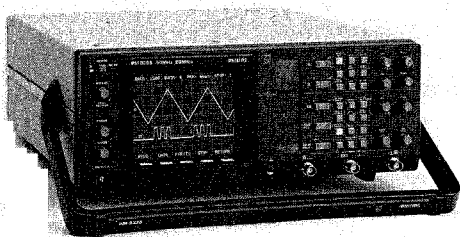


50 MHz Digital Storage Oscilloscope

PM3335 – PM3337

Service Manual

4822 872 05332
890401/1



IMAT3386

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



PHILIPS

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

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

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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 personal injury.

1.4 SYMBOLS



High voltage ≥ 1000 V (red)



Live part (black/yellow)



Read the operating instructions



Protective earth (black)
(grounding) terminal

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 15).
- 1.6.6 After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in section 15 have to be performed.

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^oC).
- 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 and has been supplied in a safe condition.

C. Initial Characteristics

. Overall dimensions:

- Width

| | |
|------------------|----------|
| Including handle | : 387 mm |
| Excluding handle | : 350 mm |
- Length

| | |
|-------------------------------|------------|
| Including handle | : 518,5 mm |
| Excluding handle, excl. knobs | : 443,5 mm |
| Excluding handle, incl. knobs | : 455,5 mm |
- Height

| | |
|---------------------|------------|
| Including feet | : 146,5 mm |
| Excluding feet | : 134,5 mm |
| Excl. under-cabinet | : 132,5 mm |

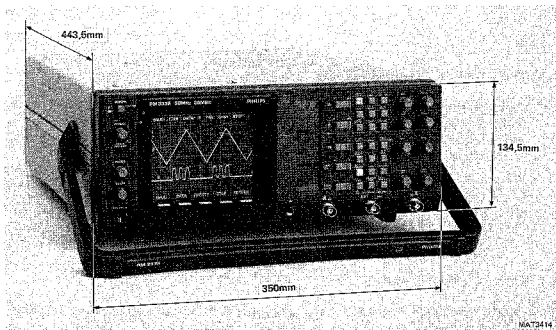


Figure 2.1 Dimensions of oscilloscope PM3335.

* Mass : 8,5 kg

* Operating positions:

- a. Horizontally on bottom feet
- b. Vertically on rear feet
- c. On the carrying handle in two sloping positions.

D. CONTENTS

- 2.1. Display
- 2.2. Vertical deflection or Y axis
- 2.3. Horizontal deflection or X axis
- 2.4. Triggering
- 2.5. Signal acquisition
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| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|------------------------------------|---|---|
| 2.1 | DISPLAY | |
| * CRT | | |
| Type No | PHILIPS D 14-372 | |
| Measuring area (h x w) | 80 x 100 mm | 8 x 10 div. 1 div. = 10 mm 1 subdiv. (sd) = 2 mm |
| * Screen type | | |
| Standard | GH (P 31) | Standard persistence (7 ms) |
| Option | GM (P 7) | Long persistence (30 ms) |
| * Total acceleration voltage | 16 kV | |
| * Graticule: | | |
| Engravings | Internal fixed | |
| Division lines | 1 cm | Horizontal as well as vertical |
| Subdivisions | 2 mm | Horizontal as well as vertical |
| Dotted lines | 1,5 and 6,5 cm from top | Only horizontal. |
| Percentages | 0%, 10%, 90%, 100% | Left side of screen |
| * Orthogonality | 90° +/- 1° | Measured in zero point. |
| * Illumination | Continuously variable | By means of potentiometer. |
| 2.2 | VERTICAL DEFLECTION OR Y AXIS | |
| * Auto set | Automatic setting according to input signal | |
| * Deflection modes and sources | Channel A and/or B or ADDED (A+B, A_B) | Channel B can be inverted. All combinations are possible in ALTERNATE as well as in CHOP mode |
| * Deflection coefficients | 2 mV/div...10 V/div | In 1, 2, 5 sequence. If probe with range indicator is used, deflection coeff. is automatically calculated in display. |
| * Variable gain control range | 1 : >2,5 | |
| * Error limit | +/- 3% | Only in calibrated position. |
| * Input impedance Paralleled by | 1 M ohm +/-2% 20 pF +/-2pF | Measured below 1 MHz Measured below 1 MHz |




| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|-----------------------------------|--|
| * Max. input voltage Max. test voltage (rms) | 400 V (d.c. + a.c. peak) 500 V | Max. duration 60 s. |
| * Bandwidth for 20 mV...10 V | > 50 MHz (-3dB, amb. 15..35°C) | Input 6 div. sine-wave. Deviation max. 5MHz for ambient 0 ... 50°C |
| * Bandwidth for 2 mV, 5 mV and 10 mV | > 35 MHz | Input 6 div. sine-wave. |
| * Rise-time | 7 ns or less | Calculated from 0,35/f-3 dB |
| * Noise 20 mV...10 V | < 0,5 sd | Measured visually. Pick up on open BNC excluded. |
| * Lower - 3 dB point | < 10 Hz | In AC position, 6 div. sine-wave |
| * Dynamic range @ 1 MHz @ 50 MHz | +/- 12 div. > 8 div. | Vernier in CAL position. Vernier in CAL position. |
| * Position range | > +/- 8 div. | Vernier in CAL position. |
| * Cross talk between channels @ 10 MHz @ 50 MHz | 1 : > 100 1 : > 50 | Both channels same attenuator setting. Input max. 8 div. sine-wave. 2, 5 and 10 V are excluded. 2, 5 and 10 V are excluded. |
| * Common Mode Rejection Ratio @ 1 MHz | 1 : > 100 | Both channels same attenuator setting, vernier adjusted for best CMRR; measured with max. 8 div. (+/- 4 div.) each channel. |
| * Visible signal delay | > 15 ns | Max. intensity, measured from line start to trigger point. |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|---|---------------|--|
| * Base-line jump: between attenuator steps 20 mV...10 V | < 1 sd | |
| Additional jump between 10 mV <--> 20 mV | < 1,5 sd | |
| Normal Invert jump | < 1 sd | Only channel B. |
| ADD jump | < 0,6 div. | When A and B are positioned in screen centre (20 mV...10 V). Max.jump in any two positions of the VARIABLE control. |
| Variable jump | < 1 sd | |

2.3 HORIZONTAL DEFLECTION OR X AXIS

2.3.1 Time Base

| | | |
|--|--|--|
| * Time coeff. | 0,5 s...50 ns | 1, 2, 5 sequence (magn.off) |
| Error limit | +/-3 % | Measured at -4...+4 div. from screen centre. |
| * Horizontal position range | Start of sweep and 10th div. must be shifted over screen centre | |
| * Variable control ratio | 1 : > 2,5 | |
| * Time Base magnifier | Expansion x10 | Not valid in X-deflection. |
| Error limit | +/-4 % | Measured at +4...- 4 div. from screen centre. Excluding first 50 ns and last 50 ns. |
| * Horizontal magnifier balance x10 ---> x1 | < 2,5 sd | Shift start of sweep in x10 in mid-screen position, then switch to x1. |
| * Hold-Off Minimum to maximum hold-off time ratio | 1 : > 10 | Minimum hold off time is related to time base setting. |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|---|--|---|
| 2.3.2 X-deflection | | |
| * Deflection coeff. Via channel A or B Via EXT input | 2 mV/div...10 V/div 1, 2, 5 sequence. 100 mV/div. | |
| * Error limit Via channel A or B Via EXT input | +/- 5% +/- 5% | |
| * Bandwidth | DC > 2 MHz | DC coupled |
| * Phase shift between X and Y-deflection | < 3° @ 100 kHz | DC coupled |
| * Dynamic range | > 24 div. DC... 100 kHz | DC coupled |
| 2.3.3 EXT input | | |
| * Input impedance Paralleled by | 1 M ohm +/- 2% 20 pF +/- 2 pF | $f_o < 1$ MHz $f_o < 1$ MHz |
|  * Max. input voltage Max. test voltage (rms) | 400 V (d.c. + a.c. peak) 500 V | Max. duration 60 s. |
| * Lower - 3 dB point | < 10 Hz | AC coupled |
| 2.4 TRIGGERING | | |
| * Trig. mode AUTO (auto free run) TRIGGERed SINGLE | Bright line in absence of trigger signal | Auto free run starts 100 ms (typ.) after no trig.pulse. signal. Switches automatically to auto free run if one of the display channels is grounded. In multi-channel mode (alternated) each channel is armed after reset; if sweep has already started, sweep is not finished. Not applicable in peak-to-peak coupling. |
| * Trigger source A, B, Composite (A/B), EXT, Line | | Line trigger source always triggers on mains frequency. Line trigger amplitude depends on line input voltage. Approx. 6 div. @ 220 VAC input voltage. |


| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|-----------------------------------|---|
| * Trigger coupling Peak-to-peak (p-p), DC, TVL, TVF | | |
| * Level range Peak-to-peak: | Related to peak- to-peak value | p-p coupling is DC rejected. |
| DC internal | > (+ or - 8 div.) | |
| DC EXTERNAL | > (+ or - 800 mV) | |
| TVL/TVF | Fixed level | |
| * Trigger slope | +/- | Slope sign in LCD. For TVL/TVF use + or - to chose positive or negative video |
| * Trigger sensi- vity | | |
| INTERNAL | | |
| 0 - 10 MHz | < 0,5 div. | Trig. coupling DC. |
| @ 50 MHz | < 1,0 div. | Trig. coupling DC. |
| @ 100 MHz | < 3,0 div. | Trig. coupling DC. |
| EXTERNAL | | |
| 0 - 10 MHz | < 50 mV | Trig. coupling DC. |
| @ 50 MHz | < 150 mV | Trig. coupling DC. |
| @ 100 MHz | < 500 mV | Trig. coupling DC. |
| TVL/F INTERNAL | < 0,7 div. | Sync. pulse. |
| TVL/F EXTERNAL | < 70 mV | Sync. pulse, |

2.5 SIGNAL ACQUISITION

| | | |
|---|--------------------------------------|--|
| * Sampling type @10us/div ... 50s/div | Real time | |
| * Maximum sample rate: single channel dual channel | 20 Megasamples/s 20 Megasamples/s | Sample rate depends on time/div setting |
| * Vertical (volta- ge) Resolution | 8 bits | (=0,4% of full range of 10 div) |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|---|--|---|
| * Max. base line instability: Jump (Ambient: 15 ... 35 °C): when switching to memory mode: when actuating INVertor switch between any time /div positions Drift Temperature coefficient | 0,3 div 0,3 div 0,5 div 0,1 div/h <u>± 0,05 div/K</u> | Add 25% for ambient: 0 ... 50 °C. } Measured in 20 mV/div } position. } |
| 2.7 | TIME BASE | |
| * Modes | Recurrent Single shot Multiple shot | Up to 2 shots. |
| * Time coefficients: in recurrent in single shot & multiple shot error limit (Ambient 15 .. 35 °C) in real time mode up to memory | 10 us/div ... 50 s/div 10 us/div ... 50 s/div <u>±1%</u> <u>±0,1%</u> | Add 0,5% for ambient: 0 ... 50 °C. |
| 2.8 | TRIGGER | |
| * Trigger delay: range accuracy | -20 ... 0 div <u>± 0,3 div</u> | Selectable in divisions. |
| * Trigger level view inaccuracy | <u>≤ 0,5 div</u> | Indication in LCD. |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-----------------|--|--|
| 2.9 | MEMORY | |
| | * Memory size: registers 2 register depth: acquisition 8K words register 8K words wordlength 8 bits | |
| | * Functions Clear Load Lock | Contents of acquisition are saved in register. Memory system is locked. If lock is not active the signal is written into the acquisition memory. |
| 2.10 | DISPLAY | |
| | * Sources Channel A Channel B Register A Register B | } }In any combination } } |
| | * Display expansion horizontal 0,5x, 1x, 2x, 4x, 8x, 16x and 32x. | |
| | * Number of displayed samples: single trace 4K/channel two traces 2K/channel three traces 1K/channel four traces 1K/channel | |
| 2.11 | CALCULATION FACILITIES | |
| | * Functions Ratio, Phase dV, dt, 1/dt | |
| 2.12 | AUTO SETTING | |
| | * Settling time 3s (typ.) | Auto set is done in analog mode. |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|---|----------------------------|---|
| 2.13 | CURSORS | |
| * Horizontal resolution: in single channel mode in dual channel mode | 1:1000 1:1000 | Over 10 div |
| * Vertical resolution | 1:200 | 8 div |
| * Read out resolution | 3 Digits | |
| * Voltage cursors: error limit amb. 15 ... 35 °C | +3% | Referred to input at BNC, error of probes etc. excluded. Add 3% for ambient 0 .. 40 °C. |
| cursor range | Full range | Cursors can not pass not each other. X-position is neglected. |
| * Time cursors error limit | +0,1% | |
| 2.14 | POWER SUPPLY | |
|  * Line voltage a.c. Nominal Limits of operation | 100...240 V 90...250 V | One range. |
| * Line frequency Nominal Limits of operation | 50...400 Hz 43...445 Hz | |
| * Safety requirements within specification of: IEC 348 CLASS I UL 1244 VDE 0411 CSA 556 B | | |
| * Power consumption (a.c. source) | 55W nominal | At nominal source voltage |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|-----------------|---|
| 2.15 SUNDRIES | | |
| * Z-MODULATION | | TTL-compatible. |
| ViH | > 2,0 V | Blanks display. |
| ViL | < 0,8 V | Max. intensity |
| | | Analog control between ViH and ViL is possible. |
| * CAL output | | To calibrate drop or tilt of probes. |
| Output voltage | 1,2 V +/- 1% | Rectangular output pulse. |
| Frequency | 2 kHz | |
| The output may be short-circuited to ground. | | |
| * Data and settings retention: | | When instrument is switched off or during mains failure. The oscilloscope settings and traces are saved before instrument goes down. |
| memory back-up voltage | 2V ... 3,5V | |
| memory back-up current drain recommended batteries: | Typical 100uA | @25 °C. |
| type | LR 6 | According to IEC285 (=Alkaline Manganese Penlight Battery) e.g. PHILIPS LR 6. |
| quantity | 2 pcs | Delivered with the instrument. |
| temperature rise of batteries | 20K | After warming up period of instrument. |
| retention time | typical 3 years | @ 25°C, with recommended (fresh) batteries. |
| * Temperature range | 0 ... +70°C. | @ -40 ... 0 °C settings retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer (24h) period below -30°C or above 60°C. |
| WARNING: UNDER NO CIRCUMSTANCES BATTERIES SHOULD BE LEFT IN INSTRUMENT @ TEMPERATURES BEYOND THE RATED RANGE OF THE BATTERY SPECIFICATIONS! | | |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-----------------|---------------|------------------------|
|-----------------|---------------|------------------------|

| | | |
|------|-------------------------------|--|
| 2.16 | 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/FLUKE organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

| | | |
|---|--|---|
| * Meets environmental requirements of: | MIL-T-28800 C, type III, CLASS 5 Style D | Class 5, except for operating temperature: 0 ... 40°C. Style D, except for front cover. |
| * Temperature: | | Memory back-up batteries removed from instrument, unless batteries meet temperature specifications (see also 2.15). |
| operating: | | |
| min. low temperature | 0 °C | Cf. MIL-T-28800 C par. 3.9.2.3. tested cf. par. 4.5.5.1.1. |
| max. high temperature | +50 °C | Cf. MIL-T-28800 C par. 3.9.2.4. tested cf. par. 4.5.5.1.1. |
| non-operating (storage): | | |
| min. low temperature | -40 °C | Cf. MIL-T-28800 C par. 3.9.2.3. tested cf. par. 4.5.5.1.1. |
| max. high temperature | +75°C | Cf. MIL-T-28800 C par. 3.9.2.4. tested cf. par. 4.5.5.1.1. |
| * Max. humidity operating non-operating | 95% RH | +10...30°C |
| * Max. altitude: | | MIL-T-28800 C par. 3.9.3. tested, par. 4.5.5.2. |
| operating | 4,5 km (15000 feet) | Maximum. Operating Temperature derated 3°C for each km, for each 3000 feet, above sea level. |
| non-operating (storage) | 12 km (40 000 feet) | |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|---|--|
| * Vibration (operating) | | MIL-T-28800 C par. 3.9.4.1. tested, par. 4.5.5.3.1. |
| Freq. 5...15 Hz | | |
| Sweep Time | 7 min. | |
| Excursion (p-p) | 1,5 mm | |
| Max Acceleration | 7 m/s ² (0,7 x g) | @ 15 Hz |
| Freq. 15...25 Hz | | |
| Sweep Time | 3 min. | |
| Excursion (p-p) | 1 mm | |
| Max Acceleration | 13 m/s ² (1,3 x g) | @ 25 Hz |
| Freq. 25...55 Hz | | |
| Sweep Time | 5 min. | |
| Excursion (p-p) | 0,5 mm | |
| Max Acceleration | 30 m/s ² (3 x g) | @ 55 Hz |
| Resonance Dwell | 10 min. | @ each resonance freq. (or @ 33 Hz if no resonance was found). Excursion, 9.7.1. to 9.7.2. |
| * Shock (operating) | | MIL-T-28800 C par. 3.9.5.1. tested, 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 | 11 ms | |
| Peak Acceleration | 300 m/s ² (30 x g) | |
| * Bench handling | | MIL-T-28800 C 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 | | MIL-T-28800 C par. 3.9.8.1 tested, par. 4.5.6.2.1. |
| Structural parts meet requirements of | MIL-STD-810 method 509, proced. I salt solution 20% | |
| * EMI (Electronic Magnetic Interference) | | |
| meets requirements of | MIL-STD-461 CLASS B | Applicable requirements of part 7 : CE03, CS01, CS02, CS06, RE02, RS03 |
| | VDE 0871 and VDE 0875 Grenzwert-klasse B | |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-------------------------|--|--|
| 2.17 | SAFETY | |
| * Meets requirements of | IEC 348 CLASS I VDE 0411 | Except for power cord, unless shipped with Universal European power plug. |
| | UL 1244 CSA 556 B | Except for power cord, unless shipped with North American power plug. |
| 2.18 | OPTIONAL VERSIONS | |
| * General | | These options can be factory installed only. |
| * Power cord | | Length 2,1 m (82,7 in) |
| | Universal European | VDE, KEMA listed (option .01) |
| | North American | CSA, UL listed (option .03) |
| | United Kingdom | BSI listed (option .04) |
| | Australian | SAA listed (option .08) |
| | Swiss | SAV listed (option .05) |
| * Cabinet | Rack mount | PM3337 PM3337/40. with IEEE+RS232-interface installed. |
| * Interface | IEEE-488/IEC-625 including RS 232-C | Option 40. Dump to plotters: PM 8153/1, PM 8153/6, PM 8154, PM 8155, HP 7475A and HP 7550. Dump to printers: FX80 and HP 2225 Thinkjet. |
| | RS 232-C dump only | Option 50. Dump to plotters: PM 8153/1, PM8153/6, PM 8154, PM 8155, HP 7475A and HP 7550. Dump to printers: FX80 and HP 2225 Thinkjet. |

3. INTRODUCTION TO CIRCUIT DESCRIPTION AND BLOCK DIAGRAM DESCRIPTION

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

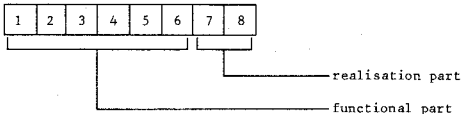
3.1.1 General

The functioning of the circuits is described per printed-circuit board (p.c.b.). For every p.c.b. (unit) a separate chapter is available containing the lay out of the p.c.b., the associated circuit diagram(s) the circuit description and a signal name list.

3.1.2 Explanation of signal name set-up

Signal name consists of two parts:

- a functional part of maximal 6 characters
- a realisation part of 2 characters



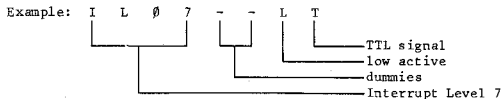
The realisation part is optional. If it is used then the functional parts should consist of 6 characters. If necessary dummies (minus sign) are used in the functional part, to make it 6 characters long.

The first character of the realisation part has the following meaning:

- H: active high signal
- L: active low signal
- X: irrelevant (e.g. counter outputs)

The second character of the realisation part is used to identify signal levels:

- A: analogue
- C: CMOS 12 V or 15 V
- D: CMOS 5 V
- E: ECL -4,5 V or -5,2 V
- T: TTL 5 V or HCT



Sometimes the functional part can also be used for a serial number e.g. to indicate a buffered version of a signal.

Example: CHPT--Ø1

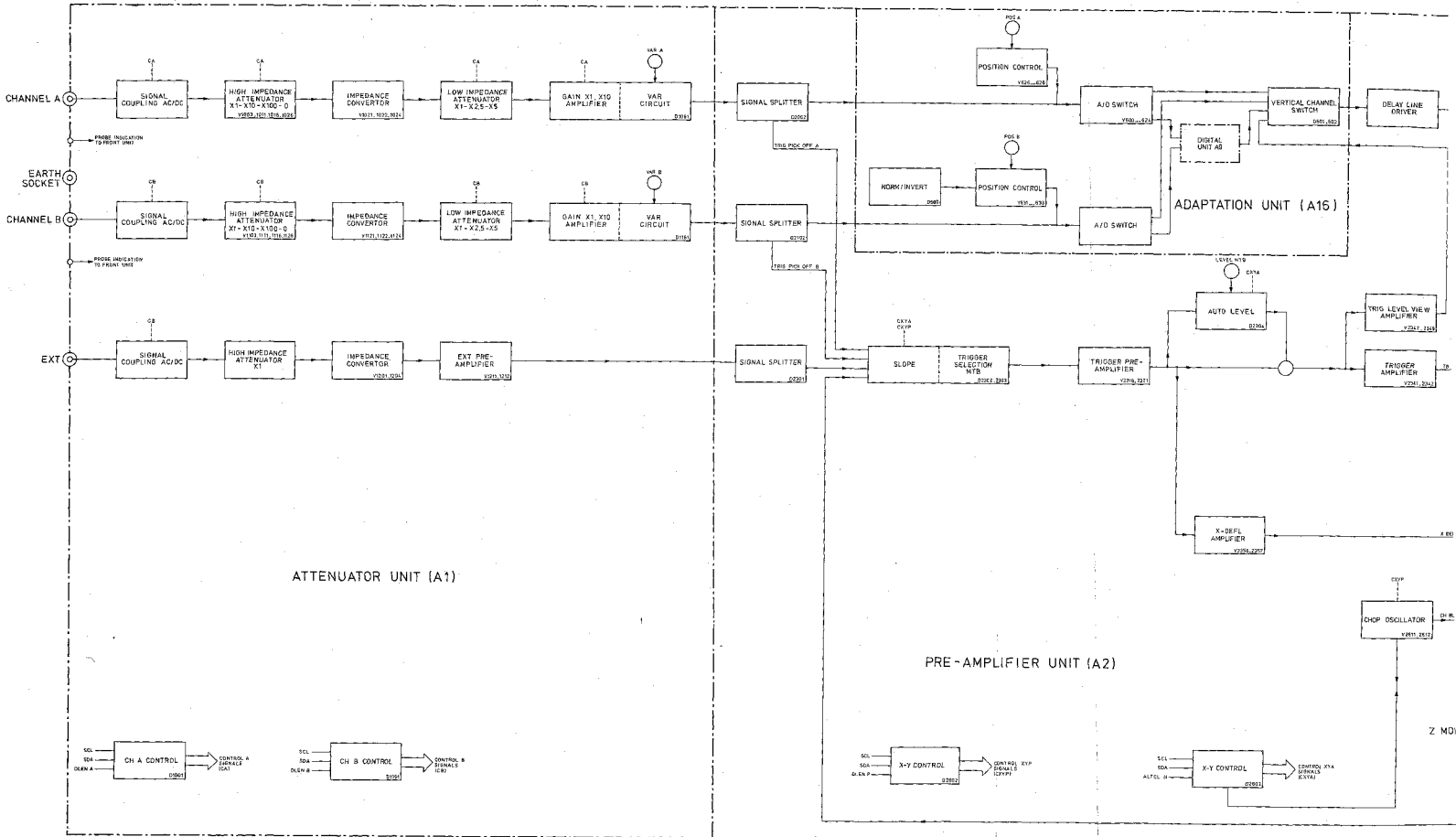
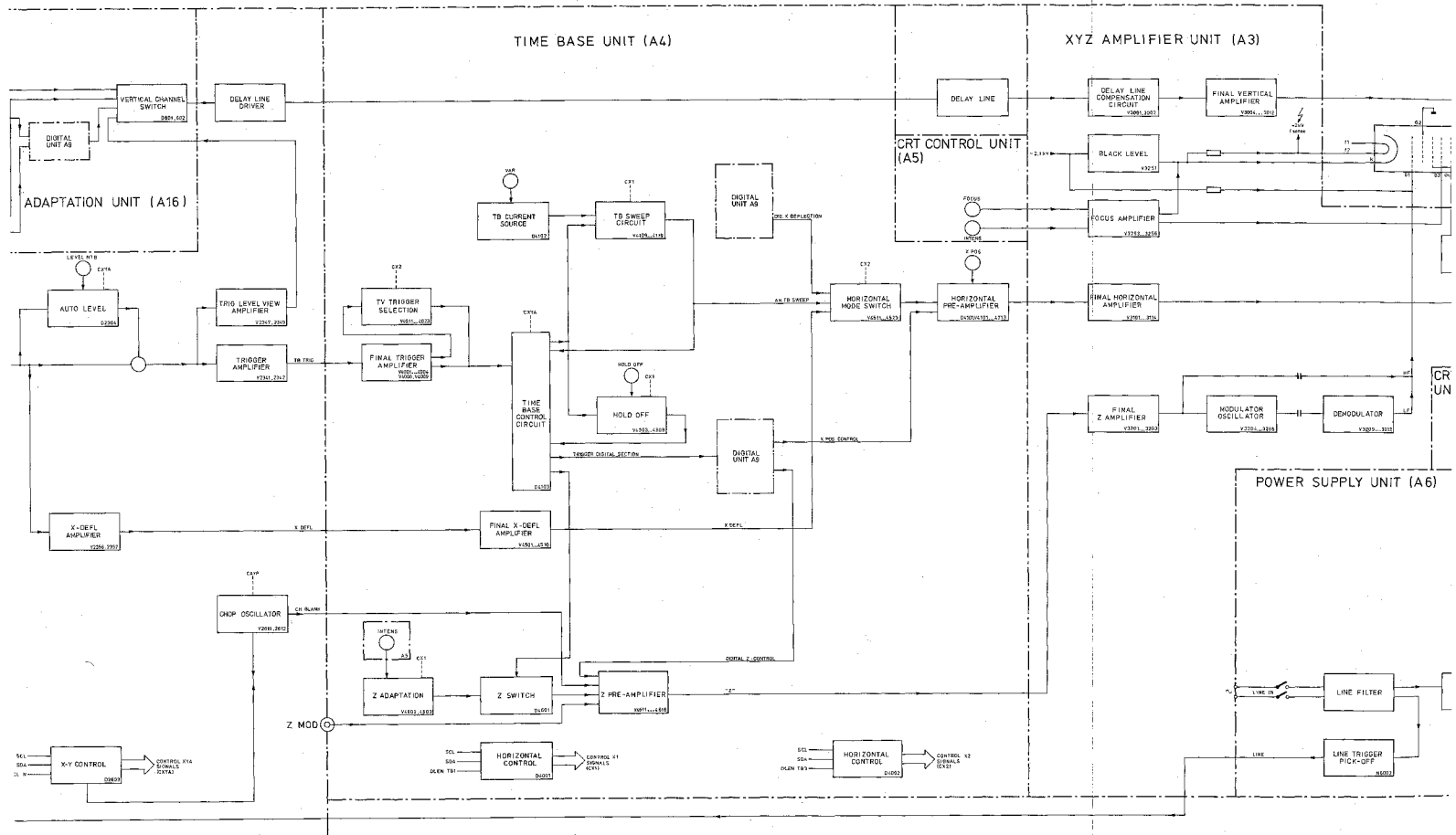


Figure 3.1 Block diagram, analog part



Signal name list:

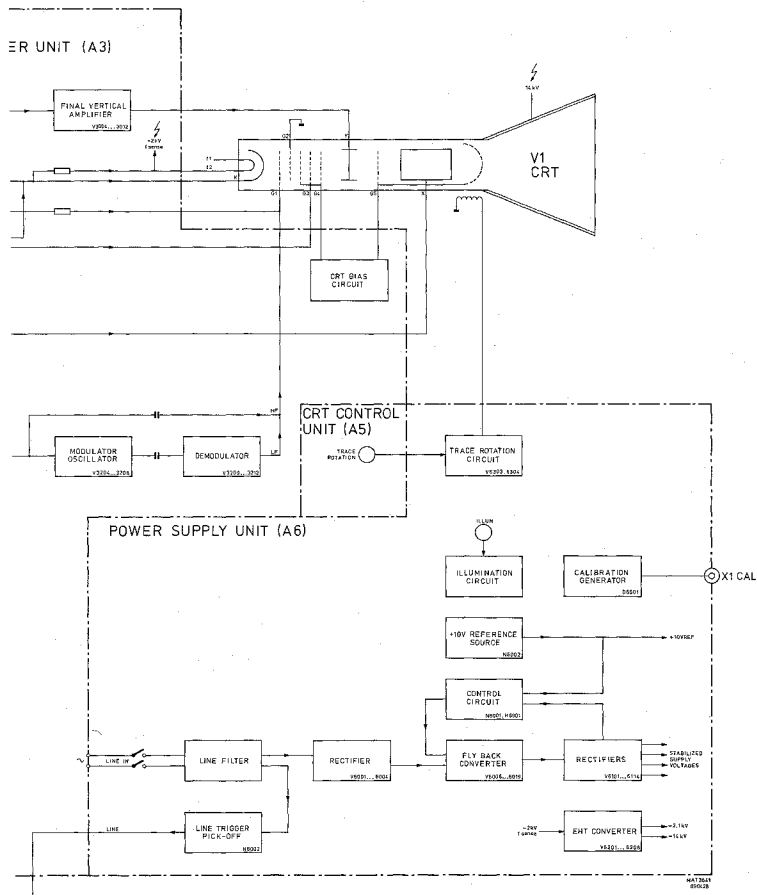
The description of the digital unit A9 contains a list with the signal names used in that unit given in alphabetical order. After each name, a short signal description is given and also the signal source and the signal destination(s). Only if the signal is generated on the unit itself, are the other units on which the signal is used (signal destination(s)) mentioned, otherwise a minus sign is filled in.

A number of power supply lines and ground lines are not mentioned on the signal name lists because they appear very often and because their function is obvious.

3.1.3 Location of electrical parts

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

| Item number | Unit no. | Printed-circuit board |
|-------------|----------|-----------------------|
| 1000-1999 | A1 | Attenuator unit |
| 2000-2999 | A2 | Pre-amplifier unit |
| 3000-3999 | A3 | XYZ amplifier unit |
| 4000-4999 | A4 | Time base unit |
| 5000-5999 | A5 | CRT control unit |
| 6000-6999 | A6 | Power-supply unit |
| 7000-7999 | A7 | Front unit |
| 8000-8999 | A8 | LCD unit |
| 9000-9999 | A9 | Digital unit |
| 600-699 | A16 | Adaptation unit |



3.2 BLOCK DIAGRAM DESCRIPTION (see figure 3.1 and 3.2)

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 item numbers 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 are given in text in CAPITALS. Signal waveforms are also indicated at block interconnections where useful.

In this instrument almost all the switches (UP-DOWN controls, softkeys and potentiometer UNCAL switches) influence the oscilloscope circuits via a microprocessor (μ P) system.

3.2.2 Attenuator unit (unit A1)

The vertical channels A and B for the signals to be displayed are identical. Each channel comprises an input SIGNAL COUPLING for AC/DC, a HIGH IMPEDANCE ATTENUATOR which gives signal attenuation of $x1$ - $x10$ or $x100$, an IMPEDANCE CONVERTER, a LOW IMPEDANCE ATTENUATOR which gives signal attenuation of $x1$ - $x2,5$ or $x5$ and a GAIN $x1$ - $x10$ AMPLIFIER block, incorporated with the CONTINUOUS CIRCUIT. This block has a variable gain, influenced by the front-panel VAR control. The gain is also increased by $x10$ in order to obtain 2-5 and 10mV settings.

Similar to the vertical channels, the external channel attenuator also has an input SIGNAL COUPLING, HIGH IMPEDANCE ATTENUATOR and IMPEDANCE CONVERTER in line. However, the external channel has only $x1$ attenuation and no LOW IMPEDANCE ATTENUATOR. The output of the external channel is fed to both MTB and DTB EXT PRE-AMPLIFIERS.

All blocks that are capable of working in different modes are controlled by the control A or control B signals. These signals are generated by the CH.A CONTROL or CH.B CONTROL blocks under influence of the SDA and SCL signals that come from the MICROPROCESSOR.

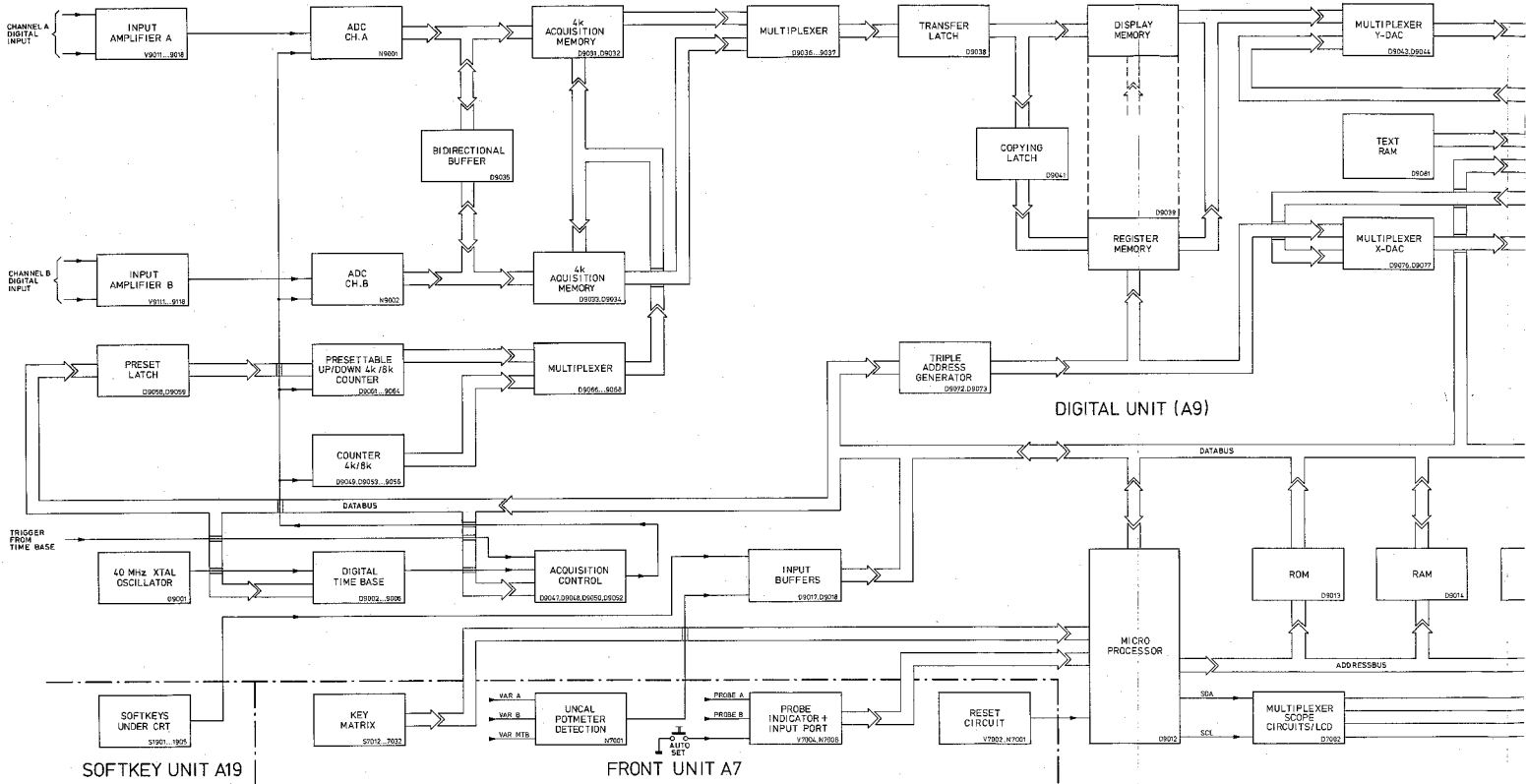
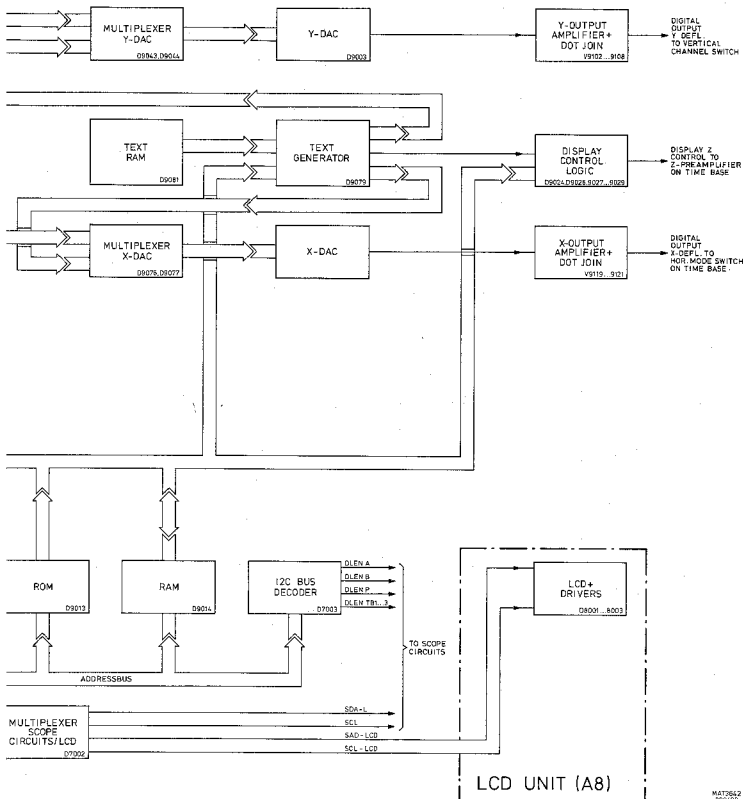


Figure 3.2 Block diagram, digital part

3.2.3 Pre-amplifier unit and adaptation unit (unit A2 and Al6)



The pre-amplifier unit incorporates the signal splitters for the vertical channels A and B, the trigger level view amplifier, the trigger circuits for the time base and the chopper oscillator circuit. Next the adaptation unit is mounted as a separate p.c.b. on the pre-amplifier unit. All these functions are controlled by the control XYP and XYA signals, generated by the X-Y CONTROL blocks under influence of the SDA and SCL signals from the MICROPROCESSOR.

* Vertical channels A and B:

Both channels are completely identical and receive their input signals from the ATTENUATOR UNIT. This signal is applied to the SIGNAL SPLITTER, which has two outputs:

- one output is applied to the SLOPE/TRIGGER SELECTION for the time base triggering.
- A second output is routed to the adaptation unit.

On the adaptation unit, vertical shift of the displayed signal is achieved by the front-panel POSITION control. Switching between the real time path and the digital storage path is obtained in the A/D SWITCH block. The digital circuit is given in figure 3.2 and described separately.

Next, the output of the VERTICAL CHANNEL SWITCH is routed via the DELAY LINE DRIVER to the DELAY LINE. The TRIGGER LEVEL VIEW channel enables display of the time base trigger level and can be used to determine the trigger point of the signal.

* Trigger circuit:

The SLOPE/TRIGGER SELECTION block receives a trigger signal from one of the vertical channels A or B, from the EXT SIGNAL SPLITTER or from the LINE TRIGGER PICK-OFF. Inverting of the trigger signal is controlled by the CXYA signals INVAM and INVBM to obtain the slope function. Routed via the TRIGGER PRE-AMPLIFIER, block the signal is split up into different paths:

- after summation of the LEVEL signal, direct to the TRIGGER AMPLIFIER
- to the AUTO LEVEL block. This block contains the different trigger facilities and levelling of the trigger signal is influenced by the front-panel LEVEL control. The output of this path is routed again to the summation point to influence the direct trigger signal.
- to the X-DEFL AMPLIFIER for X-deflection facility. This block incorporates a phase correction circuit for the X-Y display.

The TRIGGER AMPLIFIER feeds the trigger signal to the time-base unit. The trigger signal from the summation point is also routed via the TRIGGER LEVEL VIEW AMPLIFIER to the vertical CHANNEL SWITCH stage to display the trigger point.

* Chopper oscillator circuit:

A square-wave signal for chopper blanking and vertical switching is generated in the CHOP OSCILLATOR. For chopper blanking the signal is routed to the Z PRE-AMPLIFIER on the time-base unit.

3.2.4 Time-base unit (unit A4)

This unit incorporates the time-base (TB), the horizontal amplifier and the Z amplifier circuit. All functions are controlled by the CX1 and CX2 signals, generated by the HORIZONTAL CONTROL CIRCUIT blocks.

* Time-base (TB):

The trigger signal can be either routed via the FINAL TRIGGER AMPLIFIER to the TIME-BASE CONTROL CIRCUIT or first routed via the TV TRIGGER SELECTION for the TV trigger coupling. When in the AUTO mode, in the absence of trigger signals, the time base will be free running.

The CURRENT SOURCE applies the sawtooth charging current to the sweep circuit. This block generates the time base sawtooth signal, which is routed to the HORIZONTAL DISPLAY MODE SWITCH..

The HOLD OFF and the DIGITAL UNIT blocks are also under control of the TIME BASE CONTROL CIRCUIT. Hold off time is varied by the front-panel HOLD OFF control. The output of the HOLD OFF block is routed to the TIME-BASE CONTROL CIRCUIT again. The signal going to the DIGITAL UNIT triggers the digital signal acquisition.

The ALTCLN-pulse is applied to the PRE-AMPLIFIER UNIT.

3.2.5 XYZ unit (unit A3)

This unit comprises the final amplifiers for the vertical (Y) and horizontal (X) deflection and for the blanking (Z) circuit. In addition to this, the CRT control circuits are also incorporated in the unit.

* Final vertical amplifier:

The output signal from the pre-amplifier unit is first routed via the DELAY LINE to give sufficient delay to ensure that the steep leading edges of fast signals are displayed and then fed to the DELAY LINE COMPENSATION. This block compensates the signal for distortion originating in the DELAY LINE before it is applied to the FINAL VERTICAL AMPLIFIER. The output of the FINAL VERTICAL AMPLIFIER feeds the vertical deflection plates of the CRT.

* Final horizontal amplifier:

The horizontal deflection signal is routed to the FINAL HORIZONTAL AMPLIFIER, the output of which feeds the horizontal deflection plates of the CRT.

* Blanking circuit:

The output signal from the Z PRE-AMPLIFIER of the time-base unit, that determines trace blanking or unblanking and modulation is routed to the FINAL Z-AMPLIFIER. After amplification the blanking signal is split into two paths:

- the h.f. signals are fed via a high voltage capacitor to grid G1 of the CRT.
- the l.f. signals are used to modulate the amplitude of an oscillator wave-form, which then passes via another high voltage capacitor and is demodulated in the DEMODULATOR block to retrieve the original signal.

Note that the original h.f. and l.f. signals are again recombined on the grid G1.

* CRT control circuits:

The FOCUS AMPLIFIER block is influenced by both front-panel FOCUS and INTENS controls to provide a focus that is independent of the intensity, and drives the focusing grid G3 of the CRT.

The -100 V BLACK LEVEL block provides the correct presetting of the cathode voltage.

The CRT BIAS gives a d.c. voltage to the grids G4 and G5 to provide an optional adjustment for geometry and astigmatism.

3.2.6 Power supply unit

The mains input voltage is filtered and then applied to the RECTIFIER block to obtain a d.c. voltage source. Another output of the LINE FILTER block is routed via the LINE TRIGGER PICK-OFF and serves as a MTB LINE trigger signal. The rectified mains source is routed to the FLYBACK CONVERTER, which generates the necessary voltages for the oscilloscope circuits. Each supply voltage is rectified in the RECTIFIERS block.

The LOW-voltage supplies are stabilized by the CONTROL circuit to the converter.

The +10 V REF supply serves as a low-voltage reference and is generated in the +10 V REFERENCE source block. This reference voltage is also fed to the different circuits on the power supply or in the oscilloscope.

The EHT CONVERTER generates the -14 kV for the post-accelerator anode of the CRT and the -2 kV for the cathode circuits.

* Auxiliary circuits:

The CALIBRATION GENERATOR generates the CAL voltage, which is applied to the output socket X1. The CAL voltage has a square-wave of 1,2 V p-p level with a frequency of 2 kHz.

The ILLUMINATION CIRCUIT determines the amount of current passed to the graticule illumination lamp of the CRT, controlled by the ILLUM control on the front-panel.

The TRACE ROTATION CIRCUIT determines the strength and sense of the current passed to the trace rotation coil around the neck of the CRT. The current is influenced by the front-panel screwdriver-operated TRACE ROT control.

3.2.7 Digital memory and control circuits (unit A7, A8, A9 and A19)

Introduction.

The blockdiagram of the digital sections can roughly be split up into three main parts. These parts are:

- Signal acquisition: this section captures signal samples and places them in the acquisition memories.
- The memory and display part are used to store the signal and to display it on the CRT screen.
- The control section that is based upon a microprocessor takes care that the signal display and acquisition function correctly. Moreover it reads all the instrument's knobs and controls all analog and digital circuits.

The digital parts are mainly concentrated on the large digital unit A9. A small part is present on the front unit A7 and the LCD unit A8. The softkey unit A19 is located under the CRT and only incorporates five softkeys.

Signal acquisition.

The channel A(B) signals that are coming from the adaptation unit A16 are applied to the INPUT AMPLIFIERS A(B). These blocks feed the analog-to-digital converters ADC CHANNEL A and ADC CHANNEL B. The digitised signals of channel A and B can be loaded into two 4K ACQUISITION MEMORY blocks. In case of dual channel mode, each channel is loaded into one 4K memory. In case of single channel operation, the full 8K memory capacity is available for one channel. The BIDIRECTIONAL BUFFER makes it possible that the ADC-output of the selected single channel can reach the input of both 4K memories.

The addresses for the two 4K ACQUISITION MEMORIES are originating from two counters. COUNTER 4K/8K is only able to count upwards and has a range of 4K or 8K addresses. The PRESETTABLE UP/DOWN COUNTER has also a range of 4K/8K. It can also count up or down and can be preset by the MICROPROCESSOR via the block PRESET LATCH. Depending on the state of the MULTIPLEXER, the address of one of the two counters is addressing the 4K ACQUISITION MEMORIES. The possible modes are explained more in depth during the circuit description; also the trigger delay mode is explained then.

The acquisition of signal samples is synchronised by the DIGITAL TIME BASE circuit. This circuit is based upon a 40MHz XTAL OSCILLATOR that is followed by the DIGITAL TIME BASE. The DIGITAL TIME BASE is put in the appropriate position via the ADDRESSBUS of the MICROPROCESSOR. The output signal of the DIGITAL TIME BASE is applied to the ACQUISITION CONTROL block. Also this block is controlled by the MICROPROCESSOR and it takes care that the ADC's take signal samples at the correct moment and that these samples are placed in the appropriate part of the ACQUISITION MEMORIES. The trigger pulse that originates from the TIME BASE is also applied to the ACQUISITION CONTROL.

Memory section and display part.

The contents of the two 4K ACQUISITION MEMORIES can be transferred to the DISPLAY MEMORY. This happens at a particular moment after a trigger. The transfer occurs via the TRANSFER LATCH. The contents of the DISPLAY MEMORY can be copied via the COPYING LATCH into the REGISTER MEMORY. This last memory can be used to store waveforms for reference purposes.

The addressing of the DISPLAY MEMORY and the REGISTER MEMORY is done by the TRIPLE ADDRESS GENERATOR. This block is controlled by the MICROPROCESSOR and contains three separate address generators. They have the following purposes:

- The addressing of the display memory during the information transfer from ACQUISITION MEMORIES to the DISPLAY MEMORY.
- The addressing of the DISPLAY/REGISTER MEMORY during the transfer of information between these memory blocks.
- The addressing of the DISPLAY and REGISTER MEMORY during the display on the CRT screen of their contents. The contents of the addressed memory locations is applied to the vertical Y DAC and then to the Y OUTPUT AMPLIFIER. The address itself is applied to the horizontal X DAC and then to the X OUTPUT AMPLIFIER.

The X and Y OUTPUT AMPLIFIERS also incorporate a DOT JOIN facility. This means in the DOT JOIN mode a decrease of the speed of these amplifiers because a low pass filter is added. This has the result that the move from one dot to the next one is smoothed.

The input of the Y DAC and the X DAC are connected with two-position multiplexers. They are named MULTIPLEXER Y DAC and MULTIPLEXER X DAC. In one position of the multiplexer, the contents of the DISPLAY/REGISTER MEMORY is displayed. In the other position text and cursors are displayed: this is generated by the TEXT GENERATOR. This block is integrated in one IC. The kind of text to be generated is given by the MICROPROCESSOR. This text is stored into the TEXT RAM (Random Access Memory) that belongs to the TEXT GENERATOR.

Control section.

The heart of this part is formed by the MICROPROCESSOR with belonging ROM (Read Only Memory) and RAM (Random Access Memory). Via the block INPUT BUFFERS, the MICROPROCESSOR reads the softkeys under the CRT and also the UNCAL position of VARIABLE A, VARIABLE B and VARIABLE MTB. The MICROPROCESSOR directly reads the KEY MATRIX at the front unit A7. The RESET CIRCUIT on unit A7 initiates the MICROPROCESSOR when switching the power on.

The MICROPROCESSOR controls many circuits inside the oscilloscope. The blocks on the digital unit that are under control of the MICROPROCESSOR are already explained. They are all connected with the databus or parts of it. Also the LCD and the analog scope circuits are under microprocessor control. For this purpose the so-called I2C bus is used. This is a bus consisting of two signal wires: the data line SDA (Serial Data) and the synchronisation line SCL (Serial Clock). The I2C bus lines are switched to either the LCD (as SDA-LCD and SCL-LCD) or the analog scope circuits. This selection is made via the MULTIPLEXER SCOPE CIRCUITS/LCD. The analog scope circuits incorporate many control blocks that are all connected to the SDA and SCL lines of the I2C bus. The control blocks are separately addressed via the I2C BUS DECODER. If e.g. output DLEN A (Data Latch ENable A) is active, the control block of channel A on the attenuator unit accepts the data from SDA/SCL. The result is for instance that the channel A attenuator switches to another input sensitivity. Identical to this the signals DLEN B, DLEN P and DLEN TB 1..3 activate the control blocks on respectively the channel B attenuator, the preamplifier and the time base.

4. ATTENUATOR UNIT (A1)

4.1 VERTICAL ATTENUATORS

The A and B channel attenuators are identical: therefore only channel A is described.

All relay and FET switches are controlled by the microcomputer via the I²C bus. The IC D1001 converts this serial DATA into the parallel control signals for all relay or FET switches. A list of the control lines for all attenuator settings is given in the table below.

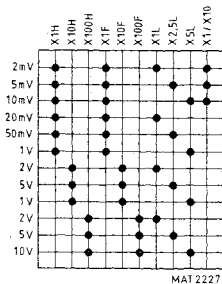


Figure 4.1 Table of attenuator settings

The channel A attenuator consists of in five stages:

Input coupling, where depending on the relay K1001 position, the input signal can either be d.c.-coupled (relay activated) or a.c.-coupled (relay not activated).

High impedance attenuator with three attenuator stages for the x1, x10 and x100 attenuation. The l.f. part of each stage is split via a resistor divider and routed via N1001 and V1019 to the output of this stage, where it is re-connected with the h.f. part of the input signal. Potentiometers R1036 (TRACE jump) serves as a offset compensation for N1001.

| | RELAY | FET | TRIMMER FOR L.F. SQUARE WAVE | L.F. RESISTOR DIVIDER |
|------|-------|-------|------------------------------|-----------------------|
| x1 | K1004 | V1011 | C1033 | -- |
| x10 | K1003 | V1006 | C1029 | R1007-R1011 |
| x100 | K1002 | V1003 | C1023 | R1019-R1004 |

Note that, when "0" (GND-A) is selected, the output is connected to ground via FET V1016 and all other relay- and FET switches are switched off.

The impedance converter serves as an inverting buffer circuit for the high impedance attenuator. For the l.f.-feedback the output signal of this stage is routed to the l.f. summation point N1001-2.

The low impedance attenuator reduces the gain by x_1 , $x_{2.5}$ and x_5 , depending on which relay is activated.

| | RELAY | RESISTOR DIVIDER |
|-----------|-------|---------------------------------|
| x_1 | K1006 | -- |
| $x_{2.5}$ | K1007 | R1053 vs R1056, R1057 and R1058 |
| x_5 | K1008 | R1053, R1056 and R1057 vs R1058 |

The continuous circuit (D1061), the differential input voltages of which are fed to pins 4 and 5.

This stage comprises the following functions:

- Continuously variable control (pin 11).
- Gain x_1 (pin 2 and 3) with offset adjustment R1064 and gain adjustment R1069.
- Gain x_{10} (pin 6 and 7) with offset adjusting R1072 and gain adjustment R1076.
- x_1/x_{10} control (pin 10) to select the 2,5 and 10 mV/DIV settings.

The differential output current from pin 13 and pin 14 is routed via a common-base circuit V1063, V1064 and applied to the pre-amplifier unit.

4.2 EXTERNAL INPUT

The external input can be subdivided into four stages:

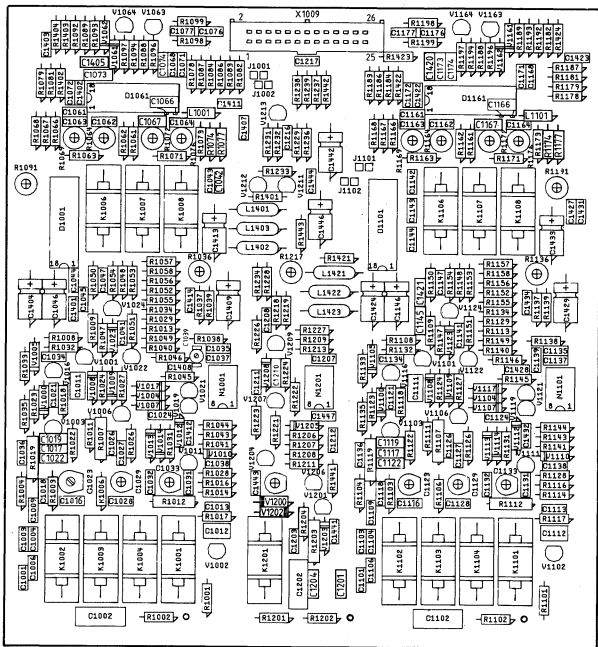
Input coupling, basically similar to the ch.A input coupling.

High impedance attenuator for the x_1 attenuator only, where the l.f. square-wave can be adjusted with trimmer C1206. The l.f. part is routed to the summation point N1201-2. R1217 serves as an offset compensation for N1201. For l.f.-feedback the output of the impedance converter is also routed to this summation point.

Note that the output of this stage is also a reconstituted version of the input signal.

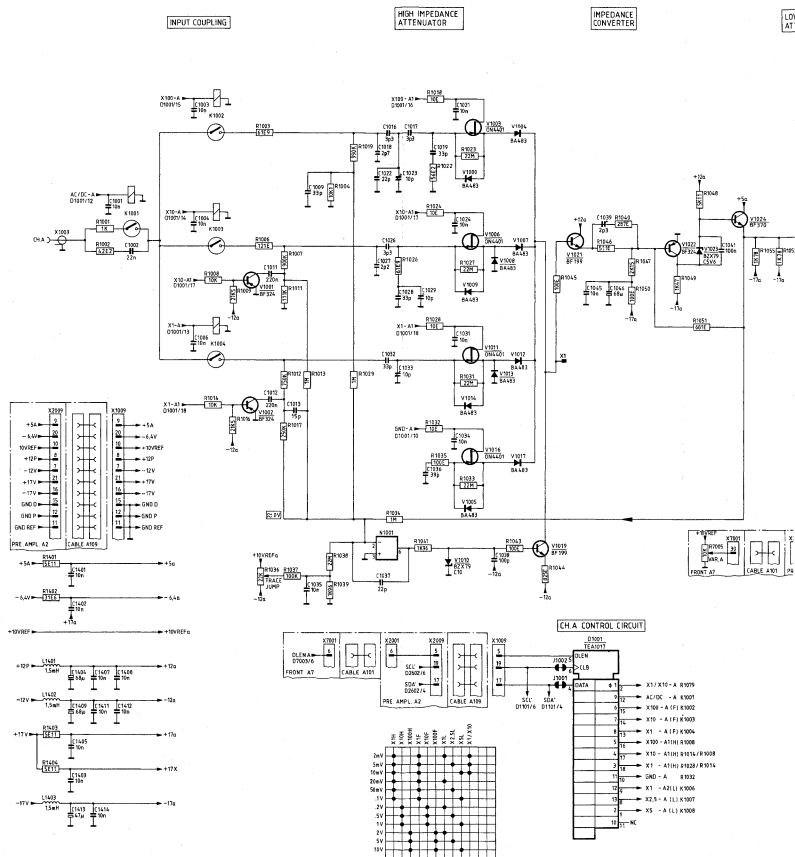
Impedance converter, is basic similar to the ch.A impedance converter.

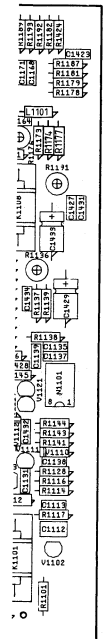
The differential amplifier V1211, V1212 converts the voltage from emitter-follower V1209 into the differential current signals EXT+ and EXT-. This signal is applied to the pre-amplifier unit and serves as external trigger signal or as an external deflection signal. The current for this stage is applied from current source V1213.



MAT3609
890428

Figure 4.2 Attenuator unit p.c.b.





MAT 3609
890428

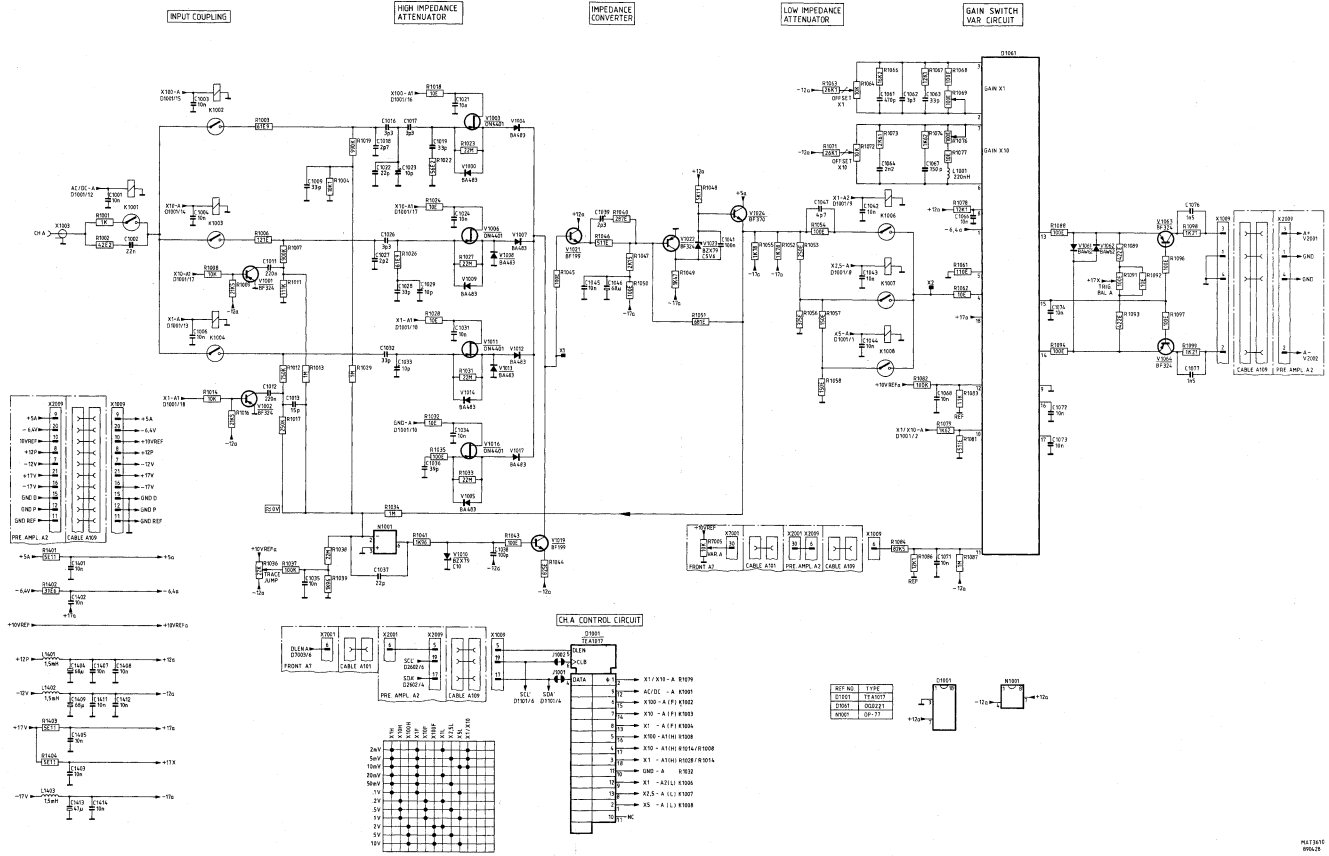


Figure 4.3 Circuit diagram of attenuator, ch. A

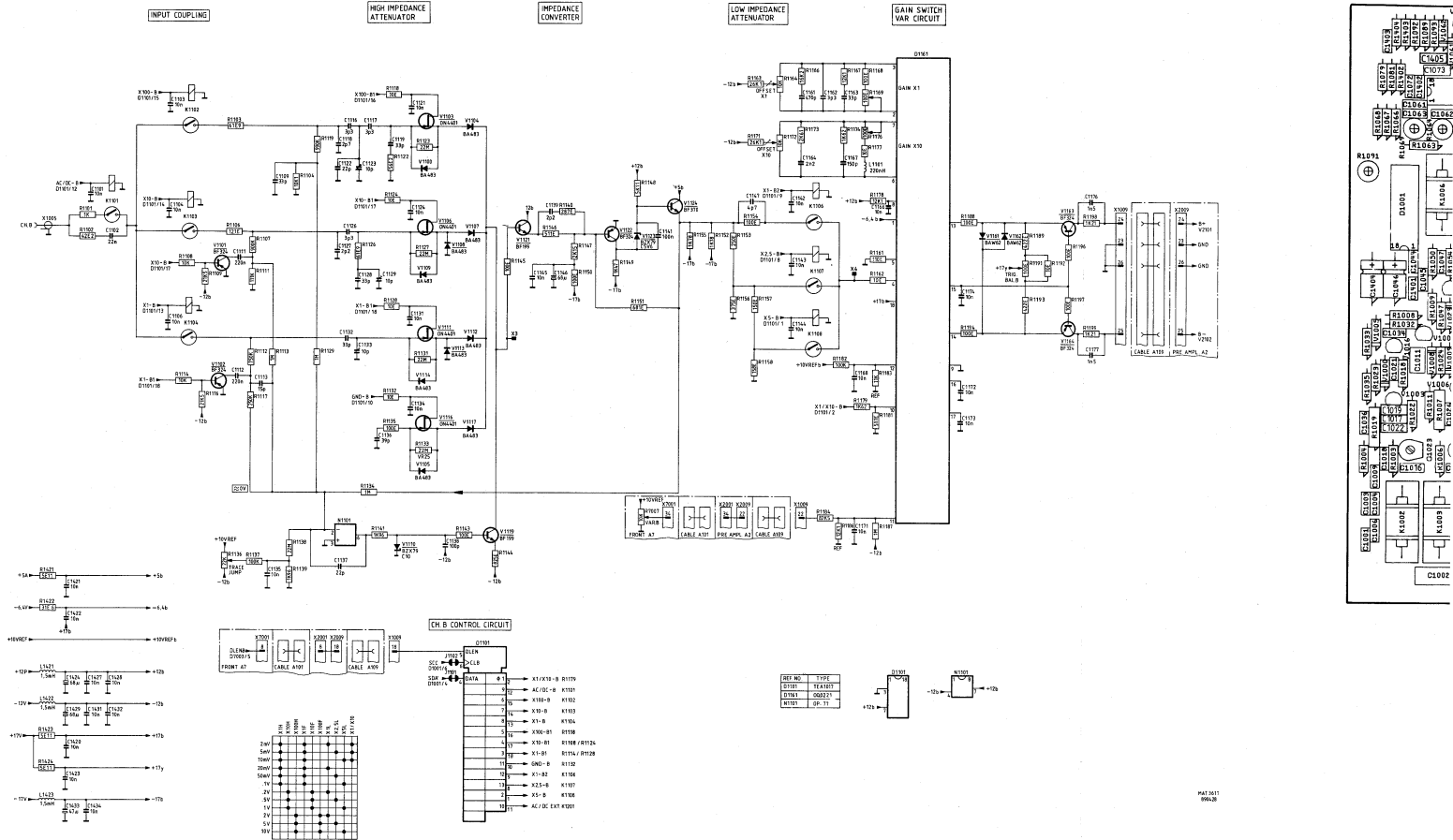


Figure 4.4 Circuit diagram of attenuator, ch.B

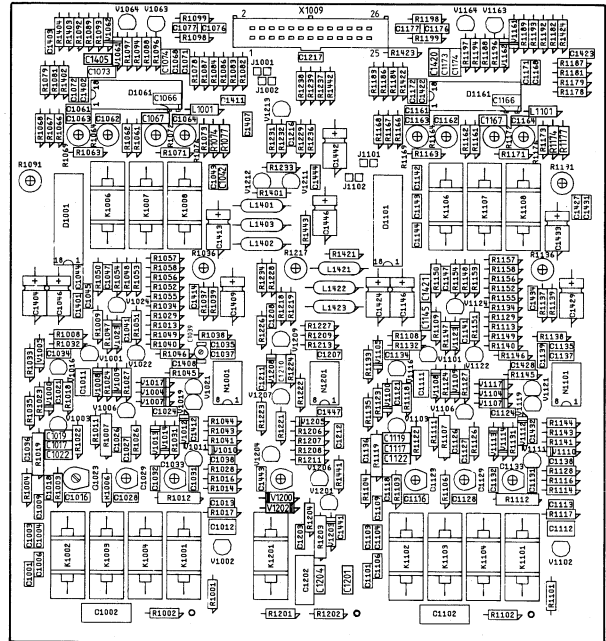
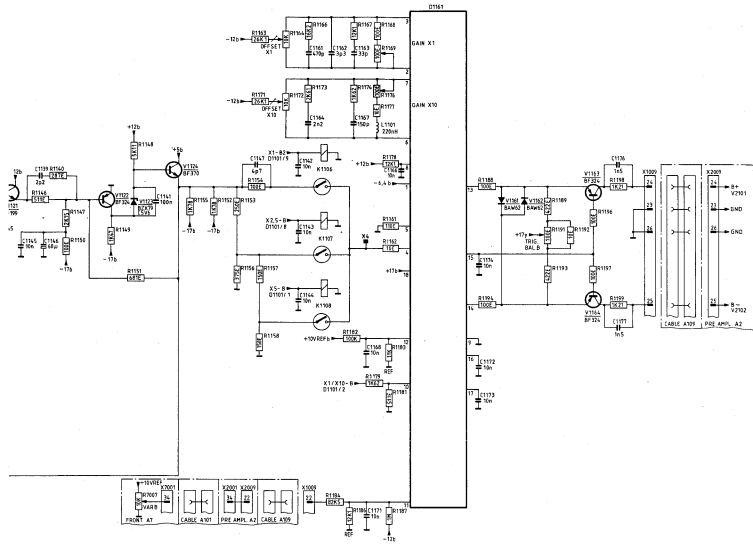
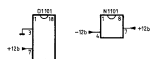
IMPEDANCE
CONVERTERLOW IMPEDANCE
ATTENUATORGAIN SWITCH
VAR CIRCUITMAT 3609
890428

Figure 4.5 Attenuator unit p.c.b.

- X1-X19-B R1179
- AC-DC-B K101
- X10-B AC152
- X1-B K103
- X1-B K104
- X10-B1 R1008
- X10-B1 R1008/R1024
- X1-B1 R1074/R1024
- GAIN-B R1102
- X1-B2 K106
- X23-B K1107
- X1-B K1108
- AC-DC EXT K1001

| REF. NO. | TYPE |
|----------|---------|
| C1001 | TK42001 |
| R1001 | 000217 |
| K1001 | Q1-17 |

MAT 3611
890428

5. PRE-AMPLIFIER UNIT (A2)

The pre-amplifier unit consists of:

- Vertical pre-amplifier
- Trigger pre-amplifier
- Pre-amplifier control, including CHOPPER oscillator

Next, the adaptation unit A16 is mounted on this board. This unit is described separately in chapter 17.

All control pulses for this unit are generated by the pre-amplifier control circuit, via the 1°C bus (see Section 5.4).

5.1 VERTICAL PRE-AMPLIFIER

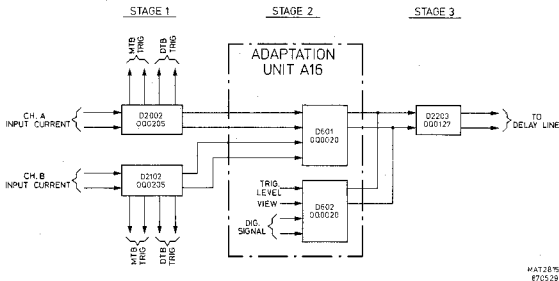


Figure 5.1 The three stages of the vertical pre-amplifier

The vertical pre-amplifier consists of three stages.

The signal splitter (Q0205) receives its input signal for channel A (B) from the attenuator unit and copies this signal into two identical differential output current signals for:

- Vertical deflection (pin 7 and 10)
- Time Base triggering (pin 5 and 12), refer to section 5.2.

The output of pin 7 and 10 is applied to the adaptation unit A16.

Stage 2 (unit A16), refer to the description of A16.

Stage 3 (D2203) serves as delay line driver where the output current of both Q00205's is converted into voltage signal applied to the delay line. The current for this stage and for the Q00205's D601 and D602 on adaptation unit A16 is supplied via R2231 and R2246. The current regulation for the common-mode circuit is achieved by transistor D2203 (12, 13, 14).

5.2 TB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

| | Signal | | Selected by: | | Inverted by: | |
|----------|--------------|------------|--------------|-----------|--------------|-----------|
| | name | routed to | name | routed to | name | routed to |
| ch. A | TRAM+, TRAM- | D2302(3,4) | AM | D2302(10) | INVAM | D2302(2) |
| ch. B | TRBM+, TRBM- | D2302(5,6) | BM | D2302(11) | INVBM | D2302(7) |
| EXTERNAL | EXT-, EXT+ | D2303(3,4) | EXTM | D2303(10) | INVAM | D2303(2) |
| line | LINE | D2303(5) | LNM | D2303(11) | INVAM | D2303(7) |

D2301 serves as a signal splitter and receives its input signal from the attenuator unit. This input current signal is copied into identical differential output current signals for EXT MTB signal (pin 6 and 11)

The symmetrical output currents from D2302 (13, 14) and D2303 (13, 14) are converted into a symmetrical voltage again in the common-base circuit V2316, V2319 followed by a shunt feedback circuit V2318 and V2321. Note that the sensitivity at the collectors of V2318 and V2321 is 110 mV/DIV.

At this point the signal path is divided into:

- a trigger path, fed to both V2333 and V2334, where depending on the current to the base, levelling of the trigger signal is obtained. Two separate series feedback circuits take care of voltage-to-current conversion:

- * V2341 and V2342 for time-base triggering.

The trigger output signal, TRIGM- and TRIGM+ are fed to the time-base unit A4.

- * V2347 and V2349 for trigger level view.

This symmetrical output can be balanced by potentiometer R2407. The TRIGV+ and TRIGV- signals are fed to D602/3,4 on the adaptation unit A16.

Integrated circuit D2304 serves as an auto level circuit. The following functions are possible:

a. Peak-peak

In this case the amplitude of the trigger signal applied to D2304 (3,7) is measured by peak-peak detectors on D2304 (2,4,6,8). The output current from D2304 (14,15) is dependent on the peak-peak level and is adjustable with the LEVEL control R7012, connected to D2304(1).

b. Triggering

In this case the level range is 16 div. The level is adjustable with R7012 and the current variation on D2304 (14,15) can be varied between +or- 0,6mA.

c. TV triggering

The level control is made ineffective. In TV triggering, the LEVEL must be set to a fixed value. This is done by applying a high level current to pin 1 via diode V2326.

d. Auto

In auto the signal LEVEL NUL is high and via diode V2325 the output level D2304 (15) is asymmetrical with output level D2304 (14). Thus the maximum signal amplitude is 2 Vp-p.

- an external deflection path, routed via the series feedback circuit V2356 and V2357, the X DEFL+ and X DEFL- signals are fed to the time base unit A2.
- R2416, R2422 and C2350 gives phase correction for the X-Y display.

5.3

PRE-AMPLIFIER CONTROL

The pre-amplifier control converts the data from the I^2C bus (SDA and SCL), derived from the microcomputer, into the control pulses for the pre-amplifier unit. To eliminate interference the SDA and SCL lines can be switched off via D2601.

This integrated circuit serves as a digital switch, controlled by the VERT IIC line. Logic high connects the outputs D2601(4,14,15) to the input "1" contact (switched on); logic low connects the outputs to the "2" contact (switched off) and gives SDA a logic low level and SCL a logic high level.

When D2601 is switched on, the serial data information is converted into parallel control pulses via D2602 and D2603, provided that D2602 is enabled (D2602-5 is high). The control lines are active when the level of the line is high.

Output Q12-D2602(9) serves as a power up not line for D2603: when the oscilloscope is in the power-up routine, Q12 is high and resets D2603. After the power-up routine, Q12 goes low and enables D2603.

Integrated circuit D2603 relieves the microcomputer of a number of such functions as:

- chop/alt
- trigger select
- time-base select (fed to time base unit A4)

Adaptation of this I.C. to the oscilloscope version is made by the ADO and AD1 inputs D2603(15,16).

For this oscilloscope, ADO must be HIGH and AD1 must be LOW.

Timing for alternate and chopped mode is derived by the ALTCLN and CHOPCL pulses.

The chopper oscillator formed by V2611 and V2612 supplies a square wave voltage of 1,5 Vp-p with a frequency of 1 MHz.

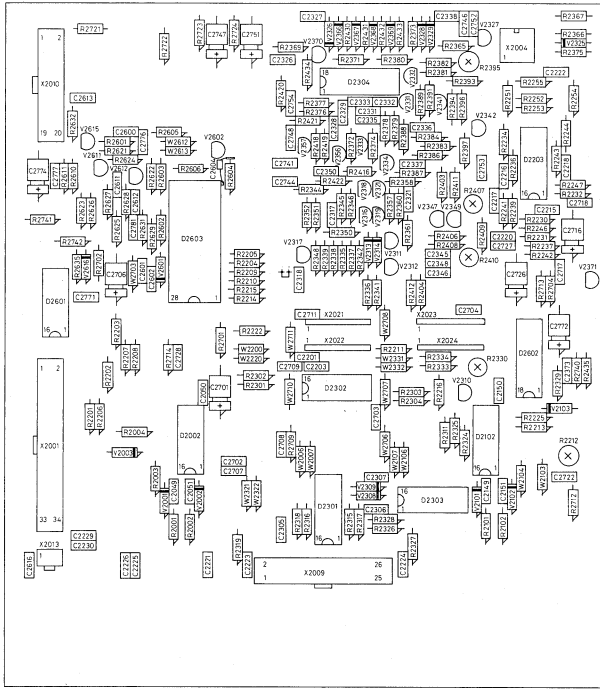
This frequency is defined by two current loops:

- I1 is determined by: V2612(c-e), C2611, R2627 and R2625.
- I2 is determined by: V2611(c-e), C2611, R2628 and R2625.

The duty cycle (I1/I1+I2) is 12% approx.

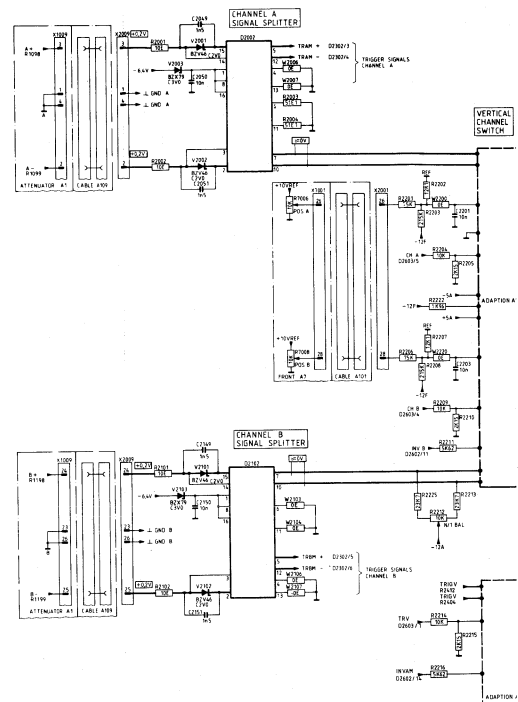
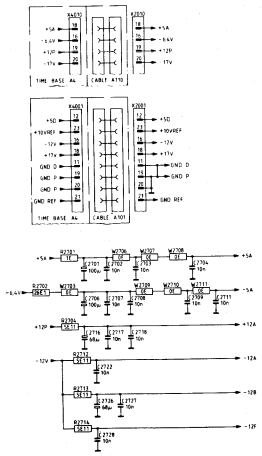
The square wave on the collector of V2612 serves as a chopper clock pulse for D2603 and gives a 500 kHz display for 2 channels CHOP, 333 kHz display for 3 channels CHOP and 250 kHz for 4 channels CHOP (A-B-TRIG VIEW-ADD).

Note that D2603(8) serves as the chopper switch, which is high when the CHOP softkey is depressed.



MAT3613
89C428

Figure 5.2 Pre-amplifier unit p.c.b.



ADAPTION

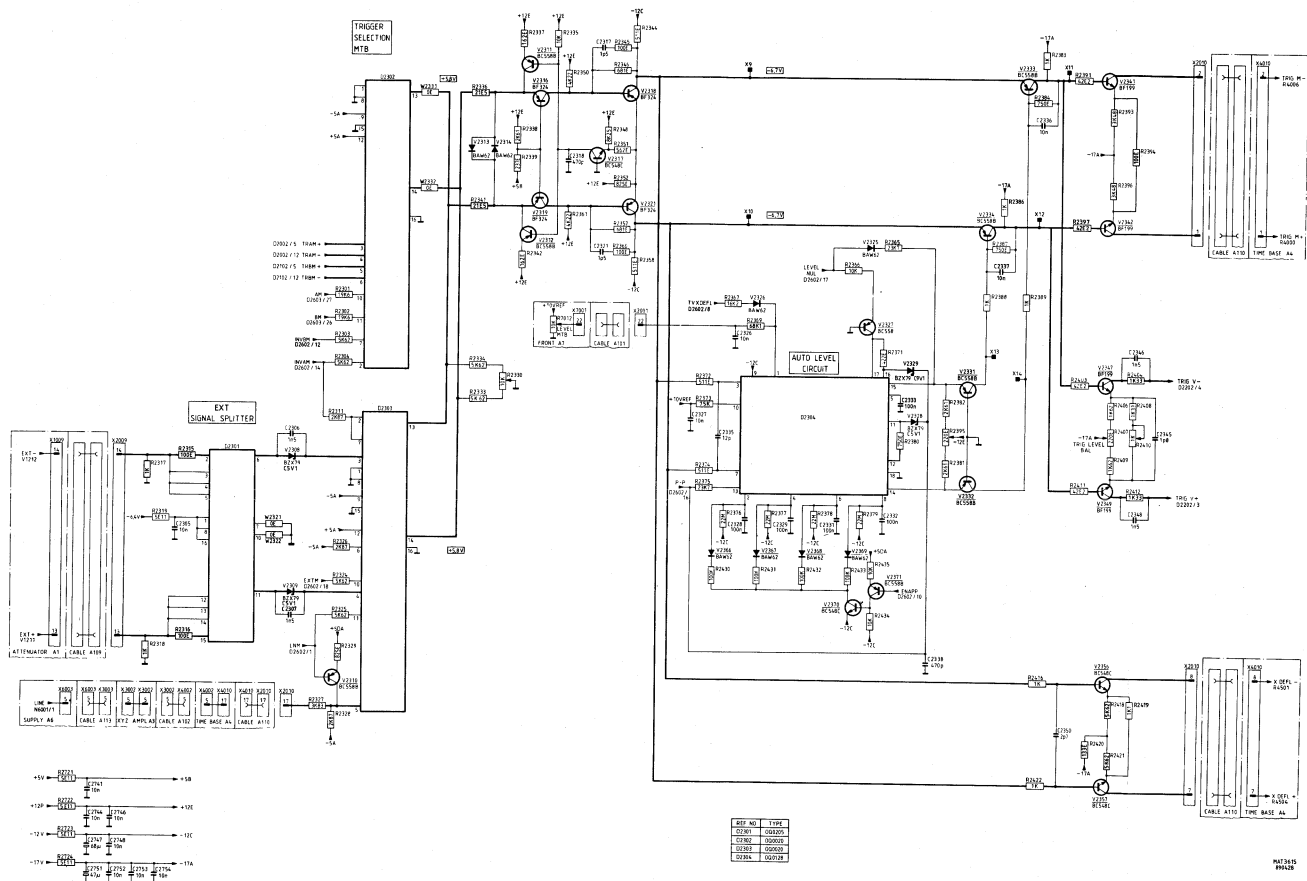
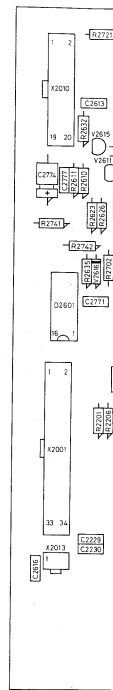


Figure 5.4 Circuit diagram of pre-amplifier, trigger switch



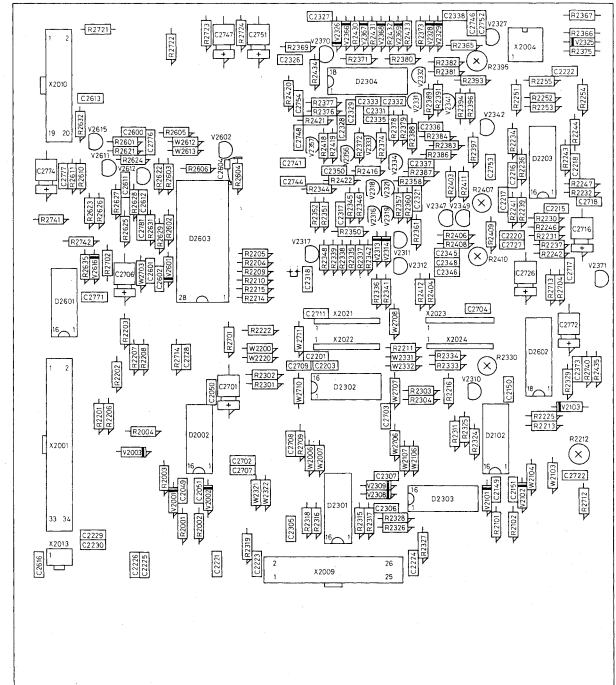
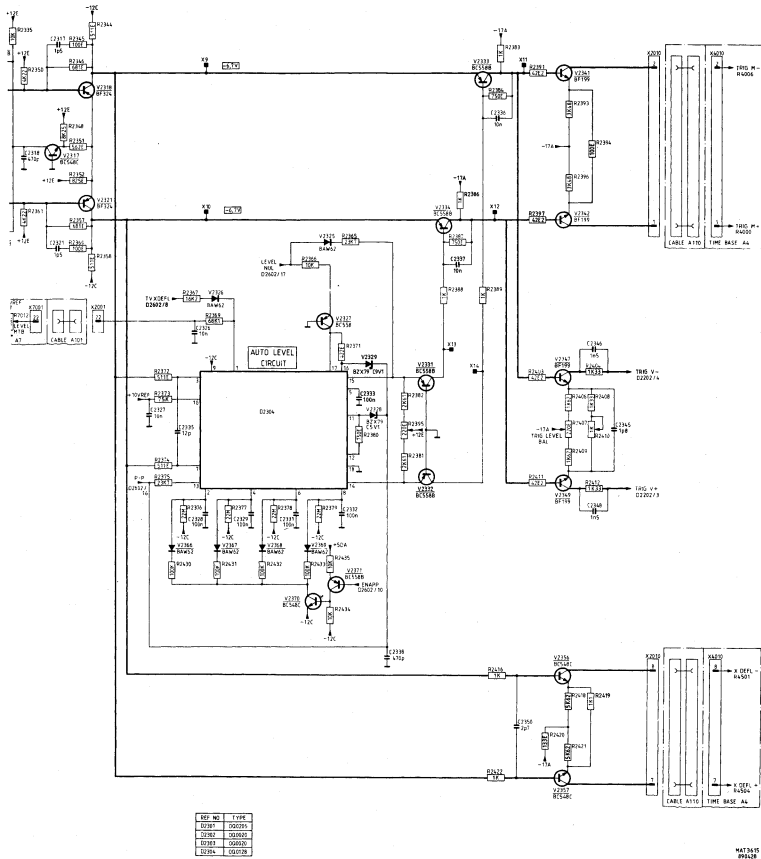


Figure 5.5 Pre-amplifier unit p.c.b.

MA5 3513
890628

MA516
89161

6. XYZ-AMPLIFIER UNIT (A3)

6.1 INTRODUCTION

Unit A3 incorporates two separate pcb's which are connected via a flatcable. One pcb includes among other things the CRT socket and is connected at the rear of the CRT. The other pcb comprising the proper final X and Z amplifiers is situated above the Cathode Ray Tube (CRT). For ease of description, unit A3 is described as one unit.

The XYZ-amplifier unit consists of:

- Final vertical (Y) amplifier.
- Final horizontal (X) amplifier.
- Final unblanking (Z) amplifier, incl. CRT.

6.2 FINAL VERTICAL (Y) AMPLIFIER

The final Y-amplifier receives its signal from the delay line and supplies the correct vertical signal to the Y-deflection plates of the CRT. For this the signal is processed in four stages:

- V3001, V3002 is a series feedback amplifier, including a delay line compensation network and potentiometer R3007 that controls current source V3003 for correction of any unbalance in the Y-deflection plates of the CRT. These circuits are connected between the emitters of both transistors V3001 and V3002.
In this stage the input voltage is converted into a current signal.
- V3004, V3006 is a shunt feedback amplifier, which gives a voltage signal to the next stage.
- V3008, V3009 is a series feedback amplifier, including a final RC-correction network and potentiometer R3038 for gain adjustment to compensate the different CRT sensitivities. V3007 supplies a constant current of 60 mA, i.e. 30 mA for each half. Note that the output again supplies a current signal.
- V3011, V3012 is a common-base amplifier for buffering the final Y-amplifier to the Y-deflection plates. The maximum amplitude on each deflection plate is: $30 \text{ mA} \times 655 \text{ E} = 20 \text{ V approx.}$

6.3 FINAL HORIZONTAL (X) AMPLIFIER

The input current for X-deflection is obtained from the time-base unit (ref: X- and X+) and processed in three stages, with circuits in the following configurations:

- V3101, V3102 is a common-base amplifier. The current "I" on the collector of both transistors determines the voltage across R3102 and R3116. This voltage is about 1,5 V p-p and feeds the next stage.
- V3103, V3106 is a series feedback amplifier, including an RC-correction network for optimum linearity of the trace and potentiometer R3118 for xl amplifier adjustment, mounted between the emitters of both transistors. V3104 serves as current source.

- V3112, V3114 are connected as a shunt feedback amplifier, with resistors R3126 and R3134 as the feedback resistors. The transistor source are emitter followers V3109, V3111. This circuit serves as the actual final amplifier, which converts the deflection current into the proper deflection voltage for the X-deflection plates of the CRT. Transistors V3108, V3116 supply the bias current for the circuit.

6.4 FINAL BLANKING (Z) AMPLIFIER AND CRT

The blanking current derived from the Z pre-amplifier of the time-base unit is routed via common base amplifier V3200 and emitter-follower V3201 to the shunt-feedback amplifier V3202. This stage is fed by current source V3203, which gives a constant current of 4 mA. The voltage on the collector of V3202 can vary between +5 V for unblanking and -35 V for fully blanking.

This Z-pulse may contain d.c., l.f. and h.f. components to be applied to grid G1 of the CRT. Since G1 is at a cathode potential of -2000 V, blocking capacitors are required between G1 and the Z-amplifier output. The h.f. component is directly routed via blocking capacitor C3211 to G1.

However, the d.c. and l.f. components are blocked, so these components are first modulated on a 200 kHz carrier signal by V3207 and V3208 to pass blocking capacitor C3209. Then the signal is demodulated again by V3209 and V3211. Finally, the reconstituted d.c. and l.f. components are added to the h.f. component.

Transistor V3251 forms a nominal 70 V zener circuit which provides the voltage difference between the cathode and G1 of the CRT. This bias voltage ensures blanking when there is no input signal. For adaptation to each CRT, this voltage can be varied between about 40 V and 100 V by means of R3252 (BLACK LEVEL). Resistor R3254 keeps the filament at the same potential as the cathode.

Any ripple on the cathode voltage is fed-back via transistor V3213 to the input of the Final Z-amplifier and added to the blanking signal. This means that the differential voltage between G1 and the cathode of the CRT is always fixed. Because this differential voltage determines the intensity of the spot, as a result, the intensity is almost independent of the ripple.

The amplifier stage V3253, V3254 and V3256 provides amplification for the range of the FOCUS control. The range of 0...+10 V gives a final range on G3 of the CRT of -1350 V ... -1600 V.

Resistor R3257 connects the INTENS control to the focus adjustment to maintain a sharply defined trace at varying brightness.

For optimum presetting of the GEOMETRY, the voltage on G5 of the CRT is set to a fixed level of -30 V. The ASTIGMATISM can be varied by means of potentiometer R3267.

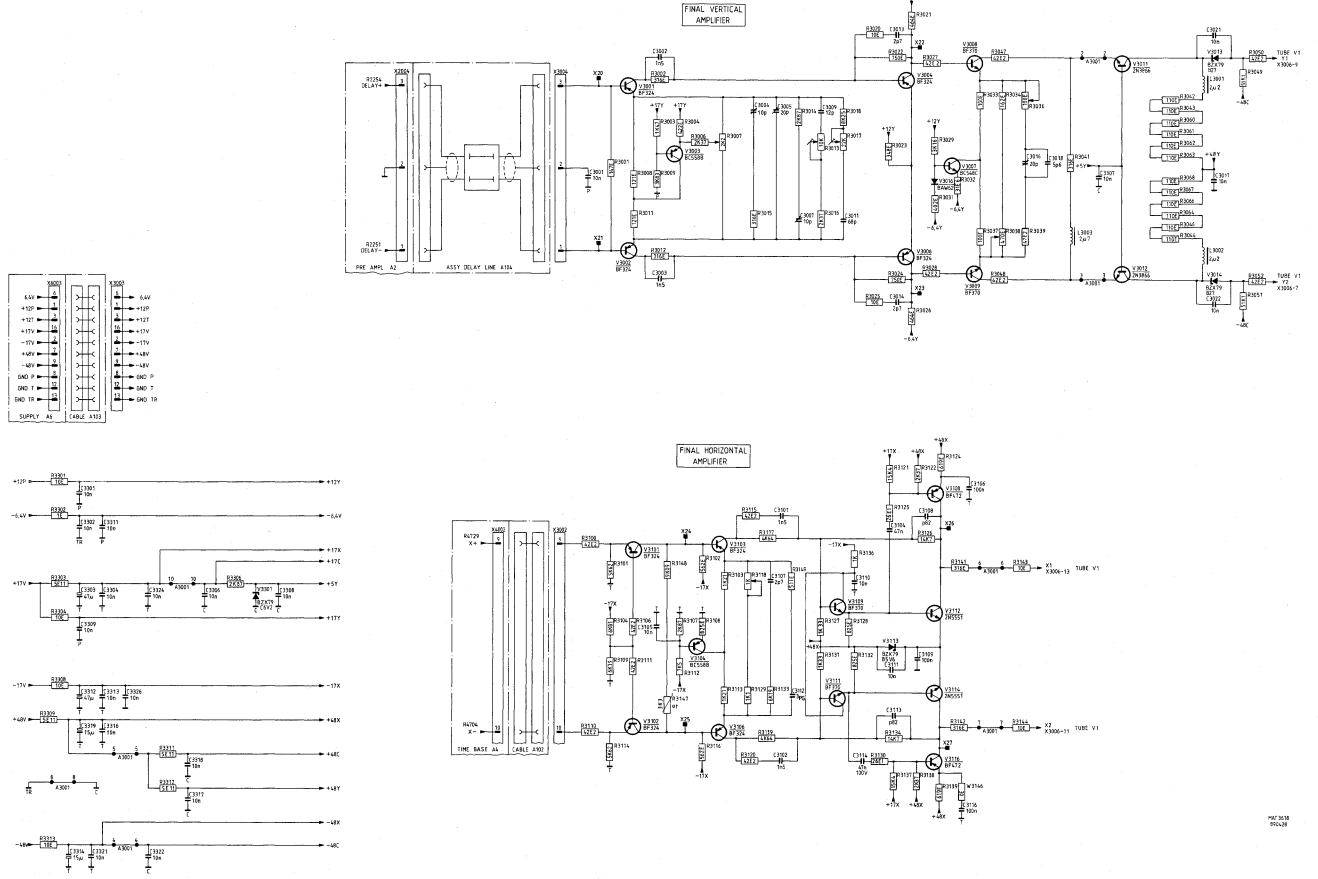
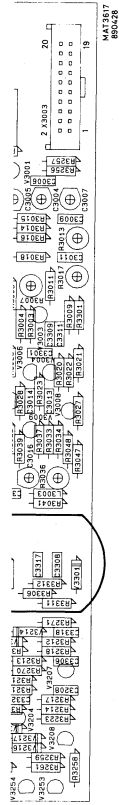


Figure 6.2 Circuit diagram of XYZ amplifiers, final X and Y amplifiers

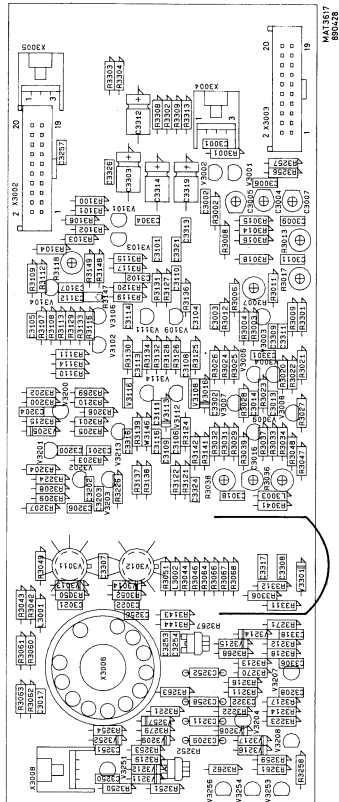


Figure 6.3 XYZ amplifier unit p.c.b.

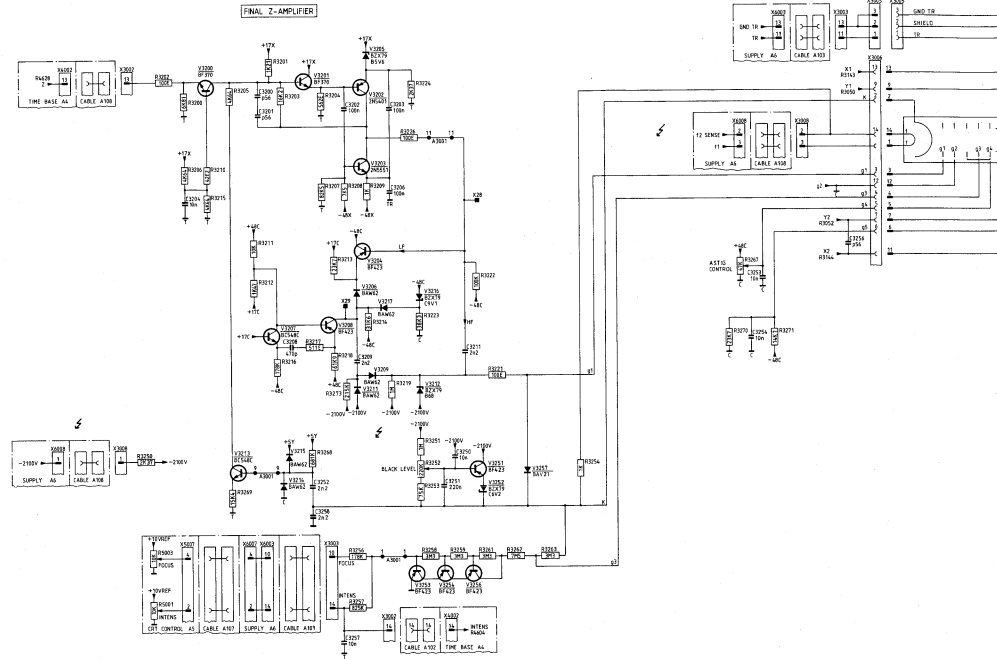


Figure 6.4 Circuit diagram of XYZ amplifiers, 2

7. TIME-BASE UNIT (A4)

The time-base unit consists of:

- Trigger amplifier
- Timing circuit
- Sweep generator
- X DEFL amplifier, incl. display mode switch
- Horizontal pre-amplifier
- Z amplifier

As a supplement, the timing diagram for several conditions of the time base is given in section 7.7.

All control pulses for this unit are generated by the time-base control circuit, via the I²C bus. Integrated circuits D4001 and D4002 convert this series DATA into the parallel control pulses, provided that DLEN TB1, and DLEN TB2 are HIGH.

7.1 TRIGGER AMPLIFIER

* TB triggering:

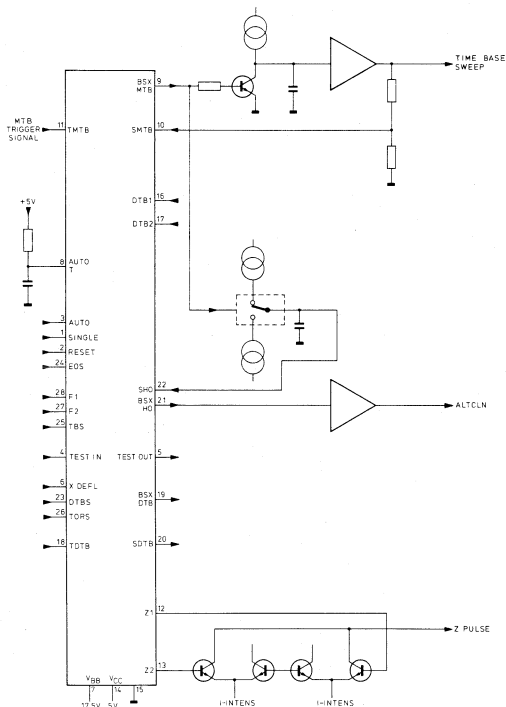
The symmetrical trigger current signals TRIGM+ and TRIGM- are derived from the pre-amplifier unit and converted into the asymmetrical trigger voltage via the summation amplifier V4004, the shunt feedback amplifier V4008 and the emitterfollower V4009. The summation amplifier adds the base signal voltage of V4004 (caused by TRIGM-) and the collector signal current of V4001 (caused by TRIGM+).

* TV triggering:

When the signal TVMTB goes LOW, the normal trigger path is blocked via V4022 and the trigger signal is routed via the TV trigger stage V4011...V4023. Transistor V4012 serves to clip the synchronisation pulse and LINE/FRAME selection is obtained by V4021. If the signal TVF/LINE is high, TV frames are detected by C4004 ... C4007. A low control signal serves line detection by C4007.

7.2 TIMING CIRCUIT (see figure 7.1)

The timing for the entire time-base circuit is obtained by D4103 together with its associated components.



MAT2291
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Figure 7.1 D4103 configuration

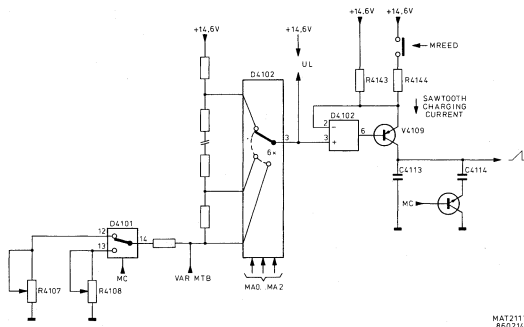
D4103 has the following relevant pin connections:

| Pin | Name | INPUT-OUTPUT | Description |
|-----|----------|---------------|--|
| 1 | SINGLE | TTL-input | Selects the single time-base mode. |
| 2 | RESET | TTL-input | Stops the sweep and starts the hold off sweep. |
| 3 | AUTO | TTL-input | Selects the AUTO trigger mode, the time base is free-running after the last trigger pulse. |
| 4 | TESTIN | TTL-input | Selects the possibility to drive several functions (TESTOUT) in combination with SINGLE and RESET. |
| 5 | TESTOUT | TTL-output | -- |
| 6 | X DEFL | TTL-input | Activates the Z1 and Z2 outputs. |
| 7 | Vbb | - | +1,5 V supply input. |
| 8 | AUTOTIME | input | RC-time determination (100 ms) for the AUTO trigger mode. |
| 9 | BSXMTB | TTL-output | Discharges the TB-sweep capacitor(s). |
| 10 | SMTB | SCHMITT-input | Determines the end of the TB-sweep. |
| 11 | TMTB | SCHMITT-input | Determines the start of the TB-sweep. |
| 12 | Z1 | TTL-output | Determines the blanking of the CRT. |
| 13 | Z2 | TTL-output | Determines the blanking of the CRT. |
| 14 | GND | - | Ground. |
| 15 | Vcc | - | +5 V supply input. |
| 16 | DTB1 | - | not used |
| 17 | DTB2 | - | not used, connected to ground. |
| 18 | TDTB | - | not used, connected to ground. |
| 19 | BSXD TB | - | not used |
| 20 | SDTB | - | not used, connected to ground. |
| 21 | BSXHO | TTL-output | Determines the ALT clock pulse |
| 22 | SHO | SCHMITT-input | Determines the end of the Hold-off sweep. |
| 23 | DTBS | - | not used; connected to supply +5Z. |
| 24 | EOS | - | Not used; connected to supply +5Z. |
| 25 | TBSX | TTL-input | Determines the TB-unblanking (HIGH) |
| 26 | TORS | TTL-input | Determines the STARTS condition (LOW) or TRIG'D condition (HIGH) of the DTB. |
| 27 | F1 | TTL-input } | Determines the time base display mode (both LOW). |
| 28 | F2 | TTL-input } | |

NOTE: All SCHMITT-inputs are at +2,5 V level.

7.3 SWEEP GENERATOR

* TB sweep generator (see figure 7.2):



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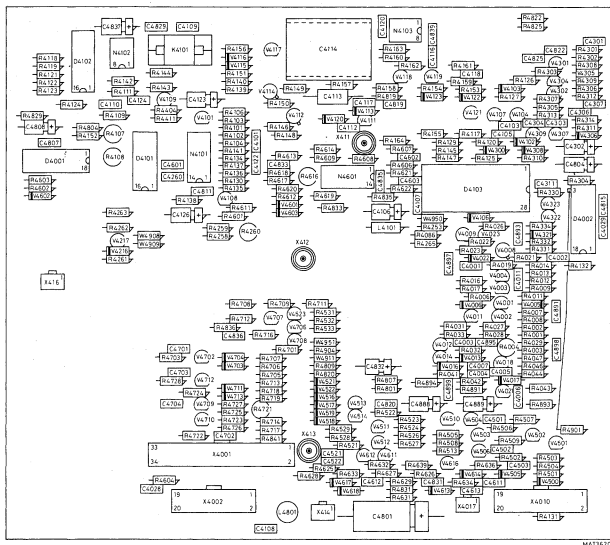
Figure 7.2 Simplified diagram of the time-base sweep generator

The sawtooth charging current $\frac{UL}{R4143 \text{ (and } R4144)}$ determines the sweep speed via C4113 (+C4114).

The circuit is controlled by the following address lines:

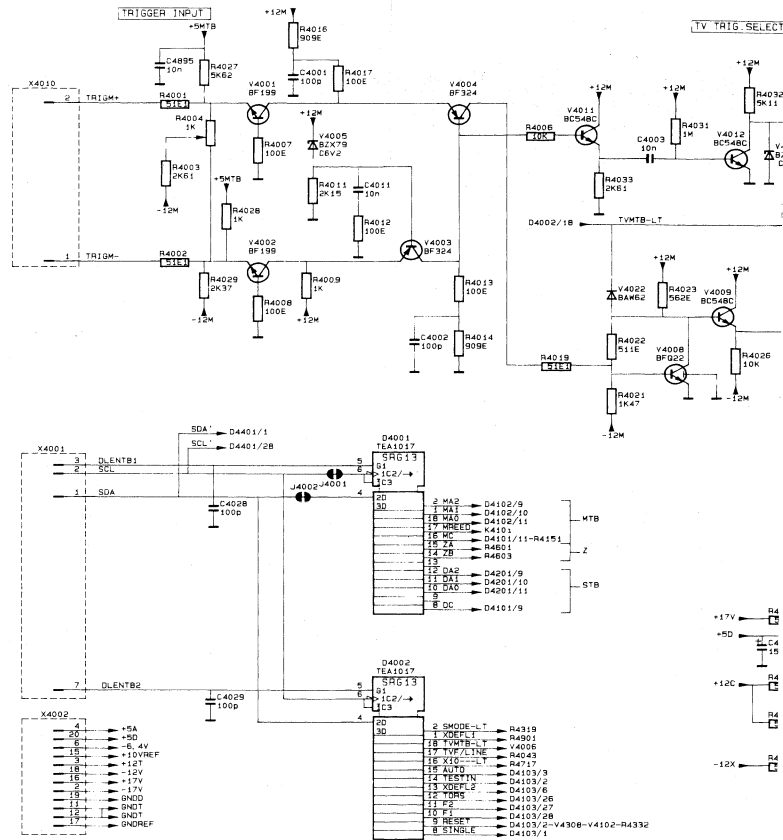
- MA0...MA2, for interconnection of D4102-3 to an input pin, thus giving six different voltage levels UL with respect to +14,6 V.
- MREED, for addition of R4144 to the sawtooth charging circuit.
- MC, for addition of C4114 to the sawtooth charging circuit and for switching over between calibration pot.meters R4107 (50ns...100us) and R4108 (200 us...0,5 s).

The voltage UL can be continuously varied by moving the VAR TB control R7009 from the CAL position. Thus a sweep variation of 1:2,5 can be obtained.



MAR1981
890550

Figure 7.4 Time-base unit p.c.b.



- X4002
- 4 → +5A
 - 5 → +5D
 - 6 → -6.4V
 - 7 → +10VREF
 - 8 → +12V
 - 9 → +17V
 - 10 → -12V
 - 11 → +17V
 - 12 → GND
 - 13 → GND
 - 14 → GND
 - 15 → GND
 - 16 → GND
 - 17 → GND
 - 18 → GND
 - 19 → GND
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 - 99 → GND
 - 100 → GND

- D4002
- 1 → XMODEL-T
 - 2 → TVTRIG-T
 - 3 → TVTRIG-T
 - 4 → TVTRIG-T
 - 5 → TVTRIG-T
 - 6 → TVTRIG-T
 - 7 → TVTRIG-T
 - 8 → TVTRIG-T
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 - 100 → TVTRIG-T

| REF NO | TYPE | +5D | +5DB |
|--------|---------|-----|------|
| D4001 | TEA1017 | | 7 |
| D4002 | TEA1017 | 7 | |
| D4103 | 100001 | | |

The function table for the sweep generator is given below:

| sweep speed | MA2 | MA1 | MA0 | MREED | MC |
|-------------|-----|-----|-----|-------|----|
| 50 ns | 1 | 1 | 1 | 0 | 0 |
| .1 us | 0 | 1 | 0 | 0 | 0 |
| .2 | 0 | 0 | 1 | 0 | 0 |
| .5 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 2 | 1 | 0 | 0 | 1 | 0 |
| 5 | 1 | 1 | 1 | 1 | 0 |
| 10 | 0 | 1 | 0 | 1 | 0 |
| 20 | 0 | 0 | 1 | 1 | 0 |
| 50 | 0 | 0 | 0 | 1 | 0 |
| .1 ms | 0 | 1 | 1 | 1 | 0 |
| .2 | 1 | 0 | 0 | 0 | 1 |
| .5 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 | 1 |
| 5 | 0 | 0 | 0 | 0 | 1 |
| 10 | 0 | 1 | 1 | 0 | 1 |
| 20 | 1 | 0 | 0 | 1 | 1 |
| 50 | 1 | 1 | 1 | 1 | 1 |
| .1 s | 0 | 1 | 0 | 1 | 1 |
| .2 | 0 | 0 | 1 | 1 | 1 |
| .5 | 0 | 0 | 0 | 1 | 1 |

NOTE: When MREED is low, then RELAY is switched on.

The sawtooth current is fed to the buffer circuit, where the h.f. sweep components (to 2 usec) are routed via C4116 and V4118, V4119. The l.f. sweep components (0,5 sec...2usec) is routed via N4103.

Finally the time-base sweep voltage is applied to the horizontal display mode switch.

* Hold-off circuit:

During the time base sweep, capacitor C4304 is discharged. In the lower sweep speeds (lower than 10us) capacitor C4302 is also discharged via V4306. After the sweep, the capacitor(s) are charged via current source V4304 until the voltage across C4304 reaches the +2,5 V level. This voltage is applied to D4103 as the SHO signal and determines if the time base can generate a new sweep.

Depending on the HOLD OFF control potentiometer R7011 adjustment, a part of the charging current leaks away via V4301 and thus continuously variation of the charging time (i.e. hold-off time) is obtained. When BSXMTB goes LOW, the time base starts to run again and at the same time C4304 (and C4302) are discharged again via V4309.

7.4 X DEFL AMPLIFIER AND DISPLAY MODE SWITCH

* X DEFL amplifier:

The circuit for converting the symmetrical X DEFL+ and X DEFL- signals into the asymmetrical voltage, applied to the display mode switch is identical to the trigger input. However, this circuit can be switched-off by diodes V4500 and V4505, provided that the X DEFL signal is HIGH.

* Horizontal display mode switch:

The three deflection signals for real time base, digital time base or X deflection are switched to the horizontal pre-amplifier via diode switches. These switches are under control of the signals X DEFL and TBS. The output of the circuit is applied to R4701 on the horizontal pre-amplifier stage. The logic table is given below:

| X DEFL | TBS | Output |
|--------|-----|-------------------|
| 1 | * | X DEFL signal |
| 0 | 0 | Digital time base |
| 0 | 1 | Real time base |

7.5 Z-AMPLIFIER

* Z-switch:

The Z-switch N4601 is configured as two differential amplifiers with a common current output to R4625. The stage is supplied by a constant current source via pin 3 and pin 9. The inputs Z1 and Z2 are derived from the timer stage D4103 and determine the unblanking of the CRT. For this oscilloscope Z1 and Z2 must be HIGH for normal intensity of the time base signal.

The amplitude of the Z-current can be varied by the front-panel INTENS control R5001. The slider of this control potentiometer drives the base pin 2 and pin 10 of both current sources.

To prevent burn-in of the CRT in the lower sweep speeds. 0,5 sec...50 usec, signal ZB is LOW and reduces the voltage to pin 2 and pin 10.

Signal ZA is a software-controlled pulse to blank the trace when the AMPL/DIV switch is used.

* Z Pre-amplifier:

In normal condition, the full current for CRT blanking derived from N4601 is routed via R4625, V4612 and R2628 to the XYZ Amplifier A3.

However, there are two conditions for additional blanking:

- In the chopped mode of the vertical channels the display is blanked during switching over between channels. This happens by connecting the CHOPBLN pulse to V4611. When this pulse is HIGH, transistor V4611 conducts and a part of the blanking current flows via V4611 emitter-collector to the +5 K (+5V supply) rail.
- if a HIGH level is applied to the external Z MOD input on the rear panel, this signal causes conducting of V4616 so that a part of the blanking current flows via V4616 emitter-collector to the +5 K rail.

7.6 HORIZONTAL PREAMPLIFIER

The horizontal preamplifier drives the final X-amplifier on unit A6. It is a balanced amplifier that consists of V4702 and V4712. The amplifier receives the selected X-deflection signal. This signal can be the analog time base signal, the digital time base signal or the X-deflection signal. This signal is applied to the base of V4702. The base of V4712 receives a d.c. signal that determines the horizontal shift of the display on the CRT screen. The preamplifier can work with two different amplification factors:

- If X MAGN is inactive, the signal X10---LT is high. This has the result that V4706 is on and V4708 is off at the same time. The amplification is determined by the emitterresistors R4705 and R4718. V4707 serves as a constant current source.
- If X MAGN is active, the signal X10---LT is low. This has the result that V4706 is off and V4708 is on at the same time. The amplification is determined by the emitterresistors R4706, R4707, R4719 and R4721. This gives a 10 times gain increase compared with the other mode.

The signal that determines the horizontal shift of the signal is applied to the base of transistor V4712. This signal can be derived either from the X POS potentiometer via W4909 (during normal signal display) or via trimming potentiometer R4260 (during display of text and/or cursors). The selection is done in multiplexer D4101 under control of signal XPOSOFF-HT that is high during text display. The signal is low during display of the signal.

7.7 TIMING DIAGRAM

The following figure gives the timing diagram for D4103 for a free running time base sweep.

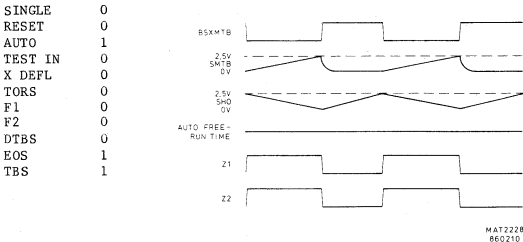


Figure 7.3 Free-running sweep-timing diagram

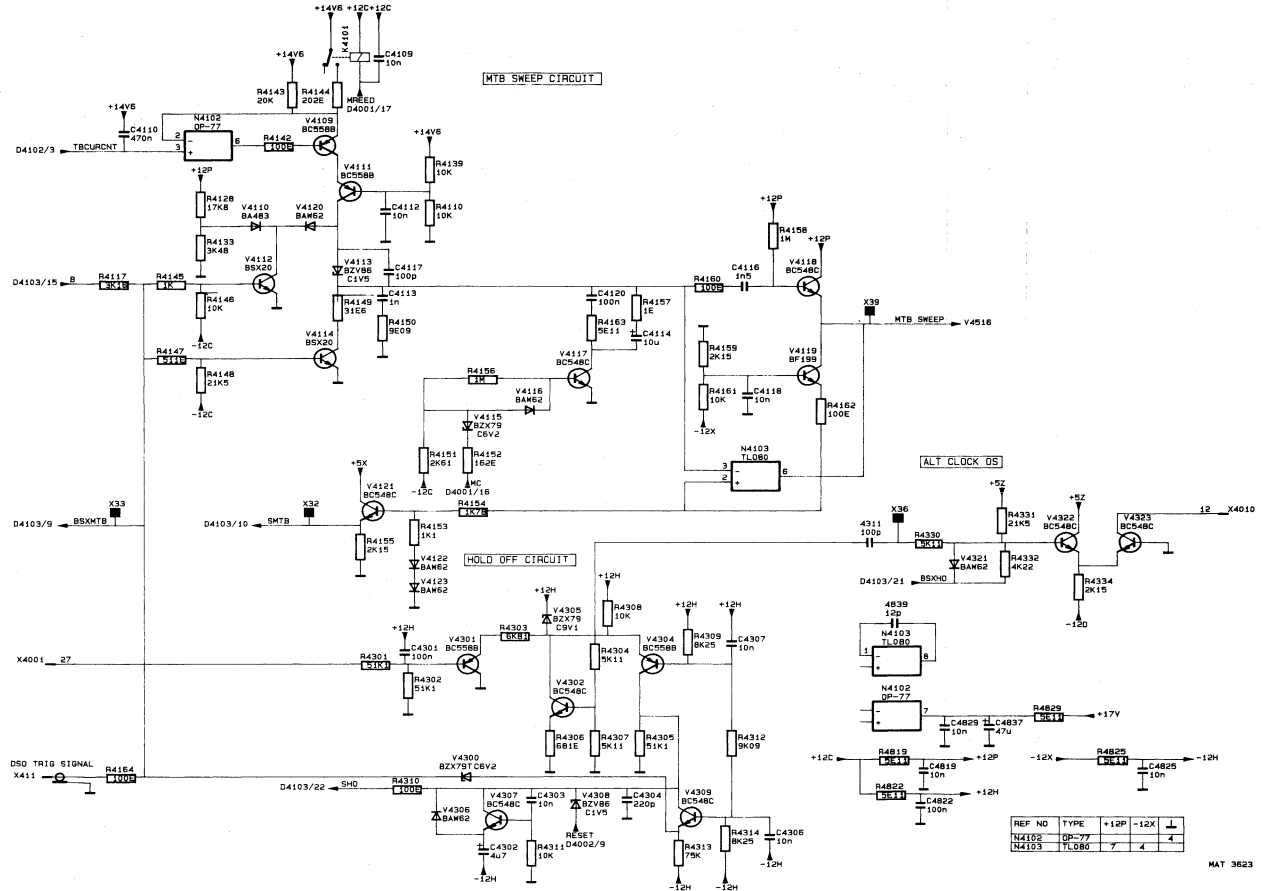


Figure 7.8 Circuit diagram of time-base, sweep generator and hold-off

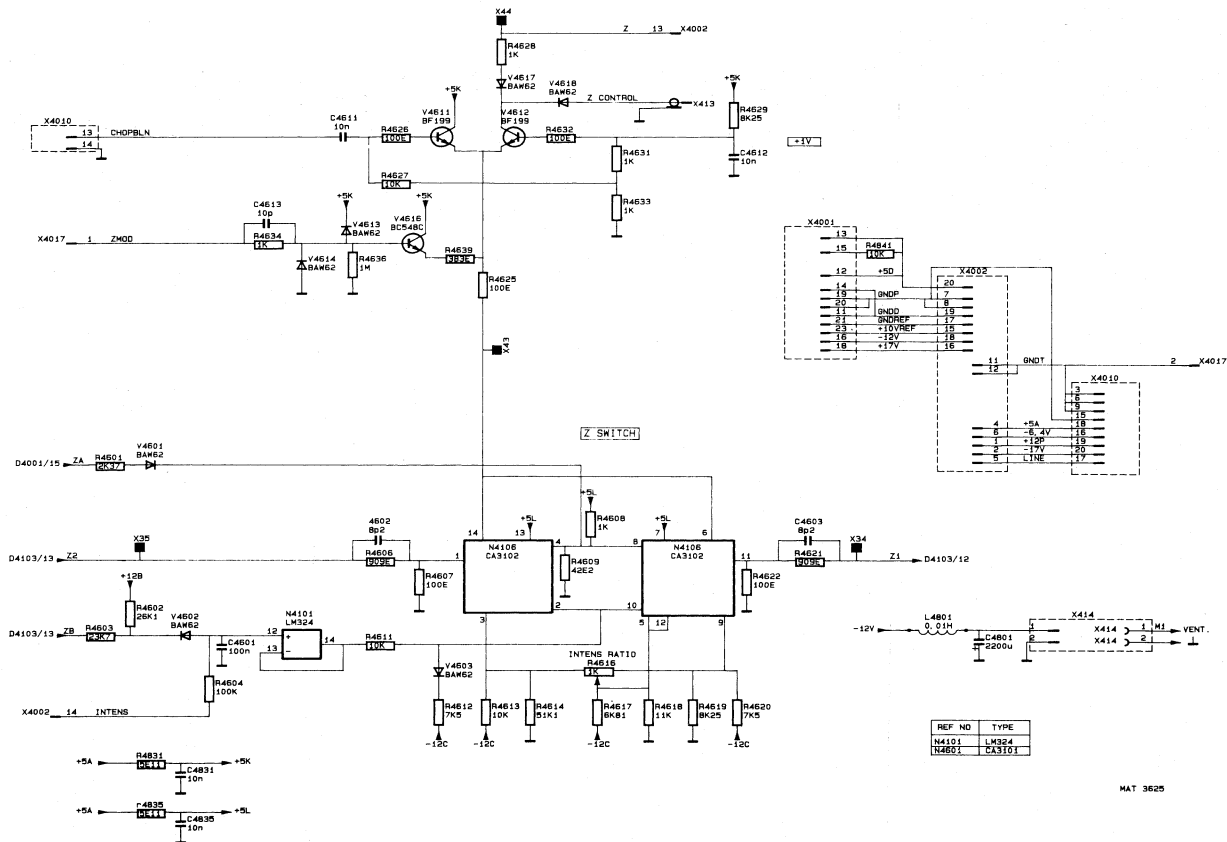


Figure 7.10 Circuit diagram of time-base, Z-amplifier

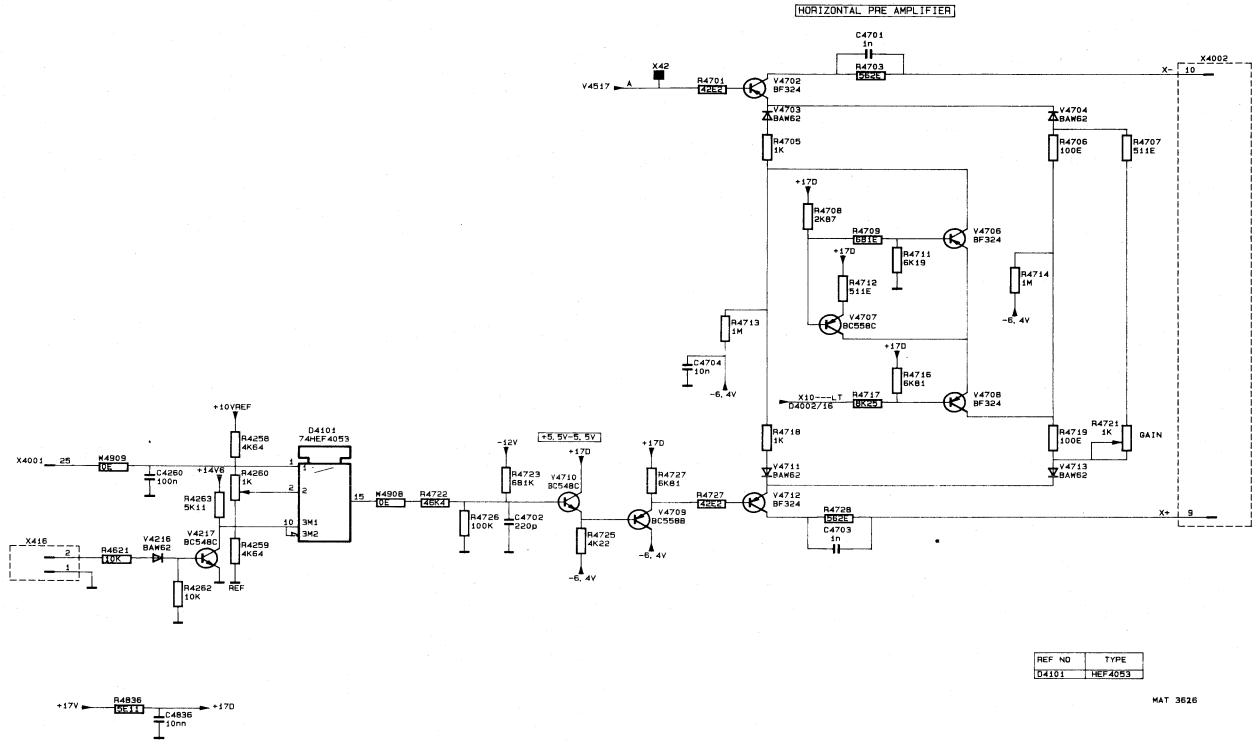


Figure 7.11 Circuit diagram of time-base, horizontal pre-amplifier

8. CRT CONTROL UNIT (A5)

This unit incorporates the potentiometers that control the CRT functions. These potentiometers are INTENS (R1), screwdriver operated control TRACE ROT (R2), FOCUS (R3) and ILLUM (R4). The range of these potentiometers is between 0 V and +10 V. The way these potentiometers influences the associated circuit is described together with the description of the relevant circuit part.

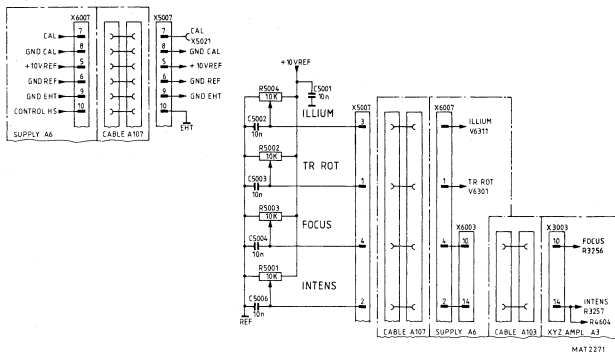


Figure 8.1 Circuit diagram of CRT control

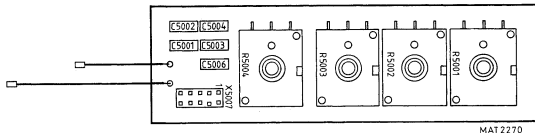


Figure 8.2 CRT control unit p.c.b.

9. POWER SUPPLY UNIT (A6)

Basically, the power supply unit consists of:

- input circuit
- converter circuit
- secondary output rectifiers
- HT supply
- CAL oscillator
- CRT control circuit

9.1 INPUT CIRCUIT

The instrument may be powered from a nominal mains voltage of 90 V...264 V a.c.

The mains voltage is primary protected by a fuse of 1 AT, which is located on the rear of the instrument.

After rectification by the diode bridge V6001...V6004 a d.c. voltage is applied to the converter circuit.

This voltage is smoothed by capacitors C6007, C6008 and three chokes. Depending on the mains voltage, the rectified voltage is 120 V...370 V.

A fixed part of the mains voltage serves as a LINE-trigger signal. The amplitude of the LINE trigger signal is $1/22x$ MAINS.

NOTE: The LINE trigger signal is not present when a d.c. voltage serves as MAINS.

9.2 CONVERTER CIRCUIT (see figure 9.1 and figure 9.2)

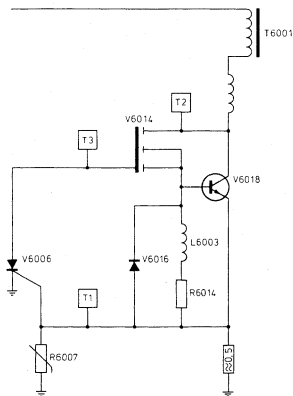
The flyback converters consists of transistor V6014 and V6018 and their associated components. The converter frequency depends on the LINE IN amplitude and is for 110 Vac: 30 kHz approx. For 220 Vac: 45 kHz approx.

Transistors V6014 and T6018 conduct on the forward stroke and charge transformer T6001. The thyristor V6013 fires when the voltage on the gate reaches the firing level (0,6 V approx). Consequently, V6018 blocks - V6014 blocks, for the duration of the flyback stroke, during which the secondary windings discharge via the diode rectifiers into the smoothing capacitors. The NTC resistor R6009 provides temperature compensation for the firing point of the thyristor.

During the flyback, capacitor C6009 charges again via the path T6001-1, V6012, V6009, R6004, C6009 and T6001-2.

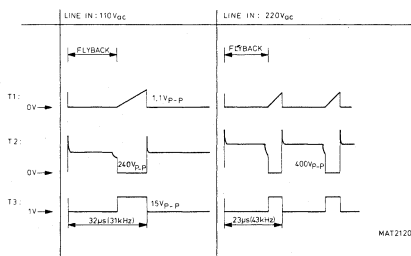
The voltage stabilizer with transistor V6009 gives a square-wave to the gate of transistor V6014 with a maximum amplitude of 15 V.

The dv/dt limiter with L6004, L6006, V6017 and V6019 serves to eliminate the switching spikes present on the collector of V6018 (measuring point X46).



MAT2119
860214

Figure 9.1 Converter circuit



MAT2120

Figure 9.2 Timing diagram converter circuit

9.3 SECONDARY OUTPUT RECTIFIERS

The output voltages taken from the secondary windings of transformer T6001 are rectified by diodes and smoothed by capacitors in conventional circuits.

A "CROWBAR" circuit with transistor V6137 and V6112 protects the +5 V supply.

When the +5 V level is too high, transistor V6137 (and V6112) conduct and the power supply goes into short circuit mode.

A voltage protection circuit using V6134, V6136 and V6112 protects against overloads protection. When the power supply is overloaded, these components conduct and the power supply goes into in the short-circuit mode.

9.4 HT SUPPLY

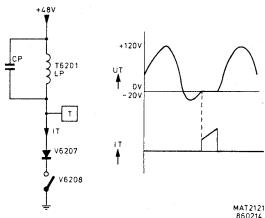


Figure 9.3 HT oscillator

The HT supply consists of an oscillator and a regulator circuit. Transformer T6201 determines the frequency (50 kHz approx.) of the oscillator. The output signal voltage on the secondary winding of T6201 is rectified by diode V6209 and smoothed by C6211. The -2,1 kV is also converted to +14,5 kV in the HT multiplier D6201 and routed via connector X6030 to the post-acceleration anode of the CRT.

To regulate this HT voltage the -2 kV is fed to the input of OP-AMP N6002.

The output level of N6002 determines the energy to T6201, and thus the amplitude of the HT-voltage.

9.5 CALIBRATOR

The calibrator circuit consists of two analogue switches D6501(8-9) and D6501(11-12) controlled by the active HIGH enable inputs 6 and 12 respectively, that are connected as an 2 kHz astable oscillator. Capacitor C6502 and resistor R6504 determine the 2 kHz frequency. The oscillator outputs, applied to enable inputs 5 and 13 of the second stage are in anti-phase with each other. Depending on the level of input 5 and 13, the CAL voltage will have a 1,2 V level or a 0 V level.

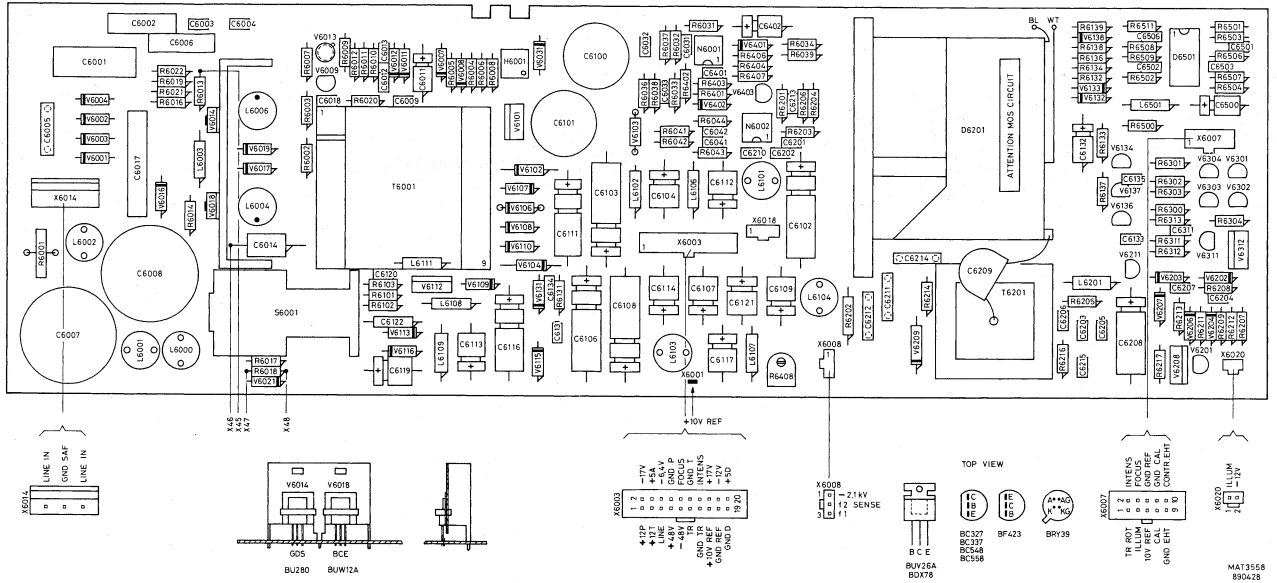


Figure 9.4 Power supply unit p.c.b.

10. FRONT UNIT (A7-A8)

The front unit consists of:

- the key-matrix and reset circuit
- the front controls, probe indicator and auxiliary circuits
- the LCD display

The microprocessor that reads and controls this unit is located on the digital unit A9. The interconnection between both units is made by means of a 40-pole flatcable.

10.1 KEY-MATRIX AND RESET CIRCUIT

The front keys are grouped in a matrix configuration consisting of 9 lines. Every key (except the AUTO SET key) is present at the crossing point of two lines. The 9 lines are named KEY0 ... KEY8 and are directly read by the microprocessor D9012 on digital unit A9.

The reset circuit generates the signal RESET-HT. This signal is high during some time after switching-on of the instrument. This high level forces the microcomputer on unit A9 to initiate its main program.

10.2 FRONT PANEL CONTROLS, PROBE INDICATOR AND AUXILIARY CIRCUITS

The front-panel potentiometers give voltages between 0...10 V to the various circuits. To determine the UNCAL position of VAR A, VAR B or VAR NTB, the dc voltages on the slider of the potentiometer are applied to triple comparator N7001. When the voltage level of the control is lower than 0,7 V a logic high is read. The UNCAL data is read by the microprocessor via a buffer that is present on unit A9.

Integrated circuit D7004 (OQ0044) detects the kind of probe which is connected to the oscilloscope. Depending on the resistance between the probe indication input (pin 3 for channel A and pin 16 for channel B) and ground, the V/DIV reading of the LCD automatically increases according to the table below. Depending on the type of probe (e.g. 10:1, 100:1) the indication ring incorporates a different resistance value.

| Pin 3 (16) | Pin 6 (17) | Pin 7 (12) | V/DIV attenuation |
|------------|------------|------------|-------------------|
| 2k32 | 0 | 0 | x10 |
| 6k98 | 1 | 0 | x100 |
| 7k68 | 0 | 1 | x1 |
| 10k | 1 | 1 | x1 |

The 4 output signals of D7004 are read by the microprocessor via buffer D7006. This buffer also reads the AUTO SET key and the signals TEST OUT (high if scope is triggered), NOPTION (low for optional trigger facilities) and REMRQN (if low the interface option tells the microprocessor that the scope must go to remote). When the enable inputs pin 1 and 19 are made low by multiplexer D7002, the inputs of the buffer D7006 are read by the microprocessor.

D7002 is the multiplexer that makes a separation between the I2C lines that drive the LCD drivers and the I2C lines for the other circuits. This is controlled by the SEL II C line. If this line is high, the SDA (Serial Data) and SCL (Serial clock) lines control the LCD drivers on LCD unit A8.

D7003 decodes the address lines A8, A9 and A11 into the DLEN (Data Latch Enable) signals that select one of the serial-parallel conversion circuits.

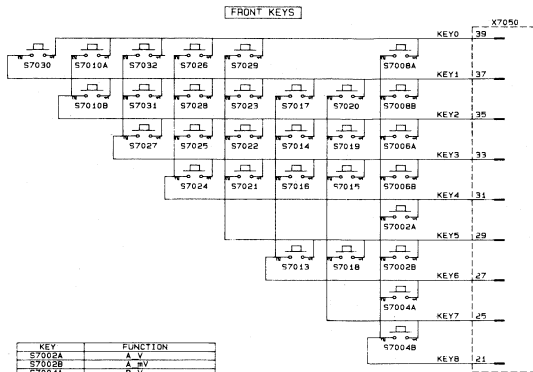
10.3 LCD DISPLAY CIRCUIT

The LCD is driven by three drivers D8001, D8002 and D8003 (PCF8577). The temperature dependent supply voltage VCPCF is 4 V approx. at 25°C. When the temperature increases, this voltage decreases. This is achieved by NTC resistor R7036. As a result the intensity of the LCD is constant over a wide temperature range.

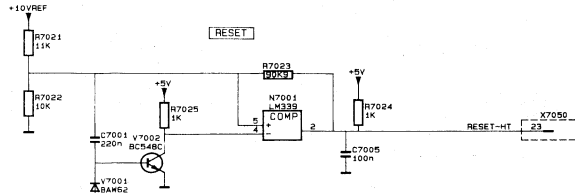
The single-pin built-in oscillator on pin 37 of D8001 provides the modulation frequency for the LCD segment driver outputs. Capacitor C7008 and resistor R7018 are connected to this pin to form the oscillator, with a frequency of 150 Hz approx. Pin 36 and pin 37 are used to determine the LCD driver address in the I²C bus.

The outputs pin 1...pin 32 directly drive the LCD.

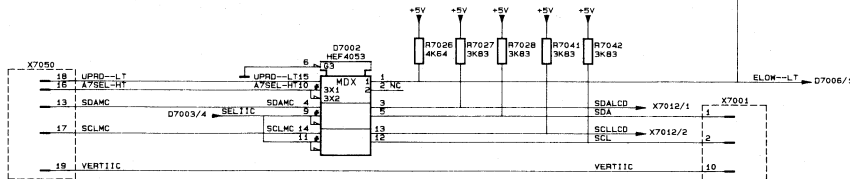
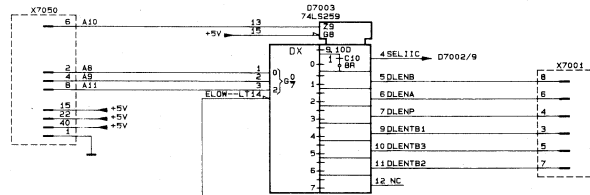
Outputs BP1 and BP2 (pin 33 and pin 34) drive the COMMON pins of the LCD.



| KEY | FUNCTION |
|--------|------------------|
| S7004 | A SV |
| S7002B | A SV |
| S7004A | B SV |
| S7004B | B SV |
| S7004 | TS B |
| S7005B | TS B |
| S7008 | TRIG DEL-- |
| S7008B | TRIG DEL--> |
| S7010A | DISPL PART-- |
| S7010B | DISPL PART--> |
| S7012 | A AUTOSET |
| S7013 | A AC/DC |
| S7014 | A AC/DC |
| S7015 | A V |
| S7016 | ALT/CHDP |
| S7017 | PILOT |
| S7018 | B ADD/INVERT |
| S7019 | B B |
| S7020 | B AC/DC |
| S7021 | TS TRIG MODE |
| S7022 | RESET |
| S7023 | XOFL/LEVEL VIEW |
| S7024 | TS TRIG SOURCE |
| S7025 | TS |
| S7026 | TS TRIG COUPLING |
| S7027 | DIGITAL MEMORY |
| S7028 | LOCK |
| S7029 | XMAGN |
| S7030 | LOAD |
| S7031 | DYSP |
| S7032 | STATUS |

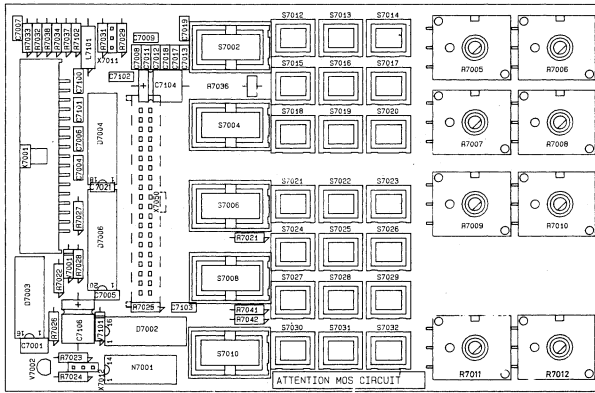


C. BUS DECODER



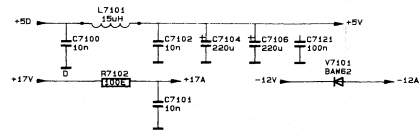
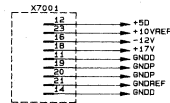
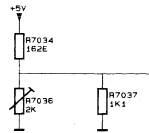
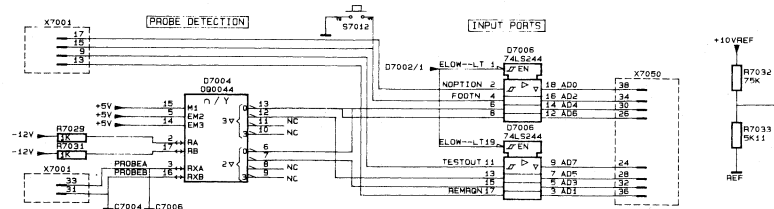
| REF. NO. | TYPE | +5V | -12A | +17A | |
|----------|---------|-----|------|------|----|
| D7003 | 74LS259 | 16 | | | 8 |
| D7002 | 74002 | 16 | | | 8 |
| N7001 | LM339 | | 3 | | 12 |

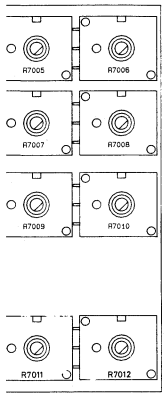
Figure 10.1 Circuit diagram of front unit, key matrix and auxiliary



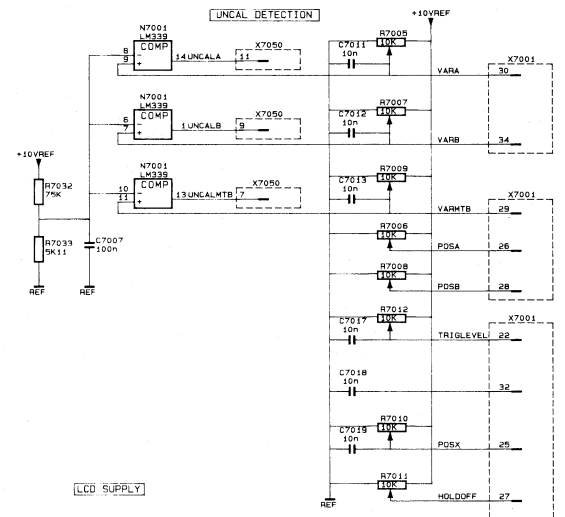
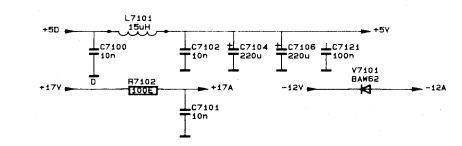
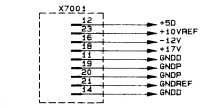
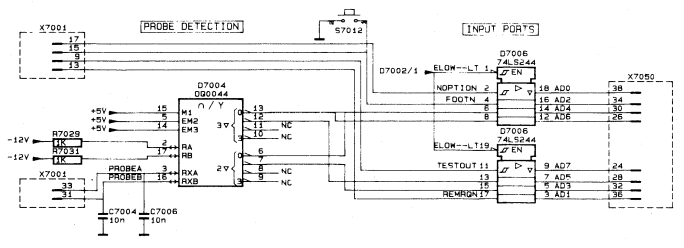
482 245 8170.7
MAT 3627

Figure 10.2 Front unit p.c.b.





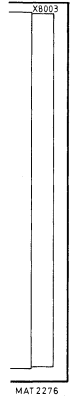
4222 245 0170.7
MAT 3627



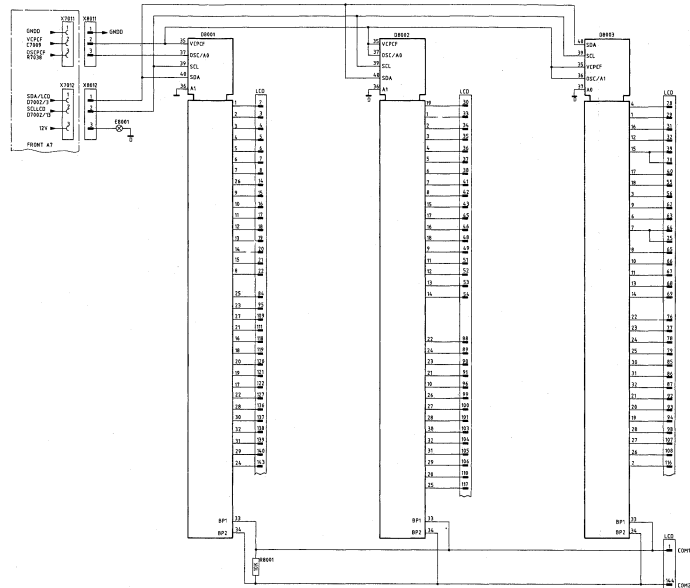
| REF. NO. | TYPE | +5V | +10VREF | +17V | -12V |
|----------|---------|-----|---------|------|------|
| D7004 | D00044 | 4 | 38 | | 4 |
| D7006 | 74LS244 | 2 | 38 | | 10 |
| N7001 | LM339 | 1 | 26 | 3 | 12 |

MAT 3629

Figure 10.3 Circuit diagram of front unit, front controls and probe indication



nit p.c.b.



| REF. NO. | TYPE | QTY |
|----------|---------|-----|
| 0801 | PCF8574 | 30 |
| 0802 | PCF8574 | 30 |
| 0803 | PCF8574 | 30 |

| COMP | LCR | COMP | LCR |
|---------|---------|---------|---------|
| DISPLAY | SEGMENT | DISPLAY | SEGMENT |
| 001 | MC | 001 | MC |
| 002 | MC | 002 | MC |
| 003 | MC | 003 | MC |
| 004 | MC | 004 | MC |
| 005 | MC | 005 | MC |
| 006 | MC | 006 | MC |
| 007 | MC | 007 | MC |
| 008 | MC | 008 | MC |
| 009 | MC | 009 | MC |
| 010 | MC | 010 | MC |
| 011 | MC | 011 | MC |
| 012 | MC | 012 | MC |
| 013 | MC | 013 | MC |
| 014 | MC | 014 | MC |
| 015 | MC | 015 | MC |
| 016 | MC | 016 | MC |
| 017 | MC | 017 | MC |
| 018 | MC | 018 | MC |
| 019 | MC | 019 | MC |
| 020 | MC | 020 | MC |
| 021 | MC | 021 | MC |
| 022 | MC | 022 | MC |
| 023 | MC | 023 | MC |
| 024 | MC | 024 | MC |
| 025 | MC | 025 | MC |
| 026 | MC | 026 | MC |
| 027 | MC | 027 | MC |
| 028 | MC | 028 | MC |
| 029 | MC | 029 | MC |
| 030 | MC | 030 | MC |
| 031 | MC | 031 | MC |
| 032 | MC | 032 | MC |
| 033 | MC | 033 | MC |
| 034 | MC | 034 | MC |
| 035 | MC | 035 | MC |
| 036 | MC | 036 | MC |
| 037 | MC | 037 | MC |
| 038 | MC | 038 | MC |
| 039 | MC | 039 | MC |
| 040 | MC | 040 | MC |
| 041 | MC | 041 | MC |
| 042 | MC | 042 | MC |
| 043 | MC | 043 | MC |
| 044 | MC | 044 | MC |
| 045 | MC | 045 | MC |
| 046 | MC | 046 | MC |
| 047 | MC | 047 | MC |
| 048 | MC | 048 | MC |
| 049 | MC | 049 | MC |
| 050 | MC | 050 | MC |
| 051 | MC | 051 | MC |
| 052 | MC | 052 | MC |
| 053 | MC | 053 | MC |
| 054 | MC | 054 | MC |
| 055 | MC | 055 | MC |
| 056 | MC | 056 | MC |
| 057 | MC | 057 | MC |
| 058 | MC | 058 | MC |
| 059 | MC | 059 | MC |
| 060 | MC | 060 | MC |
| 061 | MC | 061 | MC |
| 062 | MC | 062 | MC |
| 063 | MC | 063 | MC |
| 064 | MC | 064 | MC |
| 065 | MC | 065 | MC |
| 066 | MC | 066 | MC |
| 067 | MC | 067 | MC |
| 068 | MC | 068 | MC |
| 069 | MC | 069 | MC |
| 070 | MC | 070 | MC |
| 071 | MC | 071 | MC |
| 072 | MC | 072 | MC |
| 073 | MC | 073 | MC |
| 074 | MC | 074 | MC |
| 075 | MC | 075 | MC |
| 076 | MC | 076 | MC |
| 077 | MC | 077 | MC |
| 078 | MC | 078 | MC |
| 079 | MC | 079 | MC |
| 080 | MC | 080 | MC |
| 081 | MC | 081 | MC |
| 082 | MC | 082 | MC |
| 083 | MC | 083 | MC |
| 084 | MC | 084 | MC |
| 085 | MC | 085 | MC |
| 086 | MC | 086 | MC |
| 087 | MC | 087 | MC |
| 088 | MC | 088 | MC |
| 089 | MC | 089 | MC |
| 090 | MC | 090 | MC |
| 091 | MC | 091 | MC |
| 092 | MC | 092 | MC |
| 093 | MC | 093 | MC |
| 094 | MC | 094 | MC |
| 095 | MC | 095 | MC |
| 096 | MC | 096 | MC |
| 097 | MC | 097 | MC |
| 098 | MC | 098 | MC |
| 099 | MC | 099 | MC |
| 100 | MC | 100 | MC |

HP912

INV **> 0.0** nV ACDC

A LEVEL VIEW ALT
B ADD CHOP

INV **> 0.0** nV ACDC

NOT TRIG'D ARMED

TB X-DEFL MULTI
AUTO TRIG SINGLE

*** 0.00** ms
> 0.00 μs

MAGN 32481016 X

AEXTBACDC LINE
P-PDCTV LFHF

DIGITAL MEMORY

0.0000 mV

REG STATUS ROLL
LOCK DOTS PLOT
0 1/2 1

REWOTE MENU

| COMP | LCR | COMP | LCR |
|---------|---------|---------|---------|
| DISPLAY | SEGMENT | DISPLAY | SEGMENT |
| 001 | MC | 001 | MC |
| 002 | MC | 002 | MC |
| 003 | MC | 003 | MC |
| 004 | MC | 004 | MC |
| 005 | MC | 005 | MC |
| 006 | MC | 006 | MC |
| 007 | MC | 007 | MC |
| 008 | MC | 008 | MC |
| 009 | MC | 009 | MC |
| 010 | MC | 010 | MC |
| 011 | MC | 011 | MC |
| 012 | MC | 012 | MC |
| 013 | MC | 013 | MC |
| 014 | MC | 014 | MC |
| 015 | MC | 015 | MC |
| 016 | MC | 016 | MC |
| 017 | MC | 017 | MC |
| 018 | MC | 018 | MC |
| 019 | MC | 019 | MC |
| 020 | MC | 020 | MC |
| 021 | MC | 021 | MC |
| 022 | MC | 022 | MC |
| 023 | MC | 023 | MC |
| 024 | MC | 024 | MC |
| 025 | MC | 025 | MC |
| 026 | MC | 026 | MC |
| 027 | MC | 027 | MC |
| 028 | MC | 028 | MC |
| 029 | MC | 029 | MC |
| 030 | MC | 030 | MC |
| 031 | MC | 031 | MC |
| 032 | MC | 032 | MC |
| 033 | MC | 033 | MC |
| 034 | MC | 034 | MC |
| 035 | MC | 035 | MC |
| 036 | MC | 036 | MC |
| 037 | MC | 037 | MC |
| 038 | MC | 038 | MC |
| 039 | MC | 039 | MC |
| 040 | MC | 040 | MC |
| 041 | MC | 041 | MC |
| 042 | MC | 042 | MC |
| 043 | MC | 043 | MC |
| 044 | MC | 044 | MC |
| 045 | MC | 045 | MC |
| 046 | MC | 046 | MC |
| 047 | MC | 047 | MC |
| 048 | MC | 048 | MC |
| 049 | MC | 049 | MC |
| 050 | MC | 050 | MC |
| 051 | MC | 051 | MC |
| 052 | MC | 052 | MC |
| 053 | MC | 053 | MC |
| 054 | MC | 054 | MC |
| 055 | MC | 055 | MC |
| 056 | MC | 056 | MC |
| 057 | MC | 057 | MC |
| 058 | MC | 058 | MC |
| 059 | MC | 059 | MC |
| 060 | MC | 060 | MC |
| 061 | MC | 061 | MC |
| 062 | MC | 062 | MC |
| 063 | MC | 063 | MC |
| 064 | MC | 064 | MC |
| 065 | MC | 065 | MC |
| 066 | MC | 066 | MC |
| 067 | MC | 067 | MC |
| 068 | MC | 068 | MC |
| 069 | MC | 069 | MC |
| 070 | MC | 070 | MC |
| 071 | MC | 071 | MC |
| 072 | MC | 072 | MC |
| 073 | MC | 073 | MC |
| 074 | MC | 074 | MC |
| 075 | MC | 075 | MC |
| 076 | MC | 076 | MC |
| 077 | MC | 077 | MC |
| 078 | MC | 078 | MC |
| 079 | MC | 079 | MC |
| 080 | MC | 080 | MC |
| 081 | MC | 081 | MC |
| 082 | MC | 082 | MC |
| 083 | MC | 083 | MC |
| 084 | MC | 084 | MC |
| 085 | MC | 085 | MC |
| 086 | MC | 086 | MC |
| 087 | MC | 087 | MC |
| 088 | MC | 088 | MC |
| 089 | MC | 089 | MC |
| 090 | MC | 090 | MC |
| 091 | MC | 091 | MC |
| 092 | MC | 092 | MC |
| 093 | MC | 093 | MC |
| 094 | MC | 094 | MC |
| 095 | MC | 095 | MC |
| 096 | MC | 096 | MC |
| 097 | MC | 097 | MC |
| 098 | MC | 098 | MC |
| 099 | MC | 099 | MC |
| 100 | MC | 100 | MC |

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Figure 10.5 Circuit diagram of LCD unit

11. DIGITAL UNIT (A9)

INPUT AMPLIFIERS AND ADC CIRCUIT

This part of the circuit comprises two identical circuits (one for channel A and one for channel B) of which the channel A circuit is explained.

Every circuit incorporates an analog input amplifier followed by an analog into digital converter (ADC). The balanced current signal from V616/V617 (V621/V622 in channel B) on the adaptation unit A16 is applied to the emitters of common base circuit V9011/V9012. The signal currents in every branch are equal (0,1 mA/div) and are in antiphase. Trimming potentiometer R9064 is used for gain adjustment. The biasing currents in both branches are equal. With no signal, the currents through V9011, V9016 and V9012, V9013, V9014 are equal and no current is running towards the base of V9017. V9017 is a shuntfeedback amplifier that converts current into voltage signal. The voltage amplitude is determined by the resistance value of R9083; C9074 limits the bandwidth of this stage. The output voltage of V9017 is applied to pin 8 of the ADC N9001 via emitterfollower V9018. The biasing voltage at the output of the emitter follower is adjusted to +2,5V with offset adjustment R9078. The inputvoltage range of the ADC lies between +1,6 and +3,4V.

The emitter of common base transistor V9013 is always at +0,6V which is identical to the base voltage of V9017. The transistors V9014, V9016 serve as a current mirror: if due to signal the current applied to V9011 sinks with e.g.0,1 mA the current in V9012 rises with the same amount. The current mirror on its turn adds this signal current and as a result the current in R9083 increases with 0,2 mA.

The ADC has 8 bits of output information coded AQDB00 (least significant bit)... AQDB07 (most significant bit) for channel A. For channel B the 8 bits are coded AQDB10 (least significant bit) ... AQBD17 (most significant bit). If pin22 (enable ADC) is low, the ADC can convert the analog input signal at pin 8 into digital at the moment that pin 16 (start conversion) goes from low to high level.

11.2 ACQUISITION MEMORIES

This diagram incorporates the 8K acquisition memory. The memory is loaded with the output information of the two ADC's. In dual channel mode the channel A ADC output (AQDB00 ... 07) is providing the information that is loaded into the 4K memory D9031, D9032. The channel B ADC information is loaded into the other 4K memory D9033, D9034. The information is loaded into the memory if pin 18 (Chip Select RAM) and pin 21 (write acquisition) are both low. The 12 bit memory address (necessary to address 4K) is AQAB00 (least significant bit) ... AQAB11 (most significant bit). This address is generated by an address generator that is present on the acquisition control logic. With address line AQAB11 low the memories D9031 and D9033 are enabled. Via inverter D9023/5,6 the memories D9032 and D9034 are enabled if address line AQAB11 is high.

If only one channel is selected, the full 8K memory is available for that channel. If channel A is selected, the 4K memory D9031, D9032 is loaded and then via bidirectional buffer D9035 the 4K memory D9033, D9034. If channel B is selected, the 4K memory D9033, D9034 is loaded and then via bidirectionalbuffer D9035 the 4K memory D9031, D9032. The bidirectional buffer is controlled by or gate D9030/9,10,8. The input signals for these gates are explained on the next circuit diagram where they are generated. The output signals ENAD1-LTand ENAD2-LT are the enable signals for ADC 1 and ADC 2.

The contents of the acquisition memory can be transferred to the instrument's display section via the two-position multiplexers D9036, D9037. Depending on the state of pin 1 of the multiplexers (select databus) either the information from D9031, D9032 (pin 1 low) or the information from D9033, D9034 (pin 1 high) is transferred. When reading the contents of the acquisition memories their control input pin 20 is low and pin 21 is high.

11.3 ACQUISITION CONTROL LOGIC

The acquisition control logic plays the central role in the signal acquisition:

it generates all the necessary control signals for the ADC's, the acquisition memories, two counters and the exchange of data from acquisition part to the display part of the instrument. The diagram comprises two counters. Counter 1 consists of the 4-bit counters D9053, D9054, D9056 and D-flipflop D9049. This counter can only count upwards and can be preset to 0000 by control signal RSCN1-LT (reset counter 1) because its data inputs are connected to 0V. The clockpulse for counter 1 is CKCN1 (clockpulse counter 1). Counter 2 consists of the 4-bit counters D9061, D9062, D9063 and D9064. This counter can be preset to a certain preset value by control signal LDCN2-LT (load counter 2). This 13-bit preset value comes from the outputs of the latches D9058, D9059. These latches are loaded in advance by the instrument's microprocessor via the control signals CKPR1 (clock pretrigger) and CKPR2. Moreover counter 2 can count up or down: this is controlled by the signal UPDO (up/down). The counter counts up with UPDO being low and its counts down with UPDO high. Both counters have a range of 0 ... 4K in dual channel mode: two 4K memories for respectively channel A and B are addressed in parallel. The range in single channel mode is 8K because the two 4K memories are placed behind each other so that 8K must be addressed by the counter. The two-position multiplexers D9066, D9067 and D9068 select the address for the acquisition memory: this can be either the outputs of counter 1 (SLAQAB/selectacquisition address bus = low) or the outputs of counter 2 (SLAQAB = high).

The acquisition system can take in information in two different modes that depend on the TIME/DIV setting of the instrument. The modes are D1 mode for 10 μ s ... 1ms/div and D2 for 2ms ... 50s/div. The difference between the two modes is that in the D2 mode the waveform is built up on the CRT screen while the acquisition is busy taking-in signal samples.

Working principle of D1 mode (refer to timing diagram, the signals SState0 and SState1 are also given because they can serve as a reference):

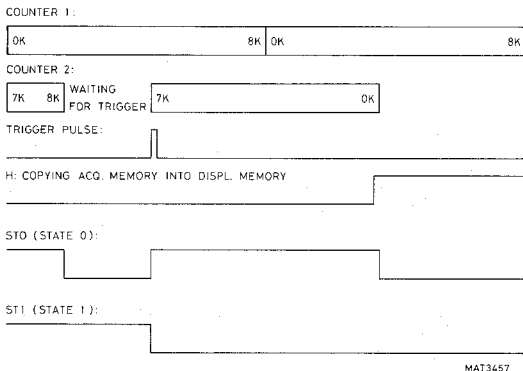


Figure 11.1 States of counter 1 and counter 2

The acquisition starts after reset of counter 1 to 0000 and after it has preset counter 2 to the so-called precharge-value. This value depends on the adjusted pretrigger value. If this value is e.g. -3 div, the precharge-value is in single channel $8192 - (3 * 400) = 6992$ (7K approx) because 1 div equals 400 samples then. In dual channel the value is $4096 - (3 * 200) = 3496$ because 1 div equals 200 samples then. The now following example is based upon a pretrigger value of -3 div in single channel mode:

the acquisition starts with counter 1 at 0000 and counts upwards so that the digitized signal samples from the ADC are placed in successive acquisition memory locations. At the same time counter 2 counts up from the precharge value towards 8192. The system can not trigger during this period; this assures that at least 3 div of signal are stored in memory before a trigger can occur. The clockpulse frequencies for counter 1 and 2 are equal during this mode. At the moment that counter 2 has reached 8192, it is reset to the precharge value (in this example 6992) and switched to count down mode. The system now is able to get triggered and stands waiting for a trigger pulse. This trigger pulse comes as "DSO TRIG SIGNAL" from connector X411 on the time base. It is applied to X9011 and consequently to D9050/pin13. Inbetween counter 1 goes on counting up and addressing successive acquisition memory locations. Counter 2 starts to count down from 6992 ... 0000 if the trigger occurs. This goes on until the value 0000 is reached: now counter 2 and also counter 1 stop. This is the moment that the acquisition memory contents are copied into the display memory. How this is done will be explained on the next diagram "display logic". However bear in mind that the copying of the acquisition memory starts at the counter 1 address succeeding to the address where the acquisition stopped. The acquisition memory contents are copied into the display memory locations starting with address 0000 and onwards. The copy action stops if the display memory has received 8K signal samples. After this a new acquisition stroke starts, and so on. However after a reset command in single (multiple) shot mode, only 1 (2) acquisition stroke is performed.

Working principle of D2 mode:

the start of the acquisition stroke is identical to the D1 mode. The various circuits are preset by the microprocessor, counter 2 counts up the precharge value and then the system can react on a trigger. If this trigger occurs, the system proceeds in a way different from D1 mode: while counter 1 keeps on writing in signal samples in the acquisition memory, counter 2 is generating addresses that read the acquisition memory in order to copy this information into the display memory. In this mode the address multiplexer D9066, D9067, D9068 of the acquisition memory switches between counter 1 (ADC information is written in) and counter 2 (acquisition memory copied into display memory).

The remaining circuitry on this diagram is control circuitry. Among this circuitry are FPLA (field programmable logic array) D9048 and PAL (programmable array logic) D9047.

The FPLA and the PAL can both be regarded as a programmed read only memory where a certain combination of inputs results in a combination of outputs. The relation between in- and outputs is determined by the way the device has been programmed. The difference between PAL and FPLA lies in the internal programming possibilities of both devices.

The FPLA D9048 produces a number of control signals: STCV is used for the ADC's, WRAQ--LT is used via multiplexer D9064 to control the acquisition memories, SLAQAB controls the write/read address multiplexer, RSCN1-LT and CKCN1 control the write counter, ENADOTLT (enable ADC output) is used for the ADC's, UPD0 and CKCN2 control the read counter, OTENRALT (output enable RAM) enables the acquisition memory.

The PAL D9047 produces also a number of control signals. ST0 (state 0) and ST1 represent the four different modes of the acquisition system. These modes are:

- counter 2 counting up the precharge value.
- system stands waiting for a trigger.
- counting down after the trigger until the information transfer starts.
- information transfer from acquisition memory to display memory.

Other PAL output signals are: LDCN2 (load counter 2), SLDB (select databus) used on circuit diagram "acquisition memories", CKDPL (clock display latch) used for information transfer on circuit diagram "display logic" and ST3 (state3) that controls FPLA D9048.

The latches D9059, D9052 generate control signals such as: the acquisition mode signals D1 and D2, the DUAL channel mode signal, TBM00/TBM01/TBM02 for digital time base control and LCHA/LCHB for single channel mode with channel A or B.

11.4 DISPLAY LOGIC

The heart of this diagram is formed by the 32k display memory D9039. This IC of which half the capacity is used, incorporates the 8K display memory and the 8K register memory. In single channel mode 8K is used for the trace of one channel. In dual channel mode the even addresses of 8K are used for channel A and the odd addresses for channel B. The addresses for the display memory are generated by the ASIC (application specific IC) D9072. This device incorporates 3 address counters. Every counter has 12 bits and can address 4K of memory.

There are two additional static address lines that are set by the microcomputer so that 16K can be addressed as a total. The output of one counter is available at a time at the outputs DPAD00 ... DPAD14. The counter to be active at the outputs is determined by the control signals SC00, SC10 (select counters). The outputs DPAD13, DPAD14 are static bits and not derived from the counter outputs. The function of the three counters is now explained for the various modes that are possible. The three counters are used for (1) memory addressing during signal transfer from acquisition to display section, (2) memory addressing during the display cycle, (3) horizontal deflection during the display cycle and (4) transfer from display to register memory respectively.

Information transfer from acquisition to display memory. The acquisition brings the signal samples one by one into latch D9038 via CKDPL (clock display latch). CKDPL is also applied to the control logic so that the display part knows that information is available. This information is taken from the latch by OTENDPLT (output enable display) and loaded into the D9039 memory address determined by the 4K counter in D9072, divide-by-two stage D9073 (total address range 8K) and multiplexer D9074. The timing of this action is given in the diagram below where two transfers are given:

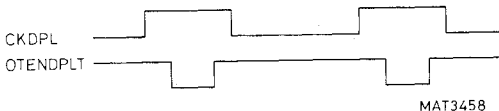


Figure 11.2 Timing diagram of signal transfer

If the display section has taken the signal sample it makes OTENDPLT high again. This is signalled to the acquisition control logic that makes CKDPL low again. Now a new signal sample can be transferred between the acquisition part and the display part. The two parts are independent and have their own systemclock (20 and 8MHz). The process that is shown can be regarded as a handshake process.

Signal display.

The display of signal means that the contents of a certain D9039 display/register memory location is converted into vertical and horizontal deflection. The vertical deflection is initiated by 8 bits DPDB00 ... DPDB07 from a certain addressed memory location. These 8 bits are applied to the Y DAC (digital to analog converter) via the multiplexers D9043, D9044. With the multiplexers in opposite position text and cursors are displayed.

The horizontal deflection is initiated by 10 bits DPAD02 ... DPAD11 that are applied to the X DAC via multiplexers D9078, D9077, D9076. With the multiplexers in opposite position text and cursors are displayed. There are 4K signal samples for one CRT screen and only 1K (equals 10 bits) for horizontal addressing. This means that at every horizontal position 4 signal samples are displayed. Now the role of the counters in D9072 on the display cycle: one counter addresses 4K out of the 32K memory range. For this purpose 15 bits are necessary: 14 bits from the counter inside D9072 and 1 bit DPAD12 from Dflipflop D9049. The counter inside D9072 is presettable because of the instrument's display part function. The contents of the addressed memory location is placed in latch D9041. Now the counter inside D9072 that is responsible for the X deflection is applied to the outputs. Ten bits of information DPAD02 ... DPAD11 are applied via multiplexers to the X DAC. This counter must be able to count in steps of 1, 2, 4, 8, 16, 32 or 64. This inconnection with the instrument's X EXPAND functions. Now the contents of latch D9041 is applied to the Y DAC while counter D9072 output determines the horizontal position of the dot on the screen via the X DAC.

Copying information from display memory into register:
 during this action the acquisition is stopped and there is no signal display on the instrument's screen. During this action two counters inside D9072 get temporarily a different function. One counter addresses the display memory location from where a signal sample must be copied. This sample is temporarily stored in latch D9041. The other counter addresses the register memory location to where the sample must copied.

Direct access of microprocessor into display/register memory:
 the microprocessor is able to address all memory locations directly via the latches D9069, D9071 via control signal CPUEN (CPU enable). The data from the addressed memory location is accessible via bidirectional latch D9042. This makes it possible for the microprocessor to read and to write into the memory.
 This is necessary if the oscilloscope is controlled via the (optional) communication interface (reading from or writing into the memory) or when the RESET key is pushed (1000 0000 is written into the memory).

11.5 DAC CIRCUITS

This diagram incorporates the (vertical) Y DAC and the (horizontal) X DAC and their output amplifiers. For the Y section a 8 bits DAC is used. It has 2 outputs delivering a balanced current output signal that is applied to an amplifier stage V9107, V9108 with gain and offset adjustments. The signal current in each output branch is 0,1 mA/div and is applied to D602/pin 5 and 6 on adaptation unit A16. The circuit with V9102 and V9106 has all transistors in conductive state in the dot join mode because signal TRAMO-HT (trace mode) is high then. The circuit switches on low pass circuits by activating the capacitors C9102 (lowpass with R9107), C9103 (low pass with R9112), C9104 (low pass with R9108) and C9106 (low pass with R9113). The low pass filters give the result that the spot on the screen between one sample and the next one moves gradually. With the low pass filters not activated, the spot moves in steps.

For the X section a 10 bits DAC is used. It has two outputs delivering a balanced current output signal of which one is not used and connected to 0V. The other output is applied to V9119 that converts current into voltage. This voltage signal (range 0 ... 6V) is applied to the time base unit A4 via emitter follower V9121. Also the X deflection circuit has a smoothing circuit for the dot join mode. This circuit comprises V9122 that switches on C9111, C9112. The working principle is identical to the corresponding circuit in the Y deflection part.

11.6 DISPLAY AND TIME BASE CONTROL

This diagram comprises the digital time base and logic for display control.

The digital time base is driven by 40MHz X-tal oscillator G9001. The 40MHz output signal is divided by two cascaded D-flipflops D9003 so that 20 and 10MHz square waves are available. Divider D9002 divides the 40MHz signal into 4 and 8 MHz signals for the the digital time base. The signals of 20, 10, 8 and 4 MHz are used for the fastest sweep speeds. They can be selected via multiplexer D9006. This multiplexer is controlled by address lines TBMO0, TBMO1, TBMO2 that come from latch D9052 on circuit diagram "acquisition control logic". The 20MHz signal is used for 10 and 20us/div in single channel. For 20us/div dual channel 10MHz is used. 8MHz (4MHz) is used for 50us/div in single (dual) channel mode.

The 8MHz signal is also routed to a programmable divider D9004. Output pin 10 of this device is used for sweep speeds 0,5ms ... 0,5 s/div. This output signal is applied to the input (pin 15) of a second divider that makes the sweep speeds 1 ... 50 s/div. The programmable divider is controlled by the microcomputer via the data lines ABDB00 ... ABDB07 and the address lines UPAD00, UPAD01. Other control lines from the microcomputer are UPWR (microprocessor write) and CSTB (chip select time base).

The display control logic:

this part of the circuit generates the control signals for the display section.

The circuit is controlled by the microcomputer data bits ABDB00 ... ABDB06 via latch D9024. The latch is loaded with the information on the data bus via signal CKDSP-LT (clock display). Because the display system works asynchronously from the microcomputer, the latch D9024 is followed by a second latch D9026 that is read out by the signal SCL0 that is synchronous with the 8MHz clock of the display control logic. The control signals that are generated by the two PAL's D9027, D9028 and multiplexer D9029. A PAL is a programmable array logic of which the function is already discussed during the explanation of circuit diagram of acquisition control logic. The multiplexer D9029 is enabled indigital memory mode (MEMON-LT low). The multiplexer positions are determined by TRAMO-HT (trace mode; H if signals are displayed, L if text/cursors are displayed). D9029 makes two output signals of which ZCONTR-LT is used to determine the intensity of the spot on the screen via V4618 on the time base. A low level switches the display on. This level is determined by ZCONTR (signal display) or by ZTENO (text/cursor display). This last signal comes from the text/cursor generator.

The other D9029 output signal XYDTCLLT switches the multiplexers D9043 ... D9076 that switch the Y and X deflection in memory on between signal and cursor/text display. This signal is the 10MHz clock in case of text/cursor display and XYDTCL in case of signal display. The most important output signals that are generated in the display control logic are:

- CPUEN-LT: L enables the display RAM so that the microcomputer can read/write into it.
 - STYDT-LT, RTYDT-LT, YDTCL-HT: L gives set/reset to flipflop D9049 in display RAM section. The clock is YDTCL-HT.
 - SLDPRALT: L selects display RAM D9039.
 - CNTCL-HT: clockpulse for transfer counter D9073.
 - OTENDPLT: L transfers acquisition memory information from latch 9038 into display RAM D9039.
 - DPRAWRLT: L enables display RAM D9039
 - CKCPL-HT, ENCP1-LT: clock and enable pulse for copy latch D9041 for copying from display into register memory.
- The most important input signals are:
- TCCPCNHT: H if terminal count occurs of counter that controls transfer from acquisition to display memory.
 - LOCK: H if system is in locked mode.
- The following timing signals are used:

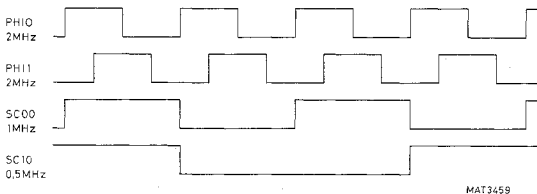


Figure 11.3 Timing diagram display and time base control

The supply voltage for the IC's D9014 (microprocessor RAM), D9046 (switch IC), D9039 (display memory/register) is coming from the +5V power supply via diode V9002 and V9003 if the line voltage is on. If the line voltage is off, the supply is coming from a back-up battery via diode V9001 (BAVO).

11.7 CPU LOGIC

This diagram comprises two main parts: the microcomputer and the textgenerator. The microcomputer consists of the 8 bit microprocessor D9012 with a read-only memory D9013 and a random access memory D9014. The address and databits UPADB00 ... UPADB07 of the microprocessor are combined and the address information is separated by the latch D9016 under control of the signal ALE (address latch enable). The read-only memory is enabled by the signal PSE(program store enable) that is generated by the microcomputer. The random access memory is enabled by signal CSUPRALT (chip select microprocessor RAM) and controlled by either UPRD--LT (microprocessor read) or UPWR--LT(microprocessor write). The buffer D9018 that is enabled by signal SFTKY-LT(softkey) permits the microcomputer to read the five softkeys under the CRT and the uncal positions of the verniers of channel A, B and time base. The buffer D9017 is used as a buffer because of the maximum fan-out of the processor.

The text generator D9079 is written in by the microprocessor by the databits ABDB00 ... ABDB07 and the address bits UPAD08, UPAD09 via the commands UPWR andTXTSL-LT (text select). The text generator uses the same 10MHz clock signal as the microcomputer. Output signals of the text generator are 10 bits TXDB00 ...TXDB09 that are used for horizontal positioning of the text and 8 bits Y2 ...Y9 that are used for vertical positioning. The signal ZTENO determines the intensity when text is written. The text generator is functioning under control of the microprocessor in a display cycle where 9,5 ... 10 ms is reserved for writing text/cursors, then 9 ms to write signal and then text/cursors, and so on.

The remaining circuitry on this diagram consists of decoding circuitry. D9019 incorporates two demultiplexers. Depending on a two bit address, one out of the four output lines is low if the enable output is low. D9021 is a demultiplexer with 8 outputs of which one is low at a time depending on a three bit address and if two enable lines are low and one line is high. Some of the control signals that are generated in this circuit are:

- CSDSP-LT (chip select display): enables the latch D9042 that gives the microcomputer direct access to the display/register memory.
- DPCNT-LT (display counter chip select): microcomputer can write data into display counter D9072.
- RSCPCNLT: reset pulse for the counter that controls the data transfer between acquisition and display memory.
- OPTWR-LT (option write):
- TXTSL-LT (text select): microcomputer can enable text generator via this line.
- CKMOR (clock mode register): clockpulse for latch D9052 that serves as mode register in acquisition control logic.
- CSTB--LT (chip select time base): chip select for time base IC D9004.
- CKPR1, CKPR2 (clock preset 1/2): clock pulse for latches that are loaded with the preset value for a 8K counter on the acquisition control logic.
- CKDSP-LT: clock pulse for latch D9024 on display mode control logic.

11.8 SIGNAL NAME LIST

| Signal Name | Description | Signal Source | Signal Destination |
|-------------|------------------------|---------------|---|
| 1CHA | Single channel A | D9052 | D9030, D9035 |
| 1CHB | Single channel B | D9052 | D9030 |
| BR | Bank read | D9064 | D9047 |
| CK08M | 8 MHz clock | D9002 | D9004, D9006 D9027, D9028 |
| CK10M | 10 MHz clock | D9003 | D9006, D9012, D9029, D9079 |
| CK20M | 20MHz clock | D9003 | D9003, D9006, D9047 |
| CKCN1 | Clock counter 1 | D9048 | D9053, D9054, D9056 |
| CKCN2 | Clock counter 2 | D9048 | D9061, D9062, D9063, D9064 |
| CKCPL-HT | Clock copy latch | D9028 | D9041 |
| CKDPL | Clock display latch | D9047 | D9027, D9038, D9048 |
| CKDSP-LT | Clock display register | D9021 | D9024 |
| CKMOR | Clock mode register | D9021 | D9052 |
| CKPR1 | Clock preset 1 | D9021 | D9058 |
| CKPR2 | Clock preset 2 | D9021 | B9059 |
| CNTCL-HT | Count clock | D9082/8 | D9072, D9073 |
| CNTCL-LT | Count clock | D9027 | D9082/9 |
| CNTOF-HT | Count overflow | D9072 | D9073, D9028, D9082/5 |
| CPUEN-HT | CPU enable | D9026 | D9023, D9027, D9028, D9072, D9074 |
| CPUEN-LT | CPU enable | D9023 | D9069, D9071 |
| CSDSP-LT | Chip select display | D9022/3 | D9022, D9042 |
| CSTB-LT | Chip select time base | D9021 | D9004 |
| CSUPRALT | Chip select uP RAM | D9046/3 | D9014, D9047 |

| Signal Name | Description | Signal Source | Signal Destination |
|-------------|-----------------------------|---------------|--|
| D1 | Tb mode 20us...2ms/div | D9052 | D9047, D9048 |
| D2 | Tb mode 5ms...50s/div | D9052 | D9047, D9048 |
| DPCNT-LT | Display counter chip select | D9019 | D9072 |
| DPRAWRLT | Display RAM write | D9022/11 | D9039 |
| DSPEN-HT | Display enable | D9026 | D9027, D9028 |
| DSPWR-LT | Display write | D9019 | D9022/2, D9022/13 |
| DUAL | Dual trace mode | D9052 | D9030, D9047, D9048, D9051 |
| ENAD1-LT | Enable ADC 1 | D9030 | N9001 |
| ENAD2-LT | Enable ADC 2 | D9030 | N9002 |
| ENADOTLT | Enable ADC output | D9048 | D9030/10, 2, 4 |
| ENCPL-LT | Enable copy latch | D9028 | D9041 |
| LDCN2-LT | Load counter 2 | D9047 | D9061, D9062, D9063, D9064 |
| LOCK--HT | Lock mode of system | D9026 | D9027 |
| MEMON-HT | Memory on | D9059 | D9023/13 |
| MEMON-LT | Memory on | D9023/12 | D9029 |
| OPTRQ-LT | Option request | D9046 | D9012, X9050 |
| OPTWR-LT | Option write | D9021 | X9050 |
| OTENDPLT | Output enable display | D9027 | D9038, D9050 |
| OTENRALT | Output enable RAM | D9048 | D9031, D9032, D9033, D9034 |
| PSE--LT | Program store enable | D9012 | D9013 |
| REGEN-HT | Register enable | D9026 | D9027, D9028 |
| RESET-HT | Reset power on | X9050 | D9012, D9046/8 |
| RESET-LT | Reset power on | D9046/9 | D9046/5, D9024, D9026, D9046/13, D9079, D9045 |
| RSCN1-LT | Reset counter 1 | D9048 | D9049, D9053, D9054, D9056 |

| Signal Name | Description | Signal Source | Signal Destination |
|-------------|-------------------------------|---------------|-------------------------------|
| RSCPCNLT | Reset CP counter | D9021 | D9073 |
| RTYDT-LT | Reset Y D-flipflop | D9026 | D9049 |
| SC00 | Select counter | D9027 | D9028, D9072, D9074 |
| SC10 | Select counter | D9027 | D9028, D9072, D9073, D9074 |
| SCL | Serial clock | D9012 | D9082 X9050 |
| SDA | Serial data | D9012 | X9050 |
| SFTKY-LT | Softkey select | D9019 | D9018 |
| SLAQAB | Select aquisition address bus | D9048 | D9066, D9067, D9068 |
| SLDB | Select databus | D9047 | D9036, D9037, D9048 |
| SLDPRALT | Select display RAM | D9022/6 | D9046/1 |
| ST0 | State 0 | D9047 | D9048 |
| ST1 | State 1 | D9047 | D9048 |
| ST2 | State 2 | D9047 | D9048 |
| STCV | Start conversion | D9048 | D9050, N9001 N9002 |
| STYDT-LT | Set Y D-flipflop | D9026 | D9049 |
| TBCK | Time base clock | D9006 | D9048 |
| TBM00 | Time base mode 00 | D9052 | D9006 |
| TBM01 | Time base mode 01 | D9052 | D9006 |
| TBM02 | Time base mode 02 | D9052 | D9006 |
| TCCN1-LT | Terminal count counter 1 | D9057/12 | D9049 |
| TCCN2-LT | Terminal count counter 2 | D9057/6 | D9050 |
| TCCPCNHT | Terminal count copy counter | D9073 | D9023, D9027, D9047 |
| TCCPCNLT | Terminal count copy counter | D9023/8 | D9012 |
| TCD1 | Terminal count D-flipflop 1 | D9049/9 | D9050, D9051 |
| TCXD | Terminal count X data | D9028 | D9027 |

| Signal Name | Description | Signal Source | Signal Destination |
|-------------|-------------------------|---------------|--|
| TRAMO-HT | Trace mode (txt/signal) | D9059 | D9029, D9043, D9044, D9076 D9077, D9078 V9101 |
| TXISL-LT | Text select | D9021 | D9079 |
| UPDO | Up /down counter 2 | D9048 | D9061, D9062, D9063, D9064 |
| UPRD--LT | Microprocessor read | D9012 | D9014, D9017, D9017, D9019, D9042, X9050 |
| UPWR--LT | Microprocessor write | D9012 | D9004, D9014, D9019, D9079, D9082 |
| VERTIIC | Vertical IC | D9012 | X9050 |
| WRAQ--LT | Write acquisition | D9048 | V9003, D9049 |
| WRAQ1-LT | Write acquisition 1 | D9051 | D9031, D9032 |
| WRAQ2-LT | Write acquisition 2 | D9051 | D9033, D9034 |
| WRB--LT | Write buffer | D9082/3 | D9072 |
| XPOSCAL | X position calibrated | D9059 | X9016 |
| XYDTCLLT | X/Y data clock | D9029 | D9043, D9044, D9076, D9077, D9078 |
| YDTCL-HT | Y D-flipflop clock | D9023/10 | D9049 |
| ZCNTR-LT | Z control | D9029 | V9004 |
| ZTEN0 | Z text enable | D9079 | D9029 |
| ABDB00//07 | Buffered uP data bus | D9017 | D9004, D9014, D9018, D9024, D9042, D9052, D9058, D9059, D9072, D9079 |
| AQAB00//03 | Acquisition address bus | D9066 | D9031, D9032 D9033, D9034 |
| AQAB04//07 | Acquisition address bus | D9067 | D9031, D9032, D9033, D9034 |
| AQAB08//10 | Acquisition address bus | D9068 | D9031, D9032 D9033, D9034 |
| AQAB11 | Acquisition address bus | D9068 | D9031, D9033 D9023/5 |

| Signal Name | Description | Signal Source | Signal Destination |
|--------------|--------------------------|----------------|-------------------------------|
| AQDB00//03 | Acquisition data bus | N9001 | D9031, D9032, D9035, D9036 |
| AQDB04//07 | Acquisition data bus | N9001 | D9031, D9032, D9035, D9037 |
| AQDB10//13 | Acquisition data bus | N9002 | D9033, D9034 D9035, D9036 |
| AQDB14//17 | Acquisition data bus | N9002 | D9033, D9034 D9035, D9037 |
| AQDBAB00//03 | Acquisition data bus A/B | D9036 | D9038 |
| AQDBAB04//07 | Acquisition data bus A/B | D9037 | D9038 |
| DPAD00,01 | Display address | D9069 | D9039, D9072 |
| DPAD02,03 | Display address | D9069 | D9039, D9072 D9078 |
| DPAD04//07 | Display address | D9069 | D9039, D9072 D9077 |
| DPAD08//11 | Display address | D9071 | D9039, D9072 D9076 |
| DPAD12//14 | Display address | D9071 | D9039, D9072 |
| DPDB00//03 | Display data bus | D9038 D9042 | D9039, D9041 D9043 |
| DPDB04//07 | Display data bus | D9038 D9042 | D9039, D9041 D9044 |
| DXDB00,01 | Deflection X data bus | D9078 | N9004 |
| DXDB02//05 | Deflection X data bus | D9077 | D9004 |
| DXDB06//09 | Deflection X data bus | D9076 | D9004 |
| DYDB00//03 | Deflection Y data bus | D9043 | D9003 |
| DYDB04//07 | Deflection Y data bus | D9044 | D9003 |
| PRAB00//03 | Pretrigger address bus | D9058 | D9061 |
| PRAB04//07 | Pretrigger address bus | D9058 | D9062 |
| PRAB08//11 | Pretrigger address bus | D9059 | D9063 |
| PRAB12 | Pretrigger address bus | D9059 | D9064 |

| Signal Name | Description | Signal Source | Signal Destination |
|-------------|-----------------------------|---------------|---|
| RDAB00//03 | Read address bus | D9061 | D9066 |
| RDAB04//07 | Read address bus | D9062 | D9067 |
| RDAB08//11 | Read address bus | D9063 | D9068 |
| TXDB00,01 | Text X data bus | D9079 | D9078 |
| TXDB02//05 | Text X data bus | D9079 | D9077 |
| TXDB06//09 | Text X data bus | D9079 | D9076 |
| TYDB02//05 | Text Y data bus | D9079 | D9043 |
| TYDB06//09 | Text Y data bus | D9079 | D9044 |
| UPAD00,01 | Microprocessor address | D9016 | D9004, D9013, D9014, D9069, D9072 |
| UPAD02 | Microprocessor address | D9016 | D9013, D9014, D9069 |
| UPAD03//07 | Microprocessor address | D9016 | D9013, D9014, D9069 |
| UPAD08//11 | Microprocessor address | D9012 | D9013, D9014, D9071, D9079, X9050 |
| UPAD12 | Microprocessor address | D9012 | D9013, D9014, D9021, D9071 |
| UPAD13 | Microprocessor address | D9012 | D9013, D9021, D9071 |
| UPADB00//07 | Microproc. address/data bus | D9012 | D9013, D9016, D9017, X9050 |
| WRAB00//03 | Write address bus | D9053 | D9066 |
| WRAB04//07 | Write address bus | D9054 | D9067 |
| WRAB08//11 | Write address bus | D9056 | D9068 |

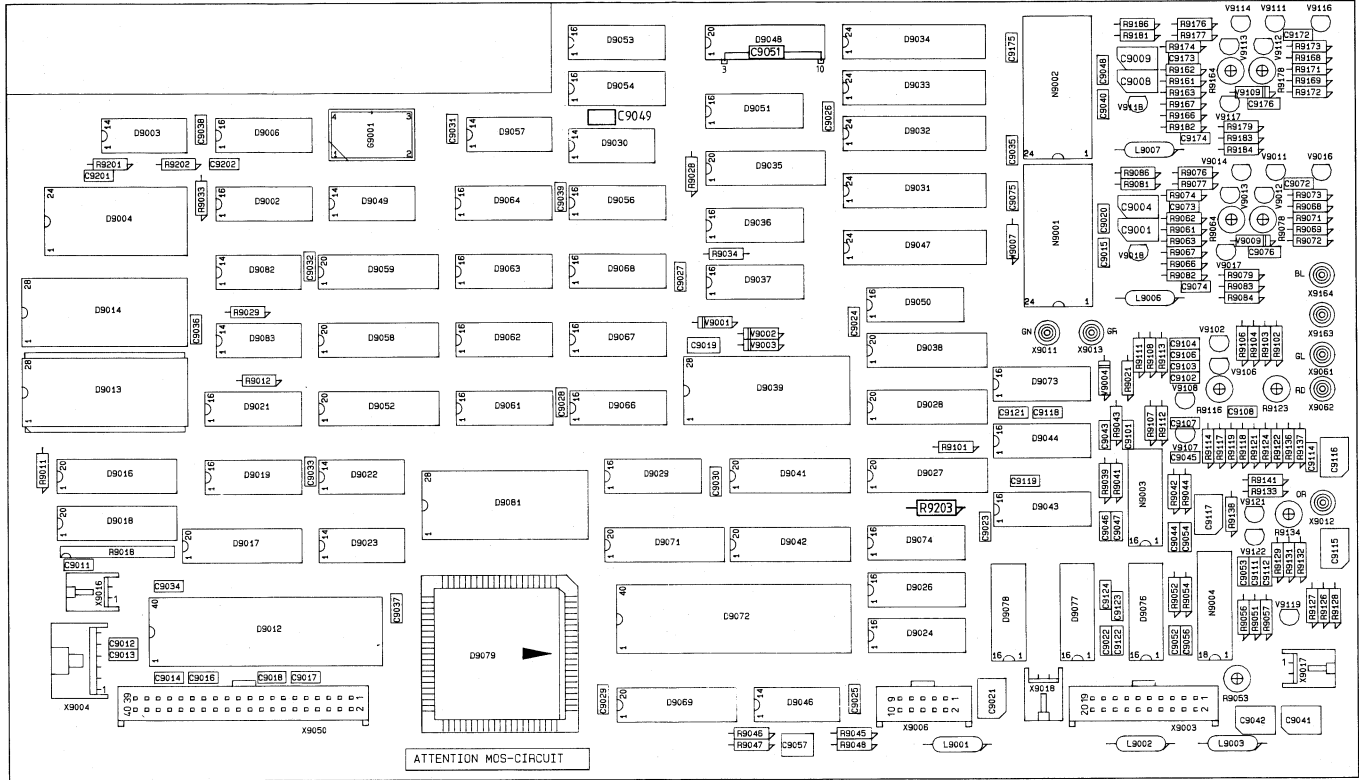


Figure 11.4 Digital unit, p.c.b. lay-out

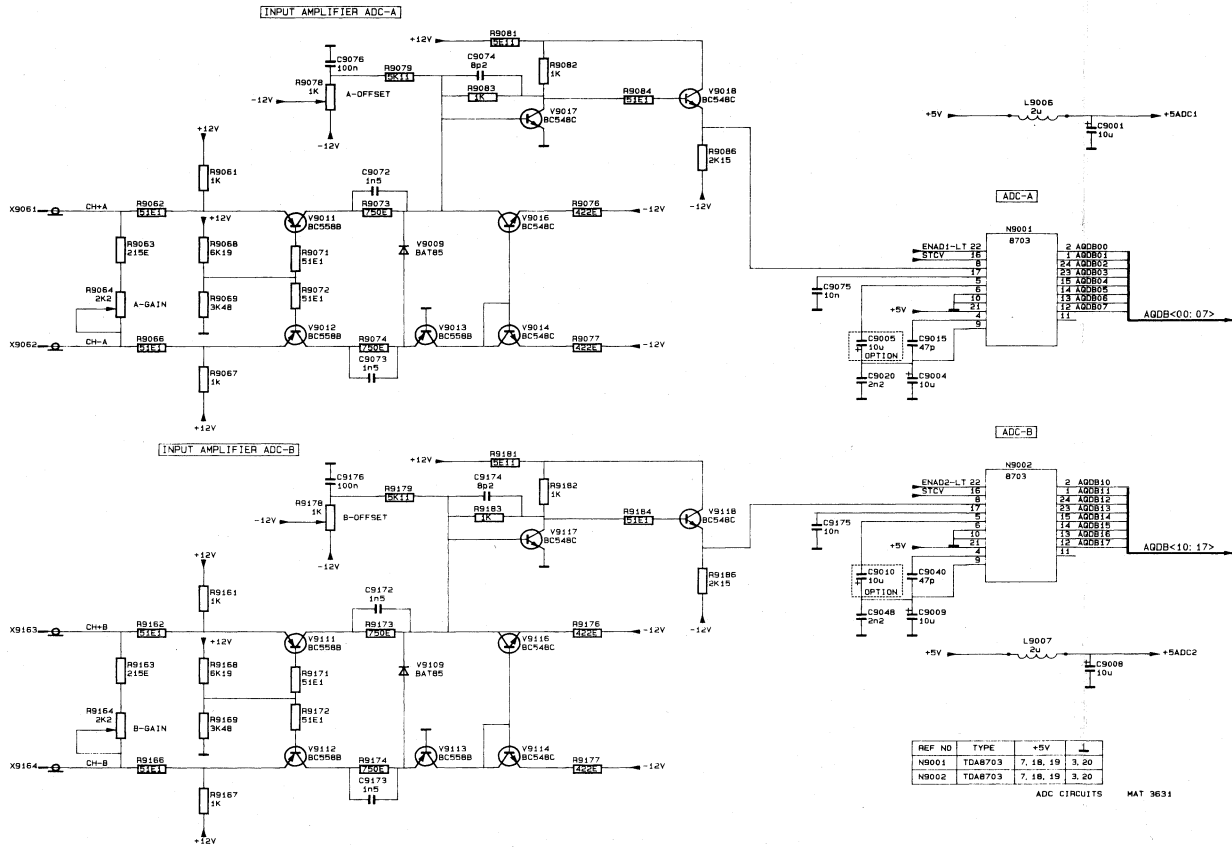
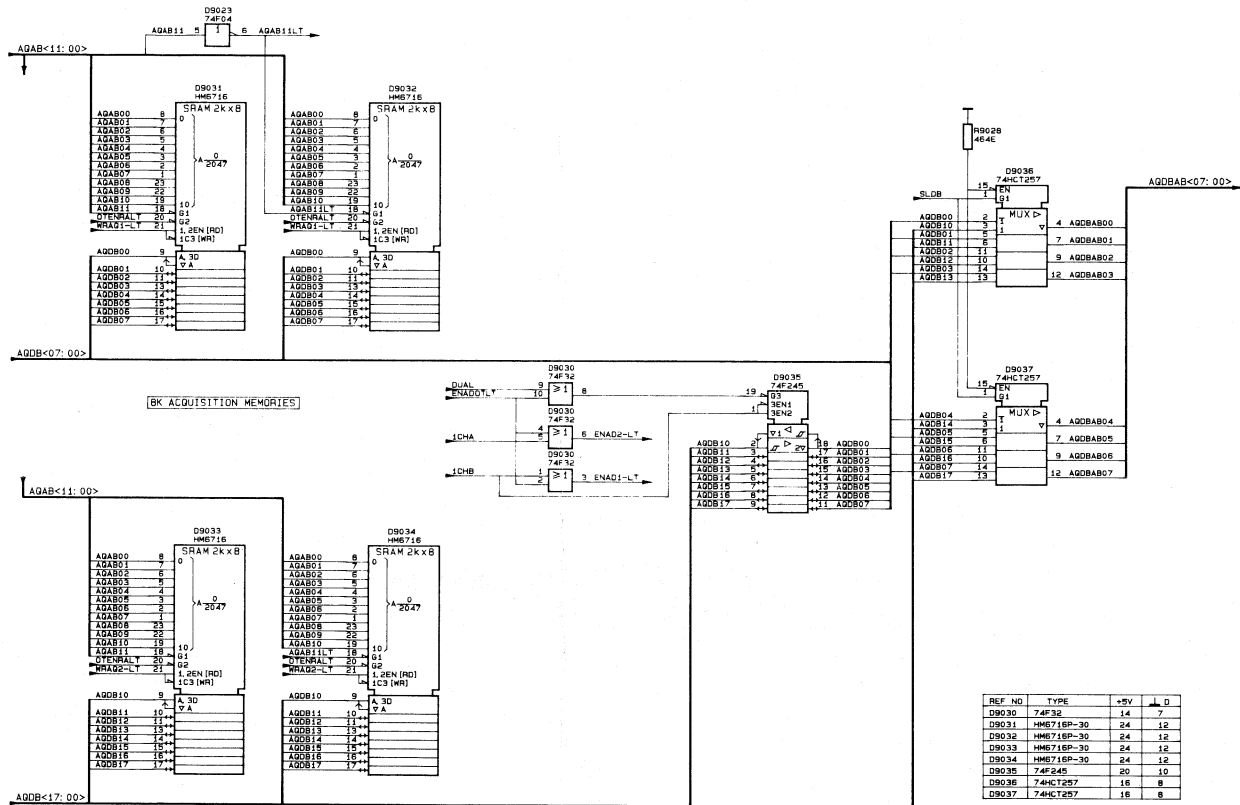


Figure 11.5 Circuit diagram of input amplifiers and ADC circuit



| REF. NO. | TYPE | +5V | A | D |
|----------|------------|-----|----|---|
| D9010 | 74F32 | 14 | 7 | |
| D9031 | HM6716P-30 | 24 | 12 | |
| D9032 | HM6716P-30 | 24 | 12 | |
| D9033 | HM6716P-30 | 24 | 12 | |
| D9034 | HM6716P-30 | 24 | 12 | |
| D9035 | 74F245 | 20 | 10 | |
| D9036 | 74HC1257 | 16 | 8 | |
| D9037 | 74HC1257 | 16 | 8 | |

Figure 11.6 Circuit diagram of acquisition memories

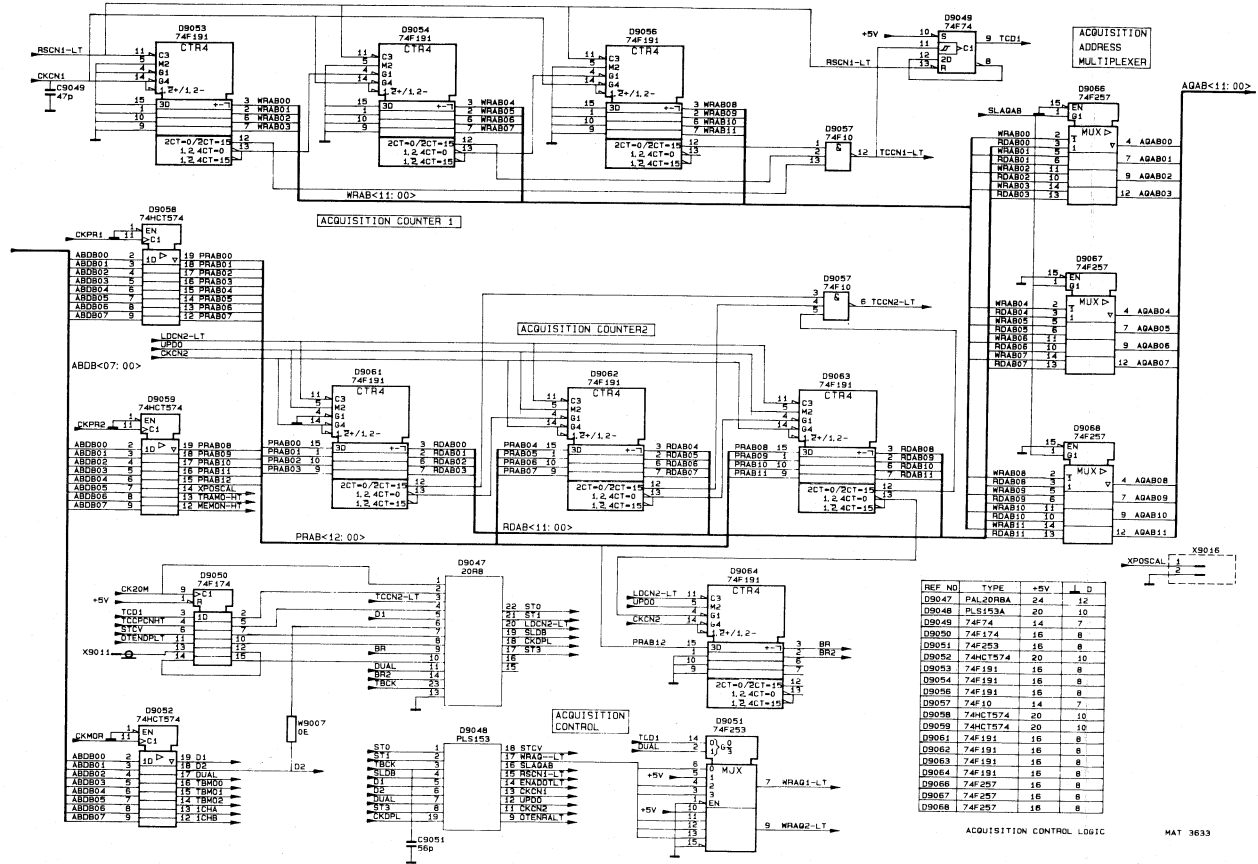
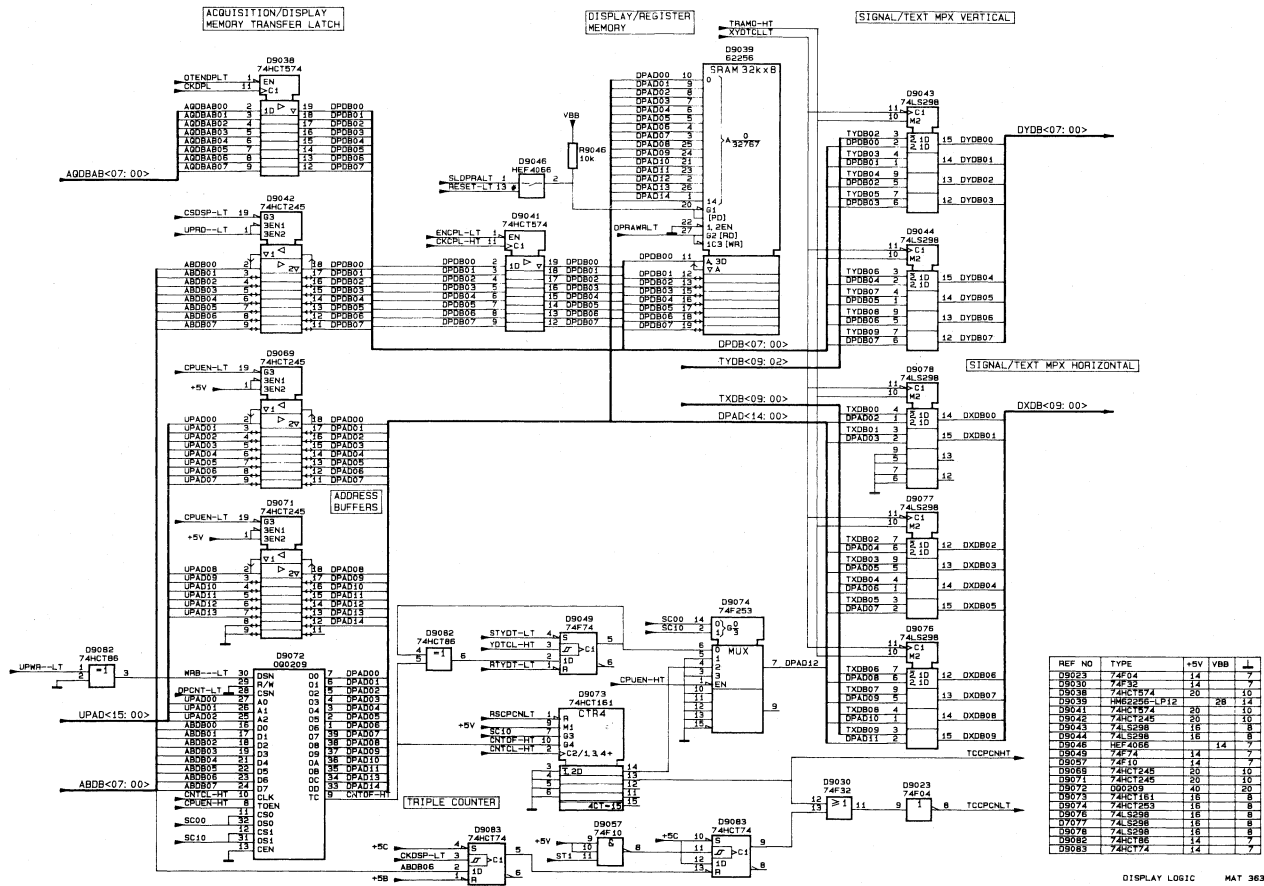


Figure 11.7 Circuit diagram of acquisition control logic



| REF NO | TYPE | +5V | VBB | ↓ |
|--------|--------------|-----|-----|----|
| D9023 | 74F04 | 14 | 7 | |
| D9024 | 74F32 | 14 | 7 | |
| D9038 | 74HC157 | 20 | 28 | 14 |
| D9039 | 9962206-LF12 | 20 | 28 | 14 |
| D9041 | 74HC157 | 20 | 28 | 14 |
| D9042 | 74HC154 | 20 | 28 | 14 |
| D9043 | 74LS258 | 16 | 8 | |
| D9044 | 74LS258 | 16 | 8 | |
| D9046 | HEF4066 | 14 | 14 | 7 |
| D9047 | 74F74 | 14 | 7 | |
| D9049 | 74F32 | 20 | 28 | 14 |
| D9072 | 090209 | 40 | 20 | |
| D9073 | 74HC154 | 16 | 8 | |
| D9074 | 74F259 | 16 | 8 | |
| D9076 | 74LS258 | 16 | 8 | |
| D9077 | 74LS258 | 16 | 8 | |
| D9078 | 74LS258 | 16 | 8 | |
| D9079 | 74LS258 | 16 | 8 | |
| D9080 | 74LS258 | 16 | 8 | |
| D9081 | 74LS258 | 16 | 8 | |
| D9082 | 74HC158 | 16 | 8 | |
| D9083 | 74LS258 | 16 | 8 | |
| D9084 | 74LS258 | 16 | 8 | |
| D9085 | 74LS258 | 16 | 8 | |
| D9086 | 74LS258 | 16 | 8 | |
| D9087 | 74LS258 | 16 | 8 | |
| D9088 | 74HC174 | 14 | 7 | |
| D9089 | 74HC154 | 20 | 28 | 14 |
| D9090 | 74LS258 | 16 | 8 | |
| D9091 | 74LS258 | 16 | 8 | |
| D9092 | 74LS258 | 16 | 8 | |
| D9093 | 74LS258 | 16 | 8 | |
| D9094 | 74LS258 | 16 | 8 | |
| D9095 | 74LS258 | 16 | 8 | |
| D9096 | 74LS258 | 16 | 8 | |
| D9097 | 74LS258 | 16 | 8 | |
| D9098 | 74LS258 | 16 | 8 | |
| D9099 | 74LS258 | 16 | 8 | |
| D9100 | 74LS258 | 16 | 8 | |

Figure 11.8 Circuit diagram of display logic

12. ADAPTATION UNIT (A16)

12.1 VERTICAL DISPLAY MODE SWITCH

The adaptation unit consists of diode switches. Depending on the selection of real-time mode or digital memory mode, the current signals of channels A and B are applied via the so-called "analogue signal path" or the so-called "digital signal path". The diode switches are under control of the signals SHAR and SHARN. The selection table is as follows:

| signal | real-time mode | digital memory mode |
|----------|----------------|---------------------|
| MEMON-HT | LOW | HIGH |
| SHAR | -12 V | +12 V |
| SHARN | +12 V | -12 V |

12.2 REAL TIME MODE AMPLIFIER

Selection of the analog signals path means that the current signals of channels A and B are directly coupled to the inputs of the analogue vertical channel switch D601 via diodes V609, V611, V612 and V613. The two devices D601 and D602 are connected in parallel and have the following switch selections:

| | D601 | | D602 |
|-----------------|--------|--------|--------|
| | pin 10 | pin 11 | pin 10 |
| A | 1 | 0 | 0 |
| B | 0 | 1 | 0 |
| TRIG LEVEL VIEW | 0 | 0 | 0 |
| ADD | 1 | 1 | 1 |

Furthermore all possible 2, 3 or 4 channel combinations are possible in alternated and chopped display (see also chapter 5).

The stage comprises the following real-time functions:

- Channel B normal/invert (HIGH is invert) on D601-11.
(The balance between normal/invert can be adjusted with R2212, see chapter 5)
- Trigger view invert (HIGH is invert) on D602-2.

The output is applied to the delay line driver on unit A2.

Channel A position control is obtained via long-tailed pair amplifier V626 and V627. This circuit is sourced by current source V628 and driven by N601. The channel B position control is identical but also includes a multiplexer D603 for normal/invert function.

12.3 DIGITAL MEMORY AMPLIFIER

Selection of the digital signal path means that the current signals of channels A and B are coupled to the common-base amplifier V616, V617, V621 and V622.

Because of the +12 V level of SHAR these transistors conduct and the currents are routed to the output. The output currents are applied to the digital unit A9.

The position controls for both channels are determined by the same circuit as for the real-time path.

Next, MEMOM-HT also causes the selection of the vertical current signals -YDAC and +YDAC. These signals are now routed to the delay-line driver via D602 on unit A2. Note that the DLD1 and DLD2 outputs are only interconnected on A2 (see also figure 5.1).

In digital memory mode, selection can be made for trigger level view by applying a high level to D602-10. This d.c. signal is received from the trigger level view pre-amplifier on unit A2.

12.4 SIGNAL NAME LIST

| Signal name | Description | Signal source | Signal destination(s) |
|-------------|------------------------|---------------|-----------------------|
| CHA | Channel A selection | D2603 | D601 |
| CH+A | Channel +A output | V616 | R702 |
| CH-A | Channel -A output | V617 | R707 |
| CH+AI | Channel +A input | D2002 | V611 - V618 - R638 |
| CH-AI | Channel -A input | D2002 | V609 - V619 - R639 |
| CHB | Channel B selection | D2603 | D601 |
| CH+B | Channel +B output | V622 | R702 |
| CH-B | channel -B output | V621 | R701 |
| CH+AI | Channel +B input | D2102 | V613 - V624 - R653 |
| CH-AI | Channel -B input | D2102 | V612 - V623 - R652 |
| DLD1 | Delay line driver ch A | D601 | D2203 |
| DLD2 | Delay line driver ch B | D602 | D2203 |
| INVAM | Invert ch A | D2602 | D602 |
| INVB | Invert ch B | D2602 | D601 - D603 |
| MEMOM-HT | Memory on | D222 | R601 |
| POS A | Position ch A | R2200 | R634 |
| POS B | Position ch B | R2220 | R629 |
| +TRIG | + Trigger | R2404 | D602 |
| -TRIG | - Trigger | R2412 | D602 |
| TRGVW | Trigger view | D2603 | D602 |
| SHAR | Store hardware | V604/V606 | V614 - V615 |
| SHARN | Store hardware not | V608 | V634 - V635 |
| +YDAC | + Y DAC signal | V531 | R617 |
| -YDAC | - Y DAC signal | V532 | R616 |

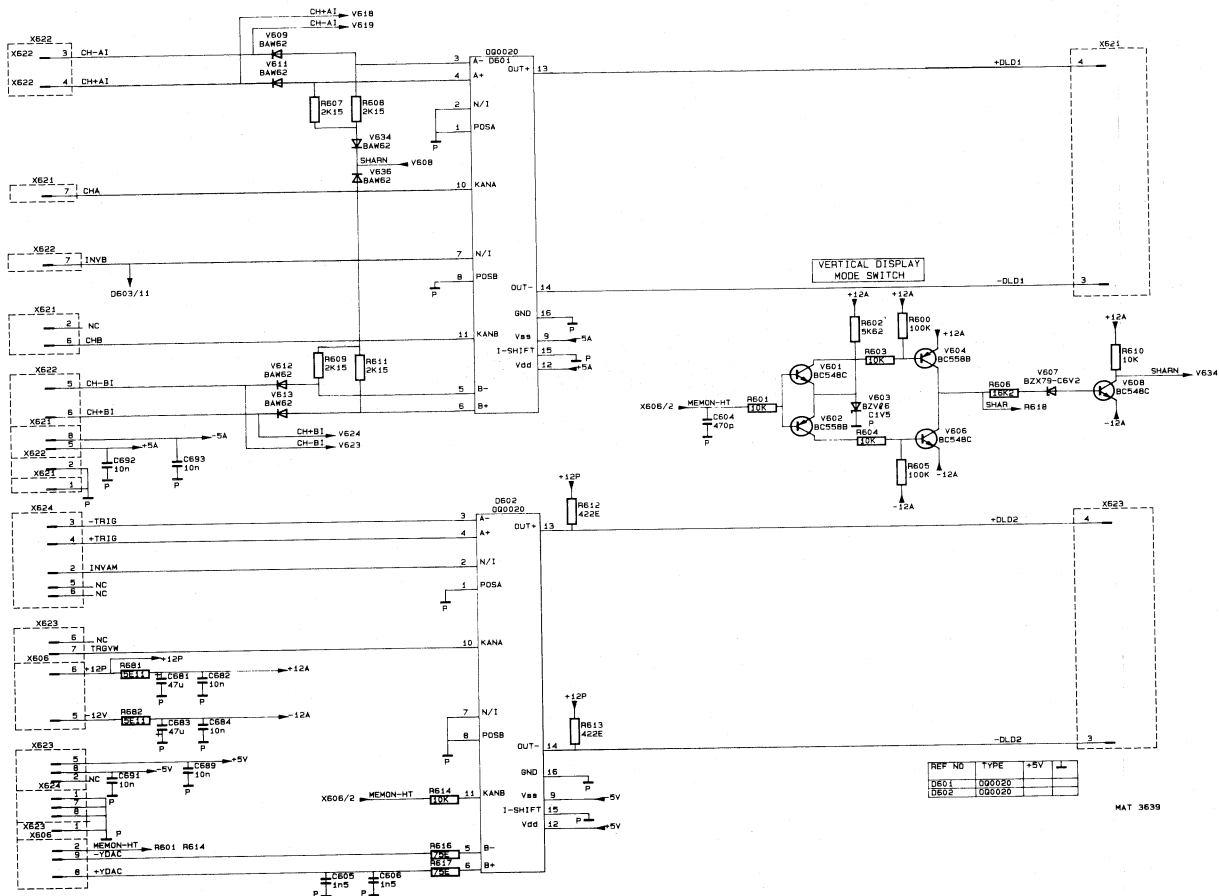


Figure 12.2 Circuit diagram of adaptation unit, section 1

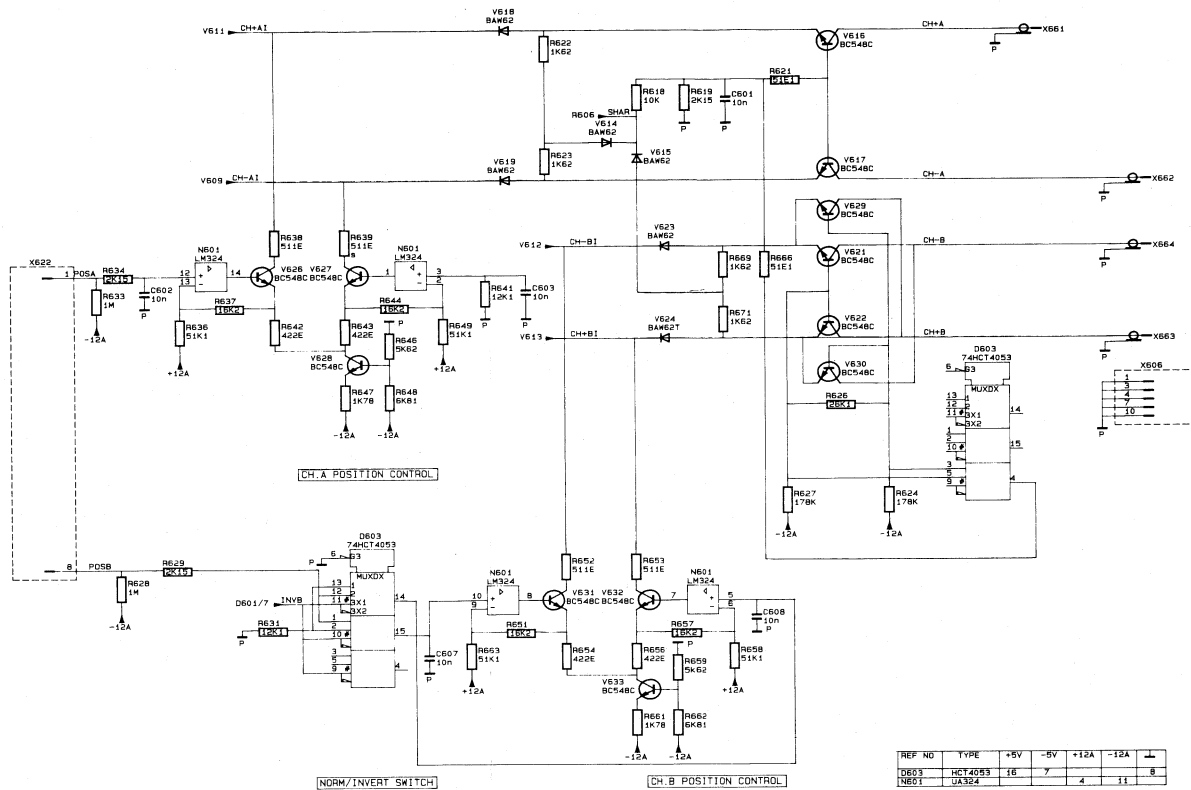


Figure 12.3 Circuit diagram of adaptation unit, section 2

13. PERFORMANCE CHECK

13.1 GENERAL INFORMATION

WARNING: Before switching-on, ensure that the instrument has been installed in accordance with the Installation Instructions outlined in Section 2 of the Operating Guide.

This procedure is intended to:

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

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

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

Warming-up time under average conditions is 30 minutes.

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

IMPORTANT NOTES

- * At the start of every check, the controls always occupy the AUTO SET position, unless otherwise stated.
- * The input voltage has to be supplied to the A-input; unless otherwise stated. Set the TIME/DIV switch to a suitable position; unless otherwise stated.
- * Tolerances given are for the instrument under test and do not include test equipment error. Bear in mind that the test equipment is properly terminated.
- * In some checks channel B is mentioned between brackets () behind channel A. It is advised to perform first channel A checks. After that the checks for channel B can be done.

13.2 PRELIMINARY SETTINGS

- Switch-on the instrument (no input signal).
- Check if all LCD segments are on for approx. 1 sec.
- Put the instrument in DIGITAL MEMORY off mode. The LCD text DIGITAL MEMORY is not visible then. All test steps are made in this instrument mode, unless otherwise mentioned.
- At the start of every check only AUTO SET must be pressed (after the input signal is applied).

13.3 RECOMMENDED TEST EQUIPMENT

The test equipment that must be used for this performance check is as given in section 15.2, except :

Trimming tool kit
Oscilloscope
Digital multimeter

13.4 CHECKING PROCEDURE

13.4.1

POWER SUPPLY

| | | |
|---|----------------|--|
| * | SUBJECT | Line voltage input |
| | TEST EQUIPMENT | Variable mains transformer |
| | MAINS VOLTAGE | Between 100 V and 240 V ac (r.m.s.) Frequency: 50 Hz...400 Hz |
| | SETTINGS | - Press POWER ON - Apply CAL signal to input A via a 10:1 probe - Press AUTO SET |
| | REQUIREMENTS | - Starts at any mains voltage between 100 V...240 V ac (r.m.s.) - Instrument performance does not change across indicated mains voltage range; displayed CAL signal distortion-free and with equal intensity. |

| | |
|-------------------|---|
| MEASURING RESULTS | ..... |
| * SUBJECT | Power Consumption (ac source) |
| TEST EQUIPMENT | Wattmeter (moving iron meter) |
| MAINS VOLTAGE | Local mains voltage 110, 220 or 240 V (r.m.s.). |
| SETTINGS | Press POWER ON |
| REQUIREMENTS | Consumes : 55 W |
| MEASURING RESULTS | ..... |

13.4.2

VERTICAL DEFLECTION OR Y-AXIS

| | |
|---------------------------|--|
| * SUBJECT | Vertical Deflection coefficients and input coupling of Channels A and B |
| TEST EQUIPMENT | Square-wave calibration generator (PG506) |
| INPUT VOLTAGE | Square-wave signal 1 kHz to input A(B), amplitude 10 mVpp...20 Vpp in 1-2-5 steps |
| SETTINGS AND REQUIREMENTS | - Apply a 1 kHz square wave signal of 10 mV to input A(B) - Set A (B) to 2 mV/div. - Check if the amplitude of the signal is 5 div. (+or- 3%) - Increase the input amplitude and vertical sensitivity with the following steps: |

| Input voltage (pp) | A (B) setting | Requirements | Measuring results |
|--------------------|---------------|-----------------|-------------------|
| 10 mV | 2 mV | 5 div. (+or-3%) | ..... |
| 20 mV | 5 mV | 4 div. (+or-3%) | ..... |
| 50 mV | 10 mV | 5 div. (+or-3%) | ..... |
| 0,1 V | 20 mV | 5 div. (+or-3%) | ..... |
| 0,2 V | 50 mV | 4 div. (+or-3%) | ..... |
| 0,5 V | 100 mV | 5 div. (+or-3%) | ..... |
| 1 V | 200 mV | 5 div. (+or-3%) | ..... |
| 2 V | 500 mV | 4 div. (+or-3%) | ..... |
| 5 V | 1 V | 5 div. (+or-3%) | ..... |
| 10 V | 2 V | 5 div. (+or-3%) | ..... |
| 20 V | 5 V | 4 div. (+or-3%) | ..... |
| 50 V | 10 V | 5 div. (+or-3%) | ..... |

- * SUBJECT Variable gain control range (continued procedure of previous subject)
- SETTING - Turn VAR control A(B) fully anti-clockwise
- REQUIREMENTS - Check if displayed amplitude $< 2 \text{ div} (1: > 2,5)$.
- MEASURING RESULTS
- * SUBJECT Input coupling (continued procedure of previous subject)
- SETTINGS AND REQUIREMENTS - Turn VAR control A(B) fully clockwise into CAL.
- Press GND; check if input signal is interrupted.
- Press GND again and then AC/DC
- Check if in DC position the signal shifts upwards compared with the AC position
- MEASURING RESULTS
- * SUBJECT Frequency response (DIGITAL MEMORY off)
- TEST EQUIPMENT Constant amplitude sine-wave generator (SG503)
- INPUT VOLTAGE Constant amplitude sine-wave signal, 120 mV frequency 50 kHz...50 MHz to input A (B).
- SETTINGS AND REQUIREMENTS - Set A (B) to 20 mV/div.
- Apply 50 kHz sine-wave signal to A (B)
- Adjust trace height to exactly 6 div.
- Increase the frequency of the input signal up to 50 MHz.
- Check if the vertical deflection is $\geq 4,2 \text{ div.}$ across the complete bandwidth range ($> 50\text{MHz}$)
- Reduce the amplitude of the input signal to 12 mV and the frequency to 50 kHz.
- Set A (B) to 2 mV.
- Adjust the trace height to exactly 6 div.
- Increase the frequency up to 35 MHz.
- Check if the vertical deflection is $\geq 4,2 \text{ div.}$ across the complete bandwidth range ($> 35\text{MHz}$)
- MEASURING RESULTS
- * SUBJECT Frequency response (DIGITAL MEMORY on)
- TEST EQUIPMENT Constant amplitude sine-wave generator (SG503)
- INPUT VOLTAGE Constant amplitude sine-wave signal, 120 mV frequency 50 kHz...10 MHz to input A (B).
- SETTINGS AND REQUIREMENTS - Set A (B) to 20 mV/div.
- Apply 50 kHz sine-wave signal to A (B)
- Press DIGITAL MEMORY in order to switch this function on: the text DIGITAL MEMORY becomes visible in the LCD
- Adjust trace height to exactly 6 div.

- Increase the frequency of the input signal up to 10 MHz.
- Check if the vertical deflection is $\geq 4,2$ div. across the complete bandwidth range ($> 10\text{MHz}$)
- Reduce the amplitude of the input signal to 12 mV and the frequency to 50 kHz.
- Set A (B) to 2 mV.
- Adjust the trace height to exactly 6 div.
- Increase the frequency up to 10 MHz.
- Check if the vertical deflection is $\geq 4,2$ div. across the complete bandwidth range

MEASURING RESULTS

*

SUBJECT Rise-Time (DIGITAL MEMORY off mode)

IMPORTANT THE RISE TIME IS A CALCULATED VALUE, ACCORDING FORMULA: $\text{BANDWIDTH} \times \text{RISE-TIME} = 0,35$

TEST EQUIPMENT Fast-rise square-wave generator (PG506)

INPUT VOLTAGE Fast-rise square-wave signal ≤ 1 ns to input A (B) frequency: 1MHz.

SETTINGS

- Set A(B) to 100 mV/div.
- Press DIGITAL MEMORY in order to switch this function off. The text DIGITAL MEMORY disappears from the LCD
- Press X MAGN
- Set TB to 5 ns/div
- Adjust the trace height exactly between the dotted lines 0% and 100% (5 div.)

REQUIREMENTS Important: $T_R(\text{measured}) =$

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

- Check the rise-time, measured between the 10% and 90% lines (4 div.);
- * measured rise-time must be: 7,1 ns or less (1,4 subdiv. or less).

MEASURING RESULTS

*

SUBJECT Noise

TEST EQUIPMENT -

INPUT VOLTAGE -

SETTINGS

- Press A/B so that channel A and B are both on
- Set channel A and B to 20 mV/div
- Press ALT/CHOP for CHOP mode
- Press AC/DC of both channels for DC input coupling
- Press GND of both channels for grounded inputs

REQUIREMENT

- Check if the amplitude of the noise on the traces is not more than 0,5 subdiv.

MEASURING RESULTS

- * SUBJECT Vertical Dynamic range
- TEST EQUIPMENT Constant amplitude sine-wave generator
- INPUT VOLTAGE Sine-wave signal of 1 MHz, 2,4 Vpp to input A(B)
- SETTINGS
- Apply sine-wave signal of 1 MHz, 2,4 Vpp to input A(B).
 - Set A (B) to 100 mV/div.
 - Shift with the Y POS control the sine-wave of channel A(B) vertically over the screen.
- REQUIREMENT
- Check if the top and bottom of the sine-wave signal can be displayed distortion-free (24 div. trace height).
- INPUT VOLTAGE Sine-wave signal of 50 MHz, 1,6 Vpp to input A(B)
- SETTINGS
- Set A (B) to 200 mV/div.
 - Set the trace height to exactly 8 div.
 - Increase the frequency of the input signal up to 50 MHz
- REQUIREMENT
- Check if a sine-wave signal of 8 div. is displayed distortion-free.
- MEASURING RESULTS
- * SUBJECT Position range (vertical)
- TEST EQUIPMENT LF Sine-wave generator
- INPUT VOLTAGE Sine-wave signal of 1 kHz, 8 V to input A(B)
- SETTINGS
- Adjust the channel A (B) input sensitivity to 1 V/div.
 - Apply a sine-wave of 1 kHz/8 div. to the channel A (B) input.
 - Adjust the channel A (B) input sensitivity to 500 mV/div.
 - Rotate the channel A (B) Y POS control fully clockwise and anti-clockwise
- REQUIREMENT
- Check if the top and the bottom of the signal can be positioned on the vertical centre line of the screen.
- MEASURING RESULTS
- * SUBJECT Cross talk between channels A and B at 10 MHz
- TEST EQUIPMENT Sine-wave calibration generator (SG503)
- INPUT VOLTAGE Sine-wave signal 10 MHz, 4 V to input A(B)
- SETTINGS
- Apply sine-wave input signal to input A(B)
 - Press AUTO SET
 - Set channel A(B) to 0,5 V/div
 - Set the generator to a trace height to 8 div.
 - Press A/B (channel with input signal off).
- REQUIREMENTS
- Check if trace height of channel without input signal B(A) is < 0,08 div (1:100).
- MEASURING RESULTS

* SUBJECT Cross talk between channels A and B at 50 MHz

TEST EQUIPMENT HF sine-wave generator (SG503)

INPUT VOLTAGE 50 MHz sine-wave signal, 4 V to input A(B)

SETTINGS - Do the same settings as indicated above

REQUIREMENTS - Check if trace height of channel without input signal B(A) is $<0,16$ div ($1:>50$).

MEASURING RESULTS

* SUBJECT Common Mode Rejection Ratio

TEST EQUIPMENT HF constant Amplitude sine-wave generator (SG503)

INPUT VOLTAGE Sine wave signal 1 MHz, 4 Vpp to inputs A and B

SETTINGS - Set A and B to 500 mV/div. (8 div.)
 - Set input coupling of channels A and B to DC
 - Press ADD/INVERT three times (ADD and INVERT on)
 - Press A/B twice so that both channels are displayed in ADD mode.

REQUIREMENT - Check if the trace height of the A-B signal is $<0,08$ div. Adjust the A and B VAR control(s) to minimise the displayed amplitude.

MEASURING RESULTS

* SUBJECT Visual Signal Delay

TEST EQUIPMENT Square wave calibration generator (PG506)

INPUT VOLTAGE Fast-rise input signal 1 MHz, <1 ns, 0,5 V to input A

SETTINGS - Apply fast-rise input signal to input A
 - Press AUTO SET
 - Put the A(B) VAR controls in the CAL position.
 - Set A to 100 mV/div.
 - Set MAIN TB to 50 ns/div.
 - Press X MAGN and turn X POS
 - Set INTENSITY fully clock-wise and TRIG LEVEL fully anti-clockwise.

REQUIREMENT - Check if visual signal delay is >15 ns

MEASURING RESULTS

SETTINGS - Put TRIG LEVEL and X POS back in mid position

* SUBJECT Base line jump
 TEST EQUIPMENT -
 INPUT VOLTAGE -
 SETTINGS Attenuator balance

- This check must be done in the service menu OFFS-A.
- To enter this menu proceed as follows:
- Press RESET and keep it pressed and then press AUTO SET.
- Select OFFS-A of CRT function controls.
- Check LCD display: "3.0" flashing.
- The attenuator is now switched between the 1-2-5 positions.
- Check if the display does not jump more than 1 subdiv.

VAR balance

- Press mV of channel A UP-DOWN input sensitivity control.
- Check LCD display: "3.1" flashing.
- Rotate VAR control of channel A and B
- Check if display does not jump more than 1 subdiv.

X1/X10 attenuator offset

- Press mV of ch. A UP-DOWN control.
- Check LCD display: "3.2" flashing.
- Check if the display does not jump more than 1,5 subdiv.

NORMAL-INVERT jump

- Press mV of ch. A UP-DOWN control four times.
- Check LCD display: "3.6" flashing.
- Check that the display does not jump more than 1 subdiv.
- Press AUTO SET two times to leave the SERVICE MENU

MEASURING RESULTS

13.4.3

HORIZONTAL DEFLECTION OR X-AXIS

- * SUBJECT OFFSET of trigger point
- TEST EQUIPMENT -
- INPUT VOLTAGE -
- SETTINGS AND REQUIREMENT
- This check must be done in the SERVICE MENU OFFS-A. To enter this menu proceed as follows:
 - Press RESET and keep it pressed and then press AUTO SET.
 - Select OFFS-A of CRT function controls.
 - Press mV of ch. A UP-DOWN control three times.
 - Check LCD display: "3.3" flashing.
 - Turn Y POS of channel B and set the point in vertical centre of the screen.
 - Check if the displayed point does not jump more than 1,5 subdiv horizontally
 - Press mV of ch. A UP-DOWN control.
 - Check LCD display: "3.4" flashing.
 - Turn Y POS of A and set point in the vertical centre
 - Check if the displayed point does not jump more than 1,5 subdiv. horizontally
 - Press mV of ch. A UP-DOWN control.
 - Check LCD display: "3.5" flashing.
 - Turn Y POS of B and set point in vertical centre
 - Check if the displayed point does not jump more than 1,5 subdiv.
 - Press AUTO SET two times to leave the SERVICE MENU
- MEASURING RESULTS
- * SUBJECT X Deflection
- TEST EQUIPMENT LF sine-wave generator
- INPUT VOLTAGE Sine wave signal 2 kHz, 3 div. trace height to input A
- SETTINGS AND REQUIREMENTS
- Press AUTO SET
 - Set the trace height to 3 div.
 - Press X DEFL
 - Check if only X DEFL is on
 - Select A of trigger source
 - Check if a line under an angle of 45° is displayed.
- MEASURING RESULTS
- * SUBJECT Time coefficients
- TEST EQUIPMENT Time marker generator (TG501)
- INPUT VOLTAGE Time marker signal 50 ns...0,5 s
- SETTINGS
- Apply a time marker signal of 50 ns to input A
 - Press AUTO SET

REQUIREMENT

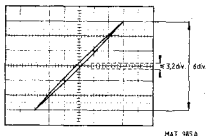
- Check the deflection coefficients in TB X1 and TB X10 according to the table below:
 Note: in X MAGN x10 is the requirement valid for the +4 ... -4 div from the screen centre and excluding the first and last 50 ns.

| Time marker pulse | TB setting | Max. coeff. error | | Measuring results |
|-------------------|------------|-------------------|---------------------|-------------------|
| | | TB X1 | TB X10 X MAGN on | |
| 50 ns | 50 ns | 3% | 4% | ..... |
| 0,1 us | 0,1 us | 3% | 4% | ..... |
| 0,2 us | 0,2 us | 3% | 4% | ..... |
| 0,5 us | 0,5 us | 3% | 4% | ..... |
| 1 us | 1 us | 3% | 4% | ..... |
| 2 us | 2 us | 3% | 4% | ..... |
| 5 us | 5 us | 3% | 4% | ..... |
| 10 us | 10 us | 3% | 4% | ..... |
| 20 us | 20 us | 3% | 4% | ..... |
| 50 us | 50 us | 3% | 4% | ..... |
| 0,1 ms | 0,1 ms | 3% | 4% | ..... |
| 0,2 ms | 0,2 ms | 3% | 4% | ..... |
| 0,5 ms | 0,5 ms | 3% | 4% | ..... |
| 1 ms | 1 ms | 3% | 4% | ..... |
| 2 ms | 2 ms | 3% | 4% | ..... |
| 5 ms | 5 ms | 3% | 4% | ..... |
| 10 ms | 10 ms | 3% | 4% | ..... |
| 20 ms | 20 ms | 3% | 4% | ..... |
| 50 ms | 50 ms | 3% | 4% | ..... |
| 0,1 s | 0,1 s | 3% | 4% | ..... |
| 0,2 s | 0,2 s | 3% | 4% | ..... |
| 0,5 s | 0,5 s | 3% | 4% | ..... |

| | |
|-------------------|---|
| * SUBJECT | Variable control ratio (VAR TB) and X MAGN balance |
| TEST EQUIPMENT | Time marker generator (TG501) |
| INPUT VOLTAGE | Time marker signal 1 us to input A |
| SETTINGS | - Set TB to 0,2 us/div; marker on first and sixth graticule line - Set the TB VAR fully anti-clockwise |
| REQUIREMENT | - Check if the VAR control range overlaps the time base steps 0,2 us to 0,5 us; first marker on first graticule line and second marker on the third graticule line or closer to the first marker (2,5:1) |
| SETTINGS | - Set the TB VAR control fully clockwise - Press X MAGN (magnifier on) - Set the top of the second marker pulse exactly in the horizontal centre of the graticule - Press X MAGN (magnifier off) |
| REQUIREMENT | - Check if the top of the second marker pulse is not shifted more than 2,5 subdiv. |
| MEASURING RESULTS | ..... |

- * SUBJECT Horizontal Deflection coefficients
 TEST EQUIPMENT Square-wave calibration generator (PG 506)
 INPUT VOLTAGE Square-wave 500mV trace height to input A
 SETTINGS
 - Press X DEFL
 - Press A/B twice for only ch. B display
 - Set A to 100 mV/div
 - Select A as X DEFL source with TRIG or X SOURCE
 REQUIREMENT - Check if a horizontal line of 5 div. is displayed (+or- 0,25 div)
 INPUT VOLTAGE - Square-wave 500 mV to input EXT
 SETTINGS AND REQUIREMENTS
 - Select EXT DC with TRIG or X SOURCE
 - Press X DEFL
 - Select EXT DC as TRIG X SOURCE
 - Check if a horizontal line of 5 div. (+or- 0,25%) is displayed.
 MEASURING RESULTS
- * SUBJECT Frequency response (horizontal)
 TEST EQUIPMENT Constant amplitude sine-wave generator (PG506)
 INPUT VOLTAGE Constant amplitude sine-wave signal, 30 mV, 50 kHz...2 MHz to input A
 SETTINGS
 - Apply a 50 kHz sine-wave signal to input A
 - Set channel A to 5 mV/div
 - Adjust the trace height to exactly 6 div.
 - Press X DEFL
 - Press A/B twice
 - Select A as horizontal deflection source with TRIG or X SOURCE
 - Adjust the input voltage for exactly 6 div. horizontal deflection
 - Increase the frequency of the input signal up to 2 MHz
 REQUIREMENTS - Check if the trace width is > 4,2 div. across the complete bandwidth range.
 MEASURING RESULTS
- * SUBJECT Maximum phase shift between horizontal and vertical deflection.
 TEST EQUIPMENT LF sine-wave generator
 INPUT VOLTAGE Sine wave signal, 2 kHz...100 kHz, trace height 6 div to input A
 SETTINGS
 - Press X DEFL
 - Select A for horizontal deflection with TRIG or X SOURCE
 - Set the trace height to exactly 6 div.
 - Increase the input frequency up to 100 kHz.

REQUIREMENT

- Check if the phase shift $< 3^\circ$ (see figure below)

MEASURING RESULTS

13.4.4

TRIGGERING

| | | |
|---|---------------------------|---|
| * | SUBJECT | Trigger Sources and trigger coupling |
| | TEST EQUIPMENT | Square-wave generator |
| | INPUT VOLTAGE | Square-wave signal 2 kHz, 800 mV trace height to input A |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set the generator to a trace height of 4 div. - Press TRIG COUPL and select DC - Adjust LEVEL for a triggered signal - Check if a square wave signal is displayed of 4 div. - Press TRIG COUPL and select p-p - Turn LEVEL and check if the signal is triggered over the complete level range. - Connect CAL signal to input B (e.g. via a 10:1 attenuator probe). - Press A/B once so that Ch. A and B are both on. - Set B to 200 mV. - Select B as trigger source by pressing TRIG or X SOURCE twice (A is not triggered) - Check if a square wave of 6 div. is displayed - Increase the freq. of the square-wave signal to input A up to 20 kHz (CAL signal to B) - Press TRIG or X SOURCE five times (A and B both selected as trigger source). - Check if two well triggered traces are displayed. - Remove input signals |

MEASURING RESULTS

| | | |
|---|----------------|---|
| * | SUBJECT | Slope selection and Level control range. |
| | TEST EQUIPMENT | LF Sine-wave generator |
| | INPUT VOLTAGE | Sine-wave signal 2 kHz - 800 mV to input A(B) |

SETTINGS AND
REQUIREMENTS

- Set A(B) to 0,1 mV/div (DC input coupling)
- Press TRIG COUPL for p-p triggering
- Turn LEVEL fully clockwise and fully anti-clockwise
- Check if the signal is well triggered over the complete LEVEL range
- Set the LEVEL control in its mid-position
- Start of signal display must be in the vertical centre
- Press TRIG COUPL once for DC mode
- Press trigger slope $\swarrow \searrow$
- Check if the sine-wave signal is inverted and is triggered on the negative slope.
- Press SLOPE once again
- Set A(B) to 50 mV/div (16 div. trace height)
- Turn the LEVEL
- Check if the LEVEL range is $> \pm 8$ div. and if the signal is triggered on the positive slope.
- Use the A(B) Y POS to position the signal top and bottom in the CRT viewing area.
- Set A(B) to 0,1 V/div
- Check if NOT TRIG'D is visible in the LCD, if the LEVEL control is set in its extreme positions
- Remove input signal

MEASURING RESULTS

*

| | |
|---------------------------|---|
| SUBJECT | Trigger Sensitivity |
| TEST EQUIPMENT | Sine-wave generator (SG503) |
| INPUT VOLTAGE | Sine-wave signal 10 MHz - 50 MHz - 100 MHz to input A (B) |
| SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Press AC/DC (input coupling of A(B) to DC) - Press TB TRIG MODE for TRIG mode - Press TRIG COUPL for DC trigger coupling - Apply a sine-wave signal of 10 MHz approx. 250 mVpp to input A(B) - Set A(B) to 0,2 V/div. - Rotate TRIG LEVEL for a stable triggered display - Decrease amplitude of input signal - Operate TRIG LEVEL for a triggered display - Check if the signal is well-triggered at amplitudes $\geq 0,5$ div. - Decrease the frequency of the input signal to 50 kHz - Check if the signal stays well triggered at amplitudes $\geq 0,5$ div. - Increase the frequency of the input signal up to 50 MHz. - Decrease amplitude of input signal to approx 1 div. - Turn LEVEL - Check if the signal is well-triggered at amplitudes ≥ 1 div. - Increase the frequency of the input signal up to 100 MHz |

- Decrease amplitude to approx 3 div.
- Check if the signal is well-triggered at amplitudes ≥ 3 div.
- Remove input signal

MEASURING RESULTS

| | | |
|---|-------------------|---|
| * | SUBJECT | Trigger sensitivity TVL-IVF |
| | TEST EQUIPMENT | TV pattern generator with video output (PM5518) |
| | INPUT VOLTAGE | Video signal to input A (B) |
| | SETTINGS | <ul style="list-style-type: none"> - Press TB TRIG mode for TRIG mode - Press AC/DC for DC input coupling - Apply a video signal to input A(B) with an amplitude of 0,7 div. sync. pulse amplitude - Press TRIG COUPL for TVL and TVF |
| | REQUIREMENTS | - Check for a stable triggering on TVL and TVF at sync. amplitudes of $>0,7$ div. |
| | MEASURING RESULTS | ..... |

13.4.5

CURSORS

| | | |
|---|-------------------|---|
| * | SUBJECT | Voltage cursor accuracy |
| | TEST EQUIPMENT | SQ. wave calibration generator PG 506 |
| | SETTINGS | <ul style="list-style-type: none"> - Apply a sq. wave voltage of 1 Vpp to the ch. A input. - Set A to 200 mV/div. - Select DC input coupling for channel A(B) - Press DIGITAL MEMORY and then LOCK - Select CURSORS of the softkeys under the CRT - Select via softkey MODE: V-CURS ON, T-CURS OFF and V on (RATIO off). - Press RETURN. - Select V-CRTR and position the REFERENCE cursor exactly on the bottom of the cursor. - Position the "delta" cursor exactly on the top of the signal. - Press LOCK again so that the text LOCK disappears from the LCD. - Press RETURN once. |
| | REQUIREMENT | Check for a voltage cursor read-out at the top of the screen of 1.00 V + or - 30 mV. |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Time cursor accuracy |
| | TEST EQUIPMENT | Time marker generator TG 501 |
| | SETTINGS | <ul style="list-style-type: none"> - Apply an 1 ms time marker signal to the ch. A input. - Set TB to 1 ms/DIV. - Press LOCK. |

- Select via softkey MODE: V-CURS OFF, T-CURS ON and T on (RATIO and PHase off).
- Press RETURN.
- Select T-CTRL and position the REFERENCE cursor exactly on the second time marker pulse.
- Position the "delta" cursor exactly on the 10th time marker pulse.

REQUIREMENT Check for a time cursor read-out of 8.00 ms, + or - 0,0008 ms.

MEASURING RESULTS

SETTINGS - Press DIGITAL MEMORY so that this function becomes inactive.

13.4.6

AUXILIARY INPUTS AND OUTPUTS

| | | |
|---|---------------------------|--|
| * | SUBJECT | Z-MOD Sensitivity |
| | TEST EQUIPMENT | Square-wave generator |
| | INPUT VOLTAGE | Square-wave signal, 1 kHz, duty cycle 50%, amplitude 0..2,5Vpp to input A and Z-in (rear side) |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set TB to 0,5 ms/div. - Select DC for channel A input coupling - Set the trace of channel A in mid position - Apply square-wave signal of 2,5 Vpp, 1 kHz to input A and Z-MOD input (base line 0 V). - Check if only the bottom half of the square wave signal is displayed (500 us blanking and 500 us unblanking) - Decrease the amplitude of the input signal to 1 Vpp. - Set A to 0,5 V/div. - Check if the top half of the square-wave signal is visible with a lower intensity and will be completely unblanked at an input voltage of < 0,8 V |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | CAL Frequency and output voltage |
| | TEST EQUIPMENT | - |
| | INPUT VOLTAGE | CAL output signal to input A (e.g. via a 10:1 attenuator probe. |
| | SETTINGS | <ul style="list-style-type: none"> - Press GND of channel A - Set the trace in the centre of the screen - Press GND of channel A - Select DC of A input coupling |
| | REQUIREMENTS | - Check if a positive going square wave signal is displayed of 1,2 Vpp, frequency 2 kHz and with a bottom level of 0 volt. |
| | MEASURING RESULTS | ..... |

14. DISMANTLING THE INSTRUMENT

14.1 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 the 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.

14.2 REMOVING THE TOP AND BOTTOM COVERS

The instrument is protected by two covers: a top cover and a bottom cover. To remove these covers, proceed as follows:

- Slacken the two screws that secure both covers, located at the rear of the instrument.
- Gently push each cover backwards until it can be lifted.
- The covers can be removed by lifting them clear of the instrument.

14.3 ACCESS TO PARTS FOR THE CHECKING AND ADJUSTING PROCEDURES

After removing both covers (section 14.2), the digital unit and the time base unit have to be positioned vertically on the chassis. How to position these units is indicated in figure 14.1.

If necessary, the power supply unit can be lifted out of the instrument. To do so, proceed as follows:

- Push both parts at the back of the extension shaft towards each other so that the extension shaft can easily be loosened from the ON/OFF switch on the power supply unit.
- Remove the complete extension shaft.
- Push both lips that secure the power supply unit sideways and gently lift this unit out of the instrument.
- Fix the power supply unit in the available p.c.b. guide fixing.

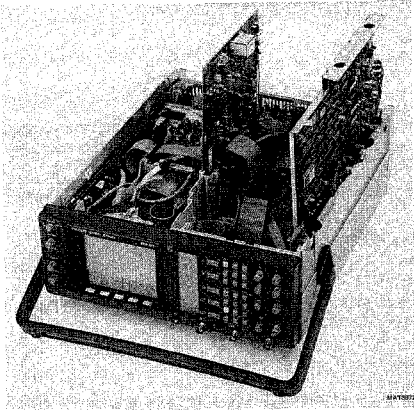


Figure 14.1 Access to all parts for adjusting the oscilloscope

NOTE: For checking and adjusting the instrument it is not necessary to remove the bottom cover.

15. ADJUSTING PROCEDURE

15.1 GENERAL INFORMATION

The following information provides the complete checking and adjusting procedure for the instrument. As various control functions are interdependent, a certain order of adjustment is necessary.

The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment.

Before any check or adjustment, the instrument must attain its normal operating temperature.

- Warming-up time under average conditions is 30 minutes.
- Where possible, instrument performance should be checked before any adjustment is made.
- All limits and tolerances given in this section are calibration guides, and should not be interpreted as instrument specifications unless they are also published in section 2.
- Tolerances given are for the instrument under test and do not include test equipment error.
- The most accurate display adjustments are made with a stable, well-focused low intensity display.
- All controls that 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 maintenance and repair during which the instrument will be opened.

If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by 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.

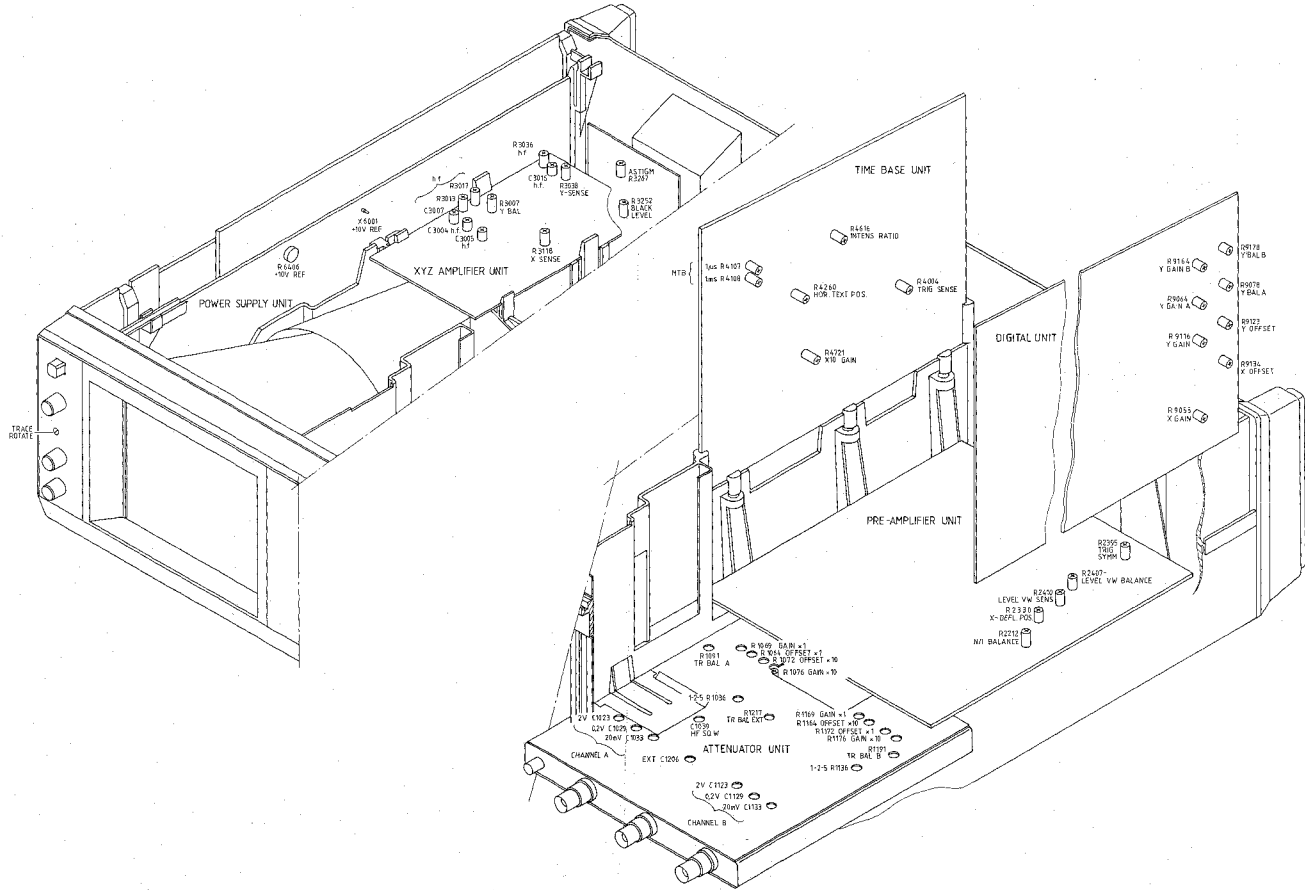


Figure 15.1 Adjusting elements

15.2 RECOMMENDED TEST AND CALIBRATION EQUIPMENT

| Type of instrument | Required specification | Example of recommended instrument |
|---|---|---|
| Function generator | Freq.: 1 MHz ... 10 MHz Sine-wave/Square-wave Ampl. 0...20 Vpp DC offset 0...+5 V Rise-time <30 ns Duty cycle 50 % | Philips PM5134 |
| Constant amplitude sine-wave generator | Freq.: 100 kHz ... 50 MHz Constant ampl. of 120 mVpp and 3 Vpp | Tektronix SG 503 |
| Square-wave calibration generator | For ampl. calibration: Freq.: 1 kHz Ampl.: 10 mV ... 50 V For rise-time measurements: Freq.: 1 MHz Ampl.: 10 mV ... 500 mV Rise-time: <1 ns | Tektronix PG 506 |
| Time-marker generator | Repetition rate: 0,5 s ... 0,05 / μ s | Tektronix TG 501 |
| Digital multimeter | Wide voltage, current | Philips PM2524 with AC, DC and resistance ranges. High-voltage probe. Required: 0,1% accuracy ,PM9246 |
| Oscilloscope | The bandwidth must be the same or higher than the bandwidth of the instrument under test. | Philips PM3055 |
| Variable mains transformer | Well-insulated output voltage 90...264 Vac | Philips ord.number 2422 529 00005 |
| Moving-iron meter | | |
| Dummy probe 2:1 | 1 Megohm \pm 0,1 %/20 pF | |
| Cables, T-piece, 10:1 attenuator, terminations for the generators | Good quality BNC types for fast rise-time square-wave and high freq. sine-wave. | |
| Trimming tools | | Philips 800NTX (ord. kitnumber 4822 310 50015) |

15.3 SURVEY OF ADJUSTING ELEMENTS

| Adjustment | Adjusting element(s) | Unit | Signal type, Generator, menu | Requirement |
|--|----------------------|--------------|--|--|
| <u>POWER SUPPLY (see section 15.4.2)</u> | | | | |
| +10 V supply | R6406 X6001 | power supply | digital voltm. | 10 V (+, - 10 mV) |
| <u>CRT DISPLAY (see section 15.4.3)</u> | | | | |
| pre adjustment | R4616 | time base | - | mid position |
| black level | R3252 | CRT socket | - | INTENS 10 ⁰ from c.c.w spot just invisible. line parr. |
| TRACE ROTATION | front | - | | graticule |
| Astigmatism | R3267 | CRT socket | function generator 1 kHz/6 div. sine wave DIGITAL MEMORY on. | well defined trace + text |
| <u>DISPLAY SECTION ADJUSTMENT OF DIGITAL MEMORY (see section 15.4.4)</u> | | | | |
| X-offset | R9134 | dig. unit | service menu DISPLAY | correct X-pos. |
| Y-offset | R9123 | dig. unit | service menu DISPLAY | correct Y-pos. |
| X-gain | R9053 | dig. unit | service menu DISPLAY | 10 div. X-defl. |
| Y-gain | R9116 | dig. unit | service menu DISPLAY | 6 div. Y-defl. |
| X-offset text | R4260 | time base | service menu DISPAY | correct X-pos. of text |

| Adjustment | Adjusting Unit element(s) | Unit | Signal type, Generator, menu | Requirement |
|--|---------------------------|-------------|-----------------------------------|--|
| <u>GAIN, LF S.Q. WAVE</u> (see sections 15.4.5 and 15.4.6) | | | | |
| EXT input | C1206 | atten. unit | calibrated sq. wave: 0,5 V/1 kHz | dots at beginning + end of line same intensity |
| | R3118 | XYZ ampl. | calibrated sq. wave: 0,5 V/1 kHz | 5 div. horizontal |
| A input | R1069 | atten. unit | calibrated sq. wave: 0,1 mV/1 kHz | 5 div. vertical at A sens. 20 mV/div. |
| | C1033 | atten. unit | calibrated sq. wave: 0,1 V/1 kHz | Straight pulse top at A sens. 20 mV/div. |
| | R3038 | XYZ ampl. | calibrated sq. wave: 0,1 mV/1 kHz | 5 div. vertical at A sens. 20 mV/div. |
| | R1076 | atten. unit | calibrated sq. wave: 10 mV/1 kHz | 5 div. vertical at A sens. 2 mV/div. |
| | C1029 | atten. unit | calibrated sq. wave: 1 V/1 kHz | Straight pulse top at A sens. 0,2 V/div. |
| | C1023 | atten. unit | calibrated sq. wave: 10 V/1 kHz | Straight pulse top at A sens. 2 V/div. |
| | B input | C1133 | atten. unit | calibrated sq. wave: 0,1 V/1 kHz | Straight pulse top at B sens. 20 mV/div. |
| R1169 | | atten. unit | calibrated sq. wave: 0,1 V/1 kHz | 5 div. vertical at B sens. 20 mV/div. |
| R1176 | | atten. unit | calibrated sq. wave: 10 mV/1 kHz | 5 div. vertical at B sens. 2 mV/div. |

| Adjustment | Adjusting element(s) | Unit | Signal type, Generator, menu | Requirement |
|------------|----------------------|-------------|---------------------------------|--|
| | C1129 | atten. unit | calibrated sq. wave: 1 V/1 kHz | Straight pulse top at A sens. 0,2 V/div. |
| | C1123 | atten. unit | calibrated sq. wave: 10 V/1 kHz | Straight pulse top at A sens. 2 V/div. |

OFFSET (see section 15.4.7)

| | | | | |
|----------------|-------|--------------|----------------|--|
| 1-2-5 bal. A | R1036 | atten. unit | serv.menu: 3.0 | minimise jump |
| 1-2-5 bal. B | R1136 | atten. unit | serv.menu: 3.0 | minimise jump |
| VAR balance A | R1064 | atten. unit | serv.menu: 3.1 | Turn VAR jump |
| VAR balance B | R1164 | atten. unit | serv.menu: 3.1 | Turn VAR jump |
| 1-10 balance A | R1072 | atten. unit | serv.menu: 3.2 | VAR CAL jump |
| 1-10 balance B | R1172 | atten. unit | serv.menu: 3.2 | VAR CAL jump |
| Trig.bal. A | R1091 | atten. unit | serv.menu: 3.3 | VAR CAL jump |
| Trig.bal. B | R1191 | atten. unit | serv.menu: 3.4 | VAR CAL jump |
| Trig.bal. EXT | R1217 | atten. unit | serv.menu: 3.5 | VAR CAL jump |
| Norm.Inv. bal. | R2212 | preamplifier | serv.menu: 3.6 | VAR CAL jump |
| Final Y ampl. | R3007 | XYZ-ampl. | serv.menu: 3.7 | Minimise jump with LEVEL. Centre line with R3007 |

X-DEFLECTION AND TRIGGERING (see section 15.4.8)

| | | | | |
|---------------------|---------|------------------------------|---------------------|-----------------------------------|
| X-defl. offset | R2330 | preamplifier -- | | spot in horizontal mid of screen |
| Trigger sensitivity | (R2395) | preamplifier -- factory adj. | | adjustment in "mid" position |
| | R4004 | time base | sine-wave 0,4V/1kHz | triggered signal at + and - slope |

| Adjustment | Adjusting element(s) | Unit | Signal type, Generator, menu | Requirement |
|--|----------------------|--------------|------------------------------|---|
| LEVEL preset | R2410 | preamplifier | -- | LEVEL pos. such that does not move when turning R2410 |
| LEVEL VIEW balance | R2407 | preamplifier | sine-wave to A 8 V/1 kHz | min. jump between LEVEL VIEW on/off |
| LEVEL VIEW sensitivity | R2410 | preamplifier | sine-wave to A 8 V/1 kHz | LEVEL 3 div. up or down. Min. jump between LEVEL VIEW on/off |
| <u>TIME BASE</u> (see section 15.4.9) | | | | |
| sweep speed: 1 ms/div. | R4108 | time base | time markers: 1 ms | max. accuracy between 2nd and 10th graticule line |
| 1 us/div. | R4107 | time base | 1 us | max. accuracy between 2nd and 10th graticule line |
| X MAGN and 0,1 ms/div. | R4721 | time base | 0,1 us | max. accuracy between 2nd and 10th graticule line |
| <u>HF SQ. WAVE</u> (see section 15.4.10) | | | | |
| | | | fast-rise sq. wave: | |
| Pulse response channel B | R3017 | XYZ-ampl. | 100 mV/ 1 MHz | Optimal pulse response |
| | R3013 C3007 | XYZ-ampl. | 100 mV/ 1 MHz | Optimal pulse response |
| | R3036 C3004 | XYZ-ampl. | 100 mV/ 1 MHz | Optimal pulse response |
| | C3016 | XYZ-ampl. | 100 mV/ 1 MHz | Optimal pulse response |
| | C3005 | XYZ-ampl. | 100 mV/ 1 MHz | Optimal pulse response |

| Adjustment | Adjusting element(s) | Unit | Signal type, Generator, menu | Requirement |
|--------------------------|----------------------|-----------------|--------------------------------|---|
| Pulse response channel A | C1039 | attenuator unit | 100 mV/ 1 MHz | Make channel A equal to B |
| A-offset | R9078 | dig. unit | -- | minimal line jump between memory on/off |
| A-gain | R9064 | dig. unit | calibrated sq. wave 100mV 1kHz | 5 div. Y-defl. via channel 20 mV/div. |
| B-offset | R9178 | dig. unit | -- | minimal line jump between memory on/off |
| B-gain | R9164 | dig. unit | calibrated sq. wave 100mV 1kHz | 5 div. Y-defl. via channel 20 mV/div. |

15.4 ADJUSTING PROCEDURE

The adjusting elements and measuring points are given in figure 22.1.

NOTE: Use always an insulated adjustment tool.

15.4.1 Preparation

Before starting the checking and adjusting procedure, it is necessary to be aware of the following.

- Unless otherwise indicated, the time base must be triggered on the channel that is selected for vertical display and the trigger path is P-P coupled. The time base must function in the AUTO mode and its sweep speed must be adjusted to give good display of the phenomena of interest. The INTENS and FOCUS control must be adjusted to a well-defined trace display.
- Preliminary setting of the controls:
 - All VAR controls must be set in CAL position
 - All POS and LEVEL controls must be set in mid-position.
 - The HOLD OFF control must be set to MIN position.
- The adjustments are done in the memory off mode (text DIGITAL MEMORY not visible in LCD), unless it is otherwise indicated.
- It is advised to take good notice of the LCD where all currently active functions are indicated. This because of the fact that many front panel keys make sequential access possible to various modes.
- Take care to remove the input voltage after each section.
- All signal values are peak-to-peak values (pk-pk), unless otherwise indicated.

For better access to the adjusting elements on the time base unit and the power supply unit, proceed as indicated in section 14.3.

ATTENTION: Do not readjust potentiometer R2395, situated on the Pre-amplifier unit. However, if this potentiometer is inadvertently turned, proceed as indicated in section 15.4.8. under "trigger sensitivity".

15.4.2 Power supply adjustment

- Connect the instrument to the mains voltage and switch the oscilloscope on.
- Connect a digital multimeter to connection point X6001 (+10V REF) on the power supply unit and the instrument's mass.
- Adjust R6406 so that the supply voltage is exactly +10 V (tolerance: $\pm 0,01$ V).

15.4.3 CRT display adjustment

Black level:

- Press AUTO SET.
- Press X DEFL key.
- Set the INTENS control to 10^0 from its left hand stop.
- Set R4616 on the time base in its mid position.
- Adjust R3252 on the CRT socket so that the spot is just invisible.

Trace rotation:

- Press X DEFL key again for deflection via MTB.
- Adjust the front-panel TRACE ROTATION control so that the trace runs exactly in parallel with the horizontal graticule lines.

Astigmatism:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Apply a 6 V/1 kHz sine-wave signal to input A.
- Set the INTENS control for normal brightness.
- Adjust R3267 on the CRT socket (and the FOCUS control) so that the trace is sharp and well-defined over the whole screen area.
- Press the DIGITAL MEMORY key (the instrument comes into the DIGITAL MEMORY mode) and the CURSORS softkey and check also if the text in the top and bottom of the screen is sharp and well-defined. Readjust R3267 on the CRT socket if necessary.

15.4.4 Display section adjustment of digital memory.

- Press the DIGITAL MEMORY key if the text DIGITAL MEMORY is present in the LCD (this switches the DIGITAL MEMORY off).
- Adjust control X POS so that the start of the trace begins exactly at the beginning of the graticule (in horizontal sense).
- Press the RESET key and keep it pressed while pressing the AUTO SET key: this gives access to the service menu.
- Press the CRT softkey DISPLAY: the test waveform that is indicated in the figure below appears on the screen.
- Adjust the X-offset with R9134 on the digital unit so that the waveform as indicated in the figure is obtained as much as possible.
- Adjust the Y-offset with R9123 on the digital unit so that the waveform as indicated in the figure is obtained as much as possible.
- Adjust the X-gain to 10 div with R9053 on the digital unit.
- Adjust the Y-gain to 6 div with R9116 on the digital unit.
- Adjust the X-offset of the text with R4260 on the time base so that the two squares are exactly in the horizontal mid of the screen.
- Press AUTO SET in order to leave the service menu.

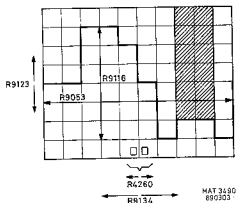


Figure 15.2 Display section adjustment

15.4.5 Gain and LF-sq.wave response EXT and A input

Adjustments located on attenuator unit, unless otherwise indicated.

Input EXT:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Press X DEFL.
- Select TRIG SOURCE "EXT DC".
- EXT input signal: calibrated sq.wave 0,5 V/1 kHz.
- Adjust C1206 for dots with equal intensity at the beginning and end of the horizontal line.
- Adjust R3118 on XYZ-amplifier for 5 div. horizontal deflection (+ or -0,1 div.).

Input A:

- Press the X DEFL key (instrument goes back to normal time base mode)
- Select TRIG SOURCE "A".
- A input signal: calibrated sq.wave 100 mV/1 kHz.
- Channel A sensitivity: 20 mV/div.
- Adjust R1069 for 5 div. vertical deflection (+ or - 0,1 div.).
- Remove the input signal.

15.4.6 Gain and LF-sq.wave response channel A(B)

Adjustments are located on attenuator unit, except R3038 that is located on XYZ-amplifier.

- Do the adjustments for channel A first. Then those mentioned between brackets for channel B.
- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Select TRIG SOURCE "A(B)".
- Adjust vertical gain to 5 div. (+ or - 0,1 div.) and pulse top as straight as possible (max. distortion + or - 0,075 div.).
Use a calibrated sq.wave signal.

| Input signal channel A(B) | Input sensitivity channel A(B) | Adjusting element | |
|------------------------------|-----------------------------------|-------------------|---------------|
| | | sq.wave resp. | gain |
| 0,1 V | 20 mV/div. | C1033 (C1133) | R3038 (R1169) |
| 10 mV | 2 mV/div. | - | R1076 (R1176) |
| 1 V | 0,2 V/div. | C1029 (C1129) | - |
| 10 V | 2 V/div. | C1023 (C1123) | - |

15.4.7 Offset channel A(B)

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT-softkey OFFS-A.
- The successive steps in the following adjustment procedure must be selected with the channel A UP-DOWN control that is normally used to select the input sensitivity of channel A.
- The adjustments are located on the attenuator unit; unless otherwise noted in last column of table.

| Adjustment step | Adjustment point | Max instab. |
|-------------------------|---------------------|--|
| 3.0 1-2-5 balance A(B) | R1036 (R1136) | 0,1 div. |
| 3.1 VAR-balance A(B) | R1064 (R1164) | 0,2 div. Turn VAR A(B) |
| 3.2 x1/x10 balance A(B) | R1072 (R1172) | 0,2 div. VAR A(B) in CAL |
| 3.3 Trig. balance A | R1091 | 0,3 div. |
| 3.4 Trig. balance B | R1191 | 0,3 div. |
| 3.5 Trig. balance EXT | R1217 | 0,3 div. |
| 3.6 Norm/Inv. bal. B | R2212 | 0,1 div. on pre amplifier |
| 3.7 Final Y bal. | R3007 | 0,2 div. on XYZ-ampl. Minimise jump with TRIG LEVEL. Centre line with R3007. |

- Press AUTO SET to leave the service menu.

15.4.8 X-deflection and triggering.

Adjustments on preamplifier unless otherwise noted.

X-deflection offset:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Operate the X POS control so that the start of the trace coincides exactly with the beginning of the graticule (in horizontal sense).
- Press the X DEFL key.
- Adjust R2330 so that the spot is exactly in the horizontal mid of the screen.

Trigger sensitivity:

Important: R2395 is a factory-adjustment and must not be turned. If it is turned by mistake, you have to proceed as follows:

- Connect a digital voltmeter between the "connector side" of R4001 and R4002 on the time base unit. Refer to the p.c.b. lay-out in chapter 7 for the position of these resistors.
- Adjust R2395 so that the read-out of the voltmeter is 0 volt exactly

Now the adjustment of R4004:

- Press the X DEFL key (instrument goes back to normal time base mode)
- Put R2395 in its mid position.
- Apply a sinewave of 0,4 V/1 kHz to the channel A input.
- Operate the trigger slope key / repeatedly. ****
- Adjust R4004 on the time base so that the signal is triggered in the two trigger slope positions.

Level view adjustment:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Press the CND key of channel A.
- Put the channel A trace in the vertical mid of the screen with the Y POS control and keep the control in that position.
- Select DC TRIGger COUPLing.
- Press the X DEFL key twice so that the LEVEL VIEW mode is activated (this is also indicated in the LCD).
- Put the TRIGger LEVEL control in such a position that the trace does not move when turning R2410 between its extreme positions. Keep the LEVEL control in this position.

- Press the X DEFL key in order to return to normal time base mode.
- Press the GND key of channel A so that this channel is not grounded anymore.
- Adjust the generator to a sinewave voltage of 8 V/1 kHz.
- Select a sweep speed of 50 ns/div for the time base: this stretches the sinewave into a line.
- Turn the INTENSITY control fully clockwise to make the trace visible
- Switch the X DEFL key repeatedly between LEVEL VIEW and normal mode and adjust R2407 to minimal trace shift.

- Press the X DEFL key in order to switch the LEVEL VIEW mode on.
- Turn the TRIGGER LEVEL control so that the line is 3 div above the the vertical mid of the graticule.
- Switch the X DEFL key repeatedly between LEVEL VIEW and normal mode and adjust R2410 so that the vertical shift of the trace is not more than 0,4 div.

- Press the X DEFL key in order to switch the LEVEL VIEW mode on.
- Turn the TRIGGER LEVEL control so that the line is 3 div under the the vertical mid of the graticule.
- Switch the X DEFL key repeatedly between LEVEL VIEW and normal mode and readjust R2410 slightly if the vertical shift of the trace is more than 0,4 div.

15.4.9 Time base sweep speeds

Adjustments on time base unit.

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Channel A input signal: time marker pulse 1 ms.
- Select an input sensitivity of 0,5 V/div for channel A.
- Adjust Y POS A, TRIG LEVEL and channel A input sensitivity for a well-readable display.
- Adjust R4108 so that 2nd and 10th marker pulse coincide with the corresponding graticule lines (max. deviation 0,16 div.). Use X POS for a correct horizontal position.

- Channel A input signal: time marker pulse 1 us.
- Time base sweep speed: 1 us/div.
- Adjust R4107 so that 2nd and 10th marker pulse coincide with corresponding graticule lines. Max. deviation 0,16 div.

- Channel A input signal: time marker pulse 0,1 ms.
- Press X MAGN.
- Time base sweep speed: 0,1 ms/div.
- Adjust R4721 so that 2nd and 10th marker pulse coincide with corresponding graticule lines. Use X POS for a correct horizontal position; the control must stay approximately in its mid position. Max. deviation 0,24 div.
- Turn X POS fully clockwise and fully counter clockwise and check that the marker pulse deviation does not exceed 0,24 div.
- Remove the input signal.

15.4.10 HF sq.wave response channel B and A.

Adjustments on XYZ-amplifier.

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Apply to channel B a square wave signal of 1MHz/>900mV with a fast rise time < 1 ns via an 10:1 attenuator and terminated into 50 ohms
- Press A/B twice so that channel B is displayed.
- Select channel B as TRIGger SOURCE.
- Select an input sensitivity of 20 mV/div for channel B.
- Select a sweep speed of 0,1 us/div for the time base.
- Center the signal with the channel B Y POS control.
- Adjust R3013/C3007, R3036/C3004, C3005, C3016 and R3017 to a rising pulse edge with maximum steepness and a pulse top that is a flat as possible. Refer to the figure below. This figure also indicates the influence of the adjustments on certain parts of the rising edge and the top of the pulse. If necessary adapt the time base sweep speed and switch the X MAGN on to obtain a better view of the phenomena of interest.
- Check that the pulse via channel B has a rise-time of < 7 ns and that pulse aberrations are $< 0,2$ div. peak-to-peak. Tilt must not exceed + or - 0,1 div.

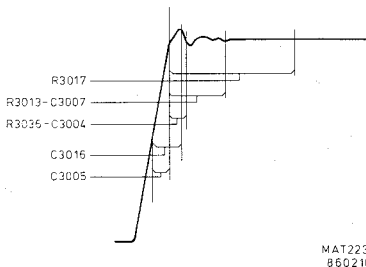


Figure 15.3 Square-wave response

- Press key A/B so that channel A is displayed.
- Move the generator signal from input B to input A.
- Select channel A as the TRIGGER SOURCE.
- Select an input sensitivity of 20 mV/div for channel A.
- Center the signal with the channel A Y POS control.
- Make the pulse response of channel A as much as possible equal to that of channel B with R1039 on the attenuator unit.
- Check that the pulse via channel A has a rise-time of ≤ 7 ns and that pulse aberrations are $\leq 0,2$ div. peak-to-peak. Tilt must not exceed + or - 0,1 div.

15.4.11 Gain and offset in digital memory mode.

All adjustments are located on the digital unit.

Channel A:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Select an input sensitivity of 20 mV/div for channel A.
- Press the GND key of channel A.
- Position the line exactly in the vertical mid of the screen.
- Operate the DIGITAL MEMORY key repeatedly and minimise the trace shift with R 9078.
- Press the GND key of channel A so that this channel is not grounded anymore.
- Apply a calibrated square wave signal of 100 mV/1 kHz to the A channel input.
- Adjust the amplitude of the signal to 5 div with R9064.

Channel B:

- Press RESET and keep it pressed while pressing AUTO SET: this gives access to the service menu.
- Press CRT softkey APPL.
- Press CRT softkey STANDARD SETTING: this brings the scope back to normal mode with predefined settings.
- Press the A/B key twice so that channel B is displayed.
- Select an input sensitivity of 20 mV/div for channel B.
- Press the GND key of channel B.
- Position the line exactly in the vertical mid of the screen.
- Operate the DIGITAL MEMORY key repeatedly and minimise the trace shift with R 9178.
- Press the GND key of channel B so that this channel is not grounded anymore.
- Select B as trigger source.
- Apply a calibrated square wave signal of 100 mV/1 kHz to the B channel input.
- Adjust the amplitude of the signal to 5 div with R9164.

16. CORRECTIVE MAINTENANCE

16.1 REPLACEMENTS

WARNING: The EHT cable is directly connected to the CRT. When the EHT cable to the post-acceleration anode is disconnected, the cable must be discharged by shorting the terminal to the instrument's earth.

16.1.1 Standard parts

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

NOTE: Physical size and shape of a component may affect the instrument's performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.

16.1.2 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.

16.1.3 Transistors and Integrated Circuits

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

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

16.1.4 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.

16.1.5 Handling MOS devices

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

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

16.1.5.1 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.

16.1.5.2 Testing or handling

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

16.1.5.3 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 electrical (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.

16.1.5.4 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.

16.1.5.5 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

16.1.5.6 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.

16.1.5.7 Voltage surges

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

16.2 REMOVING THE UNITS AND MECHANICAL PARTS

NOTE: For installation, work in reversed sequence.

16.2.1 Attenuator unit (A1)

- First put the digital unit A9 in upright position. Refer to figure 16.4 that indicates this position.
- Push gently both clamping lips that secure the metal locking plate for the attenuator unit and remove the locking plate.
- Push the attenuator unit backwards for about 1 cm.
- Remove the front unit (see section 16.2.7).
- Remove the control knobs of the CRT control unit.
- Pull gently both clamping lips that secure the front profile gently backwards and loosen the front profile.

ATTENTION: To avoid damage, ensure that the BNCs of the attenuator unit are behind the front profile before loosening the front profile.

Now the attenuator unit can easily be pulled out of the instrument after removing the connector with flat cable and the ground connector.

Dismantling the Attenuator unit:

- For access to the components of the unit, remove both upper and bottom covers.
- When removing the BNCs first unsolder the wire to the pcb and then unscrew the BNC-nut with a spanner of max. 5 mm thickness.

16.2.2 Pre-amplifier unit (A2) and Adaptation unit (A16)

- First put the digital unit A9 in upright position. Refer to figure 16.4 that indicates this position.
- Then remove the time-base unit (see section 16.2.4).
- Unlock the two p.c.b. supports
- The complete p.c.b. can be removed from the instrument after having removed all flat cables.

16.2.3 XYZ-amplifier unit (A3)

The XYZ amplifier unit incorporates two separate p.c.b.'s connected via a flat cable. One p.c.b. includes amongst other things the CRT socket and must be loosened first. For this, the CRT socket must be carefully removed from the CRT.

Now the part situated above the CRT can be removed as follows:

- Remove all flat cables and the delay line cable plug.
- Pull all clamping lips that secure the XYZ-amplifier unit p.c.b. outwards and take out the complete unit. Refer to figure 16.1.

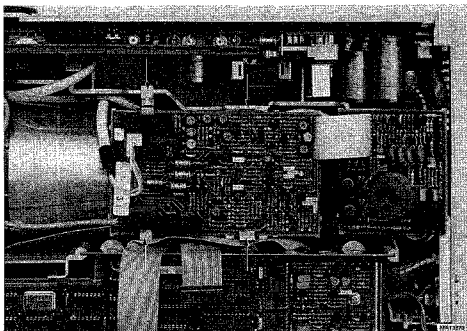


Figure 16.1 Clamping lips for XYZ-amplifier unit

16.2.4 Time-base unit (A4)

- Put the digital unit in upright position such as indicated in figure 16.4.
- Unlock the 3 plastic p.c.b. supports with a special tool that matches the diameter of the p.c.b. support (see section 16.6.2).
- The complete p.c.b. can be taken out of the instrument after having removed all flat cables. The time base can also be placed upright on the chassis: this is indicated in figure 16.4.

16.2.5 CRT control unit (A5)

- Remove the front unit (see section 16.2.7)
- Loosen the front profile (see section 16.2.1)
- Now the CRT control unit can be pulled out of the front profile after having removed the flat-cable and the CAL connector.

16.2.6 Power supply unit (A6)

WARNING: Inside the power supply pcb there are many parts that carry dangerous high voltages. Some of these voltages remain 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 removing the p.c.b. If working on the power supply unit under live condition cannot be avoided, it must be done by a qualified technician who is aware of the dangers involved. Moreover the use of a mains separation transformer is strongly recommended.

- Remove the extension shaft from the ON/OFF switch by pushing both ends together.
- Push both clamping lips that secure the power supply unit.
- Lift the power supply unit outside the instrument.
- Place the p.c.b. in the unit slider.

- NOTES: - After the mentioned actions, the power supply unit can be measured under working conditions, provided that all cables are still connected to the unit.
- The flat cable to the CRT control unit can easily be removed now when having positioned the power supply unit like described.
- Remove the two flat cables, the power supply cable, the two- and three-pole cable connectors and the EHT-connector from the CRT.
- WARNING: The EHT cable is directly connected to the CRT. When the EHT cable to the post-acceleration anode is disconnected, the cable must be discharged by shorting the terminal to the instrument's earth.
- The power supply can now be taken out of the instrument.

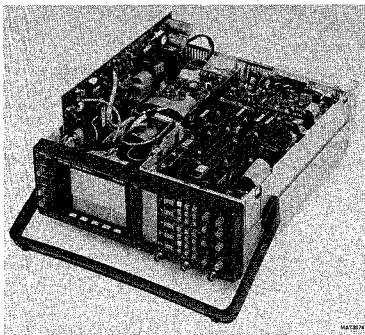


Figure 16.2 Power supply unit in service position.

16.2.7 Front unit (A7) and LCD unit (A8)

- Put the digital unit A9 and the time base unit A4 in their upright position such as indicated in figure 16.4.
- Unscrew the two screws, located at the rear of the front unit.
- Now the complete unit assembly can be slid out of the front profile of the instrument.

NOTE: After the above actions, the front unit can be measured under working conditions, provided that the flat cable is still connected to the unit.

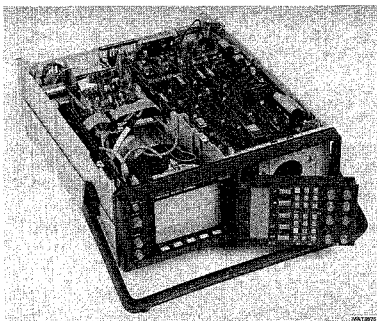


Figure 16.3 Measuring the front unit working condition

For accessibility to the component side of the front unit and LCD unit, proceed as follows:

- Unplug the connector with flat cable.
- Remove all control knobs; the knobs can be easily pulled off the potentiometer spindles.
- Pull all clamping lips that secure the front unit p.c.b. gently outwards and loosen the text plate.

NOTE: The LCD unit is connected to the front unit by means of two 3-pin connectors and can be easily pulled off. The LCD display lamp is accessible after pulling of the LCD unit.

16.2.8 Digital unit A9

Measuring position and p.c.b. exchange:

- The digital unit is directly accessible after removal of the instrument's top cover: all components are accessible for measuring purposes then.
- The unit can be separated from its mounting plate after removal of the multipole and coaxial connectors and 6 mounting screws.
- The mounting plate is fixed to the right-hand side panel of the oscilloscope with 2 self-tapping screws.
- The digital unit (and its mounting plate) can be put in upright position such as indicated in figure 16.4.

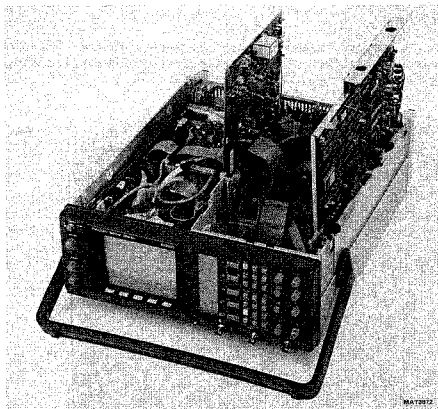


Figure 16.4 Measuring digital unit A9 and time base unit A4 in upright position for measuring in working condition.

16.2.9 Removing the delay-line cable

The delay-line cable is a 54 cm cable that is connected between the preamplifier unit and the XYZ amplifier unit.

To remove the delay-line cable, proceed as follows:

- For access to the delay line cable, remove the digital unit, the time base unit and the pre-amplifier/adaptation unit.
- Unlock the plastic clamps that fix the cable to the instrument's chassis and to the units.
- Remove the plug that connects the delay-line cable to the pre-amplifier unit.
- Unlock the plastic clamp that fixes the cable to the XYZ-amplifier unit.
- Remove the plug that connects the delay-line cable to the XYZ-amplifier unit.

16.2.10 Replacement of CRT

IMPORTANT: It is strongly recommended to study this chapter and the associated illustration before starting the replacement. Refer also to figure 16.5 for this.

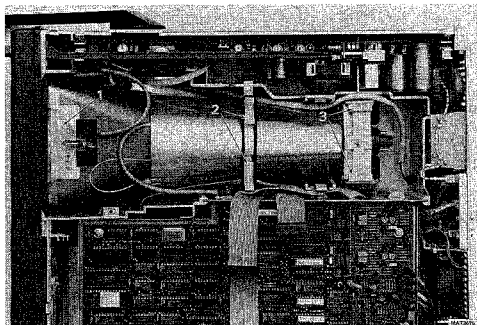


Figure 16.5 Removing the CRT

- Remove the XYZ-amplifier unit, see section 16.2.3.
- Remove the graticule lamp holder (1).
- Remove the bezel with the screen filter.
- Remove the two plastic pcb supports (2).
- Unlock the EHT-cable. Discharge the end of the cable to earth potential in order to prevent electric shock. This earth potential can be obtained via a measuring lead connected to the metal chassis plate at the rear panel of the oscilloscope.

WARNING: Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode.

- Push the two clamping lips that secure the CRT support (3) and gently lift the CRT, incl. metal shielding out of the instrument.

NOTE: Before re-assembling a new CRT, first remove its protective cover and place the CRT front rubber around the CRT-front.

16.3 SOLDERING TECHNIQUES

Working method:

- Carefully unsolder one after the other the soldering leads of the semi-conductor.
- Remove all superfluous soldering material. Use a suction iron of suction litze wire.
- Check that the leads of the replacement part are clean and pre-tinned on the soldering place.
- Locate the replacement semi-conductor exactly on its place, and solder each lead 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 leads 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 6 A, voltage 6 V, in combination with PLATO pin-point tip type 0-569.
- ERSA miniature soldering iron, type minor 040 B, voltage 6 V.
- Low Voltage Mini Soldering Iron, type 800/12 W-6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with lmm pin-point tip, order no. 4822 395 10012.

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

16.4 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.

16.5 TROUBLE SHOOTING

16.5.1 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.

16.5.2 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 15. "Checking and Adjusting".
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC's that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes.
Check the voltage between base and emitter (0,7 V approx. in conductive state) and the voltage between collector and emitter (0,2 V 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 sections 3...19.
- 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 waveform responses when HF signals are passed through the circuit. Also an inductance meter can be used.

- Data latches.

To measure on inputs and outputs of data latches a measuring oscilloscope can be triggered by the clock signal which is connected to the clock input of the data latch. This measurement can only be made 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.

16.5.3 Power-up routine

Every time the instrument is switched-on an initialisation program is executed. By simply watching the LCD after switching on, it can be determined if the microcomputer related control part of the oscilloscope is functioning correctly.

Directly after switching on, the instrument's internal serial control bus is checked and if everything is OK all segments in the LCD will light up. Passing this test means that the serial bus that controls the LCD and that puts the circuitry in the desired mode, functions correctly. This control bus is the so-called I2C bus and a general description of its configuration can be found in the explanation of the digital block diagram (where the control signals are generated) and the analog block diagram (where the control signals are setting the circuitry in the desired mode. The block diagram shows that the control signals are generated on the digital unit A9 and that the distribution occurs via the front unit A7.

After the test of the serial control bus, the RAM where the scope's settings are stored is tested. These settings are compared with a sumcheck figure. If the test is successfully passed, the settings from before switching-on are becoming active and thus also visible in the LCD. If the sumcheck test is not passed (e.g. if the memory back-up batteries are not installed or empty), the RAM is tested byte for byte. This is done by writing and reading 10101010 and 01010101 bit patterns in every memory location. If a fault is detected, the program keeps on trying to write and read into the defective memory address. This can be measured with an oscilloscope at the RAM's chip enable input and at the read and write inputs (half the frequency).

If this test is passed the instrument starts up with default settings and the LCD is updated correspondingly.

16.5.4 Trouble-shooting the power supply

To determine whether a certain fault condition is initiated by the 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. These resistors can be ordered at Concern Service.

| Supply voltage | Output current | Dummy resistance and their service ordering numbers |
|----------------|----------------|---|
| + 5 V | 2,4 A | 2,9E-12W: 3 x 10E (4822 112 21052) and 22E (4822 11221063) in parallel. |
| - 6,4 V | 930 mA | 6,9E-6W: 8,2E (4822 112 41052) and 47E (4822 110 23072) in parallel. |
| + 12 V | 720 mA | 17,2E-8,7W: 33E (4822 112 41067) and 39E (4822 112 43069) in parallel. |
| - 12 V | 500 mA | 24,7E-6W: 39E (4822 112 41069) and 68E (4822 112 41076) in parallel. |
| + 17 V | 340 mA | 51E-6W: 1E (4822 110 23027) in serial with 2 x 100E (4822 112 41081) in parallel. |
| - 17 V | 100 mA | 171E-1,7W: 270E (4822 110 43092) and 470E (4822 110 43098) in parallel. |
| + 48 V | 140 mA | 341E-7W: 330E (4822 112 41094) in serial with 12E (4822 110 23056) in parallel. |
| + 48 V | 40 mA | 1k22-2W: 2k2 (4822 110 23116) and 2k7 (4822 110 23118) in parallel. |

16.6 SPECIAL TOOLS

16.6.1 Trimming Kit SBC 317 - 4822 310 50095

The SBC 317 Trimming Kit matches every current trimming requirement for all products. The set contains 27 items (22 different bits, plus 3 bit holders and 2 extension pieces). The insulated holders and extension 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 are duplicated. In addition, a spare set of 8 bits is separately available as replacement (4822 310 50016).

The Trimming Kit contains the following parts:

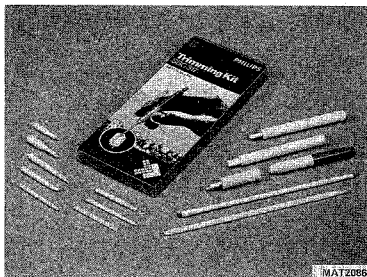


Figure 16.6 Trimming tool kit

16.6.2 p.c.b. Snapper - 5322 535 91942

A special tool is available for removal of the p.c.b. from the p.c.b. supports. Information on how to use this tool is given in chapter 16.2. The ordering number of this tool is 5322 535 91942

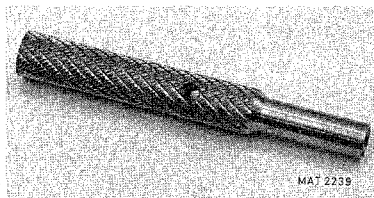


Figure 16.7 p.c.b. Snapper

16.7 RECALIBRATION AFTER REPAIR

After any electrical component has been renewed the calibration of its associated 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.

17. SAFETY INSPECTION AND TEST AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

THE PRIMARY

17.1 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 rigidity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

17.2 SAFETY COMPONENTS

Components in the primary circuit may only be renewed by components selected by Philips, see also section 16.1.2.

17.3 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.

17.4 CHECKING THE INSULATION RESISTANCE

Measure the insulation resistance at $U = 500$ V 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 Meg-ohm.

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

17.5 CHECKING THE LEAKAGE CURRENT

The leakage current shall be measured between each pole of the mains supply in turn, and all accessible conductive parts connected together (including the measuring earth terminal). The leakage current is not excessive if the measured currents from the mentioned parts does not exceed 0,5 mA rms.

17.6 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 connected to the accessible conductive parts.

Mechanical parts located at rear panel

| Item | Qty | Ordering code | Description |
|------|-----|----------------|---------------------------------------|
| 31 | 2 | 5322 462 50324 | Rear foot |
| -- | 1 | 5322 267 10004 | BNC socket for Z-MOD |
| -- | 2 | 5322 502 12003 | Screws for mains input socket |
| -- | 1 | 5322 321 21616 | Line cable, European version |
| -- | 1 | 5322 321 10446 | Line cable, USA version |
| -- | 1 | 5322 321 21617 | Line cable, British version |
| -- | 1 | 5322 321 21618 | Line cable, Swiss version |
| -- | 1 | 5322 321 21781 | Line cable, Australean version |
| -- | 1 | 5322 219 81119 | Mains input socket, incl. fuse holder |
| -- | 1 | 4822 253 30024 | Fuse 1,6A (for mains input) |

Mechanical parts located around the Cathode Ray Tube

| Item | Qty | Ordering code | Description |
|------|-----|----------------|--------------------------|
| 16 | 1 | 5322 460 60404 | CRT front rubber |
| 17 | 1 | 5322 462 40957 | Light conductor for CRT |
| 18 | 1 | 5322 134 40534 | Lamp 28V-40mA |
| 19 | 1 | 5322 131 20169 | Cath. Ray Tube D14-372GH |
| 25 | 1 | 5322 466 30163 | CRT shielding |
| 28 | 1 | 5322 466 30164 | CRT manchet, rubber |
| 29 | 1 | 5322 462 10263 | CRT support, plastic |

Printed circuit boards

| Item | Unit nr. | Ordering code | Description |
|------|----------|----------------|--|
| 36 | A1 | 5322 216 51114 | Attenuator unit |
| 35 | A2 | 5322 216 51196 | Pre-amplifier unit |
| 26 | A3 | 5322 216 51117 | XYZ-amplifier unit |
| 33 | A4 | 5322 216 51239 | Time-base unit |
| 14 | A5 | 5322 216 51118 | CRT-control unit |
| 23 | A6 | 5322 216 51195 | Power supply unit |
| 52 | A7 | 5322 216 51233 | Front unit |
| 53 | A8 | 5322 216 51207 | LCD unit |
| 32 | A9 | 5322 216 51232 | Digital unit A9 |
| 34 | A15 | 5322 216 51204 | Adaptation unit |
| 4 | A18 | 5322 216 51209 | Unit with 5 pushbuttons under CRT screen |

18.2 CABLES AND CONNECTORS

18.2.1 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 to 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:

| | | |
|-------------------------|--------------------|----------------|
| 6 pole cable connector | X7019 | 5322 268 40301 |
| 10 pole cable connector | X606-X5007-X6007 | 5322 268 40234 |
| 20 pole cable connector | X2010-X3002-X3003 | 5322 268 40235 |
| | X4002-X4010-X6009 | |
| | X7091 | |
| 26 pole cable connector | X1009-X2009 | 5322 267 70175 |
| 34 pole cable connector | X2001-X4001 | 5322 268 40236 |
| 40 pole cable connector | X9050-X7050-(X150) | 5322 267 70227 |

The following AMP-connectors are available:

| | |
|---|----------------|
| 2 pole-single, without contact pins | 5322 268 40232 |
| 3 pole-single, without contact pins | 5322 268 40233 |
| bus contact for AMP-cable connector, per piece: | 5322 268 20152 |
| 5 pole connector for power-in: | 5322 267 50452 |
| bus contact for connector, per piece: | 5322 268 24128 |

NOTE: The flatcables are fixed onto the p.c.b. connectors by means of a pair of flatcable connector clamps, per piece

5322 401 11156

18. PARTS LIST

(subject to alteration without notice)

18.1 MECHANICAL PARTS (Are indicated in figure 18.1)

| Item | Qty | Ordering code | Description |
|------|-----|----------------|------------------------------------|
| 1 | 1 | 5322 459 20503 | Bezel |
| 2 | 1 | 5322 414 20213 | Positioning strip, plastic |
| 3 | 1 | 5322 464 90484 | Fixation strip |
| 5 | 1 | 5322 480 30181 | Contrast filter blue |
| 6 | 1 | 5322 455 81083 | Textfilm on bezel PM3335 |
| 6 | 1 | 5322 455 81084 | Textfilm on bezel PM3337 |
| 7 | 1 | 5322 268 14052 | CAL socket |
| 8 | 1 | 4822 530 70296 | Clamping spring for CAL socket |
| 9 | 11 | 5322 414 10018 | Control knob with spring |
| 10 | 1 | 5322 464 90252 | Front frame |
| 11 | 1 | 5322 455 81026 | Textfilm CRT unit |
| 12 | 1 | 5322 455 81085 | Textfilm for handle PM3335 |
| 13 | 1 | 5322 498 50219 | Handle assembly |
| 15 | 1 | 5322 414 60142 | Power-on knob, green-brown |
| 20 | 2 | 5322 492 63355 | Spring for handle |
| 21 | 1 | 5322 535 80735 | Extension part for power-on switch |
| 22 | 1 | 5322 447 91499 | Upper cabinet |
| 24 | 2 | 5322 462 10265 | P.c.b. support for A3 |
| 27 | 2 | 5322 462 10264 | P.c.b. guiding for A6 |
| 30 | 1 | 5322 464 90486 | Chassis |
| 37 | 6 | 5322 462 30304 | P.c.b. support |
| 38 | 1 | 5322 464 90249 | Bottom cabinet |
| 39 | 2 | 5322 464 90253 | Attenuator cover |
| 40 | 4 | 5322 462 50325 | Bottom foot |
| 41 | 3 | 5322 506 21188 | BNC spacer ring |
| 42 | 3 | 5322 532 41006 | BNC extension bush |
| 43 | 3 | 5322 267 10004 | BNC socket |
| 44 | 1 | 5322 464 90254 | Front unit frame |
| 45 | 1 | 5322 455 81086 | Textfilm for front unit |
| 46 | 23 | 5322 276 11856 | Softkey brown |
| 47 | 1 | 5322 276 12332 | Softkey white |
| 48 | 1 | 5322 276 11857 | Softkey green |
| 49 | 5 | 5322 277 10878 | UP-DOWN key brown |
| 50 | 2 | 5322 492 63354 | Range indication spring |
| 51 | 1 | 5322 450 60952 | LCD window |
| 54 | 1 | 5322 256 60289 | Battery back-up holder |
| 55 | 1 | 5322 361 10326 | FAN assembly |
| 56 | 2 | 5322 401 11278 | Metal fastener for A9 |
| 57 | 2 | 5322 290 40257 | Flat cable clamp |
| 58 | 2 | 5322 256 64014 | Battery holder |
| -- | 2 | 5322 255 40928 | Heatsink for V3011 and V3012 |
| -- | 2 | 5322 255 40059 | Spacer for heatsink V3011, V3012 |
| -- | 2 | 5322 401 10954 | Delay line cable clamp |

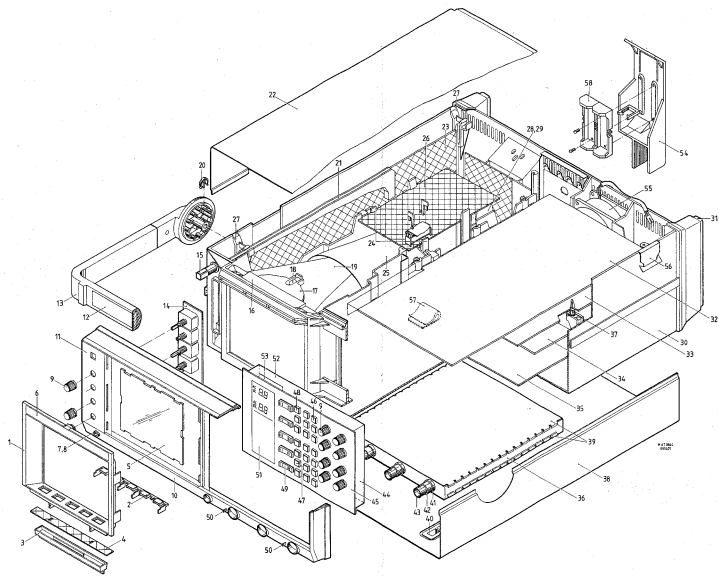


Figure 18.1 Exploded view

18.2.2 P.c.b.-connectors (male headers)

| Type | Item | Ordering number |
|-------------------------|---|-----------------|
| 2 pole-single | X414-X416-X2013-X4017 X6018-X6020 | 5322 265 20275 |
| 2 pole-single 90° type | X9016-X9017-X9018 | 5322 265 20356 |
| 3 pole-single | X6008-X6019 | 5322 265 30434 |
| 3 pole single | X7011-X7012 | 5322 265 30396 |
| 3 pole-single 90° type | X2004-X3004-X3005- X3008 | 5322 265 30433 |
| 5 pole-single | X6014 | 5322 265 40436 |
| 6 pole-single 90° type | X9004 | 5322 265 30741 |
| 10 pole-double | X606-X5007-X6007-X9006 | 5322 265 40485 |
| 10 pole-double 90° type | X606 | 5322 265 51188 |
| 20 pole-double | X2010-X3002-X3003 X4002-X4010-X6003 X9003 | 5322 265 51129 |
| 26 pole-double | X1009-X2009 | 5322 265 61071 |
| 34 pole-double | X9050-7050 | 5322 265 61069 |
| 34 pole-double 90° type | X7001 | 5322 265 61068 |
| 40 pole-double | X98-X808 | 5322 265 61072 |

18.2.3 50 Ohm cables and connectors

The 50 Ohm coax-cables are standardized, so some cables are a little bit too long.

The tules around the cable end may have a different colour; if necessary it can be replaced by the original one.

| | |
|-------------------------------|----------------|
| - Cable, 30 cm long, 90° type | 5322 321 22617 |
| - Cable, 45 cm long | 5322 321 22616 |

The 50 Ohm coax-connector socket consists of two parts, bush and pin.

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

18.2.4 Miscellaneous cables

| | |
|---|----------------|
| - Delay line cable, 54 cm long | 5322 321 21595 |
| - Flex jump cable, used for interconnection for A3 - 11 pole. | 5322 290 60605 |

18.2.5 Miscellaneous sockets and connectors

| | |
|--|----------------|
| CRT socket | 5322 255 40502 |
| p.c.b. socket, 3 pole (X7011, X7012) | 5322 265 30396 |
| p.c.b. socket, 3 pole (X8011, X8012) | 5322 267 40667 |
| Socket for D9079 | 5322 255 40828 |
| Socket for D801 | 5322 255 40815 |
| p.c.b. socket, 8 pole (X621, X622, X623, X624) | 5322 265 40483 |
| p.c.b. socket, 8 pole (X2021, X2022, X2023, X2024) | 5322 267 50786 |

18.3 ELECTRICAL PARTS

18.3.1 CAPACITORS

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|---------------|-------|-------------|---------------|
| C 1118 | 0.25PF | 2.7PF | 5322 | 122 | 32894 |
| C 1119 | 2K | 33PF | 5322 | 122 | 32872 |
| C 1121 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1122 | 2K | 22PF | 5322 | 122 | 32143 |
| C 1123 | 7-10.0 PF | MUR | 5322 | 125 | 11013 |
| C 1124 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1126 | 0.25PF | 1.3PF | 5322 | 122 | 32551 |
| C 1127 | 0.25PF | 2.2PF | 5322 | 122 | 32774 |
| C 1128 | 2K | 33PF | 5322 | 122 | 32072 |
| C 1129 | 7-10.0 PF | MUR | 5322 | 125 | 11013 |
| C 1131 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1132 | 2K | 33PF | 5322 | 122 | 32551 |
| C 1133 | 7-10.0 PF | MUR | 5322 | 125 | 11013 |
| C 1134 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1135 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1136 | 2K | 33PF | 5322 | 122 | 31069 |
| C 1137 | 2K | 22PF | 5322 | 122 | 32143 |
| C 1138 | 2K | 100PF | 4822 | 122 | 31314 |
| C 1139 | 0.25PF | 2.2PF | 4822 | 122 | 31036 |
| C 1140 | 2K | 100PF | 4822 | 122 | 31316 |
| C 1141 | 63V 10K | 100NF | 5322 | 121 | 42492 |
| C 1142 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1143 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1144 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1145 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1146 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1147 | 0.25PF | 4.7PF | 4822 | 122 | 31822 |
| C 1161 | 10K | 470PF | 4822 | 122 | 30334 |
| C 1162 | 0.25PF | 1.6PF | 5322 | 122 | 31821 |
| C 1163 | 2K | 33PF | 5322 | 122 | 32572 |
| C 1164 | 10K | 2.2NF | 4822 | 122 | 30114 |
| C 1166 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1167 | 2K | 150PF | 4822 | 122 | 31413 |
| C 1168 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1171 | -20+50K | 10NF | 4822 | 122 | 30144 |
| C 1172 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1173 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1174 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1176 | 10K | 1.5NF | 4822 | 122 | 31169 |
| C 1177 | 10K | 1.5NF | 4822 | 122 | 31169 |
| C 1201 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1202 | 400V 10K | 22NF | 5322 | 121 | 43088 |
| C 1203 | 2K | 33PF | 5322 | 122 | 32551 |
| C 1204 | 0.25PF | 5.9PF | 4822 | 122 | 31217 |
| C 1206 | 7-10.0 PF | MUR | 5322 | 125 | 11013 |
| C 1207 | 2K | 22PF | 5322 | 122 | 32072 |
| C 1208 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1209 | 0.25PF | 2.2PF | 4822 | 122 | 31414 |
| C 1211 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1212 | 2K | 100PF | 4822 | 122 | 31316 |
| C 1213 | 0.25PF | 1.8PF | 5322 | 122 | 32313 |
| C 1214 | 0.25PF | 0.68PF | 4822 | 122 | 31215 |
| C 1216 | 2K | 12PF | 4822 | 122 | 31036 |
| C 1217 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1401 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1402 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1403 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1404 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1405 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1407 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1408 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1409 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1411 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1412 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1413 | -10+50K | 47UF | 4822 | 124 | 20689 |
| C 1414 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1420 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1421 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1422 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1423 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1424 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1427 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1428 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1429 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1431 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1432 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1433 | -10+50K | 47UF | 4822 | 124 | 20689 |
| C 1434 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1441 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1442 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1443 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1444 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 1446 | -10+50K | 68UF | 4822 | 124 | 20689 |
| C 1447 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 2049 | 10K | 1.5NF | 4822 | 122 | 31169 |
| C 2050 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 2051 | 10K | 1.5NF | 4822 | 122 | 31169 |
| C 2150 | -20+50K | 10NF | 4822 | 122 | 31169 |
| C 2151 | -20+50K | 10NF | 4822 | 122 | 31414 |
| C 2159 | 10K | 1.5NF | 4822 | 122 | 31169 |

| POS#R | DESCRIPTION | ORDERING CODE | POS#R | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|--------|---------------|----------------|
| C 2201 | -20+50X 10NF | 4822 122 31414 | C 3021 | -20+50X 10NF | 4822 122 31414 |
| C 2203 | -20+50X 10NF | 4822 122 31414 | C 3022 | -20+50X 10NF | 4822 122 31414 |
| C 2215 | 0.25PF 6.8PF | 4822 122 31049 | C 3101 | 10X 1.5NF | 4822 122 31169 |
| C 2216 | 0.25PF 2.7PF | 4822 122 31052 | C 3102 | 10X 1.5NF | 4822 122 31169 |
| C 2217 | -20+50X 10NF | 4822 122 31414 | C 3103 | 7-10PF | 5322 125 11013 |
| C 2218 | 0.25PF 2.7PF | 4822 122 31038 | C 3104 | 100V 10X 10NF | 5322 121 42491 |
| C 2219 | 0.25PF 1.5NF | 4822 122 31034 | C 3105 | -20+50X 10NF | 4822 122 31414 |
| C 2221 | 10X 1.5NF | 4822 122 31169 | C 3106 | 63V 10X 100NF | 5322 121 42492 |
| C 2222 | 0.25PF 8.2PF | 4822 122 31052 | C 3107 | 0.25PF 2.7PF | 4822 122 31038 |
| C 2223 | 10X 1.5NF | 4822 122 31169 | C 3108 | 0.25PF 0.82PF | 4822 122 31414 |
| C 2224 | 10X 1.5NF | 4822 122 31169 | C 3109 | 63V 10X 100NF | 5322 121 42492 |
| C 2225 | 10X 470PF | 4822 122 30034 | C 3110 | 10X 1.5NF | 4822 122 31414 |
| C 2226 | 10X 470PF | 4822 122 30034 | C 3111 | -20+50X 10NF | 4822 122 31414 |
| C 2229 | 10X 470PF | 4822 122 30034 | C 3112 | 0.25PF 3.9PF | 5322 122 36107 |
| C 2230 | 10X 470PF | 4822 122 30034 | C 3113 | 0.25PF 0.82PF | 4822 122 31414 |
| C 2305 | -20+50X 10NF | 4822 122 31414 | C 3114 | 100V 10X 47NF | 5322 121 42491 |
| C 2306 | 10X 1.5NF | 4822 122 31169 | C 3116 | 63V 10X 100NF | 5322 121 42492 |
| C 2307 | 10X 1.5NF | 4822 122 31169 | C 3200 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2317 | 0.25PF 1.5PF | 5322 122 32101 | C 3201 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2318 | 10X 470PF | 4822 122 30034 | C 3202 | 63V 10X 100NF | 5322 121 42492 |
| C 2521 | 0.25PF 1.5PF | 5322 122 32101 | C 3203 | 63V 10X 100NF | 5322 121 42492 |
| C 2526 | -20+50X 10NF | 4822 122 31414 | C 3204 | -20+50X 10NF | 4822 122 31414 |
| C 2527 | -20+50X 10NF | 4822 122 31414 | C 3205 | 63V 10X 100NF | 5322 122 31414 |
| C 2528 | 63V 10X 100NF | 5322 121 42492 | C 3208 | 10X 470PF | 4822 122 30034 |
| C 2529 | 63V 10X 100NF | 5322 121 42492 | C 3209 | -10+10X 2.2NF | 5322 122 35851 |
| C 2531 | 63V 10X 100NF | 5322 121 42492 | C 3211 | -10+10X 2.2NF | 5322 122 35851 |
| C 2532 | 63V 10X 100NF | 5322 121 42492 | C 3250 | 100V 10X 10NF | 4822 121 41857 |
| C 2533 | 63V 10X 100NF | 4822 121 42492 | C 3251 | 63V 10X 220NF | 4822 121 42408 |
| C 2535 | 4825 | 4822 122 31056 | C 3252 | -10+10X 2.2NF | 5322 122 35851 |
| C 2536 | -20+50X 10NF | 4822 122 31414 | C 3253 | -20+50X 10NF | 4822 122 31414 |
| C 2537 | -20+50X 10NF | 4822 122 31414 | C 3254 | -20+50X 10NF | 4822 122 31414 |
| C 2538 | 10X 470PF | 4822 122 30034 | C 3256 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2545 | 0.25PF 0.8PF | 5322 122 32103 | C 3257 | -20+50X 10NF | 4822 122 31414 |
| C 2546 | 10X 1.5NF | 4822 122 31169 | C 3258 | -10+10X 2.2NF | 5322 122 35851 |
| C 2548 | 10X 1.5NF | 4822 122 31169 | C 3301 | -20+50X 10NF | 4822 122 31414 |
| C 2550 | 0.25PF 2.7PF | 4822 122 31038 | C 3302 | -20+50X 10NF | 4822 122 31414 |
| C 2600 | 2X 22PF | 5322 122 32163 | C 3303 | -10+50X 47UF | 4822 124 20699 |
| C 2601 | 63V 10X 100NF | 5322 121 42492 | C 3304 | -20+50X 10NF | 4822 122 31414 |
| C 2602 | -20+50X 10NF | 4822 122 31414 | C 3305 | -20+50X 10NF | 4822 122 31414 |
| C 2604 | 10X 1.5NF | 4822 122 31169 | C 3307 | -20+50X 10NF | 4822 122 31414 |
| C 2611 | 10X 1NF | 4822 122 30087 | C 3308 | -20+50X 10NF | 4822 122 31414 |
| C 2612 | -20+50X 10NF | 4822 122 31414 | C 3309 | 10NF | 4822 122 31414 |
| C 2613 | 10X 470PF | 4822 122 30034 | C 3311 | -20+50X 10NF | 4822 122 31414 |
| C 2616 | 10X 470PF | 4822 122 30034 | C 3312 | -10+50X 47UF | 4822 124 20699 |
| C 2701 | -10+50X 180UF | 4822 124 20679 | C 3313 | -20+50X 10NF | 4822 122 31414 |
| C 2702 | -20+50X 10NF | 4822 122 31414 | C 3314 | -10+50X 15UF | 4822 124 20729 |
| C 2703 | -20+50X 10NF | 4822 122 31414 | C 3315 | -20+50X 10NF | 4822 122 31414 |
| C 2704 | -20+50X 10NF | 4822 122 31414 | C 3317 | -20+50X 10NF | 4822 122 31414 |
| C 2706 | -10+50X 100UF | 4822 124 20679 | C 3318 | -20+50X 10NF | 4822 122 31414 |
| C 2707 | -20+50X 10NF | 4822 122 31414 | C 3319 | -10+50X 15UF | 4822 124 20729 |
| C 2708 | -20+50X 10NF | 4822 122 31414 | C 3321 | -20+50X 10NF | 4822 122 31414 |
| C 2709 | -20+50X 10NF | 4822 122 31414 | C 3322 | -20+50X 10NF | 4822 122 31414 |
| C 2711 | -20+50X 10NF | 4822 122 31414 | C 3324 | -20+50X 10NF | 4822 122 31414 |
| C 2716 | -10+50X 68UF | 4822 124 20689 | C 3326 | -20+50X 10NF | 4822 122 31414 |
| C 2717 | -20+50X 10NF | 4822 122 31414 | C 4001 | 2X 100PF | 4822 122 31316 |
| C 2718 | -20+50X 10NF | 4822 122 31414 | C 4002 | 2X 100PF | 4822 122 31316 |
| C 2722 | -20+50X 10NF | 4822 122 31414 | C 4003 | 100V 10X 10NF | 4822 121 41857 |
| C 2726 | -10+50X 68UF | 4822 124 20689 | C 4004 | 10X 4.7NF | 4822 122 31125 |
| C 2727 | -20+50X 10NF | 4822 122 31414 | C 4005 | 10X 4.7NF | 4822 122 31125 |
| C 2728 | -20+50X 10NF | 4822 122 31414 | C 4006 | -20+50X 10NF | 4822 122 31414 |
| C 2741 | -20+50X 10NF | 4822 122 31414 | C 4907 | 10X 470PF | 4822 122 30034 |
| C 2744 | -20+50X 10NF | 4822 122 31414 | C 4911 | -20+50X 10NF | 4822 122 31414 |
| C 2746 | -20+50X 10NF | 4822 122 31414 | C 4928 | 2X 100PF | 4822 122 31316 |
| C 2747 | -10+50X 68UF | 4822 124 20689 | C 4929 | 2X 100PF | 4822 122 31316 |
| C 2748 | -20+50X 10NF | 4822 122 31414 | C 4101 | -20+50X 10NF | 4822 122 31414 |
| C 2751 | -10+50X 47UF | 4822 124 20699 | C 4103 | -20+50X 10NF | 4822 122 31414 |
| C 2752 | -20+50X 10NF | 4822 122 31414 | C 4105 | 63V 10X 100NF | 5322 121 42492 |
| C 2753 | -20+50X 10NF | 4822 122 31414 | C 4106 | -10+50X 150UF | 4822 124 20672 |
| C 2754 | -20+50X 10NF | 4822 122 31414 | C 4107 | 63V 10X 100NF | 5322 121 42492 |
| C 2771 | -20+50X 10NF | 4822 122 31414 | C 4108 | 2X 100PF | 4822 122 31316 |
| C 2772 | -10+50X 150UF | 4822 124 20672 | C 4109 | -20+50X 10NF | 4822 122 31414 |
| C 2773 | -20+50X 10NF | 4822 122 31414 | C 4110 | 63V 10X 470NF | 5322 121 42979 |
| C 2774 | -10+50X 68UF | 4822 124 20689 | C 4112 | -20+50X 10NF | 4822 122 31414 |
| C 2776 | -20+30X 10NF | 4822 122 31414 | C 4113 | 630V 1X 1NF | 4822 121 50591 |
| C 2777 | 63V 10X 100NF | 5322 121 42492 | C 4114 | 100V 10X 1NF | 5322 121 41727 |
| C 2781 | -20+50X 10NF | 4822 122 31414 | C 4116 | 10X 1.5NF | 4822 122 31169 |
| C 3001 | -20+50X 10NF | 4822 122 31414 | C 4117 | 10X 10PF | 4822 122 31414 |
| C 3002 | 10X 1.5NF | 4822 122 31169 | C 4118 | -20+50X 10NF | 4822 122 31414 |
| C 3003 | 10X 1.5NF | 4822 122 31169 | C 4120 | 63V 10X 100NF | 5322 121 42492 |
| C 3004 | 7-10.0 PF MUR | 5322 125 11013 | C 4122 | 63V 10X 100NF | 5322 121 42492 |
| C 3005 | 2-20PF MUR | 5322 125 50296 | C 4123 | -10+50X 47UF | 4822 124 20699 |
| C 3007 | 7-10.0 PF MUR | 5322 125 11013 | C 4124 | -20+50X 10NF | 4822 122 31414 |
| C 3008 | 0.25PF 8.2PF | 4822 122 31052 | C 4126 | -10+50X 47UF | 4822 124 20699 |
| C 3009 | 2X 12PF | 4822 122 31056 | C 4260 | 63V 10X 100NF | 5322 121 42492 |
| C 3011 | 2X 68PF | 4822 122 31349 | C 4301 | 63V 10X 100NF | 5322 121 42492 |
| C 3013 | 0.25PF 2.7PF | 4822 122 31038 | C 4302 | -10+50X 4.7UF | 4822 124 20726 |
| C 3014 | 0.25PF 2.7PF | 4822 122 31038 | C 4303 | 100V 10X 10NF | 4822 121 41857 |
| C 3016 | 2-20PF MUR | 5322 125 50296 | C 4304 | 63V 10X 2X | 4822 121 50919 |
| C 3017 | -20+50X 10NF | 4822 122 31414 | C 4306 | -20+50X 10NF | 4822 122 31414 |
| C 3018 | 0.25PF 5.4PF | 5322 122 32163 | C 4307 | -20+50X 10NF | 4822 122 31414 |

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|-----------------|----------------|
| C 4511 | 2x 100PF | 4822 122 31316 |
| C 4501 | -20+50X 10NF | 4822 122 31414 |
| C 4502 | -20+50X 10NF | 4822 122 31414 |
| C 4503 | 9.25PF 3.9PF | 5322 121 42492 |
| C 4521 | 6.3V 10X 100NF | 5322 121 42492 |
| C 4522 | 6.3V 10X 100NF | 5322 121 42492 |
| C 4602 | 6.25PF 8.2PF | 4822 122 31522 |
| C 4603 | 0.25PF 8.2PF | 4822 122 31522 |
| C 4611 | -20+50X 10NF | 4822 122 31414 |
| C 4612 | -20+50X 10NF | 4822 122 31414 |
| C 4613 | 2x 10PF | 4822 122 32185 |
| C 4701 | 10x 1NF | 4822 122 30027 |
| C 4702 | 2x 220PF | 4822 122 30994 |
| C 4703 | 10x 1NF | 4822 122 30027 |
| C 4704 | -20+50X 10NF | 4822 122 31414 |
| C 4801 | -20+20X 2200UF | 4822 124 21382 |
| C 4804 | -10+50X 1300UF | 4822 124 20672 |
| C 4807 | -20+50X 10NF | 4822 122 31414 |
| C 4808 | -10+50X 68UF | 4822 124 20689 |
| C 4811 | -20+50X 10NF | 4822 122 31414 |
| C 4815 | -20+50X 10NF | 4822 122 31414 |
| C 4819 | -20+50X 10NF | 4822 122 31414 |
| C 4820 | -20+50X 10NF | 4822 122 31414 |
| C 4822 | -20+50X 10NF | 4822 122 31414 |
| C 4825 | -20+50X 10NF | 4822 122 31414 |
| C 4829 | -20+50X 10NF | 4822 122 31414 |
| C 4831 | -20+50X 10NF | 4822 122 31414 |
| C 4832 | -10+50X 20x 1NF | 4822 122 31414 |
| C 4835 | -20+50X 10NF | 4822 122 31414 |
| C 4835 | -20+50X 10NF | 4822 122 31414 |
| C 4836 | -20+50X 10NF | 4822 122 31414 |
| C 4837 | -10+50X 47UF | 4822 124 20699 |
| C 4839 | 2x 12PF | 4822 122 31056 |
| C 4848 | -10+50X 47UF | 4822 124 20699 |
| C 4889 | -10+50X 47UF | 4822 124 20699 |
| C 4891 | -20+50X 10NF | 4822 122 31414 |
| C 4893 | -20+50X 10NF | 4822 122 31414 |
| C 4895 | -20+50X 10NF | 4822 122 31414 |
| C 4897 | -20+50X 10NF | 4822 122 31414 |
| C 4898 | -20+50X 10NF | 4822 122 31414 |
| C 4899 | -20+50X 10NF | 4822 122 31414 |
| C 5001 | -20+50X 10NF | 4822 122 31414 |
| C 5002 | -20+50X 10NF | 4822 122 31414 |
| C 5003 | -20+50X 10NF | 4822 122 31414 |
| C 5004 | -20+50X 10NF | 4822 122 31414 |
| C 5006 | 10NF | 4822 124 20716 |
| C 6001 | 250V 10X 220NF | 5322 121 44142 |
| C 6002 | ME275 20X 1NF | 5322 121 42583 |
| C 6003 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6004 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6005 | -20+50X 1.5NF | 5322 122 50992 |
| C 6006 | ME275 20X 1NF | 5322 121 42583 |
| C 6007 | -10+50X 68UF | 5322 124 22796 |
| C 6008 | -10+50X 68UF | 5322 124 22796 |
| C 6009 | 100V 10X 47NF | 3322 121 42491 |
| C 6011 | -10+50X 33UF | 4822 124 20712 |
| C 6012 | 16.5x 2x 220PF | 4822 122 30994 |
| C 6013 | 10x 4.7NF | 4822 122 31125 |
| C 6014 | 160V 1x 33NF | 3322 121 50997 |
| C 6017 | 2KV 5x 1.5NF | 5322 121 43243 |
| C 6018 | 10x 4.7NF | 4822 122 31125 |
| C 6031 | 100V 10X 10NF | 4822 121 41857 |
| C 6032 | 6.3V 10X 100NF | 4822 121 42492 |
| C 6033 | 100V 10X 10NF | 4822 121 41857 |
| C 6041 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6042 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6109 | -20+20X 6800UF | 4822 124 40692 |
| C 6111 | -20+20X 6800UF | 4822 124 40692 |
| C 6102 | -10+50X 6800UF | 4822 124 20685 |
| C 6103 | -10+50X 6800UF | 4822 124 20685 |
| C 6104 | -10+50X 220UF | 4822 124 20681 |
| C 6106 | -10+50X 470UF | 4822 124 20695 |
| C 6107 | -10+50X 150UF | 4822 124 20691 |
| C 6108 | -10+50X 470UF | 4822 124 20695 |
| C 6109 | -10+50X 150UF | 4822 124 20691 |
| C 6111 | -10+50X 220UF | 4822 124 20716 |
| C 6112 | -10+50X 100UF | 4822 124 20701 |
| C 6113 | -10+50X 100UF | 4822 124 20701 |
| C 6114 | -10+50X 100UF | 4822 124 20701 |
| C 6116 | -10+50X 680UF | 4822 124 20734 |
| C 6117 | -10+50X 220UF | 4822 124 20731 |
| C 6119 | -10+50X 22UF | 4822 124 20731 |
| C 6120 | -20+50X 10NF | 4822 122 31414 |
| C 6121 | -10+50X 22UF | 4822 124 20731 |
| C 6122 | 630V 1x 660PF | 5322 121 51214 |
| C 6131 | 6.3V 10X 470NF | 5322 121 42979 |
| C 6132 | -10+50X 100UF | 4822 122 30878 |
| C 6133 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6134 | 10X 1NF | 4822 122 30027 |

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|----------------|----------------|
| C 6201 | -20+50X 10NF | 4822 122 31414 |
| C 6201 | 100V 10X 47NF | 5322 121 42491 |
| C 6202 | 2x 47PF | 4822 122 31072 |
| C 6203 | 6.3V 10X 220NF | 4822 121 42408 |
| C 6204 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6205 | 100V 10X 100NF | 5322 121 42578 |
| C 6207 | 10x 4.7NF | 4822 122 31125 |
| C 6208 | -10+50X 68UF | 4822 124 20734 |
| C 6209 | -20+50X 2.2NF | 5322 122 50093 |
| C 6210 | 100V 10X 100NF | 5322 121 42578 |
| C 6211 | -20+50X 10NF | 5322 122 30301 |
| C 6212 | -10+50X 10NF | 5322 122 30301 |
| C 6213 | 10x 4.7NF | 4822 122 31125 |
| C 6214 | 20x 470PF | 5322 122 50086 |
| C 6215 | 100V 10X 100NF | 5322 121 42578 |
| C 6311 | -20+50X 10NF | 4822 122 31414 |
| C 6312 | -20+50X 10NF | 4822 122 31414 |
| C 6401 | 6.3V 10X 100NF | 5322 121 42492 |
| C 6402 | -10+50X 68UF | 4822 124 20689 |
| C 6500 | -10+50X 68UF | 4822 124 20689 |
| C 6501 | -20+50X 10NF | 4822 122 31414 |
| C 6502 | 100V 10X 10NF | 4822 122 31457 |
| C 6503 | 2x 100PF | 4822 122 31316 |
| C 6506 | 2x 100PF | 4822 122 31316 |
| C 7001 | 6.3V 10X 220NF | 4822 121 42408 |
| C 7004 | -20+50X 10NF | 4822 122 31414 |
| C 7005 | 6.3V 10X 100NF | 5322 121 42492 |
| C 7007 | -20+50X 10NF | 4822 122 31414 |
| C 7008 | 6.3V 10X 100NF | 5322 121 42492 |
| C 7008 | 10X 680PF | 4822 122 36053 |
| C 7009 | 6.3V 10X 100NF | 5322 121 42492 |
| C 7011 | -20+50X 10NF | 4822 122 31414 |
| C 7012 | -20+50X 10NF | 4822 122 31414 |
| C 7013 | -20+50X 10NF | 4822 122 31414 |
| C 7017 | -20+50X 10NF | 4822 122 31414 |
| C 7018 | -20+50X 10NF | 4822 122 31414 |
| C 7019 | -20+50X 10NF | 4822 122 31414 |
| C 7021 | 6.3V 10X 100NF | 5322 121 42492 |
| C 7100 | -20+50X 10NF | 4822 122 31414 |
| C 7101 | -20+50X 10NF | 4822 122 31414 |
| C 7102 | -20+50X 10NF | 4822 122 31414 |
| C 7103 | -20+50X 10NF | 4822 122 31414 |
| C 7104 | -10+50X 220UF | 4822 124 20661 |
| C 7106 | -10+50X 220UF | 4822 124 20661 |
| C 9001 | -20+20X 10UF | 5322 124 21956 |
| C 9004 | -20+20X 10UF | 5322 124 21956 |
| C 9005 | -20+20X 10UF | 5322 124 21956 |
| C 9008 | -20+20X 10UF | 5322 124 21956 |
| C 9009 | -20+20X 10UF | 5322 124 21956 |
| C 9010 | -20+20X 10UF | 5322 124 21956 |
| C 9011 | 2x 100PF | 4822 122 31316 |
| C 9012 | 2x 100PF | 4822 122 31316 |
| C 9013 | 2x 100PF | 4822 122 31316 |
| C 9014 | 2x 100PF | 4822 122 31316 |
| C 9015 | 2x 47PF | 4822 122 31072 |
| C 9016 | 2x 100PF | 4822 122 31316 |
| C 9017 | 2x 100PF | 4822 122 31316 |
| C 9018 | 2x 100PF | 4822 122 31316 |
| C 9019 | 6.3V 10X 220NF | 4822 121 42408 |
| C 9020 | 10x 2.2NF | 4822 122 30114 |
| C 9021 | -20+20X 33UF | 5322 124 21957 |
| C 9022 | -20+80X 22NF | 4822 122 30105 |
| C 9023 | -20+80X 22NF | 4822 122 30105 |
| C 9024 | -20+80X 22NF | 4822 122 30105 |
| C 9025 | -20+80X 22NF | 4822 122 30103 |
| C 9026 | -20+80X 22NF | 4822 122 30103 |
| C 9027 | -20+80X 22NF | 4822 122 30103 |
| C 9028 | -20+80X 22NF | 4822 122 30103 |
| C 9029 | -20+80X 22NF | 4822 122 30103 |
| C 9030 | -20+80X 22NF | 4822 122 30103 |
| C 9031 | -20+80X 22NF | 4822 122 30103 |
| C 9032 | -20+80X 22NF | 4822 122 30103 |
| C 9033 | -20+80X 22NF | 4822 122 30103 |
| C 9034 | -20+80X 22NF | 4822 122 30103 |
| C 9035 | -20+80X 22NF | 4822 122 30103 |
| C 9036 | -20+80X 22NF | 4822 122 30103 |
| C 9037 | -20+80X 22NF | 4822 122 30103 |
| C 9038 | -20+80X 22NF | 4822 122 30103 |
| C 9039 | -20+80X 22NF | 4822 122 30103 |
| C 9040 | 2x 47PF | 4822 122 31072 |
| C 9042 | -20+20X 15UF | 5322 124 21958 |
| C 9043 | -20+20X 33UF | 5322 124 21958 |
| C 9045 | -20+80X 22NF | 4822 122 30103 |
| C 9046 | -20+80X 22NF | 4822 122 30103 |
| C 9046 | -20+80X 22NF | 4822 122 30103 |
| C 9047 | -20+80X 22NF | 4822 122 30103 |
| C 9048 | 10x 2.2NF | 4822 122 30114 |
| C 9049 | 2x 47PF | 4822 122 31072 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-----------------|----------------|--------|---------------|----------------|
| R 1094 | MRS25 1X 100E | 5322 116 53126 | R 1204 | VR25 10X 22M | 5322 116 51785 |
| R 1095 | MRS25 1X 100E | 5322 116 53126 | R 1205 | MRS25 1X 1K33 | 5322 116 53243 |
| R 1097 | MRS25 1X 100E | 5322 116 53126 | R 1207 | MRS25 1X 100E | 5322 116 53126 |
| R 1098 | MRS25 1X 1K21 | 4822 116 52956 | R 1208 | MRS25 1X 825E | 5322 116 53541 |
| R 1099 | MRS25 1X 1K21 | 4822 116 52956 | R 1209 | MRS25 1X 1M | 4822 116 52843 |
| R 1101 | MRS25 1X 1K | 4822 116 53108 | R 1211 | MRS25 1X 100E | 5322 116 53126 |
| R 1102 | MRS25 1X 42E2 | 5322 116 53515 | R 1213 | MRS25 1X 1M | 4822 116 52843 |
| R 1103 | MRS25 1X 61E9 | 5322 116 53645 | R 1217 | 0.3M 25X 20K | 5322 116 53126 |
| R 1104 | 1/4M 25X 10K1 | 5322 116 53604 | R 1218 | MRS25 1X 100K | 4822 116 52973 |
| R 1106 | MRS25 1X 121E | 4822 116 52955 | R 1219 | MRS25 1X 1K47 | 5322 116 53185 |
| R 1107 | 0.4M 0.25X 900K | 5322 116 53614 | R 1221 | MRS25 1X 681E | 4822 116 53123 |
| R 1108 | MRS25 1X 10K | 4822 116 53022 | R 1222 | MRS25 1X 2K87 | 5322 116 53513 |
| R 1109 | MRS25 1X 21K5 | 5322 116 53541 | R 1223 | MRS25 1X 1K33 | 5322 116 53126 |
| R 1111 | 1/4M 25X 111K | 5322 116 53609 | R 1224 | MRS25 1X 1K | 4822 116 53108 |
| R 1112 | 0.4M 0.25X 750K | 5322 116 53588 | R 1226 | MRS25 1X 5K11 | 5322 116 53694 |
| R 1113 | 1/4M 25X 1M | 5322 116 53398 | R 1227 | MRS25 1X 1K33 | 5322 116 53512 |
| R 1114 | MRS25 1X 10K | 4822 116 53022 | R 1228 | MRS25 1X 100E | 5322 116 53126 |
| R 1116 | MRS25 1X 21K5 | 5322 116 53241 | R 1229 | MRS25 1X 75E | 5322 116 53265 |
| R 1117 | 1/4M 25X 250K | 5322 116 53507 | R 1231 | MRS25 1X 75E | 5322 116 53265 |
| R 1118 | MRS25 1X 10E | 4822 116 52891 | R 1232 | MRS25 1X 825E | 5322 116 53538 |
| R 1119 | 0.4M 0.25X 990K | 5322 116 53615 | R 1233 | MRS25 1X 148E | 5322 116 53591 |
| R 1122 | MRS25 1X 56E2 | 5322 116 53644 | R 1234 | MRS25 1X 100E | 5322 116 53126 |
| R 1123 | VR25 10X 22M | 5322 116 51785 | R 1236 | MRS25 1X 162E | 5322 116 53523 |
| R 1124 | MRS25 1X 10E | 4822 116 52891 | R 1237 | MRS25 1X 100E | 5322 116 53126 |
| R 1126 | MRS25 1X 61E9 | 5322 116 53645 | R 1238 | MRS25 1X 100E | 5322 116 53126 |
| R 1127 | VR25 10X 22M | 5322 116 51785 | R 1239 | MRS25 1X 7K5 | 4822 116 53028 |
| R 1128 | MRS25 1X 10E | 4822 116 52891 | R 1401 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1129 | 1/4M 25X 1M | 5322 116 53398 | R 1402 | MRS25 1X 31E6 | 5322 116 56956 |
| R 1131 | MRS25 1X 10E | 5322 116 53108 | R 1403 | MRS25 1X 100E | 5322 116 53126 |
| R 1132 | MRS25 1X 10E | 4822 116 52891 | R 1404 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1133 | VR25 10X 22M | 5322 116 51785 | R 1421 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1134 | MRS25 1X 1M | 4822 116 52843 | R 1422 | MRS25 1X 31E6 | 5322 116 54064 |
| R 1135 | MRS25 1X 100E | 5322 116 53126 | R 1423 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1136 | 0.3M 25X 10K | 5322 116 53083 | R 1424 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1137 | MRS25 1X 10K | 4822 116 52973 | R 1425 | MRS25 1X 100E | 5322 116 53126 |
| R 1138 | VR25 10X 22M | 5322 116 51785 | R 1462 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1139 | MRS25 1X 1K96 | 5322 116 53257 | R 1463 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1140 | MRS25 1X 287E | 5322 116 53221 | R 2001 | MRS25 1X 10E | 4822 116 52891 |
| R 1141 | MRS25 1X 1K96 | 5322 116 53237 | R 2002 | MRS25 1X 10E | 4822 116 52891 |
| R 1143 | MRS25 1X 10E | 5322 116 53126 | R 2003 | MRS25 1X 51E1 | 5322 116 53213 |
| R 1144 | MRS25 1X 825E | 5322 116 53541 | R 2004 | MRS25 1X 5E11 | 5322 116 53213 |
| R 1145 | MRS25 1X 31E6 | 5322 116 53126 | R 2101 | MRS25 1X 10E | 4822 116 52891 |
| R 1146 | MRS25 1X 31E6 | 5322 116 53135 | R 2102 | MRS25 1X 10E | 4822 116 52891 |
| R 1147 | MRS25 1X 2K15 | 5322 116 53239 | R 2103 | MRS25 1X 75K | 5322 116 53266 |
| R 1148 | MRS25 1X 5K11 | 5322 116 53494 | R 2104 | MRS25 1X 12K1 | 4822 116 52937 |
| R 1149 | MRS25 1X 10E | 5322 116 53108 | R 2203 | MRS25 1X 215K | 5322 116 53425 |
| R 1150 | MRS25 1X 100E | 5322 116 53126 | R 2204 | MRS25 1X 10E | 4822 116 53022 |
| R 1151 | MRS25 1X 681E | 4822 116 51213 | R 2205 | MRS25 1X 2K19 | 5322 116 53239 |
| R 1152 | MRS25 1X 1K78 | 5322 116 53208 | R 2206 | MRS25 1X 75K | 5322 116 53266 |
| R 1153 | 1/4M 25X 530E | 5322 116 53606 | R 2207 | MRS25 1X 12K1 | 4822 116 52937 |
| R 1154 | MRS25 1X 100E | 5322 116 53126 | R 2208 | MRS25 1X 215K | 5322 116 53425 |
| R 1155 | MRS25 1X 10E | 5322 116 53208 | R 2209 | MRS25 1X 10E | 4822 116 53022 |
| R 1156 | 1/4M 25X 375E | 5322 116 53407 | R 2210 | MRS25 1X 2K15 | 5322 116 53239 |
| R 1157 | 1/4M 25X 150E | 5322 116 53399 | R 2211 | MRS25 1X 5K62 | 5322 116 53495 |
| R 1158 | 1/4M 25X 150E | 5322 116 53399 | R 2212 | 0.3M 25X 10K | 4822 105 10455 |
| R 1161 | MRS25 1X 110E | 4822 116 52906 | R 2213 | MRS25 1X 23K7 | 5322 116 53537 |
| R 1162 | MRS25 1X 10E | 4822 116 52891 | R 2214 | MRS25 1X 10K | 4822 116 53022 |
| R 1163 | MRS25 1X 26K1 | 5322 116 53261 | R 2215 | MRS25 1X 2K15 | 5322 116 53239 |
| R 1164 | 0.3M 25X 10K | 4822 105 10455 | R 2216 | MRS25 1X 5K62 | 5322 116 53495 |
| R 1166 | MRS25 1X 16K2 | 5322 116 53589 | R 2222 | MRS25 1X 1K96 | 5322 116 53237 |
| R 1167 | MRS25 1X 12K1 | 4822 116 52937 | R 2225 | MRS25 1X 23K7 | 5322 116 53537 |
| R 1168 | MRS25 1X 100E | 5322 116 53126 | R 2230 | MRS25 1X 147E | 5322 116 53569 |
| R 1169 | 0.3M 25X 100E | 5322 105 20029 | R 2231 | MRS25 1X 422E | 5322 116 53592 |
| R 1171 | MRS25 1X 26K1 | 5322 116 53261 | R 2232 | MRS25 1X 535E | 5322 116 53532 |
| R 1172 | 0.3M 25X 10K | 4822 105 10455 | R 2234 | MRS25 1X 42E2 | 5322 116 53515 |
| R 1173 | MRS25 1X 2K61 | 5322 116 53327 | R 2236 | MRS25 1X 681E | 4822 116 53123 |
| R 1174 | MRS25 1X 1K62 | 5322 116 53257 | R 2237 | MRS25 1X 385E | 5322 116 53332 |
| R 1176 | 0.3M 25X 100E | 5322 105 20029 | R 2239 | MRS25 1X 34E8 | 5322 116 53591 |
| R 1177 | MRS25 1X 10E | 4822 116 52891 | R 2240 | MRS25 1X 385E | 5322 116 53332 |
| R 1178 | MRS25 1X 12K1 | 4822 116 52937 | R 2242 | MRS25 1X 385E | 5322 116 53332 |
| R 1179 | MRS25 1X 1K62 | 5322 116 53257 | R 2243 | MRS25 1X 681E | 4822 116 53123 |
| R 1181 | MRS25 1X 511E | 5322 116 53135 | R 2244 | MRS25 1X 422E | 5322 116 53592 |
| R 1182 | MRS25 1X 100K | 4822 116 52973 | R 2246 | MRS25 1X 385E | 5322 116 53332 |
| R 1183 | MRS25 1X 10E | 4822 116 52907 | R 2247 | MRS25 1X 75E | 5322 116 53339 |
| R 1184 | MRS25 1X 82K5 | 5322 116 53581 | R 2251 | MRS25 1X 75E | 5322 116 53339 |
| R 1186 | MRS25 1X 12K1 | 4822 116 52937 | R 2252 | MRS25 1X 750E | 5322 116 53265 |
| R 1187 | MRS25 1X 1M | 4822 116 52843 | R 2254 | MRS25 1X 75E | 5322 116 53339 |
| R 1188 | MRS25 1X 100E | 5322 116 53126 | R 2255 | MRS25 1X 287E | 5322 116 53213 |
| R 1189 | MRS25 1X 422E | 5322 105 20029 | R 2301 | MRS25 1X 19K4 | 5322 116 53258 |
| R 1191 | 0.3M 25X 100E | 5322 105 20029 | R 2302 | MRS25 1X 19K6 | 5322 116 53258 |
| R 1192 | MRS25 1X 10E | 4822 116 52891 | R 2303 | MRS25 1X 5K62 | 5322 116 53495 |
| R 1193 | MRS25 1X 422E | 5322 116 53592 | R 2304 | MRS25 1X 5K62 | 5322 116 53495 |
| R 1194 | MRS25 1X 100E | 5322 116 53126 | R 2311 | MRS25 1X 2K87 | 5322 116 53513 |
| R 1196 | MRS25 1X 100E | 5322 116 53126 | R 2315 | MRS25 1X 100E | 5322 116 53126 |
| R 1197 | MRS25 1X 100E | 5322 116 53126 | R 2316 | MRS25 1X 100E | 5322 116 53126 |
| R 1198 | MRS25 1X 1K21 | 4822 116 52956 | R 2317 | MRS25 1X 1K | 4822 116 53108 |
| R 1199 | MRS25 1X 1K21 | 4822 116 52956 | R 2318 | MRS25 1X 1K | 4822 116 53108 |
| R 1201 | MRS25 1X 1K | 4822 116 53108 | R 2319 | MRS25 1X 5E11 | 4822 116 52999 |
| R 1202 | MRS25 1X 68E1 | 5322 116 53264 | R 2324 | MRS25 1X 5K62 | 5322 116 53495 |
| R 1205 | 0.4M 0.1X 1M | 5322 116 51605 | | | |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
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| R 2326 | MRS25 1x 2K87 | 5322 116 53513 | R 2629 | MRS25 1x 10K | 4822 116 53522 |
| R 2327 | MRS25 1x 10K | 4822 116 53479 | R 2631 | MRS25 1x 10K | 5322 116 53528 |
| R 2328 | MRS25 1x 2K37 | 5322 116 53513 | R 2632 | MRS25 1x 10K | 5322 116 53532 |
| R 2329 | MRS25 1x 825E | 5322 116 53541 | R 2635 | MRS25 1x 10K | 4822 116 53522 |
| R 2330 | 0.3M 25x 10K | 4822 105 10455 | R 2701 | MRS25 1x 1E | 4822 116 52976 |
| R 2333 | MRS25 1x 5K62 | 5322 116 53495 | R 2702 | MRS25 1x 2E1E | 5322 116 53723 |
| R 2334 | MRS25 1x 5K62 | 5322 116 53495 | R 2704 | MRS25 1x 5E11 | 4822 116 52988 |
| R 2335 | MRS25 1x 10K | 4822 116 53022 | R 2712 | MRS25 1x 5E11 | 4822 116 52999 |
| R 2336 | MRS25 1x 21E5 | 5322 116 53426 | R 2713 | MRS25 1x 5E11 | 4822 116 52999 |
| R 2337 | MRS25 1x 162E | 5322 116 53523 | R 2714 | MRS25 1x 5E11 | 4822 116 52999 |
| R 2338 | MRS25 1x 2K61 | 5322 116 53327 | R 2721 | MRS25 1x 5E11 | 4822 116 52999 |
| R 2339 | MRS25 1x 10K | 4822 116 53259 | R 2722 | MRS25 1x 1E | 4822 116 52976 |
| R 2341 | MRS25 1x 21E5 | 5322 116 53426 | R 2723 | MRS25 1x 1E | 4822 116 52999 |
| R 2342 | MRS25 1x 162E | 5322 116 53523 | R 2724 | MRS25 1x 5E11 | 4822 116 52999 |
| R 2344 | MRS25 1x 511E | 5322 116 53135 | R 2740 | MRS25 1x 5E11 | 5322 116 54964 |
| R 2345 | MRS25 1x 100E | 5322 116 53126 | R 2741 | MRS25 1x 31E5 | 4822 116 52999 |
| R 2346 | MRS25 1x 681E | 4822 116 53123 | R 2742 | MRS25 1x 5E11 | 5322 116 53569 |
| R 2348 | MRS25 1x 8K23 | 5322 116 53267 | R 3002 | MRS25 1x 31E5 | 5322 116 5514 |
| R 2350 | MRS25 1x 4K22 | 5322 116 53294 | R 3003 | MRS25 1x 1K47 | 5322 116 53185 |
| R 2351 | MRS25 1x 562E | 5322 116 53214 | R 3004 | MRS25 1x 422E | 5322 116 53592 |
| R 2352 | MRS25 1x 825E | 4822 116 53561 | R 3006 | MRS25 1x 2K37 | 5322 116 53593 |
| R 2353 | MRS25 1x 681E | 4822 116 53123 | R 3007 | 0.3M 25x 2K2 | 5322 105 20032 |
| R 2358 | MRS25 1x 111E | 5322 116 53155 | R 3008 | MRS25 1x 121E | 4822 116 52955 |
| R 2360 | MRS25 1x 100E | 5322 116 53126 | R 3009 | MRS25 1x 5K83 | 4822 116 53079 |
| R 2361 | MRS25 1x 4K22 | 5322 116 53244 | R 3011 | MRS25 1x 121E | 4822 116 52955 |
| R 2365 | MRS25 1x 2K37 | 5322 116 53537 | R 3012 | MRS25 1x 31E5 | 4822 116 53146 |
| R 2366 | MRS25 1x 10K | 4822 116 53022 | R 3013 | 0.3M 25x 10K | 4822 105 10455 |
| R 2367 | MRS25 1x 162E | 5322 116 53523 | R 3014 | MRS25 1x 2K87 | 5322 116 53513 |
| R 2369 | MRS25 1x 68K1 | 5322 116 53338 | R 3015 | MRS25 1x 31E5 | 5322 116 53514 |
| R 2371 | MRS25 1x 422E | 5322 116 53592 | R 3016 | MRS25 1x 2K37 | 5322 116 53536 |
| R 2372 | MRS25 1x 511E | 5322 116 53135 | R 3017 | 0.3M 25x 2K2 | 5322 105 20032 |
| R 2373 | MRS25 1x 75K | 5322 116 53266 | R 3018 | MRS25 1x 8K23 | 5322 116 53267 |
| R 2374 | MRS25 1x 8K23 | 5322 116 53155 | R 3020 | MRS25 1x 10E | 4822 116 52891 |
| R 2375 | MRS25 1x 2K37 | 5322 116 53537 | R 3021 | MRS25 1x 644E | 5322 116 53232 |
| R 2376 | VR25 10x 22M | 5322 116 51785 | R 3022 | MRS25 1x 750E | 5322 116 53265 |
| R 2377 | VR25 10x 22M | 5322 116 51785 | R 3023 | MRS25 1x 348E | 5322 116 53593 |
| R 2378 | VR25 10x 22M | 5322 116 51785 | R 3024 | MRS25 1x 750E | 5322 116 53265 |
| R 2379 | VR25 10x 22M | 5322 116 51785 | R 3025 | MRS25 1x 10E | 4822 116 52891 |
| R 2380 | MRS25 1x 750E | 5322 116 53265 | R 3026 | MRS25 1x 464E | 5322 116 53252 |
| R 2381 | MRS25 1x 2K61 | 5322 116 53327 | R 3027 | MRS25 1x 422E | 5322 116 53515 |
| R 2382 | MRS25 1x 2K61 | 4822 116 53327 | R 3028 | MRS25 1x 422E | 5322 116 53515 |
| R 2383 | MRS25 1x 1K | 4822 116 53108 | R 3029 | MRS25 1x 3K16 | 4822 116 53639 |
| R 2384 | MRS25 1x 750E | 5322 116 53265 | R 3031 | MRS25 1x 402E | 5322 116 53639 |
| R 2386 | MRS25 1x 1K | 4822 116 53108 | R 3032 | MRS25 1x 31E6 | 5322 116 54964 |
| R 2387 | MRS25 1x 750E | 4822 116 53108 | R 3033 | MRS25 1x 162E | 5322 116 53126 |
| R 2388 | MRS25 1x 1K | 4822 116 53108 | R 3034 | MRS25 1x 100E | 5322 116 53523 |
| R 2389 | MRS25 1x 4K22 | 4822 116 53515 | R 3035 | 0.3M 25x 10K | 5322 105 20032 |
| R 2391 | MRS25 1x 10K | 4822 116 53515 | R 3037 | MRS25 1x 100E | 5322 116 53126 |
| R 2393 | MRS25 1x 3K48 | 4822 116 53515 | R 3038 | 0.3M 25x 470E | 5322 105 20028 |
| R 2394 | MRS25 1x 100E | 5322 116 53126 | R 3039 | MRS25 1x 422E | 5322 116 53515 |
| R 2395 | 0.3M 25x 220E | 5322 105 20031 | R 3041 | MRS25 1x 31E6 | 5322 116 53514 |
| R 2396 | MRS25 1x 3K48 | 4822 116 53515 | R 3042 | MRS25 1x 110E | 4822 116 52906 |
| R 2397 | MRS25 1x 422E | 5322 116 53515 | R 3043 | MRS25 1x 110E | 4822 116 52906 |
| R 2398 | MRS25 1x 422E | 5322 116 53515 | R 3044 | MRS25 1x 110E | 4822 116 52906 |
| R 2400 | MRS25 1x 1K33 | 5322 116 53512 | R 3046 | MRS25 1x 110E | 4822 116 52906 |
| R 2406 | MRS25 1x 10K | 4822 116 53022 | R 3047 | MRS25 1x 422E | 5322 116 53515 |
| R 2407 | 0.3M 25x 220E | 5322 105 20031 | R 3048 | MRS25 1x 422E | 5322 116 53515 |
| R 2408 | MRS25 1x 1K33 | 5322 116 53512 | R 3049 | MRS25 1x 51K1 | 4822 116 53121 |
| R 2409 | MRS25 1x 1K62 | 5322 116 53527 | R 3050 | MRS25 1x 422E | 5322 116 53515 |
| R 2410 | 0.3M 25x 1K | 5322 105 20032 | R 3051 | MRS25 1x 51K1 | 4822 116 53121 |
| R 2411 | MRS25 1x 422E | 5322 116 53515 | R 3052 | MRS25 1x 422E | 5322 116 53515 |
| R 2412 | MRS25 1x 1K33 | 5322 116 53512 | R 3060 | MRS25 1x 110E | 4822 116 52906 |
| R 2416 | MRS25 1x 1K | 4822 116 53108 | R 3061 | MRS25 1x 110E | 4822 116 52906 |
| R 2418 | MRS25 1x 5K62 | 5322 116 53495 | R 3062 | MRS25 1x 110E | 4822 116 52906 |
| R 2419 | MRS25 1x 1K1 | 5322 116 53475 | R 3063 | MRS25 1x 110E | 4822 116 52906 |
| R 2420 | MRS25 1x 1K1 | 5322 116 53464 | R 3064 | MRS25 1x 110E | 4822 116 52906 |
| R 2421 | MRS25 1x 5K62 | 4822 116 53208 | R 3066 | MRS25 1x 110E | 4822 116 52906 |
| R 2422 | MRS25 1x 1K | 4822 116 53108 | R 3067 | MRS25 1x 110E | 4822 116 52906 |
| R 2423 | MRS27 1x 100K | 4822 116 52975 | R 3068 | MRS25 1x 110E | 4822 116 52906 |
| R 2431 | MRS25 1x 100K | 4822 116 52973 | R 3102 | MRS25 1x 110E | 4822 116 52906 |
| R 2432 | MRS25 1x 100K | 4822 116 52973 | R 3103 | MRS25 1x 5K62 | 5322 116 53513 |
| R 2433 | MRS25 1x 100K | 4822 116 52973 | R 3104 | MRS25 1x 5K62 | 5322 116 53513 |
| R 2434 | MRS25 1x 10K | 4822 116 53022 | R 3107 | MRS25 1x 2K87 | 5322 116 53513 |
| R 2435 | MRS25 1x 10K | 4822 116 53022 | R 3108 | MRS25 1x 825E | 5322 116 53561 |
| R 2436 | MRS25 1x 10K | 4822 116 53022 | R 3109 | MRS25 1x 6K19 | 5322 116 53263 |
| R 2437 | MRS25 1x 10K | 4822 116 53022 | R 3110 | MRS25 1x 422E | 5322 116 53515 |
| R 2438 | MRS25 1x 10K | 4822 116 53022 | R 3111 | MRS25 1x 7K5 | 4822 116 53028 |
| R 2439 | MRS25 1x 10K | 4822 116 53022 | R 3112 | MRS25 1x 7K5 | 4822 116 52956 |
| R 2440 | MRS25 1x 10K | 4822 116 53022 | R 3113 | MRS25 1x 1K21 | 4822 116 52956 |
| R 2441 | MRS25 1x 10K | 4822 116 53022 | R 3114 | MRS25 1x 5K62 | 5322 116 53495 |
| R 2442 | MRS25 1x 10K | 4822 116 53022 | R 3115 | MRS25 1x 422E | 5322 116 53515 |
| R 2443 | MRS25 1x 10K | 4822 116 53022 | R 3116 | MRS25 1x 5K62 | 5322 116 53214 |
| R 2444 | MRS25 1x 10K | 4822 116 53022 | R 3117 | MRS25 1x 464E | 5322 116 53214 |
| R 2445 | MRS25 1x 10K | 4822 116 53022 | R 3118 | 0.3M 25x 1K | 5322 105 20032 |
| R 2446 | MRS25 1x 10K | 4822 116 53022 | R 3119 | MRS25 1x 4K64 | 5322 116 53212 |
| R 2447 | MRS25 1x 10K | 4822 116 53022 | | | |

| POSNR | DESCRIPTION | ORDERING CODE |
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| R 3121 | MRS25 1X 1K64 | 5322 116 53234 |
| R 3122 | MRS25 1X 2K37 | 5322 116 53536 |
| R 3124 | MRS25 1X 619E | 5322 116 53337 |
| R 3125 | MRS25 1X 2E61 | 4622 116 53723 |
| R 3126 | MRS25 1X 1K47 | 5322 116 53531 |
| R 3127 | MRS25 1X 1K1 | 5322 116 53512 |
| R 3128 | MRS25 1X 825E | 5322 116 53591 |
| R 3129 | MRS25 1X 1K1 | 5322 116 53473 |
| R 3130 | MRS25 1X 2E61 | 5322 116 53723 |
| R 3131 | MRS25 1X 1K33 | 5322 116 53512 |
| R 3132 | MRS25 1X 825E | 5322 116 53591 |
| R 3133 | MRS25 1X 61K9 | 5322 116 53265 |
| R 3134 | MRS25 1X 1K47 | 4622 116 53531 |
| R 3136 | MRS25 1X 1K | 4622 116 53108 |
| R 3137 | MRS25 1X 19K4 | 5322 116 53234 |
| R 3138 | MRS25 1X 2K37 | 5322 116 53536 |
| R 3139 | MRS25 1X 619E | 5322 116 53337 |
| R 3140 | MRS25 1X 316E | 5322 116 53114 |
| R 3142 | MRS25 1X 316E | 5322 116 53514 |
| R 3143 | MRS25 1X 10E | 4622 116 52891 |
| R 3144 | MRS25 1X 10E | 4622 116 52891 |
| R 3147 | 0.5M 10X 9K3 | 5322 116 50234 |
| R 3148 | MRS25 1X 9107 | 5322 116 53285 |
| R 3149 | MRS25 1X 511E | 5322 116 53135 |
| R 3200 | MRS25 1X 6K81 | 5322 116 53292 |
| R 3201 | MRS25 1X 1K21 | 4622 116 52956 |
| R 3202 | MRS25 1X 109E | 5322 116 53126 |
| R 3203 | MRS25 1X 16K2 | 5322 116 53589 |
| R 3204 | MRS25 1X 567E | 4622 116 53214 |
| R 3205 | MRS25 1X 4K64 | 5322 116 53212 |
| R 3206 | MRS25 1X 19K | 4622 116 53022 |
| R 3207 | MRS25 1X 82K9 | 5322 116 53581 |
| R 3208 | MRS25 1X 7K5 | 4622 116 53028 |
| R 3209 | MRS25 1X 1K | 4622 116 53108 |
| R 3210 | MRS25 1X 42E2 | 5322 116 53515 |
| R 3211 | MRS25 1X 19K | 4622 116 53022 |
| R 3212 | MRS25 1X 1K47 | 5322 116 53185 |
| R 3213 | MRS25 1X 23K7 | 5322 116 53537 |
| R 3214 | MRS25 1X 31K6 | 5322 116 53262 |
| R 3215 | MRS25 1X 4K64 | 5322 116 53212 |
| R 3216 | MRS25 1X 178K | 5322 116 53555 |
| R 3217 | MRS25 1X 19K | 4622 116 53022 |
| R 3218 | MRS25 1X 61K9 | 5322 116 53233 |
| R 3219 | MRS25 1X 1M | 4622 116 52843 |
| R 3221 | MRS25 1X 109E | 5322 116 53126 |
| R 3222 | MRS25 1X 42E2 | 5322 116 53515 |
| R 3223 | MRS25 1X 39K3 | 4622 116 53264 |
| R 3224 | MRS25 1X 2K37 | 5322 116 53536 |
| R 3226 | MRS25 1X 109E | 5322 116 53126 |
| R 3250 | MRS25 1X 2K37 | 5322 116 53536 |
| R 3251 | MRS25 1X 1M | 4622 116 52843 |
| R 3253 | MRS25 1X 79K | 5322 116 53264 |
| R 3254 | MRS25 1X 178K | 4622 116 53108 |
| R 3256 | MRS25 1X 178K | 5322 116 53555 |
| R 3257 | MRS25 1X 825K | 5322 116 53341 |
| R 3258 | VR25 3X 3M3 | 4622 110 72201 |
| R 3259 | VR25 3X 3M3 | 4622 110 72201 |
| R 3261 | VR25 3X 3M3 | 4622 110 72201 |
| R 3263 | VR25 3X 3M3 | 4622 110 72201 |
| R 3267 | 25X 47K | 5122 105 20037 |
| R 3268 | MRS25 1X 681K | 5322 116 53553 |
| R 3269 | MRS25 1X 15K4 | 5322 116 53234 |
| R 3270 | MRS25 1X 23K7 | 5322 116 53537 |
| R 3271 | MRS25 1X 1K47 | 4622 116 53531 |
| R 3275 | MRS25 1X 215K | 5322 116 53425 |
| R 3301 | MRS25 1X 10E | 4622 116 52891 |
| R 3302 | MRS25 1X 1E | 4622 116 52976 |
| R 3303 | MRS25 1X 5E11 | 4622 116 52999 |
| R 3304 | MRS25 1X 5E11 | 4622 116 52999 |
| R 3306 | MRS25 1X 2K87 | 5322 116 53513 |
| R 3308 | MRS25 1X 10E | 4622 116 52891 |
| R 3309 | MRS25 1X 5E11 | 4622 116 52999 |
| R 3311 | MRS25 1X 5E11 | 4622 116 52999 |
| R 3312 | MRS25 1X 5E11 | 4622 116 52999 |
| R 3313 | MRS25 1X 10E | 4622 116 52891 |
| R 4001 | MRS25 1X 51E1 | 5322 116 53213 |
| R 4002 | MRS25 1X 51E1 | 5322 116 53213 |
| R 4003 | MRS25 1X 2K61 | 5322 116 53327 |
| R 4004 | 0.5M 25X 1K | 5322 105 20032 |
| R 4006 | MRS25 1X 10K | 4622 116 53022 |
| R 4007 | MRS25 1X 100E | 5322 116 53126 |
| R 4008 | MRS25 1X 100E | 5322 116 53126 |
| R 4009 | MRS25 1X 1K | 4622 116 53108 |
| R 4011 | MRS25 1X 2K13 | 5322 116 53239 |
| R 4012 | MRS25 1X 100E | 5322 116 53126 |
| R 4013 | MRS25 1X 100E | 5322 116 53126 |
| R 4014 | MRS25 1X 91E1 | 4622 116 53833 |
| R 4016 | MRS25 1X 909E | 4622 116 53533 |
| R 4017 | MRS25 1X 100E | 5322 116 53126 |

| POSNR | DESCRIPTION | ORDERING CODE |
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| R 4019 | MRS25 1X 51E1 | 5322 116 53213 |
| R 4021 | MRS25 1X 1K47 | 5322 116 53185 |
| R 4022 | MRS25 1X 511E | 5322 116 53135 |
| R 4023 | MRS25 1X 562E | 5322 116 53214 |
| R 4026 | MRS25 1X 909E | 4622 116 53533 |
| R 4027 | MRS25 1X 5K62 | 5322 116 53495 |
| R 4028 | MRS25 1X 1K1 | 5322 116 53108 |
| R 4029 | MRS25 1X 2K37 | 5322 116 53536 |
| R 4031 | MRS25 1X 1M | 4622 116 52843 |
| R 4032 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4033 | MRS25 1X 2K61 | 5322 116 53327 |
| R 4041 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4042 | MRS25 1X 3K16 | 4622 116 53021 |
| R 4043 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4044 | MRS25 1X 661K | 5322 116 53593 |
| R 4046 | MRS25 1X 10K | 4622 116 53022 |
| R 4047 | MRS25 1X 12K1 | 4622 116 52957 |
| R 4086 | MRS25 1X 969E | 4622 116 53533 |
| R 4101 | MRS25 1X 100K | 4622 116 52973 |
| R 4102 | MRS25 1X 4K64 | 5322 116 53212 |
| R 4103 | MRS25 1X 11K | 4622 116 52907 |
| R 4104 | MRS25 1X 46K4 | 5322 116 53314 |
| R 4106 | MRS25 1X 42E2 | 5322 116 53592 |
| R 4107 | 0.5M 25X 10K | 5322 105 20032 |
| R 4108 | 0.5M 25X 10K | 4622 105 10455 |
| R 4109 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4111 | MRS25 1X 12K1 | 4622 116 52957 |
| R 4117 | MRS25 1X 3K16 | 4622 116 53021 |
| R 4118 | 1/4M 25X 50E | 5322 116 53405 |
| R 4119 | 1/4M 25X 50E | 5322 116 53405 |
| R 4120 | MRS25 1X 150E | 4622 116 53108 |
| R 4121 | 1/4M 25X 10K | 5322 116 53327 |
| R 4122 | 1/4M 25X 250E | 5322 116 53406 |
| R 4123 | 1/4M 25X 500E | 5322 116 53408 |
| R 4124 | 1/4M 25X 1K5 | 5322 116 53401 |
| R 4125 | MRS25 1X 100E | 5322 116 53126 |
| R 4126 | MRS25 1X 969E | 4622 116 53533 |
| R 4127 | MRS25 1X 1K62 | 5322 116 53297 |
| R 4128 | MRS25 1X 178K | 5322 116 53235 |
| R 4129 | MRS25 1X 1M | 4622 116 52843 |
| R 4130 | MRS25 1X 1K | 4622 116 53108 |
| R 4131 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4132 | MRS25 1X 3K16 | 4622 116 53021 |
| R 4133 | MRS25 1X 5K48 | 4622 116 53315 |
| R 4134 | MRS25 1X 10K | 4622 116 53022 |
| R 4135 | MRS25 1X 1K | 4622 116 53108 |
| R 4136 | MRS25 1X 10K | 4622 116 53022 |
| R 4137 | MRS25 1X 1K47 | 4622 116 53531 |
| R 4138 | MRS25 1X 969E | 4622 116 53533 |
| R 4139 | MRS25 1X 10K | 4622 116 53022 |
| R 4140 | MRS25 1X 10K | 4622 116 53022 |
| R 4141 | MRS25 1X 1K47 | 4622 116 53531 |
| R 4142 | MRS25 1X 100E | 5322 116 53126 |
| R 4143 | 1/4M 0.1M 20K | 5322 116 52697 |
| R 4144 | 1/4M 0.1M 20E2 | 5322 116 53415 |
| R 4145 | MRS25 1X 1K | 4622 116 53108 |
| R 4146 | MRS25 1X 10K | 4622 116 53022 |
| R 4147 | MRS25 1X 511E | 5322 116 53135 |
| R 4148 | MRS25 1X 21K5 | 5322 116 53261 |
| R 4149 | MRS25 1X 31E6 | 5322 116 54964 |
| R 4150 | MRS25 1X 969E | 5322 116 53536 |
| R 4151 | MRS25 1X 2K61 | 5322 116 53327 |
| R 4152 | MRS25 1X 162E | 5322 116 53523 |
| R 4153 | MRS25 1X 1K1 | 5322 116 53473 |
| R 4154 | MRS25 1X 1K78 | 5322 116 53208 |
| R 4155 | MRS25 1X 2K13 | 5322 116 53239 |
| R 4156 | MRS25 1X 1M | 4622 116 52843 |
| R 4157 | MRS25 1X 1E | 4622 116 52976 |
| R 4158 | MRS25 1X 1M | 4622 116 52843 |
| R 4159 | MRS25 1X 2K13 | 5322 116 53239 |
| R 4160 | MRS25 1X 100E | 5322 116 53126 |
| R 4161 | MRS25 1X 10K | 4622 116 53022 |
| R 4162 | MRS25 1X 100E | 5322 116 53126 |
| R 4163 | MRS25 1X 5E11 | 4622 116 52999 |
| R 4164 | MRS25 1X 100E | 5322 116 53126 |
| R 4253 | MRS25 1X 1K | 4622 116 53108 |
| R 4258 | MRS25 1X 4K64 | 5322 116 53212 |
| R 4259 | MRS25 1X 4K64 | 5322 116 53212 |
| R 4260 | 0.5M 25X 1K | 5322 105 20032 |
| R 4261 | MRS25 1X 10K | 4622 116 53022 |
| R 4262 | MRS25 1X 10K | 4622 116 53022 |
| R 4263 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4265 | MRS25 1X 100E | 5322 116 53126 |
| R 4301 | MRS25 1X 51K1 | 4622 116 53121 |
| R 4302 | MRS25 1X 51K1 | 4622 116 53121 |
| R 4303 | MRS25 1X 6K81 | 5322 116 53292 |
| R 4304 | MRS25 1X 5K11 | 5322 116 53494 |
| R 4305 | MRS25 1X 51K1 | 4622 116 53121 |
| R 4306 | MRS25 1X 661E | 4622 116 53123 |
| R 4307 | MRS25 1X 5K11 | 5322 116 53494 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
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| R 4308 | MRS25 1x 10K | 4822 116 53022 | R 4809 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4309 | MRS25 1x 8K25 | 5322 116 53267 | R 4819 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4310 | MRS25 1x 10K | 5322 116 53276 | R 4829 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4311 | MRS25 1x 10K | 4822 116 53022 | R 4822 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4312 | MRS25 1x 9K09 | 5322 116 53253 | R 4825 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4315 | MRS25 1x 7K5 | 4822 116 53028 | R 4829 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4314 | MRS25 1x 8K25 | 5322 116 53267 | R 4831 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4350 | MRS25 1x 3K1 | 5322 116 53494 | R 4833 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4351 | MRS25 1x 21K5 | 5322 116 53241 | R 4835 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4352 | MRS25 1x 4K22 | 5322 116 53246 | R 4836 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4334 | MRS25 1x 2K15 | 5322 116 53239 | R 4841 | MRS25 1x 10K | 4822 116 53022 |
| R 4404 | MRS25 1x 2K37 | 5322 116 53536 | R 4891 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4411 | MRS25 1x 2K37 | 5322 116 53536 | R 4893 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4501 | MRS25 1x 15K3 | 5322 116 53489 | R 4904 | MRS25 1x 5E11 | 4822 116 52999 |
| R 4502 | MRS25 1x 4K22 | 5322 116 53246 | R 4901 | MRS25 1x 5E2E | 5322 116 53214 |
| R 4503 | MRS25 1x 6K81 | 5322 116 53252 | R 4904 | MRS25 1x 1E | 4822 116 52976 |
| R 4504 | MRS25 1x 1K3 | 5322 116 53509 | R 5001 | PP17 20x 10K | 5322 101 30546 |
| R 4505 | MRS25 1x 211E | 5322 116 53135 | R 5002 | PP17 20x 10K | 5322 101 30546 |
| R 4506 | MRS25 1x 2K15 | 5322 116 53239 | R 5003 | PP17 20x 10K | 5322 101 30546 |
| R 4507 | MRS25 1x 750E | 5322 116 53265 | R 5004 | PP17 20x 10K | 5322 101 30546 |
| R 4508 | MRS25 1x 11K | 4822 116 52907 | R 6001 | 1.7A 20X 82E | 4822 116 30669 |
| R 4509 | MRS25 1x 2K15 | 5322 116 53239 | R 6002 | MRS25 1x 383K | 5322 116 53576 |
| R 4513 | MRS25 1x 1K47 | 5322 116 53185 | R 6003 | MRS25 1x 383K | 5322 116 53576 |
| R 4521 | MRS25 1x 4K2 | 5322 116 53537 | R 6004 | MRS25 1x 316E | 5322 116 53232 |
| R 4522 | MRS25 1x 2K37 | 5322 116 53537 | R 6005 | MRS25 1x 464E | 5322 116 53232 |
| R 4523 | MRS25 1x 16K2 | 5322 116 53589 | R 6006 | MRS25 1x 10K | 4822 116 53022 |
| R 4524 | MRS25 1x 1K47 | 4822 116 53531 | R 6007 | MRS25 1x 10K | 4822 116 53022 |
| R 4526 | MRS25 1x 2K37 | 5322 116 53536 | R 6008 | MRS25 1x 316E | 5322 116 53514 |
| R 4527 | MRS25 1x 19K6 | 5322 116 53258 | R 6009 | 0.3M 10x 1K5 | 4822 116 53268 |
| R 4528 | MRS25 1x 5K62 | 5322 116 53495 | R 6010 | MRS25 1x 1K47 | 4822 116 53531 |
| R 4529 | MRS25 1x 21K5 | 5322 116 53241 | R 6011 | MRS25 1x 237E | 5322 116 53259 |
| R 4531 | MRS25 1x 10K | 4822 116 53022 | R 6012 | MRS25 1x 178E | 5322 116 53572 |
| R 4532 | MRS25 1x 10K | 4822 116 53022 | R 6013 | MRS25 1x 100E | 5322 116 53126 |
| R 4533 | MRS25 1x 3K48 | 4822 116 53515 | R 6014 | MRS25 1x 351E | 4822 116 52995 |
| R 4601 | MRS25 1x 2K37 | 5322 116 53536 | R 6016 | MRS25 1x 10K | 4822 116 53022 |
| R 4602 | MRS25 1x 26K1 | 5322 116 53261 | R 6017 | MRS25 1x 1E | 4822 116 52976 |
| R 4603 | MRS25 1x 2K37 | 5322 116 53537 | R 6018 | MRS25 1x 1E | 4822 116 52976 |
| R 4604 | MRS25 1x 10K | 4822 116 52973 | R 6019 | MRS25 1x 10K | 4822 116 52976 |
| R 4606 | MRS25 1x 909E | 4822 116 53535 | R 6020 | MRS25 1x 21E5 | 5322 116 53022 |
| R 4607 | MRS25 1x 100E | 5322 116 53126 | R 6021 | MRS25 1x 10K | 4822 116 53022 |
| R 4608 | MRS25 1x 1K | 4822 116 53108 | R 6022 | MRS25 1x 10K | 4822 116 53022 |
| R 4609 | MRS25 1x 4E2E | 5322 116 53515 | R 6031 | MRS25 1x 563E | 5322 116 53332 |
| R 4611 | MRS25 1x 10K | 4822 116 53022 | R 6032 | 1.4W .25E 7K5 | 5322 116 80473 |
| R 4612 | MRS25 1x 1K5 | 4822 116 53022 | R 6033 | 1.4W .25E 7K5 | 5322 116 80473 |
| R 4613 | MRS25 1x 10K | 4822 116 53022 | R 6034 | MRS25 1x 6K19 | 5322 116 53263 |
| R 4614 | MRS25 1x 51K1 | 4822 116 53121 | R 6036 | MRS25 1x 7K5 | 4822 116 53028 |
| R 4616 | 0.3M 25x 1K | 5322 105 20032 | R 6037 | MRS25 1x 31K6 | 5322 116 53262 |
| R 4617 | MRS25 1x 6K81 | 5322 116 53152 | R 6038 | MRS25 1x 100E | 5322 116 53126 |
| R 4618 | MRS25 1x 10K | 4822 116 53108 | R 6039 | MRS25 1x 10E | 4822 116 52973 |
| R 4619 | MRS25 1x 8K25 | 5322 116 53267 | R 6041 | MRS25 1x 3K83 | 4822 116 53079 |
| R 4620 | MRS25 1x 7K5 | 4822 116 53028 | R 6042 | MRS25 1x 3K53 | 4822 116 53079 |
| R 4621 | MRS25 1x 909E | 4822 116 53535 | R 6043 | MRS25 1x 100K | 4822 116 52973 |
| R 4622 | MRS25 1x 100E | 5322 116 53126 | R 6044 | MRS25 1x 100K | 4822 116 52973 |
| R 4623 | MRS25 1x 100E | 5322 116 53126 | R 6101 | MRS25 1x 100E | 5322 116 53126 |
| R 4624 | MRS25 1x 100E | 5322 116 53126 | R 6102 | MRS25 1x 100E | 5322 116 53126 |
| R 4627 | MRS25 1x 10K | 4822 116 53022 | R 6103 | MRS25 1x 1K | 4822 116 53108 |
| R 4628 | MRS25 1x 1K | 4822 116 53108 | R 6131 | MRS25 1x 10E | 4822 116 52991 |
| R 4629 | MRS25 1x 8K25 | 5322 116 53267 | R 6132 | MRS25 1x 100K | 4822 116 52973 |
| R 4631 | MRS25 1x 1K | 4822 116 53108 | R 6133 | MRS25 1x 100K | 4822 116 52973 |
| R 4632 | MRS25 1x 100E | 5322 116 53126 | R 6134 | MRS25 1x 1K | 4822 116 53108 |
| R 4633 | MRS25 1x 1K | 4822 116 53108 | R 6136 | MRS25 1x 466E | 5322 116 53212 |
| R 4634 | MRS25 1x 1K | 4822 116 53108 | R 6137 | MRS25 1x 316E | 5322 116 53514 |
| R 4636 | MRS25 1x 1M | 4822 116 52845 | R 6138 | MRS25 1x 1K | 4822 116 53108 |
| R 4639 | MRS25 1x 3E2E | 5322 116 53532 | R 6139 | MRS25 1x 100E | 5322 116 53126 |
| R 4701 | MRS25 1x 8K25 | 5322 116 53267 | R 2201 | 1.4W .25E 160K | 5322 116 83412 |
| R 4703 | MRS25 1x 562E | 5322 116 53214 | R 6202 | VR23 1x 31M6 | 5322 116 64103 |
| R 4705 | MRS25 1x 1K | 4822 116 53108 | R 6203 | MRS25 1x 100K | 4822 116 52973 |
| R 4706 | MRS25 1x 100E | 5322 116 53126 | R 6204 | MRS25 1x 10K | 4822 116 53022 |
| R 4707 | MRS25 1x 1E | 5322 116 53135 | R 6205 | MRS25 1x 1K | 4822 116 53108 |
| R 4708 | MRS25 1x 2K87 | 5322 116 53513 | R 6206 | MRS25 1x 16K2 | 5322 116 53589 |
| R 4709 | MRS25 1x 681E | 4822 116 53123 | R 6207 | MRS25 1x 51E1 | 5322 116 53213 |
| R 4711 | MRS25 1x 6K19 | 5322 116 53263 | R 6208 | MRS25 1x 464E | 5322 116 53212 |
| R 4712 | MRS25 1x 511E | 5322 116 53135 | R 6209 | MRS25 1x 4K64 | 5322 116 53212 |
| R 4713 | MRS25 1x 10K | 4822 116 52843 | R 6211 | MRS25 1x 46K4 | 5322 116 53314 |
| R 4714 | MRS25 1x 1M | 4822 116 52843 | R 6212 | MRS25 1x 464E | 5322 116 53212 |
| R 4716 | MRS25 1x 6K81 | 5322 116 53252 | R 6213 | MRS25 1x 215E | 5322 116 53325 |
| R 4717 | MRS25 1x 8K25 | 5322 116 53267 | R 6214 | VR23 3x 10M | 5322 116 53513 |
| R 4718 | MRS25 1x 1K | 4822 116 53108 | R 6216 | MRS25 1x 100E | 5322 116 53126 |
| R 4719 | MRS25 1x 100E | 5322 116 53126 | R 6217 | MRS25 1x 1E | 4822 116 52976 |
| R 4721 | 0.3M 25x 1K | 5322 105 20032 | R 6300 | MRS25 1x 2K61 | 5322 116 53327 |
| R 4722 | MRS25 1x 46K4 | 5322 116 53314 | R 6301 | MRS25 1x 464E | 5322 116 53327 |
| R 4723 | MRS25 1x 681E | 5322 116 53513 | R 6302 | MRS25 1x 909E | 5322 116 53079 |
| R 4724 | MRS25 1x 4E2E | 5322 116 53515 | R 6303 | MRS25 1x 3K83 | 4822 116 53079 |
| R 4725 | MRS25 1x 4K22 | 5322 116 53246 | R 6304 | MRS25 1x 6K81 | 5322 116 53252 |
| R 4726 | MRS25 1x 10K | 4822 116 52973 | R 6311 | MRS25 1x 750E | 5322 116 53265 |
| R 4727 | MRS25 1x 6K81 | 5322 116 53252 | R 6312 | MRS25 1x 4K22 | 5322 116 53246 |
| R 4728 | MRS25 1x 750E | 5322 116 53265 | R 6313 | MRS25 1x 82E5 | 5322 116 53461 |
| R 6801 | MRS25 1x 5E11 | 4822 116 52999 | R 6401 | MRS25 1x 1K78 | 5322 116 53208 |
| R 6804 | MRS25 1x 5E11 | 4822 116 52999 | R 6402 | MRS25 1x 178K | 5322 116 53555 |
| R 6807 | MRS25 1x 5E11 | 4822 116 52999 | R 6403 | MRS25 1x 215E | 5322 116 53525 |

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| R 6404 | MRS25 1x 6K81 | 5322 116 53252 |
| R 6406 | MRS25 1x 26K1 | 5322 116 53261 |
| R 6407 | MRS25 1x 3K48 | 4822 116 53315 |
| R 6508 | MPT10 20x 10K | 5322 105 10113 |
| R 6509 | MRS25 1x 10E | 4822 116 52891 |
| R 6501 | MRS25 1x 511E | 5322 116 53115 |
| R 6502 | MRS25 1x 100K | 4822 116 52973 |
| R 6503 | MRS25 1x 3K11 | 5322 116 53494 |
| R 6504 | MRS25 1x 1K78 | 5322 116 53258 |
| R 6506 | MRS25 1x 5K62 | 5322 116 53695 |
| R 6507 | MRS25 1x 511E | 5322 116 53115 |
| R 6508 | 1/4W 25x 3K67 | 5322 116 53411 |
| R 6509 | 1/4W 25x 500E | 5322 116 53408 |
| R 6511 | MRS25 1x 5E2E | 5322 116 53214 |
| R 7005 | PP17 20x 10K | 5322 101 30546 |
| R 7006 | PP17 20x 10K | 5322 101 30546 |
| R 7007 | PP17 20x 10K | 5322 101 30546 |
| R 7008 | PP17 20x 10K | 5322 101 30546 |
| R 7009 | PP17 20x 10K | 5322 101 30546 |
| R 7010 | PP17 20x 10K | 5322 101 30546 |
| R 7011 | PP17 20x 10K | 5322 101 30546 |
| R 7012 | PP17 20x 10K | 5322 101 30546 |
| R 7021 | MRS25 1x 11K | 4822 116 52907 |
| R 7022 | MRS25 1x 10K | 4822 116 53022 |
| R 7023 | MRS25 1x 90K9 | 5322 116 53582 |
| R 7024 | MRS25 1x 1K | 4822 116 53108 |
| R 7025 | MRS25 1x 51E1 | 5322 116 53213 |
| R 7026 | MRS25 1x 3K83 | 4822 116 53079 |
| R 7027 | MRS25 1x 3K83 | 4822 116 53079 |
| R 7028 | MRS25 1x 3K83 | 4822 116 53079 |
| R 7029 | MRS25 1x 1K | 4822 116 53108 |
| R 7031 | MRS25 1x 1K | 4822 116 53108 |
| R 7032 | MRS25 1x 75K | 5322 116 53494 |
| R 7033 | MRS25 1x 5K11 | 5322 116 53494 |
| R 7034 | MRS25 1x 162E | 5322 116 53523 |
| R 7036 | 0.5W 10x 2K2 | 4822 116 53054 |
| R 7037 | MRS25 1x 1K1 | 5322 116 53473 |
| R 7038 | MRS25 1x 1M | 4822 116 52843 |
| R 7041 | MRS25 1x 3K83 | 4822 116 53079 |
| R 7042 | MRS25 1x 3K83 | 4822 116 53079 |
| R 7045 | MRS25 1x 1M | 4822 116 52843 |
| R 7102 | MRS25 1x 100E | 5322 116 53126 |
| R 8001 | MCR16 1x 10K | 4822 111 90249 |
| R 9011 | MRS25 1x 4E | 5322 116 53232 |
| R 9012 | MRS25 1x 10K | 4822 116 53022 |
| R 9013 | MRS25 1x 1E | 4822 116 52976 |
| R 9018 | -105-103 10K | 5322 111 90473 |
| R 9021 | MRS25 1x 1K1 | 5322 116 53473 |
| R 9028 | MRS25 1x 4E | 5322 116 53232 |
| R 9029 | MRS25 1x 3K11 | 5322 116 53494 |
| R 9033 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9034 | MRS25 1x 9K11 | 5322 116 53494 |
| R 9039 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9341 | MRS25 1x 10E | 4822 116 52891 |
| R 9362 | MRS25 1x 2K37 | 4822 116 52891 |
| R 9643 | MRS25 1x 10E | 4822 116 52891 |
| R 9644 | MRS25 1x 10K | 5322 116 53237 |
| R 9645 | MRS25 1x 10K | 4822 116 53022 |
| R 9646 | MRS25 1x 10K | 4822 116 53022 |
| R 9647 | MRS25 1x 10K | 4822 116 53022 |
| R 9648 | MRS25 1x 10K | 4822 116 53022 |
| R 9651 | MRS25 1x 2K61 | 5322 116 53327 |
| R 9652 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9653 | 0.3W 25x 2K2 | 5322 105 20033 |
| R 9654 | MRS25 1x 10E | 4822 116 52891 |
| R 9656 | MRS25 1x 10E | 4822 116 52891 |
| R 9657 | MRS25 1x 7K5 | 4822 116 53028 |
| R 9661 | MRS25 1x 1K | 4822 116 53108 |
| R 9662 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9663 | MRS25 1x 215E | 5322 116 53325 |
| R 9664 | 0.3W 25x 2K2 | 5322 105 20033 |
| R 9666 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9667 | MRS25 1x 1K | 4822 116 53108 |
| R 9668 | MRS25 1x 6K19 | 5322 116 53243 |
| R 9669 | MRS25 1x 3K48 | 4822 116 53315 |
| R 9671 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9672 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9673 | MRS25 1x 750E | 5322 116 53265 |
| R 9674 | MRS25 1x 10E | 4822 116 52891 |
| R 9676 | MRS25 1x 422E | 5322 116 53592 |
| R 9677 | MRS25 1x 422E | 5322 116 53592 |
| R 9678 | 0.3W 25x 1K | 5322 105 20032 |
| R 9679 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9681 | MRS25 1x 5E11 | 4822 116 52999 |
| R 9682 | MRS25 1x 10E | 4822 116 53108 |
| R 9683 | MRS25 1x 1K | 4822 116 53108 |
| R 9684 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9686 | MRS25 1x 2K15 | 5322 116 53239 |
| R 9101 | MRS25 1x 4K22 | 5322 116 53246 |
| R 9102 | MRS25 1x 51E1 | 5322 116 53213 |

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| R 9103 | MRS25 1x 511K | 5322 116 53354 |
| R 9104 | MRS25 1x 511K | 5322 116 53354 |
| R 9106 | MRS25 1x 4K22 | 5322 116 53246 |
| R 9107 | MRS25 1x 1K | 4822 116 53108 |
| R 9108 | MRS25 1x 1K | 4822 116 53108 |
| R 9111 | MRS25 1x 750E | 5322 116 53265 |
| R 9112 | MRS25 1x 1K78 | 5322 116 53208 |
| R 9113 | MRS25 1x 1K78 | 5322 116 53208 |
| R 9114 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9116 | 0.3W 25x 10K | 4822 105 10395 |
| R 9117 | MRS25 1x 316K | 4822 116 53058 |
| R 9118 | MRS25 1x 3K83 | 4822 116 53079 |
| R 9119 | MRS25 1x 3K83 | 4822 116 53079 |
| R 9121 | MRS25 1x 10E | 4822 116 52891 |
| R 9122 | MRS25 1x 10K | 4822 116 53022 |
| R 9123 | 0.3W 25x 1K | 5322 105 20032 |
| R 9124 | MRS25 1x 10K | 4822 116 53022 |
| R 9126 | MRS25 1x 31K6 | 5322 116 53262 |
| R 9127 | MRS25 1x 2K87 | 5322 116 53513 |
| R 9128 | MRS25 1x 750E | 5322 116 53265 |
| R 9129 | MRS25 1x 1K | 4822 116 53108 |
| R 9131 | MRS25 1x 1K78 | 5322 116 53208 |
| R 9132 | MRS25 1x 51E1 | 4822 116 53021 |
| R 9133 | MRS25 1x 4K22 | 5322 116 53246 |
| R 9134 | 0.3W 25x 220K | 5322 105 20039 |
| R 9136 | MRS25 1x 1E | 4822 116 52976 |
| R 9137 | MRS25 1x 1E | 4822 116 52976 |
| R 9138 | MRS25 1x 1E | 4822 116 52976 |
| R 9141 | MRS25 1x 5K22 | 5322 116 53222 |
| R 9141 | MRS25 1x 1K | 4822 116 53108 |
| R 9142 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9143 | MRS25 1x 215E | 5322 116 53325 |
| R 9144 | 0.3W 25x 2K2 | 5322 105 20035 |
| R 9146 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9147 | MRS25 1x 1K | 4822 116 53108 |
| R 9148 | MRS25 1x 6K19 | 5322 116 53265 |
| R 9149 | MRS25 1x 3K48 | 4822 116 53315 |
| R 9171 | MRS25 1x 51E1 | 4822 116 53213 |
| R 9172 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9173 | MRS25 1x 750E | 5322 116 53265 |
| R 9174 | MRS25 1x 750E | 5322 116 53265 |
| R 9176 | MRS25 1x 422E | 5322 116 53592 |
| R 9177 | MRS25 1x 422E | 5322 116 53592 |
| R 9178 | 0.3W 25x 1K | 5322 105 20032 |
| R 9179 | MRS25 1x 5K11 | 5322 116 53494 |
| R 9181 | MRS25 1x 5E11 | 4822 116 52999 |
| R 9182 | MRS25 1x 1K | 4822 116 53108 |
| R 9183 | MRS25 1x 1K | 4822 116 53108 |
| R 9184 | MRS25 1x 51E1 | 5322 116 53213 |
| R 9186 | MRS25 1x 2K15 | 5322 116 53239 |
| R 9201 | MRS25 1x 31E6 | 5322 116 54964 |
| R 9202 | MRS25 1x 31E6 | 5322 116 54964 |
| R 9203 | MRS25 1x 422E | 5322 116 53592 |
| U 3262 | VR25 5x 7M5 | 5322 116 60131 |

18.3.3 COILS

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|----------------|----------------|
| L 1001 | 0.22UH 10x TDK | 5322 157 53284 |
| L 1101 | 0.22UH 10x TDK | 5322 157 53284 |
| L 1401 | 150UH 10x TDK | 4822 156 21295 |
| L 1402 | 150UH TDK | 4822 156 21293 |
| L 1403 | 150UH TDK | 4822 156 21293 |
| L 1404 | 150UH TDK | 4822 156 21293 |
| L 1405 | 150UH TDK | 4822 156 21293 |
| L 1421 | 150UH TDK | 4822 156 21295 |
| L 1422 | 150UH TDK | 4822 156 21295 |
| L 1423 | 150UH TDK | 4822 156 21295 |
| L 3001 | 2.0UH 10x TDK | 5322 157 53509 |
| L 3002 | 2.0UH 10x TDK | 5322 157 53509 |
| L 3003 | 2.7UH 10x TDK | 5322 157 53511 |
| L 4101 | 7.0UH TDK | 4822 157 53179 |
| L 6001 | 0.01H TDK | 5322 157 53019 |
| L 6009 | 100UH TDK | 5322 157 52363 |
| L 6010 | 150UH TDK | 5322 157 52365 |
| L 6002 | 100UH TDK | 5322 157 52363 |
| L 6003 | 5.6UH TDK | 4822 157 52259 |
| L 6004 | 220UH TDK | 5322 157 53524 |
| L 6006 | 220UH TDK | 5322 157 53524 |
| L 6101 | 10UH TDK | 5322 157 52513 |
| L 6102 | 82UH TDK | 4822 158 10563 |
| L 6103 | 100UH TDK | 5322 157 52363 |
| L 6104 | 100UH TDK | 5322 157 52363 |
| L 6106 | 82UH TDK | 4822 158 10563 |
| L 6107 | 82UH TDK | 4822 158 10563 |
| L 6108 | 82UH TDK | 4822 158 10563 |
| L 6109 | 82UH TDK | 4822 158 10563 |
| L 6111 | 15UH TDK | 5322 157 52519 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|----------------|--------|-------------|--------------------|
| L 4201 | 82UH | 4822 158 10565 | V 1119 | BF199 | PEL 4822 130 44154 |
| L 4501 | 82UH | 4822 158 10565 | V 1121 | BF199 | PEL 4822 130 44154 |
| L 7101 | 15UH | 5322 157 52519 | V 1122 | BF324 | PEL 4822 130 41448 |
| L 9001 | 2.0UH | 4822 157 51757 | V 1123 | BZX79-C5V6 | PEL 4822 130 34173 |
| L 9002 | 2.0UH | 4822 157 51757 | V 1124 | BF324 | PEL 4822 130 42589 |
| L 9003 | 2.0UH | 4822 157 51757 | V 1161 | BAH62 | PEL 4822 130 30613 |
| L 9006 | 2.0UH | 4822 157 51757 | V 1163 | BF324 | PEL 4822 130 41448 |
| L 9007 | 2.0UH | 4822 157 51757 | V 1164 | BF324 | PEL 4822 130 41448 |
| | | | V 1200 | BZV86-C1V4 | PEL 4822 130 81423 |

18.3.4 SEMI-CONDUCTORS

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|--------------------|--------|-------------|--------------------|
| V 0601 | BC548C | PEL 4822 130 44196 | V 1206 | BF199 | PEL 4822 130 44154 |
| V 0602 | BC558B | PEL 4822 130 44197 | V 1207 | BF324 | PEL 4822 130 41448 |
| V 0603 | BZV86-C1V4 | PEL 4822 130 81423 | V 1208 | BZX79-C5V6 | PEL 4822 130 34173 |
| V 0604 | BC558B | PEL 4822 130 44197 | V 1209 | BF199 | PEL 4822 130 44154 |
| V 0606 | BC548C | PEL 4822 130 44196 | V 1211 | BF324 | PEL 4822 130 41448 |
| V 0607 | BZX79-C6V2 | PEL 4822 130 34167 | V 1212 | BF324 | PEL 4822 130 41448 |
| V 0608 | BC548C | PEL 4822 130 44196 | V 1213 | BF324 | PEL 4822 130 41448 |
| V 0609 | BAH62 | PEL 4822 130 30613 | V 2002 | BZV86-C2V0 | PEL 4822 130 81426 |
| V 0611 | BAH62 | PEL 4822 130 30613 | V 2003 | BZX79-C3V0 | PEL 4822 130 31881 |
| V 0612 | BAH62 | PEL 4822 130 30613 | V 2101 | BZV86-C2V0 | PEL 4822 130 81424 |
| V 0613 | BAH62 | PEL 4822 130 30613 | V 2102 | BZV86-C2V0 | PEL 4822 130 81424 |
| V 0614 | BAH62 | PEL 4822 130 30613 | V 2103 | BZX79-C3V0 | PEL 4822 130 31881 |
| V 0615 | BAH62 | PEL 4822 130 30613 | V 2308 | BZX79-C5V1 | PEL 4822 130 34233 |
| V 0616 | BC548C | PEL 4822 130 44196 | V 2309 | BZX79-C5V1 | PEL 4822 130 34233 |
| V 0617 | BC548C | PEL 4822 130 44196 | V 2310 | BC558B | PEL 4822 130 44197 |
| V 0618 | BAH62 | PEL 4822 130 30613 | V 2311 | BC558B | PEL 4822 130 44197 |
| V 0619 | BAH62 | PEL 4822 130 30613 | V 2312 | BC558B | PEL 4822 130 44197 |
| V 0621 | BC548C | PEL 4822 130 44196 | V 2314 | BAH62 | PEL 4822 130 30613 |
| V 0622 | BC548C | PEL 4822 130 44196 | V 2316 | BF324 | PEL 4822 130 41448 |
| V 0623 | BAH62 | PEL 4822 130 30613 | V 2117 | BC568C | PEL 4822 130 44194 |
| V 0624 | BAH62 | PEL 4822 130 30613 | V 2318 | BF324 | PEL 4822 130 41448 |
| V 0626 | BC548C | PEL 4822 130 44196 | V 2319 | BF324 | PEL 4822 130 41448 |
| V 0627 | BC548C | PEL 4822 130 44196 | V 2321 | BF324 | PEL 4822 130 41448 |
| V 0628 | BC548C | PEL 4822 130 44196 | V 2325 | BAH62 | PEL 4822 130 30613 |
| V 0629 | BC548C | PEL 4822 130 44196 | V 2326 | BAH62 | PEL 4822 130 30613 |
| V 0630 | BC548C | PEL 4822 130 44196 | V 2327 | BC558B | PEL 4822 130 44197 |
| V 0631 | BC548C | PEL 4822 130 44196 | V 2328 | BZX79-C5V1 | PEL 4822 130 34233 |
| V 0632 | BC548C | PEL 4822 130 44196 | V 2329 | BZX79-C5V1 | PEL 4822 130 30862 |
| V 0633 | BC548C | PEL 4822 130 44196 | V 2331 | BC558B | PEL 4822 130 44197 |
| V 0634 | BAH62 | PEL 4822 130 30613 | V 2332 | BC558B | PEL 4822 130 44197 |
| V 0636 | BAH62 | PEL 4822 130 30613 | V 2333 | BC558B | PEL 4822 130 44197 |
| V 1000 | BA483 | PEL 4822 130 32656 | V 2334 | BC558B | PEL 4822 130 44197 |
| V 1001 | BF324 | PEL 4822 130 41448 | V 2341 | BF199 | PEL 4822 130 44154 |
| V 1002 | BF324 | PEL 4822 130 41448 | V 2342 | BF199 | PEL 4822 130 44154 |
| V 1003 | ON4401 | PEL 5322 150 61498 | V 2349 | BF199 | PEL 4822 130 44154 |
| V 1004 | BA483 | PEL 4822 130 32656 | V 2356 | BC548C | PEL 4822 130 44196 |
| V 1005 | BA483 | PEL 4822 130 32656 | V 2357 | BC548C | PEL 4822 130 44196 |
| V 1006 | ON4401 | PEL 5322 150 61498 | V 2366 | BAH62 | PEL 4822 130 30613 |
| V 1007 | BA483 | PEL 4822 130 32656 | V 2367 | BAH62 | PEL 4822 130 30613 |
| V 1008 | BA483 | PEL 4822 130 32656 | V 2368 | BAH62 | PEL 4822 130 30613 |
| V 1009 | BA483 | PEL 4822 130 32656 | V 2369 | BAH62 | PEL 4822 130 30613 |
| V 1010 | BZX79-C10 | PEL 4822 130 34297 | V 2370 | BC548C | PEL 4822 130 44196 |
| V 1011 | ON4401 | PEL 5322 150 61498 | V 2371 | BC558B | PEL 4822 130 44197 |
| V 1012 | BA483 | PEL 4822 130 32656 | V 2601 | BZX79-C6V2 | PEL 4822 130 34167 |
| V 1013 | BA483 | PEL 4822 130 32656 | V 2602 | BC548C | PEL 4822 130 44196 |
| V 1014 | BA483 | PEL 4822 130 32656 | V 2611 | BF199 | PEL 4822 130 44154 |
| V 1016 | ON4401 | PEL 5322 150 61498 | V 2612 | BF199 | PEL 4822 130 44154 |
| V 1017 | BA483 | PEL 4822 130 32656 | V 2615 | BC548C | PEL 4822 130 44196 |
| V 1019 | BF199 | PEL 4822 130 44154 | V 2616 | BZV86-C1V4 | PEL 4822 130 81423 |
| V 1021 | BF199 | PEL 4822 130 44154 | V 3001 | BF324 | PEL 4822 130 41448 |
| V 1022 | BF324 | PEL 4822 130 41448 | V 3002 | BF324 | PEL 4822 130 41448 |
| V 1023 | BZX79-C5V6 | PEL 4822 130 34173 | V 3003 | BC558B | PEL 4822 130 44197 |
| V 1024 | BF370 | PEL 4822 130 42589 | V 3004 | BF324 | PEL 4822 130 41448 |
| V 1061 | BAH62 | PEL 4822 130 30613 | V 3006 | BF324 | PEL 4822 130 41448 |
| V 1062 | BAH62 | PEL 4822 130 30613 | V 3007 | BC548C | PEL 4822 130 44196 |
| V 1063 | BF324 | PEL 4822 130 41448 | V 3008 | BF370 | PEL 4822 130 42589 |
| V 1064 | BF324 | PEL 4822 130 41448 | V 3009 | BF370 | PEL 4822 130 42589 |
| V 1100 | BA483 | PEL 4822 130 32656 | V 3011 | 2N3866-01 | PEL 5322 150 61799 |
| V 1101 | BF324 | PEL 4822 130 41448 | V 3012 | 2N3866-01 | PEL 5322 150 61799 |
| V 1102 | BF324 | PEL 4822 130 41448 | V 3013 | BZX79-B27 | PEL 4822 130 34379 |
| V 1103 | ON4401 | PEL 5322 150 61498 | V 3014 | BZX79-B27 | PEL 4822 130 34379 |
| V 1104 | BA483 | PEL 4822 130 32656 | V 3016 | BAH62 | PEL 4822 130 30613 |
| V 1105 | BA483 | PEL 4822 130 32656 | V 3101 | BF324 | PEL 4822 130 41448 |
| V 1106 | ON4401 | PEL 5322 150 61498 | V 3102 | BF324 | PEL 4822 130 41448 |
| V 1107 | BA483 | PEL 4822 130 32656 | V 3103 | BF324 | PEL 4822 130 41448 |
| V 1108 | BA483 | PEL 4822 130 32656 | V 3104 | BC558B | PEL 4822 130 44197 |
| V 1109 | BA483 | PEL 4822 130 32656 | V 3106 | BF324 | PEL 4822 130 41448 |
| V 1110 | BZX79-C10 | PEL 4822 130 34297 | V 3108 | BF472 | PEL 5322 150 42555 |
| V 1111 | ON4401 | PEL 5322 150 61498 | V 3109 | BF370 | PEL 4822 130 42589 |
| V 1112 | BA483 | PEL 4822 130 32656 | V 3111 | BF370 | PEL 4822 130 42589 |
| V 1113 | BA483 | PEL 4822 130 32656 | V 3112 | 2N5511 | PEL 5322 150 44691 |
| V 1114 | BA483 | PEL 4822 130 32656 | V 3113 | BZX79-B5V6 | PEL 4822 130 34173 |
| V 1116 | ON4401 | PEL 5322 150 61498 | | | |
| V 1117 | BA483 | PEL 4822 130 32656 | | | |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|--------------------|--------|-------------|--------------------|
| V 3114 | ZH5551 | PEL 5322 130 44491 | V 4513 | BC558B | PEL 4822 130 46197 |
| V 3115 | BF423 | PEL 5322 130 42535 | V 4514 | BAH62 | PEL 4822 130 46197 |
| V 3200 | BF370 | PEL 4822 130 42589 | V 4516 | BAH62 | PEL 4822 130 30613 |
| V 3201 | BF370 | PEL 4822 130 42589 | V 4517 | BAH62 | PEL 4822 130 30613 |
| V 3202 | ZH5401 | PEL 5322 130 42534 | V 4518 | BAH62 | PEL 4822 130 30613 |
| V 3203 | ZH5551 | PEL 5322 130 44491 | V 4519 | BAH62 | PEL 4822 130 30613 |
| V 3204 | BF423 | PEL 4822 130 41646 | V 4521 | BAH62 | PEL 4822 130 30613 |
| V 3205 | BZX79-C9V6 | PEL 4822 130 30613 | V 4522 | BAH62 | PEL 4822 130 30613 |
| V 3206 | BAH62 | PEL 4822 130 30613 | V 4523 | BC548C | PEL 4822 130 44196 |
| V 3207 | BC548C | PEL 4822 130 44196 | V 4601 | BAH62 | PEL 4822 130 30613 |
| V 3208 | BF423 | PEL 4822 130 41646 | V 4602 | BAH62 | PEL 4822 130 30613 |
| V 3209 | BAH62 | PEL 4822 130 30613 | V 4603 | BAH62 | PEL 4822 130 30613 |
| V 3211 | BAH62 | PEL 4822 130 30613 | V 4611 | BF199 | PEL 4822 130 44154 |
| V 3212 | BZX79-B68 | PEL 4822 130 30864 | V 4612 | BF199 | PEL 4822 130 44154 |
| V 3213 | BC548C | PEL 4822 130 44196 | V 4613 | BAH62 | PEL 4822 130 30613 |
| V 3214 | BAH62 | PEL 4822 130 30613 | V 4614 | BAH62 | PEL 4822 130 30613 |
| V 3215 | BAH62 | PEL 4822 130 30613 | V 4616 | BC548C | PEL 4822 130 44196 |
| V 3216 | BZX79-C9V1 | PEL 4822 130 30862 | V 4617 | BAH62 | PEL 4822 130 30613 |
| V 3217 | BAH62 | PEL 4822 130 30613 | V 4618 | BAH62 | PEL 4822 130 30613 |
| V 3251 | BF423 | PEL 4822 130 41646 | V 4702 | BF324 | PEL 4822 130 41448 |
| V 3252 | BZX79-C6V2 | PEL 4822 130 34167 | V 4703 | BAH62 | PEL 4822 130 30613 |
| V 3253 | BF423 | PEL 4822 130 41646 | V 4704 | BAH62 | PEL 4822 130 30613 |
| V 3254 | BF423 | PEL 4822 130 41646 | V 4706 | BF324 | PEL 4822 130 41448 |
| V 3256 | BF423 | PEL 4822 130 41646 | V 4707 | BC558B | PEL 4822 130 44197 |
| V 3257 | BAV21 | PEL 4822 130 30842 | V 4708 | BF324 | PEL 4822 130 41448 |
| V 3301 | BZX79-C6V2 | PEL 4822 130 34167 | V 4799 | BC558B | PEL 4822 130 44197 |
| V 4000 | BF199 | PEL 4822 130 44154 | V 4710 | BC548C | PEL 4822 130 44196 |
| V 4002 | BF199 | PEL 4822 130 44154 | V 4711 | BAH62 | PEL 4822 130 30613 |
| V 4003 | BF324 | PEL 4822 130 41448 | V 4712 | BF324 | PEL 4822 130 41448 |
| V 4004 | BF324 | PEL 4822 130 41448 | V 4713 | BAH62 | PEL 4822 130 30613 |
| V 4005 | BZX79-C6V2 | PEL 4822 130 34167 | V 6001 | BYV9E | PEL 5322 130 34679 |
| V 4006 | BAH62 | PEL 4822 130 30613 | V 6002 | BYV9E | PEL 5322 130 34679 |
| V 4008 | BFQ223 | PEL 5322 130 42031 | V 6003 | BYV9E | PEL 5322 130 34679 |
| V 4009 | BC548C | PEL 4822 130 44196 | V 6004 | BYV9E | PEL 5322 130 34679 |
| V 4011 | BC548C | PEL 4822 130 44196 | V 6007 | BAX12 | PEL 5322 130 34605 |
| V 4012 | BC548C | PEL 4822 130 44196 | V 6008 | BAX12 | PEL 5322 130 34605 |
| V 4013 | BZX79-C9V1 | PEL 4822 130 34233 | V 6009 | BC337 | PEL 4822 130 40855 |
| V 4014 | BC548C | PEL 4822 130 44196 | V 6011 | BAX12 | PEL 5322 130 34605 |
| V 4016 | BZX79-C3V6 | PEL 5322 130 34834 | V 6012 | BZX79-C15 | PEL 4822 130 34281 |
| V 4017 | BAH62 | PEL 4822 130 30613 | V 6013 | BRX39 | PEL 5322 130 40482 |
| V 4018 | BC548C | PEL 4822 130 44196 | V 6014 | BUK456-800B | PEL 5322 130 45926 |
| V 4021 | BC548C | PEL 4822 130 44196 | V 6016 | BYV27-150 | PEL 4822 130 31628 |
| V 4022 | BAH62 | PEL 4822 130 30613 | V 6017 | BYV9E | PEL 5322 130 34679 |
| V 4023 | BC548C | PEL 4822 130 44196 | V 6018 | BUK12A | PEL 4822 130 42146 |
| V 4101 | BC558B | PEL 4822 130 44197 | V 6019 | BYV26C | PEL 4822 130 32343 |
| V 4102 | BAH62 | PEL 4822 130 30613 | V 6021 | BZX79-C3V0 | PEL 4822 130 31881 |
| V 4103 | BAH62 | PEL 4822 130 30613 | V 6031 | BZX79-C3V6 | PEL 5322 130 34679 |
| V 4104 | BC548C | PEL 4822 130 44196 | V 6101 | M8R2545CT | PEL 5322 130 81179 |
| V 4106 | BAH62 | PEL 4822 130 30613 | V 6102 | BYV9C | PEL 4822 130 41487 |
| V 4107 | BC327 | PEL 4822 130 40854 | V 6103 | BYV9C | PEL 4822 130 41487 |
| V 4108 | BC548C | PEL 4822 130 44196 | V 6104 | BYV26-150 | PEL 5322 130 32043 |
| V 4109 | BC558B | PEL 4822 130 44197 | V 6105 | BYV27-150 | PEL 4822 130 31628 |
| V 4110 | BA483 | PEL 4822 130 32656 | V 6107 | BYV9E | PEL 4822 130 41487 |
| V 4111 | BC558B | PEL 4822 130 44197 | V 6108 | BYV27-150 | PEL 4822 130 31628 |
| V 4112 | BSX20 | PEL 4822 130 41795 | V 6109 | BYV9C | PEL 4822 130 41487 |
| V 4113 | BZV86-C1V4 | PEL 4822 130 81423 | V 6110 | BYV27-150 | PEL 4822 130 31628 |
| V 4114 | BSX20 | PEL 4822 130 41795 | V 6113 | BYV9C | PEL 4822 130 41487 |
| V 4115 | BZX79-C6V2 | PEL 4822 130 34167 | V 6115 | BYV27-150 | PEL 4822 130 31628 |
| V 4116 | BAH62 | PEL 4822 130 30613 | V 6116 | BYV27-150 | PEL 4822 130 31628 |
| V 4117 | BC548C | PEL 4822 130 44196 | V 6131 | BAX12 | PEL 5322 130 34605 |
| V 4118 | BC548C | PEL 4822 130 44196 | V 6132 | BAH62 | PEL 4822 130 30613 |
| V 4119 | BF199 | PEL 4822 130 44154 | V 6133 | BZX79-C6V2 | PEL 4822 130 34167 |
| V 4120 | BAH62 | PEL 4822 130 30613 | V 6134 | BF423 | PEL 4822 130 41646 |
| V 4121 | BC548C | PEL 4822 130 44196 | V 6136 | BF423 | PEL 4822 130 41646 |
| V 4122 | BAH62 | PEL 4822 130 30613 | V 6137 | BF423 | PEL 4822 130 41646 |
| V 4123 | BAH62 | PEL 4822 130 30613 | V 6138 | BZX79-C5V6 | PEL 4822 130 34173 |
| V 4216 | BAH62 | PEL 4822 130 30613 | V 6201 | BC327 | PEL 4822 130 40854 |
| V 4217 | BC548C | PEL 4822 130 44196 | V 6202 | BZX79-C15 | PEL 4822 130 34281 |
| V 4300 | BZX79-C6V2 | PEL 4822 130 34167 | V 6203 | BAV21 | PEL 4822 130 30842 |
| V 4301 | BC558B | PEL 4822 130 44197 | V 6204 | BAV21 | PEL 4822 130 30842 |
| V 4302 | BC548C | PEL 4822 130 44196 | V 6205 | BAV21 | PEL 4822 130 30842 |
| V 4304 | BC558B | PEL 4822 130 44197 | V 6207 | BYV27-150 | PEL 4822 130 31628 |
| V 4305 | BZX79-C9V1 | PEL 4822 130 30862 | V 6208 | BUZ5A | PEL 5322 130 42722 |
| V 4306 | BAH62 | PEL 4822 130 30613 | V 6209 | BYV19 | PEL 4822 130 41485 |
| V 4307 | BC548C | PEL 4822 130 44196 | V 6211 | BC337 | PEL 4822 130 40855 |
| V 4308 | BZV86-C1V4 | PEL 4822 130 81423 | V 6301 | BC548C | PEL 4822 130 44196 |
| V 4309 | BC548C | PEL 4822 130 44196 | V 6302 | BC558B | PEL 4822 130 44197 |
| V 4321 | BAH62 | PEL 4822 130 30613 | V 6303 | BC337 | PEL 4822 130 40855 |
| V 4322 | BC548C | PEL 4822 130 44196 | V 6304 | BC327 | PEL 4822 130 40854 |
| V 4323 | BC548C | PEL 4822 130 44196 | V 6311 | BC337 | PEL 4822 130 40855 |
| V 4500 | BAH62 | PEL 4822 130 30613 | V 6312 | BZX78 | PEL 5322 130 44278 |
| V 4501 | BC548C | PEL 4822 130 44196 | V 6313 | BRV196 | PEL 5322 130 54294 |
| V 4502 | BC548C | PEL 4822 130 44196 | V 6402 | BAX12 | PEL 5322 130 34605 |
| V 4503 | BC548C | PEL 4822 130 44196 | V 6403 | BC337 | PEL 4822 130 40855 |
| V 4504 | BC548C | PEL 4822 130 44196 | V 7001 | BAH62 | PEL 4822 130 30613 |
| V 4505 | BAH62 | PEL 4822 130 30613 | V 7002 | BC548C | PEL 4822 130 44196 |
| V 4506 | BC548C | PEL 4822 130 44196 | V 7101 | BAH62 | PEL 4822 130 30613 |
| V 4510 | BC558B | PEL 4822 130 44197 | V 9001 | BAT85 | PEL 4822 130 31983 |
| V 4511 | BC558B | PEL 4822 130 44197 | V 9002 | BAT85 | PEL 4822 130 31983 |
| V 4512 | BC558B | PEL 4822 130 44197 | V 9003 | BAT85 | PEL 4822 130 31983 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|--------------------|--------|-------------|--------------------|
| V 9004 | BZX79-CSV9 | PEL 4822 130 31981 | D 9044 | N7415298N | SIG 5322 209 85937 |
| V 9009 | BAT85 | PEL 4822 130 31983 | D 9046 | HEF40668P | PEL 5322 209 10357 |
| V 9011 | BC558B | PEL 4822 130 44197 | D 9047 | FLA | 5322 209 51655 |
| V 9012 | BC558B | PEL 4822 130 44197 | D 9048 | FPLA | 5322 209 51656 |
| V 9013 | BC558B | PEL 4822 130 44197 | D 9049 | 74F74PC | FSC 5322 209 81474 |
| V 9014 | BC548C | PEL 4822 130 44196 | D 9050 | 74F174PC | FSC 5322 209 83326 |
| V 9016 | BC548C | PEL 4822 130 44196 | D 9051 | 74F525PC | FSC 5322 209 81777 |
| V 9017 | BC548C | PEL 4822 130 44196 | D 9052 | PC74HC1574P | PEL 5322 209 11489 |
| V 9018 | BC548C | PEL 4822 130 44196 | D 9053 | 74F191PC | FSC 5322 209 81676 |
| V 9018 | BC548C | PEL 4822 130 44196 | D 9054 | 74F191PC | FSC 5322 209 81676 |
| V 9106 | BC548C | PEL 4822 130 44196 | D 9056 | 74F191PC | FSC 5322 209 81676 |
| V 9107 | BC548C | PEL 4822 130 44196 | D 9057 | 74F191PC | FSC 5322 209 81676 |
| V 9108 | BC548C | PEL 4822 130 44196 | D 9058 | PC74HC1574P | PEL 5322 209 11489 |
| V 9109 | BAT85 | PEL 4822 130 31983 | D 9059 | PC74HC1574P | PEL 5322 209 11489 |
| V 9111 | BC558B | PEL 4822 130 44197 | D 9061 | 74F191PC | FSC 5322 209 81676 |
| V 9112 | BC558B | PEL 4822 130 44197 | D 9062 | 74F191PC | FSC 5322 209 81676 |
| V 9113 | BC558B | PEL 4822 130 44197 | D 9063 | 74F191PC | FSC 5322 209 81676 |
| V 9114 | BC548C | PEL 4822 130 44196 | D 9064 | 74F257APC | FSC 5322 209 71672 |
| V 9116 | BC548C | PEL 4822 130 44196 | D 9067 | 74F257APC | FSC 5322 209 71672 |
| V 9117 | BC548C | PEL 4822 130 44196 | D 9068 | 74F257APC | FSC 5322 209 71672 |
| V 9118 | BC548C | PEL 4822 130 44196 | D 9069 | PC74HC1616P | PEL 5322 209 11476 |
| V 9119 | BC548C | PEL 4822 130 44196 | D 9071 | PC74HC1616P | PEL 5322 209 11476 |
| V 9121 | BC548C | PEL 4822 130 44196 | D 9073 | PC74HC1616P | PEL 5322 209 11476 |
| V 9122 | BC548C | PEL 4822 130 44196 | D 9074 | 74F257PC | FSC 5322 209 81771 |

18.3.5 INTERGRATED CIRCUITS

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|--------------------|--------|-------------|--------------------|
| D 0601 | PLIFIER | 5322 209 80991 | D 0603 | PLIFIER | 5322 209 80991 |
| D 0602 | PLIFIER | 5322 209 80991 | N 1101 | OP-770P | PWI 5322 130 60937 |
| D 0605 | CTANCT4053P | PEL 4822 209 71584 | N 1201 | LF356N | NSC 5322 209 86451 |
| D 1001 | TEA1017/N9 | PEL 5322 209 60191 | N 4101 | LM324N | NSC 4822 209 80587 |
| D 1101 | TEA1017/N9 | PEL 5322 209 60191 | N 4101 | LM324N | NSC 4822 209 80587 |
| D 2203 | ARRAY 00 0127 | 5322 209 80992 | N 4102 | OP-770P | PWI 5322 130 60937 |
| D 2302 | PLIFIER | 5322 209 80991 | N 4103 | TL080CP | T 1 5322 209 75444 |
| D 2303 | PLIFIER | 5322 209 80991 | N 4601 | CA1102E | PCA 5322 209 72657 |
| D 2601 | HEF4055BP | PEL 5322 209 10576 | N 6001 | LM358N | NSC 4822 209 70672 |
| D 2602 | TEA1017/N9 | PEL 5322 209 60191 | N 6002 | LM358N | NSC 4822 209 70672 |
| D 4001 | TEA1017/N9 | PEL 5322 209 60191 | N 7001 | LM339AN | NSC 5322 209 60188 |
| D 4002 | TEA1017/N9 | PEL 5322 209 60191 | N 9001 | TDA2703/CP | PEL 5322 209 61133 |
| D 4101 | HEF4055BP | PEL 5322 209 10576 | N 9002 | TDA2703/CP | PEL 5322 209 61133 |
| D 4102 | HEF4055BP | PEL 5322 209 10576 | N 9003 | DAC-08EP | NSC 5322 209 11253 |
| D 4201 | HEF40668P | PEL 4822 321 21267 | N 9004 | DACL08PX | PWI 5322 209 71665 |
| D 4202 | HEF40668P | PEL 5322 209 10337 | | | |
| D 4501 | HEF4053BP | PEL 5322 209 10576 | | | |
| D 7002 | SN74LS28N | 5322 209 85405 | | | |
| D 7003 | PC74HC1259P | PEL 5322 209 11119 | | | |
| D 7005 | SN74LS259BN | 5322 209 86007 | | | |
| D 7006 | SN74LS244N | 5322 209 86017 | | | |
| D 7006 | SN74LS244N | 5322 209 86017 | | | |
| D 8001 | PCF8577T | PEL 5322 209 70024 | | | |
| D 8002 | PCF8577T | PEL 5322 209 70024 | | | |
| D 8003 | PCF8577T | PEL 5322 209 70024 | | | |
| D 9002 | 74F153APC | FSC 5322 209 85343 | | | |
| D 9003 | 74F74PC | FSC 5322 209 81474 | | | |
| D 9004 | P8254 | INT 5322 209 82406 | | | |
| D 9006 | 74F251APC | FSC 5322 209 71656 | | | |
| D 9012 | P8032AH | INT 5322 209 11318 | | | |
| D 9013 | PRON | 5322 209 51668 | | | |
| D 9016 | M6264ALP-12 | HIT 5322 209 60192 | | | |
| D 9016 | PC74HC1573P | PEL 5322 209 11488 | | | |
| D 9017 | PC74HC1245P | PEL 5322 209 11117 | | | |
| D 9018 | PC74HC1245P | PEL 5322 209 11117 | | | |
| D 9019 | PC74HC1139P | PEL 5322 209 11111 | | | |
| D 9021 | PC74HC1134P | PEL 5322 209 11111 | | | |
| D 9022 | PC74HC108P | PEL 5322 209 11265 | | | |
| D 9023 | 74F04PC | FSC 5322 209 81577 | | | |
| D 9024 | PC74HC1174P | PEL 5322 209 11478 | | | |
| D 9026 | PC74HC1174P | PEL 5322 209 11478 | | | |
| D 9027 | PAL | 5322 209 51663 | | | |
| D 9028 | PAL | 5322 209 51664 | | | |
| D 9029 | PC74HC157P | FSC 5322 209 11263 | | | |
| D 9030 | 74F32PC | FSC 4822 209 82133 | | | |
| D 9031 | HM6716P-30 | HIT 5322 209 61135 | | | |
| D 9032 | HM6716P-30 | HIT 5322 209 61135 | | | |
| D 9033 | HM6716P-30 | HIT 5322 209 61135 | | | |
| D 9033 | 74F245PC | FSC 5322 209 82169 | | | |
| D 9036 | PC74HC1257P | PEL 5322 209 11114 | | | |
| D 9037 | PC74HC1257P | PEL 5322 209 11114 | | | |
| D 9038 | PC74HC1574P | PEL 5322 209 11489 | | | |
| D 9039 | M6225ALP-12 | HIT 5322 209 72122 | | | |
| D 9041 | PC74HC1574P | PEL 5322 209 11489 | | | |
| D 9042 | PC74HC1245P | PEL 5322 209 11117 | | | |
| D 9043 | N7415298N | SIG 5322 209 85937 | | | |

18.3.6 MISCELLANEOUS

| | | | |
|--------|-----------------|----------|----------------|
| E 0001 | 113.4 | 28V 80MA | 5322 130 40534 |
| E 8001 | 60MA | MG9912 | 5322 130 40849 |
| G 9001 | R9-40-50-40M | S.R | 5322 242 72575 |
| N 4001 | CXK35 | PEL | 5322 130 90137 |
| H 8002 | LRH145-1 | PEL | 5322 209 60193 |
| K 1001 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1002 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1003 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1004 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1006 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1007 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1008 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1101 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1102 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1103 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1104 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1106 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1107 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1108 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 1201 | DRELAIS IL 12 V | | 5322 280 20125 |
| K 6101 | DRELAIS IL 12 V | | 5322 280 20125 |
| S 7001 | BR | | 5322 276 11859 |
| S 7002 | BR | | 5322 277 10878 |
| S 7004 | BR | | 5322 277 10878 |
| S 7006 | BR | | 5322 277 10878 |
| S 7008 | BR | | 5322 277 10878 |
| S 7010 | BR | | 5322 277 10878 |
| S 7012 | BR | | 5322 276 11857 |
| S 7013 | BR | | 5322 276 11856 |
| S 7014 | BR | | 5322 276 11856 |
| S 7015 | BR | | 5322 276 11856 |
| S 7016 | BR | | 5322 276 11856 |
| S 7017 | BR | | 5322 276 11856 |

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|
| S 7018 | | 5322 276 11856 |
| S 7019 | | 5322 276 11856 |
| S 7020 | | 5322 276 11856 |
| S 7021 | | 5322 276 11856 |
| S 7022 | | 5322 276 11856 |
| S 7023 | | 5322 276 11856 |
| S 7024 | | 5322 276 11856 |
| S 7025 | | 5322 276 11856 |
| S 7026 | | 5322 276 11856 |
| S 7028 | | 5322 276 11856 |
| S 7029 | | 5322 276 11856 |
| S 7030 | | 5322 276 11856 |
| S 7031 | | 5322 276 11856 |
| S 7032 | | 5322 276 11856 |
| V 0001 | D14-3720H PEL | 5322 131 20169 |