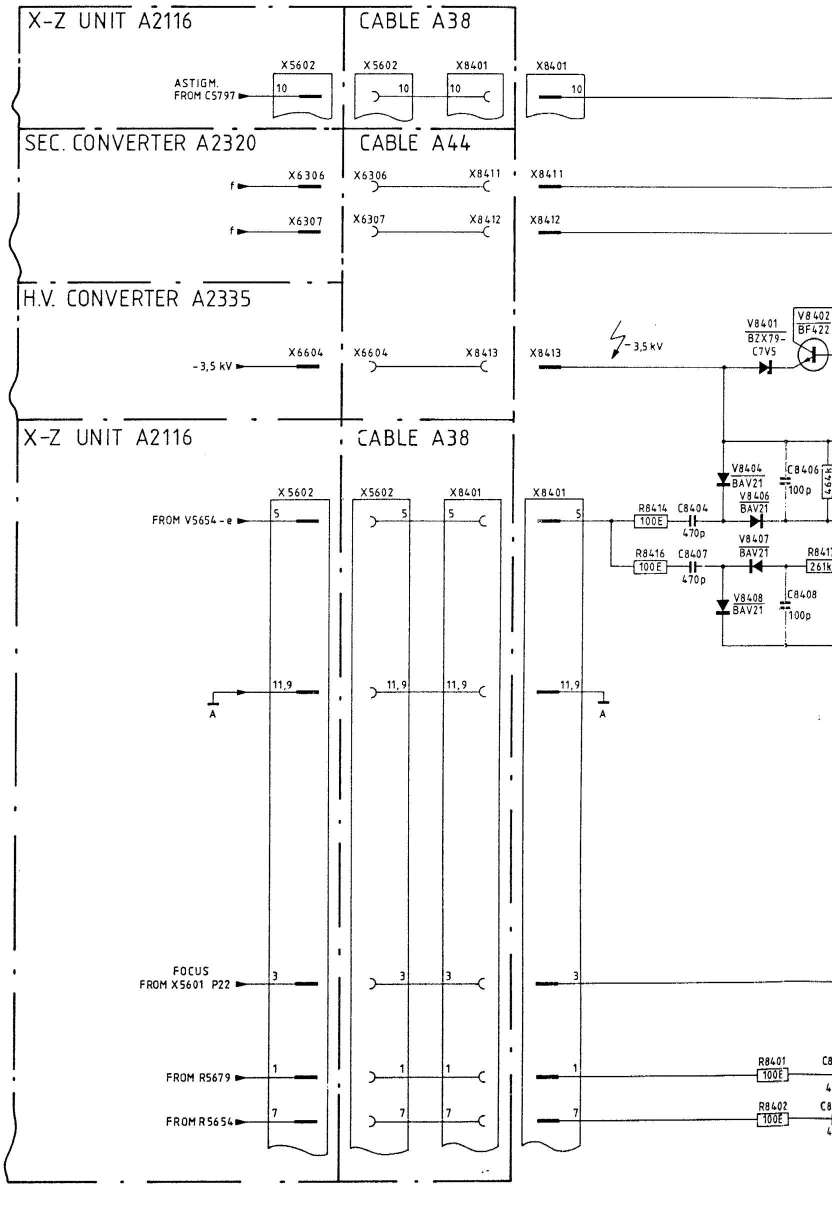


Fig.17.1. CRT-socket, p.c.b. lay-out.

17-3


X-Z UNIT A2116
CABLE A38
X5602
X8401
ASTIGM. FROM C5797
SEC. CONVERTER A2320
CABLE A44
X6306
X8411
X6307
X8412
H.V. CONVERTER A2335
X6604
X8413
-3,5 kV
V8401 BZX79-C7V5
V8402 BF422
X-Z UNIT A2116
CABLE A38
FROM V5654-e
R8414 100E
C8404 470p
R8416 100E
C8407 470p
V8404 BAV21
V8406 BAV21
V8407 BAV21
V8408 BAV21
C8406 100p
C8408 100p
FOCUS FROM X5601 P22
FROM R5679
FROM R5654
R8401 100E
R8402 100E

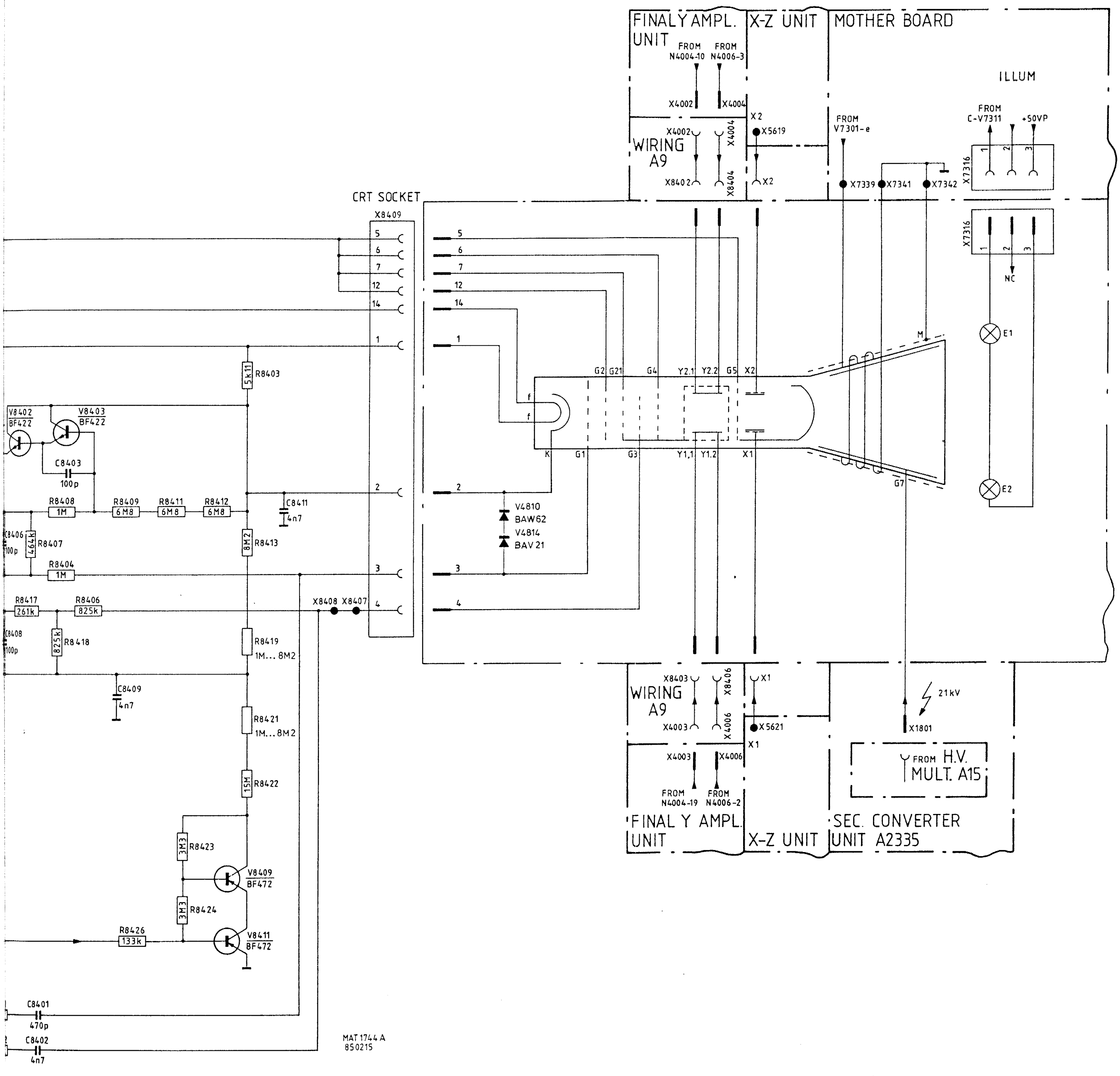


Fig.17.2. CRT-socket, circuit diagram.

17.1 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

17.1.1 CAPACITORS

POSNR	DESCRIPTION			ORDERING CODE
C 8401	CAP.CERAMIC	20%	470PF	5322 122 50086
C 8402	CAP.CERAMIC	20%	4.7NF	5322 122 50087
C 8403	CAP.CERAMIC	2%	100PF	5322 122 32655
C 8404	CAP.CERAMIC	20%	470PF	5322 122 50086
C 8406	CAP.CERAMIC	2%	100PF	5322 122 32655
C 8407	CAP.CERAMIC	20%	470PF	5322 122 50086
C 8408	CAP.CERAMIC	2%	100PF	5322 122 32655
C 8409	CAP.CERAMIC	20%	4.7NF	5322 122 50087
C 8411	CAP.CERAMIC	20%	4.7NF	5322 122 50087

17.1.2 RESISTORS

R 8401	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 8402	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 8403	RES.METAL FILM	MR25	1%	5K11	5322 116 54595
R 8404	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 8406	RES.METAL FILM	MR25	1%	825K	5322 116 51398
R 8407	RES.METAL FILM	MR25	1%	464K	5322 116 55207
R 8408	RES.METAL FILM	MR25	1%	1M	5322 116 55535
R 8409	RES.HI-TENSION	VR25	5%	6M8	4822 110 72209
R 8411	RES.HI-TENSION	VR25	5%	6M8	4822 110 72209
R 8412	RES.HI-TENSION	VR25	5%	6M8	4822 110 72209
R 8413	RES.HI-TENSION	VR25	5%	8M2	4822 110 72212
R 8414	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 8416	RES.METAL FILM	MR25	1%	100E	5322 116 55549
R 8417	RES.METAL FILM	MR25	1%	162K	5322 116 54716
R 8418	RES.METAL FILM	MR25	1%	825K	5322 116 51398
R 8419	RES.HI-TENSION	VR25	5%	8M2	4822 110 72212
R 8421	RES.HI-TENSION	VR25	5%	8M2	4822 110 72212
R 8422	RES.HI-TENSION	VR37	5%	15M	4822 110 42218
R 8423	RES.HI-TENSION	VR25	5%	3M3	4822 110 72201
R 8424	RES.HI-TENSION	VR25	5%	3M3	4822 110 72201
R 8426	RES.METAL FILM	MR25	1%	133K	5322 116 54708

17.1.3 SEMI CONDUCTORS

V 8401	DIODE,REFERENCE	BZX79-C7V5	PEL	4822 130 30861
V 8402	TRANSISTOR	BF422	PEL	4822 130 41782
V 8403	TRANSISTOR	BF422	PEL	4822 130 41782
V 8404	DIODE	BAV21	PEL	4822 130 30842
V 8406	DIODE	BAV21	PEL	4822 130 30842
V 8407	DIODE	BAV21	PEL	4822 130 30842
V 8408	DIODE	BAV21	PEL	4822 130 30842
V 8409	TRANSISTOR	BF472	PEL	5322 130 42535
V 8411	TRANSISTOR	BF472	PEL	5322 130 42535

17.1.4 MISCELLANEOUS

X 8409	SOCKET	55595	5322 255 40502

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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.

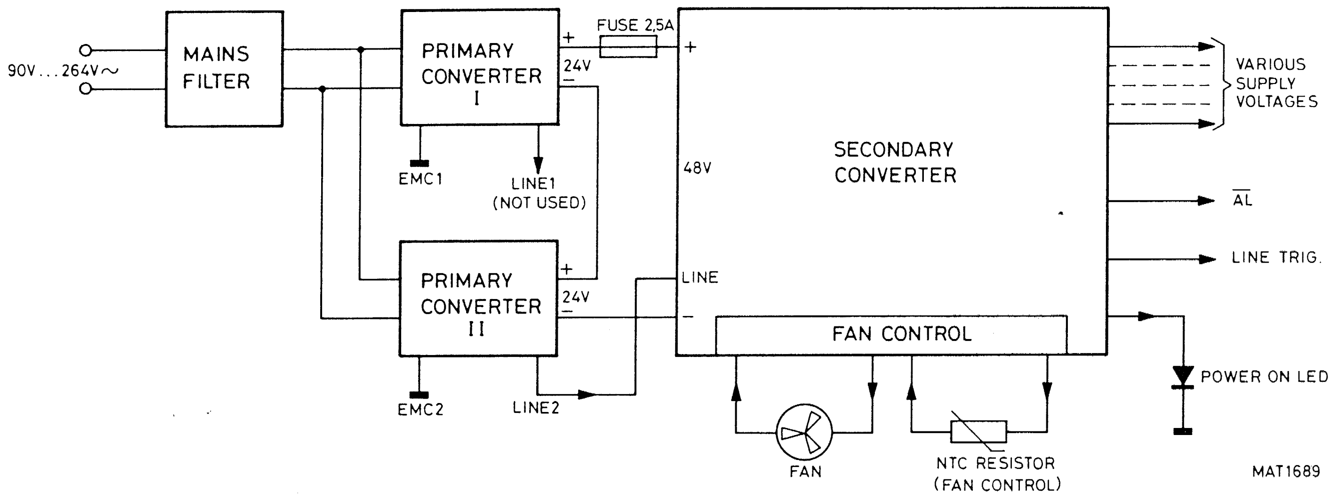


Fig.18.1. Interconnections of primary converters.

The mains filter and bridge recifier

The mains input (90 V...246 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 note 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.

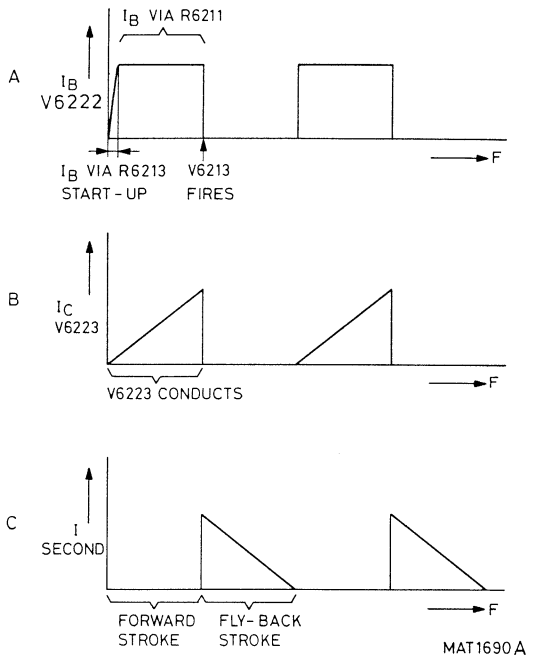
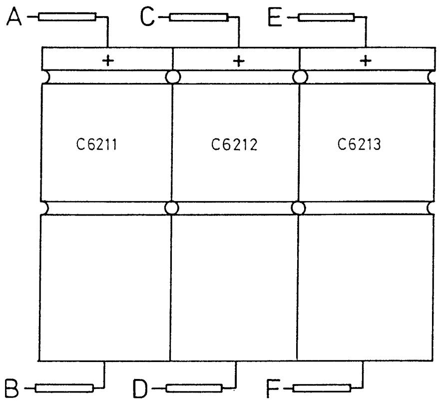


Fig.18.2. Waveforms in primary converter.

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.



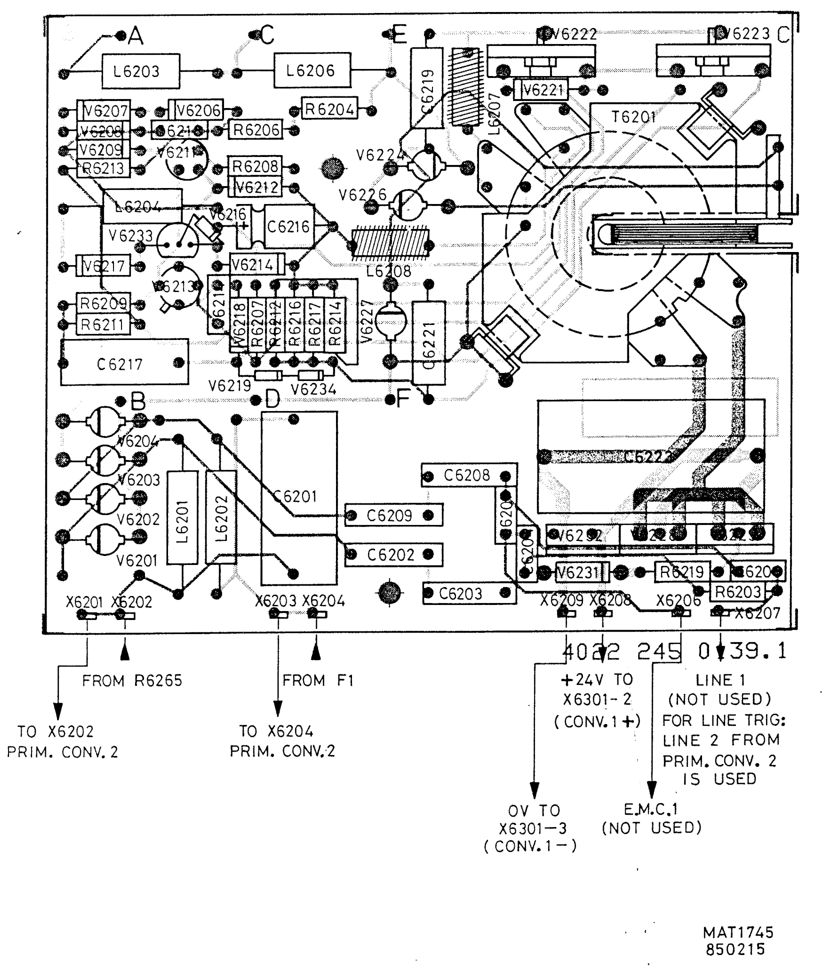
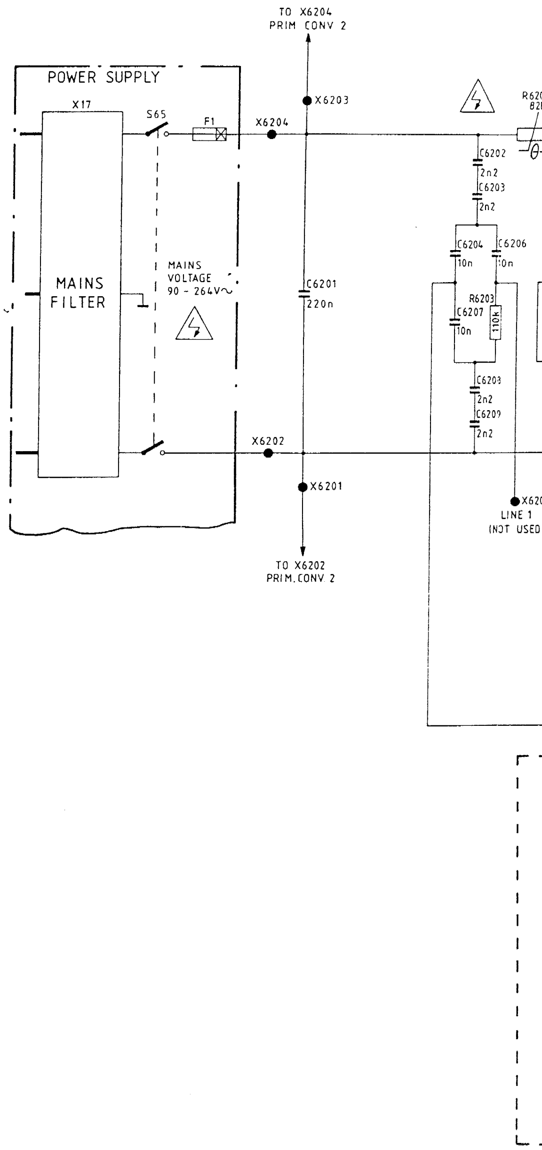


Fig.18.3. Primary converter unit, p.c.b. lay-out.

18-5


TO X6204
PRIM CONV 2
POWER SUPPLY
X17
S65
F1
X6204
X6203
MAINS
FILTER
MAINS
VOLTAGE
90 - 264V~
C6201
220n
C6202
2n2
C6203
2n2
C6204
10n
C6206
R6203
C6207
10n
110k
C6208
2n2
C6209
2n2
X6202
X6201
LINE 1
(NOT USED
TO X6202
PRIM. CONV 2

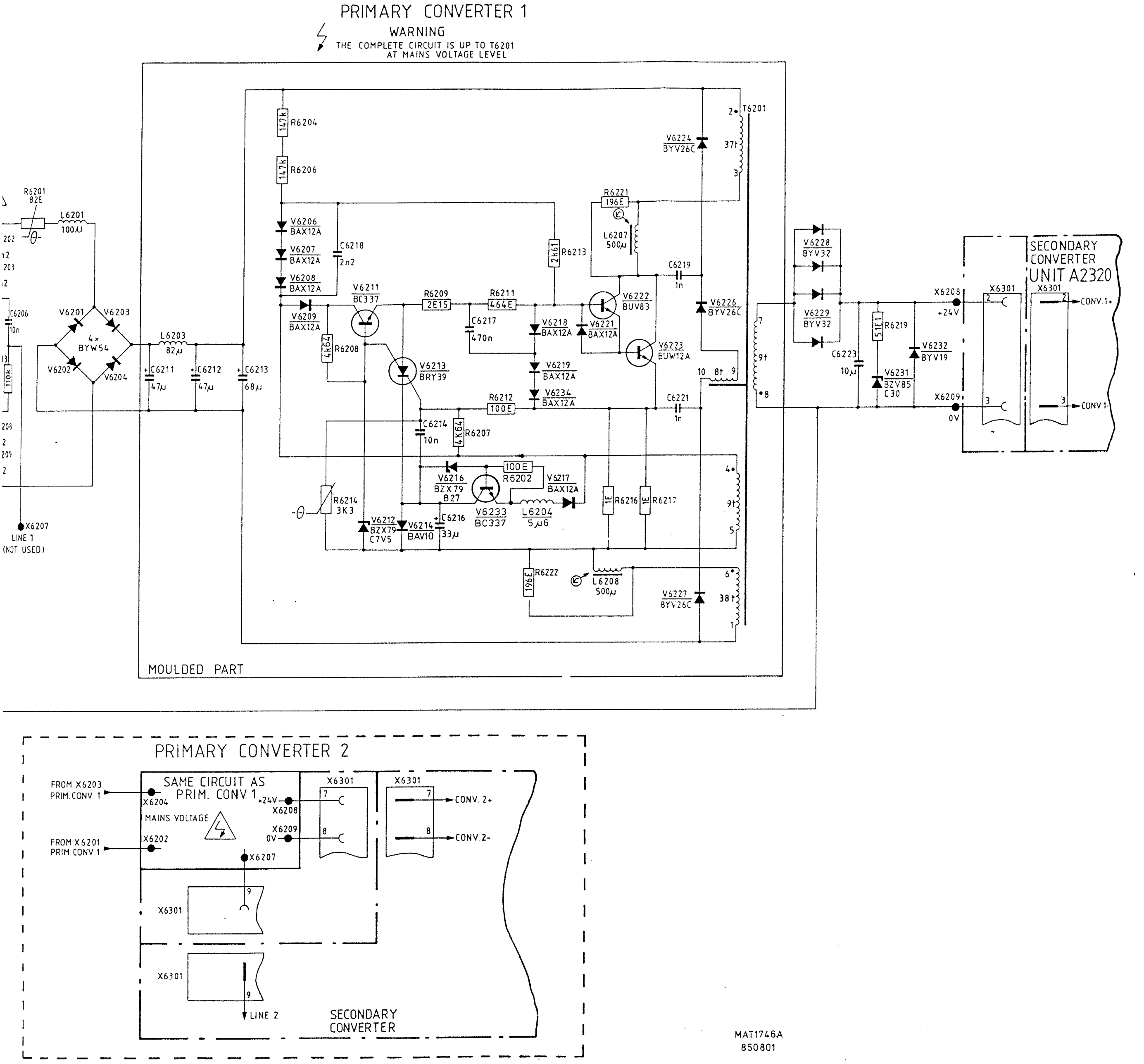


Fig.18.4. Primary converter unit, circuit diagram.

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

18.1.2 RESISTORS

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

18.1.3 SEMI CONDUCTORS

V 6201	DIODE	BYW54	PEL	5322 130 34919
V 6202	DIODE	BYW54	PEL	5322 130 34919
V 6203	DIODE	BYW54	PEL	5322 130 34919
V 6204	DIODE	BYW54	PEL	5322 130 34919
V 6228	DIODE	BYV32-150	PEL	5322 130 31637
V 6229	DIODE	BYV32-150	PEL	5322 130 31637

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18.1.4 MISCELLANEOUS

L 6201	COIL	100UH	TDK	5322 157 52363
F6101	fuse	2,5A TZ		4822 253 30026
V6231		BZV85-C30		5322 130 32702
V6232		BYV19-45		5322 130 32703

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

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(+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.

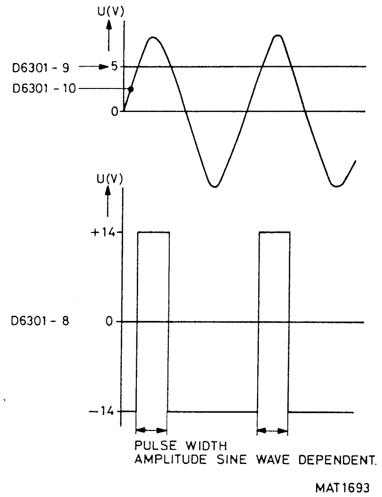

Fig.19.2. Voltage waveforms in the line trigger circuit.

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.

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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.

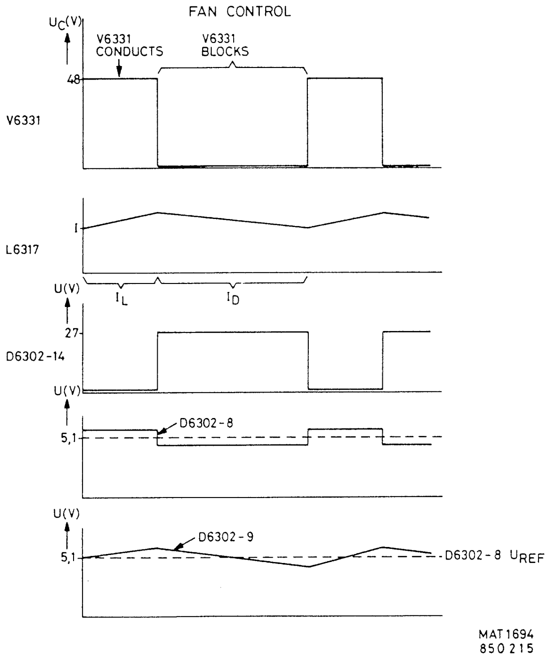

Fig.19.3. Waveforms in fan control circuit.

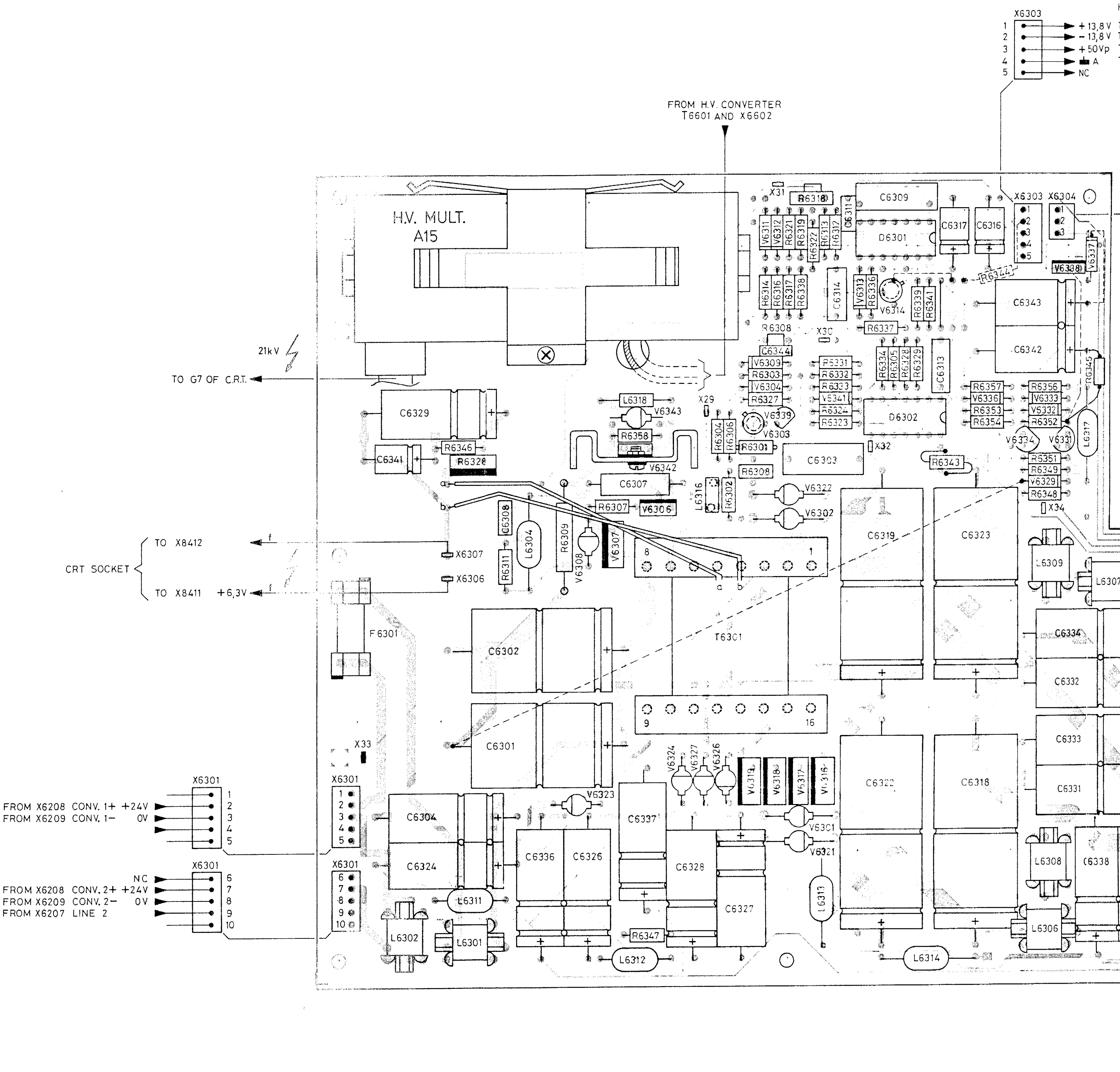

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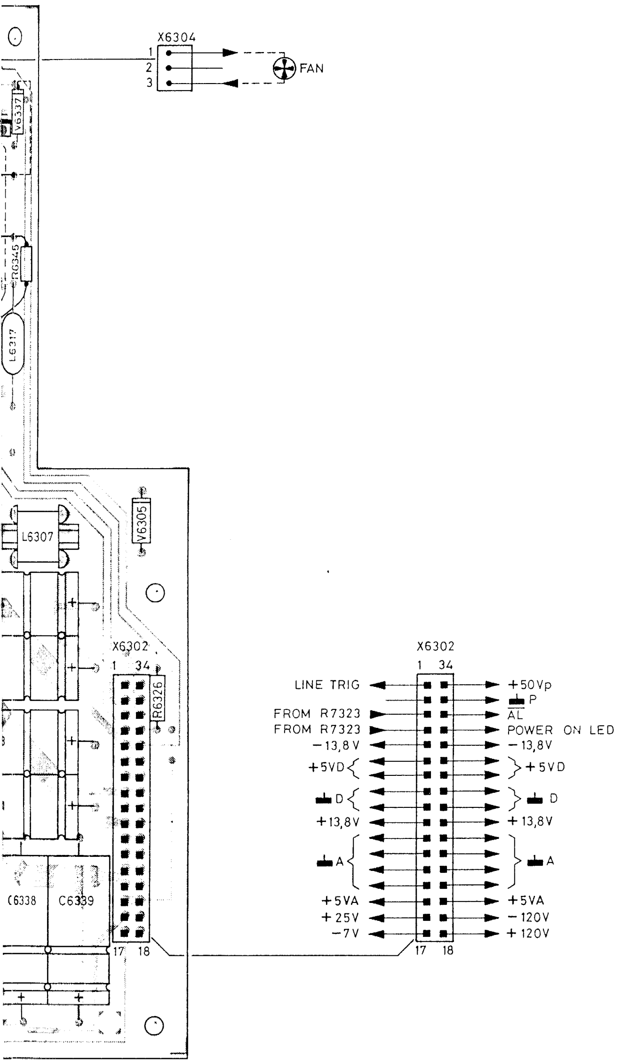
Fig.19.4. Secondary converter unit, p.c.b. lay-out.

19-8

HV CONVERTER:

+13,8V TO X6601-1
−13,8V TO X6601-2
+50Vp TO X6601-3
⊥A TO X6601-4
NC



MAT1747A
850801

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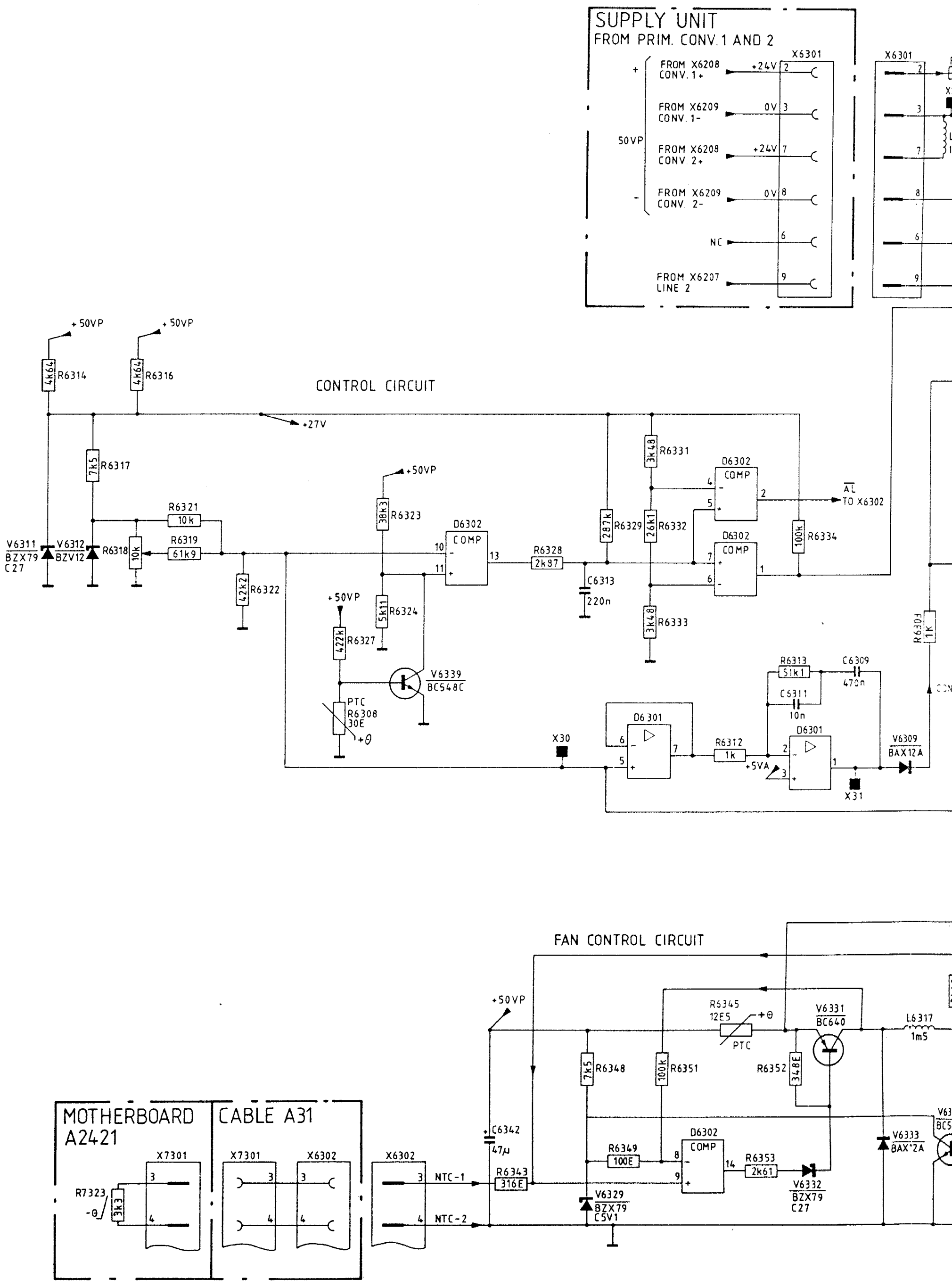
SECON


SUPPLY UNIT
FROM PRIM. CONV. 1 AND 2
X6301
FROM X6208 CONV. 1+
FROM X6209 CONV. 1-
FROM X6208 CONV 2+
FROM X6209 CONV. 2-
NC
FROM X6207 LINE 2
+24V
0V
50VP
CONTROL CIRCUIT
+50VP
R6314
R6316
4K64
+27V
R6317
7k5
R6321
10k
R6319
61k9
R6318
V6311
BZX79
C27
V6312
BZV12
42K2
R6322
R6323
38k3
D6302
COMP
R6328
2k97
C6313
220n
R6327
422k
R6324
5k11
V6339
BC548C
PTC
R6308
30E
R6331
3k48
R6329
287k
R6332
26k1
R6333
R6334
100k
AL
TO X6302
R6303
1K
R6313
51k1
C6309
470n
C6311
10n
D6301
R6312
1k
+5VA
X30
X31
V6309
BAX12A
FAN CONTROL CIRCUIT
R6345
12E5
PTC
V6331
BC640
L6317
1m5
R6348
7k5
R6351
100k
R6352
348E
C6342
47μ
R6349
100E
R6353
2k61
R6343
316E
V6329
BZX79
C5V1
V6332
BZX79
C27
V6333
BAX12A
MOTHERBOARD
A2421
CABLE A31
X7301
X6302
R7323
3k3
NTC-1
NTC-2

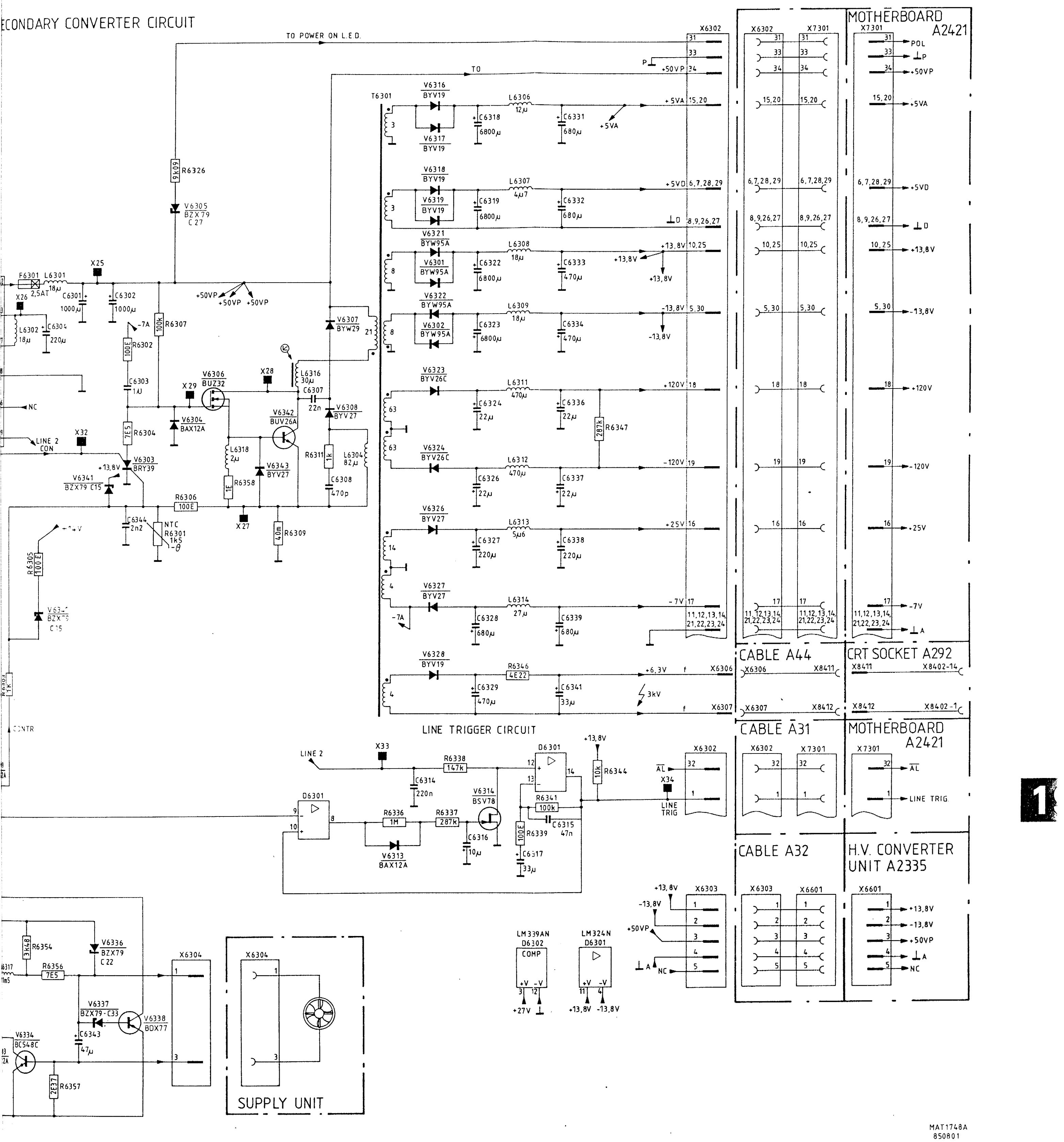


Fig.19.5. Secondary converter unit, circuit diagram.

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	10%	2.2NF	4822 122 30114

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

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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 6343	RES.METAL FILM	MR25	1%	316E		5322 116 54511
R 6344	RES.METAL FILM	MR25	1%	10K		4822 116 51253
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 6231	DIODE	BZV85-C30	PEL	5322 130 32702
V 6232	DIODE	BYV19-45	PEL	5322 130 32703
V 6301	DIODE	BYW95A	PEL	5322 130 31925
V 6302	DIODE	BYW95A	PEL	5322 130 31925
V 6303	THYRISTOR	BRY39	PEL	5322 130 40482
V 6304	DIODE	BAX12A	PEL	5322 130 34605
V 6305	DIODE,REFERENCE	BZX79-C27	PEL	4822 130 34379
V 6306	TRANSISTOR	BUZ32	PEL	5322 130 42721
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 6318	DIODE	BYV19-40	PEL	5322 130 32937
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 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

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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

F6301	fuse	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

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).

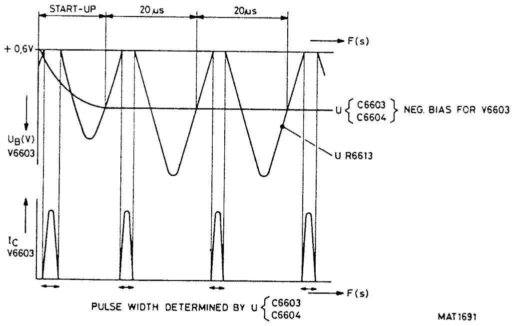


Fig.20.1. Waveforms in high-voltage converter.

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

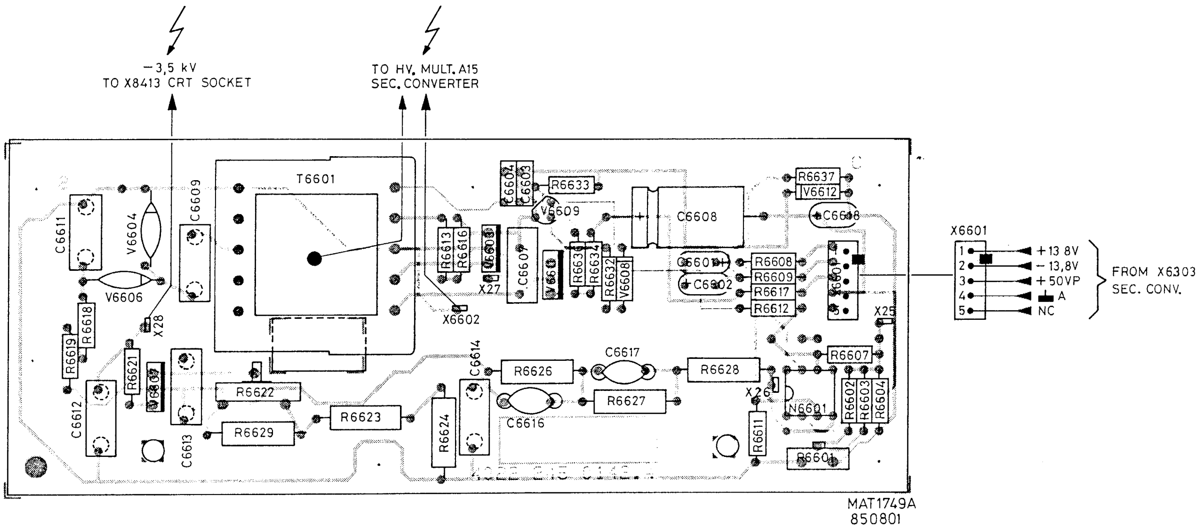


Fig.20.2. High-voltage converter, p.c.b. lay-out.

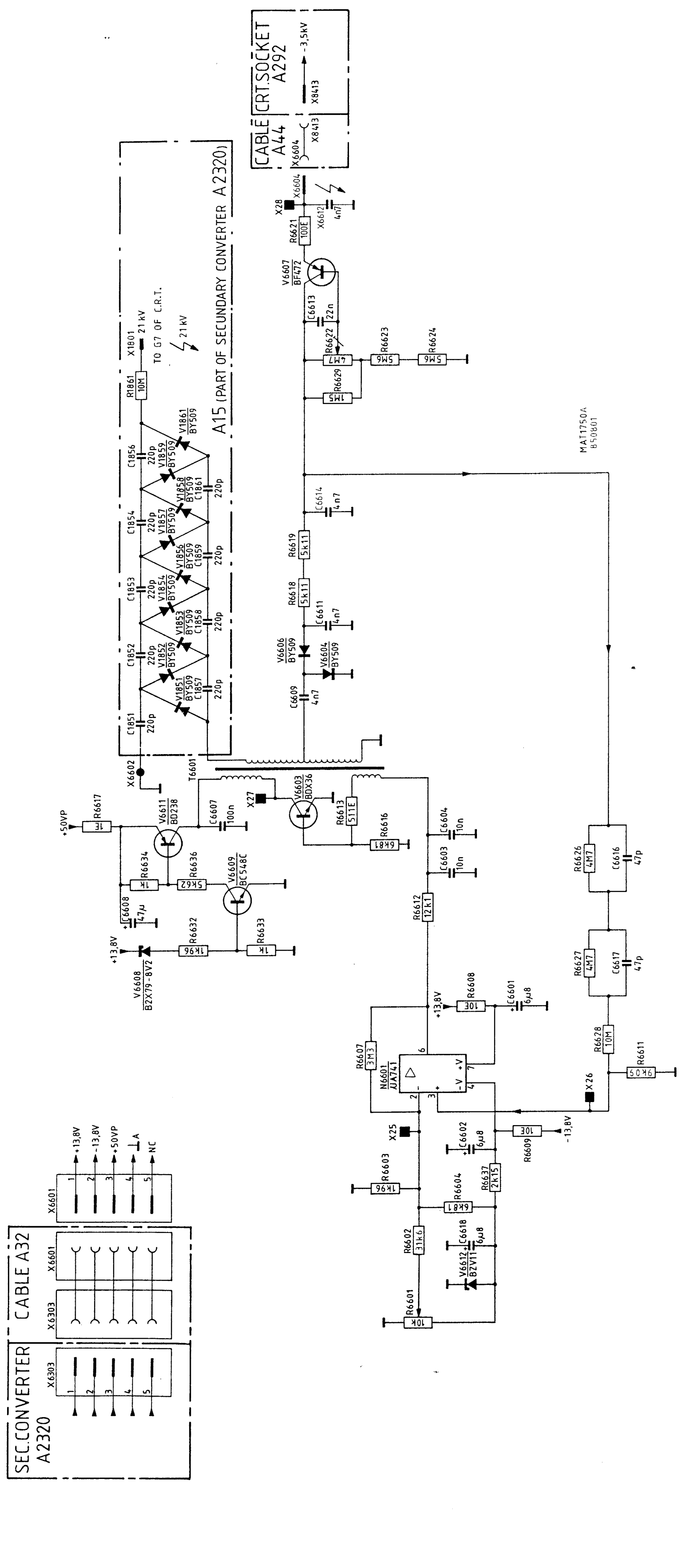


Fig.20.3. High-voltage converter, circuit diagram.

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 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 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%	12K1	5322 116 50572
R 6613	RES.METAL FILM	MR25	1%	511E	4822 116 51282
R 6616	RES.METAL FILM	MR25	1%	6K81	4822 116 51252
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 10667
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 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 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 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

2

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.
Q1, Q2 and Q6 are not used.
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 0Q200 (V7313)

When the circuit boards XZ amplifier, time base or final Y amplifier are removed, the OE- line can go to low and 0Q200 could be damaged. Diode V7313 protects 0Q200 against this possibility.

Calibrator
The calibrator circuit consists of a divider circuit (D7302, D7303, D7304) to provide a 2 kHz square-wave followed by a controlled switched current source (V7304, V7306) to provide an accurate calibration voltage.

The 3 MHz square-wave input is derived from CPU unit and applied to input 10 of counter D7302 (HEF 4040). Together with D7303, this divides the 3 MHz input by 750 to produce a 4 kHz output. In turn, this is applied to D-type flip-flop D7304 to divide it by two to obtain a 50% duty cycle.
The 2 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 1 V square-wave output over the 50-ohm resistor R7318 at the collector of V7306, switched by V7304 at a frequency of 2 kHz.
The 0 V level of the output signal occurs when switch V7304 conducts; the 1 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.

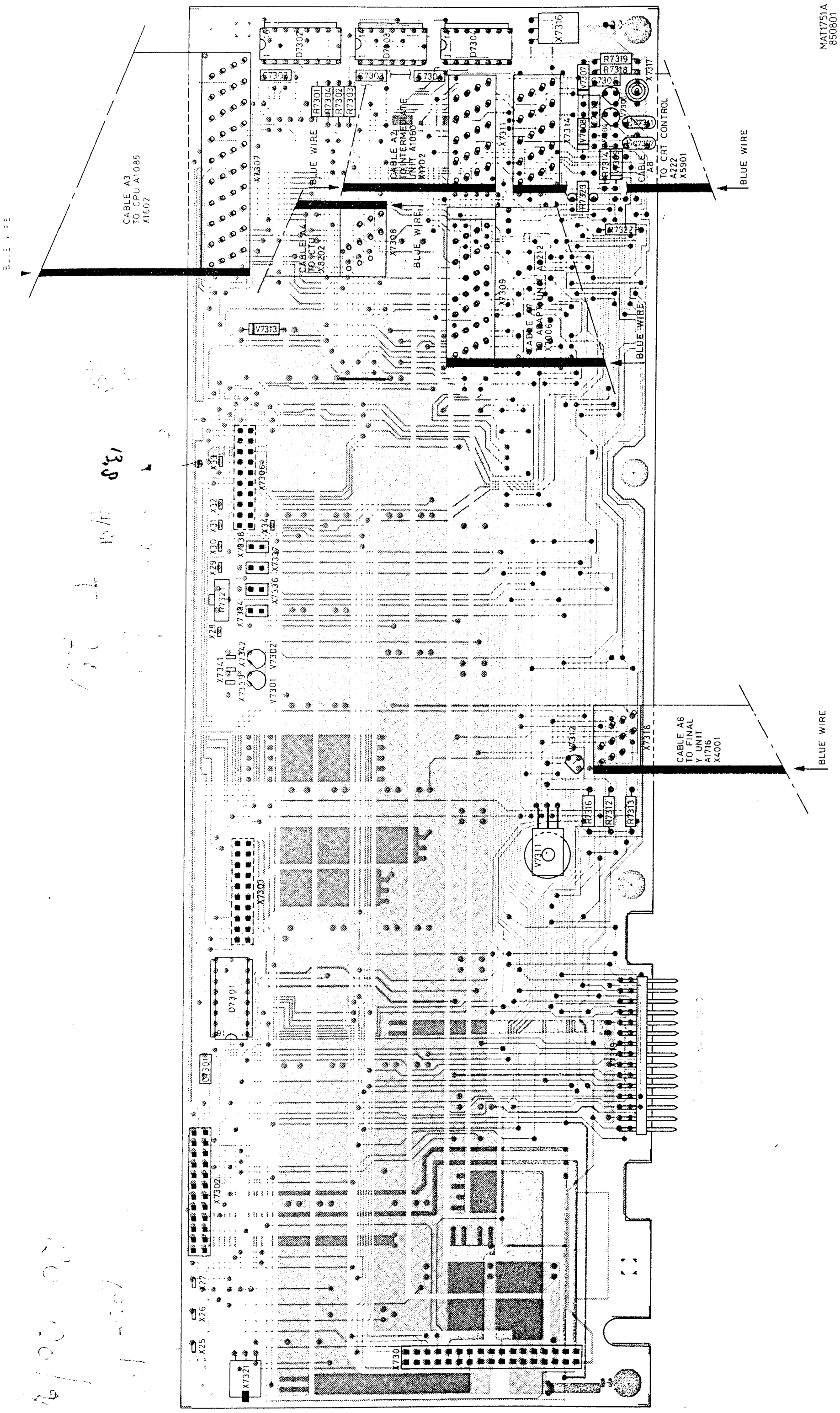
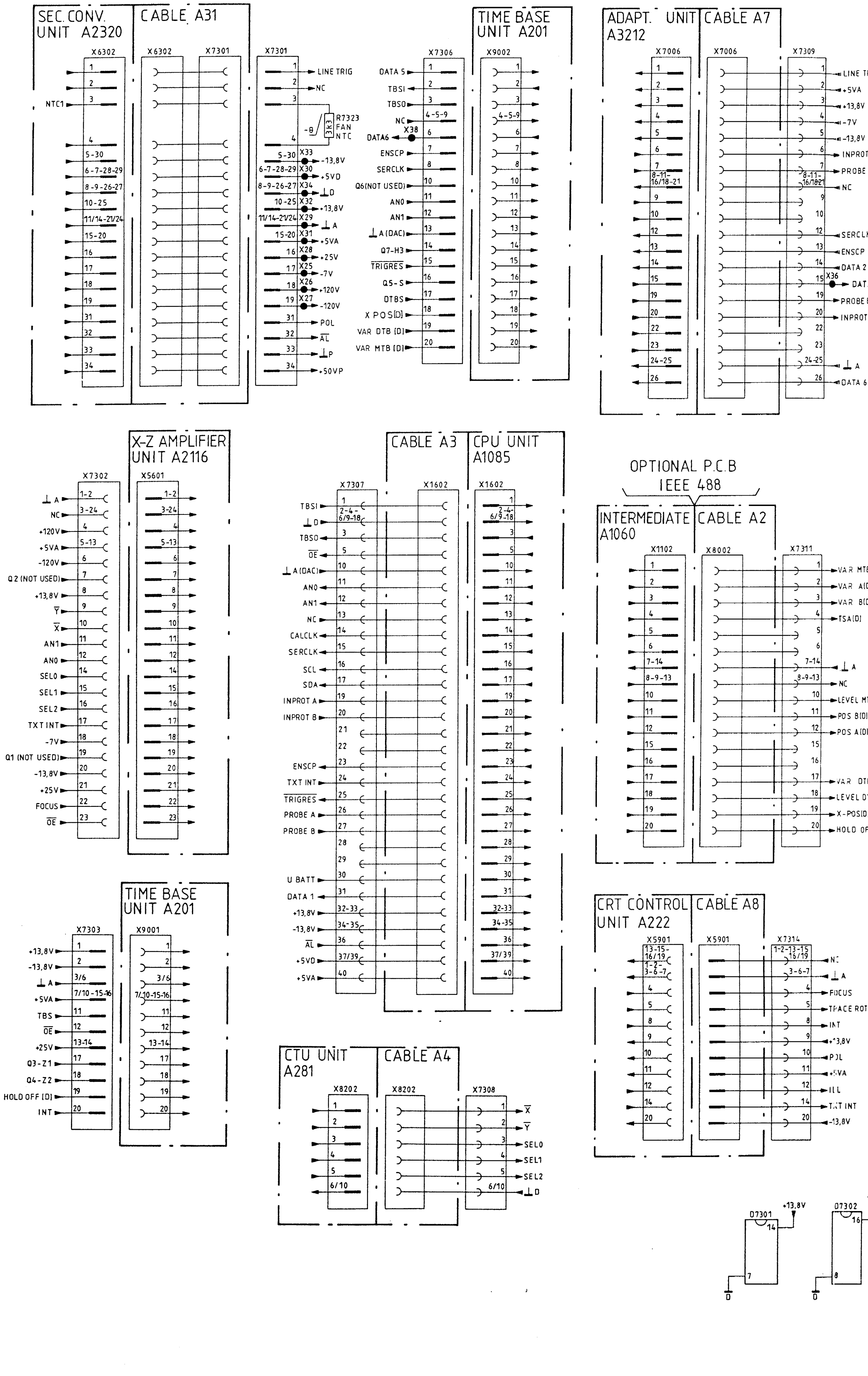
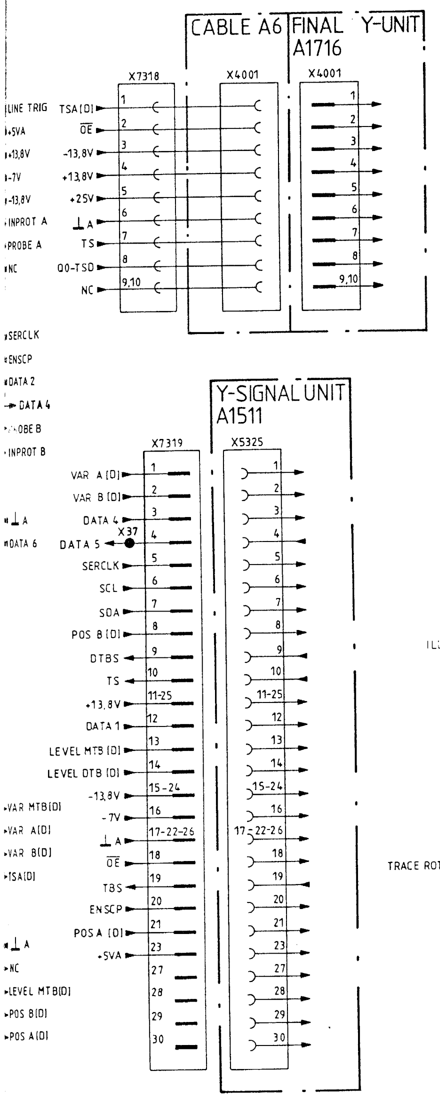


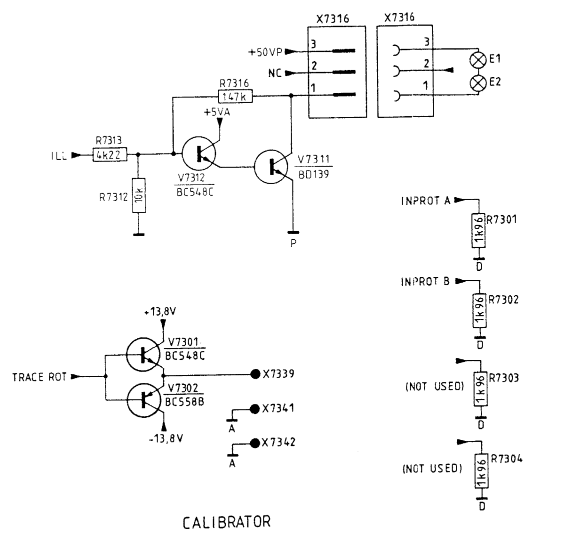
Fig.21.1. Motherboard, p.c.b. lay-out.

21-5



SEC. CONV. UNIT A2320
CABLE A31
X6302
X7301
NTC1
LINE TRIG
NC
R7323 FAN NTC
3K3
-θ
X33 -13,8V
X30 +5VD
X34 ⊥D
X32 +13,8V
X29 ⊥A
X31 +5VA
X28 +25V
X25 -7V
X26 +120V
X27 -120V
POL
AL
⊥P
+50VP
TIME BASE UNIT A201
X7306
X9002
DATA 5
TBSI
TBSO
NC
X38
DATA6
ENSCP
SERCLK
Q6(NOT USED)
AN0
AN1
⊥A (DAC)
Q7-H3
TRIGRES
Q5-S
DTBS
X POS (D)
VAR DTB (D)
VAR MTB (D)
ADAPT. UNIT A3212
CABLE A7
X7006
X7309
+5VA
+13,8V
-7V
-13,8V
NC
SERCLK
ENSCP
X36
⊥A
X-Z AMPLIFIER UNIT A2116
X7302
X5601
⊥A
NC
+120V
+5VA
-120V
Q2 (NOT USED)
+13,8V
Y
X
AN1
AN0
SEL0
SEL1
SEL2
TXT INT
-7V
Q1 (NOT USED)
-13,8V
+25V
FOCUS
OE
CABLE A3
CPU UNIT A1085
X7307
X1602
TBSI
⊥D
TBSO
OE
⊥A (DAC)
AN0
AN1
NC
CALCLK
SERCLK
SCL
SDA
INPROT A
INPROT B
ENSCP
TXT INT
TRIGRES
PROBE A
PROBE B
U BATT
DATA 1
+13,8V
-13,8V
AL
+5VD
+5VA
OPTIONAL P.C.B IEEE 488
INTERMEDIATE A1060
CABLE A2
X1102
X8002
X7311
NC
TIME BASE UNIT A201
X7303
X9001
+13,8V
-13,8V
⊥A
+5VA
TBS
OE
+25V
Q3-Z1
Q4-Z2
HOLD OFF (D)
INT
CRT CONTROL UNIT A222
CABLE A8
X5901
X7314
⊥A
FOCUS
INT
+13,8V
TXT INT
-13,8V
CTU UNIT A281
CABLE A4
X8202
X7308
X
Y
SEL0
SEL1
SEL2
⊥D
+13,8V
D7301
D7302





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 X7312-2-11:X7314-3-6-7:X7318-6:X7319-17-22-26:X7341:X7342
⊥A (DAC)	X7301-11-12-13-14-21-22-23-24	X7306-13:X7307-10
⊥D	X7301-8-9-26-27	X34:X7307-2-4-6-7-8-9-18:X7308-6-7-8-9-10:X7321-1
⊥P	X7301-33	INTERNAL
+5VA	X7301-15-20	X31:X7302-5-13:X7303-7-8-9-10-15-16:X7307-40:X7309-2: X7312-9:X7314-11:X7319-23
+5VD	X7301-6-7-28-29	X30:X7307-37-38-39
-7V	X7301-17	X25:X7302-18:X7309-4: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	X7316-3
-120V	X7301-19	X27:X7302-6
+120V	X7301-18	X26:X7302-4
AL	X7301-32	X7307-36
AN0	X7307-11	X7302-12:X7306-11
AN1	X7307-12	X7302-11:X7306-12
CAL CLK	X7307-14	INTERNAL
VAR A [D]	X7311-2	X7319-1
VAR B [D]	X7311-3	X7319-2
VAR DTB [D]	X7311-17	X7306-19
VAR MTB [D]	X7311-1	X7306-20
DATA 1	X7307-31	X7319-12: INTERNAL
DATA 2	INTERNAL	X7309-14: X35
DATA 3		(NOT USED)
DATA 4	X7309-15	X7319-3: X36
DATA 5	X7319-4	X7306-1: 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	X7303-19:X7312-8
ILL	X7314-12	INTERNAL
INPROT A	X7309-6	X7307-19:INTERNAL
INPROT B	X7309-20	X7307-20:INTERNAL
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
$\overline{OE}$	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	X7303-17
Q4-Z2	INTERNAL	X7303-18
Q5-S	INTERNAL	X7306-16
Q6	INTERNAL	X7306-10 (NOT USED)
Q7-H3	INTERNAL	X7306-14
SCL	X7307-16	X7319-6
SDA	X7307-17	X7319-17
SEL0	X7308-3	X7302-14
SEL	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
$\overline{TRACE\ ROT}$	X7314-5	INTERNAL
$\overline{TRIG\ RES}$	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

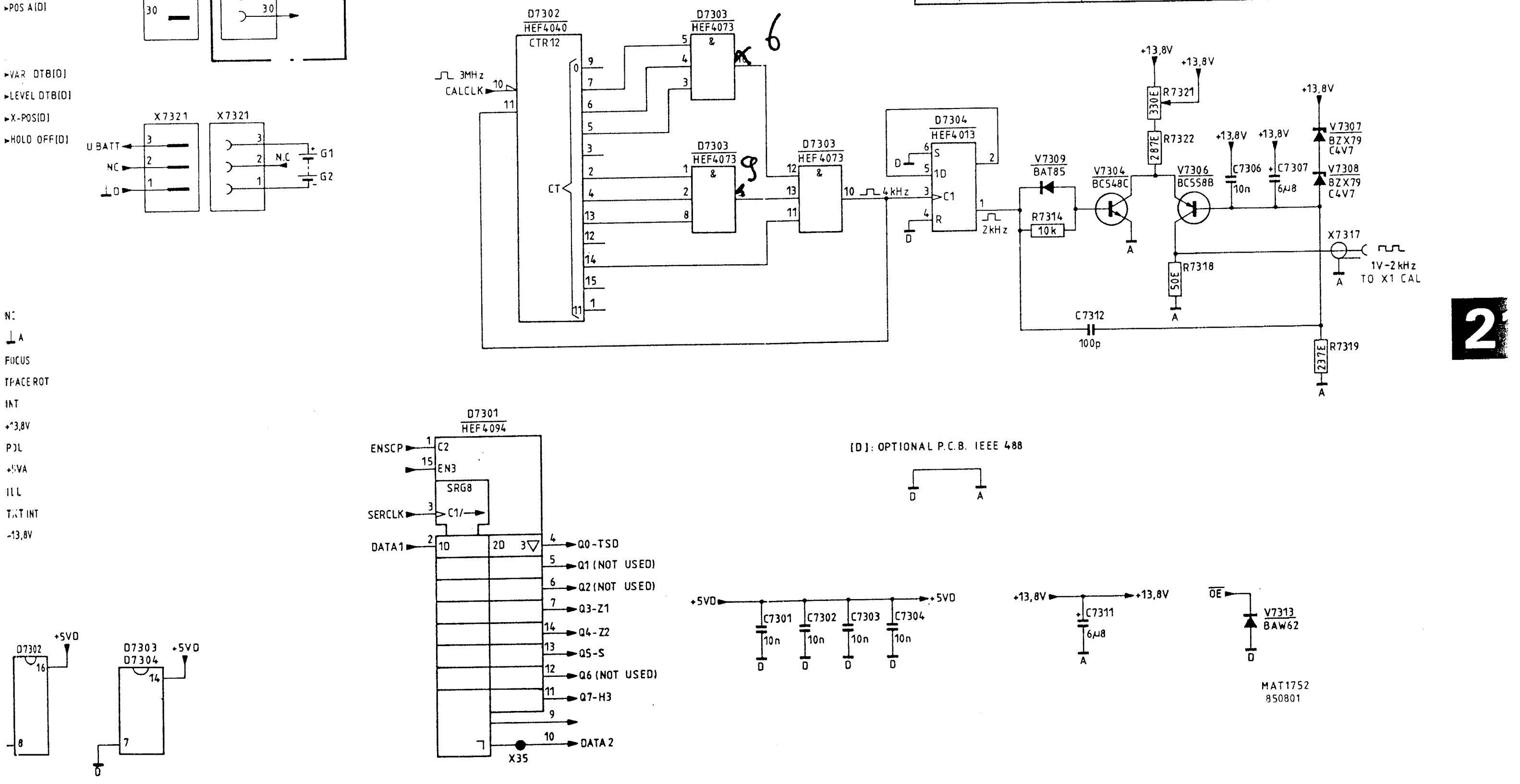


Fig.21.2. Motherboard, p.c.b. lay-out.

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	-20+50%	10NF	4822 122 31414
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

D 7301	INTEGR.CIRCUIT	HEF4094BP	PEL	5322 209 14485
D 7302	INTEGR.CIRCUIT	HEF4040BP	PEL	5322 209 14269
D 7303	INTEGR.CIRCUIT	HEF4073BP	PEL	4822 209 10266
D 7304	INTEGR.CIRCUIT	HEF4013BP	PEL	4822 209 10248

21.1.3 RESISTORS

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 54506
R 7323	RES.N.T.C.	0.5W	10%	3K3	5322 116 30234

21.1.4 SEMI CONDUCTORS

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

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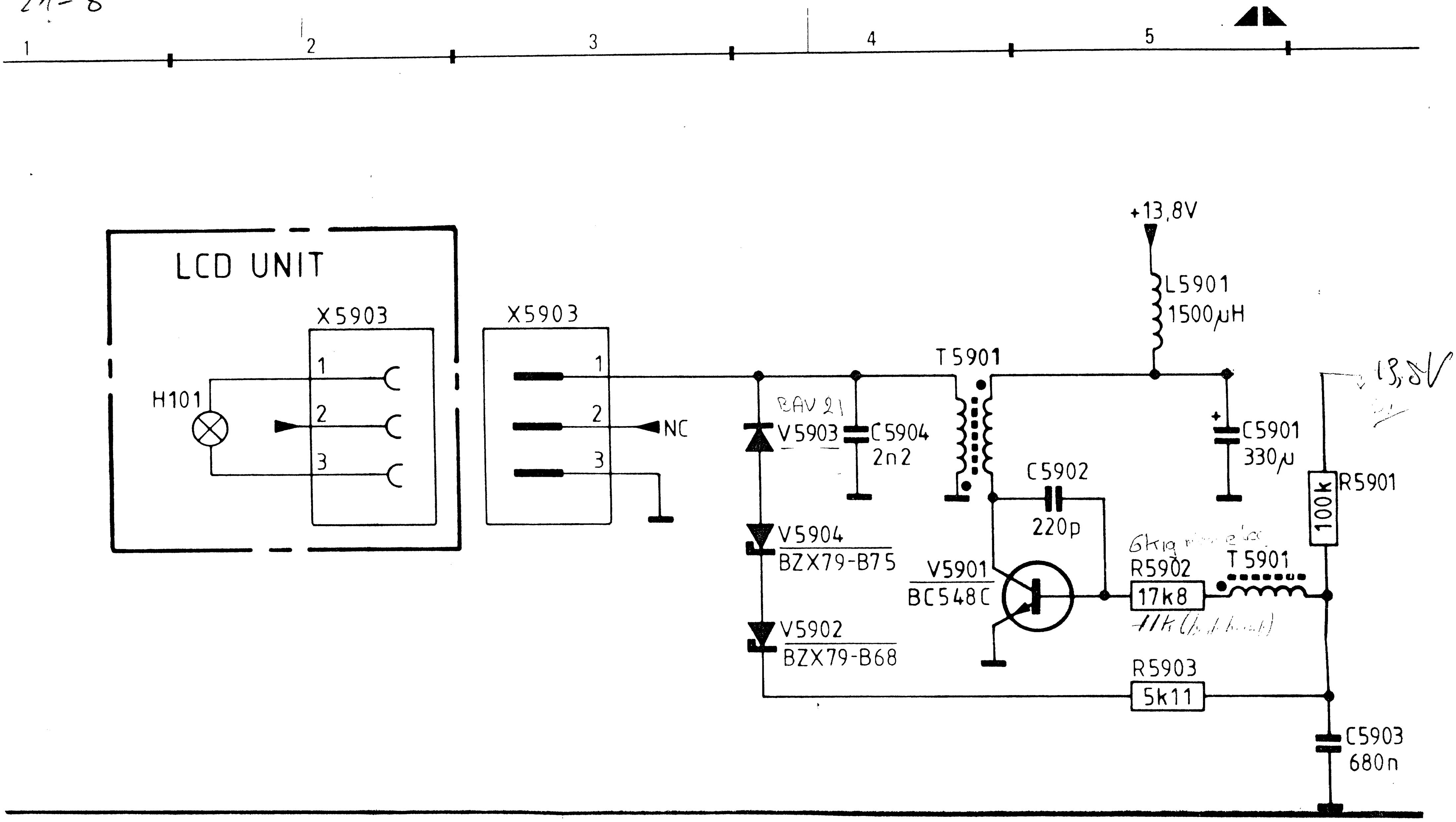

1
2
3
4
5
LCD UNIT
X5903
1
2
3
H101
X5903
1
2
3
NC
+13,8V
L5901
1500µH
T5901
BAV 21
V5903
C5904
2n2
V5904
BZX79-B75
V5902
BZX79-B68
C5902
220p
V5901
BC548C
R5902
17k8
11k
T5901
C5901
330µ
R5901
100k
13,8V
R5903
5k11
C5903
680n

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

This unit incorporates the potentiometers that control the CRT functions. 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 circuit part. The CRT controls unit is connected with the motherboard via a flat cable.

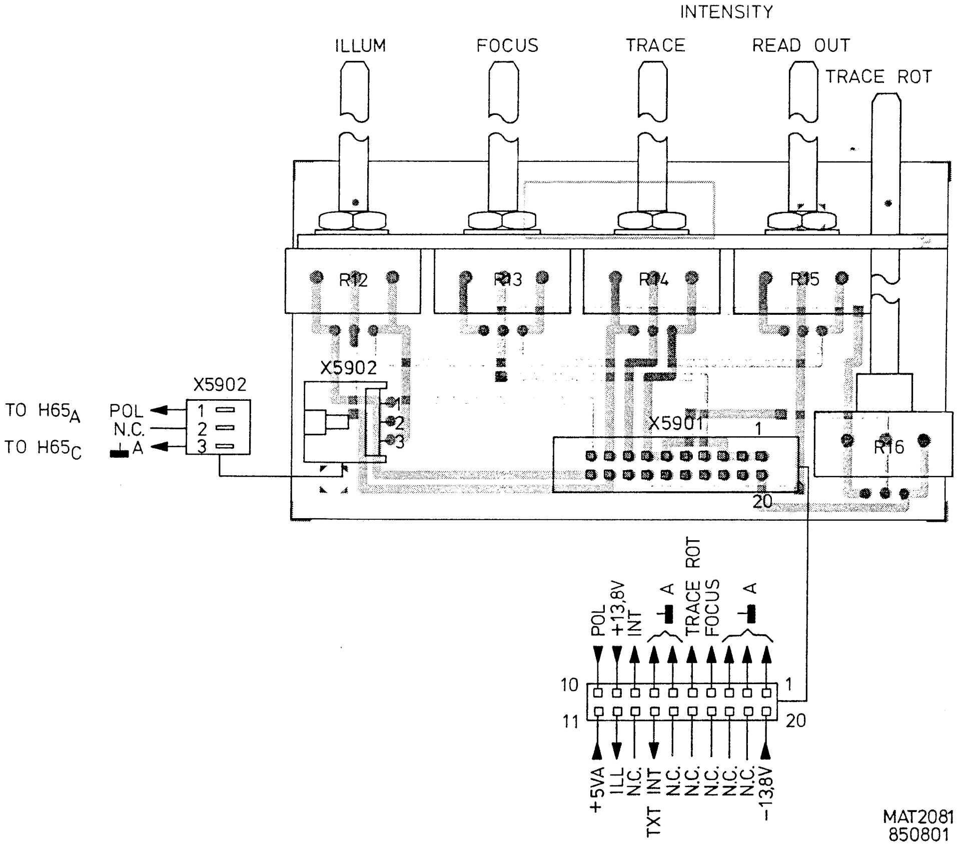

Fig.22.1. CRT controls unit, p.c.b. lay-out.

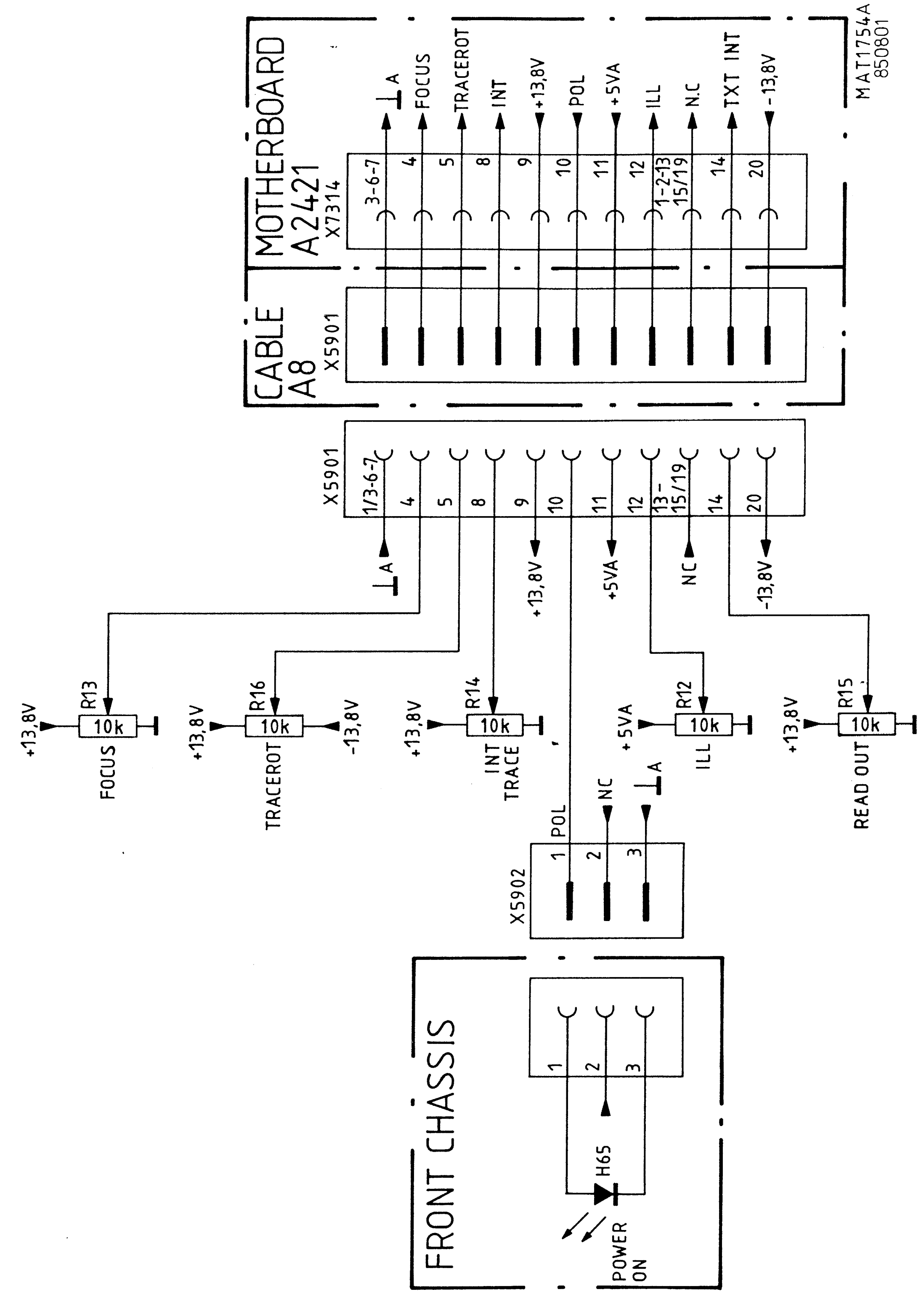

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Fig.22.2 CRT controls unit, circuit diagram.

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

R0012... 015	POTM.CARB.TRACK	0,1W 20% 10K	5322 101 20812
R0016	POTM.CARB.TRACK	0,1W 20% 10K	5322 101 20813

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.
- 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".

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 15 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.

2

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 attenuator unit partly PG506. For fast-rise square wave response 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 PM5129
	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 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	Adjustment 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 PM3295
11. Digital multimeter	Wide voltage, current and resistance ranges. Required accuracy 0,1%	Checking the instrument under test.	Philips PM2524 and high-voltage probe PM9246

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 -3,33 kVolt present at connector X8413 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.

ATTENTION: Be aware that after removal of the rear plate, several points can be touched that carry dangerous live voltages.

Now proceed as follows:
- Adjust R6622 to its stop position so that the voltage measured at X8413 is maximal.
- Adjust R6601 to 3330 Volt present at X8413.
- Reinstall the rear plate again.

Trace rotation (R16, front panel)

Adjust the trace exactly in parallel with the horizontal graticule lines.

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 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.

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.

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.
- 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).

- This adjustment is done in the service routine "Central Processor 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 ALT and finally A+B. Now we are in the part of the service routine that gives + 10 Volt on tag "DAC" of the central processor unit.
- Measure this voltage (with respect to the instruments mass) with a digital multimeter: if necessary readjust R1653.
- Leave the service routine by depressing AUTO SET four times.

Oscillator frequency adjustment on CRT text unit (R8207)

- Make the text visible on the screen with the READ OUT INTENSITY control.
- Check that the pulse on tag "Y" is low for exactly 6m.sec: if not readjust R8207.
- Reinstall the metal plate of the front unit compartment again.

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, R9412/time base)

- 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.
- Select MTB INTENS for horizontal display and STARTS DTB mode.
- Adjust the MAIN TB to a sweep speed of 100 us/div.
- Adjust the DEL´D TB to a sweep speed of 20 us/div.
- Adjust R9412 so that the intensified part of the trace is just visible in all TRACE INTENS positions.

Square-wave response of Z-amplifier (C5618, C5616, C5628, 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 C5618 and C5616 (C5628 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).

Text adjustment on final Y-amplifier (R4002, R4038, R4076, R4079, R4083, R5090/signal unit).

- Switch the TRACE and READ OUT INTENSITY on.
- Apply a 100Hz/6 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/6 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/6 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/6 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/6 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/6 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/6 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/6 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. 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, then depress the vertical display made switch A two times, then depress switch A (B). Now the channel A (B) input sensitivity switches automatically between 5 and 500 mV.
- Adjust R7001 (R7004) so that the trace jump is minimal.
- Depress AUTO SET four times to leave the service routine

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Gain adjustments channel A (B) (R4902, R4952, R4967, R5017, signal unit).

- Apply a 1kHz/5 Volt calibrated square-wave original 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 1 Volt/div.
- Adjust R4902 (R4967) to a vertical display of exactly 5 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 channel B INVERT pushbuttons together, then depress A, then depress A+B. Now depress pushbutton A(B).
- 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.

Position symmetry adjustment channel A (B) (R5046, R5081 signal unit).

- Activate the "AC" pushbutton of the channel A (B) input coupling switches.
- Adjust the channal A (B) input sensitivity to 500 mV/div.
- Apply a sine-wave of 1kHz/8 Volt peak to peak to the channal A (B) input socket.
- Adjust the MAIN TB to a sweep time of 200 microsec/div.
- Shift the signal completely upwards and downwards and check that the signal top (visible in the bottom of the screen) and the signal bottom (visible in the top of the screen) are equal. If not readjust R5046 (5081).

Vertical shift range check channel A (B).

- Adjust the channel A (B) input sensitivity to 1V/div.
- Apply a sine-wave of 1kHz/4,8 div. to the channel A (B) input.
- Adjust the channel A (B) input sensitivity to 200mV/div.
- Rotate the channel A (B) Y POS control fully clockwise and anti-clockwise and check if the top and bottom of the signal can be positioned inside the graticule.

Channel A (B) VAR control check.

- Adjust the channel A (B) input sensitivity to 2 Volt/div.
- Apply a sine-wave of 1kHz/5 div. to the channel A (B) input.
- Turn the channel A (B) VAR control fully anti-clockwise.
- Check that the amplitude of the sine-wave on the screen lies between 2 and 1,45 div.
- Turn the channel A (B) VAR control back to its calibrated position.
- Do the same check for the channel A (B) input sensitivity of 5V/div.

25.3.5. 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 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 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 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.

25.3.6. Adjustment of time-base and final X-amplifier.

Final X-amplifier balances (R5726, R5738).

- Select MTB for X-deflection, sweep speed 1 microsec/div., AUTO mode, X POS in horizontal mid of screen and TB MAGN on.
- Connect a measuring oscilloscope between the instrument's earth and X34 (X35). Adjust the measuring oscilloscope to 20V/div: the baseline with no input signal must be 0,6 div. below the vertical mid of the screen. Sweep speed of measuring oscilloscope: 20 microsec/div.
- Adjust R5726 (5738) so that the peak-to-peak value of the signal on the screen of the measuring oscilloscope lies symmetrically around the vertical mid of the screen.

- Apply a 50 microsec. time marker signal.
- Adjust the second time marker to the horizontal mid of the screen.
- Switch the TB MAGN off and check that the second time marker has not shifted more than 0,14 div. If this is not obtained, readjust R5726 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 pulse response and linearity (C5704, C5714, C5702, C5713).

- Switch the function TB MAGN on.
- Select a MAIN TB sweep time of 2 n.sec/div.
- Apply a 500 MHz sine-wave signal to input A.
- Adjust X POS so that the centre of the magnified sweep is in the centre of the screen.
- Connect a measuring oscilloscope between X33 (X36) and the instrument´s earth. When measuring on X33, invert the signal displayed on the measuring oscilloscope.
- Adjust C5704 (C5714) to maximum straightness of the pulse top displayed on the measuring oscilloscope.
- Adjust C5702 (C5713) for maximum steepness of the leading edge of the pulse displayed on the screen. The pulse may not have overshoot.
- Apply a 2 n.sec time marker pulse to channel A.
- Check the marker pulses on the screen. If the sweep speed is too low, this may be corrected by readjusting C5704 and C5714 to a somewhat higher capacitance value. Both trimming capacitors must be increased with the same amount (must be turned over the same angle).
- Check the linearity: the marker pulse in the horizontal mid of the screen must not deviate more than 0,1 div. if the markers at the begin and end at the screen coincide exactly with the first and last graticule line. 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).

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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.

<u>DTB trace position adjustment (R9205/time base)</u>

- 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.

<u>Delayed time base delay and delta T adjustments (R9348, R9347, R9346, R9344).</u>

- Switch the READ OUT INTENSITY on and the TRACE INTENSITY off.
- 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, then depress vertical display mode switch A and then B.
- Switch the READ OUT INTENSITY off and the TRACE INTENSITY on.
- 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 <u>DEL´D TB</u> 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 <u>DEL´D TB</u> 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.

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- 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.

25.3.7. 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.

25.3.8. Cursor adjustment (R5784, R5791, R5779, R5781, R5758, R5762, R5773).

- Switch the READ OUT INTENSITY on and the TRACE INTENSITIY off.
- The now following adjustments must be done in the service routine "final X-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 reference cursor (dashed line) covers the graticule line in the mid of the screen.
- Adjust R5784 so that delta cursor (dotted line) 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 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 reference cursor (dashed line) covers the graticule line in the vertical mid of the screen.
- Adjust R5791 so that the delta cursor (dotted line) covers the last graticule line in the bottom of the screen. If necessary repeat the previous and this step.
- 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.

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25.3.9. Square-wave response of final Y-amplifier (R4039, R4041, C4017, R4050, C4019, R4047, R4042).

Note: Take the pulse distortion of the calibration generator into account when performing the now following calibration steps. Check the calibration generator with a sampling oscilloscope.

- The adjustments are done via channel A.
- The required fast rise-time square-wave must be obtained from the square-wave generator via a tunnel diode pulser.
- Adjust channel A to an input sensitivity of 50mV/div.
- Select DC and 50 Ohm (generator termination) input coupling for channel A.
- Apply a 10kHz/6 div. square-wave signal with a rise-time faster than 500 psec. to the channel A input.
- Adjust the MAIN TB sweep speed to 20 usec/div.
- Adjust the square-wave response with R4039.
- Apply a 100kHz/6 div. square-wave signal with a rise-time faster than 500 psec. to the channel A input.
- Adjust the MAIN TB sweep speed to 2 us/div.
- Adjust the square-wave response with R4041 and C4017.

- Apply a 1MHz/6 div. square-wave signal with a rise-time faster than 500 p. sec. 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 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 350MHz. Check also that there are no dips in the frequency reponse.

NOTE: Two generators are required to cover the whole frequency range (see list of recommended test and calibration equipment). The amplitude of each generator must be adjusted to 6 div. at 50kHz.

25.3.10. 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, signal unit).

- Before starting the adjustments turn R5191 and R5192 fully anti- clockwise.
- 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 100 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 50 ns/div.
- Adjust R5192 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 0,3 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.

25.3.11. 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, R5277, R5304, R5269)

- Before starting the adjustments turn R5276 and R5277 fully anti-clockwise.
- 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.
- Depres pushbutton AUTO of the MAIN TB mode selector.

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- 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 100 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.

- Adjust the MAIN TB to a sweep of 50 ns/div.
- Adjust R5277 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 UNIT 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.

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.

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- 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 - 0,2 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.

25.3.12. Calibration voltage adjustment (R7321, mother board)

Check that the amplitude of the calibration signal lies between 0 Volt and +1 Volt (+/- 1%). This results in a read-out of 500 mV on a digital AC-millivoltmeter (duty-cycle of cal. voltage is 50%).
If not, readjust R7321.

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 parts replacements can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE: Physical size and shape of a component may affect 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.

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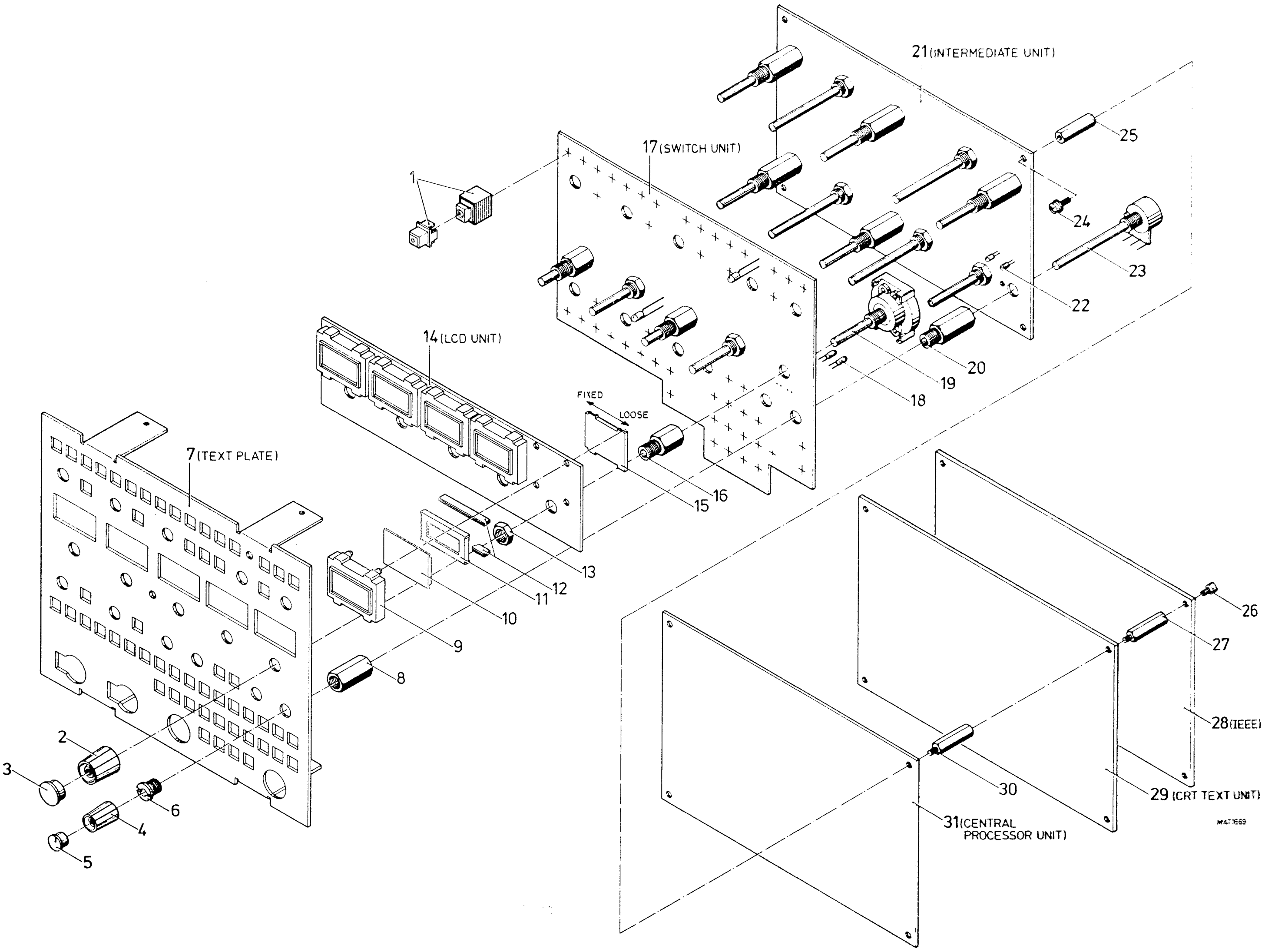

Fig.26.1.Exploded view of front unit.

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.
- 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)
- Take the front unit out of the instrument
- Unplug the flatcable coming from the intermediate unit
- Remove 4 screws (26)
- 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.

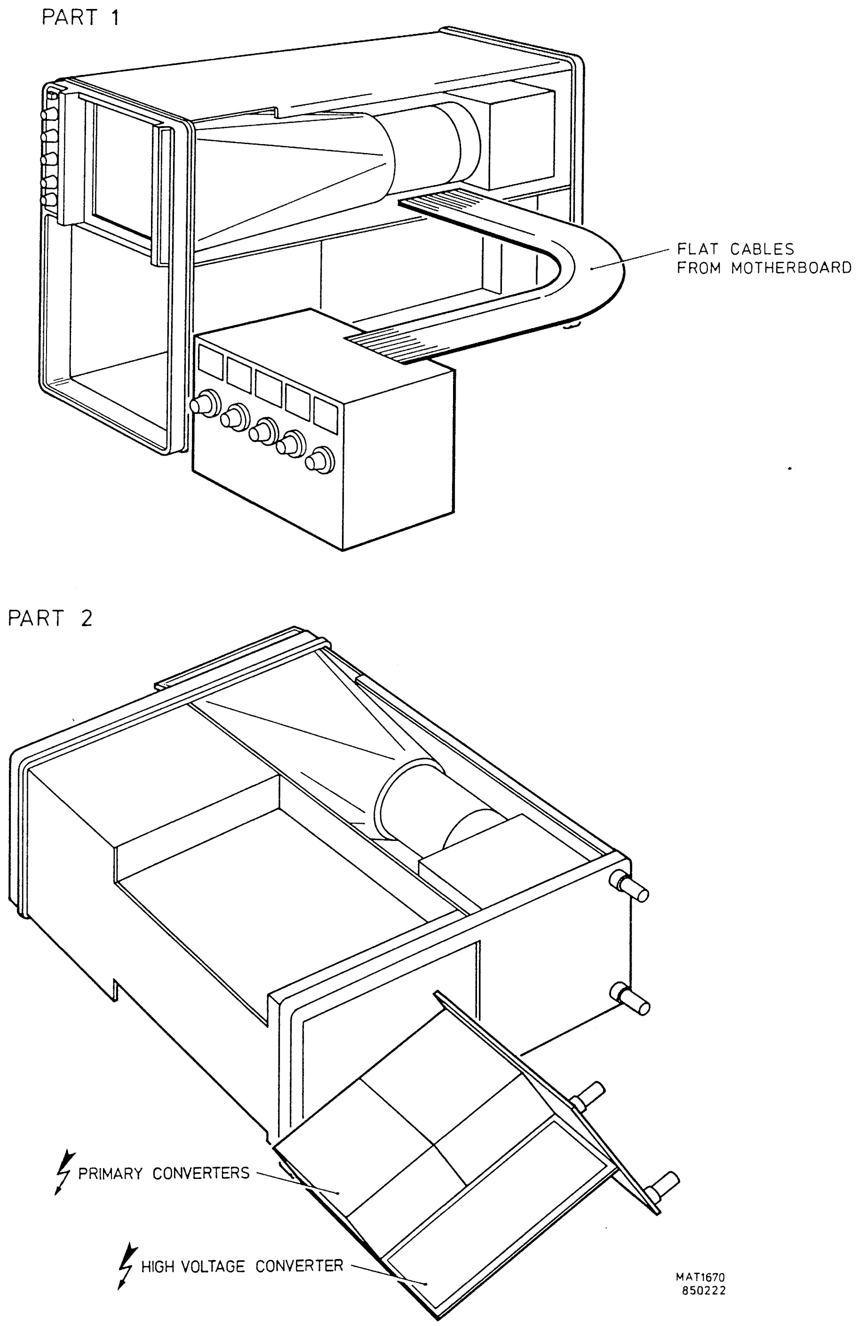

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Fig.26.2. Measuring the front unit and power supplies under working conditions.

NOTE: after this action the component side of the CRT text unit is visible.

CRT text unit (unit A281)

- 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.

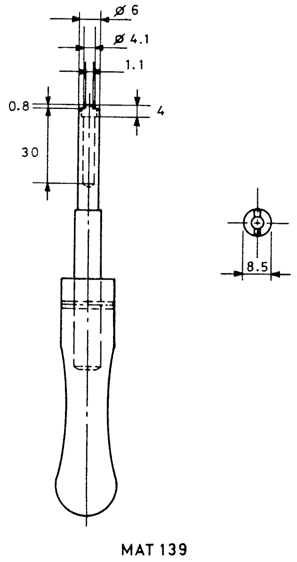
NOTE: after this action the component side of the central processor unit is visible.

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.



Eig.26.3.Dimensional drawing of tool for slotted nut.

LCD unit (unit A 1011)
- 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. 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:
- 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.

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.

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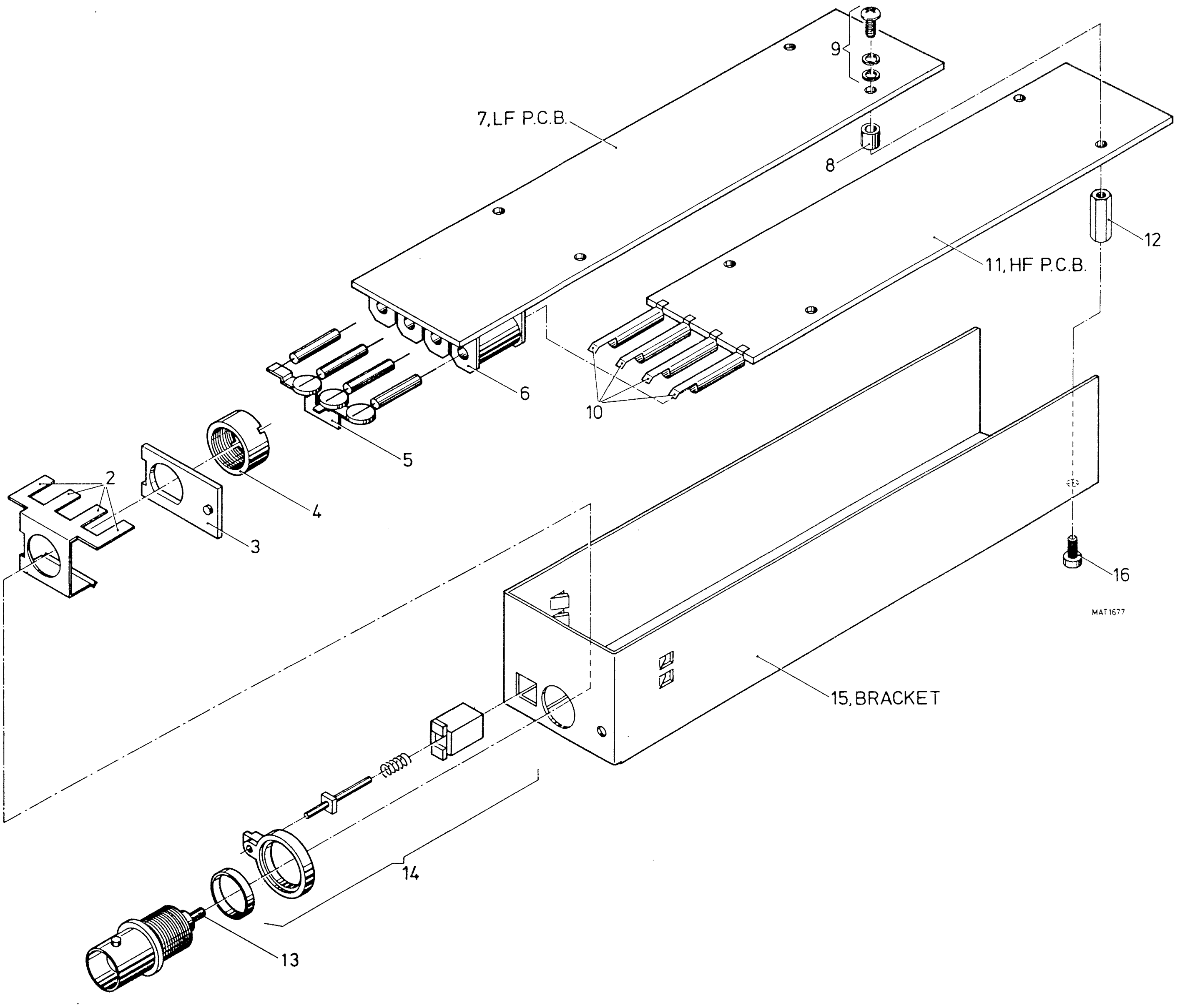

Fig 26.4.Exploded view of attenuator unit.

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.

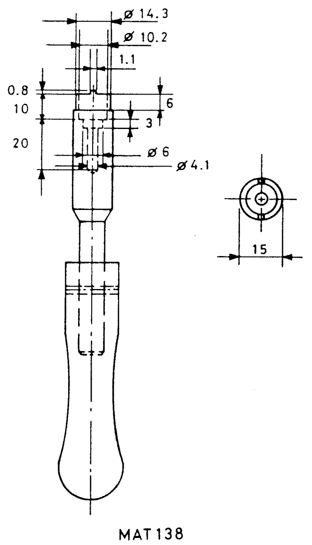

Fig. 26.5. Dimensional drawing of tool for BNC input sockets.

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.

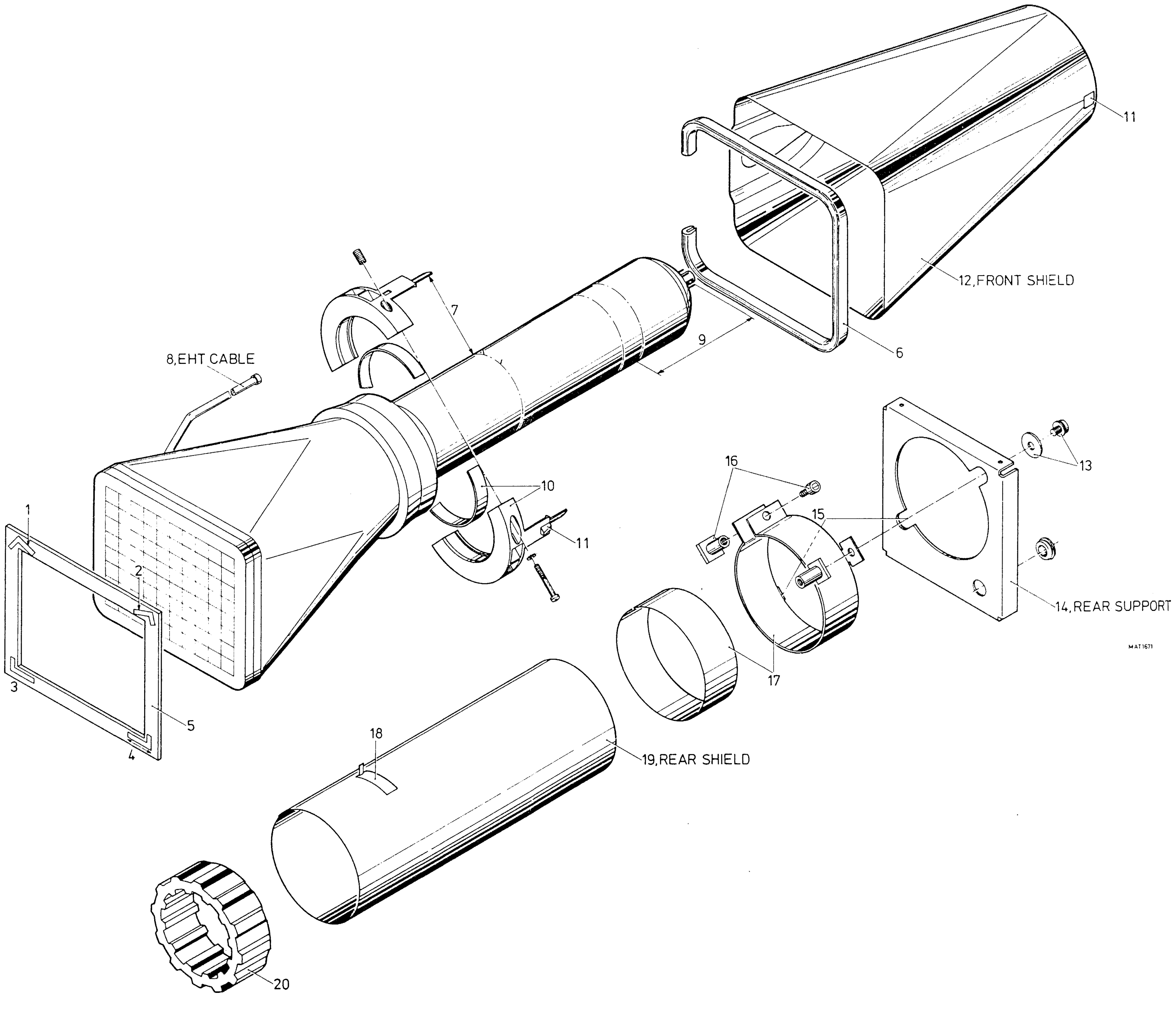

Fig.26.6. Exploded view of CRT and belonging mechanical parts

IMPORTANT: it is strongly 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.

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 four 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. See chapter 26.1.7.9.

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 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 CRT-screen positions screws (1), (2) and (4). These screws are hexagon types.
- 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.

Installing the new CRT.

- Install the positioning ring (10) so that its positioning tags (7) are at the same level as the side connection pins of the CRT (see fig 26.6.), one tag must be situated between the X and Y pins. The position of the clamping springs must be so, that the front shield (12) fits 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).
- Put the rubber ring (20) around the CRT. The distance (9) between the ring and the end of the CRT-socket pins must be 7 centimeters (typical value).

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.

6

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.

26

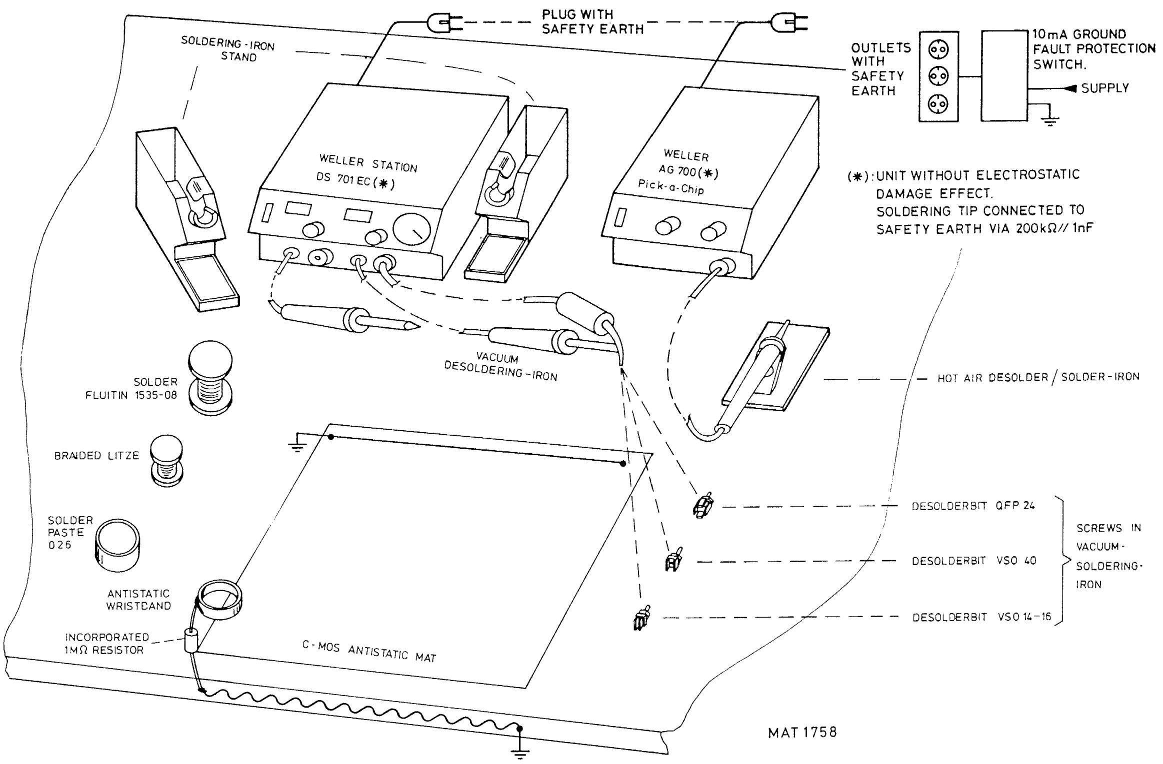

Fig.26.7. Arrangement of working area for S.M.D. exchange.

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)

The Trimming Kit containts the following parts:

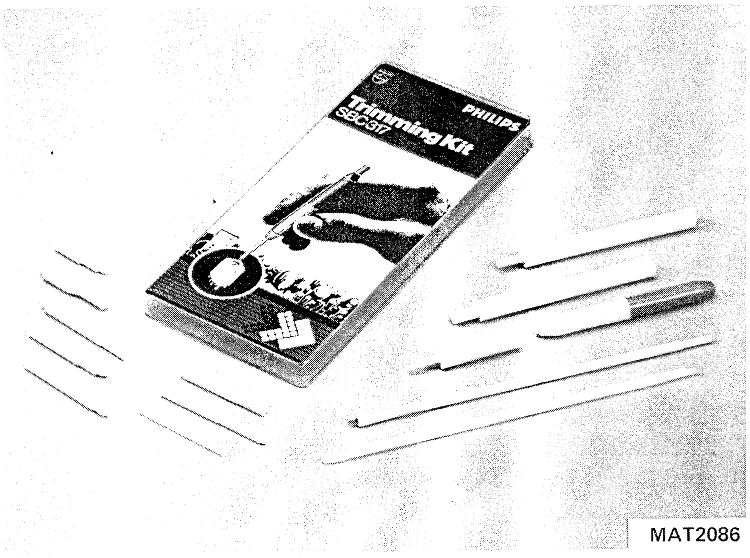

Fig. 26.8 Trimming tool kit

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.

6

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.

2

- 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 triggerd 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. In instruments without CRT-text it is recommended to follow this description carefully because you miss the menu on the CRT-screen then.

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.

2

Structure of service routines:

```
                         NORMAL MODE


                  depress Ch. A and B
                  INVERT simultaneously (*):
                  SERVICE MODE
                          |
  --------------------------------------------------
  |                                                |
depress                                         depress
TRIG VIEW (*):                                  A (*):
IEEE SET UP                                     TEST + CALIBRATION
                                                OF UNITS (P.C.B.´s)
                                                   |
  -------------------------------------------------|
  |              |           |         |          |
depress        depress     depress   depress    depress
TRIG VIEW (*)  A (*):      A+B (*)   B (*):     ALT (*):
FRONT UNIT     ATTENUATOR  Y-PREAMP  TIME BASE  FINAL X AMPLIFIER
TEST           UNIT TEST   TEST      TEST       TEST
  |
--------------------------------------------------
  |             |  |          |        |          |
depress         | depress     |      depress      |
TRIG VIEW (*):  | A+B(*):     |      ALT (*):     |
TABLE WITH      | SWITCH      |      CENTRAL      |
FRONT SETTINGS  | UNIT TEST   |      PROCESSOR    |
ON SCREEN       |             |      UNIT TEST    |
                |             |                   |
        Depress           depress             depress
        A (*):            B (*):              CHOP (*):
        LCD UNIT          INTERMEDIATE        CRT TEXT
        TEST              UNIT TEST           UNIT TEST.
```

(*) means: depress AUTO SET to move upwards in the tree-structure.

Explanation of the service routines.

IEEE SET UP.
In this mode the vertical display mode switches permit selection of the modes "talk only" (TRIG VIEW depressed), "listen only" (A depressed) and "talk and listen" (A+B depressed). 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.

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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.

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-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.
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.A 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.

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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 ratio/reference value; 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.

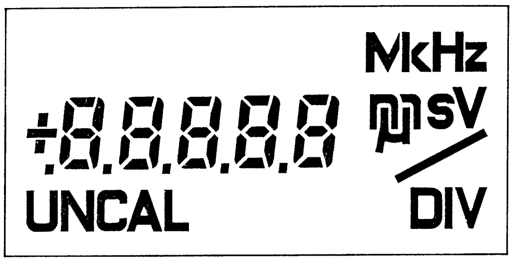

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Fig.26.9. LCD with all elements activated.

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 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 RDRRO 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 RDPRO 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 RDPRO 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.

2

CRT TEXT UNIT 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: on the CRT screen, alternately four points of the display area are on, four points are blanked, four points are on, and so on. This is done both in horizontal and vertical direction.
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.

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^{o}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 3,5 mA rms.

2

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.

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 456 90127
15	1	Text strip above c.r.t (adhesive backside)	5322 456 90126
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

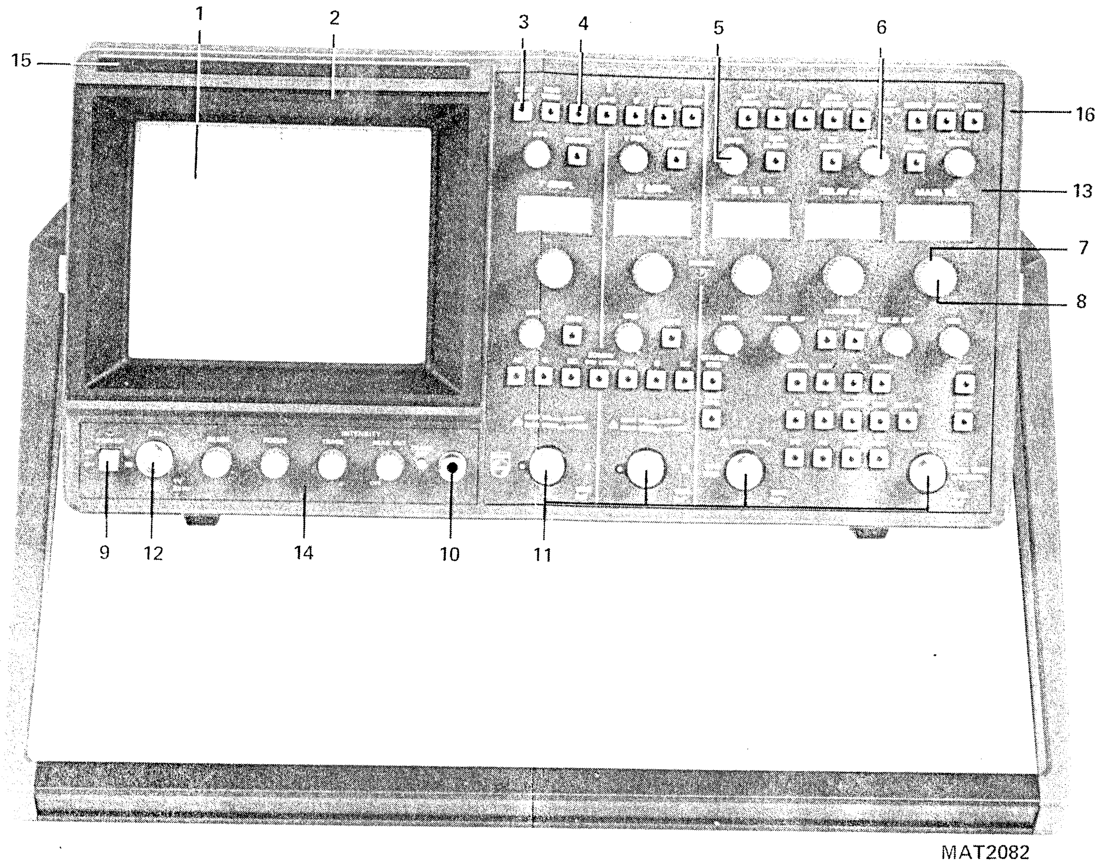
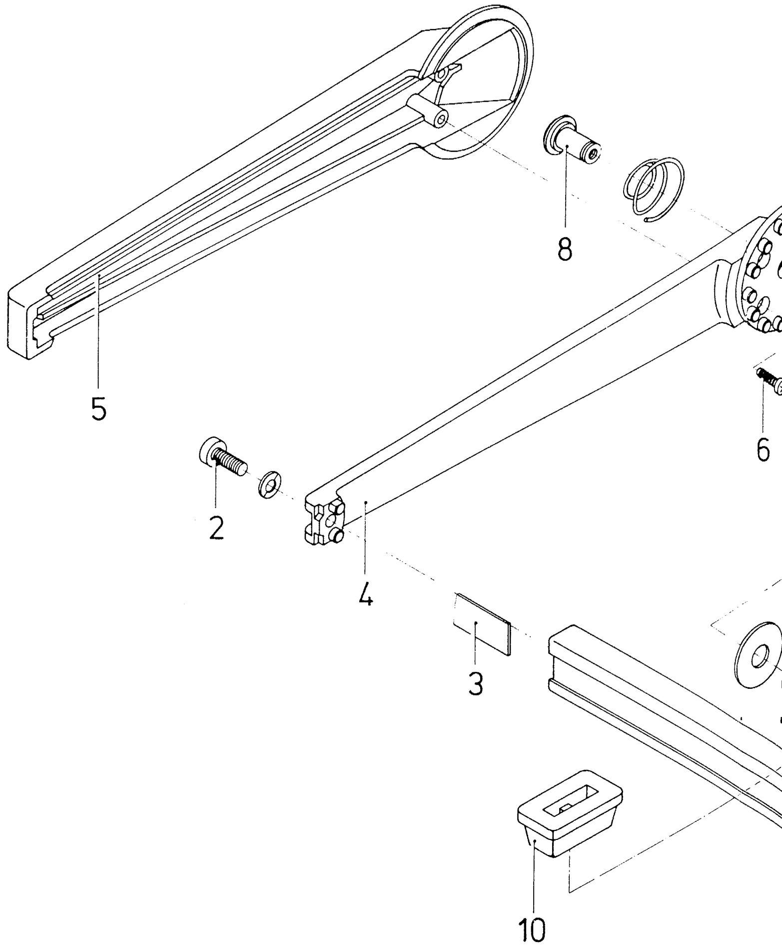


Fig. 28.1 Mechanical parts FRONT SIDE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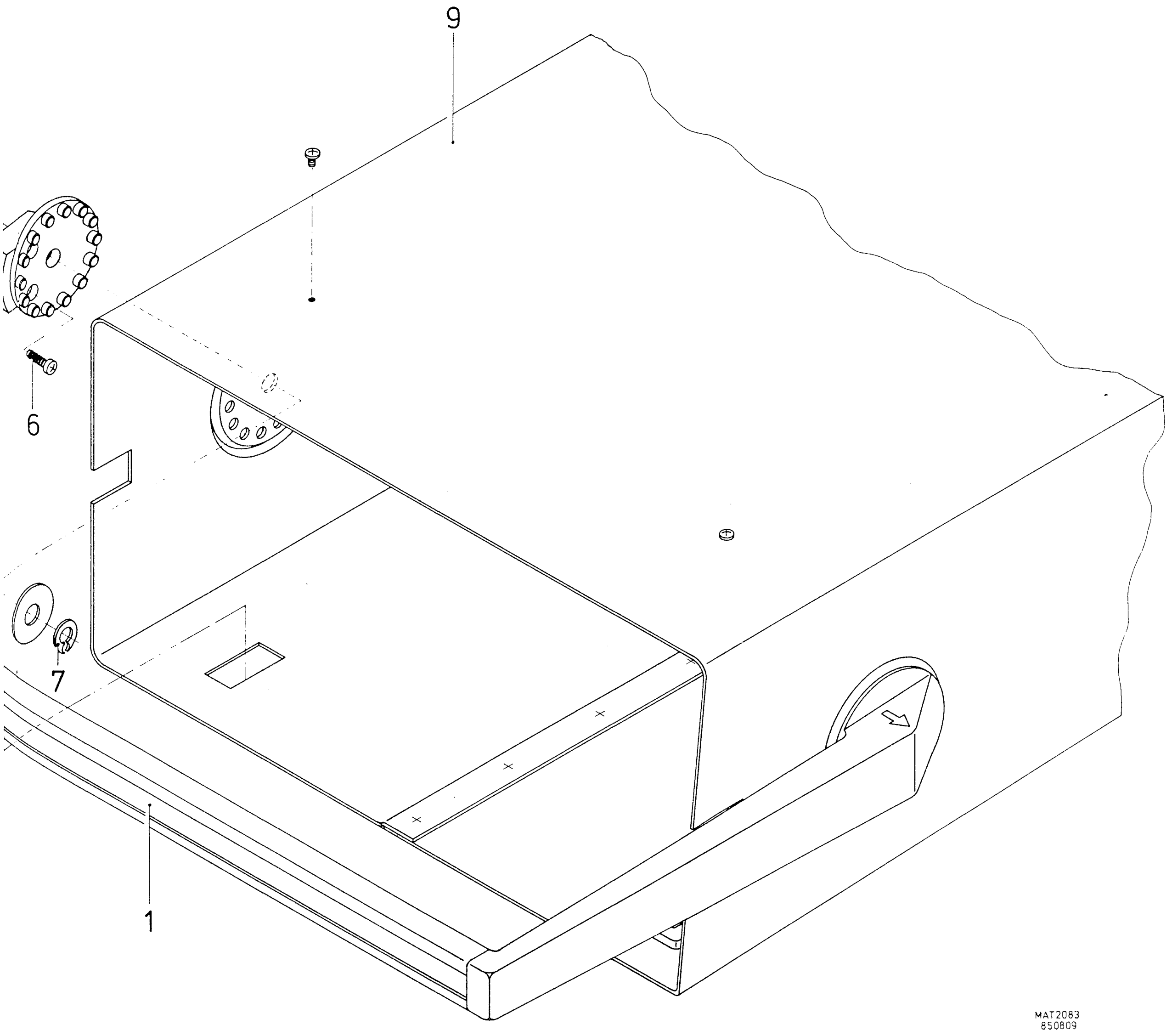


Fig. 28.3 CARRYING HANDLE and HOUSING

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
3	1	Textstrip	5322 456 90128
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

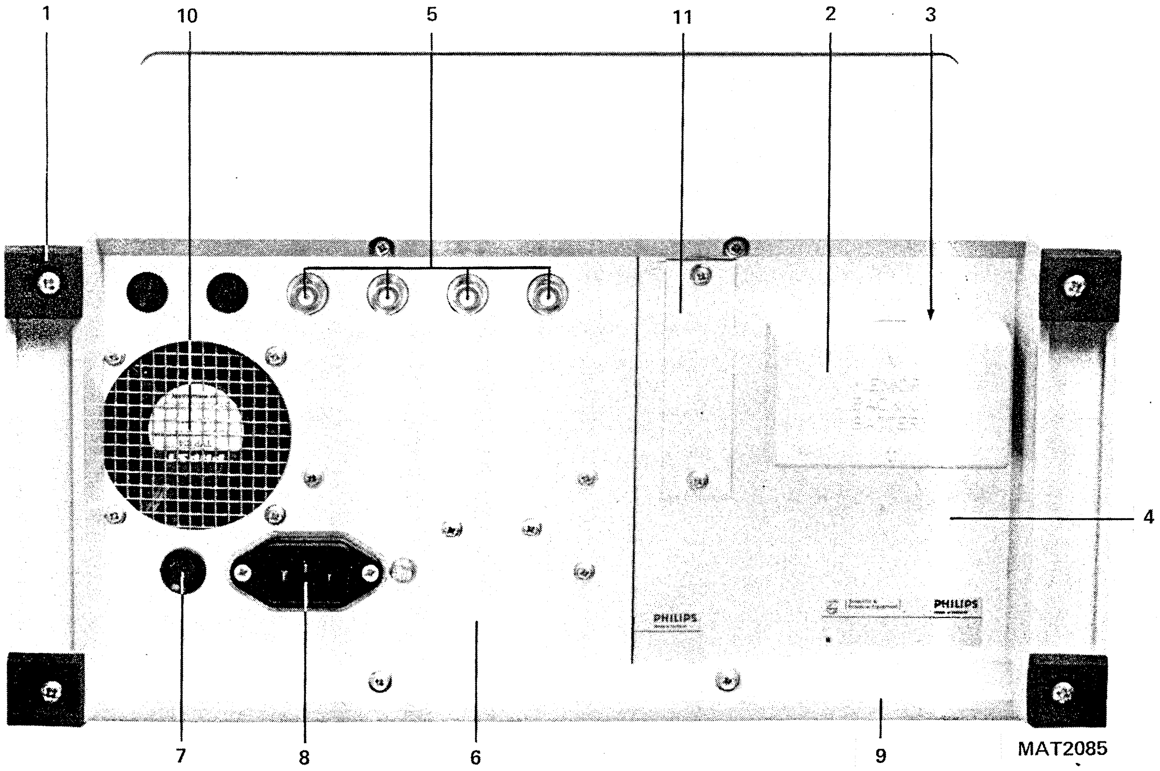


Fig. 28.2 Mechanical parts REAR SIDE

General FRAME parts (fig. 28.4)

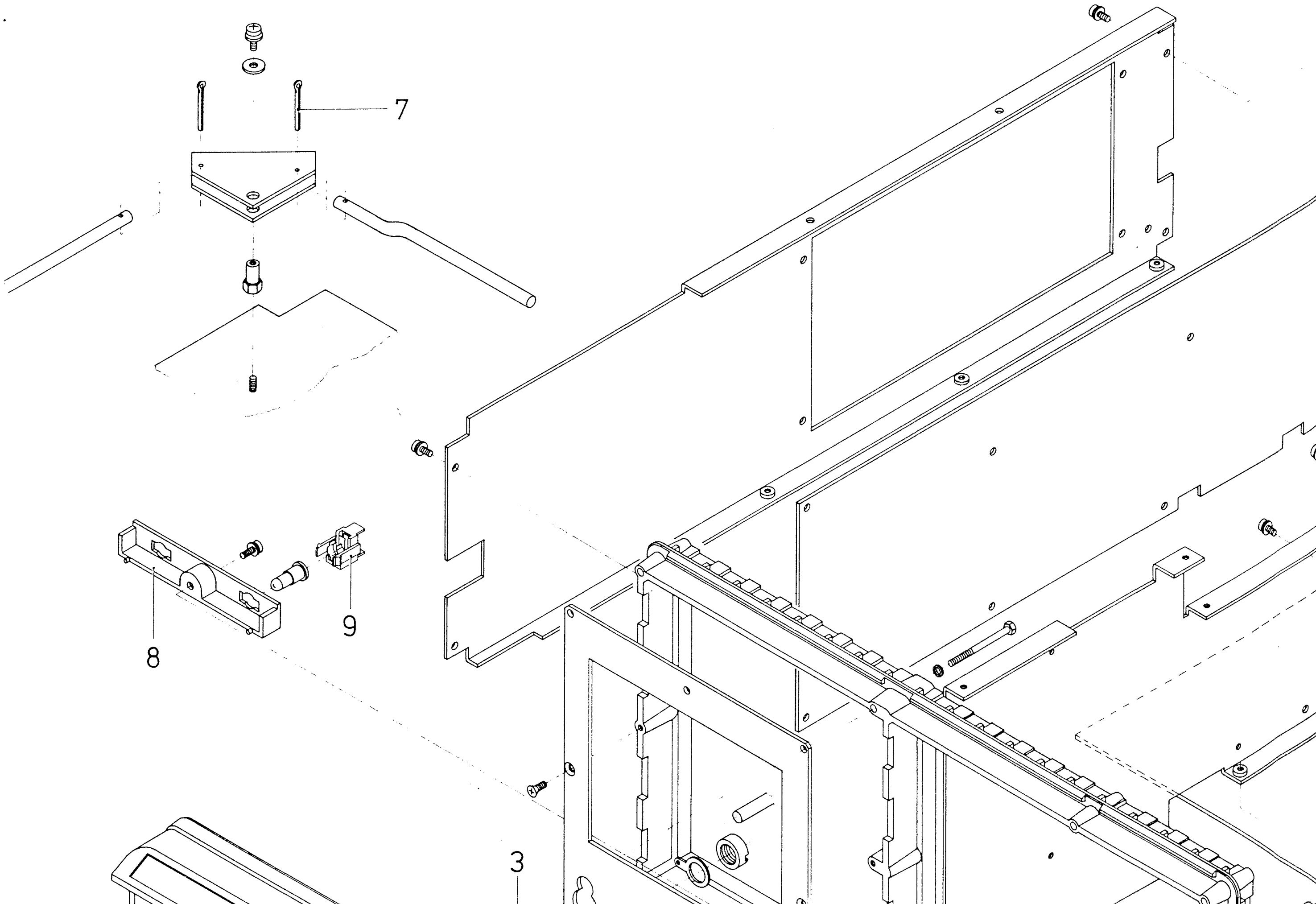
Item	Qty/instr.	Description	Ordering number
1	1	Spring for power on switch	5322 492 41354
2	1	BNC CAL output socket	5322 267 10004
3	1	Extension bush for CAL socket	5322 532 21075
4	2	Front cover lock	5322 526 40481
5	1	Alluminium front frame	5322 447 90609
6	1	Alluminium rear frame	5322 447 90611
7	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
1	48	Pushbutton switch S1...S64 (without cover, for cover see item 4 fig 28.1)	5322 276 11459
9	5	Window for LCD	5322 459 20304
10	5	LCD Display H24...H28	5322 130 90231
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
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
1 and 2	2	Clamping piece top side crt	5322 401 10911
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



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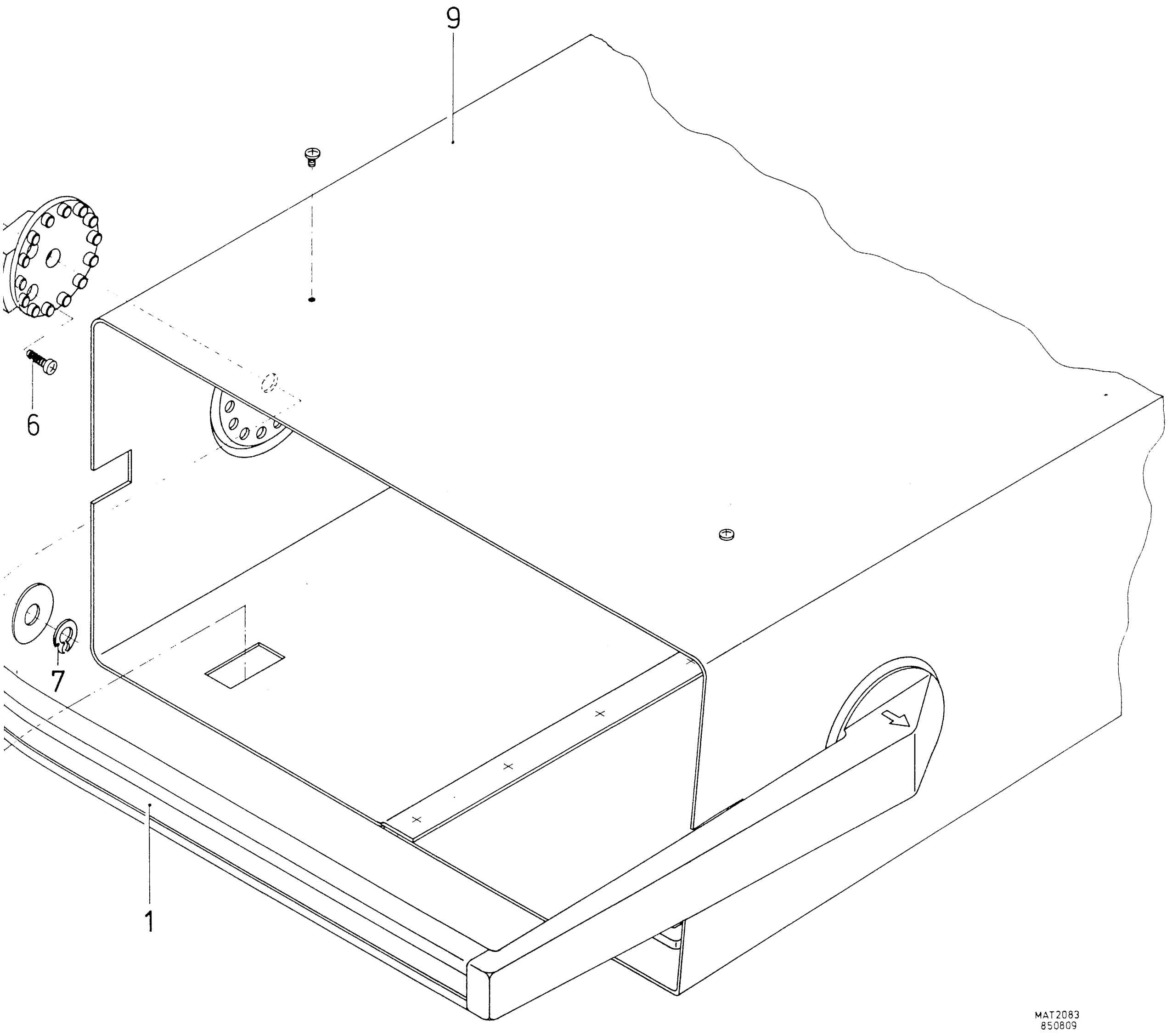

Fig. 28.3 CARRYING HANDLE and HOUSING

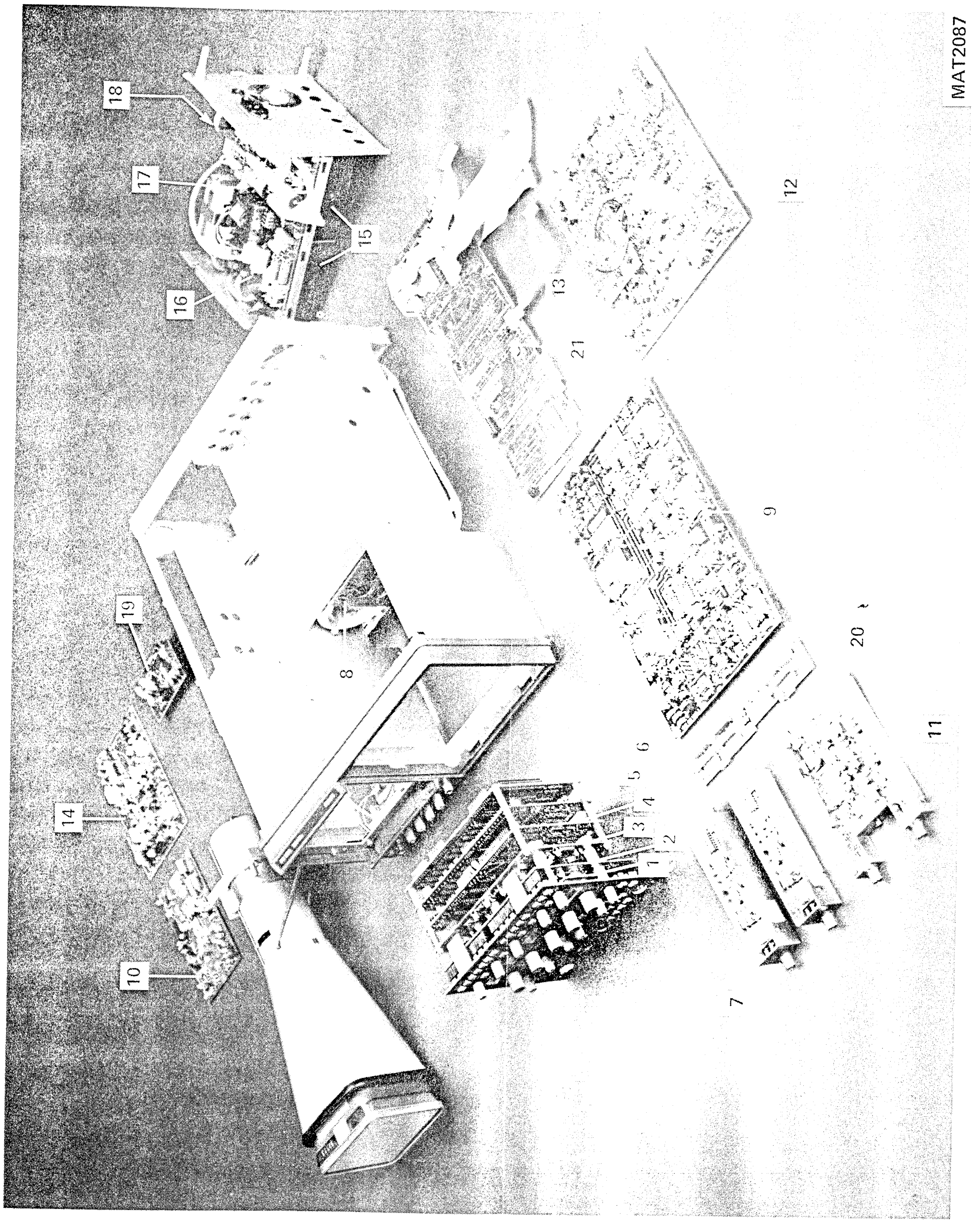

Fig. 28.5 Survey of UNITS

28.2 UNITS (fig. 28.5, unless otherwise stated)

- Front unit

Item	Description	Ordering number
1	LCD unit A1011	5322 216 51097
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 51107
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	
11 - Fig. 26.4	HF attenuator unit A1111	
8	Delay line unit A162	5322 216 51104
9	Y Signal unit A1511	5322 216 51103
10	Final Y amplifier unit A1716	5322 216 51105

28.2.2 Horizontal deflection:

Item	Description	Ordering number
11	Trigger unit A1311	5322 216 51084
12	Time base unit A2011 (incl. A2016)	5322 216 51091
13	Time base logic unit A2016	5322 216 51087
14	X-Z amplifier unit A2116	5322 216 51092

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

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 might have the wrong colour, but if necessary it can be replaced by the original one.

Connectors	Ordering number	Remarks
X5613-X9502 X5617-X9503 X5622-X4011	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

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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		
X1102,X5901,X7303			
X7306,X8001,X8002	10 pole-dbl	Must be sawn	
X4001,X8202	5 pole-dbl	on the required	
X5601,X8003	12 pole-dbl	width	5322 265 61061
X6302,X7301	17 pole-dbl		
X8401	6 pole-dbl		
X9003,X9004,			
X9006,X9007	8 pole-single		5322 265 40483
S8001,S8201,		Must be sawn	
X6304	3 pole-single	on the required	
X6301,X6303	5 pole-single	width	5322 265 40483
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	
X7006	13 pole-dbl	on the required	
		width	5322 265 40484
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		
X1101	6 pole-dbl		
X5325	15 pole-dbl	Must be sawn	
X7001,X7003	7 pole-dbl	on the required	
X7002,X7004,X7007	9 pole-dbl	width	5322 267 60165
X7302	12 pole-dbl		
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

<u>50 Ohm Coax-connector socket</u> (36 connectors per instrument)

Outer part (bush)	5322 268 24116
Inner part (pin)	5322 268 14141

28.4 MISCELLANEOUS

Fuse F6101 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

MAINS CORDS:

		Last digit 12nc of oscilloscope (on packing)
European	version	1
U.S.A.	version	3
U.K.	version	4
Swiss	version	5
Australian	version	8