

60 MHz Dual Time Base Oscilloscope

PM3055

Service Manual

4822 872 05327

880411/2



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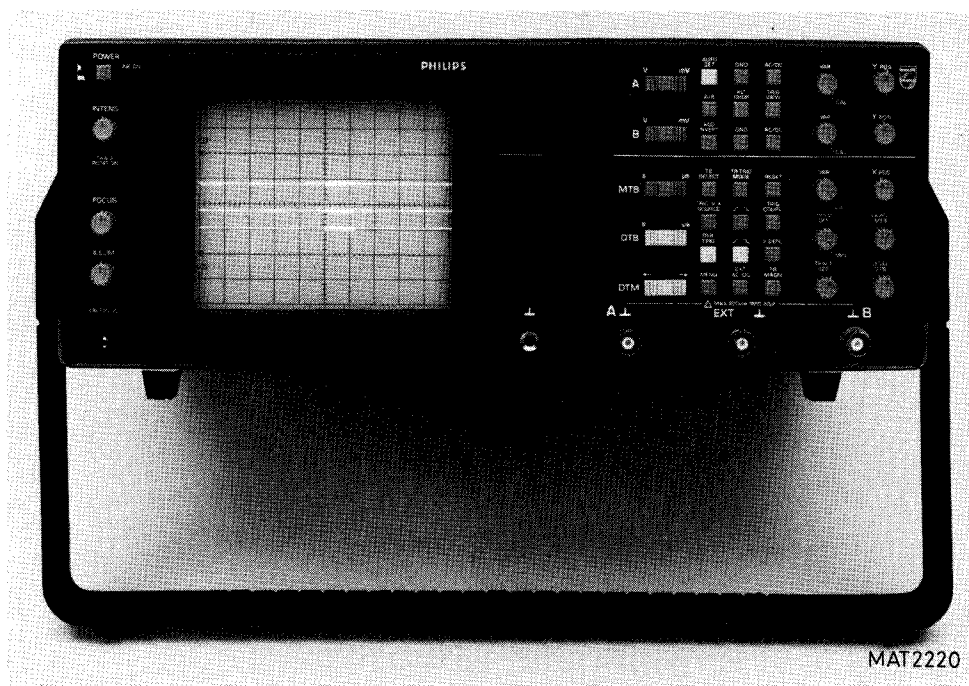
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WARNING: These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock do not perform any servicing other than that specified in the Operating Instructions unless you are fully qualified to do so.



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

B. Safety Characteristics

- This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B 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, excl. knobs | : 518,5 | mm |
| Excluding handle, excl. knobs | : 443,5 | mm |
| Including handle, incl. knobs | : 530,5 | 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 |

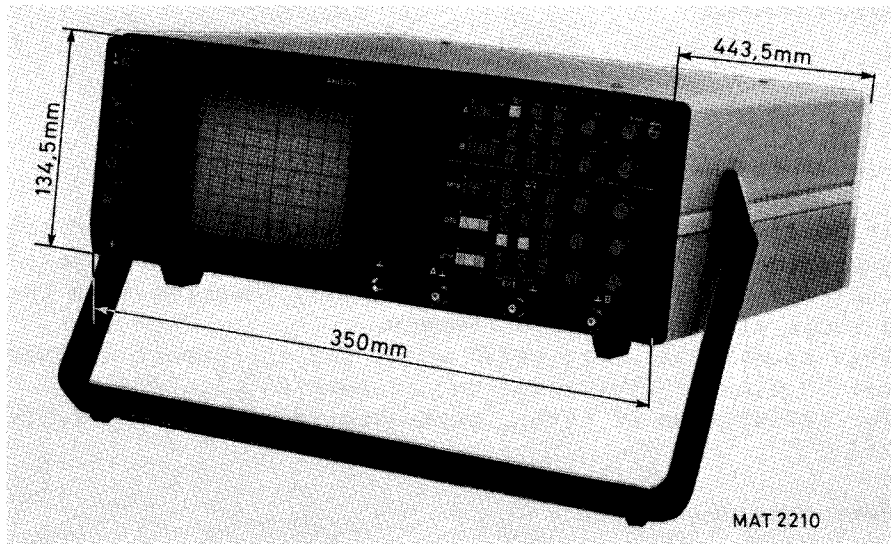


Figure 2.1 Dimensions

- * Mass : 7,5 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. Power Supply
- 2.6. Auxiliary inputs or outputs
- 2.7. Environmental characteristics
- 2.8. Safety

| | 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) | |
| | Option | GM (P 7) | Long persistence |
| | * Total acceleration voltage | 16 kV | |
| | * Graticule | | |
| | Engravings | Internal fixed | |
| | Division lines | 1 cm | Horizontal as well as vertical |
| | Subdivisions | 2 mm | Idem. |
| | Dotted lines | 1,5 and 6,5 cm from top | Only horizontal. |
| | Percentages | 0%, 10%, 90%, 100% | |
| | * Orthogonality | 90° +/- 1° | Measured in zero point. |
| | * Illumination | Continuously variable | |
| | * Display time per channel in chopped mode | < 2 us | |
| | * LCD liquid crystal display | | All relevant settings are visible in display. |
| | Type No | LC 9438130 | |
| | Visible area | 25,4 x 88,8 mm | |
| | Back lighting | Permanently on | |
| 2.2 | VERTICAL DEFLECTION OR Y AXIS | | |
| 2.2.1 | Channels A and B | | |
| | * Deflection coeff. | 2 mV/div...10 V/div | In 1, 2, 5 sequence. If PM 8936/09 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 at $f_0 < 1$ MHz Measured at $f_0 < 1$ MHz |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|-----------------------------------|---|
| * Max. input voltage Max. test voltages (rms) | 400 V (d.c. + a.c. peak) 500 V | Max. duration 60 sec. |
| * Bandwidth for 20 mV...10 V | > 60 MHz (amb.: 0...35°C) | Input 6 div. sine-wave. |
| Bandwidth for 2 mV, 5 mV and 10 mV | > 35 MHz | Input 6 div. sine-wave. |
| * Rise-time | 5,8 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 | > +/- 12 div. | Vernier in cal. position. |
| @ 50 MHz | > 8 div. | Vernier in cal. position. |
| * Position range | > +/- 8 div. | Vernier in cal. position. |
| * Decoupling factor between channels | | Both channels same attenuator setting. |
| @ 10 MHz | 1 : > 100 | Input max. 8 div. sine-wave. |
| @ 50 MHz | 1 : > 50 | 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. |
| * L.F.Non Linearity | < 3% | |
| * 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). |
| Variable jump | < 1 sd | Max.jump in any position of the vernier. |

2.2.2 Triggerview

| | | |
|--|--|---|
| * Bandwidth via A or B channel 2 mV, 5 mV, 10 mV 20 mV...10 V | > 35 MHz > 50 MHz (Amb.: 0...35°C) | 6 div. sine-wave |
| Via EXT. input | > 50 MHz | 6 div. sine-wave (+/- 3 div. from screen centre). |
| * Deflection coeff. Via channel A or B | 2 mV/div...10 V/div | 1, 2, 5 sequence (see Channel A, B). |
| Via EXT. input | 100 mV/div. | |
| Error limit | < 5% | INTERNAL, EXTERNAL. |
| * Lower - 3 dB point AC coupling EXT. input | < 10 Hz | Only when trigger coupling is DC. |
| * Line jump trigger source | < 2 sd | Jump between trigger source A, B composite and EXT. |
| * OFFSET trig.point from screen centre | < 1,5 sd | |
| * Delay EXT. trigger view and channel A or B | < 10 ns | |
| * Dynamic range EXT. input | | |
| @ 1 MHz | > +/- 12 div. | |
| @ 50 MHz | > 6 div. | |

| | CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-------|--|---|---|
| 2.3 | HORIZONTAL DEFLECTION OR X AXIS | | |
| | * Horizontal display modes | MTB, MTBI, ALT.TB, DTB X-DEFL | |
| 2.3.1 | Main Time Base (MTB) | | |
| | * Time coeff. | 0,5 sec...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 *10 | 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 * 10 ---> * 1 | < 2,5 sd | Shift start of sweep in * 10 in mid-screen position, then switch to * 1. |
| | * Hold-Off Minimum to maximum hold-off time ratio | 1 : > 10 | Minimum hold off time is related to time base setting. |
| 2.3.2 | Delay Time Base (DTB) | | |
| | * Time coeff. | 1 ms...50 ns | Sequence 1, 2, 5. |
| | Error limit | | See MTB |
| | * Horizontal position range | | See MTB |
| | * Time Base Magnifier | | See MTB |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|---|------------------------------------|
| * Delay time Multiplier | | |
| Error limit | 3% + 1% incremental delay error + 25 ns +/- 5 ns | * 1 only |
| Incremental delay time error | < 1% | * 1 only |
| * Resolution | 1 : 10 000 | |
| * Delay Time Jitter | 1 : > 20 000 | |
| * Trace separation | | Only valid in alternate time base. |
| Shift range | > +/- 4 div. | DTB shifts only. |
| 2.3.3 X-deflection | | |
| * Deflection coeff. | | |
| Via channel A or B | 2 mV/div...10 V/div 1, 2, 5 sequence. | |
| Via EXT. input | 100 mV/div. | |
| * Error limit | | |
| Via channel A or B | < +/- 5% | |
| Via EXT. input | < +/- 5% | |
| * Bandwidth | DC > 2 MHz | DC coupled |
| * Phase shift between X and Y-deflection | < 3° @ 100 kHz | |
| * Dynamic range | > +/- 12 div. @ 100 kHz | |
| 2.3.4 EXT input | | |
| * Input impedance | 1 M ohm +/- 2% | $f_o < 1 \text{ MHz}$ |
| Paralleled by | 20 pF +/- 2 pF | $f_o < 1 \text{ MHz}$ |
| * Max. input voltage | 400 V (d.c. + a.c. peak) | |
| Max. test voltage (rms) | 500 V | Max. duration 60 sec. |
| * Lower - 3 dB point | < 10 Hz | AC coupled |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|----------------------------------|--|---|
| 2.4 | TRIGGERING | |
| 2.4.1 | MTB triggering | |
| * Trig.mode | | |
| AUTO (auto free run) | Bright line in absence of trigger signal | Auto free run starts 100 ms (typ.) after no trig.pulse. |
| Triggered | | Switches automatically to auto free run if one of the display channels is grounded. |
| Single | | 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 (AB), EXT, Line | | Line trigger source always triggers on main frequency. Line trigger amplitude depends on line input voltage. Approx. 6 div. @ 220 VAC input voltage. |
| * Trigger coupling | | |
| Peak-to-peak (p-p), DC, TVL, TVF | | |
| * Level range | | |
| Peak-to-peak | Related to peak-to-peak | 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 and + or - if TVL/F in chosen for positive or negative video. |
| * Trigger sensitivity | | |
| 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. |
| EXTERNAL | < 70 mV | Sync. pulse. |

| | CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-------|---|----------------------------|--|
| 2.4.2 | DTB Triggering | | |
| | * DTB trigger source Starts, A, B, Composite (AB), EXT and TVL | | TVL has same trig.source as MTB trig. source TVL only valid if MTB trig. coupling TVL or TVF is chosen. |
| | * Coupling | DC | |
| | * Trigger sensi- tivity | See MTB | |
| | * Trigger Level range | > (+ or - 8 div.) | |
| | * Trigger slope | +/- | Slope sign in LCD, if TVL is chosen. Slope sign is not valid |
| 2.5 | POWER SUPPLY | | |
| | * Line input vol- tage AC Nominal Limits of ope- ration | 100 - 240 V 90 - 264 V | One range. |
| | * Line frequency Nominal Limits of ope- ration | 50 - 400 Hz 45 - 440 Hz | |
| | * Safety require- ments within specification of: IEC 348 CLASS I UL 1244 VDE 0411 CSA 556 B | | |
| | * Power consumption | 45 W | |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|--|---|
| AUXILIARY INPUTS OR OUTPUTS | | |
| * Z-MOD | | TTL-compatible. |
| ViH | > 2,0 V | Blanks display. |
| ViL | < 0,8 V | Max. intensity |
| | | Analogue control between ViH and ViL is possible. |
| * DIN plug 9-pin (female) | | For IEEE control, front-panel memory back-up. |
| * CAL | | To calibrate drop or tilt probes. |
| Output voltage | 1,2 V +/- 1% | Rectangular output pulse. |
| Frequency | 2 kHz | |
| The output may be short-circuit to ground. | | |
| ENVIRONMENTAL CHARACTERISTICS | | |
| <p>The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.</p> <p>Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.</p> | | |
| * Meets environmental requirements of: | MIL-T-28800 C, type III, CLASS 5 Style D | |
| * Temperature | | |
| Operation temp. range within specification | 10...40°C | MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1. |
| Limits of operation temperature range | 0 ...50°C | Idem. |
| Non-operating (Storage) | - 40°C/+ 75°C | MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1. |
| * Max. humidity | | |
| operating | 95% RH | 10...30°C |
| non-operating | | |
| * 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 | 7 min. | |
| Sweep Time | | |
| Excursion (p-p) | 1,5 mm | |
| Max Acceleration | 7 m/s ² (0,7 x g) | @ 15 Hz |
| Freq. 15...25 Hz | 3 min. | |
| Sweep Time | | |
| Excursion (p-p) | 1 mm | |
| Max Acceleration | 13 m/s ² (1,3 x g) | @ 25 Hz |
| Freq. 25...55 Hz | 5 min. | |
| Sweep Time | | |
| 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 | 11 ms |
| Peak Acceleration | 300 m/s ² (30 x g) | |
| * Bench handling | | Mil-T-28800 C par. 3.9.5.3. tested, par. 4.5.5.4.3. |
| Meets requirements of | MIL-STD-810 method 516, proced. V | |
| * Salt Atmosphere | | MIL-T-28800C par. 3.9.8.1 tested, par. 4.5.6.2.1. |
| Structural parts meet requirements of | MIL-STD-810 methode 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 |
|--|---|--|
| * Magnetic Radiated Susceptibility Maximum Deflection Factor | | Tested in conformity with IEC 351-1 par. 5.1.3.1. Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a flux intensity (p-p value) of 1,42 mT (14,2 gauss) and of symmetrical sine-wave form with a frequency of 45...66Hz. |
| 2.8 SAFETY | | |
| * Meets requirements of | IEC 348 CLASS I VDE 0411 UL 1244 CSA 556 B | Except for power cord, unless shipped with Universal European power plug. Except for power cord, unless shipped with North American power plug. |
| * Max. X-Radiation | | Measured @ 5 cm from surface of instrument for a target area of 10 cm ² |
| * Recovery time | 15 min. 30 min. 45 min. 60 min. | -10°C ----> + 25°C ambient temp. -20°C ----> + 25°C ambient temp. -30°C ----> + 25°C ambient temp. -40°C ----> + 40°C ambient temp. |

2. CHARACTERISTICS

A. Performance Characteristics

- Properties expressed in numerical values with stated tolerance are guaranteed by PHILIPS Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- For definitions of terms, reference is made to IEC Publication 351-1.

B. Safety Characteristics

- This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety requirements for Electronic Measuring Apparatus, UL 1244 and CSA 556B 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, excl. knobs | : 518,5 | mm |
| Excluding handle, excl. knobs | : 443,5 | mm |
| Including handle, incl. knobs | : 530,5 | 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 |

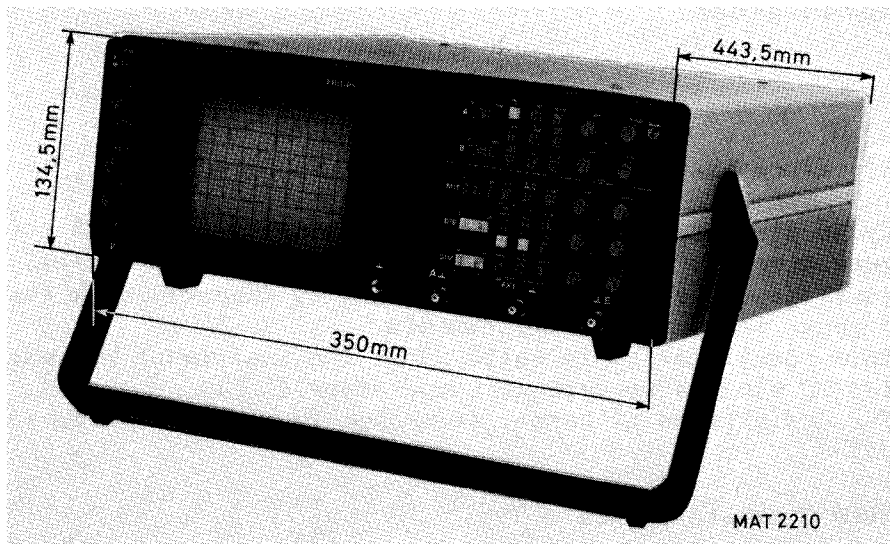


Figure 2.1 Dimensions

- * Mass : 7,5 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. Power Supply
- 2.6. Auxiliary inputs or outputs
- 2.7. Environmental characteristics
- 2.8. Safety

| | 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) | |
| | Option | GM (P 7) | Long persistence |
| | * Total acceleration voltage | 16 kV | |
| | * Graticule | | |
| | Engravings | Internal fixed | |
| | Division lines | 1 cm | Horizontal as well as vertical |
| | Subdivisions | 2 mm | Idem. |
| | Dotted lines | 1,5 and 6,5 cm from top | Only horizontal. |
| | Percentages | 0%, 10%, 90%, 100% | |
| | * Orthogonality | 90° +/- 1° | Measured in zero point. |
| | * Illumination | Continuously variable | |
| | * Display time per channel in chopped mode | < 2 us | |
| | * LCD liquid crystal display | | All relevant settings are visible in display. |
| | Type No | LC 9438130 | |
| | Visible area | 25,4 x 88,8 mm | |
| | Back lighting | Permanently on | |
| 2.2 | VERTICAL DEFLECTION OR Y AXIS | | |
| 2.2.1 | Channels A and B | | |
| | * Deflection coeff. | 2 mV/div...10 V/div | In 1, 2, 5 sequence. If PM 8936/09 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 at $f_0 < 1$ MHz Measured at $f_0 < 1$ MHz |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|-----------------------------------|---|
| * Max. input voltage Max. test voltages (rms) | 400 V (d.c. + a.c. peak) 500 V | Max. duration 60 sec. |
| * Bandwidth for 20 mV...10 V | > 60 MHz (amb.: 0...35°C) | Input 6 div. sine-wave. |
| Bandwidth for 2 mV, 5 mV and 10 mV | > 35 MHz | Input 6 div. sine-wave. |
| * Rise-time | 5,8 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 | > +/- 12 div. | Vernier in cal. position. |
| @ 50 MHz | > 8 div. | Vernier in cal. position. |
| * Position range | > +/- 8 div. | Vernier in cal. position. |
| * Decoupling factor between channels | | Both channels same attenuator setting. |
| @ 10 MHz | 1 : > 100 | Input max. 8 div. sine-wave. |
| @ 50 MHz | 1 : > 50 | 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. |
| * L.F.Non Linearity | < 3% | |
| * 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). |
| Variable jump | < 1 sd | Max.jump in any position of the vernier. |
| 2.2.2 Triggerview | | |
| * Bandwidth via A or B channel 2 mV, 5 mV, 10 mV | > 35 MHz | 6 div. sine-wave |
| 20 mV...10 V | > 50 MHz (Amb.: 0...35°C) | |
| Via EXT. input | > 50 MHz | 6 div. sine-wave (+/- 3 div. from screen centre). |
| * Deflection coeff. Via channel A or B | 2 mV/div...10 V/div | 1, 2, 5 sequence (see Channel A, B). |
| Via EXT. input | 100 mV/div. | |
| Error limit | < 5% | INTERNAL, EXTERNAL. |
| * Lower - 3 dB point AC coupling EXT. input | < 10 Hz | Only when trigger coupling is DC. |
| * Line jump trigger source | < 2 sd | Jump between trigger source A, B composite and EXT. |
| * OFFSET trig.point from screen centre | < 1,5 sd | |
| * Delay EXT. trigger view and channel A or B | < 10 ns | |
| * Dynamic range EXT. input | | |
| @ 1 MHz | > +/- 12 div. | |
| @ 50 MHz | > 6 div. | |

| | CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-------|--|---|---|
| 2.3 | HORIZONTAL DEFLECTION OR X AXIS | | |
| | * Horizontal display modes | MTB, MTBI, ALT.TB, DTB X-DEFL | |
| 2.3.1 | Main Time Base (MTB) | | |
| | * Time coeff. | 0,5 sec...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 *10 | 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 * 10 ---> * 1 | < 2,5 sd | Shift start of sweep in * 10 in mid-screen position, then switch to * 1. |
| | * Hold-Off Minimum to maximum hold-off time ratio | 1 : > 10 | Minimum hold off time is related to time base setting. |
| 2.3.2 | Delay Time Base (DTB) | | |
| | * Time coeff. | 1 ms...50 ns | Sequence 1, 2, 5. |
| | Error limit | | See MTB |
| | * Horizontal position range | | See MTB |
| | * Time Base Magnifier | | See MTB |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|---|------------------------------------|
| * Delay time Multiplier | | |
| Error limit | 3% + 1% incremental delay error + 25 ns +/- 5 ns | * 1 only |
| Incremental delay time error | < 1% | * 1 only |
| * Resolution | 1 : 10 000 | |
| * Delay Time Jitter | 1 : > 20 000 | |
| * Trace separation | | Only valid in alternate time base. |
| Shift range | > +/- 4 div. | DTB shifts only. |
| 2.3.3 X-deflection | | |
| * Deflection coeff. | | |
| Via channel A or B | 2 mV/div...10 V/div 1, 2, 5 sequence. | |
| Via EXT. input | 100 mV/div. | |
| * Error limit | | |
| Via channel A or B | < +/- 5% | |
| Via EXT. input | < +/- 5% | |
| * Bandwidth | DC > 2 MHz | DC coupled |
| * Phase shift between X and Y-deflection | < 3° @ 100 kHz | |
| * Dynamic range | > +/- 12 div. @ 100 kHz | |
| 2.3.4 EXT input | | |
| * Input impedance | 1 M ohm +/- 2% | $f_o < 1 \text{ MHz}$ |
| Paralleled by | 20 pF +/- 2 pF | $f_o < 1 \text{ MHz}$ |
| * Max. input voltage | 400 V (d.c. + a.c. peak) | |
| Max. test voltage (rms) | 500 V | Max. duration 60 sec. |
| * Lower - 3 dB point | < 10 Hz | AC coupled |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|----------------------------------|--|---|
| 2.4 | TRIGGERING | |
| 2.4.1 | MTB triggering | |
| * Trig.mode | | |
| AUTO (auto free run) | Bright line in absence of trigger signal | Auto free run starts 100 ms (typ.) after no trig.pulse. |
| Triggered | | Switches automatically to auto free run if one of the display channels is grounded. |
| Single | | 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 (AB), EXT, Line | | Line trigger source always triggers on main frequency. Line trigger amplitude depends on line input voltage. Approx. 6 div. @ 220 VAC input voltage. |
| * Trigger coupling | | |
| Peak-to-peak (p-p), DC, TVL, TVF | | |
| * Level range | | |
| Peak-to-peak | Related to peak-to-peak | 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 and + or - if TVL/F is chosen for positive or negative video. |
| * Trigger sensitivity | | |
| 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. |
| EXTERNAL | < 70 mV | Sync. pulse. |

| | CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-------|---|----------------------------|--|
| 2.4.2 | DTB Triggering | | |
| | * DTB trigger source Starts, A, B, Composite (AB), EXT and TVL | | TVL has same trig.source as MTB trig. source TVL only valid if MTB trig. coupling TVL or TVF is chosen. |
| | * Coupling | DC | |
| | * Trigger sensi- tivity | See MTB | |
| | * Trigger Level range | > (+ or - 8 div.) | |
| | * Trigger slope | +/- | Slope sign in LCD, if TVL is chosen. Slope sign is not valid |
| 2.5 | POWER SUPPLY | | |
| | * Line input vol- tage AC Nominal Limits of ope- ration | 100 - 240 V 90 - 264 V | One range. |
| | * Line frequency Nominal Limits of ope- ration | 50 - 400 Hz 45 - 440 Hz | |
| | * Safety require- ments within specification of: IEC 348 CLASS I UL 1244 VDE 0411 CSA 556 B | | |
| | * Power consumption | 45 W | |

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|--|--|---|
| AUXILIARY INPUTS OR OUTPUTS | | |
| * Z-MOD | | TTL-compatible. |
| ViH | > 2,0 V | Blanks display. |
| ViL | < 0,8 V | Max. intensity |
| | | Analogue control between ViH and ViL is possible. |
| * DIN plug 9-pin (female) | | For IEEE control, front-panel memory back-up. |
| * CAL | | To calibrate drop or tilt probes. |
| Output voltage | 1,2 V +/- 1% | Rectangular output pulse. |
| Frequency | 2 kHz | |
| The output may be short-circuit to ground. | | |
| ENVIRONMENTAL CHARACTERISTICS | | |
| <p>The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.</p> <p>Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.</p> | | |
| * Meets environmental requirements of: | MIL-T-28800 C, type III, CLASS 5 Style D | |
| * Temperature | | |
| Operation temp. range within specification | 10...40°C | MIL-T-28800 C par. 3.9.2.3. tested, par. 4.5.5.1.1. |
| Limits of operation temperature range | 0 ...50°C | Idem. |
| Non-operating (Storage) | - 40°C/+ 75°C | MIL-T-28800 C par. 3.9.2.3. tested, 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 | 7 min. | |
| Sweep Time | | |
| Excursion (p-p) | 1,5 mm | |
| Max Acceleration | 7 m/s ² (0,7 x g) | @ 15 Hz |
| Freq. 15...25 Hz | 3 min. | |
| Sweep Time | | |
| Excursion (p-p) | 1 mm | |
| Max Acceleration | 13 m/s ² (1,3 x g) | @ 25 Hz |
| Freq. 25...55 Hz | 5 min. | |
| Sweep Time | | |
| 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 | 11 ms |
| Peak Acceleration | 300 m/s ² (30 x g) | |
| * Bench handling | | Mil-T-28800 C par. 3.9.5.3. tested, par. 4.5.5.4.3. |
| Meets requirements of | MIL-STD-810 method 516, proced. V | |
| * Salt Atmosphere | | MIL-T-28800C par. 3.9.8.1 tested, par. 4.5.6.2.1. |
| Structural parts meet requirements of | MIL-STD-810 methode 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 |
|--|---|--|
| * Magnetic Radiated Susceptibility Maximum Deflection Factor | | Tested in conformity with IEC 351-1 par. 5.1.3.1. Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a flux intensity (p-p value) of 1,42 mT (14,2 gauss) and of symmetrical sine-wave form with a frequency of 45...66Hz. |
| 2.8 SAFETY | | |
| * Meets requirements of | IEC 348 CLASS I VDE 0411 UL 1244 CSA 556 B | Except for power cord, unless shipped with Universal European power plug. Except for power cord, unless shipped with North American power plug. |
| * Max. X-Radiation | | Measured @ 5 cm from surface of instrument for a target area of 10 cm ² |
| * Recovery time | 15 min. 30 min. 45 min. 60 min. | -10°C ----> + 25°C ambient temp. -20°C ----> + 25°C ambient temp. -30°C ----> + 25°C ambient temp. -40°C ----> + 40°C ambient temp. |

3. INTRODUCTION TO CIRCUIT DESCRIPTION AND BLOCK DIAGRAM DESCRIPTION

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

The functioning of the circuits is described per printed-circuit board (p.c.b.). For every p.c.b. a separate chapter (4-10) is available containing the lay out of the p.c.b., the associated circuit diagram(s) and the circuit description.

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 | Figure |
|-------------|----------|-----------------------|--------|
| 1000-1999 | A1 | Attenuator unit | 4 |
| 2000-2999 | A2 | Pre-amplifier unit | 5 |
| 3000-3999 | A3 | XYZ amplifier unit | 6 |
| 4000-4999 | A4 | Time-base unit | 7 |
| 5000-5999 | A5 | CRT control unit | 8 |
| 6000-6999 | A6 | Power supply | 9 |
| 7000-7999 | A7 | Front unit | 10 |
| 8000-8999 | A8 | LCD unit | 10 |

3.2 BLOCK DIAGRAM DESCRIPTION (see figure 3.1).

3.2.1 Introduction

This block diagram description is based around all the important functional blocks and their interconnections. The interconnections between all p.c.b.'s are given in the interconnection diagram of figure 14.5. 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 microcomputer (uC) system.

3.2.2 Control unit

Because the functional description of the control unit (see chapter 10) is almost similar to the blockdiagram description, no specific attention is given in this chapter to this unit.

3.2.3 Attenuator unit

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 a grounded input or a signal attenuation of $\times 1$ - $\times 10$ or $\times 100$, an IMPEDANCE CONVERTER, a LOW IMPEDANCE ATTENUATOR which gives signal attenuation of $\times 1$ - $\times 2,5$ or $\times 5$ and a GAIN $\times 1$ - $\times 10$

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 $\times 10$ 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 $\times 1$ attenuation and no LOW IMPEDANCE ATTENUATOR. The output of the external channel is fed to both MTB and DTB TRIGGER 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.

3.2.4 Pre-amplifier unit

This unit incorporates the signal splitters for the vertical channels A and B, the trigger view amplifier, the trigger circuits for the MTB and DTB and the chopper oscillator circuit. All these functions are controlled by the control XYP and control XYA signals, generated by the X-Y CONTROL blocks.

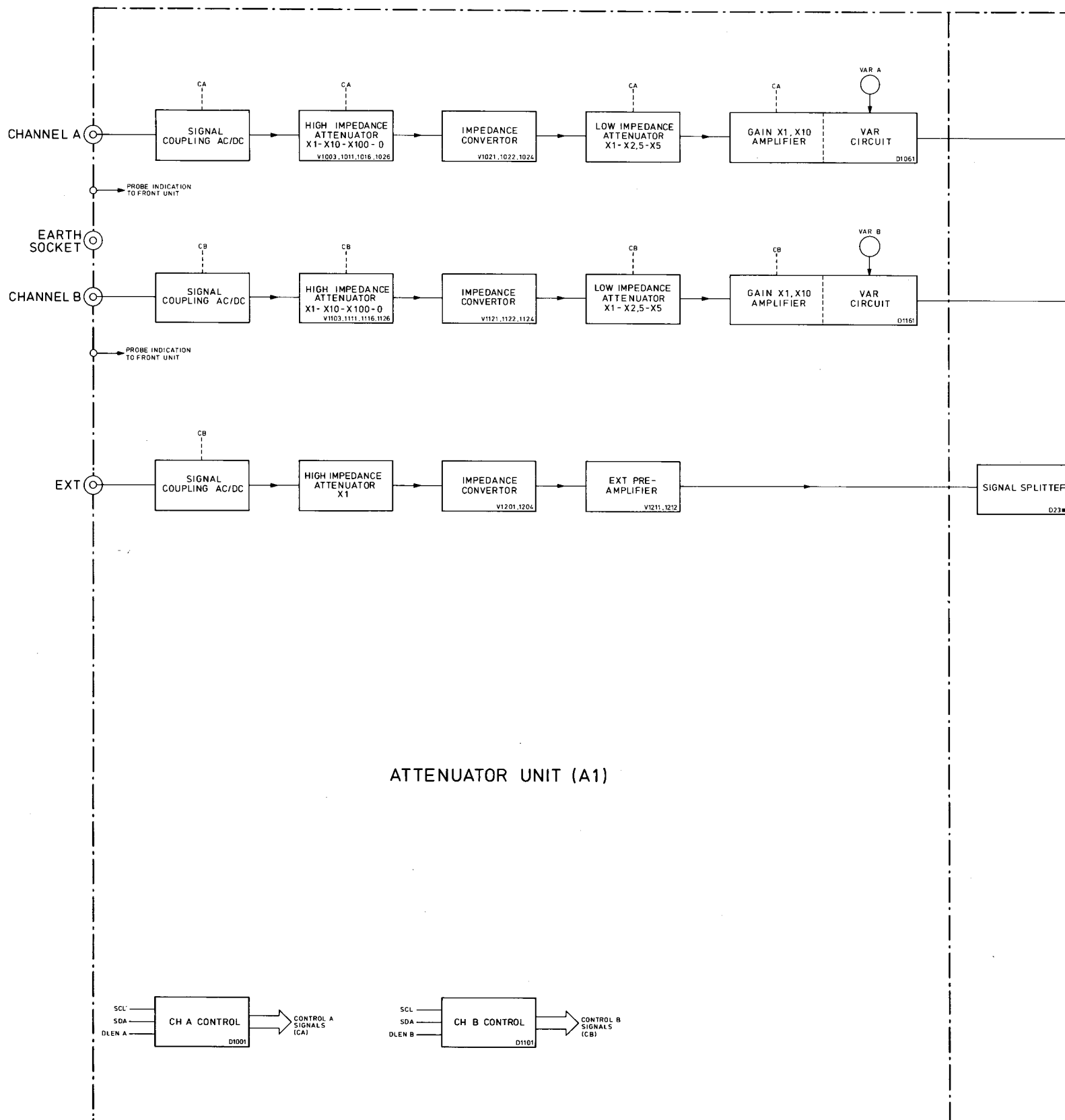
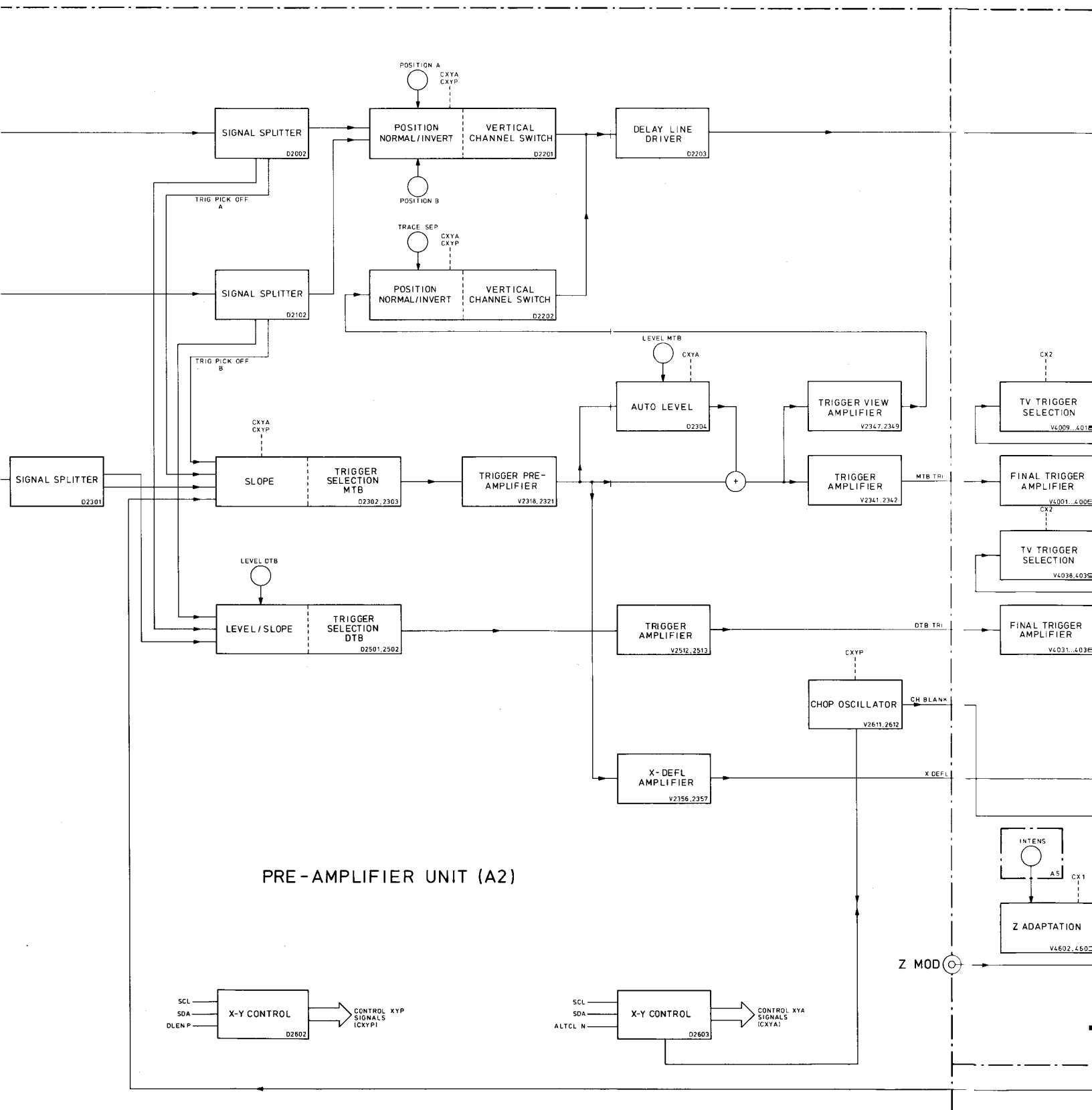
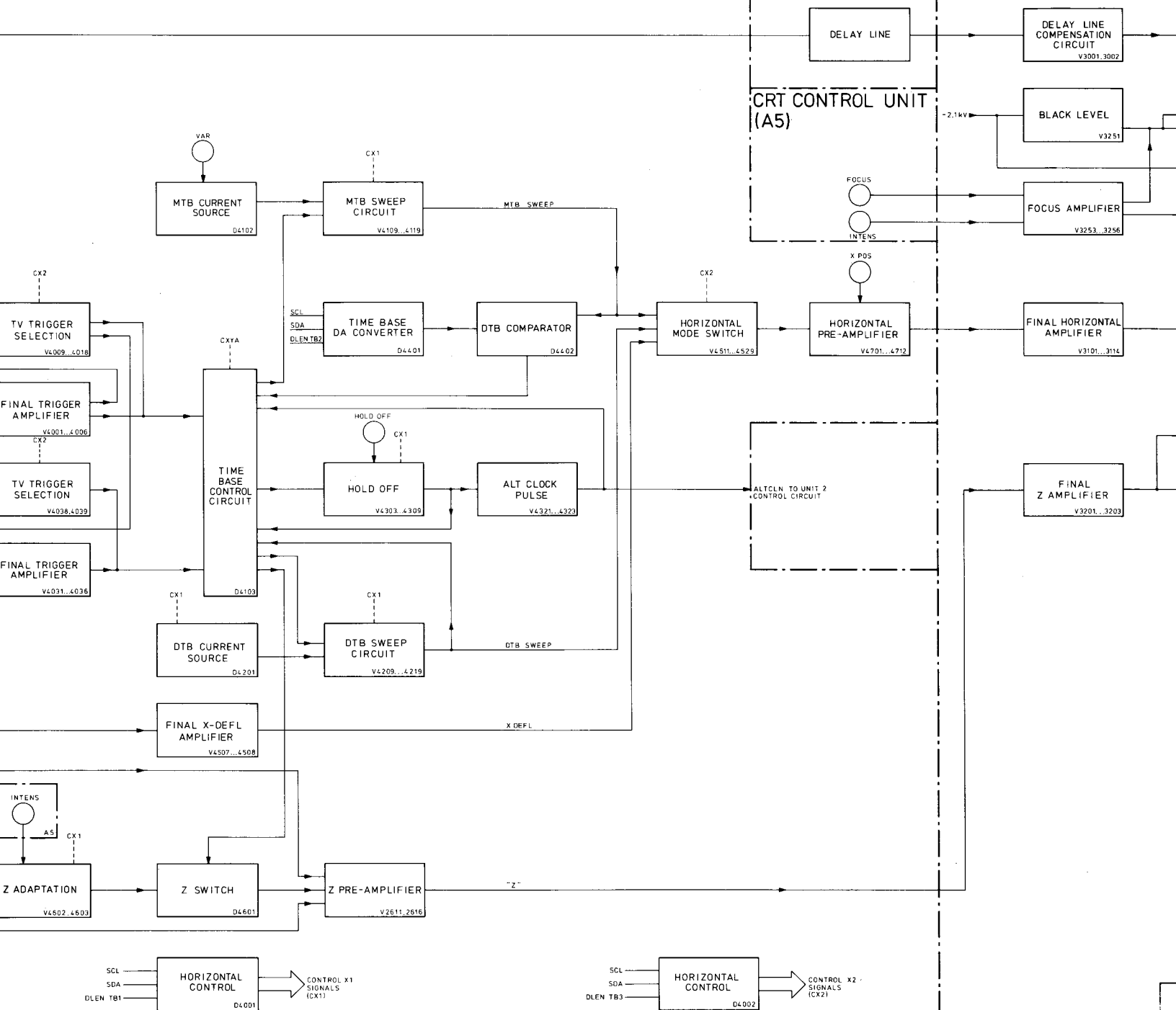


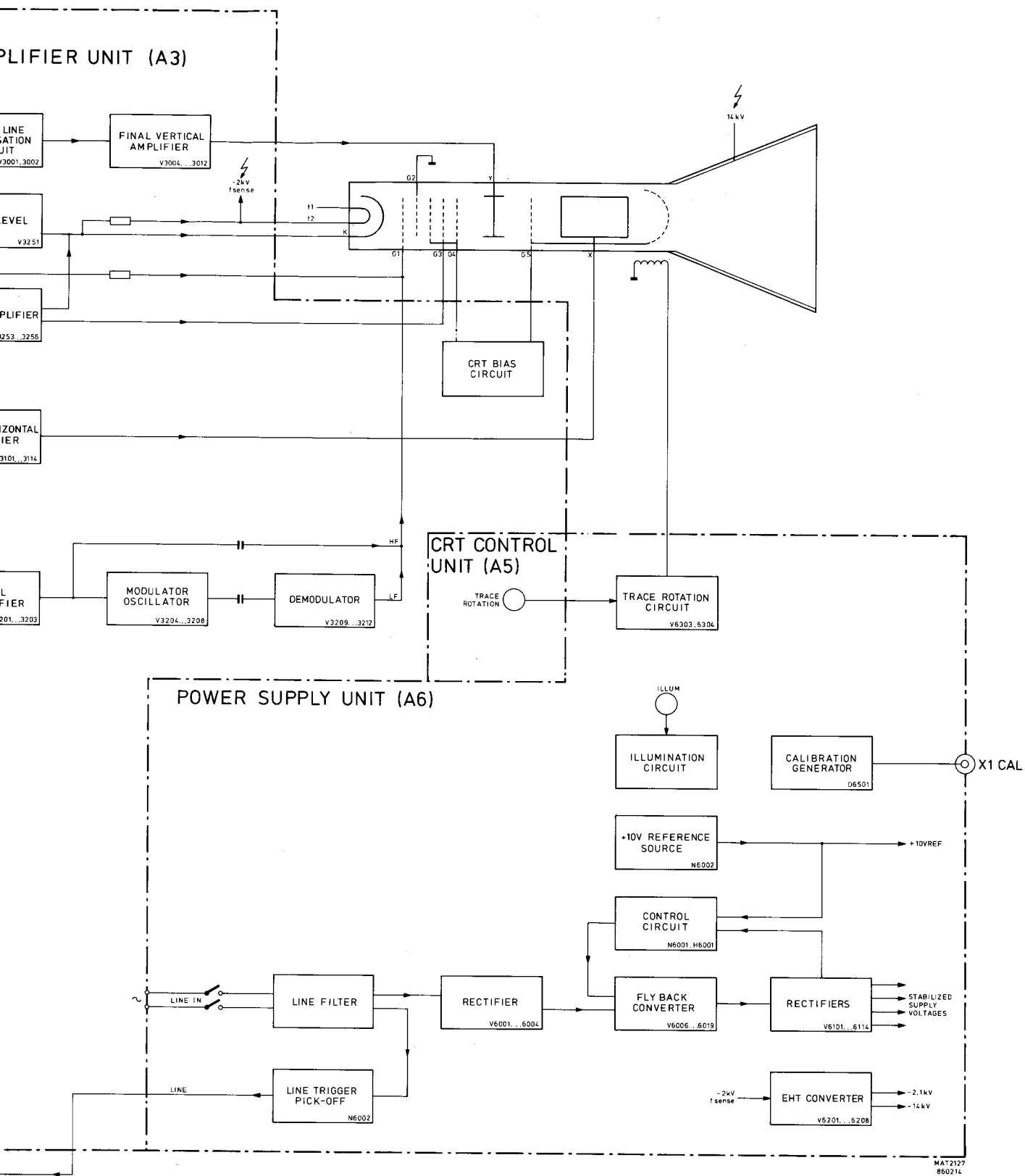
Figure 3.1 Block diagram



TIME BASE UNIT (A4)

XYZ AMPLIFIER U





* 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 three outputs:

- two outputs applied to the SLOPE/TRIGGER SELECTIONS for MTB or DTB triggering.
- a third output routed to the POSITION/NORMAL-INVERT block.

This block is incorporated with the VERTICAL CHANNEL SWITCH in a single IC. Vertical shift of the displayed signal is achieved by the front-panel POSITION control. The output of this block and the output of the TRIGGER VIEW channel are routed via the DELAY LINE DRIVER to the DELAY LINE. The TRIGGER VIEW channel enables display of the MTB trigger source and can be used as a third vertical channel with limited specifications. The front-panel TRACE SEP control influences the position of the trace of the DTB signals related to the trace of the MTB signal.

* MTB 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 MTB slope function. Routed via the TRIGGER PRE-AMPLIFIER, block the signal is split up into three 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 MTB trigger signal to the time-base unit. The trigger signal from the summation point is also routed via the TRIGGER VIEW AMPLIFIER to the vertical CHANNEL SWITCH stage to display this signal.

* DTB trigger circuit:

Basically, for triggering purposes this circuit is identical to the MTB trigger circuit. This circuit also has a SLOPE/TRIGGER SELECTION and TRIGGER AMPLIFIER block. However, the DTB trigger circuit has no LINE trigger or AUTO LEVEL facility. The LEVEL control directly influences the SLOPE/TRIGGER SELECTION block.

* 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.

3.2.5 Time-base unit

This unit incorporates the main time-base (MTB), the delayed time-base (DTB), 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.

* Main time-base (MTB):

The MTB trigger signal can be either directly routed 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 MTB will be free running.

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

The HOLD OFF and the ALT CLOCK PULSE 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 ALTCLN-pulse is applied to the PRE-AMPLIFIER UNIT.

3.2.6 XYZ unit

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.

3.2.7 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 1,2 V p-p level with a frequency of 2kHz square wave.

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.

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 I^2C bus. The TEA 1017 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.

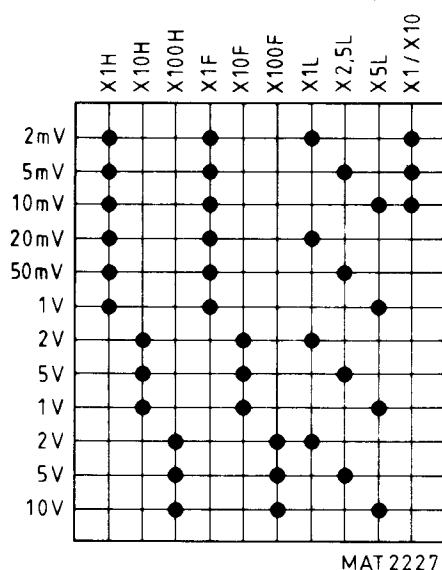


Figure 4.1 Table of attenuator settings

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 |
|------|-------|-------|---------------------------------|--------------------------|
| x 1 | K1004 | V1011 | C1033 | -- |
| x 10 | 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 x1, x2.5 and x5, depending on which relay is activated.

| | RELAY | RESISTOR DIVIDER |
|------|-------|---------------------------------|
| x1 | K1006 | -- |
| x2.5 | K1007 | R1053 vs R1056, R1057 and R1058 |
| x5 | K1008 | R1053, R1056 and R1057 vs R1058 |

The continuous circuit (OQ0203), 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 x1 (pin 2 and 3) with offset adjustment R1064 (R1164) and gain adjustment R1069 (R1169).
- Gain x10 (pin 6 and 7) with offset adjusting R1072 (R1172) and gain adjustment R1076 (R1176).
- x1/x10 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 x1 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.

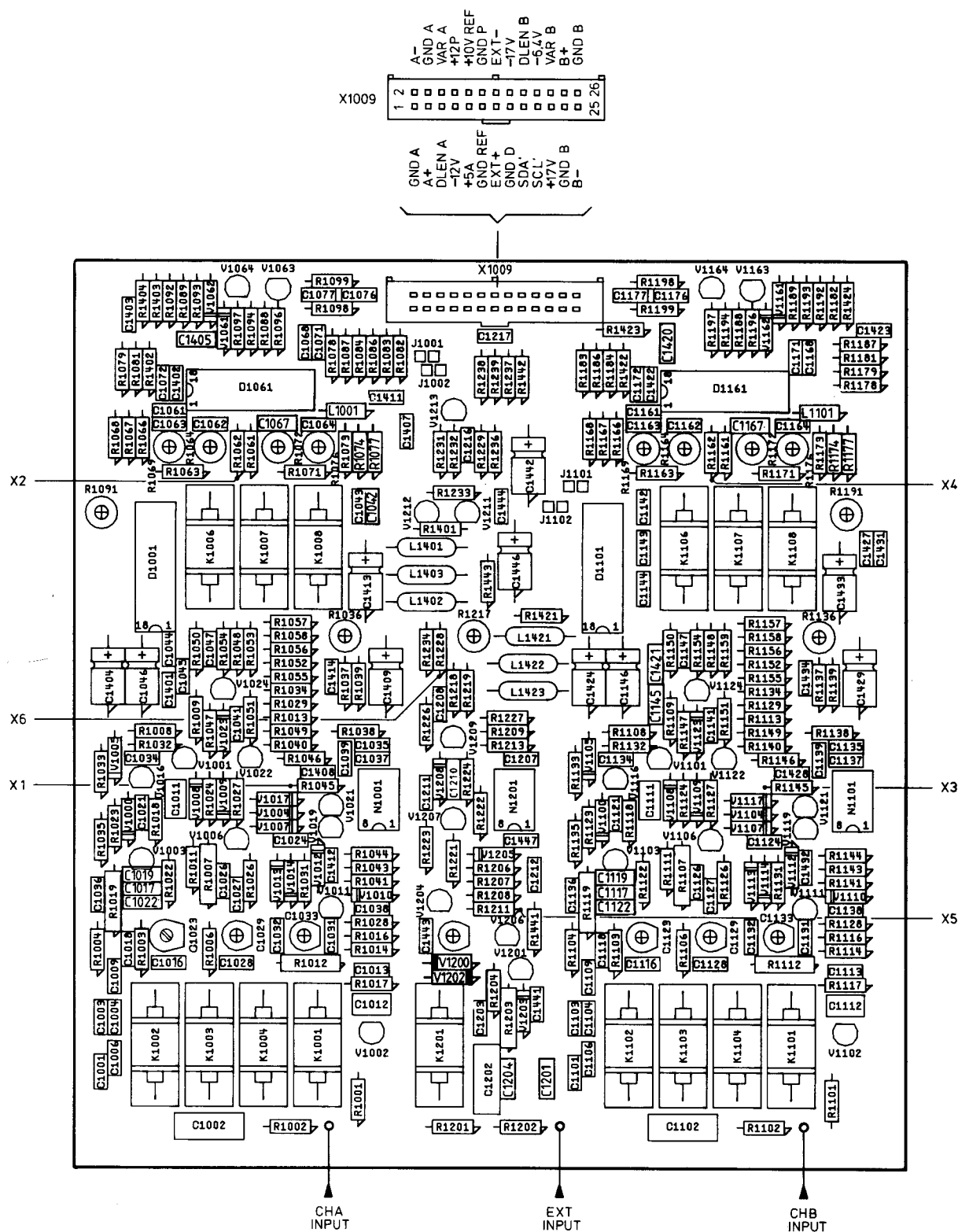

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 880205

Figure 4.2 Attenuator unit p.c.b.

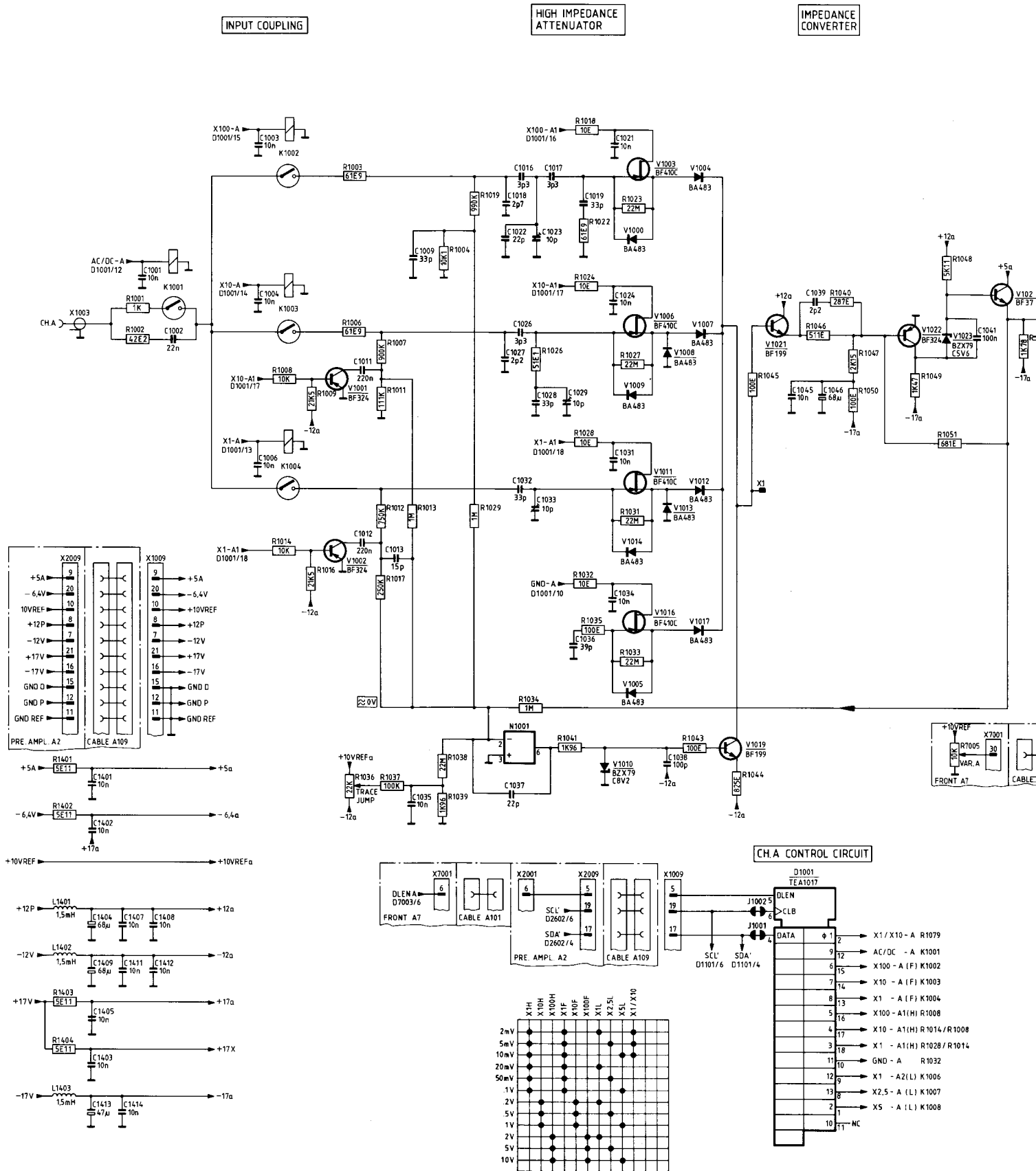
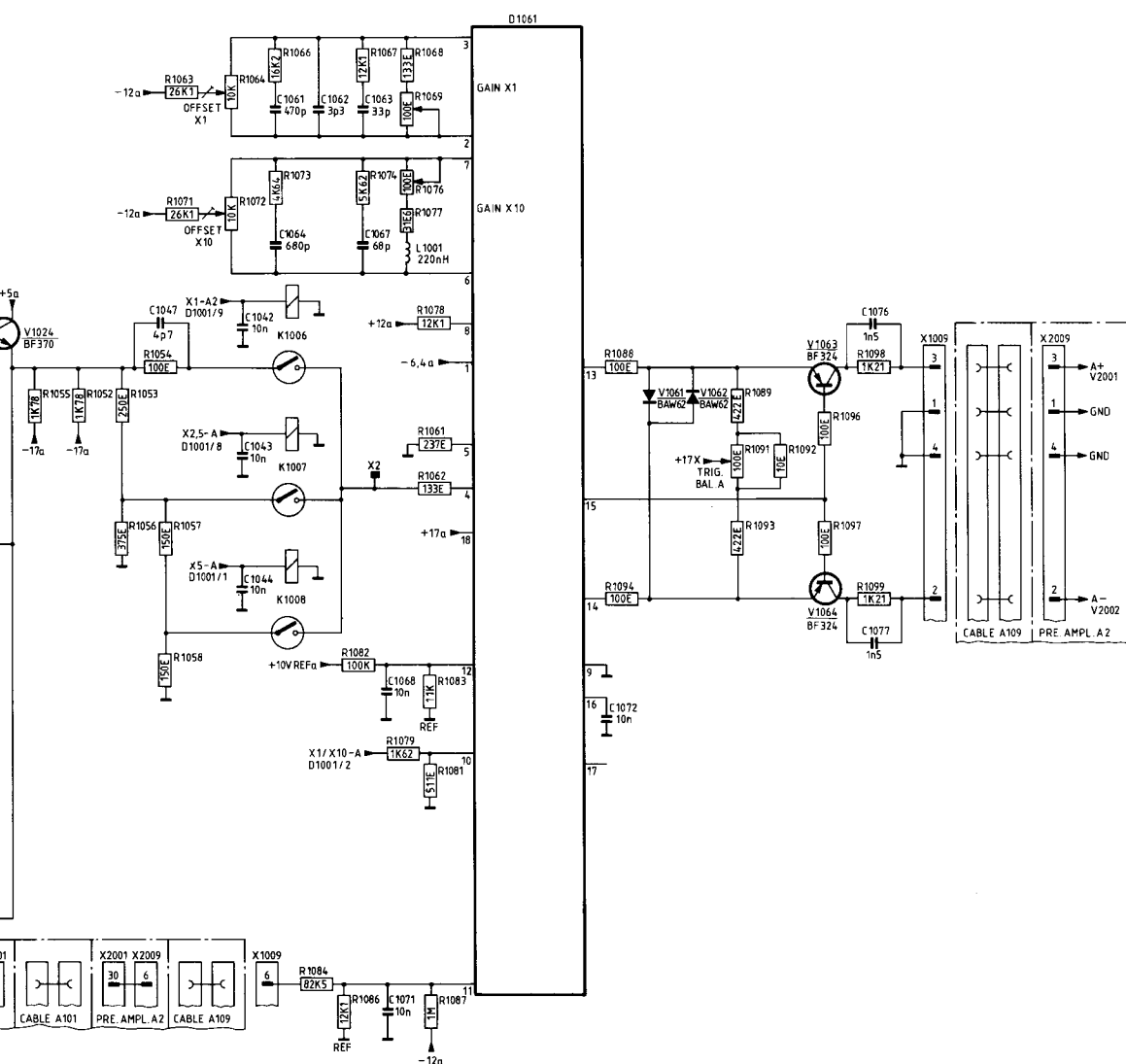


Figure 4.3 Circuit diagram of attenuator, ch. A

LOW IMPEDANCE
ATTENUATORGAIN SWITCH
VAR CIRCUITMAT3169
880212

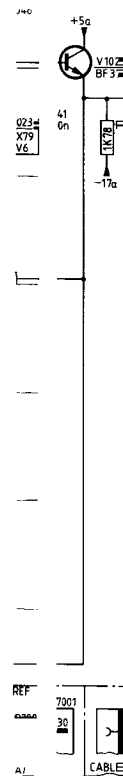
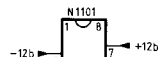
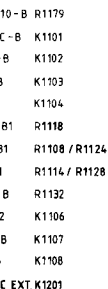


Figure 4.5 Attenuator unit p.c.b.

GAIN SWITCH
VAR CIRCUIT

MAT 3170
880212

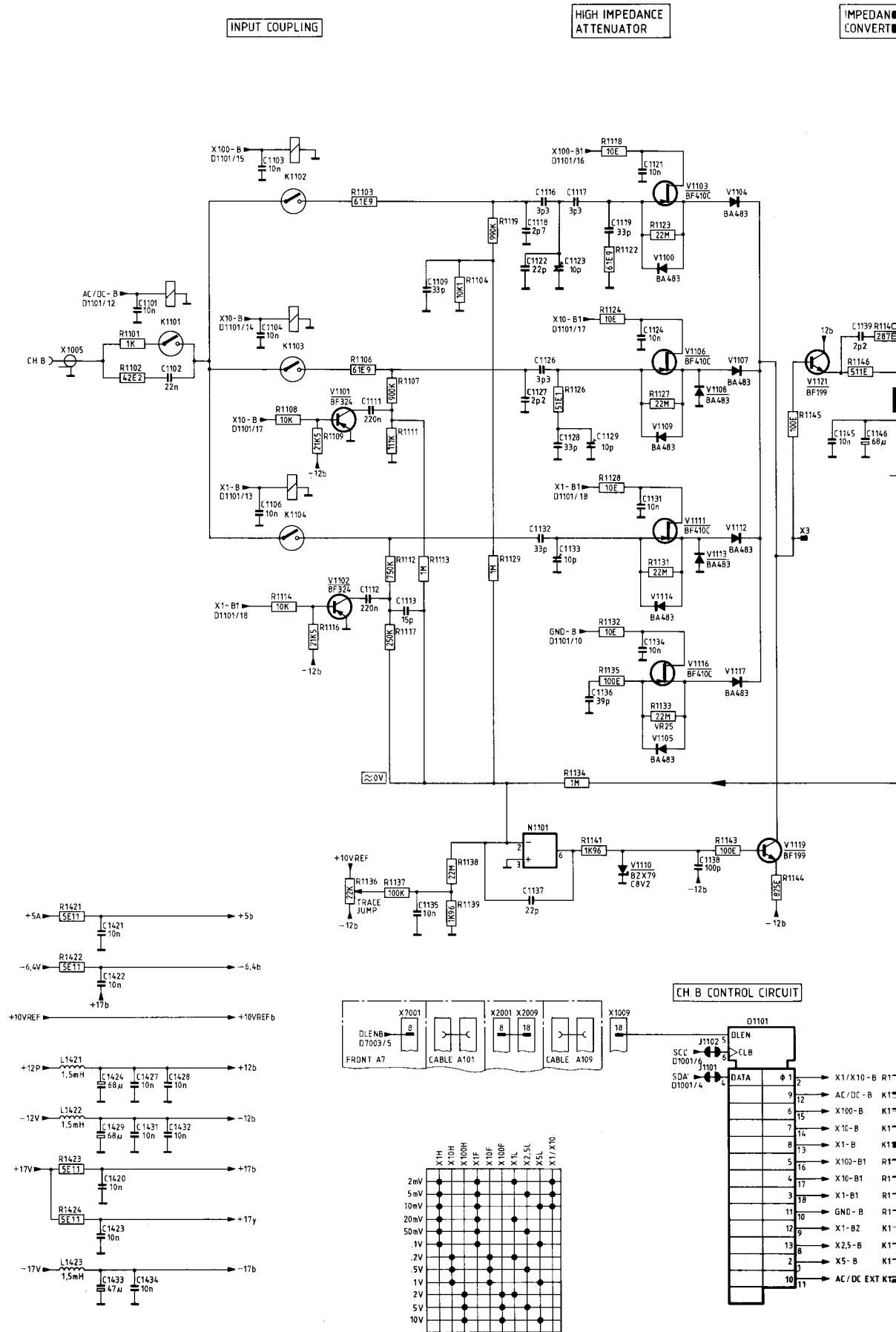


Figure 4.4 Circuit diagram of attenuator, ch. B

INPUT COUPLING

IMPEDANCE CONVERTER

EXT. P

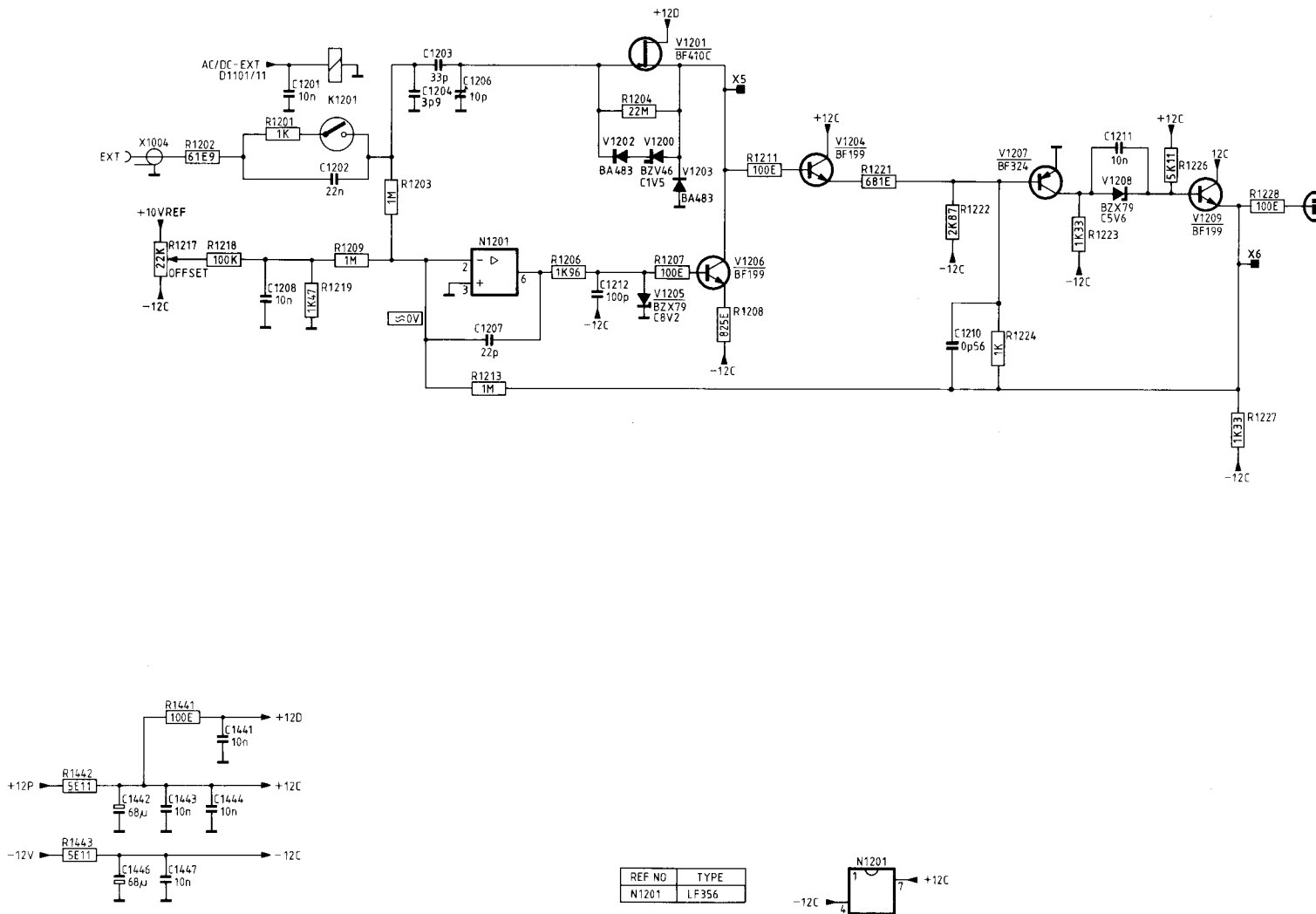
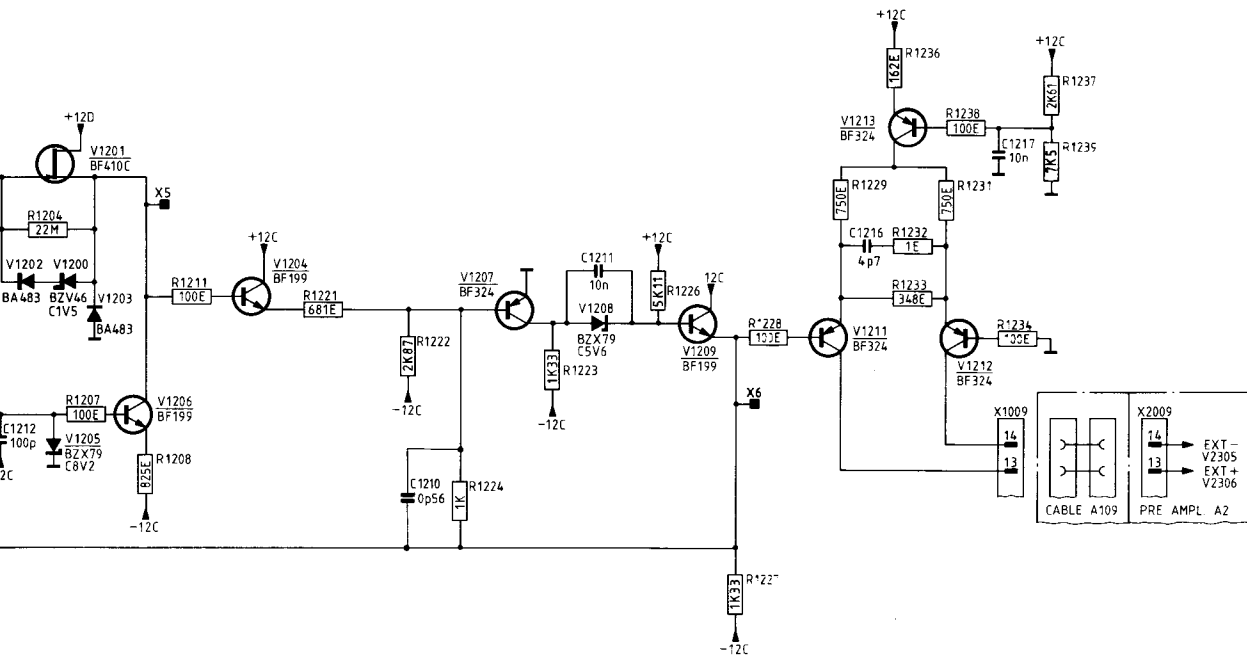


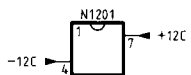
Figure 4.6 Circuit diagram of attenuator, EXT

IMPEDANCE CONVERTER

EXT. PRE-AMPLIFIER



| REF NO | TYPE |
|--------|-------|
| N1201 | LF356 |



MAT3171
880212

EXT

5. PRE-AMPLIFIER UNIT (A2)

The pre-amplifier unit consists of:

- Vertical pre-amplifier
- MTB trigger pre-amplifier
- DTB trigger pre-amplifier
- Pre-amplifier control, incl. CHOPPER oscillator.

All control pulses for this unit are generated by the pre-amplifier control circuit, via the I^2C bus (see section 5.4).

5.1 VERTICAL PRE-AMPLIFIER

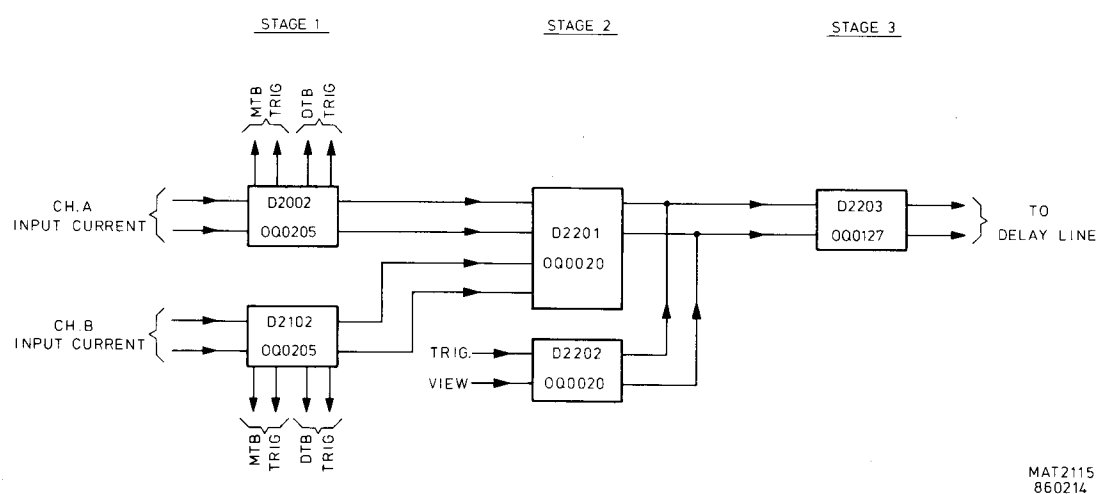


Figure 5.1 The three stages of the vertical pre-amplifier

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 three identical differential output current signals for:

- Vertical channel (pin 7 and 10)
- MTB triggering (pin 5 and 12), see section 5.2.
- DTB triggering (pin 4 and 13), see section 5.3.

Stage 2 (Q00020) consists of two integrated circuits D2201 and D2202, connected in parallel and serves as a vertical channel switch. The switch selection is as follows:

| | D2201 | | D2202 |
|-----------|--------|--------|--------|
| | pin 10 | pin 11 | pin 10 |
| A | 1 | 0 | 0 |
| B | 0 | 1 | 0 |
| TRIG VIEW | 0 | 0 | 1 |
| ADD | 1 | 1 | 0 |

Further, all possible 2, 3, or 4 channel combinations are possible in alternated or chopped display (see also section 5.4).

This stage comprises the following functions:

- Position control POS A R7006 on D2201-1 for ch. A and POS B R7008 on D2201-8 for ch. B.
- Channel B normal/invert (high is INVERT) on D2201-7.
(The balance between normal/invert can be adjusted with R2212).
- Trigger view invert (high is INVERT) on D2202-2.
- Trace separation control with R7013 on D2202-8.

Stage 3 (D2203) serves as delay line driver where the output current of both OQ0020 is converted into voltage signal applied to the delay line. The current for this stage and for D2201 and D2202 is fed via R2231 and R2246.

The current regulation for the common-mode circuit is achieved by transistor D2203 (12, 13, 14).

5.2 MTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

| Signal | | routed to | Selected by: | | inverted by: | |
|----------|--------------|------------|--------------|-----------|--------------|-----------|
| name | | | 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) | INBVM | 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 two identical differential output current signals for:

- EXT MTB signal (pin 6 and 11)
- EXT DTB signal (pin 7 and 10), (see Section 5.3).

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 main time-base triggering.
The trigger output signal, TRIGM- and TRIGM+ are fed to the time-base unit A4.
 - * V2347 and V2349 for trigger view.
This symmetrical output can be balanced by potentiometer R2407 (Trig view BAL).
The TRIGV+ and TRIGV- signals are fed to D2202 (3-4).

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 ZERO 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 DTB TRIGGER PRE-AMPLIFIER

Trigger possibilities are:

| | Signal name | routed to | Selected by: name | routed to | Inverted by: name | routed to |
|----------|----------------|------------|----------------------|-----------|----------------------|-----------|
| ch.A | TRAD+, TRAD- | D2501(3,4) | AD | D2501(10) | INVAD | D2501(2) |
| ch.B | TRBD+, TRBD- | D2501(5,6) | BD | D2501(11) | INVB | D2501(7) |
| EXTERNAL | EXT+, EXT- | D2502(5,6) | EXTD | D2502(11) | INVAD | D2502(7) |

Similar to the main time base triggering, signal splitter D2301 applies the EXT current to the OQ0020.

The LEVEL control R7014 is connected to D2502-1 to obtain a level range of 16 div.

The output of both integrated circuits, pin 13 and 14, are routed via a shunt feedback V2512, V2513, followed by a series feedback circuit V2514, V2516 and provide the DTB trigger signals TRIGD- and TRIGD+. These signals are fed to the time-base unit A4.

5.4 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:

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

Adaptation of this I.C. to the oscilloscope version is made by the AD0 and AD1 inputs D2603(15,16).

For this oscilloscope, AD0 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.



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

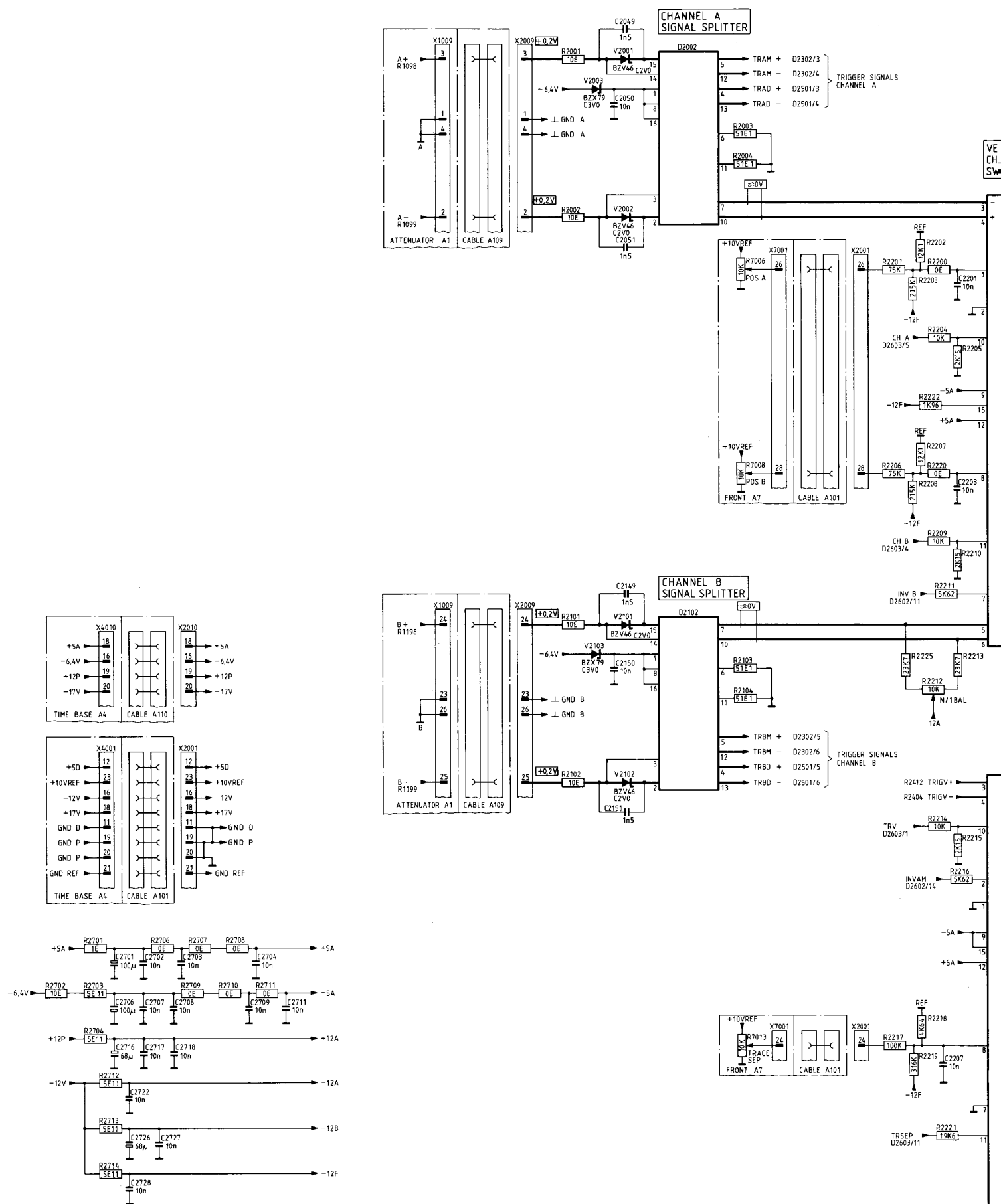
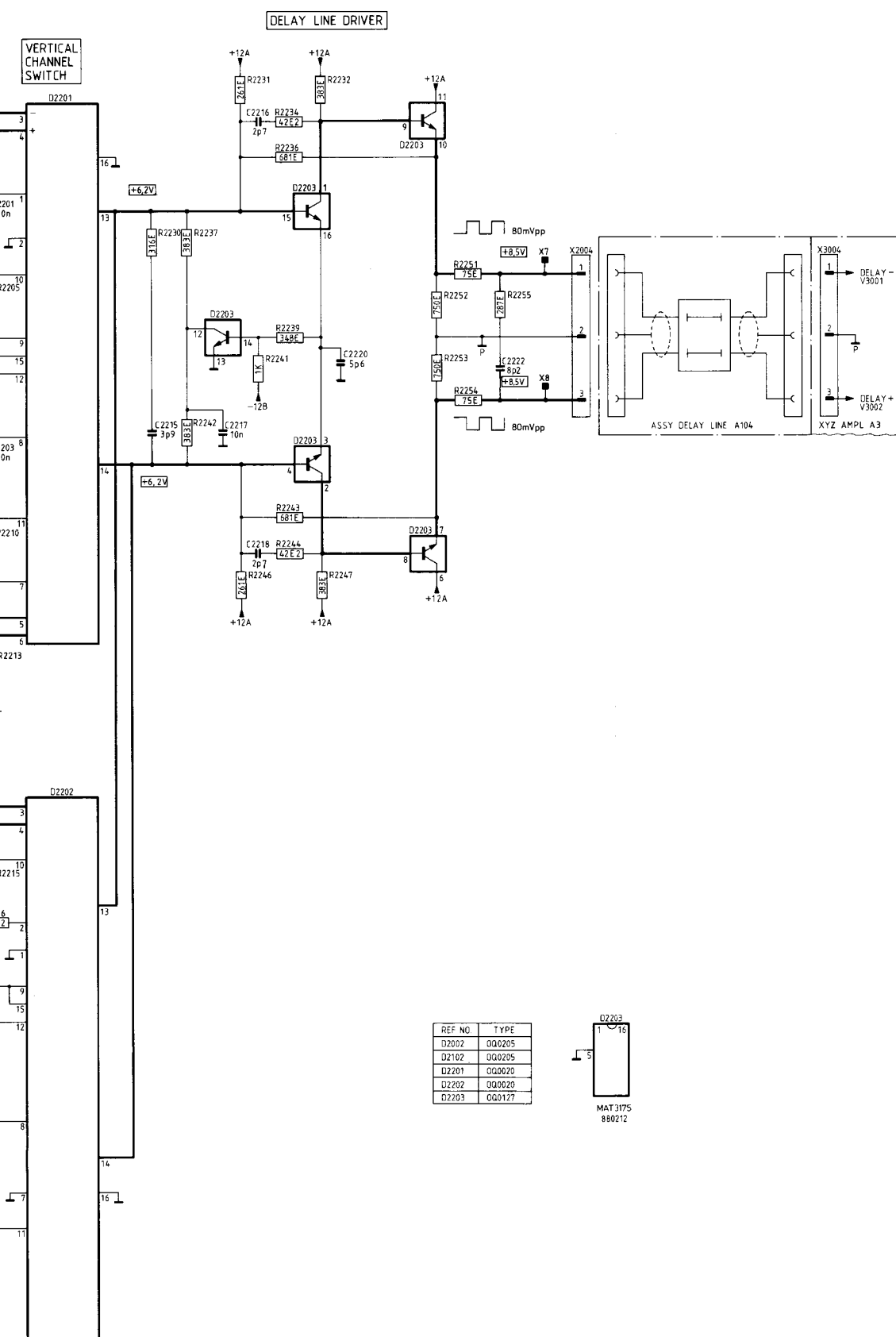


Figure 5.3 Circuit diagram of pre-amplifier, channel switch + delay line driver



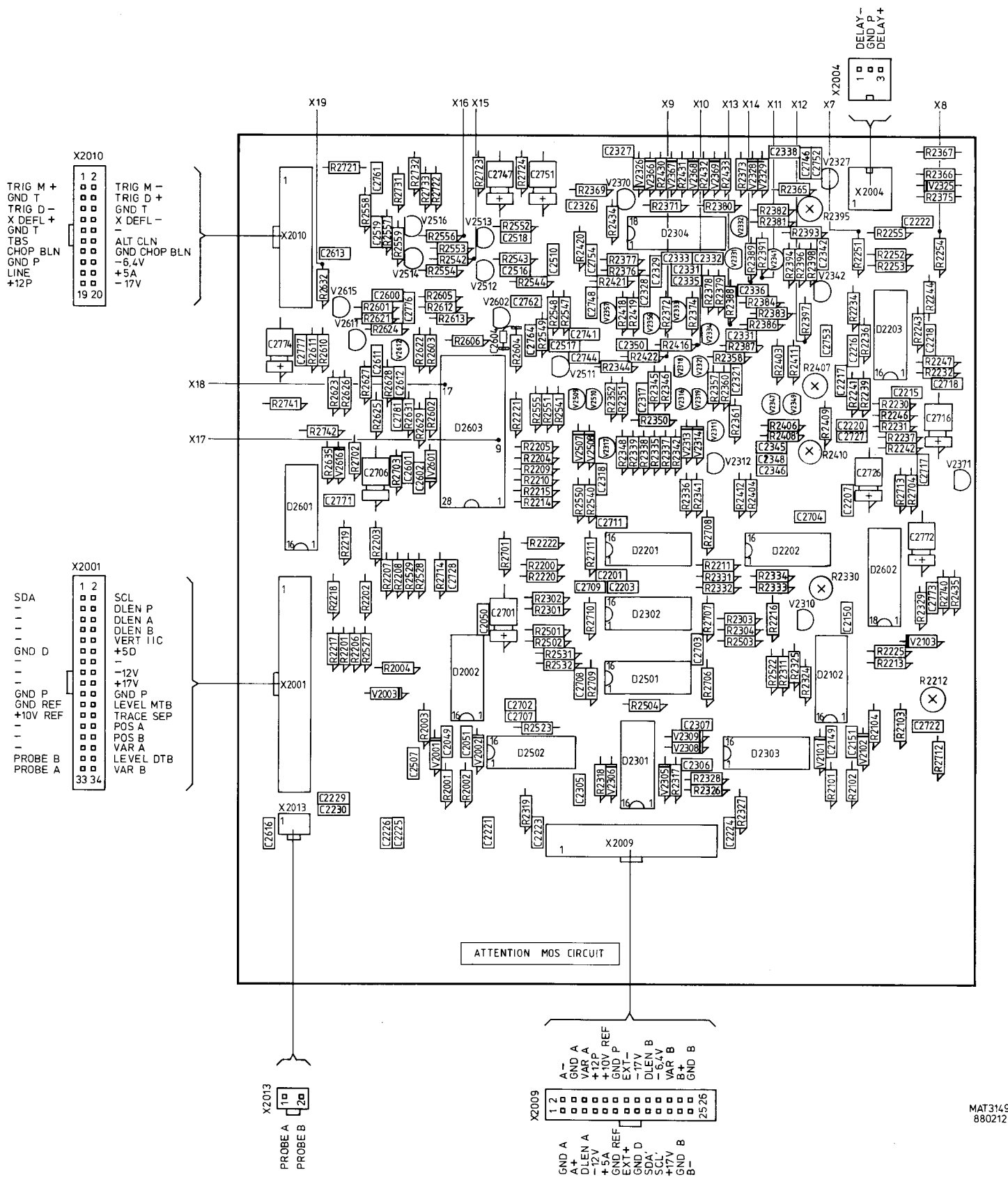
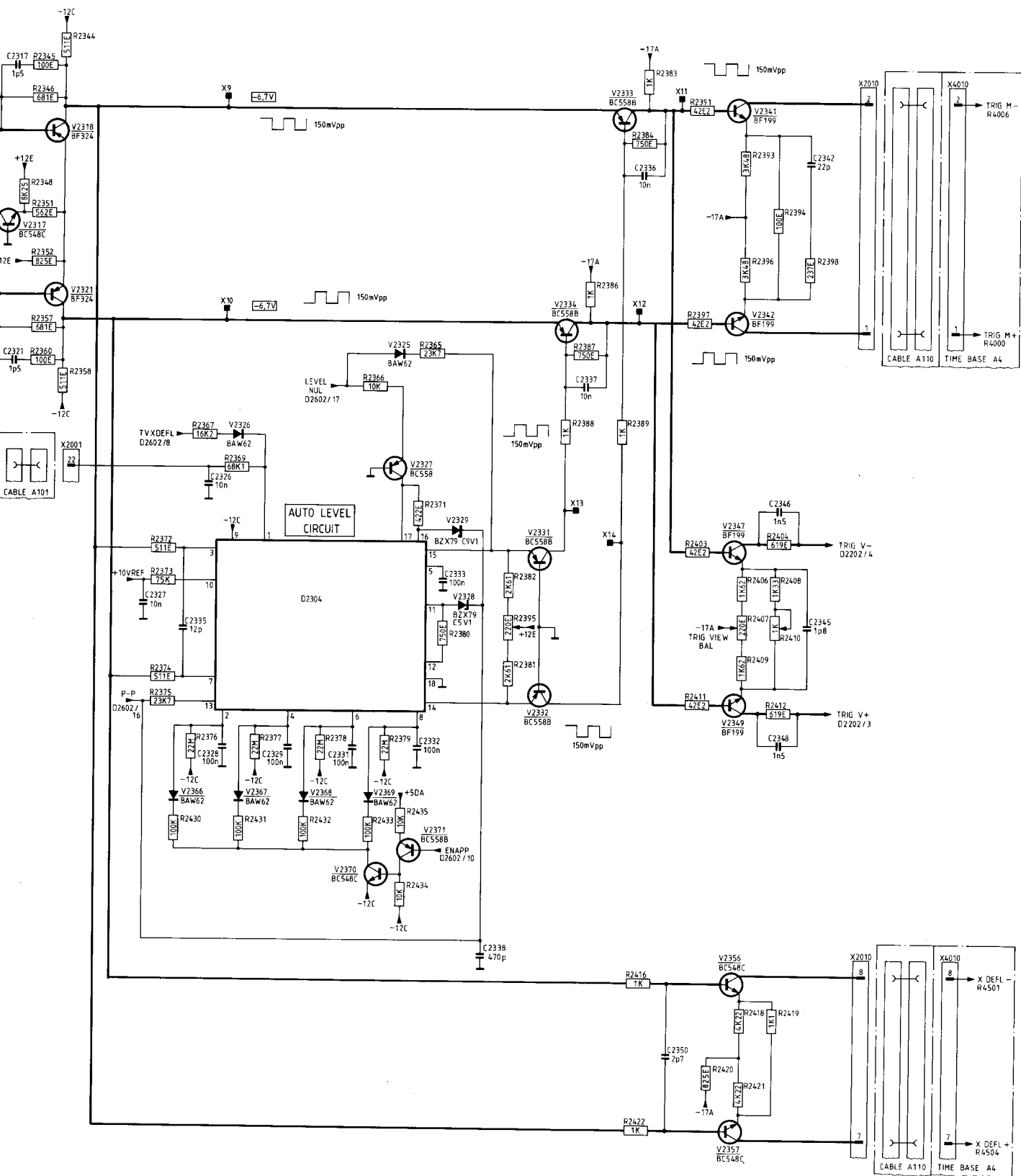


Figure 5.5 Pre-amplifier unit p.c.b.

MAT3149
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| REF NO | TYPE |
|--------|--------|
| D2301 | 000205 |
| D2302 | 000020 |
| D2303 | 000020 |
| D2304 | 000128 |

MAT3176
880212

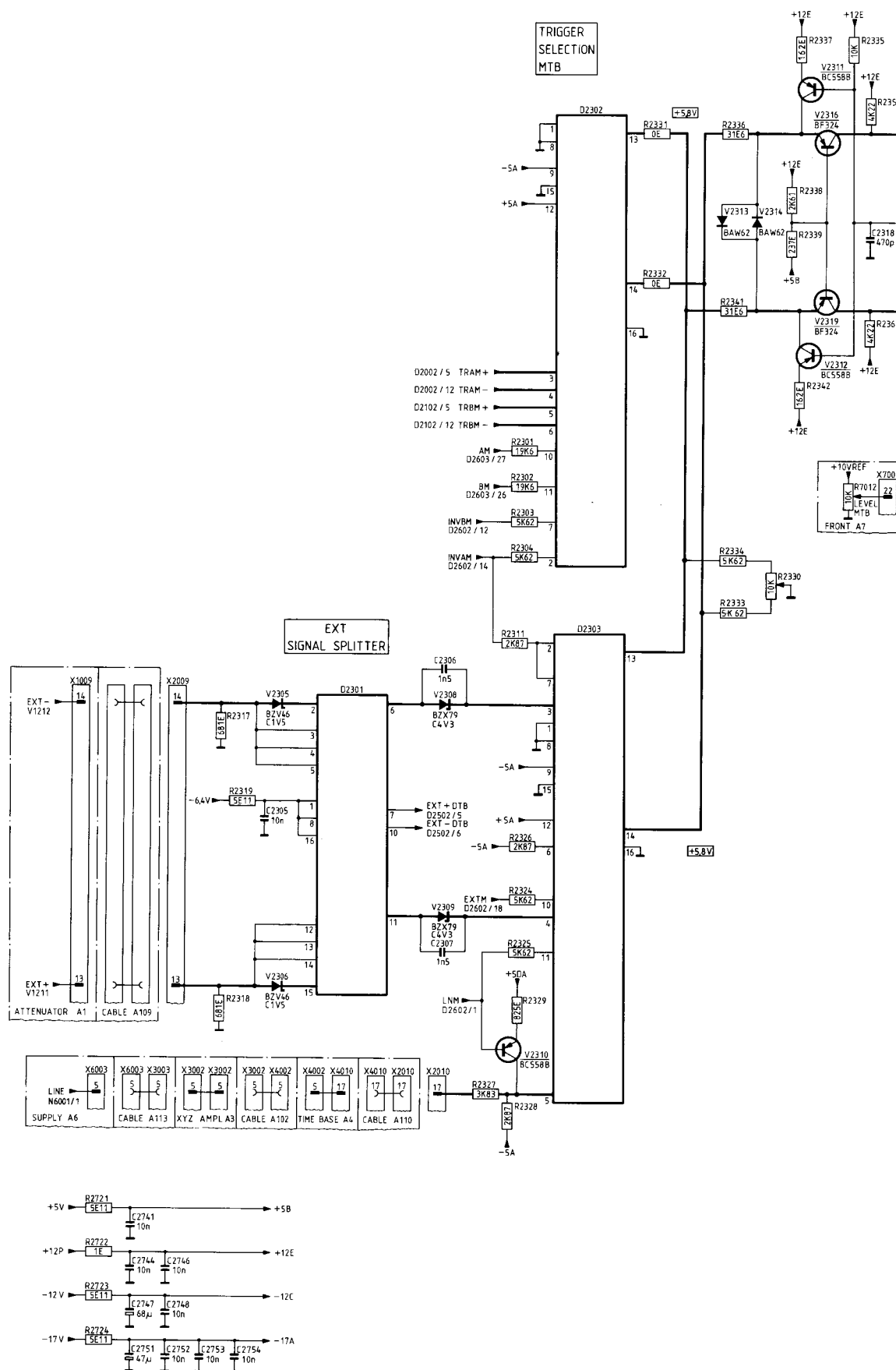


Figure 5.4 Circuit diagram of pre-amplifier, MTB trigger switch

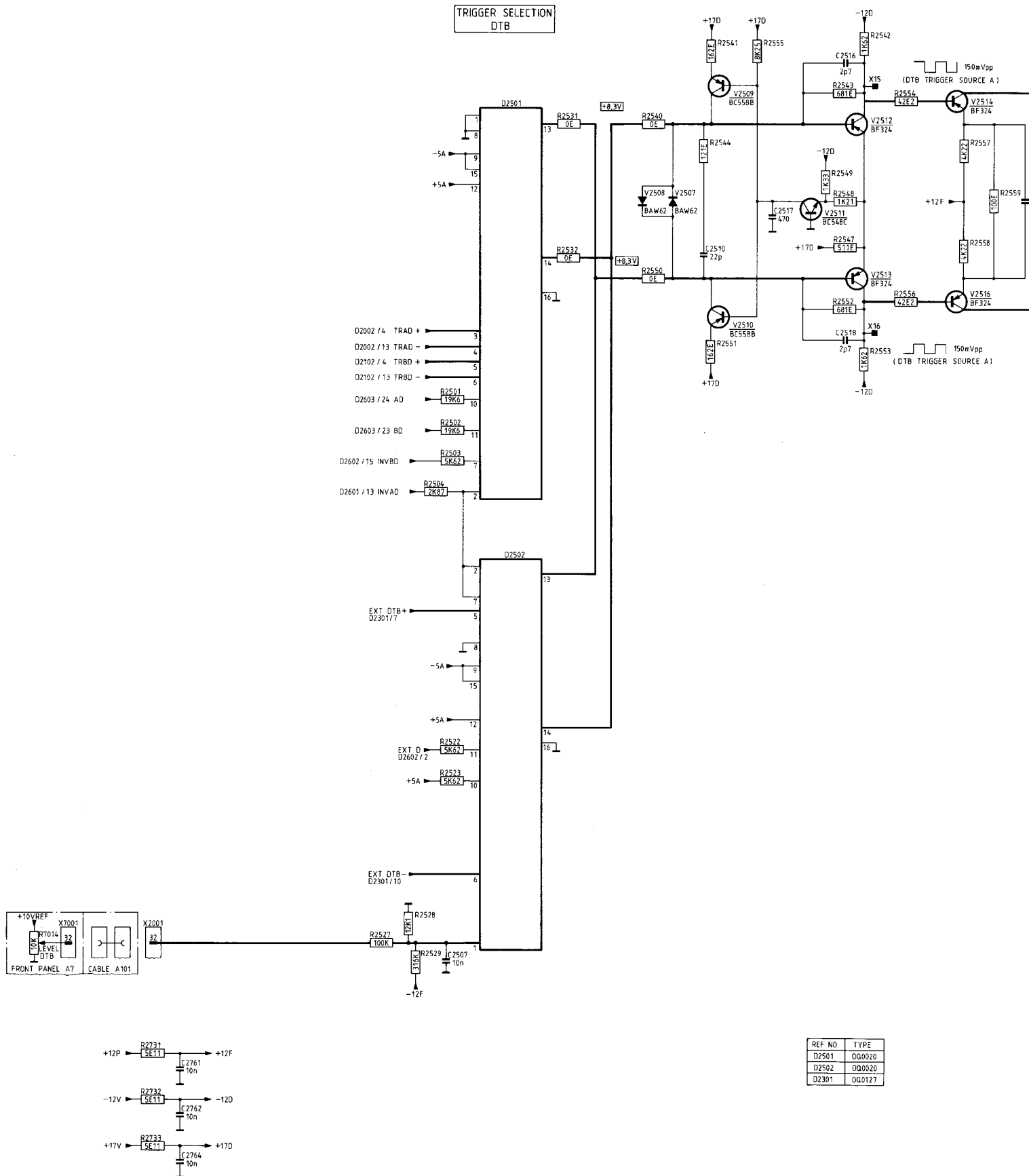
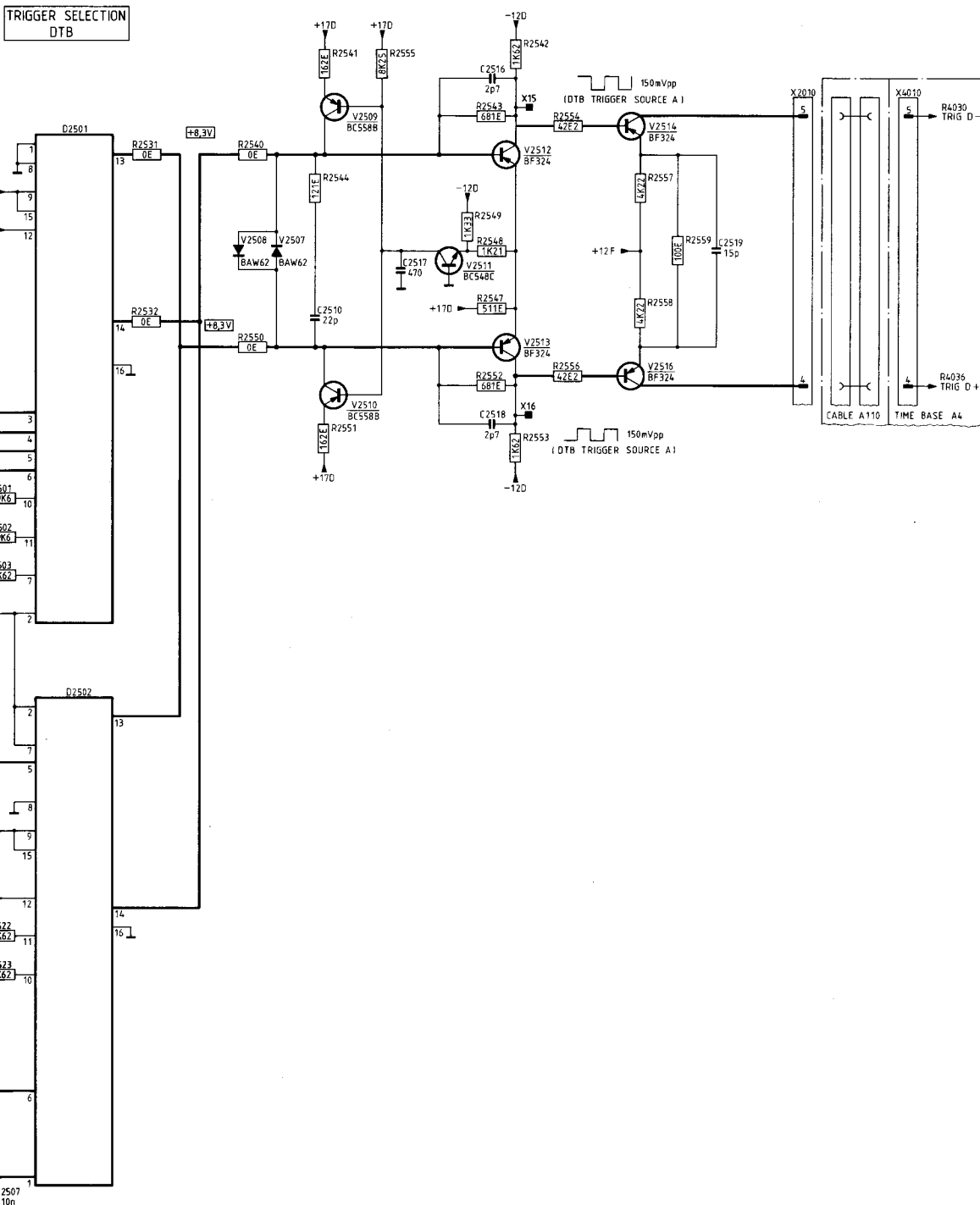


Figure 5.6 Circuit diagram of pre-amplifier, DTB trigger switch

TRIGGER SELECTION
DTB



| REF NO. | TYPE |
|---------|--------|
| D2501 | Q00020 |
| D2502 | Q00020 |
| D2301 | Q00127 |

MAT3177
880212

er, DTB trigger switch

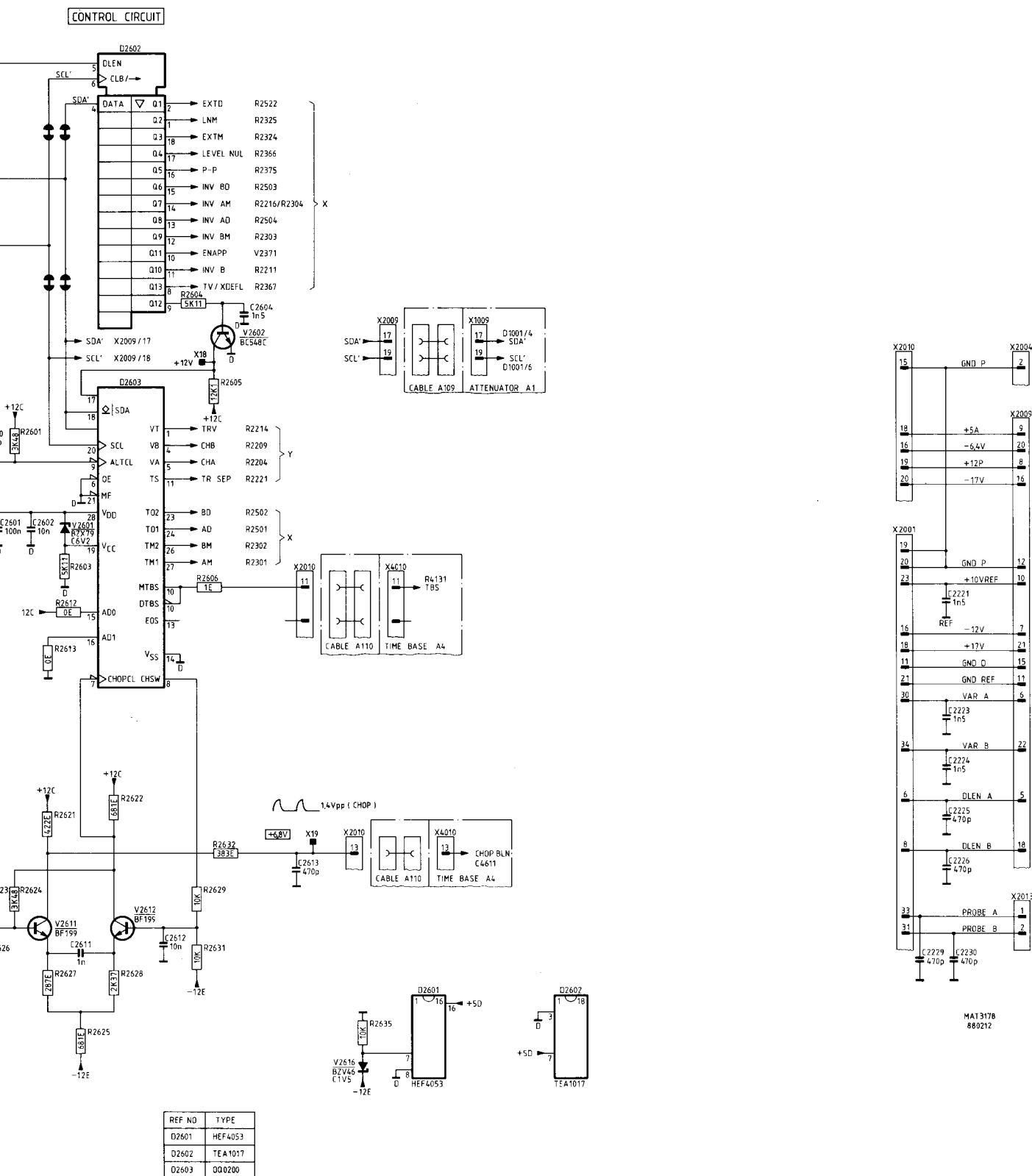
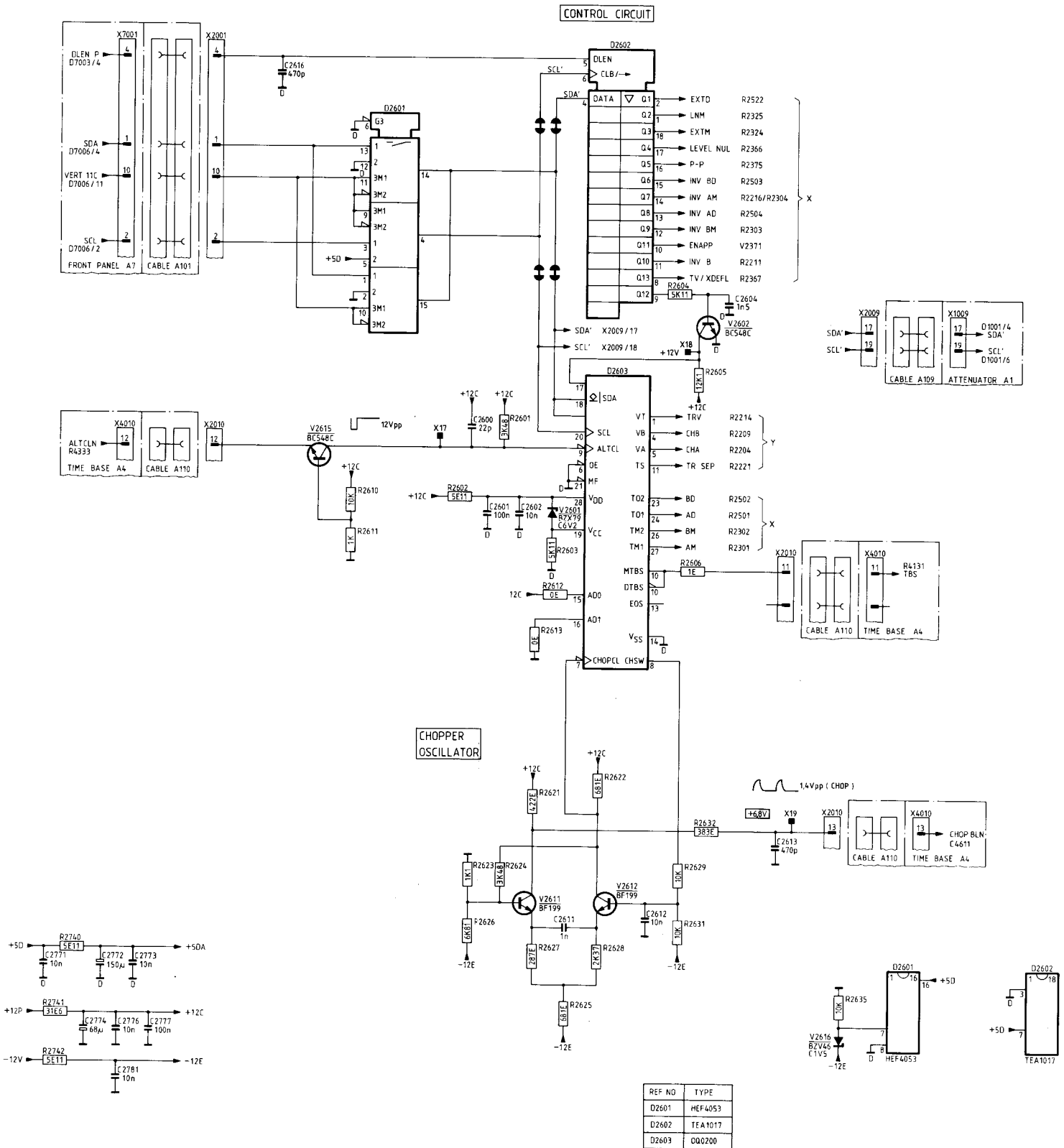


Figure 5.7 Circuit diagram of pre-amplifier, logic control



6. XYZ-AMPLIFIER UNIT (A3)

6.1 INTRODUCTION

Unit A3 incorporates two separate pcb's which are connected via X3001. One p.c.b. includes among other things the CRT socket and is connected at the rear of the CRT. The other p.c.b. comprising the proper final X and Z amplifiers is situated at the upper side of the 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 as a series feedback amplifier, including a delay line compensation network and potentiometer R3007 controlling 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.
In this stage the input voltage is converted into a current signal.
- V3004, V3006 as a shunt feedback amplifier, which gives a voltage signal to the next stage.
- V3008, V3009 as 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 side. Note that the output again supplies a current signal.
- V3011, V3012 as a common-base amplifier for buffering the final Y-amplifier to the Y-deflection plates. The maximum amplitude on each deflection plate is: $30 \text{ mA} \times 660 \text{ E} = 20 \text{ V approx.}$

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 as 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 as a series feedback amplifier, including a 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 maintains 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.

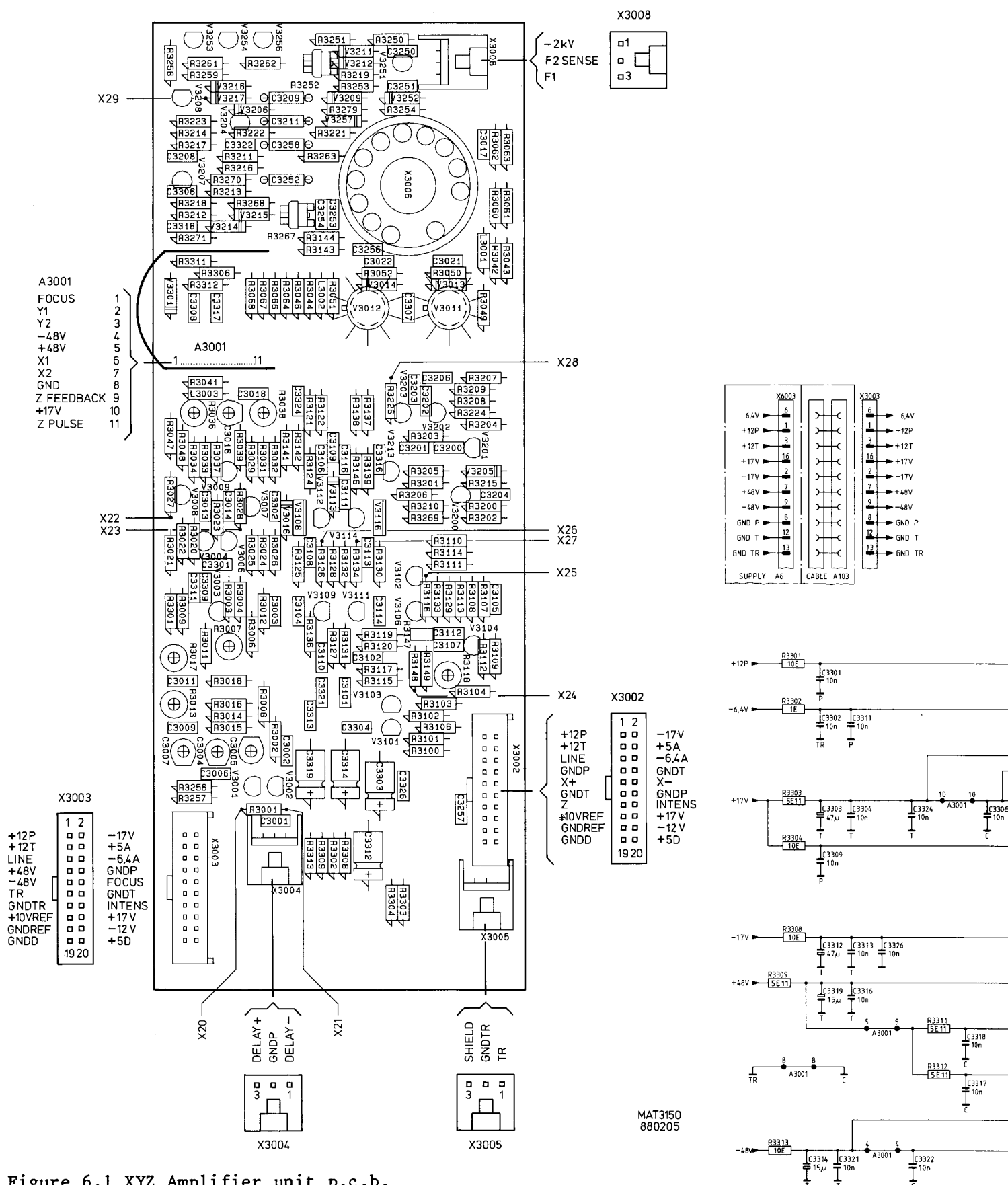


Figure 6.1 XYZ Amplifier unit p.c.b.

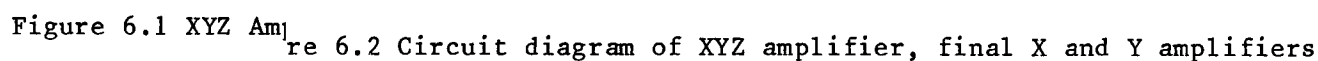




Figure 6.4 Circuit diagram of XYZ amplifier, Z amplifier and CRT circuit

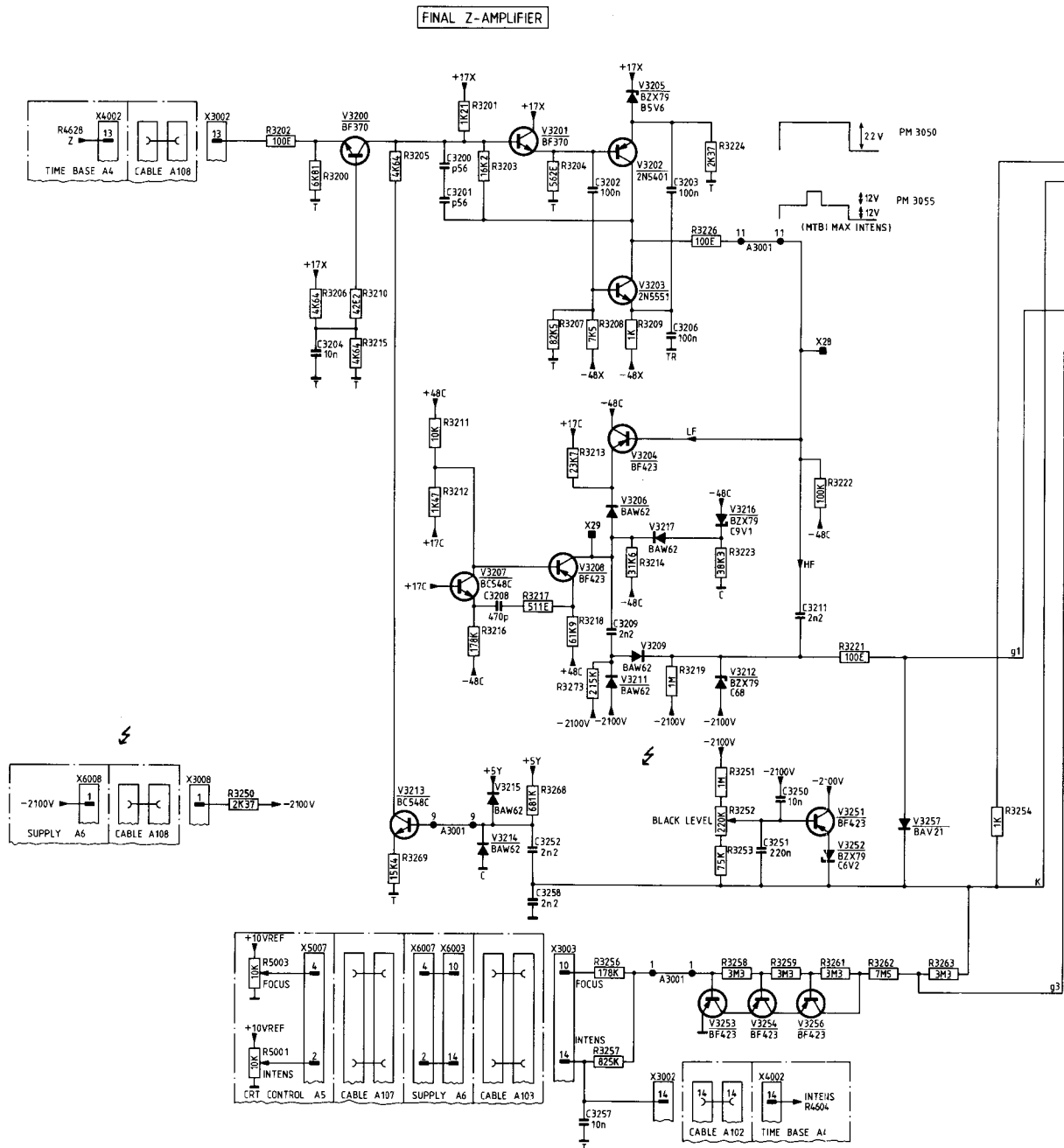


Figure 6.4 Circ

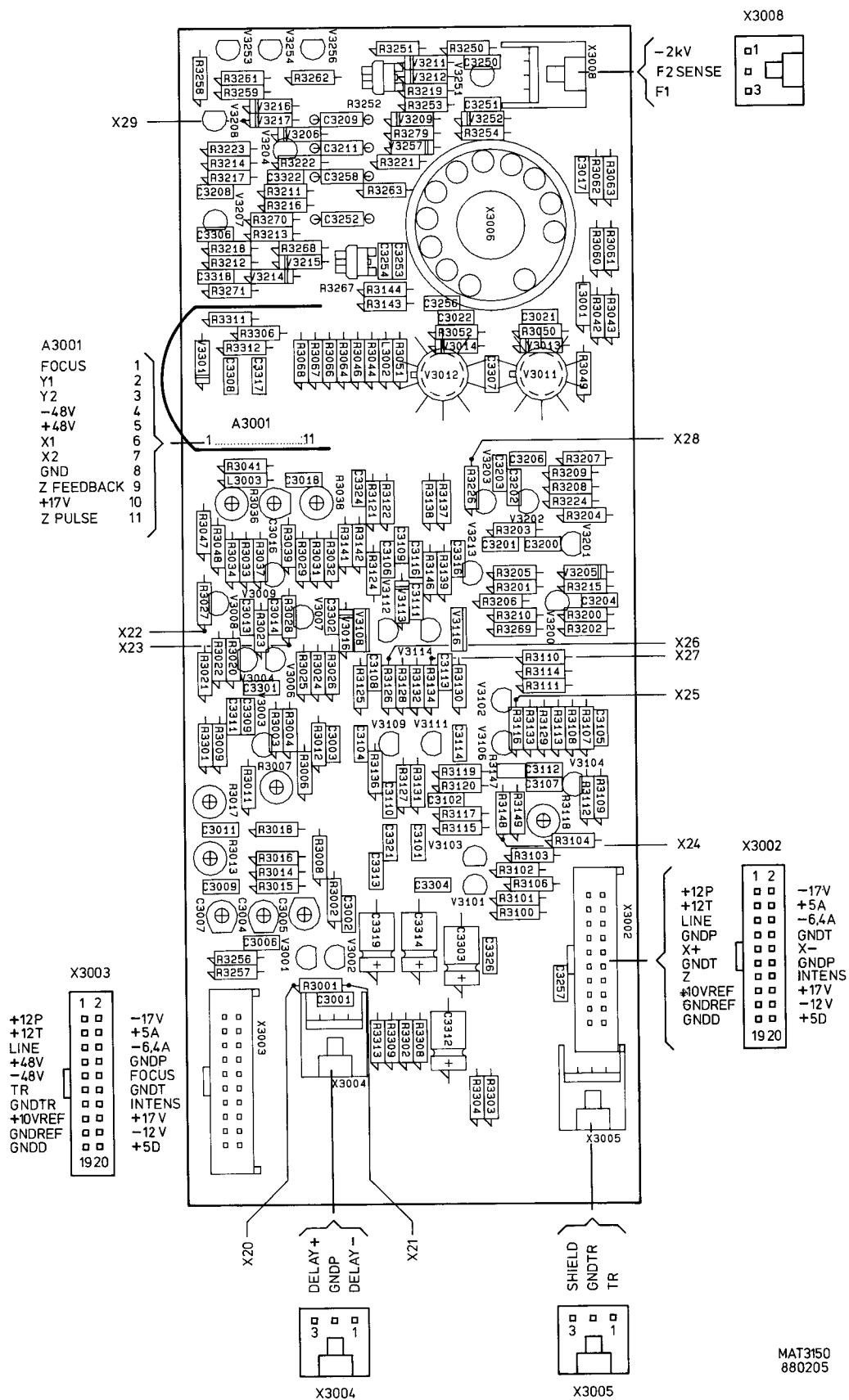


Figure 6.3 XYZ Amplifier unit p.c.b.

7. TIME-BASE UNIT (A4)

The time-base unit consists of:

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

As a supplement, the timing diagrams for several conditions of the time base are given in section 7.6.

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

* MTB triggering:

The symmetrical trigger current signals TRIGM+ and TRIGM- are derived from the pre-amplifier unit and converted into the asymmetrical MTB trigger voltage via the shunt feedback amplifier V4003 and V4006. The amplifier of this MTB trigger signal is the summation of the voltage swings across R4002 and R4003, which are proportional to the current swing of TRIGM+ and TRIGM-.

* TV triggering:

When the signal TVMTB goes LOW, the normal trigger path is blocked via V4005 and V4007 and the trigger signal is routed via the TV trigger stage V4009...V4018. Transistor V4009 serves to clip the synchronisation pulse and LINE/FRAME selection is obtained by 4016.

* DTB triggering:

The DTB triggering is almost similar to the MTB triggering. For TV triggering, the trigger signal is obtained from V4012 and, determined by C4024; only TV LINE triggering can serve as a DTB trigger signal for TV pictures.

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.

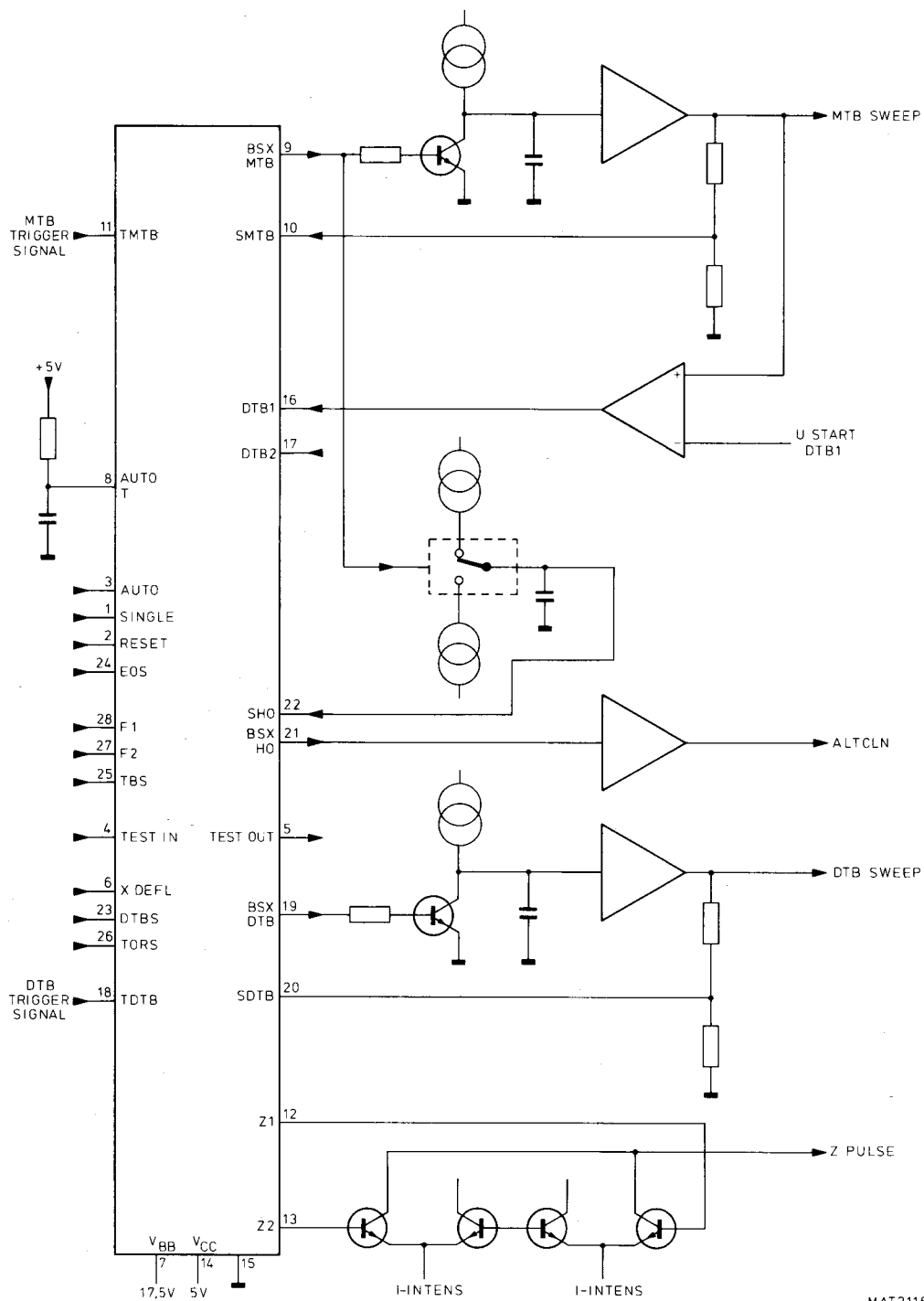


Figure 7.1 D4103 configuration

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 MTB 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 MTB-sweep capacitor(s). | | | | | | | | | | | | | | | |
| 10 | SMTB | SCHMITT-input | Determines the end of the MTB-sweep. | | | | | | | | | | | | | | | |
| 11 | TMTB | SCHMITT-input | Determines the start of the MTB-sweep. | | | | | | | | | | | | | | | |
| 12 | Z2 | TTL-output | Determines the blanking of the CRT. | | | | | | | | | | | | | | | |
| 13 | Z1 | TTL-output | Determines the blanking of the CRT. | | | | | | | | | | | | | | | |
| 14 | GND | - | Ground. | | | | | | | | | | | | | | | |
| 15 | Vcc | - | +5 V supply input. | | | | | | | | | | | | | | | |
| 16 | DTB1 | SCHMITT-input | DTB starts, or starts after trigger pulse. | | | | | | | | | | | | | | | |
| 17 | DTB2 | - | not used, connected to ground. | | | | | | | | | | | | | | | |
| 18 | TDTB | SCHMITT-input | Triggers the DTB-sweep when required. | | | | | | | | | | | | | | | |
| 19 | BSXDTB | TTL-output | Discharges the DTB sweep capacitor. | | | | | | | | | | | | | | | |
| 20 | SDTB | SCHMITT-input | Determines the end of the DTB-sweep. | | | | | | | | | | | | | | | |
| 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 +5 A. | | | | | | | | | | | | | | | |
| 24 | EOS | - | Not used; connected to +5 A. | | | | | | | | | | | | | | | |
| 25 | TBS | TTL-input | Determines the MTB-unblanking (HIGH) or the DTB-unblanking (LOW). | | | | | | | | | | | | | | | |
| 26 | TORS | TTL-input | Determines the STARTS condition (LOW) or TRIG'D condition (HIGH) of the DTB. | | | | | | | | | | | | | | | |
| 27 | F1 | TTL-input | Determines the selection for the different horizontal Display modes. | | | | | | | | | | | | | | | |
| 28 | F2 | TTL-input | | | | | | | | | | | | | | | | |
| | | | <table><tr><th>F1</th><th>F2</th><th>Display mode</th></tr><tr><td>0</td><td>0</td><td>MTB</td></tr><tr><td>0</td><td>1</td><td>MTBI</td></tr><tr><td>1</td><td>0</td><td>DTB</td></tr><tr><td>1</td><td>1</td><td>MTBI and DTB</td></tr></table> | F1 | F2 | Display mode | 0 | 0 | MTB | 0 | 1 | MTBI | 1 | 0 | DTB | 1 | 1 | MTBI and DTB |
| F1 | F2 | Display mode | | | | | | | | | | | | | | | | |
| 0 | 0 | MTB | | | | | | | | | | | | | | | | |
| 0 | 1 | MTBI | | | | | | | | | | | | | | | | |
| 1 | 0 | DTB | | | | | | | | | | | | | | | | |
| 1 | 1 | MTBI and DTB | | | | | | | | | | | | | | | | |

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

7.3 SWEEP GENERATORS

Because the MTB and DTB sweep generators are almost similar, only the MTB sweep generator is described.

* MTB sweep generator (See figure 7.2):

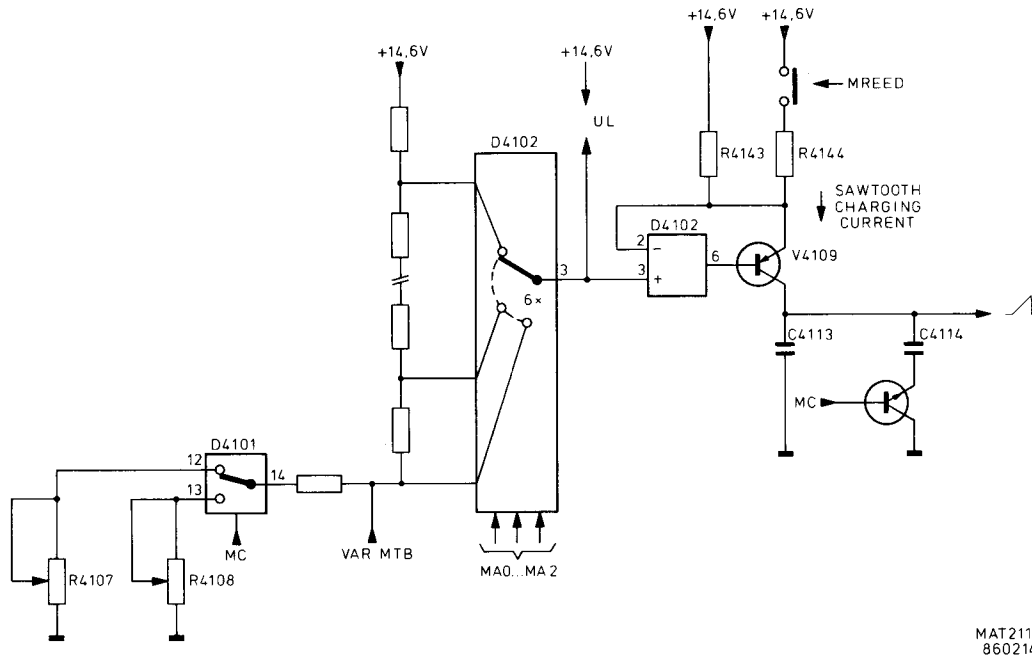


Figure 7.2 Simplified diagram of the MTB

The MTB sawtooth charging current $\frac{U_1}{R4143}$ (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 U_1 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 U_1 can be continuously varied by moving the VAR MTB control R7009 from the CAL position. Thus a sweep variation of 1:2,5 can be obtained.

The function table for the MTB and DTB sweep generators is given below:

| sweep speed | MA2 (DA2) | MA1 (DA1) | MA0 (DA0) | MREED (DREED) | MC (DC) | | |
|-------------|--------------|--------------|--------------|------------------|------------|---------------|---------------|
| 50 ns | 1 | 1 | 1 | 0 | 0 | MTB- range | DTB- range |
| .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 and DREED are low, then RELAY is switched on.

The MTB 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 MTB sweep and DTB sweep voltages are applied to the horizontal display mode switch.

* Delay time multiplier circuit:

Output signal DTB1 of comparator stage D4402 controls the starting point of the DTB depending on the adjusting of the DTM front-panel control. This signal is applied to D4103-16.

The comparator has two inputs:

- D4402-4 receives the MTB sawtooth voltage.
- D4402-2 receives a fixed adjusted voltage between 0...5 V. Digital-to-analogue (DAC) converter D4401 converts the digital information of the DTM setting (SDA-input) into an analogue current (pin 22), which in its turn is converted into the fixed comparator voltage via N4101.

At the moment that the instantaneous d.c. value of the MTB sawtooth exceeds the voltage on D4402-2, signal DTB1 goes higher.

* Hold-off circuit

During the MTB sweep, capacitor C4304 is discharged. In the lower sweep speeds (lower than 10us) capacitor C4302 is also discharged via V4306. After the MTB 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 MTB 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 MTB starts to run again and at the same time C4304 (and C4302) are discharged again via V4309.

* Alt. clock generator:

At the end of each MTB sweep the signal BSXHO goes low. This signal is routed to V4322 to generate the ALTCLN pulse, which is applied to the pre-amplifier unit A2. The ALTCLN pulse controls the channel switch on that unit at the end of each MTB sweep. When SHO reaches the +2,5 V level, BSXHO goes HIGH again.

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 MTB 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 MTB, DTB or X DEFL 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 | DTB sawtooth |
| 0 | 1 | MTB sawtooth |

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 1 and pin 8. The inputs Z1 and Z2 are derived from the timer stage D4103 and determine the unblanking of the CRT according to figure 7.3.

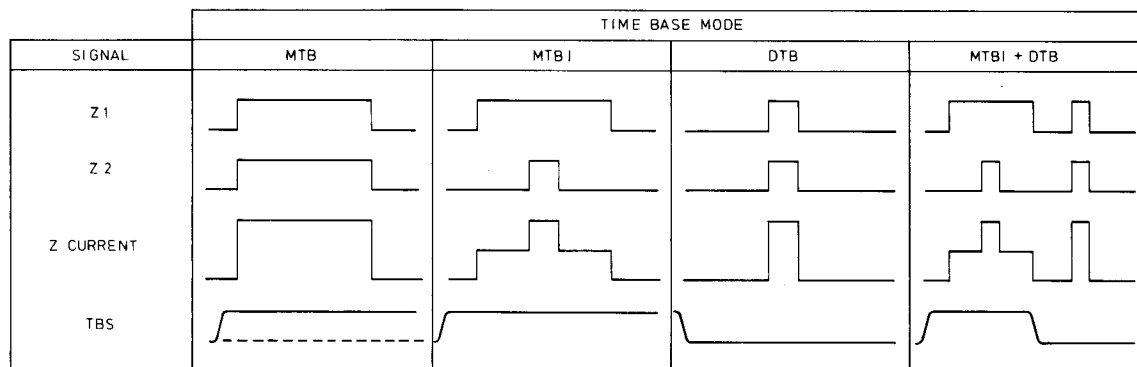
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Figure 7.3 Z-logic for the different TB modes

When both Z1 and Z2 are HIGH, the trace gives normal intensity; when only Z1 or Z2 is HIGH the trace gives half intensity. This means that, in MTBI mode, the DTB part of the trace is more intensified than the MTB part of the trace. The ratio between both intensities is adjusted by R4616. 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 7 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 7.

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 fully 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 e-c to the +5 kV 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 e-c to the +5 kV rail.

7.6 TIMING DIAGRAMS

The following figures gives the timing diagrams for D4103 for several conditions of the time-base. The conditions are:

- a free running MTB sweep
- a triggered MTB-sweep with a delayed sweep
- a triggered MTB-and DTB-sweep

* Free running MTB sweep:

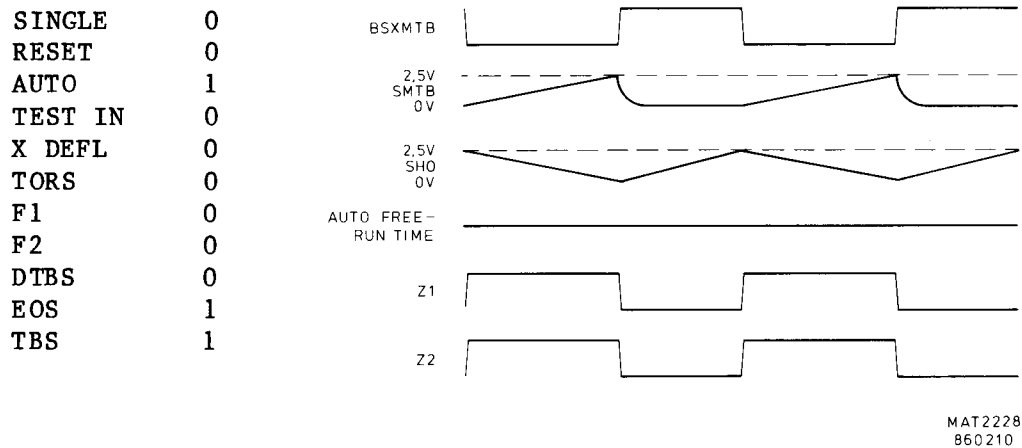


Figure 7.4 Free-running MTB sweep-timing diagram

* Triggered MTB-sweep with a delayed sweep:

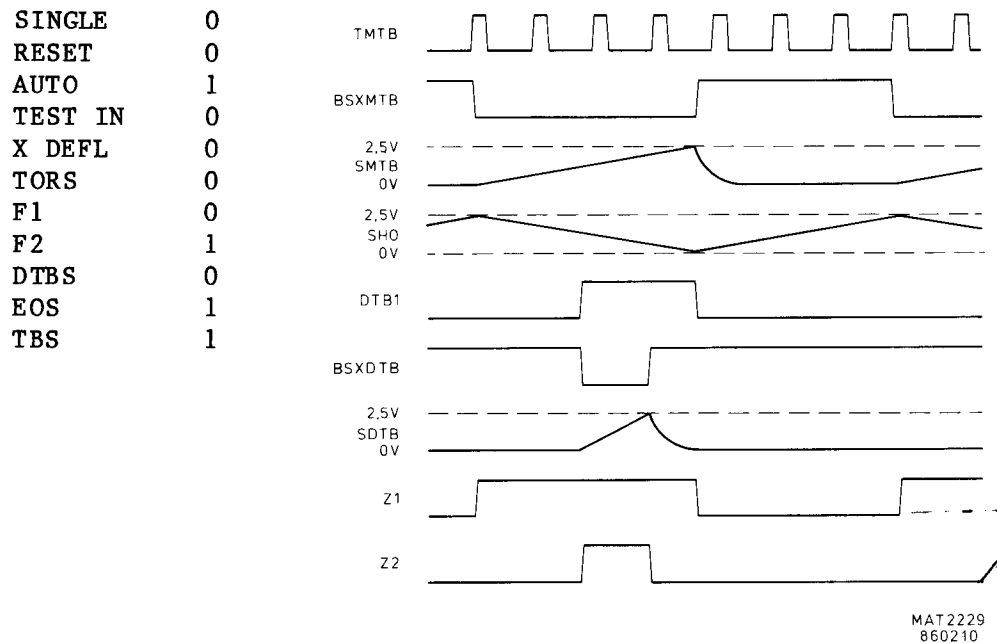


Figure 7.5 Triggered MTB-sweep with a delay sweep-timing diagram

* Triggered MTB- and DTB-sweep:

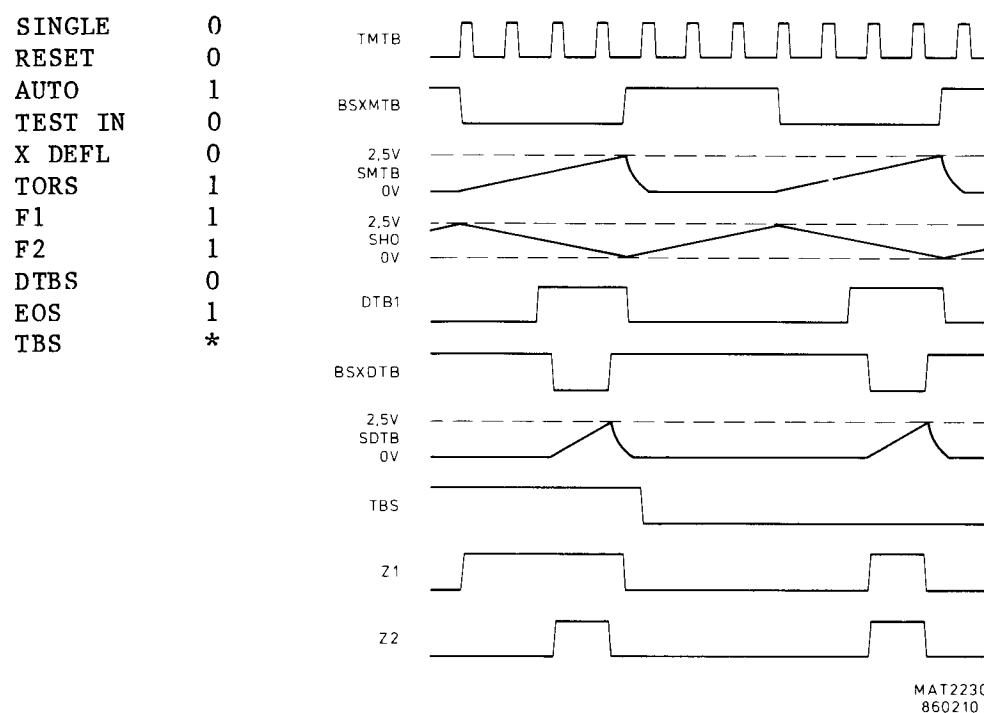


Figure 7.6 Triggered MTB- and DTB-sweep-timing diagram

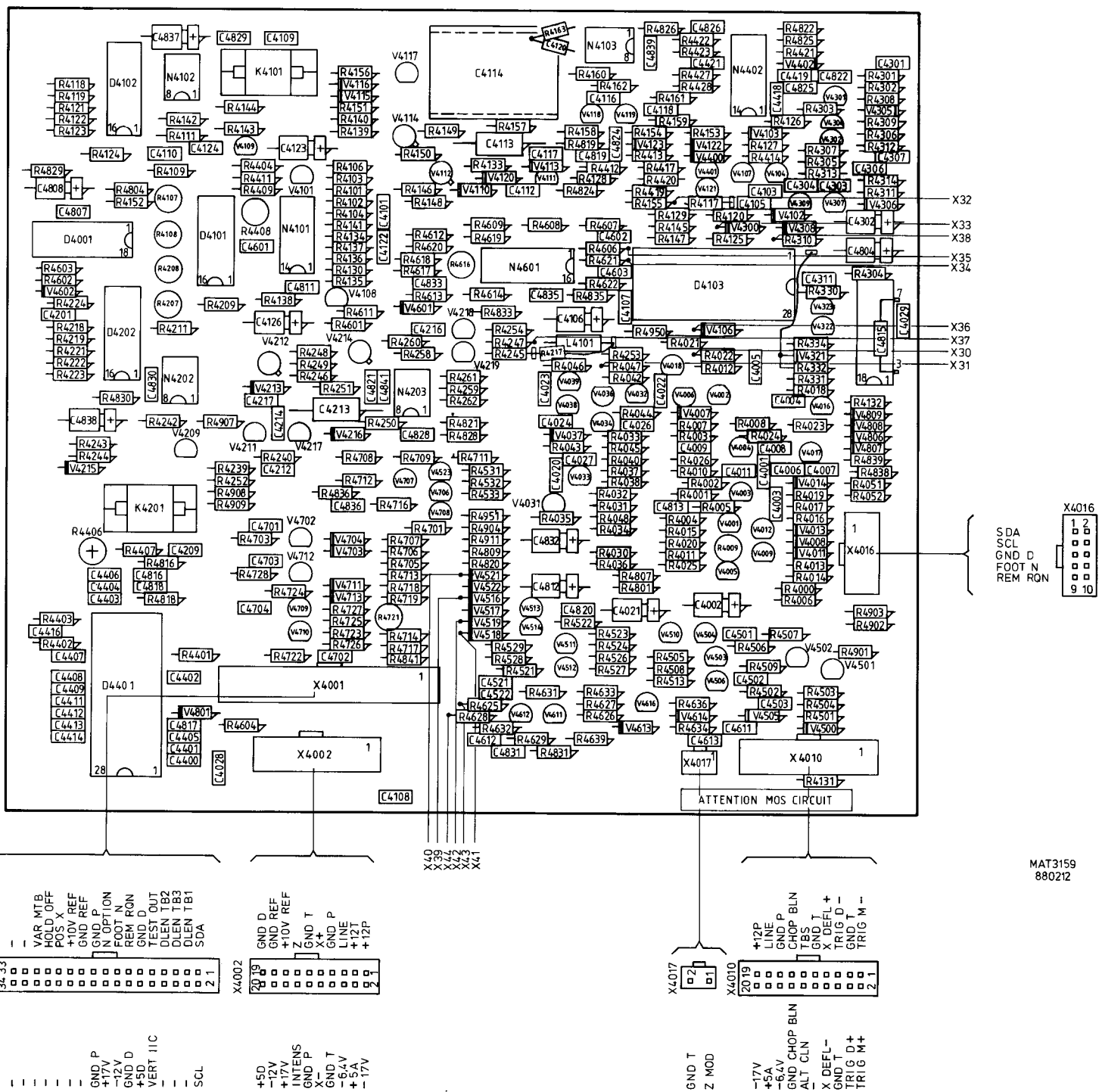


Figure 7.7 Time base unit p.c.b.

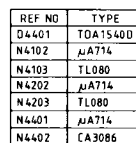


Figure 7.9 Circuit diagram of time base, MTB and DTB sweep circuits and final X DEFL amplifier

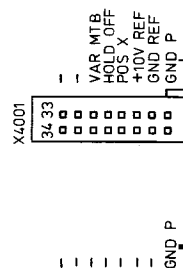
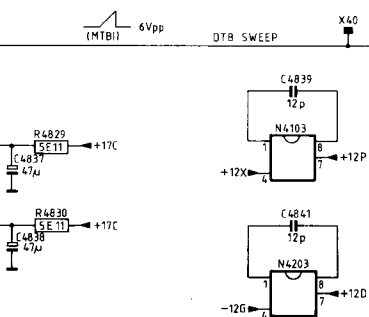
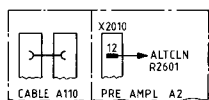


Figure 7.10 Time base unit p.c.b.

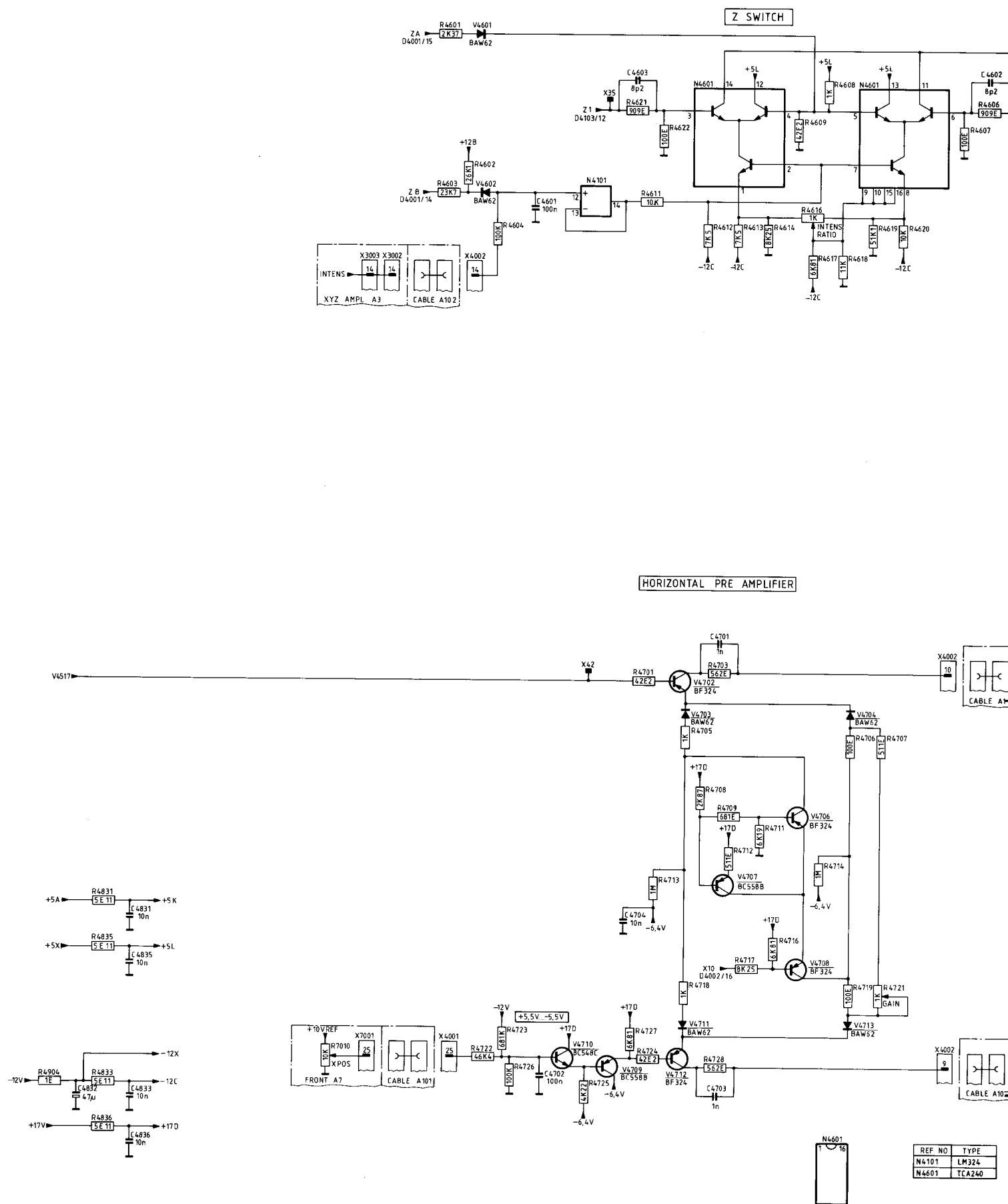
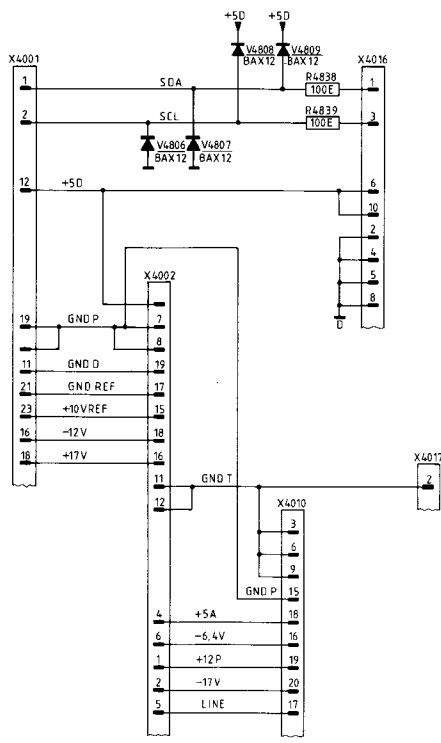
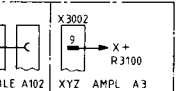
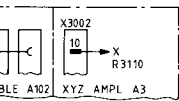
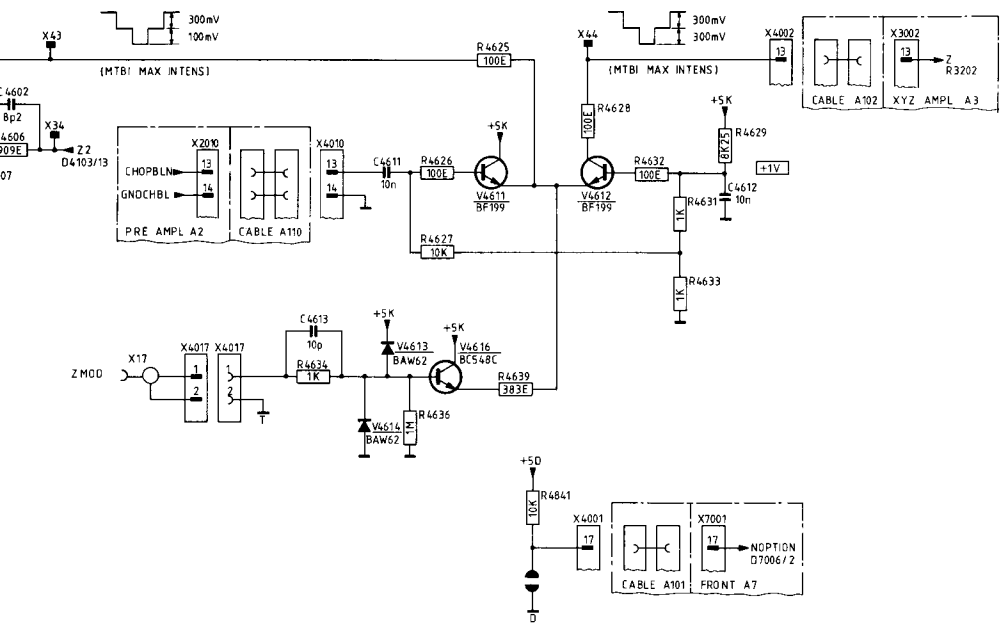


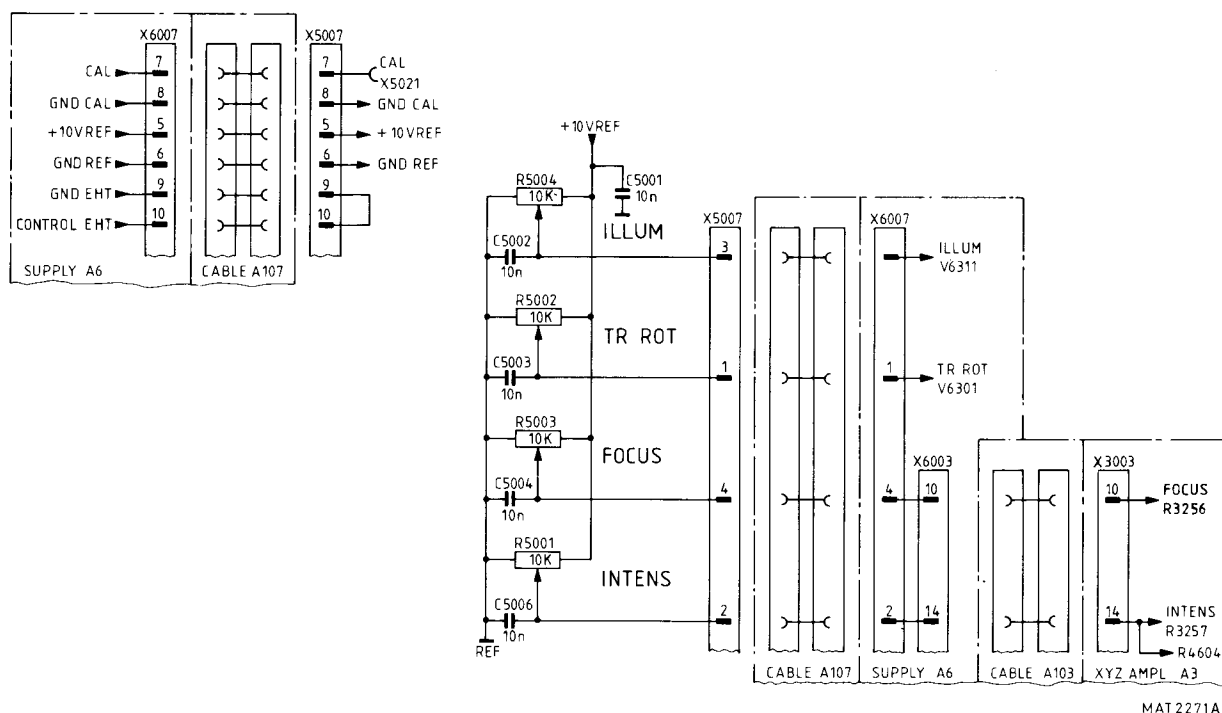
Figure 7.11 Circuit diagram of time-base, pre-amplifier and Z switch



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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.



MAT2271A

Figure 8.1 Circuit diagram of CRT control

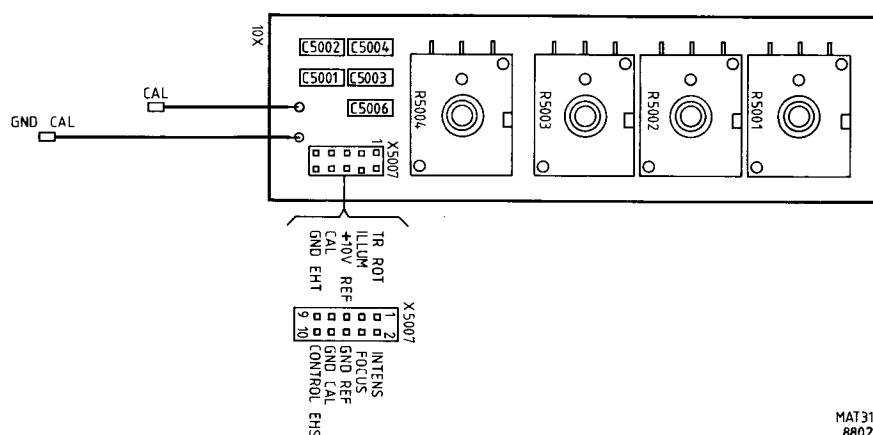
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Figure 8.2 CRT control unit p.c.b.

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 100 V...240 V a.c.

The mains voltage is primary protected by a fuse of 1,6 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 chokes L6000, L6001 and L6002.

Depending on the mains voltage, the rectified voltage is 120 V...370 V.

WARNING: All measurements on the INPUT CIRCUIT and the CONVERTER CIRCUIT should be done with a floating oscilloscope.
As reference voltage can be used measure point X48.

A fixed part of the mains voltage serves as a LINE-trigger signal. The amplitude of the LINE trigger signal is $1/22 \times \text{MAINS}$.

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)

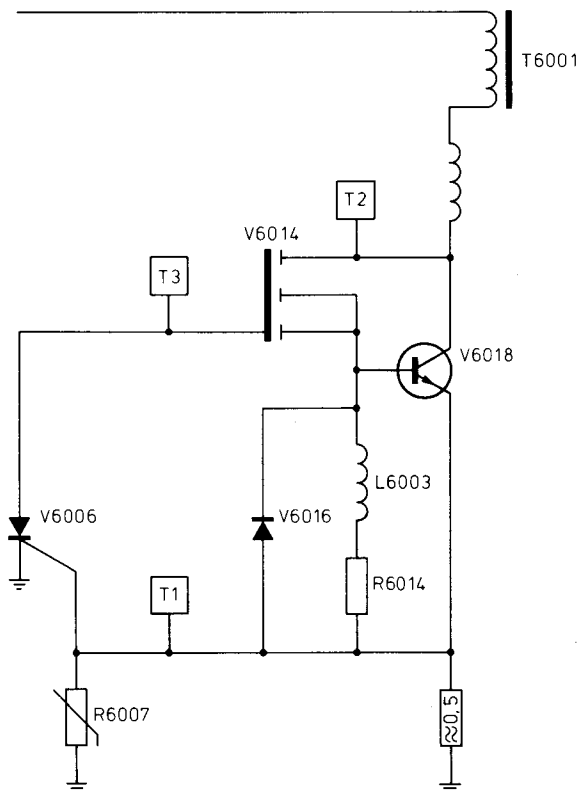
The flyback converters consists of transistor V6014 and V6018 and their associated components. The converter frequency depends on the LINE IN amplitude and is for 110 Vac: 30 kHz approx and for 220 Vac: 45 kHz approx.

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, L6002 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

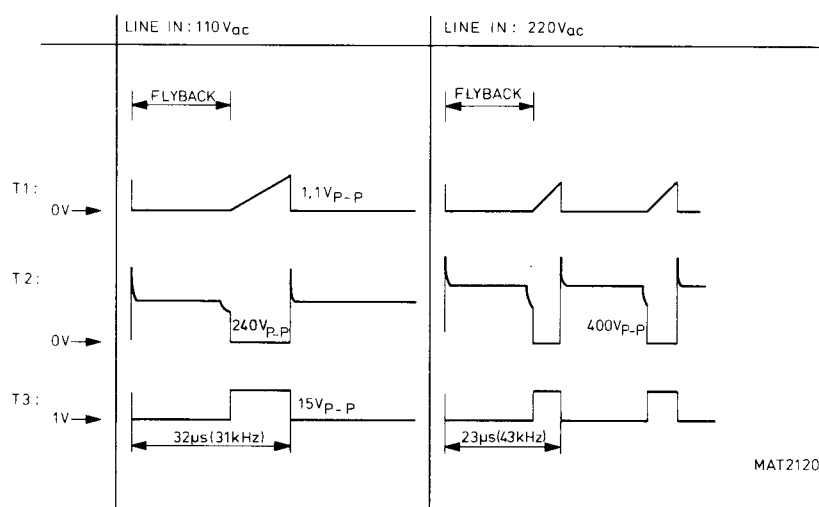


Figure 9.2 Timing diagram converter circuit

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 the short-circuit mode.

9.4 HT SUPPLY

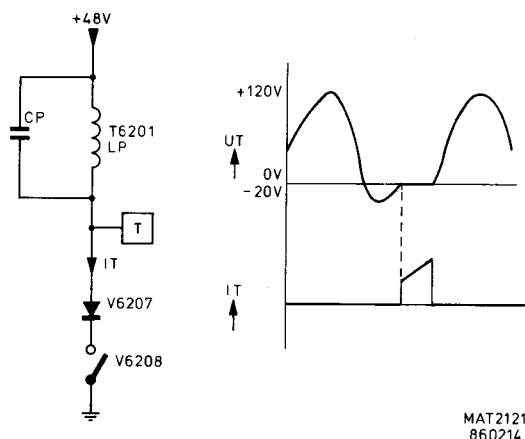


Figure 9.3 HT oscillator

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.

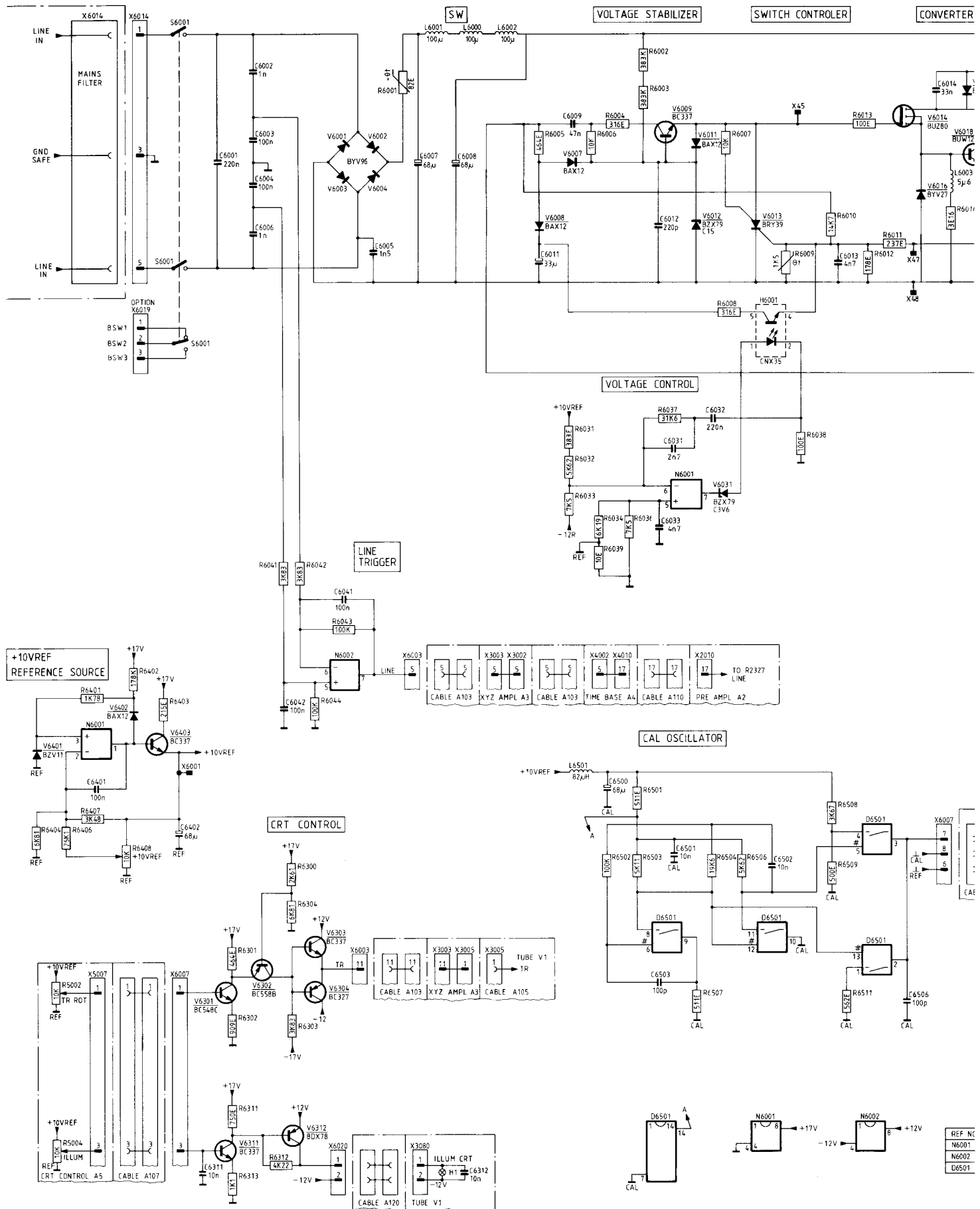


Figure 9.5 Circuit diagram of power supply



10. FRONT UNIT (A7-A8)

The front unit consists of:

- the microcomputer control circuit
- the LCD display circuit
- the front panel controls

10.1 MICROCOMPUTER CONTROL CIRCUIT

10.1.1 Introduction to MAB8052 microcomputer

The integrated circuit MAB8052, one of the MSC-51 family of single chip microcomputers, forms the basis of the microcomputer system of the oscilloscope. The MAB8052 has an internal 8 k ROM and 256 bytes RAM with address/data decoding facilities. In addition to this, the 8052 has 32 I/O lines. Data written to these lines remains unchanged until rewritten. Each line is able to serve as input or output, or both, even though outputs are statically latched. To provide specific serial data transfer possibilities, the microcomputer system contains an I²C bus interface.

10.1.2 Characteristics of the I²C bus

The I²C bus is for 2-way, 3-line communication between different ICs or modules. The three lines are a serial data line (SDA), a serial clock line (SCL) and ground. Both lines must be connected to a positive supply via a pull-up resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

Bit transfer:

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse as changes in the data line at this time will be interpreted as control signals.

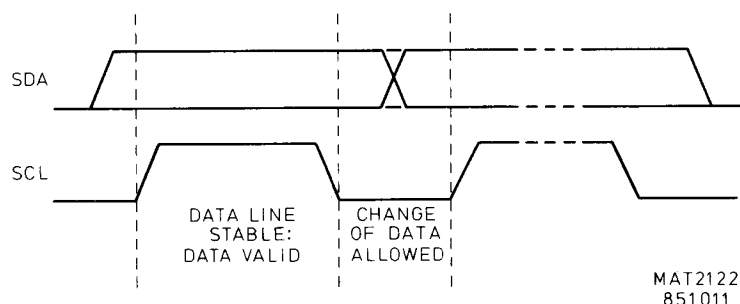
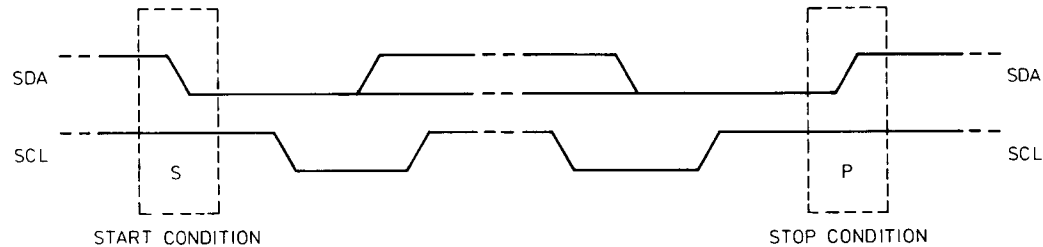


Figure 10.1 Bit transfer

Start and stop conditions:

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the start condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the stop condition (P).

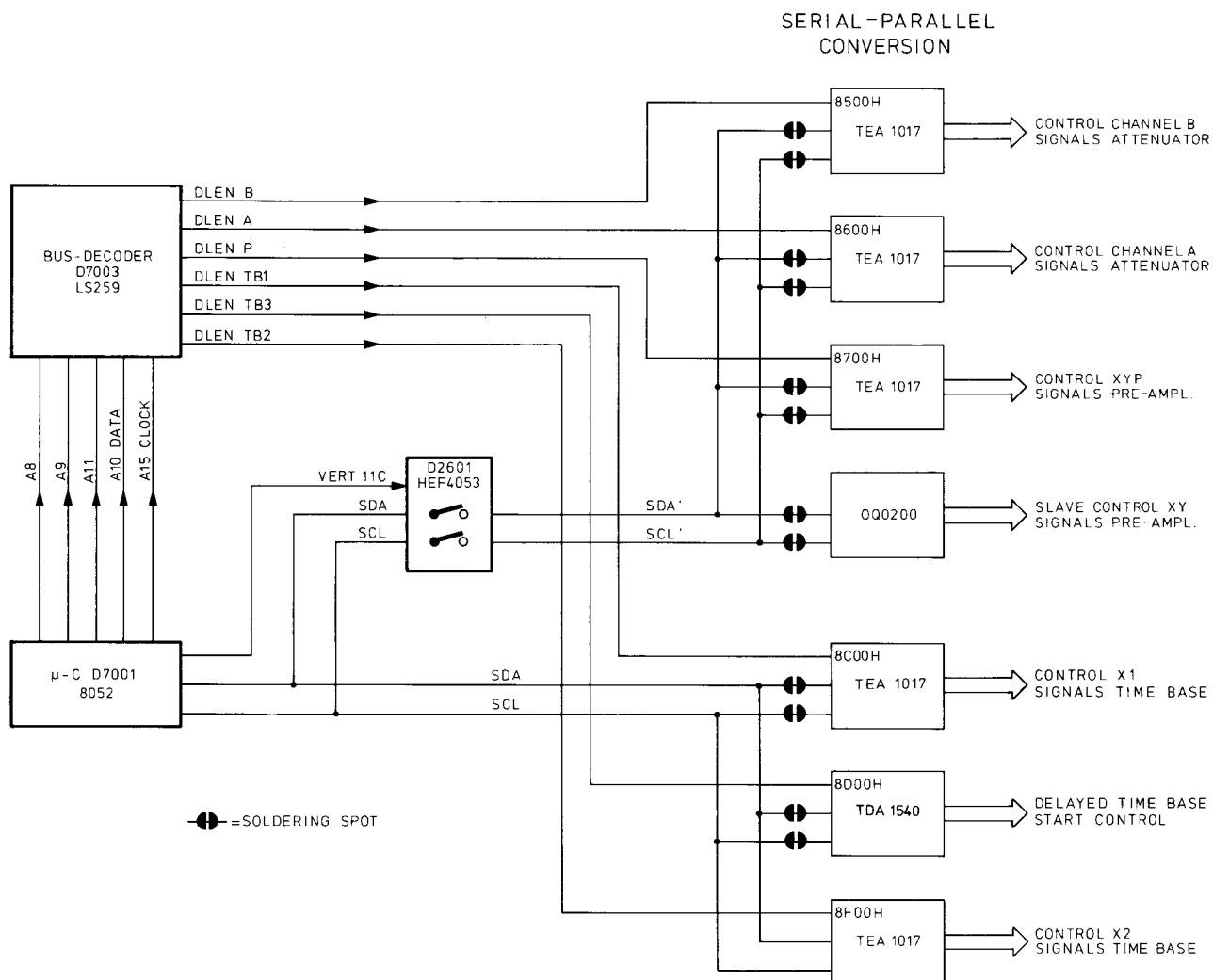


MAT2123
851011

Figure 10.2 Definition of start and stop conditions

10.1.3 I²C structure

The two lines SDA and SCL are fed to the various circuits, where, depending on the addressing, this serial information is converted into the different control signals (see figure 10.3).



MAT2125A
860214

Figure 10.3 I²C structure

To select the serial-parallel conversion circuits, the bus decoder D7003 decodes the address lines A8, A9 and A11 into the DLEN (Data latch enable) signals according to the next table

| ADDRESS LINES | | | DATA | | |
|---------------|----|----|------|-------|----------|
| A11 | A9 | A8 | A10 | | |
| 0 | 0 | 0 | 1/0 | 8400H | SEL IIC |
| 0 | 0 | 1 | 1/0 | 8500H | DLEN B |
| 0 | 1 | 0 | 1/0 | 8600H | DLEN A |
| 0 | 1 | 1 | 1/0 | 8700H | DLEN P |
| 1 | 0 | 0 | 1/0 | 8C00H | DLEN TB1 |
| 1 | 0 | 1 | 1/0 | 8D00H | DLEN TB3 |
| 1 | 1 | 0 | 1/0 | 8E00H | DLEN TB2 |
| 1 | 1 | 1 | 1/0 | 8F00H | N.C. |

To eliminate interference in the vertical circuits, the I²C bus can be switched off for this circuit by switch D2601. The timing is obtained by the VERT IIC line.

Note that for servicing, solder joints are added in the p.c.b. tracks connecting the circuits. These can be used to localize a fault in the I²C-bus by means of interrupting the bus connection.

10.1.4. Microcomputer MAB8052

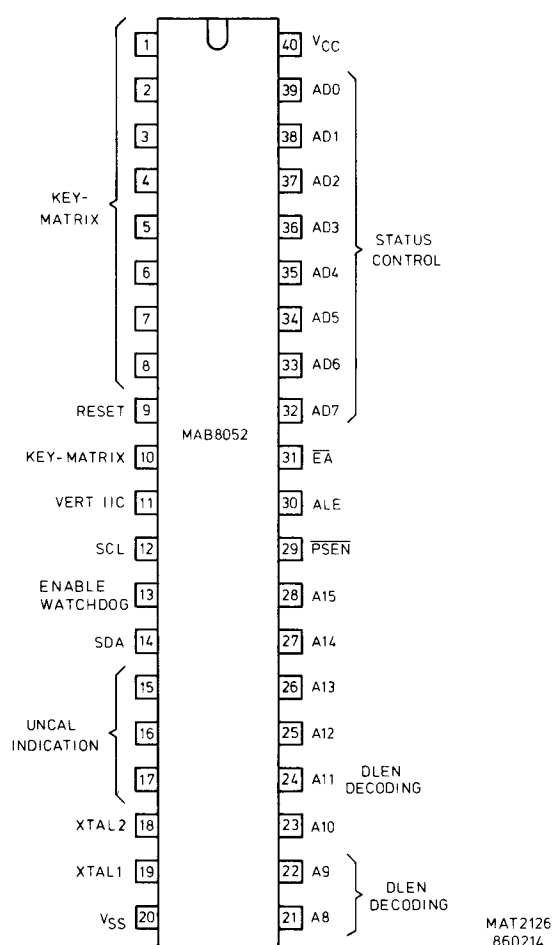


Figure 10.4 Pinning of microcomputer MAB 8052

The microprocessor has the following connections:

- * Crystal connections (pin 18 and 19)
A 12 MHz crystal is connected to the inputs XTAL1 and XTAL2 to provide an accurate timing reference source.
- * RESET input (pin 9)
After switching on a reset level HIGH is applied to this input. This reset signal forces the microcomputer to initiate the main program, beginning at the address 00000H. After the +5 V supply is within its specification, the RESET is released and the microcomputer is ready for use.
- * 8-bit quasi bidirectional I/O port (pin 1...pin 8) and quasi-bidirectional I/O port (pin 10), used to read the settings of the KEY-MATRIX switches S2...S32 (excl. S12-AUTOSET)
- * 3-bit quasi-bidirectional I/O port (pin 15...pin 17), used to read the UNCAL position of S5, S7 and S9 (UNCAL when logic HIGH).
- * WATCHDOG input (pin 13)
The WATCHDOG is a facility to control the correct function of the software. When HIGH the internal counter will run. The software gives a pulse every 64 ms max. to reset this counter, so that the 64 ms max. cycle starts again. If the software does not function correctly, the internal counter receives no reset pulse and the counter will overflow initiating the main program (start address 0000H).
- * 8-bit open drain bidirectional I/O port (pin 21...pin 28), used for addressing the serial-parallel conversion circuits (see I²C structure).
- * 8-bit quasi-bidirectional I/O port (pin 32...pin 39) used to read the status input via D7006.
- * SDA (pin 14); SCL (pin 12)
Bidirectional I²C lines.
- * VERT IIC (pin 11)
Signal used as a digital switch control to switch-off the I²C bus of the pre-amplifier control.

10.1.5. I²C decoding

Integrated circuit D7002 serves as a multiplexer to make a separation between the I²C lines for the LCD drives and the I²C lines for the other circuits, controlled by the SEL IIC line. Only when SEL IIC is HIGH (address 8400H), are the SDA and SCL lines from the microcomputer connected to unit A8.

10.1.6. Status input

Integrated circuit D7006 serves as an input port to read the following status info:

- TEST OUT, indication for triggered mode, HIGH when triggered.
- FOOTN, remote control for AUTO SET, LOW when active.
- NOPTION, adapts software for optional trigger coupling, LOW when optional triggering.
- REMRON, remote request line, LOW when active.
- probe indication status, adapts V/DIV reading for probe attenuation.

When the enable inputs (pin 1 and pin 19) become LOW, the status input is read and copied in the accumulator of the microcomputer via the data lines AD0...AD7.

Note that enabling is only possible when D7002-2 is switched-on to D7002-15, i.e. when A15 is HIGH (address 8000H ... FFFFH).

10.1.7 Probe indicator

Integrated circuit D7004 (000044) 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 next table.

| 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 |

10.1.8 C-Bus decoder

This integrated circuit decodes the address lines A8, A9 and A11 into the DLEN signals.

During the power-up all the lines are reset to LOW.

10.2 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.

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 R7038 are connected to this pin to form the oscillator, with a frequency of 150 Hz approx. Pin₃₆ and pin 37 are used to determine the LCD drivers address in the I²C bus.

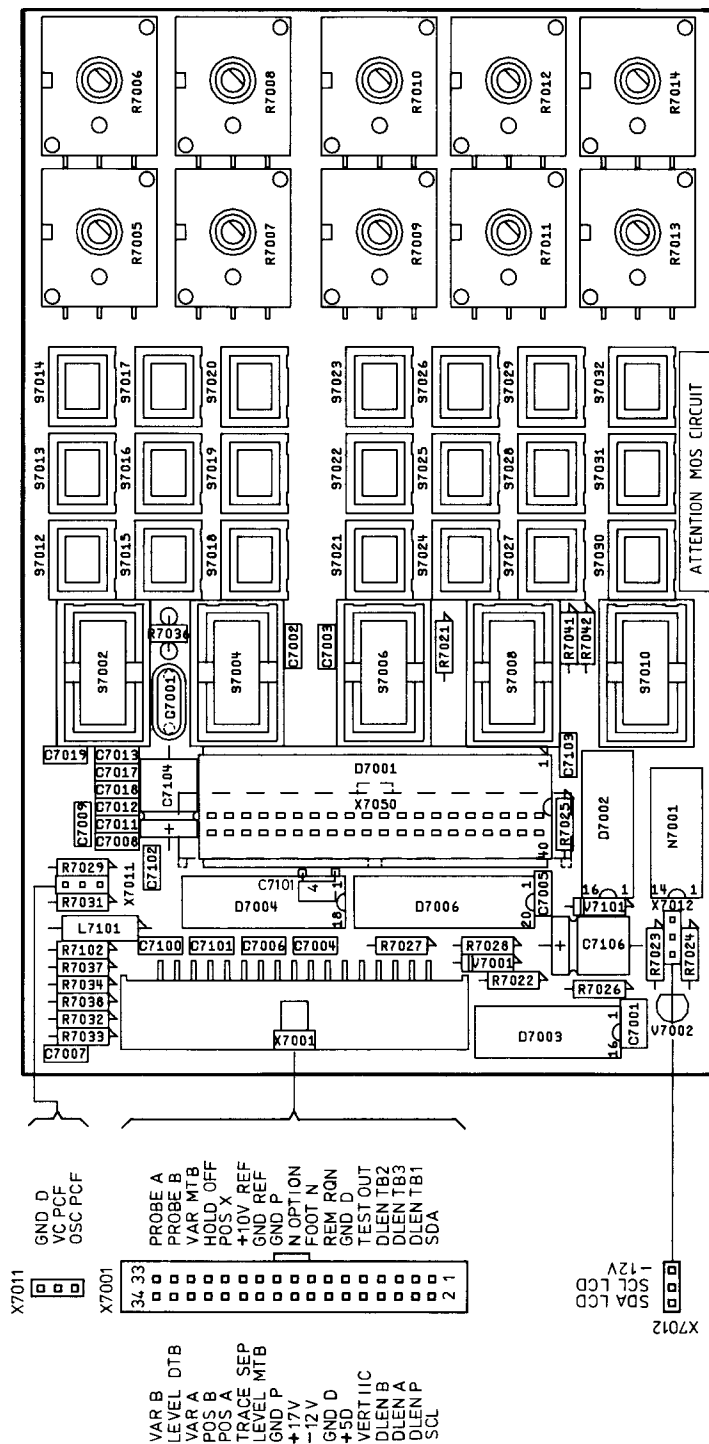
The outputs pin 1...pin 32 directly drive the LCD.

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

10.3 FRONT-PANEL CONTROLS

The front-panel controls give a voltage between 0 V...10 V to the various circuits.

To determine the UNCAL condition of VAR A, VAR B or VAR MTB, the d.c. voltages of the slider of the potentiometers are applied to comparator N7001. When the voltage level of the control is lower than 0,7 V, the microcomputer reads a logic LOW on its input and adapts the LCD display to indicate the CAL status (e.g. no flashing ">" sign visible).



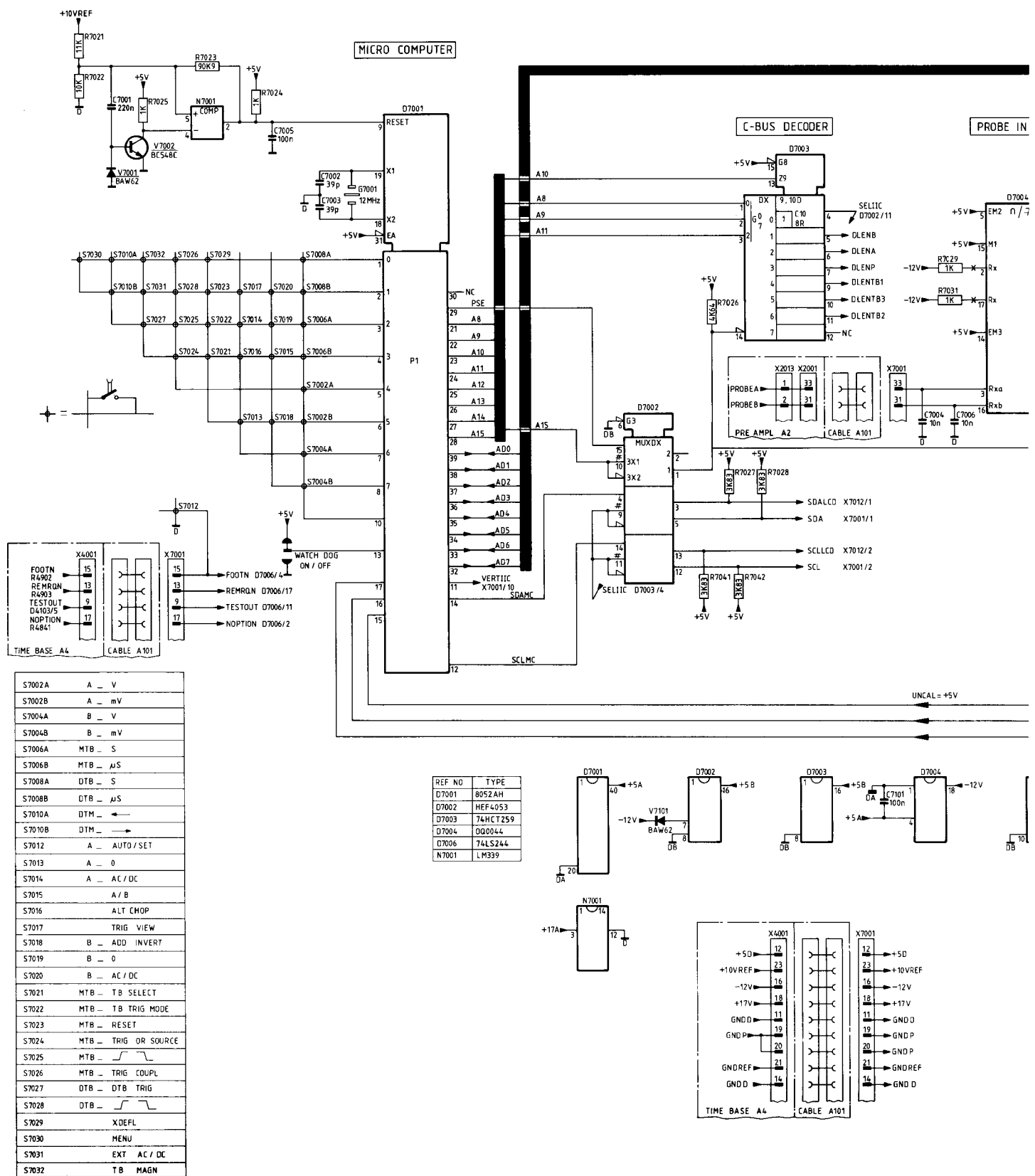
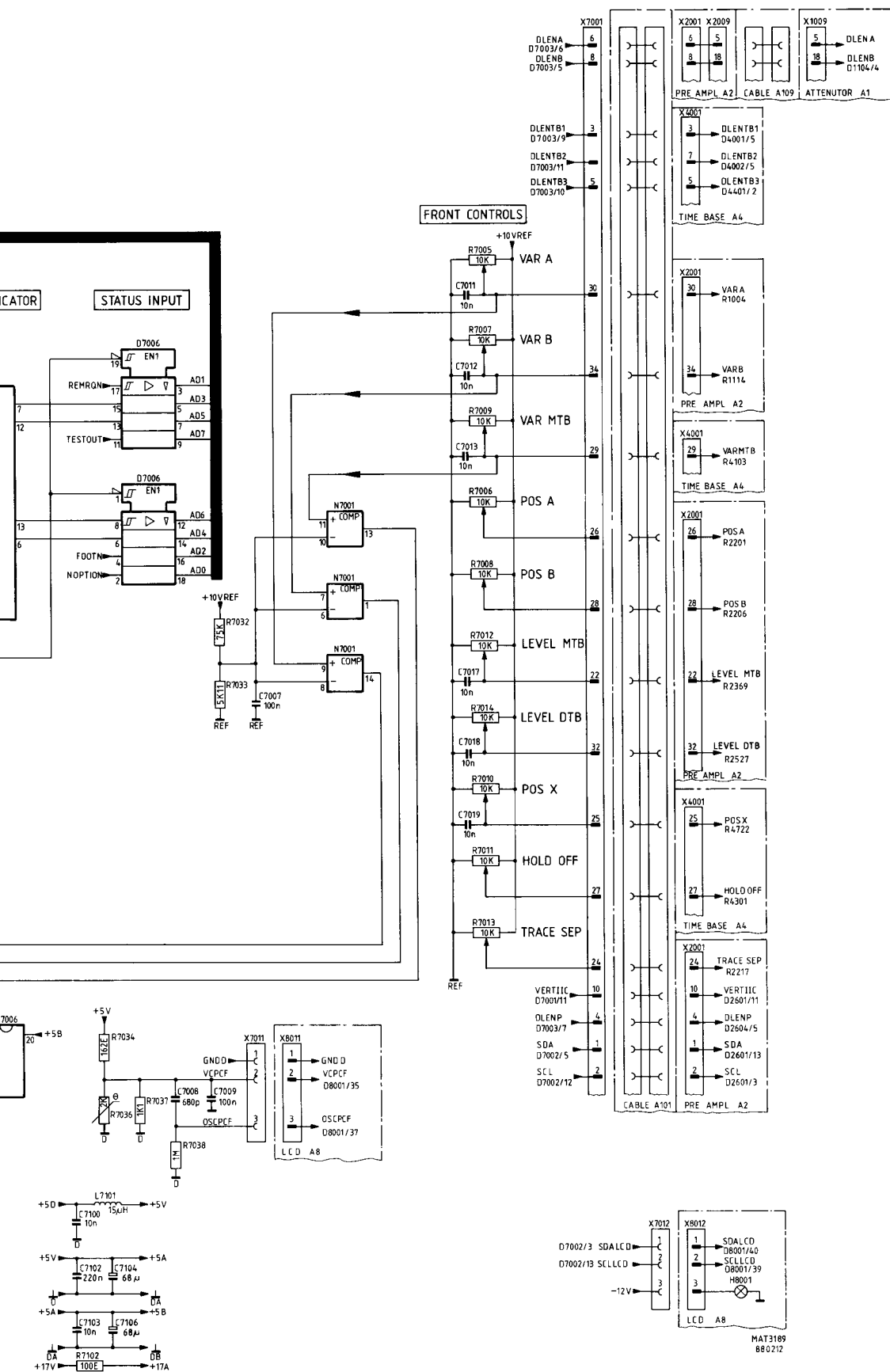


Figure 10.6 Circuit diagram of front unit



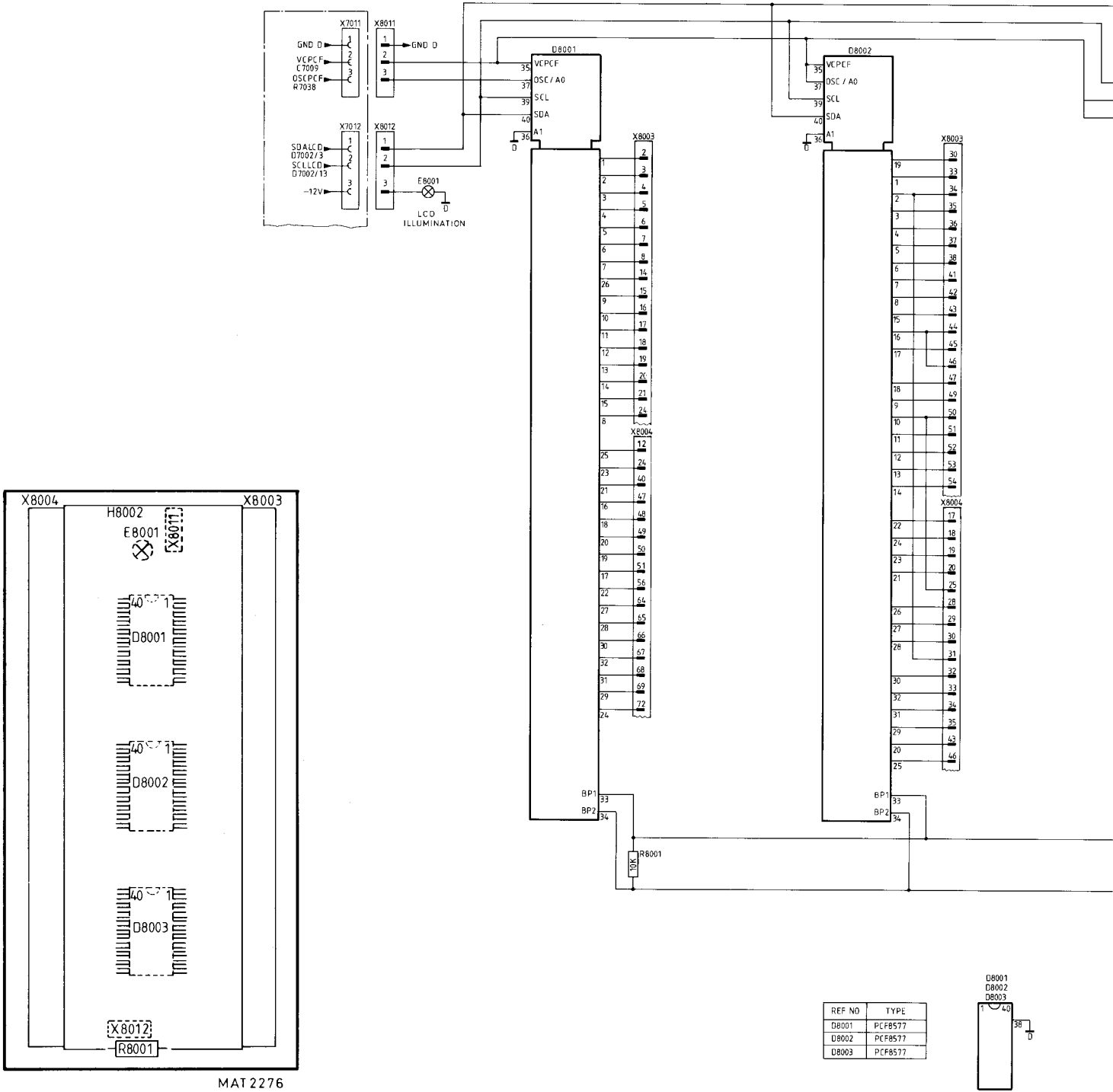
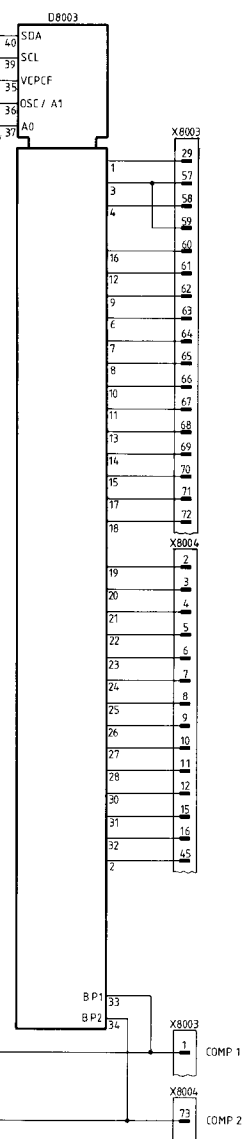


Figure 10.7 LCD unit p.c.b.



| X8004 | | | | |
|-------|-------------------|--------|-------------------|-----|
| PIN | COM1 | | COM2 | |
| | DISPLAY / SEGMENT | CH | DISPLAY / SEGMENT | CH |
| 73 | | | | |
| 72 | | | | |
| 71 | NC | | NC | |
| 70 | NC | | NC | |
| 69 | 1 a | A 1 | f | A |
| 68 | 1 g | A 1 | e | A |
| 67 | 1 c | A 1 | d | A |
| 66 | 1 b | A | P1 | A |
| 65 | TRIG VIEW | | A | |
| 64 | ADD | | B | |
| 63 | NC | | NC | |
| 62 | NC | | NC | |
| 61 | NC | | NC | |
| 60 | NC | | NC | |
| 59 | NC | | NC | |
| 58 | NC | | NC | |
| 57 | NC | | NC | |
| 56 | | | | |
| 55 | NC | | NC | |
| 54 | NC | | NC | |
| 53 | NC | | NC | |
| 52 | NC | | NC | |
| 51 | 3 a | B 3 | f | B |
| 50 | 3 g | B 3 | e | B |
| 49 | 3 c | B 3 | d | B |
| 48 | 3 b | B | P2 | B |
| 47 | TRIG' D | | NOT | |
| 46 | XDEFL | | T B | |
| 45 | | | M | |
| 44 | NC | | NC | |
| 43 | TRIG | | AUTO | |
| 42 | NC | | NC | |
| 41 | NC | | NC | |
| 40 | | | | |
| 39 | NC | | NC | |
| 38 | NC | | NC | |
| 37 | NC | | NC | |
| 36 | NC | | NC | |
| 35 | 5 a | MTB 5 | f | MTB |
| 34 | 5 g | MTB 5 | e | MTB |
| 33 | 5 c | MTB 5 | d | MTB |
| 32 | 5 b | MTB | P3 | MTB |
| 31 | | MTB | EXT | MTB |
| 30 | B | MTB | A | MTB |
| 29 | HF | | LF | |
| 28 | DC | | P - P | |
| 27 | NC | | | |
| 26 | NC | | | |
| 25 | | | * | DTB |
| 24 | | | > | DTB |
| 23 | NC | | NC | |
| 22 | NC | | NC | |
| 21 | NC | | NC | |
| 20 | 7 a | DTB 7 | f | DTB |
| 19 | 7 g | DTB 7 | e | DTB |
| 18 | 7 c | DTB 7 | d | DTB |
| 17 | 7 b | DTB | P4 | DTB |
| 16 | B | DTB | STARTS | |
| 15 | EXT | DTB | A | DTB |
| 14 | DC | DTB | AC | DTB |
| 13 | NC | | NC | DTM |
| 12 | | | | |
| 11 | 9 a | DTM 9 | f | DTM |
| 10 | 9 g | DTM 9 | e | DTM |
| 9 | 9 c | DTM 9 | d | DTM |
| 8 | 9 b | DTM | P5 | DTM |
| 7 | 10 a | DTM 10 | f | DTM |
| 6 | 10 g | DTM 10 | e | DTM |
| 5 | 10 c | DTM 10 | d | DTM |
| 4 | 10 b | DTM | P6 | DTM |
| 3 | 11 a | DTM 11 | f | DTM |
| 2 | 11 g | DTM 11 | e | DTM |
| 1 | NC | | NC | |

INV $\frac{1}{2}$ $\frac{2}{P1}$ $\frac{micV}{ACDC}$

A TRIG VIEW ALT
B ADD CHOP

INV $\frac{1}{2}$ $\frac{2}{P2}$ $\frac{micV}{ACDC}$

NOT TRIG D ARMED

MTB X-DEFL DTB
AUTO TRIG SINGLE

* $\frac{5}{P3}$ $\frac{6}{\mu s}$

AEXTBACDC LINE

LFHF OPTION

P-PDCTIVE ÷

* $\frac{7}{P4}$ $\frac{8}{\mu s}$

STARTS TVL
AEXTBACDC

REMOTE MENU

$\frac{P5}{P6}$ $\frac{P7}{P8}$ $\frac{P9}{P10}$ $\frac{P11}{P12}$ $\frac{P13}{P14}$ $\frac{P15}{P16}$ $\frac{P17}{P18}$ $\frac{P19}{P20}$ $\frac{P21}{P22}$ $\frac{P23}{P24}$ $\frac{P25}{P26}$ $\frac{P27}{P28}$ $\frac{P29}{P30}$ $\frac{P31}{P32}$ $\frac{P33}{P34}$ $\frac{P35}{P36}$ $\frac{P37}{P38}$ $\frac{P39}{P40}$ $\frac{P41}{P42}$ $\frac{P43}{P44}$ $\frac{P45}{P46}$ $\frac{P47}{P48}$ $\frac{P49}{P50}$ $\frac{P51}{P52}$ $\frac{P53}{P54}$ $\frac{P55}{P56}$ $\frac{P57}{P58}$ $\frac{P59}{P60}$ $\frac{P61}{P62}$ $\frac{P63}{P64}$ $\frac{P65}{P66}$ $\frac{P67}{P68}$ $\frac{P69}{P70}$ $\frac{P71}{P72}$ $\frac{P73}{P74}$ $\frac{P75}{P76}$ $\frac{P77}{P78}$ $\frac{P79}{P80}$ $\frac{P81}{P82}$ $\frac{P83}{P84}$ $\frac{P85}{P86}$ $\frac{P87}{P88}$ $\frac{P89}{P90}$ $\frac{P91}{P92}$ $\frac{P93}{P94}$ $\frac{P95}{P96}$ $\frac{P97}{P98}$ $\frac{P99}{P100}$ $\frac{P101}{P102}$ $\frac{P103}{P104}$ $\frac{P105}{P106}$ $\frac{P107}{P108}$ $\frac{P109}{P110}$ $\frac{P111}{P112}$ $\frac{P113}{P114}$ 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$\frac{P415}{P416}$ $\frac{P417}{P418}$ $\frac{P419}{P420}$ $\frac{P421}{P422}$ $\frac{P423}{P424}$ $\frac{P425}{P426}$ $\frac{P427}{P428}$ $\frac{P429}{P430}$ $\frac{P431}{P432}$ $\frac{P433}{P434}$ $\frac{P435}{P436}$ $\frac{P437}{P438}$ $\frac{P439}{P440}$ $\frac{P441}{P442}$ $\frac{P443}{P444}$ $\frac{P445}{P446}$ $\frac{P447}{P448}$ $\frac{P449}{P450}$ $\frac{P451}{P452}$ $\frac{P453}{P454}$ $\frac{P455}{P456}$ $\frac{P457}{P458}$ $\frac{P459}{P460}$ $\frac{P461}{P462}$ $\frac{P463}{P464}$ $\frac{P465}{P466}$ $\frac{P467}{P468}$ $\frac{P469}{P470}$ $\frac{P471}{P472}$ $\frac{P473}{P474}$ $\frac{P475}{P476}$ $\frac{P477}{P478}$ $\frac{P479}{P480}$ $\frac{P481}{P482}$ $\frac{P483}{P484}$ $\frac{P485}{P486}$ $\frac{P487}{P488}$ $\frac{P489}{P490}$ $\frac{P491}{P492}$ $\frac{P493}{P494}$ $\frac{P495}{P496}$ $\frac{P497}{P498}$ $\frac{P499}{P500}$ $\frac{P501}{P502}$ $\frac{P503}{P504}$ $\frac{P505}{P506}$ $\frac{P507}{P508}$ $\frac{P509}{P510}$ $\frac{P511}{P512}$ $\frac{P513}{P514}$ 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$\frac{P615}{P616}$ $\frac{P617}{P618}$ $\frac{P619}{P620}$ $\frac{P621}{P622}$ $\frac{P623}{P624}$ $\frac{P625}{P626}$ $\frac{P627}{P628}$ $\frac{P629}{P630}$ $\frac{P631}{P632}$ $\frac{P633}{P634}$ $\frac{P635}{P636}$ $\frac{P637}{P638}$ $\frac{P639}{P640}$ $\frac{P641}{P642}$ $\frac{P643}{P644}$ $\frac{P645}{P646}$ $\frac{P647}{P648}$ $\frac{P649}{P650}$ $\frac{P651}{P652}$ $\frac{P653}{P654}$ $\frac{P655}{P656}$ $\frac{P657}{P658}$ $\frac{P659}{P660}$ $\frac{P661}{P662}$ $\frac{P663}{P664}$ $\frac{P665}{P666}$ $\frac{P667}{P668}$ $\frac{P669}{P670}$ $\frac{P671}{P672}$ $\frac{P673}{P674}$ $\frac{P675}{P676}$ $\frac{P677}{P678}$ $\frac{P679}{P680}$ $\frac{P681}{P682}$ $\frac{P683}{P684}$ $\frac{P685}{P686}$ $\frac{P687}{P688}$ $\frac{P689}{P690}$ $\frac{P691}{P692}$ $\frac{P693}{P694}$ $\frac{P695}{P696}$ $\frac{P697}{P698}$ $\frac{P699}{P700}$ $\frac{P701}{P702}$ $\frac{P703}{P704}$ $\frac{P705}{P706}$ $\frac{P707}{P708}$ $\frac{P709}{P710}$ $\frac{P711}{P712}$ $\frac{P713}{P714}$ $\frac{P715}{P716}$ $\frac{P717}{P718}$ $\frac{P719}{P720}$ $\frac{P721}{P722}$ $\frac{P723}{P724}$ $\frac{P725}{P726}$ $\frac{P727}{P728}$ $\frac{P729}{P730}$ $\frac{P731}{P732}$ $\frac{P733}{P734}$ $\frac{P735}{P736}$ $\frac{P737}{P738}$ $\frac{P739}{P740}$ $\frac{P741}{P742}$ $\frac{P743}{P744}$ $\frac{P745}{P746}$ $\frac{P747}{P748}$ $\frac{P749}{P750}$ $\frac{P751}{P752}$ $\frac{P753}{P754}$ $\frac{P755}{P756}$ $\frac{P757}{P758}$ $\frac{P759}{P760}$ $\frac{P761}{P762}$ $\frac{P763}{P764}$ $\frac{P765}{P766}$ $\frac{P767}{P768}$ $\frac{P769}{P770}$ $\frac{P771}{P772}$ $\frac{P773}{P774}$ $\frac{P775}{P776}$ $\frac{P777}{P778}$ $\frac{P779}{P780}$ $\frac{P781}{P782}$ $\frac{P783}{P784}$ $\frac{P785}{P786}$ $\frac{P787}{P788}$ $\frac{P789}{P790}$ $\frac{P791}{P792}$ $\frac{P793}{P794}$ $\frac{P795}{P796}$ $\frac{P797}{P798}$ $\frac{P799}{P800}$ $\frac{P801}{P802}$ $\frac{P803}{P804}$ $\frac{P805}{P806}$ $\frac{P807}{P808}$ $\frac{P809}{P810}$ $\frac{P811}{P812}$ $\frac{P813}{P814}$ $\frac{P815}{P816}$ $\frac{P817}{P818}$ $\frac{P819}{P820}$ $\frac{P821}{P822}$ $\frac{P823}{P824}$ $\frac{P825}{P826}$ $\frac{P827}{P828}$ $\frac{P829}{P830}$ $\frac{P831}{P832}$ $\frac{P833}{P834}$ $\frac{P835}{P836}$ $\frac{P837}{P838}$ $\frac{P839}{P840}$ $\frac{P841}{P842}$ $\frac{P843}{P844}$ $\frac{P845}{P846}$ $\frac{P847}{P848}$ $\frac{P849}{P850}$ $\frac{P851}{P852}$ $\frac{P853}{P854}$ $\frac{P855}{P856}$ $\frac{P857}{P858}$ $\frac{P859}{P860}$ $\frac{P861}{P862}$ $\frac{P863}{P864}$ $\frac{P865}{P866}$ $\frac{P867}{P868}$ $\frac{P869}{P870}$ $\frac{P871}{P872}$ $\frac{P873}{P874}$ $\frac{P875}{P876}$ $\frac{P877}{P878}$ $\frac{P879}{P880}$ $\frac{P881}{P882}$ $\frac{P883}{P884}$ $\frac{P885}{P886}$ $\frac{P887}{P888}$ $\frac{P889}{P890}$ $\frac{P891}{P892}$ $\frac{P893}{P894}$ $\frac{P895}{P896}$ $\frac{P897}{P898}$ $\frac{P899}{P900}$ $\frac{P901}{P902}$ $\frac{P903}{P904}$ $\frac{P905}{P906}$ $\frac{P907}{P908}$ $\frac{P909}{P910}$ $\frac{P911}{P912}$ $\frac{P913}{P914}$ $\frac{P915}{P916}$ $\frac{P917}{P918}$ $\frac{P919}{P920}$ $\frac{P921}{P922}$ $\frac{P923}{P924}$ $\frac{P925}{P926}$ $\frac{P927}{P928}$ $\frac{P929}{P930}$ $\frac{P931}{P932}$ $\frac{P933}{P934}$ $\frac{P935}{P936}$ $\frac{P937}{P938}$ $\frac{P939}{P940}$ $\frac{P941}{P942}$ $\frac{P943}{P944}$ $\frac{P945}{P946}$ $\frac{P947}{P948}$ $\frac{P949}{P950}$ $\frac{P951}{P952}$ $\frac{P953}{P954}$ $\frac{P955}{P956}$ $\frac{P957}{P958}$ $\frac{P959}{P960}$ $\frac{P961}{P962}$ $\frac{P963}{P964}$ $\frac{P965}{P966}$ $\frac{P967}{P968}$ $\frac{P969}{P970}$ $\frac{P971}{P972}$ $\frac{P973}{P974}$ $\frac{P975}{P976}$ $\frac{P977}{P978}$ $\frac{P979}{P980}$ $\frac{P981}{P982}$ $\frac{P983}{P984}$ $\frac{P985}{P986}$ $\frac{P987}{P988}$ $\frac{P989}{P990}$ $\frac{P991}{P992}$ $\frac{P993}{P994}$ $\frac{P995}{P996}$ $\frac{P997}{P998}$ $\frac{P999}{P1000}$

| X8003 | | | | |
|-------|-------------------|-----|-------------------|----|
| PIN | COM1 | | COM2 | |
| | DISPLAY / SEGMENT | CH | DISPLAY / SEGMENT | CH |
| 1 | | | | |
| 2 | 2 a | A 2 | f | A |
| 3 | 2 b | A | | |
| 4 | 2 g | A 2 | e | A |
| 5 | 2 c | A 2 | d | A |
| 6 | 2 r | A | 7 | A |
| 7 | V | A | < | A |

11. PERFORMANCE CHECK

11.1 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 Manual.

This procedure is intended to:

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

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

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

Warming-up time under average conditions is 30 minutes.

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

IMPORTANT NOTES:

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

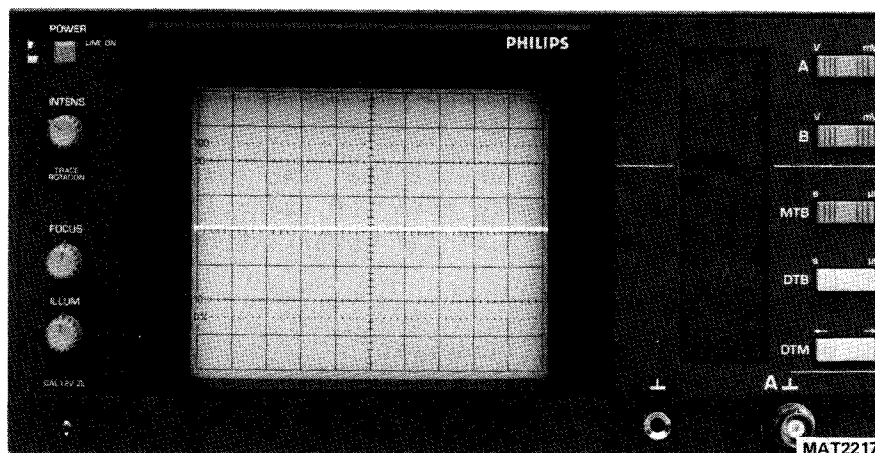


Figure 11.1 SOFTSTART condition

11.2 PRELIMINARY SETTINGS

- Switch-on the instrument (no input signal).
- Check if all LCD segments are on for approx. 1 sec.
- Press MENU and AUTO SET.
- Check if the frontcontrols are set in sequence in the softstart condition as indicated in figure 2.1.
- At the start of every check only AUTO SET must be pressed (after the input signal is applied).

11.3 RECOMMENDED TEST EQUIPMENT

The test equipment that must be used for this performance check is as given in section 13.2 of the Service manual, except:

Trimming tool kit
Oscilloscope
Digital multimeter

11.4 CHECKING PROCEDURE

11.4.1 POWER SUPPLY (characteristics: 2.5)

| | | |
|---|-------------------|--|
| * | 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 - Press AUTO SET |
| | REQUIREMENTS | - Starts at any mains voltage between 100 V...264 V ac (r.m.s.) - Instruments performance does not change over indicated mains voltage range; displayed CAL signal distortion-free and with equal intensity. |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Power Consumption (ac source) |
| | TEST EQUIPMENT | Wattmeter (moving iron meter) |
| | MAINS VOLTAGE | Mains voltage 220 V (r.m.s.). |
| | SETTINGS | Press POWER ON |
| | REQUIREMENTS | Consumes : 45 W |
| | MEASURING RESULTS | ..... |

11.4.2 DISPLAY (characteristics section 2.1)

| | | |
|---|-------------------|---|
| * | SUBJECT | Orthogonality |
| | TEST EQUIPMENT | LF sine-wave generator |
| | INPUT VOLTAGE | Sine-wave signal 50 Hz...60 Hz |
| | SETTINGS | - Set trace exactly in parallel with horizontal graticule line (see section: Trace rotation) - Apply a sine wave signal to input A. (50 Hz...60 Hz) - Set trace height to 8 div. - Press X DEFL. - Press TRIG or X SOURCE and select B as MTB trigger source |
| | REQUIREMENTS | - Check if vertical line is in parallel with the vertical graticule line in the centre of the screen. - Angle with respect to horizontal line must be $90^{\circ} \pm 1^{\circ}$ |
| | MEASURING RESULTS | ..... |

| | | |
|---|-------------------|--|
| * | SUBJECT | LCD check |
| | TEST EQUIPMENT | - |
| | INPUT VOLTAGE | - |
| | SETTINGS | <ul style="list-style-type: none"> - Press MENU and keep it pressed - Then press AUTO SET - Check if LCD indicates "1⁰", "2⁰", "AS" and "3⁰" - Press "S" of DTB UP-DOWN control - Press MENU, 8 times - All segments of the LCD should be ON according to figure 3.2 of the Operating Manual. - To leave this test: press MENU and then AUTO SET |
| | REQUIREMENTS | - Check if all segments of the LCD are on (see figure 3.2 of the Operating manual) |
| | MEASURING RESULTS | ..... |

11.4.3 VERTICAL DEFLECTION OR Y-AXIS (characteristics section 2.2)

| | | |
|---|---------------------------|--|
| * | SUBJECT | Vertical Deflection |
| | TEST EQUIPMENT | LF Square wave generator |
| | INPUT VOLTAGE | Square wave signal 1 kHz to A |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set trace height to 5 div. - Check if one square wave signal of 5 div. is displayed - Press A/B; channel A and B on - Check if a square wave signal (A) and a zero trace (B) is displayed and if A and B are on. - Press ALT/CHOP - Check if ALT or CHOP is active. - Press TRIG VIEW. - Check if two square wave signals (A and TRIG VIEW) and a zero trace (B) are displayed - Press TRIG VIEW; Check if A and B are on. |
| | INPUT VOLTAGE | Square wave signal 1 kHz to input A and B |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Press AUTO SET - Check if A, B and ALT are on - Set trace height to 4 div. - Press AC/DC of channel A and B for DC input coupling - Press ADD/INVERT twice for ADD mode. - Check if 3 square wave signals are displayed: channels A and B each 4 div. trace height and A+B with 8 div. trace height. - Press ADD/INVERT once more for ADD and INVERT mode - Check if 2 square waves of 4 div. (A and B) and a line is displayed (A-B) |
| | MEASURING RESULTS | ..... |

| | | |
|---|-------------------|--|
| * | SUBJECT | LCD check |
| | TEST EQUIPMENT | - |
| | INPUT VOLTAGE | - |
| | SETTINGS | <ul style="list-style-type: none"> - Press MENU and keep it pressed - Then press AUTO SET - Check if LCD indicates "1⁰", "2⁰", "AS" and "3⁰" - Press "S" of DTB UP-DOWN control - Press MENU, 8 times - All segments of the LCD should be ON according to figure 3.2 of the Operating Manual. - To leave this test: press MENU and then AUTO SET |
| | REQUIREMENTS | - Check if all segments of the LCD are on (see figure 3.2 of the Operating manual) |
| | MEASURING RESULTS | ..... |

11.4.3 VERTICAL DEFLECTION OR Y-AXIS (characteristics section 2.2)

| | | |
|---|---------------------------|--|
| * | SUBJECT | Vertical Deflection |
| | TEST EQUIPMENT | LF Square wave generator |
| | INPUT VOLTAGE | Square wave signal 1 kHz to A |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set trace height to 5 div. - Check if one square wave signal of 5 div. is displayed - Press A/B; channel A and B on - Check if a square wave signal (A) and a zero trace (B) is displayed and if A and B are on. - Press ALT/CHOP - Check if ALT or CHOP is active. - Press TRIG VIEW. - Check if two square wave signals (A and TRIG VIEW) and a zero trace (B) are displayed - Press TRIG VIEW; Check if A and B are on. |
| | INPUT VOLTAGE | Square wave signal 1 kHz to input A and B |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Press AUTO SET - Check if A, B and ALT are on - Set trace height to 4 div. - Press AC/DC of channel A and B for DC input coupling - Press ADD/INVERT twice for ADD mode. - Check if 3 square wave signals are displayed: channels A and B each 4 div. trace height and A+B with 8 div. trace height. - Press ADD/INVERT once more for ADD and INVERT mode - Check if 2 square waves of 4 div. (A and B) and a line is displayed (A-B) |
| | MEASURING RESULTS | ..... |

- * SUBJECT Vertical Deflection coefficients and input coupling of Channels A and B (characteristics section 2.2.1)
- 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 fully anti-clockwise
- REQUIREMENTS - Check if displayed amplitude <2 div. (1:>2,5)
- MEASURING RESULTS

- * SUBJECT Input coupling (continued procedure of previous subject)
- SETTINGS AND REQUIREMENTS
- Turn VAR control fully clockwise.
 - Press "GND"; check if input signal is interrupted.
 - Press "GND" again and then AC/DC
 - Check if in DC position the signal shifts upwards
- MEASURING RESULTS

- * SUBJECT Frequency response
- 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 60 MHz.
- Check if the vertical deflection is > 4,2 div. (-3 dB) over the complete bandwidth range (>60 MHz).
- Reduce the amplitude of the input signal to 12 mV and the frequency to 50 kHz.
- Set A (B) to 2 mV/div.
- Adjust the trace height to exactly 6 div.
- Increase the frequency up to 35 MHz.
- Check if the vertical deflection is > 4,2 div. (-3 dB) over the complete bandwidth range (>35 MHz)

MEASURING RESULTS

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*

SUBJECT

Rise-Time

IMPORTANT

THE RISE TIME IS A CALCULATED VALUE, ACCORDING
FORMULA: BANDWIDTH X RISE-TIME = 0,35

TEST EQUIPMENT

Fast-rise square-wave generator (PG506)

INPUT VOLTAGE

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

SETTINGS

- Set A(B) to 50 mV/div
- Press TB MAGN
- Set MAIN 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.);
- * rise-time must be: 5,8 ns or less (approx. 1,2 div. or less).

MEASURING RESULTS

.....

| | | |
|---|-------------------|--|
| * | SUBJECT | Noise |
| | TEST EQUIPMENT | - |
| | INPUT VOLTAGE | - |
| | SETTINGS | <ul style="list-style-type: none"> - Press A/B: channel A and B on - Set channel A and B to 20 mV/div. - Press ALT/CHOP for CHOP mode - Press GND of both channels for grounded input coupling |
| | REQUIREMENT | <ul style="list-style-type: none"> - Check if the traces are not thicker 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 | <ul style="list-style-type: none"> - 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 vertically over the screen. |
| | REQUIREMENT | <ul style="list-style-type: none"> - 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 | <ul style="list-style-type: none"> - 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 | <ul style="list-style-type: none"> - 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 | <ul style="list-style-type: none"> - Set 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. - Set 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 | Decoupling factor 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 | <ul style="list-style-type: none"> - Set channel A and B to 0,5 V/div. - Apply sine-wave input signal to input A(B) - Set the 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 | Decoupling factor 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 | <ul style="list-style-type: none"> - 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) - Adjust one VAR control (A or B) for minimum trace height difference of channel A and B. |
| | REQUIREMENT | - Check if the trace height of the A-B signal is < 0,08 div. |
| | MEASURING RESULTS | ..... |

- * SUBJECT LF linearity (vertical)
- TEST EQUIPMENT LF square-wave generator
- INPUT VOLTAGE Square-wave signal 50 kHz, 200 mV to input A(B)
- SETTINGS
- Set A (B) to 100 mV/div.
 - Set the square-wave signal in the vertical centre of the screen.
 - Adjust the square-wave signal to exactly 2 div. trace height.
 - Shift the signal with the Y POS control to the two upper and lower div. of the screen.
- REQUIREMENT
- Check if the trace height in the two upper and lower div. is 2 div. (max. ampl. deviation must be <3%)
- 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
 - Set A to 100 mV/div.
 - Set MAIN TB to 50 ns/div.
 - Press TB MAGN and turn X POS
 - Set INTENSITY fully clock-wise
 - Set trigger coupling to DC and adjust with LEVEL MTB for maximum visual signal delay.
- REQUIREMENT
- Check if visual signal delay is >15 ns
- MEASURING RESULTS
- * SUBJECT Base line jump
- TEST EQUIPMENT -
- INPUT VOLTAGE -
- SETTINGS
- Attenuator balance
- This check must be done in the SERVICE MENU "1". To enter this menu proceed as follows:
 - Press MENU and keep it pressed and then press AUTO SET
 - Press V of channel A UP-DOWN control
 - Check LCD display: "1.0" flashing
 - The attenuator is now switched between the 1-2-5 positions
 - Check if the base line do not jump more than 1,5 subdiv.
- VAR balance
- Press MENU; "1.1" flashing in LCD
 - Rotate VAR control of channel A and B
 - Check if the base lines do not jump more than 1 subdiv.

X1/X10 attenuator offset

- Press MENU; "1.2" flashing in LCD
- Check if the base lines do not jump more than 1 subdiv.

NORMAL-INVERT jump

- Press MENU four times; "1.6" flashing in LCD
- Check if the displayed point does not jump more than 1 subdiv.
- Press AUTO SET two times to leave the SERVICE MENU

MEASURING RESULTS

11.4.4 TRIGGER VIEW (characteristics section 2.2.2)

| | | |
|---|-------------------|---|
| * | SUBJECT | Deflection coefficient via A, B and EXT. |
| | TEST EQUIPMENT | Square-wave calibration generator (PG506) |
| | INPUT SIGNAL | Square-wave signal 1 kHz, amplitude given in table. |
| | | <u>TRIG VIEW via A(B)</u> |
| | SETTINGS | <ul style="list-style-type: none"> - Apply the square-wave signal to input A(B) - Press TRIG VIEW (TRIG VIEW and A(B) on) - Select A(B) as MTB trigger source - Select DC for MTB trigger coupling |
| | REQUIREMENT | <ul style="list-style-type: none"> - Check the amplitude of the TRIG VIEW signal according the table given in section 11.4.3 of this performance check. IMPORTANT: the error limit of the amplitudes displayed via TRIG VIEW is <5%!! |
| | MEASURING RESULTS | ..... |
| | | <u>TRIG VIEW via EXT</u> |
| | INPUT SIGNAL | Square-wave signal 1 kHz, 500 mV to input EXT. |
| | SETTINGS | <ul style="list-style-type: none"> - Select EXT DC as MTB trigger source. |
| | REQUIREMENT | <ul style="list-style-type: none"> - Check if the square-wave signal displayed via TRIG VIEW has an amplitude of 5 div. (+or- <5%) |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Frequency response INT and EXT (TRIGGER VIEW) |
| | TEST EQUIPMENT | Constant amplitude sine-wave generator INT (via A and B) |
| | INPUT VOLTAGE | Constant amplitude sine-wave signal, 120 mV, freq. 50 kHz...50 MHz to input A(B) |
| | SETTINGS | <ul style="list-style-type: none"> - Set A(B) to 20 mV/div. - Adjust the trace height to exactly 6 div. - Press TRIG VIEW (TRIG VIEW and A on) |

REQUIREMENTS

- Select A(B) as MTB trigger source and p-p as MTB trigger coupling
- Increase the frequency up to 50 MHz
- Check if the vertical deflection via TRIG VIEW is > 4,2 div.

MEASURING RESULTS

EXT

INPUT VOLTAGE Constant amplitude sine-wave signal, 600 mV, freq. 50 kHz...50 MHz to input EXT

SETTINGS

- Select EXT DC as MTB trigger source
- Adjust the trace height to exactly 6 div.
- Increase the frequency up to 50 MHz.

REQUIREMENT

- Check if the vertical deflection via TRIG VIEW is > 4,2 div.

MEASURING RESULTS

*

SUBJECT Lower -3dB point of trigger view

TEST EQUIPMENT LF sine-wave generator

INPUT VOLTAGE Sine-wave signal of 10 Hz, 600 mV to input EXT

SETTINGS

- Select EXT AC as MTB trigger source
- Select TRIG VIEW as vertical display mode (TRIG VIEW)
- Apply a 10 Hz, 600 mV sine-wave signal to input EXT
- Set trigger coupling to DC

REQUIREMENTS

- Check if the vertical deflection via trig. view > 4,2 div.

MEASURING RESULTS

*

SUBJECT Line jump trigger source

TEST EQUIPMENT -

INPUT VOLTAGE -

SETTINGS

- Press TRIG VIEW (TRIG VIEW and A on)
- Press TRIG or X SOURCE four times

REQUIREMENTS

- Check if A, A and B, B, EXT DC and LINE are displayed in sequence via trigger view and if the jump between base line and the start of the LINE signal is < 2 subdiv.

MEASURING RESULTS

| | | |
|---|--------------------------|--|
| * | SUBJECT | OFFSET of trigger point |
| | TEST EQUIPMENT | - |
| | INPUT VOLTAGE | - |
| | SETTINGS AND REQUIREMENT | <ul style="list-style-type: none"> - This check must be done in the SERVICE MENU - "1.0" To enter this menu proceed as follows: - Press MENU and keep it pressed and then press AUTO SET - Press V of channel A UP-DOWN control - Press MENU three times; "1.3" in LCD 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 MENU; "1.4" in LCD 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 MENU; "1.5" in LCD 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 | Delay Difference between input A (B) and ext. TRIG VIEW |
| | TEST EQUIPMENT | Square wave calibration generator. (PG506)- 50 ohm T piece PM9584 and 50 ohm terminator (for EXT) |
| | INPUT VOLTAGE | Fast-rise input signal 1MHz, 0,5V, ≤ 1 ns via 50 ohm T piece to input A/B and EXT input via 50 ohm terminator |
| | SETTINGS | <ul style="list-style-type: none"> - Apply fast-rise input signal to input A and EXT - Press AUTO SET and TRIG VIEW - Press TRIG or X SOURCE for EXT DC triggering - Set of A to 100 mV - Set input coupling A to DC - Press TB MAGN - Set INTENSITY fully clock-wise - Adjust LEVEL MTB so that both signals covers each other - Set MAIN TB to 5ns |
| | REQUIREMENTS | <ul style="list-style-type: none"> - Check if delay difference between the two displayed signal slopes is < 10 ns (< 2 div.) |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Dynamic Range (EXT input via trigger view) |
| | TEST EQUIPMENT | Constant amplitude sine-wave generator |
| | INPUT VOLTAGE | Sine-wave signal of 1 MHz, 2,4 Vpp to input EXT |
| | SETTINGS | <ul style="list-style-type: none"> - Press TRIG VIEW (TRIG VIEW and A on) - Select EXT AC as MTB trigger source - Apply sine-wave signal 1 MHz, 2,4 V to input EXT |

- Shift with the MTB LEVEL control the sine-wave signal displayed via TRIG VIEW vertically over the screen.
- REQUIREMENT
- Check if the top and bottom of the sine-wave signal can be displayed distortion free (24 div. trace height)

MEASURING RESULTS

INPUT VOLTAGE Sine-wave signal of 50 MHz, 600 mVpp to input EXT

- SETTINGS
- Press TRIG VIEW on
 - Select EXT AC as MTB trigger source
 - Apply a sine-wave signal of 50 MHz, 600 mV to input EXT.

- REQUIREMENT
- Check if a sine-wave signal of 6 div. is displayed distortion-free

MEASURING RESULTS

11.4.5

HORIZONTAL DEFLECTION OR X-AXIS
(characteristics section 2.3)

*

SUBJECT Horizontal Display modes and trace separation

TEST EQUIPMENT LF sine-wave generator

INPUT VOLTAGE Sine wave signal 2 kHz, 3 div. trace height to input A

- SETTINGS AND REQUIREMENTS
- Press AUTO SET
 - Set the trace height to 3 div. (MTB trace)
 - Set the MAIN TB to 0,5 ms/div.
 - Press TB SELECT
 - Set the DEL TB to 50 us/div.
 - Check if intensified part (DTB) is visible and if it can be shifted horizontally by the DTM control
 - Press TB SELECT
 - Check if DTB and MTB INTENS are on
 - Set the MTBI trace on the upper 3 div.
 - Turn TRACE SEP fully counter clockwise
 - Check if the bottom/half of the DTB signal can be > 4 div. shifted from the 100% graticule line
 - Set the MTBI trace on the lower 3 div.
 - Turn TRACE SEP fully clockwise
 - Check if the top half of the DTB signal can be > 4 div shifted from the 0% graticule line
 - Press TB SELECT
 - Check if only the DTB trace is displayed
 - Press TB SELECT
 - Check if only the MTB trace is displayed
 - Press X DEFL
 - Check if only X DEFL is on
 - Select A of MTB trigger source
 - Check if a line under an angle of 45° is displayed.

MEASURING RESULTS

* SUBJECT Deflection coefficient (MTB)
 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 the table below:

| Time marker pulse | MAIN TB setting ../div | Max. coeff. error | | Measuring results |
|-------------------|---------------------------|-------------------|-----------------------|-------------------|
| | | MTB X1 | MTB X10 TB 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 Horizontal position range
 TEST EQUIPMENT Time marker generator (TG501)
 INPUT VOLTAGE Time marker signal of 1 ms to input A
 SETTINGS AND REQUIREMENTS - Set MAIN TB to 0,1 ms/div.
 - Set a marker pulse on the first and last vertical graticule line
 - Set X POS fully clockwise.
 - Check if the first marker pulse is at the right side of the vertical centre line
 - Set X POS fully anti-clockwise
 - Check if the last marker pulse is at the left side of the vertical centre line.
 MEASURING RESULTS

* SUBJECT Variable control ratio (VAR MTB) and TB Magnifier balance
 TEST EQUIPMENT Time marker generator (TG501)
 INPUT VOLTAGE Time marker signal 1 us to input A

- SETTINGS - Set MAIN TB to 0,2 us/div; marker on first and sixth graticule line
- Set the MTB 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 MTB VAR control fully clockwise
- Press TB MAGN (on)
- Set the top of the second marker pulse exactly in the vertical centre of the graticule
- Press TB MAGN (off)
- REQUIREMENT - Check if the top of the second marker pulse is not shifted more than 2,5 subdiv.
- MEASURING RESULTS

*

- SUBJECT Deflection Coefficients (DTB)
- TEST EQUIPMENT Time marker generator (TG501)
- INPUT VOLTAGE Time marker signal 1 ms...50 ns to input A
- SETTINGS - Press AUTO SET
- Press TB SELECT; MTBI and DTB on
- Set MAIN TB to 2 ms/div.
- Set DEL'D TB to 1 ms/div.
- Press DTB TRIG for STARTS mode
- Set the delay time to 5.000 ms by means of the DTM control.
- REQUIREMENTS - Check the deflection coefficients in TB x 1 and TB x 10 according the table below:

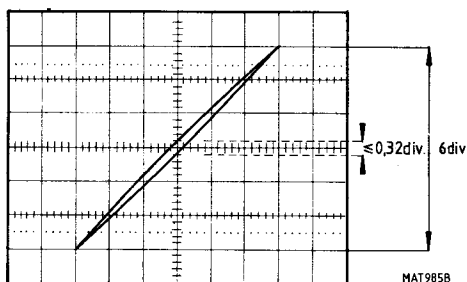
ATTENTION: To check the DTB time coefficients according the table below the uS of UP-DOWN MTB control must be operated (DTB setting is electrically coupled with MTB setting)

| MAIN TB setting | Time marker pulse | DEL'D TB setting ../div. | Max. coeff. error | | Measuring results |
|-----------------|-------------------|-----------------------------|-------------------|---------|-------------------|
| | | | MTB X1 | MTB X10 | |
| 2 ms | 1 ms | 1 ms | 3% | 4% | ..... |
| 1 ms | 0,5 ms | 0,5 ms | 3% | 4% | ..... |
| 0,5 ms | 0,2 ms | 0,2 ms | 3% | 4% | ..... |
| 0,2 ms | 0,1 ms | 0,1 ms | 3% | 4% | ..... |
| 0,1 ms | 50 us | 50 us | 3% | 4% | ..... |
| 50 us | 20 us | 20 us | 3% | 4% | ..... |
| 20 us | 10 us | 10 us | 3% | 4% | ..... |
| 10 us | 5 us | 5 us | 3% | 4% | ..... |
| 5 us | 2 us | 2 us | 3% | 4% | ..... |
| 2 us | 1 us | 1 us | 3% | 4% | ..... |
| 1 us | 0,5 us | 0,5 us | 3% | 4% | ..... |
| 0,5 us | 0,2 us | 0,2 us | 3% | 4% | ..... |
| 0,2 us | 0,1 us | 0,1 us | 3% | 4% | ..... |
| 0,1 us | 50 ns | 50 ns | 3% | 4% | ..... |

| | | |
|---|---------------------------|--|
| * | SUBJECT | Delay Time Multiplier |
| | TEST EQUIPMENT | Time marker generator (TG501) |
| | INPUT VOLTAGE | Time marker signal 10 us to input A |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Press TB SELECT; MTB INTENS and DTB on - Set MAIN TB to 5 us/div - Set DEL'D TB to 0,5 us/div. - Press DTM <-- (delay time: 0) - Check if the first marker pulse displayed via the DTB is partly visible; - Set the first marker displayed via the MTB exactly on the first graticule line - Press DTM --> so that the last marker pulse displayed via the DTB is completely visible on the first vertical graticule line. - Check if the Delay Time displayed in the LCD is >48 us. |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Maximum Jitter (DTB) |
| | TEST EQUIPMENT | Sine-wave generator |
| | INPUT SIGNAL | Sine-wave signal (1 MHz), 6 div. trace height to input A. |
| | SETTINGS | <ul style="list-style-type: none"> - Set the trace height to 6 div. - Set MAIN TB to 1 ms - Press TB SELECT; MTBI and DTB on - Set DEL'D TB to 0,5 us - Set the DELAY time to 5 ms - Press TB SELECT; only DTB on |
| | REQUIREMENT | - Check if the jitter of the DTB trace is ≤ 1 div (1 part per 20.000) |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | Horizontal Deflection coefficients |
| | TEST EQUIPMENT | Sine wave generator |
| | INPUT VOLTAGE | Sine wave signal 2 kHz, 4 div. trace height to input A |
| | SETTINGS | <ul style="list-style-type: none"> - Press EXT X DEFL - Press A/B twice for only ch. B display - Select A as X DEFL source with TRIG or X SOURCE |
| | REQUIREMENT | - Check if a horizontal line of 4 div. is displayed (+or- 5%). |
| | INPUT VOLTAGE | - Sine wave signal 2 kHz, 1 V to input EXT |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Select EXT with TRIG or X SOURCE - Press X DEFL - Check if a horizontal line of 10 div. (+or- 5%) is displayed. - Select LINE with TRIG or X SOURCE - Check if a horizontal line is displayed of approx 6 div. (at 220 V mains voltage) |
| | 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 | <ul style="list-style-type: none"> - Set A to 5 mV/div - Apply a 50 kHz sine-wave signal to input A - Set input coupling A to DC - Press X DEFL - Select A as horizontal deflection source with TRIG or X SOURCE - Press A/B twice for ch. B as vertical deflection - Adjust the input voltage for exactly 6 div. horizontal deflection - Increase the frequency of the input signal up to 2 MHz |
| REQUIREMENTS | <ul style="list-style-type: none"> - Check if the trace width is $> 4,2$ div. (-3 dB) over the complete bandwidth range. |
| MEASURING RESULTS | ..... |
| TEST EQUIPMENT | LF Sine-wave generator |
| INPUT VOLTAGE | Sine-wave signal, 10 Hz, 6 div. trace height to input A |
| SETTINGS | <ul style="list-style-type: none"> - Set the vertical deflection of A to exactly 6 div - Select X DEFL and A as X DEFL source - Set input coupling A to AC - Press A/B twice for ch. B as vertical deflection |
| REQUIREMENT | <ul style="list-style-type: none"> - Trace width is $> 4,2$ div (-3 dB) |
| 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. |
| SETTINGS | <ul style="list-style-type: none"> - 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 | <ul style="list-style-type: none"> - Check if the phase shift $< 3^{\circ}$ (see fig. below) |



MEASURING RESULTS

| 11.4.6 | MTB TRIGGERING (characteristics, section 2.4.1) | | | | | | | | | | |
|---------------------------|--|---------|--|----------------|------------------------|---------------|--|---------------------------|--|-------------------|-------|
| * | <table> <tr> <td>SUBJECT</td><td>MTB Trigger Sources and trigger coupling</td></tr> <tr> <td>TEST EQUIPMENT</td><td>Square-wave generator</td></tr> <tr> <td>INPUT VOLTAGE</td><td>Square-wave signal 2 kHz, 4 div. trace height to input A (EXT)</td></tr> <tr> <td>SETTINGS AND REQUIREMENTS</td><td> <ul style="list-style-type: none"> - Set the trace height to 4 div. - Press TRIG VIEW (A and TRIG VIEW on) - Press TRIG COUPL and select DC - Adjust LEVEL MTB for a triggered signal - Check if two square wave signals are displayed of 4 div. (Trigger view and A) - Press TRIG COUPL and select p-p - Turn LEVEL MTB and check if the signal is triggered over the complete level range. - Connect CAL signal to input B - Press A/B so that A, B and TRIG VIEW are on - Set B to 200 mV. - Select B as MTB trigger source with TRIG or X SOURCE (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 four times (A and B selected.) - Check if three well triggered traces are displayed; TRIG VIEW signal derived from A. - Remove input signals - Apply a square wave signal of 500 mV to input EXT - Select EXT as MTB trigger source with TRIG or X SOURCE - Check if a square wave signal is displayed via TRIG VIEW of 5 div. - Select LINE as MTB trigger source with TRIG or X SOURCE - Set MAIN TB to 5 ms/div - Check if a sine-wave signal (mains frequency) is displayed. </td></tr> <tr> <td>MEASURING RESULTS</td><td>.....</td></tr> </table> | SUBJECT | MTB Trigger Sources and trigger coupling | TEST EQUIPMENT | Square-wave generator | INPUT VOLTAGE | Square-wave signal 2 kHz, 4 div. trace height to input A (EXT) | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set the trace height to 4 div. - Press TRIG VIEW (A and TRIG VIEW on) - Press TRIG COUPL and select DC - Adjust LEVEL MTB for a triggered signal - Check if two square wave signals are displayed of 4 div. (Trigger view and A) - Press TRIG COUPL and select p-p - Turn LEVEL MTB and check if the signal is triggered over the complete level range. - Connect CAL signal to input B - Press A/B so that A, B and TRIG VIEW are on - Set B to 200 mV. - Select B as MTB trigger source with TRIG or X SOURCE (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 four times (A and B selected.) - Check if three well triggered traces are displayed; TRIG VIEW signal derived from A. - Remove input signals - Apply a square wave signal of 500 mV to input EXT - Select EXT as MTB trigger source with TRIG or X SOURCE - Check if a square wave signal is displayed via TRIG VIEW of 5 div. - Select LINE as MTB trigger source with TRIG or X SOURCE - Set MAIN TB to 5 ms/div - Check if a sine-wave signal (mains frequency) is displayed. | MEASURING RESULTS | |
| SUBJECT | MTB Trigger Sources and trigger coupling | | | | | | | | | | |
| TEST EQUIPMENT | Square-wave generator | | | | | | | | | | |
| INPUT VOLTAGE | Square-wave signal 2 kHz, 4 div. trace height to input A (EXT) | | | | | | | | | | |
| SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set the trace height to 4 div. - Press TRIG VIEW (A and TRIG VIEW on) - Press TRIG COUPL and select DC - Adjust LEVEL MTB for a triggered signal - Check if two square wave signals are displayed of 4 div. (Trigger view and A) - Press TRIG COUPL and select p-p - Turn LEVEL MTB and check if the signal is triggered over the complete level range. - Connect CAL signal to input B - Press A/B so that A, B and TRIG VIEW are on - Set B to 200 mV. - Select B as MTB trigger source with TRIG or X SOURCE (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 four times (A and B selected.) - Check if three well triggered traces are displayed; TRIG VIEW signal derived from A. - Remove input signals - Apply a square wave signal of 500 mV to input EXT - Select EXT as MTB trigger source with TRIG or X SOURCE - Check if a square wave signal is displayed via TRIG VIEW of 5 div. - Select LINE as MTB trigger source with TRIG or X SOURCE - Set MAIN TB to 5 ms/div - Check if a sine-wave signal (mains frequency) is displayed. | | | | | | | | | | |
| MEASURING RESULTS | | | | | | | | | | | |
| * | <table> <tr> <td>SUBJECT</td><td>MTB Slope selection and Level control range.</td></tr> <tr> <td>TEST EQUIPMENT</td><td>LF Sine-wave generator</td></tr> <tr> <td>INPUT VOLTAGE</td><td>Sine-wave signal 2 kHz - 800 mV to input A(B) (EXT)</td></tr> <tr> <td>SETTINGS AND REQUIREMENTS</td><td> <ul style="list-style-type: none"> - Set A(B) to 0,1 V/div (DC input coupling) - Press TRIG COUPL for p-p triggering - Turn LEVEL MTB fully clockwise and fully anti-clockwise - Check if the signal is well triggered over the complete LEVEL range - Set the LEVEL MTB control in its mid-position - Start of signal display must be in the vertical centre - Press TB TRIG (TRIG mode) </td></tr> </table> | SUBJECT | MTB Slope selection and Level control range. | TEST EQUIPMENT | LF Sine-wave generator | INPUT VOLTAGE | Sine-wave signal 2 kHz - 800 mV to input A(B) (EXT) | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set A(B) to 0,1 V/div (DC input coupling) - Press TRIG COUPL for p-p triggering - Turn LEVEL MTB fully clockwise and fully anti-clockwise - Check if the signal is well triggered over the complete LEVEL range - Set the LEVEL MTB control in its mid-position - Start of signal display must be in the vertical centre - Press TB TRIG (TRIG mode) | | |
| SUBJECT | MTB Slope selection and Level control range. | | | | | | | | | | |
| TEST EQUIPMENT | LF Sine-wave generator | | | | | | | | | | |
| INPUT VOLTAGE | Sine-wave signal 2 kHz - 800 mV to input A(B) (EXT) | | | | | | | | | | |
| SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set A(B) to 0,1 V/div (DC input coupling) - Press TRIG COUPL for p-p triggering - Turn LEVEL MTB fully clockwise and fully anti-clockwise - Check if the signal is well triggered over the complete LEVEL range - Set the LEVEL MTB control in its mid-position - Start of signal display must be in the vertical centre - Press TB TRIG (TRIG mode) | | | | | | | | | | |

- Press SLOPE MTB
- Check if the sine-wave signal is inverted and is triggered on the negative slope.
- Press SLOPE MTB once again
- Press TRIG COUPL for DC coupling
- Set A(B) to 50 mV/div (16 div. trace height)
- Turn the LEVEL MTB
- Check if the LEVEL range is $> +\text{or}- 8$ div. and if the signal is triggered on the positive slope.
- Remove input signal
- Apply the sine-wave signal of 2 kHz, 1,6 Vpp to EXT
- Select EXT (MTB trigger source)
- Press TRIG VIEW. (TRIG VIEW and A(B) on)
- Turn the LEVEL MTB
- Check if the LEVEL range is $> +\text{or}- 0,8$ V ($+ \text{or}- 8$ div.)

MEASURING RESULTS

*

| | |
|---------------------------|--|
| SUBJECT | Trigger Sensitivity (MTB) |
| TEST EQUIPMENT | Sine-wave generator (SG503) |
| INPUT VOLTAGE | Sine-wave signal 10 MHz-(50 MHz)-(100 MHz) to input A (B) (EXT) |
| 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. - Decrease amplitude of input signal - Turn LEVEL MTB - 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. - Increase amplitude of input signal to approx 1 div. - Turn LEVEL MTB - Check if the signal is well-triggered at amplitudes ≥ 1 div. - Increase the frequency of the input signal up to 100 MHz - Increase amplitude to approx 3 div. - Check if the signal is well-triggered at amplitudes ≥ 3 div. - Remove input signal - Apply a sine wave signal of 100 MHz, 500 mVpp to input EXT (via external 50 Ohm terminator) - Select EXT (MTB trigger source) with TRIG or X SOURCE - Press TRIG VIEW, (TRIG VIEW and A(B) on). - Turn LEVEL MTB |

- Check if a well triggered sine-wave of 5 div. (500 mV) is displayed (adjust LEVEL MTB).
- Decrease the frequency of the input signal to 50 MHz and the amplitude to 150 mV
- Check if the signal is well triggered (adjust LEVEL MTB)
- Decrease the frequency of the input signal to 10 MHz or lower
- Decrease the amplitude to 50 mV
- Check if the signal is well-triggered (adjust LEVEL MTB).

MEASURING RESULTS

* SUBJECT Trigger sensitivity TVL-TVF

TEST EQUIPMENT TV pattern generator with video output (PM5518)

INPUT VOLTAGE Video signal to input A (B)

SETTINGS

- 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

11.4.7 DTB TRIGGERING (characteristics, section 2.4.2)

* SUBJECT DTB Trigger sources and trigger coupling

TEST EQUIPMENT Square-wave generator

INPUT VOLTAGE Square-wave signal 1 kHz, 4 div. trace height to input A(B) (EXT)

SETTINGS AND REQUIREMENTS

- Set A(B) to 0,2V/div.
- Press TB SELECT to select MTBI
- Press DTB TRIG to select STARTS mode
- Set MTB to 0,5 ms/div
- Set DTB to 50 us/div
- Set the delay to 2 ms with the DTM control
- Turn LEVEL DTB
- Check if the intensified part stays triggered and starts on the fifth vertical line
- Press DTB to select A(B)
- Check if the delay time is given in div. (4 div)
- Turn LEVEL DTB
- Check that in the extreme positions of the LEVEL control the DTB is not triggered.
- Press TRIG DTB; check if A and B in composite are selected (DTB stays triggered)
- Press TRIG DTB; check if B is selected as trigger source (DTB not triggered)
- Press TRIG DTB; check if DTB is triggered via EXT (input signal also to input EXT)
- Press TRIG DTB 3 times; check if A is selected

MEASURING RESULTS

| | | |
|---|---------------------------|--|
| * | SUBJECT | DTB Trigger Sensitivity |
| | TEST EQUIPMENT | Sine-wave generator (SG503) |
| | INPUT VOLTAGE | Sine-wave signal 10 MHz (50 MHz) (100 MHz) to input A(B) (EXT) |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Press TB SELECT; select MTBI - Press DTB TRIG; select A(B) as trigger source - Set MAIN B to 0,5 us/div - Set DEL'D TB to 50 ns/div - Turn LEVEL DTB to get a well triggered intensified part - Check the DTB trigger sensitivity according the procedure given in section 6.3 <ul style="list-style-type: none"> * The EXT trigger sensitivity must be checked via channel A (input signal to EXT and A) * Read DTB instead of MTB |
| | MEASURING RESULTS | ..... |
| * | SUBJECT | DTB Slope selection and Level control range |
| | TEST EQUIPMENT | LF Sine-wave generator |
| | INPUT VOLTAGE | Sine-wave signal 2 kHz - 800 mVpp to input A(B) (EXT) |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set A(B) to 0,1 mV/div (8 div) - Select MTBI with TB SELECT - Set MAIN TB to 0,2 ms /div and DEL'D TB to 5 us/div. - Press DTB TRIG: source A(B) - Turn LEVEL DTB for a well triggered intensified part. - Press SLOPE DTB - Check if the intensified part is on the negative slope. - Press SLOPE DTB (positive triggering) - Set DEL'D TB to 0,1 ms/div. - Set A(B) to 50 mV/div. - Turn LEVEL DTB - Check if the LEVEL DTB range is > +or- 8 div. |
| | MEASURING RESULTS | ..... |

11.4.8

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...2,5 Vpp to input A and Z-in (rear side) |
| | SETTINGS AND REQUIREMENTS | <ul style="list-style-type: none"> - Set MAIN TB to 0,5 ms/div. - Set the trace of A in mid-position - Select DC for channel A Input coupling - Apply square-wave signal of 2,5 Vpp, 1 kHz to input A and Z-in. (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 |
| | 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 1,2Vpp, frequency 2 kHz |
| | MEASURING RESULTS | ..... |

12. DISMANTLING THE INSTRUMENT

12.1 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.

12.2 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.

12.3 ACCESS TO PARTS FOR THE CHECKING AND ADJUSTING PROCEDURES

After removing both covers (section 12.2) almost all adjustment and measuring points are accessible. However, for access to the adjusting elements of the time-base unit and the pre-amplifier unit first loosen the upper time-base unit and vertically fix this unit in the available p.c.b. guide fixing.

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.

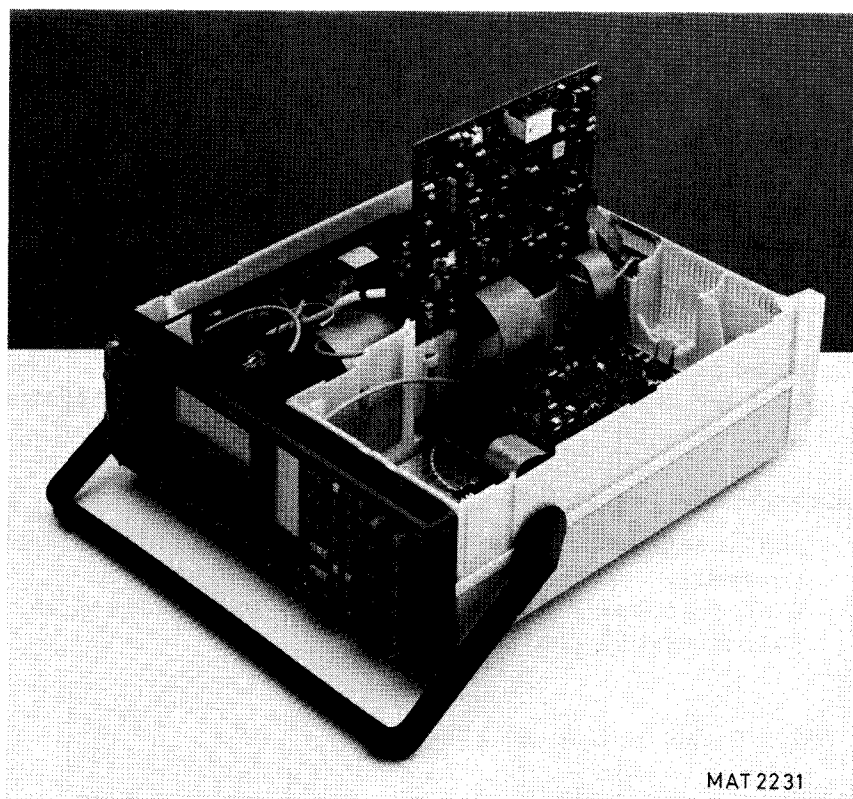


Figure 12.1 Access to all parts for checking and adjusting

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

13. CHECKING AND ADJUSTING

13.1 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.

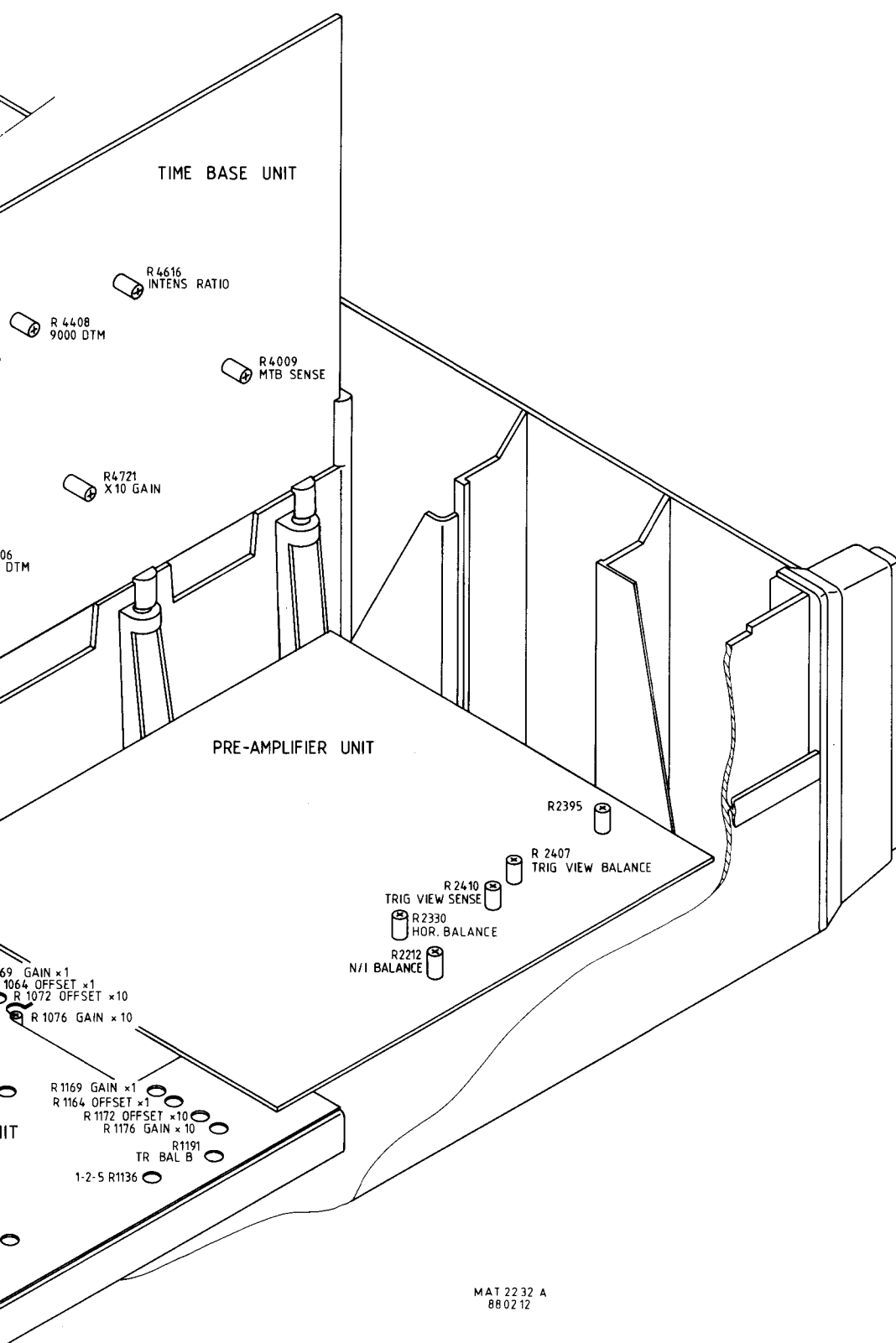
- Warming-up time under average conditions is 30 minutes.
- Where possible, instrument performance should be checked before any adjustment is made.
- All limits and tolerances given in this section are calibration guides, and should not be interpreted as instrument specifications unless they are also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



13.2 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 /us | Tektronix TG 501 |
| Digital multimeter | Wide voltage, current and resistance ranges. Required accuracy 0,1 % | Philips PM2524 and high-voltage probe 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, terminations for the generators | General Radio types for fast rise-time square-wave and high freq. sine-wave. BNC-types for other applications | |
| Trimming tool | | Philips 800NTX kit (ord. number 4822 310 50015) |

13.2 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 /us | Tektronix TG 501 |
| Digital multimeter | Wide voltage, current and resistance ranges. Required accuracy 0,1 % | Philips PM2524 and high-voltage probe 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, terminations for the generators | General Radio types for fast rise-time square-wave and high freq. sine-wave. BNC-types for other applications | |
| Trimming tool | | Philips 800NTX kit (ord. number 4822 310 50015) |

13.3 SURVEY OF ADJUSTING ELEMENTS

| ADJUSTING ELEMENT | ADJUSTMENT | INPUT SIGNAL | SECTION |
|----------------------|--|-------------------------------|---------|
| R6406 | supply voltage +10 VREF | - | 13.4.2 |
| R3252 | black level | - | 13.4.3 |
| R3267 | astigmatism | Sine-wave 120 mV-1 kHz | 13.4.3 |
| R4616 | intens ratio | - | 13.4.3 |
| C1033 | l.f.square wave response ch.A at 20 mV | square-wave 120 mV - 1 kHz | 13.4.4 |
| C1029 | l.f.square wave response ch.A at 0,2 V | square-wave 1,2 V - 1 kHz | 13.4.4 |
| C1023 | l.f. square wave response ch.A at 2 V | square-wave 12 V - 1 kHz | 13.4.4 |
| C1133 | l.f. square wave response ch.B at 20 mV | square-wave 120 mV - 1 kHz | 13.4.4 |
| C1129 | l.f. square wave response ch.B at 0,2 V | square-wave 1,2 V - 1 kHz | 13.4.4 |
| C1123 | l.f. square wave response ch.B at 2 V | square-wave 12 V - 1 kHz | 13.4.4 |
| C1206 | l.f. square wave response EXT | square-wave 600 mV - 1 kHz | 13.4.4 |
| R2410 | trig.view sensitivity | square wave 100 mV - 1 kHz | 13.4.5 |
| R3038 | vertical sensitivity | square-wave 600 mV - 1 kHz | 13.4.5 |
| R1069 | gain x1 ch.A | square-wave 100 mV - 1 kHz | 13.4.5 |
| R1169 | gain x1 ch.B | square-wave 100 mV - 1 kHz | 13.4.5 |
| R1076 | gain x10 ch.A | square-wave 10 mV - 1 kHz | 13.4.5 |
| R1176 | gain x10 ch.B | square-wave 10 mV - 1 kHz | 13.4.5 |
| R3118 | horizontal sensitivity | square-wave 100 mV - 1 kHz | 13.4.6 |

| ADJUSTING ELEMENT | ADJUSTMENT | INPUT SIGNAL | SECTION |
|----------------------|------------------------------|---|---------|
| R1036-R1136 | offset ch.A (ch.B) | - | 13.4.7 |
| R1064-R1164 | offset x1 ch.A (ch.B) | - | 13.4.7 |
| R1072-R1172 | offset x10 ch.A (ch.B) | - | 13.4.7 |
| R2330 | horizontal balance | - | 13.4.7 |
| R1091 | trigger balance ch.A | - | 13.4.7 |
| R1191 | trigger balance ch.B | - | 13.4.7 |
| R1217 | trigger balance EXT | - | 13.4.7 |
| R2212 | norm/invert balance | - | 13.4.7 |
| R2407 | trig view balance | - | 13.4.7 |
| R3007 | vertical balance | - | 13.4.7 |
| R4009 | sensitivity MTB | Sine-wave 80 mV - 10 kHz | 13.4.8 |
| R4108 | MTB gain 1 ms | time marker 1 ms | 13.4.9 |
| R4107 | MTB gain 1 us | time marker 1 us | 13.4.9 |
| R4207 | DTB gain 1 ms | time marker 1 ms | 13.4.10 |
| R4208 | DTB gain 1 us | time marker 1 us | 13.4.10 |
| R4721 | gain x10 MAGN | time marker 100 us | 13.4.11 |
| R4406-R4408 | offset-gain DTM | - | 13.4.12 |
| R3017 | h.f. square-wave response | square-wave 120 mV - 1 MHz rise-time <u><1</u> ns | 13.4.13 |
| R3013 | | | 13.4.13 |
| C3007 | | | 13.4.13 |
| C3004 | | | 13.4.13 |
| C3005 | | | 13.4.13 |
| C3036 | | | 13.4.13 |
| C3016 | | | 13.4.13 |

13.4 CHECKING AND ADJUSTING PROCEDURE

The adjusting elements and measuring points are given in figure 13.1.

NOTE: Use always an insulated adjustment tool.

13.4.1 Preparation

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

- Unless otherwise indicated, the MAIN TB must be triggered on the channel that is selected for vertical display and the trigger path is P-P coupled. The MAIN TB must function in the AUTO mode and its sweep speed must be adjusted to give good display of the phenomena of interest. The DEL'D TB is not used. 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.
- Take care to remove the input voltage after each section.

For better access to the adjusting elements on the time base unit and the power supply unit, proceed as indicated in section 12.3.

ATTENTION: Do not readjust potentiometer R2395, situated on the Pre-amplifier unit. However, if this potentiometer is inadvertently turned, proceed as follows:

- Set R2395 in its mid-position.
- Readjust R4009 according to section 13.4.8.

13.4.2 Power supply adjustment

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

13.4.3 CRT display adjustment

Black level:

- Press X DEFL key
- Set the INTENS control to 10° from its left hand stop.
- Adjust R3252 so that the spot is just not visible.

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:

- Apply a 120 mV/1 kHz sine-wave signal to input A.
- Press AUTO SET key.
- Set the INTENS control for normal brightness.
- Adjust R3267 (and the FOCUS control) so that the trace is sharp and well-defined over the whole screen area.

Intens ratio:

- Press TB SELECT key for MTBI.
- Set UP-DOWN MTB to 5 microsec.
- Set UP-DOWN DTB to 1 microsec.
- Set the INTENS control so that the DTB part of the trace is clearly visible.
- Adjust R4616 for a normal visible MTB trace. The DTB part of the trace must be well distinguished from the MTB trace.

13.4.4 Square-wave response attenuator

Channels A and B:

The vertical adjustments of channels A and B are identical. The indication for channel B are shown in brackets behind those of channel A. It is advisable to perform first the channel A adjustments in this section.

- Apply a calibrated square-wave signal, frequency 1 kHz to input A (B).
- Press AUTO SET key.
- Press AC/DC key ch.A (ch.B) for DC input coupling.
- Set the adjusting elements for a straight pulse top with a maximum pulse top error of + or - 1,5 % (see table below).

| INPUT SIGNAL YA (YB) | UP-DOWN ch.A (ch.B) | Adjusting element |
|-------------------------|------------------------|-------------------|
| 120 mV | 20 mV | C1033 (C1133) |
| 1,2 V | 0,2 V | C1029 (C1129) |
| 12 V | 2 V | C1023 (C1123) |

External amplifier:

- Apply a 600 mV/1 kHz calibrated square-wave signal to input EXT.
- Press AUTO SET key.
- Press TRIG VIEW key for TRIG.VIEW.
- Press A/B key for only TRIG VIEW display.
- Press TRIG or X SOURCE key for EXT source.
- Press EXT AC/DC key for DC input coupling.
- Adjust C1206 for a straight pulse top with a maximum pulse top error of + or - 1,5 %.

13.4.5 Adjustment of vertical sensitivities

Trigger view sensitivity:

- Apply a 100 mV/1 kHz calibrated square-wave signal to input A.
- Press AUTO SET key.
- Set UP/DOWN ch.A to 20 mV.
- Press AC/DC key ch.A for DC input coupling
- Press TRIG coupl. key for DC trigger coupling
- Press TRIG VIEW key.
- Adjust R2410 so that both signals are identical.

Sensitivity final Y-amplifier

- Apply a 600 mV/1 kHz calibrated square-wave signal to input EXT.
- Press TRIG VIEW key.
- Press A/B key for only TRIG VIEW display.
- Press TRIG or X SOURCE key for EXT source.
- Press EXT AC/DC key for DC input coupling.

- Press TRIG coupl. key for DC trigger coupling
- Adjust R3038 for a vertical display of exactly 6 divisions.

NOTE: The vertical position can be adjusted by the MTB LEVEL control.

Gain adjustment channel A (B).

The vertical adjustments of channels A and B are identical.

The indications for channel B are shown in brackets after those of channel A. It is advisable to perform first the channel A adjustments in this section.

- Apply a 100 mV/1 kHz calibrated square-wave signal to input A (B).
- Press AUTO SET key.
- Set UP-DOWN ch.A (ch.B) to 20 mV.
- Press AC/DC key ch.A (ch.B) for DC input coupling.
- Adjust R1065 (R1165) for a vertical display of exactly 5 divisions.
- Apply a 10 mV/1 kHz calibrated square-wave signal to input A (B).
- Press AUTO SET key.
- Set UP-DOWN ch.A (ch.B) to 2 mV.
- Press AC/DC key ch.A (ch.B) for DC input coupling.
- Adjust R1076 (R1176) for a vertical display of exactly 5 divisions.

13.4.6 Adjustment of horizontal sensitivity

- Apply a 100 mV/1 kHz calibrated square-wave signal to input B.
- Press AUTO SET key.
- Press AC/DC key ch. B for DC input coupling.
- Press X DEFL key.
- Press A/B key for channel A selection.
- Set UP-DOWN ch.B to 20 mV.
- Adjust R3118 for a trace width of exactly 5 divisions.

13.4.7 Offset adjustments

The adjustment in this Section are performed in SERVICE MENU "1". To enter this service menu, proceed as follows:

- Press MENU key.
- Keep MENU key pressed and press also AUTO SET key.
- Check LCD displays: "1", "2" and "3".
- Press V-ch.A (c.i. the left side of the channel A UP-DOWN control).
- Check LCD displays: "1.0".
- Each adjustment procedure can now be sequentially selected by pressing the MENU key. The LCD will indicate which order is selected (1.0...1.8).
- Adjust the potentiometers for minimum trace jump.

| MEASURING | ADJUSTMENT | POTENTIOMETER | REMARKS |
|-----------|-------------------|---------------|---|
| 1.0 | 1-2-5 adjustment | R1036 (R1136) | rotate VAR A (B) |
| 1.1 | x1 continue | R1064 (R1164) | |
| 1.2 | x1/x10 offset | R1072 (R1172) | |
| 1.3 | trig. balance A | R1091 | |
| 1.4 | trig. balance B | R1191 | line in centre of screen. see also section 13.4.13 |
| 1.5 | trig. balance EXT | R1217 | |
| 1.6 | NORM/INV. | R2212 | |
| 1.7 | trig.view balance | R2407 | |
| | Y balance | R3007 | |
| 1.8 | DTM 1000-9000 | R4406-R4408 | |

- Press AUTO SET key twice to leave the service menu again.

Horizontal balance:

- Press MENU key.
- Press AUTO SET key.
- Set starting point of the trace to the first vertical graticule line.
- Press X DEFL key.
- Adjust R2330 so that the point is in the centre of the screen.

13.4.8 Adjustment of trigger sensitivity

- Apply a 80 mV/10 kHz sine-wave signal to input A
- Press AUTO SET key.
- Set UP-DOWN ch.A to 0,2 V.
- Set UP-DOWN MTB to 0,1 msec.
- Ensure that the trace height is exactly 0,4 division.
- Adjust R4009 for a well triggered display.

13.4.9 Adjustment of the MTB sweep times

Adjustment of 1 msec:

- Apply a 1 msec time marker signal to input A.
- Press AUTO SET key
- Set UP-DOWN MTB to 1 msec.
- Adjust R4108 and the X POS control so that the 2nd and 10th marker pulses coincide exactly with the 2nd and 10th vertical graticule lines.

Adjustment of 1 microsec:

- Change the time marker signal to 1 microsec.
- Set UP-DOWN MTB to 1 microsec.
- Adjust R4107 and manipulate the X POS control so that the 2nd and 10th marker pulses coincide exactly with the 2nd and 10th vertical graticule lines.

13.4.10 Adjustment of the DTB sweep times

Adjustment of 1 msec:

- Apply a 1 msec time marker signal to input A.
- Press AUTO SET key.
- Set UP-DOWN MTB to 2 msec.
- Press TB SELECT key for DTB-mode.
- Set UP-DOWN DTB to 1 msec.
- Adjust R4207 and the X POS control so that the 2nd and 10th marker pulses coincide exactly with the 2nd and 10th vertical graticule lines.

Adjustment of 1 microsec:

- Change the time marker signal to 1 microsec.
- Press AUTO SET key.
- Set UP-DOWN MTB to 2 microsec.
- Press TB SELECT key for DTB-mode.
- Set UP-DOWN DTB to 1 microsec.
- Adjust R4208 and the X POS control so that the 2nd and 10th marker pulses coincide exactly with the 2nd and 10th vertical graticule lines.

13.4.11 Adjustment of x10 sweep times

Adjustment of 100 microsec:

- Apply a 100 microsec. time marker signal to input A.
- Press AUTO SET key.
- Set UP-DOWN MTB to 1 msec.
- Press TB MAGN key for x10 magnification.
- Ensure that the LCD gives a 0,1 ms display.
- Adjust R4721 and the X POS control so that the 2nd and 10th marker pulses coincide exactly with the 2nd and 10th vertical graticule lines. This must be valid over 10 % to 90 % of the total X-deflection range.

13.4.12 Adjustment of delay time multiplier

The delay time multiplier adjustment can be performed with SERVICE MENU "1", measuring point 1.8 (see section 13.4.7)

- Set the start of the trace exactly on the first vertical graticule line by means of the X POS control.
- Enter SERVICE MENU "1".
- Select measuring number "1.8".
- Adjust R4406 and R4408 so that the start of the intensified part of the trace coincides with the 2nd and 10th vertical graticule lines respectively.
- Repeat the adjustments of R4406 and R4408 a couple of times since they are interdependent.
- Depress AUTO SET twice to leave the service menu again.

13.4.13 Square-wave response of final Y-amplifier

Adjustment of square-wave response:

- Apply a 120 mV/1 MHz calibrated square-wave signal with rise time faster than 1 nsec to input A.
- Press AUTO SET key.
- Set UP-DOWN ch.A to 20 mV.
- Set UP-DOWN MTB to 0,5 microsec.
- Adjust the square-wave response with R3017.
- Set UP/DOWN MTB to 0,1 microsec.
- Adjust the square-wave response with R3013 and C3007.
- Press TB MAGN key for x10 magnification.
- Adjust the square-wave response with C3004, C3005, C3016 and R3036.
- Remove the input signal again.

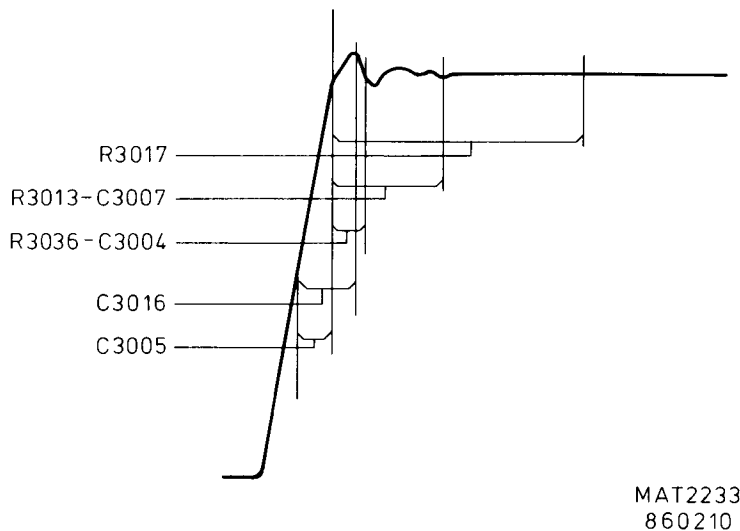


Figure 13.2 Square-wave response

Checking the chopper interference:

- Press A/B key so that both channels A and B are displayed.
- Press ALT/CHOP key for a chopped display.
- Set UP-DOWN ch.A and ch.B to 1 V.
- Press TB MAGN again for x1 magnification.
- Set UP-DOWN MTB to 0,5 msec.
- Press both 0 keys for channel A and B.
- Adjust Y POS A and Y POS B controls for a 6 division distance between both lines.
- Ensure that the chopper interference between both channels is as small as possible; if necessary, readjust R3017.

NOTE: When readjustment of R3017 is necessary, it is recommended to ensure that the h.f. square-wave response is still correct. If necessary, readjust the relevant adjusting components.

Bandwidth check:

The indications for channel B are shown in brackets after those of channel A.

- Apply a 120 mV/50 kHz calibrated sine wave signal to input A(B). This 6 division signal amplitude functions as a reference.
- Press AUTO SET key.
- Set UP-DOWN ch.A (ch.B) to 20 mV.
- Set UP-DOWN MTB to 0,1 msec.
- Ensure that the amplitude display on the screen does not become smaller than 4,2 divisions over the total frequency range up to 50 MHz.

13.4.14 Checking the AUTO SET function

- Set UP-DOWN ch.A to 10 V.
- Set UP-DOWN MTB to 0,5 sec.
- Apply a 120 mV/1 kHz sine-wave to input A.
- Press AUTO SET key.
- Ensure that a triggered sine-wave signal is visible on the screen with 2...5 division amplitude and 2...5 periods.

14. CORRECTIVE MAINTENANCE

14.1 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.

14.1.1 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.

14.1.2 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 or representative.

14.1.3 Transistors and Integrated Circuits

- Return transistors and IC's to their original positions, if removed during routine maintenance.
- Do not renew or switch semi-conductor 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.

14.1.4 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.

14.1.5 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.

14.1.5.1 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.

14.1.5.2 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.

14.1.5.3 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.

14.1.5.4 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.

14.1.5.5 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

14.1.5.6 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.

14.1.5.7 Voltage surges

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

14.2 REMOVING THE UNITS AND MECHANICAL PARTS

NOTE: For installation, reverse the sequence.

14.2.1 Attenuator unit (A1)

- 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 14.2.7).
- 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 p.c.b. and then unscrew the BNC-nut with a spanner of max. 5 mm thickness.

14.2.2 Pre-amplifier unit (A2)

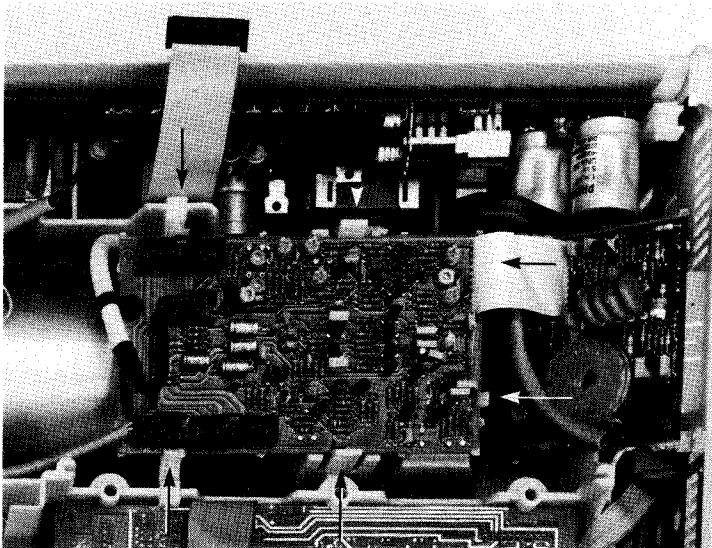
- First remove the time-base unit (see section 14.2.4).
- Unlock the two p.c.b. supports
- The complete p.c.b. can be removed from the instrument after having removed all flat cables.

14.2.3 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 among other things the CRT socket and must be loosened first. For this, the CRT socket must be gently 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 six clamping lips that secure the XYZ-amplifier unit p.c.b. outwards and take out the complete unit.



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Figure 14.1 Six clamping lips for XYZ-amplifier unit

14.2.4 Time-base unit (A4)

- Unlock the p.c.b. support with a special tool that fits the diameter of the p.c.b. support (see section 14.6.2).
- The complete p.c.b. can be taken out of the instrument after having removed all flat cables.

14.2.5 CRT control unit (A5)

- Remove the front unit (see section 14.2.7)
- Loosen the front profile (see section 14.2.1)
- Now the CRT control unit can be pulled out of the front profile after having removed the flat-cable and the CAL connector.

14.2.6 Power supply unit (A6)

WARNING: Inside the power supply p.c.b. 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.

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

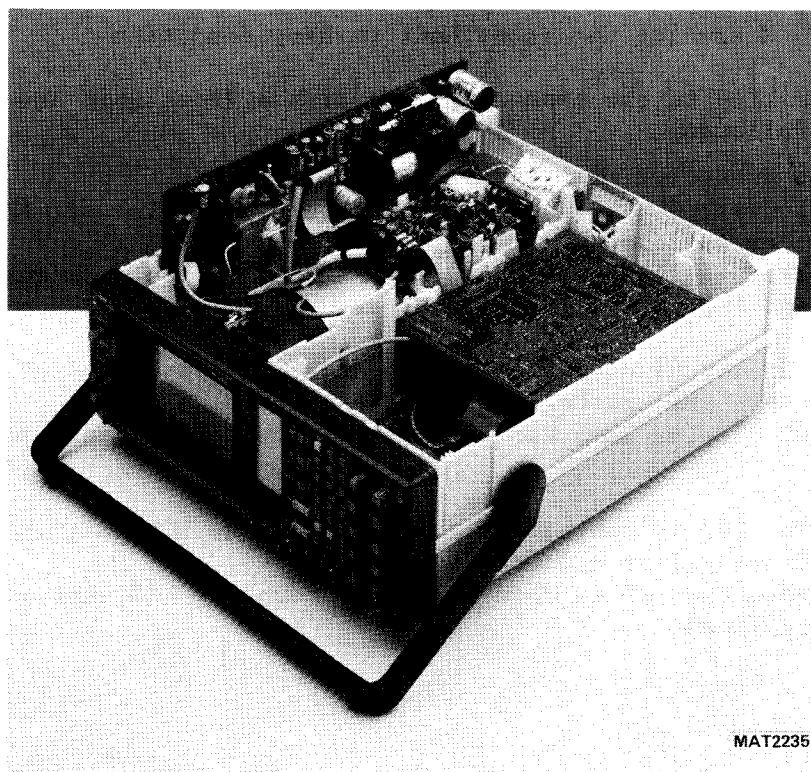
NOTE: After the above actions, the power supply unit can be measured under working conditions, provided that all cables are still connected to the unit.

NOTE: The flat cable to the CRT control unit can easily be removed now when removing this unit.

- 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.



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Figure 14.2 Power supply unit outside the instrument

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

- 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.

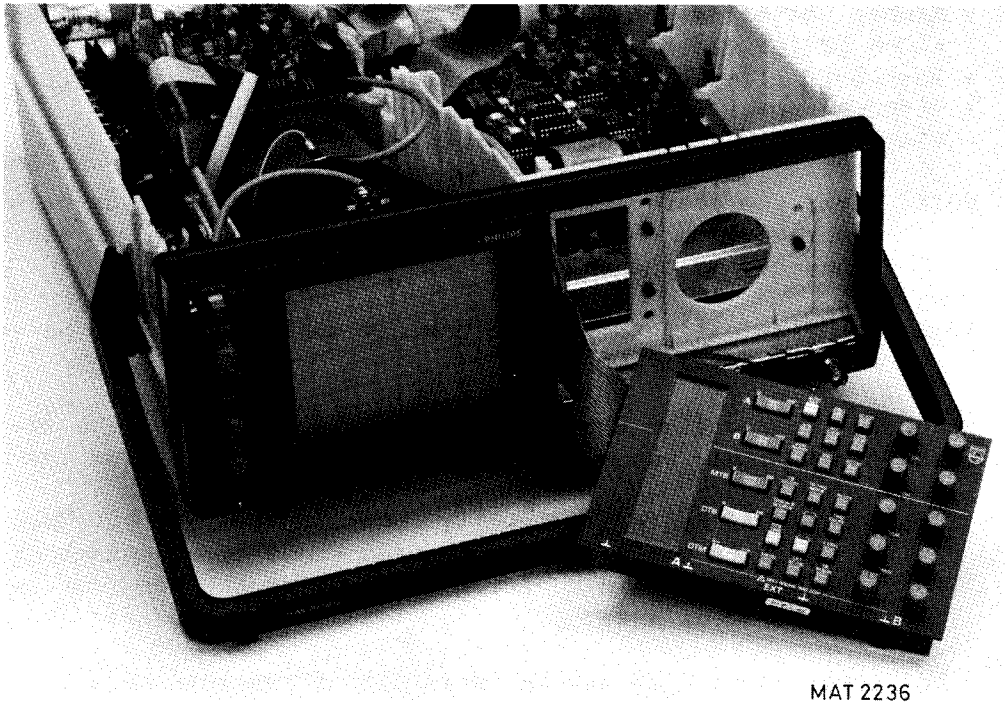


Figure 14.3 Measuring the front unit working condition

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 easily be 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 can be reached after pulling off the LCD unit.

ATTENTION: The LCD is unbreakably connected to the LCD unit and cannot be exchanged as a separate component.
When the LCD is defective, the complete LCD unit must be replaced.

14.2.8 Removing the delay line cable

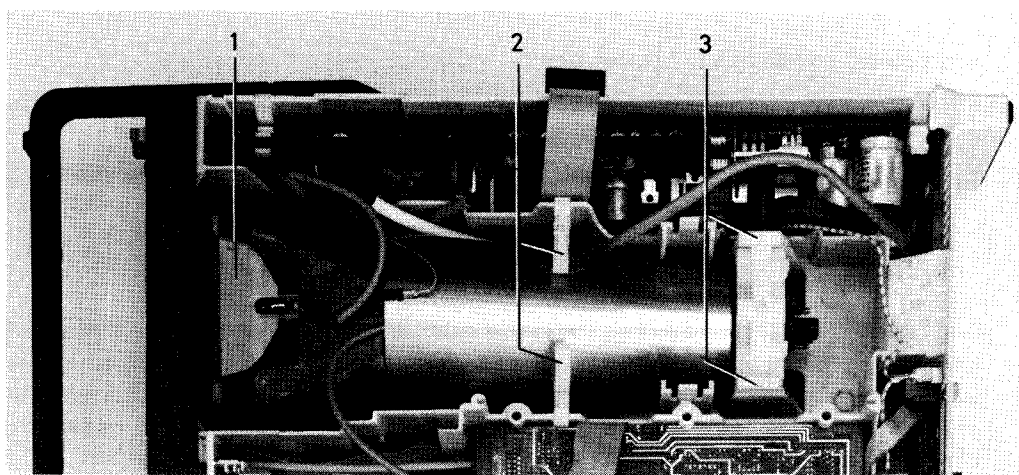
The delay line cable is a 54 cm cable that is connected to the amplifier unit and to the XYZ amplifier unit.

To remove the delay line cable, proceed as follows:

- For access to the delay line cable, remove the time-base unit (See section 14.2.4) and the pre-amplifier unit (see section 14.2.2).
- Unlock the plastic clamps that fix the cable to the instrument's chassis and to the units.
- Remove the plug that connect the delay line cable to the pre-amplifier unit.
- Unscrew the plastic clamp that fix the cable to the XYZ-amplifier unit.
- Remove the plug that connects the delay line cable to the XYZ-amplifier unit.

14.2.9 Replacement of CRT

IMPORTANT: It is strongly recommended to study of this chapter and the associated illustration (figure 14.4) before starting replacement.



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Figure 14.4 Removing the CRT

- Remove the XYZ-amplifier unit, see section 14.2.3.
- Remove the graticule lamp holder (1).
- Remove the bezel with the screen filter.
- Remove the two plastic p.c.b. supports (2).
- Unlock the EHT-cable.

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.

14.3 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.

14.4 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.

14.5 TROUBLE SHOOTING

14.5.1 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.

14.5.2 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 13. "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...10.

- 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 pcb. 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.

14.5.3 Power-up routine

Every time the instrument is switched-on the following initialisation program is executed:

- Resetting the IIC-bus.
- Resetting D2603 (OQ 0200)
- Determining the SLAVE-address of D2603.
- Checking if Service routine is required (if yes the program will continue with the service routine).
- Checking the "WATCH-DOG" on A7 (if HIGH, all relevant LCD-segments will be lighting for about 1 sec).
- Eventually initialisation of the IEEE-option.

If during the program-run a circuit is found to be faulty, the program stops. It is recommended to switch-off and after a few seconds switch-on again. This will reset the micro-computer controlled system automatically. If the instrument goes in the same faulty situation again, the following procedure indicates how to handle. If no fault is found, all relevant LCD-segments will be lighting for about one second. After this the normal program is executed.

PROCEDURE:

Check the SDA and SCL lines after having switched-on. On the SCL a clock-pulse must be present, while the SDA gives the data-information (looks like a random pulse). If one of these signals is not present, you can localize on what unit the fault exists. This can be done by first unplugging connector X1009 or X2001 on resp. A1 and A2. To localize what serial-parallel conversion IC is defective, you can disconnect the solder joint in the SDA and SCL print track lead to that IC. The following IC's can be disconnected in this way: D1001, D1101, D2602, D2603, D4001, D4002, D4401.

When the instrument restarts every time again, this means the WATCHDOG is initiating the main program (see also section 10.1.4), the watchdog can be disabled. This can be done by means of the solder joint jumper on the rear of the front unit p.c.b. (near X7001).

When disabled, pin 13 of the microcomputer is set to a low level.

14.5.4 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 | 2,1E-12W: 3 x 8E (4822 112 21052) and 10E (4822 112 21054) 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 41067) in parallel. |
| + 17 V | 340 mA | 51E-6W: 1E (4822 110 23027) in serial with 2 x 100 E(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). |
| - 48 V | 40 mA | 1k22-2W: 2k2 (4822 110 23116) and 2k7 (4822 110 23118) in parallel. |

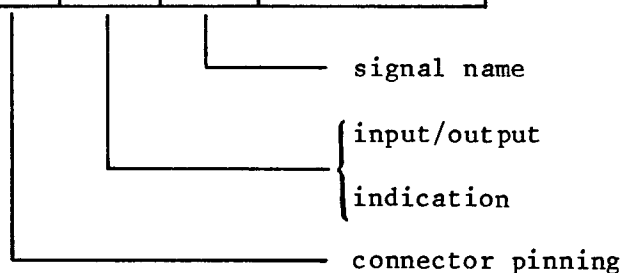
14.5.5 P.c.b. interconnections

Figure 14.5 gives a survey of all interconnections between the p.b.c.'s and to the CRT. Also the interconnections between the connectors on board level is given in this diagram.

An explanation of the connector indication is given below:

| | | | |
|---|---|---|--|
| 1 | * | | |
| 2 | | o | |
| 3 | x | | |
| 4 | | | |

- *: Input signal for the related p.c.b.
- o: Output signal for the related p.c.b.
- x: Interconnection between two or more sockets of the p.c.b.
Not used on the related p.c.b.



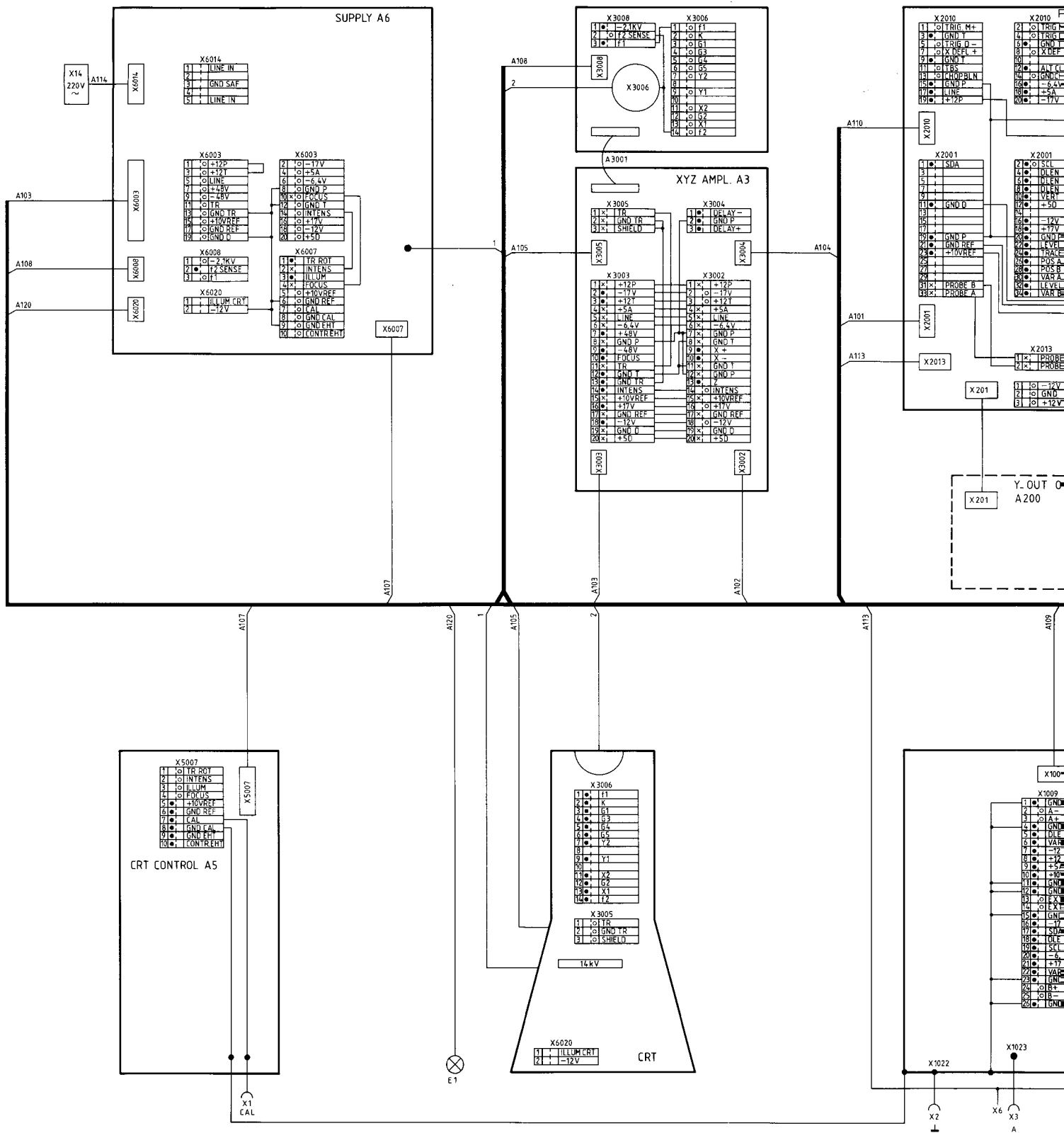
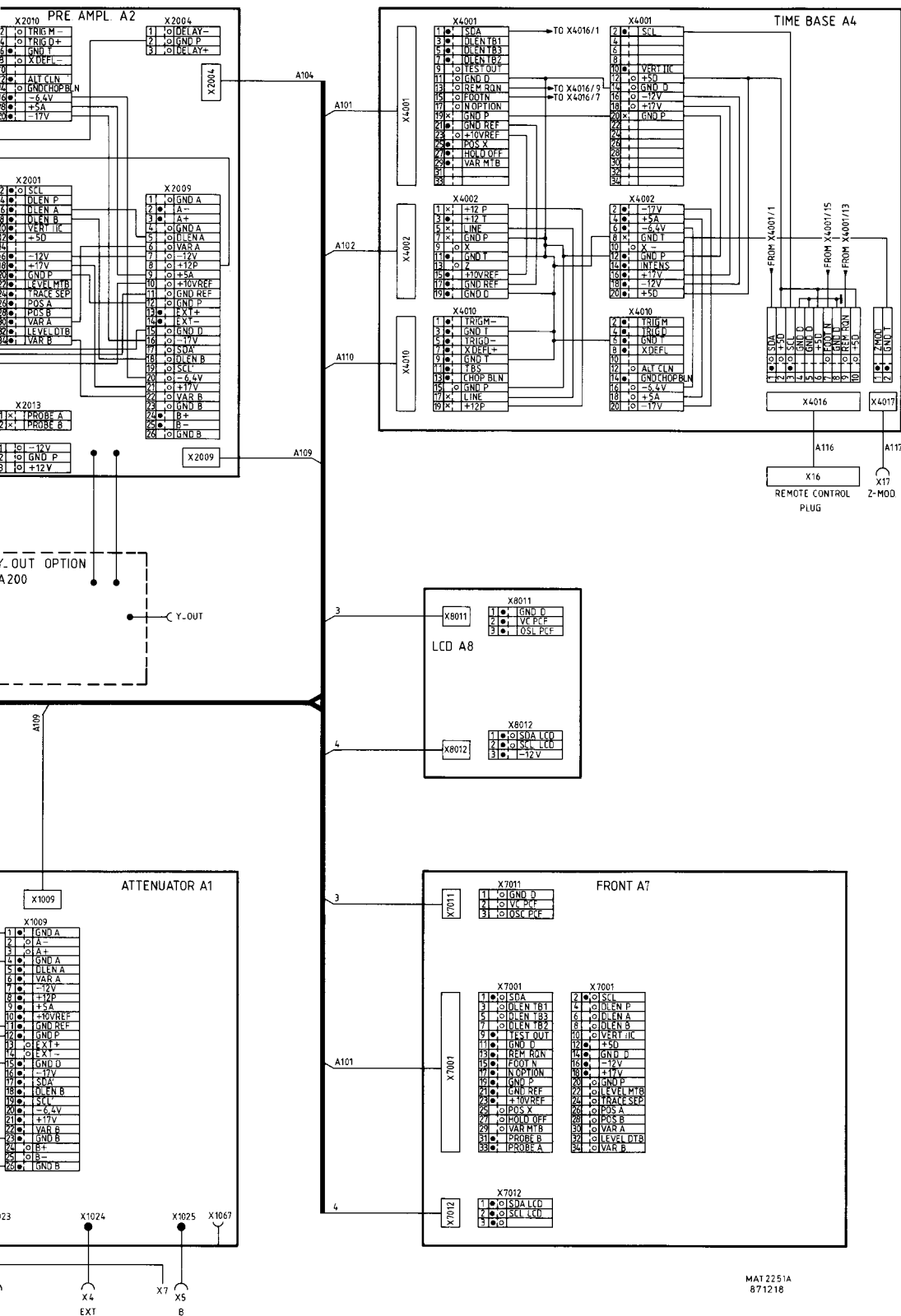


Figure 14.5 P.c.b. interconnections



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The Trimming Kit contains the following parts:

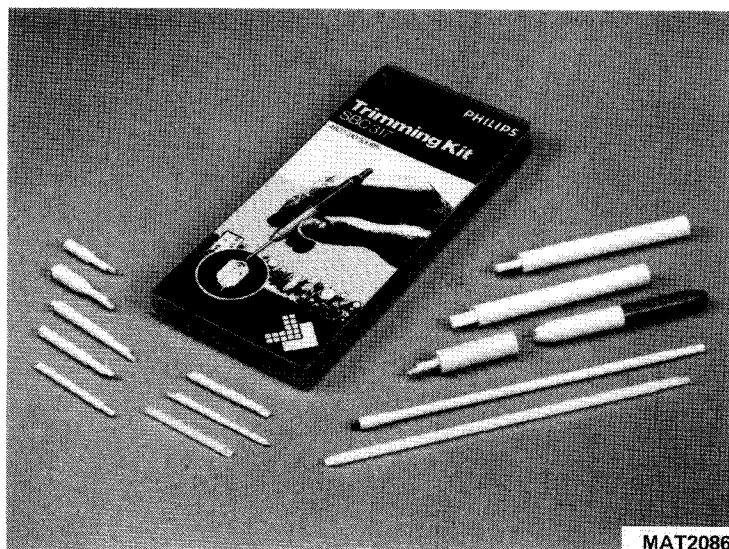


Figure 14.7 Trimming tool kit

14.6.2 P.c.b. snapper - 5322 535 91942

A special tool is available for removal of the pcb from the p.c.b. supports. Information on how to use this tool is given in chapter 14.2. The ordering number of this tool is 5322 535 91942

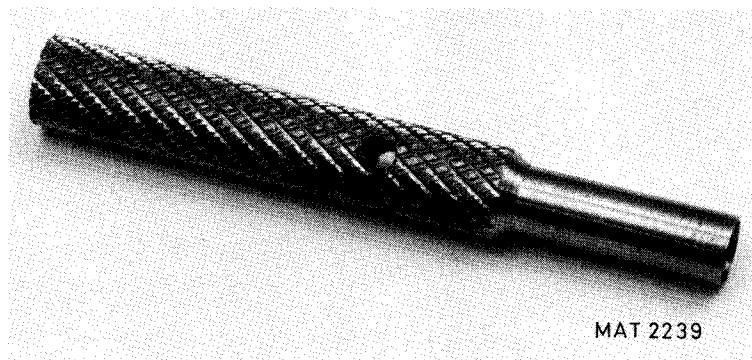


Figure 14.8 P.c.b. snapper

14.7 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.

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

15.1 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.

15.2 SAFETY COMPONENTS

Components in the primary circuit may only be renewed by components selected by Philips, see also section 14.1.2.

15.3 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.

15.4 CHECKING THE INSULATION RESISTANCE

Measure the insulation resistance at $U = 500 \text{ V dc}$ 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).

15.5 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.

15.6 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.

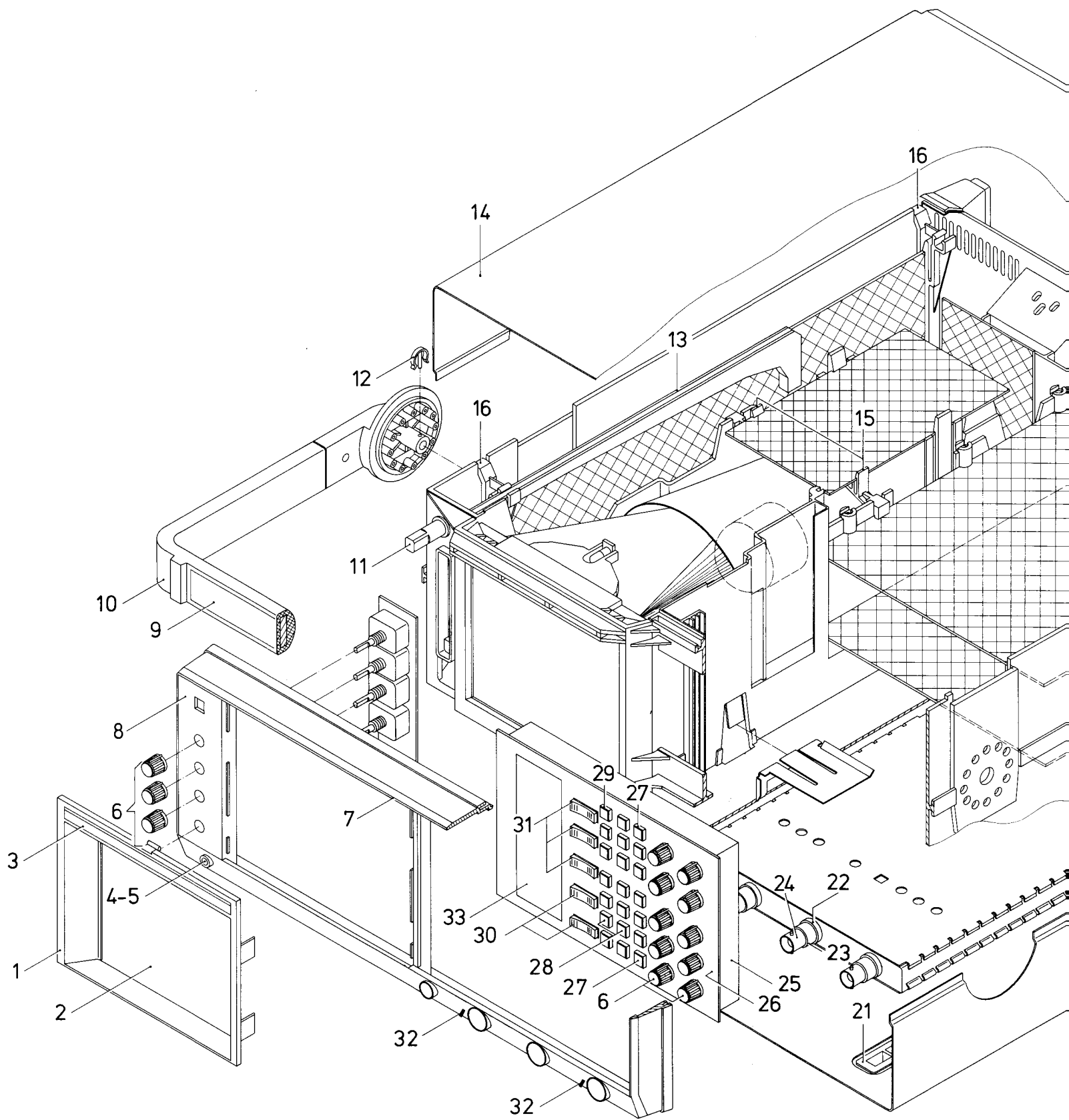
16. PARTS LIST

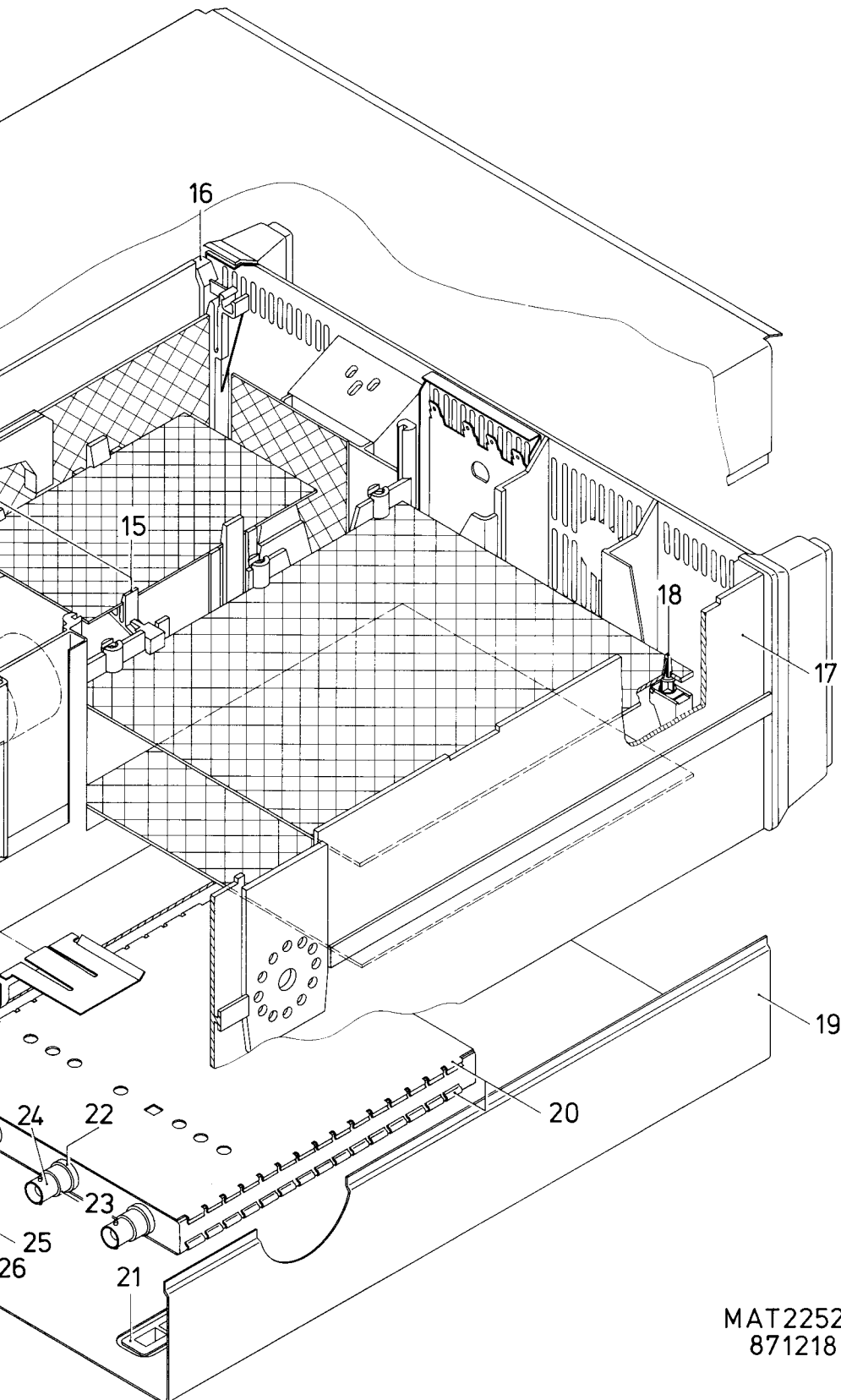
(subject to alteration without notice)

16.1 MECHANICAL PARTS

16.1.1 Mechanical parts indicated in figure 16.1.

| Item | Qty | Ordering code | Description |
|------|-----|----------------|------------------------------------|
| 1 | 1 | 5322 381 10779 | Bezel |
| 2 | 1 | 5322 480 30181 | Contrast filter blue |
| 3 | 1 | 5322 455 81075 | Textfilm on bezel PM3055 |
| 3 | 1 | 5322 455 81076 | Textfilm on bezel PM3057 |
| 4 | 1 | 5322 268 14052 | CAL socket |
| 5 | 1 | 4822 530 70296 | Clamping spring for CAL socket |
| 6 | 13 | 5322 414 10018 | Control knob with spring |
| 7 | 1 | 5322 464 90252 | Front frame |
| 8 | 1 | 5322 455 81026 | Textfilm CRT unit |
| 9 | 1 | 5322 455 81025 | Textfilm for handle |
| 10 | 1 | 5322 498 50219 | Handle assembly |
| 11 | 1 | 5322 414 60142 | Power-on knob, green-brown |
| 12 | 2 | 5322 492 63355 | Spring for handle |
| 13 | 1 | 5322 535 80735 | Extension part for power-on switch |
| 14 | 1 | 5322 464 90248 | Upper cabinet |
| 15 | 2 | 5322 462 10265 | P.c.b. support for A3 |
| 16 | 2 | 5322 462 10264 | P.c.b. guiding for A6 |
| 17 | 1 | 5322 464 90486 | Chassis |
| 18 | 6 | 5322 462 30304 | P.c.b. support |
| 19 | 1 | 5322 464 90249 | Bottom cabinet |
| 20 | 2 | 5322 464 90253 | Attenuator cover |
| 21 | 4 | 5322 462 50325 | Bottom foot |
| 22 | 3 | 5322 506 41006 | BNC nut |
| 23 | 3 | 5322 532 21188 | BNC spacer ring |
| 24 | 3 | 5322 267 10004 | BNC socket |
| 25 | 1 | 5322 464 90254 | Front unit frame |
| 26 | 1 | 5322 455 81028 | Textfilm for front unit |
| 27 | 18 | 5322 276 11856 | Softkey brown |
| 28 | 2 | 5322 276 11858 | Softkey beige |
| 29 | 1 | 5322 276 11857 | Softkey green |
| 30 | 2 | 5322 277 10879 | UP-DOWN key beige |
| 31 | 3 | 5322 277 10878 | UP-DOWN key brown |
| 32 | 2 | 5322 492 63354 | Range indication spring |
| 33 | 1 | 5322 450 60952 | LCD window |
| -- | 3 | 5322 401 10954 | Delay line cable clamp |
| -- | 2 | 5322 255 40054 | Heatsink for V3011 and V3012 |





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Figure 16.1 Exploded view

16.1.2 Mechanical pa

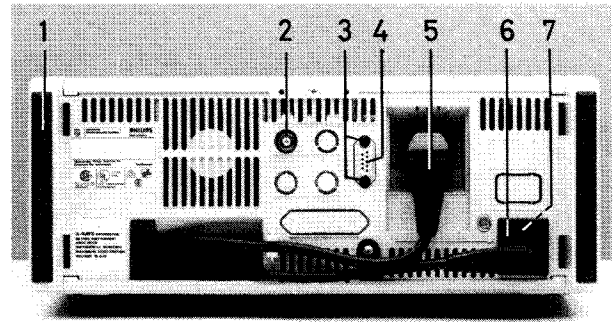
| Item | Qty |
|------|-----|
| 1 | 2 |
| 2 | 1 |
| 3 | 4 |
| 4 | 1 |
| 5 | 1 |
| | 1 |
| | 1 |
| | 1 |
| 6 | 1 |
| 7 | 1 |

16.1.3 Mechanical pa

| Item | Qty |
|------|-----|
| 1 | 1 |
| 2 | 1 |
| 3 | 1 |
| 4 | 1 |
| 5 | 1 |
| 6 | 1 |

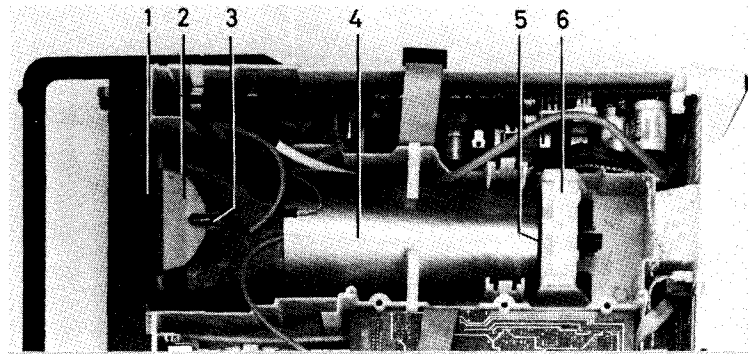
16.2 UNITS (see fi

| Item | Unit |
|------|------|
| 1 | A1 |
| 2 | A2 |
| 3 | A3 |
| 4 | A4 |
| 5 | A5 |
| 6 | A6 |
| 7 | A7 |
| 8 | A8 |



MAT2254

Figure 16.2 Rear view



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Figure 16.3 Inside view showing the parts in the

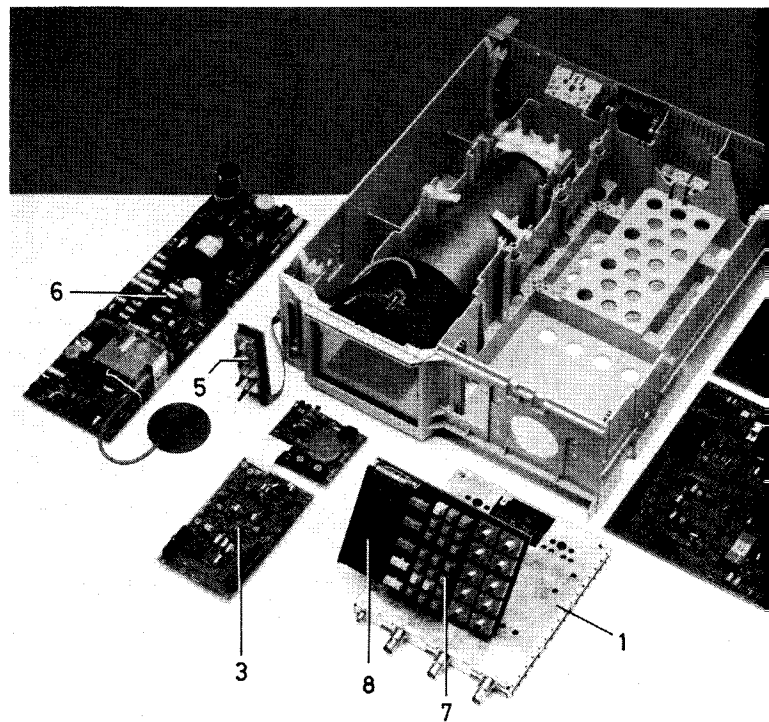
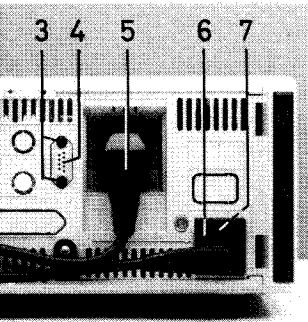
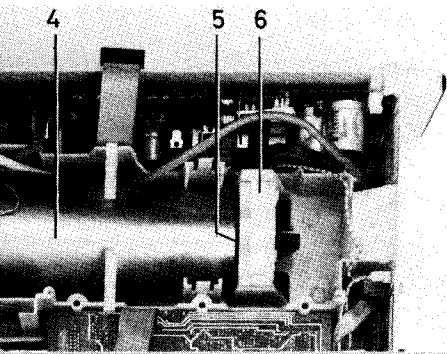


Figure 16.4 View of the units



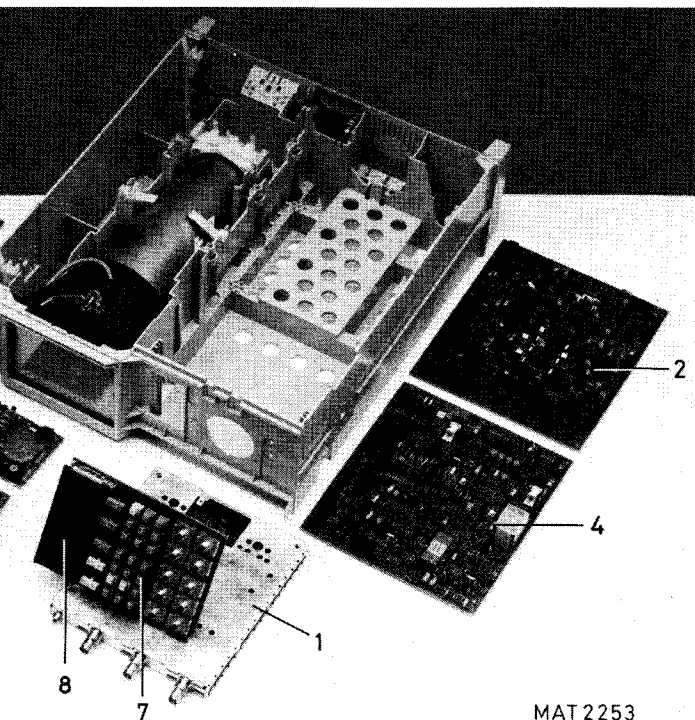
MAT2254

ew



MAT 2296

view showing the parts in the CRT compartment



MAT 2253

the units

16.1.2 Mechanical parts

| Item | Qty |
|------|-----|
| 1 | 2 |
| 2 | 1 |
| 3 | 4 |
| 4 | 1 |
| 5 | 1 |
| | 1 |
| | 1 |
| | 1 |
| 6 | 1 |
| 7 | 1 |

16.1.3 Mechanical parts

| Item | Qty |
|------|-----|
| 1 | 1 |
| 2 | 1 |
| 3 | 1 |
| 4 | 1 |
| 5 | 1 |
| 6 | 1 |

16.2 UNITS (see figure 16-1)

| Item | Unit |
|------|------|
| 1 | A1 |
| 2 | A2 |
| 3 | A3 |
| 4 | A4 |
| 5 | A5 |
| 6 | A6 |
| 7 | A7 |
| 8 | A8 |

16.1.2 Mechanical parts indicated in figure 16.2

| Item | Qty | Ordering code | Description |
|------|-----|----------------|--|
| 1 | 2 | 5322 462 50324 | Rear foot |
| 2 | 1 | 5322 267 10004 | BNC socket for Z-MOD |
| 3 | 4 | 5322 502 12003 | Screw for Remote control socket and Mains socket |
| 4 | 1 | 5322 321 22665 | Remote control socket, incl. cable |
| 5 | 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 |
| 6 | 1 | 5322 219 81119 | Mains input socket, incl. fuse holder |
| 7 | 1 | 4822 253 30024 | Fuse 1,6A (for mains input) |

16.1.3 Mechanical parts indicated in figure 16.3

| Item | Qty | Ordering code | Description |
|------|-----|----------------|-------------------------|
| 1 | 1 | 5322 460 60404 | CRT front rubber |
| 2 | 1 | 5322 462 40957 | Light conductor for CRT |
| 3 | 1 | 5322 134 40534 | Lamp 28V-40mA |
| 4 | 1 | 5322 466 30163 | CRT shielding |
| 5 | 1 | 5322 466 30164 | CRT manchet, rubber |
| 6 | 1 | 5322 462 10263 | CRT support |

16.2 UNITS (see figure 16.4)

| Item | Unit nr. | Ordering code | Description |
|------|----------|----------------|--------------------|
| 1 | A1 | 5322 216 51114 | Attenuator unit |
| 2 | A2 | 5322 216 51116 | Pre-amplifier unit |
| 3 | A3 | 5322 216 51117 | XYZ-amplifier unit |
| 4 | A4 | 5322 216 51115 | Time-base unit |
| 5 | A5 | 5322 216 51118 | CRT-control unit |
| 6 | A6 | 5322 216 51119 | Power supply unit |
| 7 | A7 | 5322 216 51113 | Front unit |
| 8 | A8 | 5322 216 51121 | LCD unit |

16.3 CABLES AND CONNECTORS

16.3.1 Flatcables and connectors

For the flatcables used in this oscilloscope, the required version must be made by yourself with the following parts:

- Universal flatcable, 40 wires, length 60 cm 5322 323 50112

To get the required number of wires, the flat cable must be split by means of a pair of scissors or a knife.
The cable must be cut 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:

| | |
|---|----------------|
| 10 pole cable connector X4016-X5007-X6007 | 5322 268 40234 |
| 20 pole cable connector X2010-X3002-X3003 | 5322 268 40235 |
| X4002-X4010-X6009 | |
| 26 pole cable connector X1009-X2009 | 5322 267 70175 |
| 34 pole cable connector X2001-X4001-X7001 | 5322 268 40236 |

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 |
| - Flatcable connector clamp | 5233 401 11156 |

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

| Type | Item | Ordering number |
|-------------------------|-------------------------|-----------------|
| 2 pole-single | X2013-X4017-X6020 | 5322 265 20275 |
| 3 pole-single | X6006-X6019 | 5322 265 30434 |
| 3 pole single | X6018 (power supply) | 5322 265 40435 |
| 3 pole-single 90° type | X2004-X3004-X3005-X3008 | 5322 265 30433 |
| 5 pole-single | X6014 | 5322 265 40436 |
| 10 pole-double | X4016-X5007-X6007 | 5322 265 40485 |
| 20 pole-double | X2010-X3002-X3003 | 5322 265 51129 |
| 26 pole-double | X1009-X2009 | 5322 265 61071 |
| 34 pole-double | X2001-X4001 | 5322 265 61069 |
| 34 pole-double 90° type | X7001 | 5322 265 61068 |
| CRT-socket | X3006 | 5322 255 40502 |

16.3.3 Miscellaneous cables

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

16.4 ELECTRICAL PARTS

16.4.1 CAPACITORS

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|--------|---------------|----------------|
| C 201 | -20+50% 10NF | 4822 122 31414 | C 1131 | -20+50% 10NF | 4822 122 31414 |
| C 202 | 2% 100PF | 4822 122 31316 | C 1132 | 2% 33PF | 5322 122 32551 |
| C 203 | 7-10.0 PF | 5322 125 11013 | C 1133 | 7-10.0 PF | 5322 125 11013 |
| C 204 | 10% 1NF | 4822 122 30027 | C 1134 | -20+50% 10NF | 4822 122 31414 |
| C 251 | -10+50% 68UF | 4822 124 20689 | C 1135 | -20+50% 10NF | 4822 122 31414 |
| C 252 | -20+50% 10NF | 4822 122 31414 | C 1136 | 2% 39PF | 4822 122 31069 |
| C 253 | -20+50% 10NF | 4822 122 31414 | C 1137 | 2% 22PF | 5322 122 32143 |
| C 254 | -10+50% 68UF | 4822 124 20689 | C 1138 | 2% 100PF | 4822 122 31316 |
| C 256 | -20+50% 10NF | 4822 122 31414 | C 1139 | 0.25PF 2.2PF | 4822 122 31036 |
| C 257 | -20+50% 10NF | 4822 122 31414 | C 1141 | 63V 10% 100NF | 5322 121 43083 |
| C 421 | -20+50% 10NF | 4822 122 31414 | C 1142 | -20+50% 10NF | 4822 122 31414 |
| C 422 | -20+50% 10NF | 4822 122 31414 | C 1143 | -20+50% 10NF | 4822 122 31414 |
| C 423 | -20+50% 10NF | 4822 122 31414 | C 1144 | -20+50% 10NF | 4822 122 31414 |
| C 1001 | -20+50% 10NF | 4822 122 31414 | C 1145 | -20+50% 10NF | 4822 122 31414 |
| C 1002 | 400V 10% 22NF | 5322 121 40308 | C 1146 | -10+50% 68UF | 4822 124 20689 |
| C 1003 | -20+50% 10NF | 4822 122 31414 | C 1147 | 0.25PF 4.7PF | 4822 122 31822 |
| C 1004 | -20+50% 10NF | 4822 122 31414 | C 1161 | 10% 470PF | 4822 122 30034 |
| C 1006 | -20+50% 10NF | 4822 122 31414 | C 1162 | 0.25PF 3.3PF | 4822 122 31821 |
| C 1009 | 2% 33PF | 5322 122 32072 | C 1163 | 2% 33PF | 5322 122 32072 |
| C 1011 | 63V 10% 220NF | 5322 121 43084 | C 1164 | 10% 680PF | 4822 122 30053 |
| C 1012 | 63V 10% 220NF | 5322 121 43084 | C 1167 | 2% 68PF | 4822 122 31349 |
| C 1013 | 2% 15PF | 4822 122 31823 | C 1168 | -20+50% 10NF | 4822 122 31414 |
| C 1016 | 0.25PF 3.3PF | 5322 122 32549 | C 1171 | -20+50% 10NF | 4822 122 31414 |
| C 1017 | 0.25PF 3.3PF | 4822 122 31821 | C 1172 | -20+50% 10NF | 4822 122 31414 |
| C 1018 | 0.25PF 2.7PF | 5322 122 32894 | C 1176 | 10% 1.5NF | 4822 122 31169 |
| C 1019 | 2% 33PF | 5322 122 32072 | C 1177 | 10% 1.5NF | 4822 122 31169 |
| C 1021 | -20+50% 10NF | 4822 122 31414 | C 1201 | -20+50% 10NF | 4822 122 31414 |
| C 1022 | 2% 22PF | 5322 122 32143 | C 1202 | 400V 10% 22NF | 5322 121 40308 |
| C 1023 | 7-10.0 PF MUR | 5322 125 11013 | C 1203 | 2% 33PF | 5322 122 32551 |
| C 1024 | -20+50% 10NF | 4822 122 31414 | C 1204 | 0.25PF 3.9PF | 4822 122 31217 |
| C 1026 | 0.25PF 3.3PF | 5322 122 32549 | C 1206 | 7-10.0 PF | 5322 125 11013 |
| C 1027 | 0.25PF 2.2PF | 5322 122 32774 | C 1207 | 2% 22PF | 5322 122 32143 |
| C 1028 | 2% 33PF | 5322 122 32072 | C 1208 | -20+50% 10NF | 4822 122 31414 |
| C 1029 | 7-10.0 PF MUR | 5322 125 11013 | C 1210 | 0.25PF 0.56PF | 5322 122 32107 |
| C 1031 | -20+50% 10NF | 4822 122 31414 | C 1211 | -20+50% 10NF | 4822 122 31414 |
| C 1032 | 2% 33PF | 5322 122 32551 | C 1212 | 2% 100PF | 4822 122 31316 |
| C 1033 | 7-10.0 PF MUR | 5322 125 11013 | C 1216 | 0.25PF 4.7PF | 4822 122 31822 |
| C 1034 | -20+50% 10NF | 4822 122 31414 | C 1217 | -20+50% 10NF | 4822 122 31414 |
| C 1035 | -20+50% 10NF | 4822 122 31414 | C 1401 | -20+50% 10NF | 4822 122 31414 |
| C 1036 | 2% 39PF | 4822 122 31069 | C 1402 | -20+50% 10NF | 4822 122 31414 |
| C 1037 | 2% 22PF | 5322 122 32143 | C 1403 | -20+50% 10NF | 4822 122 31414 |
| C 1038 | 2% 100PF | 4822 122 31316 | C 1404 | -10+50% 68UF | 4822 124 20689 |
| C 1039 | 0.25PF 2.2PF | 4822 122 31036 | C 1405 | -20+50% 10NF | 4822 122 31414 |
| C 1041 | 63V 10% 100NF | 5322 121 43083 | C 1407 | -20+50% 10NF | 4822 122 31414 |
| C 1042 | -20+50% 10NF | 4822 122 31414 | C 1408 | -20+50% 10NF | 4822 122 31414 |
| C 1043 | -20+50% 10NF | 4822 122 31414 | C 1409 | -10+50% 68UF | 4822 124 20689 |
| C 1044 | -20+50% 10NF | 4822 122 31414 | C 1411 | -20+50% 10NF | 4822 122 31414 |
| C 1045 | -20+50% 10NF | 4822 122 31414 | C 1412 | -20+50% 10NF | 4822 122 31414 |
| C 1046 | -10+50% 68UF | 4822 124 20689 | C 1413 | -10+50% 47UF | 4822 124 20699 |
| C 1047 | 0.25PF 4.7PF | 4822 122 31822 | C 1414 | -20+50% 10NF | 4822 122 31414 |
| C 1061 | 10% 470PF | 4822 122 30034 | C 1420 | -20+50% 10NF | 4822 122 31414 |
| C 1062 | 0.25PF 3.3PF | 4822 122 31821 | C 1421 | -20+50% 10NF | 4822 122 31414 |
| C 1063 | 2% 33PF | 5322 122 32072 | C 1422 | -20+50% 10NF | 4822 122 31414 |
| C 1064 | 10% 680PF | 4822 122 30053 | C 1423 | -20+50% 10NF | 4822 122 31414 |
| C 1067 | 2% 68PF | 4822 122 31349 | C 1424 | -10+50% 68UF | 4822 124 20689 |
| C 1068 | -20+50% 10NF | 4822 122 31414 | C 1427 | -20+50% 10NF | 4822 122 31414 |
| C 1071 | -20+50% 10NF | 4822 122 31414 | C 1428 | -20+50% 10NF | 4822 122 31414 |
| C 1072 | -20+50% 10NF | 4822 122 31414 | C 1429 | -10+50% 68UF | 4822 124 20689 |
| C 1076 | 10% 1.5NF | 4822 122 31169 | C 1431 | -20+50% 10NF | 4822 122 31414 |
| C 1077 | 10% 1.5NF | 4822 122 31169 | C 1432 | -20+50% 10NF | 4822 122 31414 |
| C 1101 | -20+50% 10NF | 4822 122 31414 | C 1433 | -10+50% 47UF | 4822 124 20699 |
| C 1102 | 400V 10% 22NF | 5322 121 40308 | C 1434 | -20+50% 10NF | 4822 122 31414 |
| C 1103 | -20+50% 10NF | 4822 122 31414 | C 1441 | -20+50% 10NF | 4822 122 31414 |
| C 1104 | -20+50% 10NF | 4822 122 31414 | C 1442 | -10+50% 68UF | 4822 124 20689 |
| C 1106 | -20+50% 10NF | 4822 122 31414 | C 1443 | -20+50% 10NF | 4822 122 31414 |
| C 1109 | 2% 33PF | 5322 122 32072 | C 1444 | -20+50% 10NF | 4822 122 31414 |
| C 1111 | 63V 10% 220NF | 5322 121 43084 | C 1446 | -10+50% 68UF | 4822 124 20689 |
| C 1112 | 63V 10% 220NF | 5322 121 43084 | C 1447 | -20+50% 10NF | 4822 122 31414 |
| C 1113 | 2% 15PF | 4822 122 31823 | C 2049 | 10% 1.5NF | 4822 122 31169 |
| C 1116 | 0.25PF 3.3PF | 5322 122 32549 | C 2050 | -20+50% 10NF | 4822 122 31414 |
| C 1117 | 0.25PF 3.3PF | 4822 122 31821 | C 2051 | 10% 1.5NF | 4822 122 31169 |
| C 1118 | 0.25PF 2.7PF | 5322 122 32894 | C 2149 | 10% 1.5NF | 4822 122 31169 |
| C 1119 | 2% 33PF | 5322 122 32072 | C 2150 | -20+50% 10NF | 4822 122 31414 |
| C 1121 | -20+50% 10NF | 4822 122 31414 | C 2151 | 10% 1.5NF | 4822 122 31169 |
| C 1122 | 2% 22PF | 5322 122 32143 | C 2201 | -20+50% 10NF | 4822 122 31414 |
| C 1123 | 7-10.0 PF | 5322 125 11013 | C 2203 | -20+50% 10NF | 4822 122 31414 |
| C 1124 | -20+50% 10NF | 4822 122 31414 | C 2207 | -20+50% 10NF | 4822 122 31414 |
| C 1126 | 0.25PF 3.3PF | 5322 122 32549 | C 2215 | 0.25PF 3.9PF | 5322 122 34107 |
| C 1127 | 0.25PF 2.2PF | 5322 122 32774 | C 2216 | 0.25PF 2.7PF | 4822 122 31038 |
| C 1128 | 2% 33PF | 5322 122 32072 | C 2217 | -20+50% 10NF | 4822 122 31414 |
| C 1129 | 7-10.0 PF | 5322 125 11013 | C 2218 | 0.25PF 2.7PF | 4822 122 31038 |
| | | | C 2220 | 0.25PF 5.6PF | 5322 122 32163 |
| | | | C 2221 | 10% 1.5NF | 4822 122 31169 |
| | | | C 2222 | 0.25PF 8.2PF | 4822 122 31052 |
| | | | C 2223 | 10% 1.5NF | 4822 122 31169 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|--------|---------------|----------------|
| C 2224 | 10% 1.5NF | 4822 122 31169 | C 3022 | -20+50% 10NF | 4822 122 31414 |
| C 2225 | 10% 470PF | 4822 122 30034 | C 3101 | 10% 1.5NF | 4822 122 31169 |
| C 2226 | 10% 470PF | 4822 122 30034 | C 3102 | 10% 1.5NF | 4822 122 31169 |
| C 2229 | 10% 470PF | 4822 122 30034 | C 3104 | 100V 10% 47NF | 5322 121 43088 |
| C 2230 | 10% 470PF | 4822 122 30034 | C 3105 | -20+50% 10NF | 4822 122 31414 |
| C 2305 | -20+50% 10NF | 4822 122 31414 | C 3106 | 63V 10% 100NF | 5322 121 43083 |
| C 2306 | 10% 1.5NF | 4822 122 31169 | C 3107 | 0.25PF 2.7PF | 4822 122 31038 |
| C 2307 | 10% 1.5NF | 4822 122 31169 | C 3108 | 0.25PF 0.82PF | 4822 122 31214 |
| C 2317 | 0.25PF 1.5PF | 5322 122 32101 | C 3109 | 63V 10% 100NF | 5322 121 43083 |
| C 2318 | 10% 470PF | 4822 122 30034 | C 3110 | -20+50% 10NF | 4822 122 31414 |
| C 2321 | 0.25PF 1.5PF | 5322 122 32101 | C 3111 | -20+50% 10NF | 4822 122 31414 |
| C 2326 | -20+50% 10NF | 4822 122 31414 | C 3113 | 0.25PF 0.82PF | 4822 122 31214 |
| C 2327 | -20+50% 10NF | 4822 122 31414 | C 3114 | 100V 10% 47NF | 5322 121 43088 |
| C 2328 | 63V 10% 100NF | 5322 121 43083 | C 3116 | 63V 10% 100NF | 5322 121 43083 |
| C 2329 | 63V 10% 100NF | 5322 121 43083 | C 3200 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2331 | 63V 10% 100NF | 5322 121 43083 | C 3201 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2332 | 63V 10% 100NF | 5322 121 43083 | C 3202 | 63V 10% 100NF | 5322 121 43083 |
| C 2333 | 63V 10% 100NF | 5322 121 43083 | C 3203 | 63V 10% 100NF | 5322 121 43083 |
| C 2335 | 2% 12PF | 4822 122 31056 | C 3204 | -20+50% 10NF | 4822 122 31414 |
| C 2336 | -20+50% 10NF | 4822 122 31414 | C 3206 | 63V 10% 100NF | 5322 121 43083 |
| C 2337 | -20+50% 10NF | 4822 122 31414 | C 3208 | 10% 470PF | 4822 122 30034 |
| C 2338 | 10% 470PF | 4822 122 30034 | C 3209 | -20+50% 2.2NF | 5322 122 50093 |
| C 2342 | 2% 22PF | 5322 122 32143 | C 3211 | -20+50% 2.2NF | 5322 122 50093 |
| C 2345 | 0.25PF 0.18PF | 5322 122 32162 | C 3250 | 100V 10% 10NF | 5322 121 43086 |
| C 2346 | 10% 1.5NF | 4822 122 31169 | C 3251 | 63V 10% 220NF | 5322 121 43084 |
| C 2348 | 10% 1.5NF | 4822 122 31169 | C 3252 | -20+50% 2.2NF | 5322 122 50093 |
| C 2350 | 0.25PF 2.7PF | 4822 122 31038 | C 3253 | -20+50% 10NF | 4822 122 31414 |
| C 2507 | -20+50% 10NF | 4822 122 31414 | C 3254 | -20+50% 10NF | 4822 122 31414 |
| C 2510 | 2% 22PF | 5322 122 32143 | C 3256 | 0.25PF 0.56PF | 5322 122 32107 |
| C 2516 | 0.25PF 2.7PF | 4822 122 31038 | C 3257 | -20+50% 10NF | 4822 122 31414 |
| C 2517 | 10% 470PF | 4822 122 30034 | C 3258 | -20+50% 2.2NF | 5322 122 50093 |
| C 2518 | 0.25PF 2.7PF | 4822 122 31038 | C 3301 | -20+50% 10NF | 4822 122 31414 |
| C 2519 | 2% 15PF | 4822 122 31823 | C 3302 | -20+50% 10NF | 4822 122 31414 |
| C 2600 | 2% 22PF | 5322 122 32143 | C 3303 | -10+50% 47UF | 4822 124 20699 |
| C 2601 | 63V 10% 100NF | 5322 121 43083 | C 3304 | -20+50% 10NF | 4822 122 31414 |
| C 2602 | -20+50% 10NF | 4822 122 31414 | C 3306 | -20+50% 10NF | 4822 122 31414 |
| C 2604 | 10% 1.5NF | 4822 122 31169 | C 3307 | -20+50% 10NF | 4822 122 31414 |
| C 2611 | 10% 1NF | 4822 122 30027 | C 3308 | -20+50% 10NF | 4822 122 31414 |
| C 2612 | -20+50% 10NF | 4822 122 31414 | C 3309 | -20+50% 10NF | 4822 122 31414 |
| C 2613 | 10% 470PF | 4822 122 30034 | C 3311 | -20+50% 10NF | 4822 122 31414 |
| C 2616 | 10% 470PF | 4822 122 30034 | C 3312 | -10+50% 47UF | 4822 124 20699 |
| C 2701 | -10+50% 100UF | 4822 124 20679 | C 3313 | -20+50% 10NF | 4822 122 31414 |
| C 2702 | -20+50% 10NF | 4822 122 31414 | C 3314 | -10+50% 15UF | 4822 124 20729 |
| C 2703 | -20+50% 10NF | 4822 122 31414 | C 3316 | -20+50% 10NF | 4822 122 31414 |
| C 2704 | -20+50% 10NF | 4822 122 31414 | C 3317 | -20+50% 10NF | 4822 122 31414 |
| C 2706 | -10+50% 100UF | 4822 124 20679 | C 3318 | -20+50% 10NF | 4822 122 31414 |
| C 2707 | -20+50% 10NF | 4822 122 31414 | C 3319 | -10+50% 15UF | 4822 124 20729 |
| C 2708 | -20+50% 10NF | 4822 122 31414 | C 3321 | -20+50% 10NF | 4822 122 31414 |
| C 2709 | -20+50% 10NF | 4822 122 31414 | C 3322 | -20+50% 10NF | 4822 122 31414 |
| C 2711 | -20+50% 10NF | 4822 122 31414 | C 3324 | -20+50% 10NF | 4822 122 31414 |
| C 2716 | -10+50% 68UF | 4822 124 20689 | C 3326 | -20+50% 10NF | 4822 122 31414 |
| C 2717 | -20+50% 10NF | 4822 122 31414 | C 4001 | 63V 10% 100NF | 5322 121 43083 |
| C 2718 | -20+50% 10NF | 4822 122 31414 | C 4002 | -10+50% 47UF | 4822 124 20699 |
| C 2722 | -20+50% 10NF | 4822 122 31414 | C 4003 | 63V 10% 100NF | 5322 121 43083 |
| C 2726 | -10+50% 68UF | 4822 124 20689 | C 4004 | -20+50% 10NF | 4822 122 31414 |
| C 2727 | -20+50% 10NF | 4822 122 31414 | C 4005 | -20+50% 10NF | 4822 122 31414 |
| C 2728 | -20+50% 10NF | 4822 122 31414 | C 4006 | 10% 4.7NF | 4822 122 31125 |
| C 2741 | -20+50% 10NF | 4822 122 31414 | C 4007 | 10% 4.7NF | 4822 122 31125 |
| C 2744 | -20+50% 10NF | 4822 122 31414 | C 4008 | 10% 470PF | 4822 122 30034 |
| C 2746 | -20+50% 10NF | 4822 122 31414 | C 4009 | 0.25PF 3.9PF | 5322 122 34107 |
| C 2747 | -10+50% 68UF | 4822 124 20689 | C 4011 | 2% 100PF | 4822 122 31316 |
| C 2748 | -20+50% 10NF | 4822 122 31414 | C 4020 | 63V 10% 100NF | 5322 121 43083 |
| C 2751 | -10+50% 47UF | 4822 124 20699 | C 4021 | -10+50% 47UF | 4822 124 20699 |
| C 2752 | -20+50% 10NF | 4822 122 31414 | C 4022 | -20+50% 10NF | 4822 122 31414 |
| C 2753 | -20+50% 10NF | 4822 122 31414 | C 4023 | -20+50% 10NF | 4822 122 31414 |
| C 2754 | -20+50% 10NF | 4822 122 31414 | C 4024 | 2% 47PF | 4822 122 31072 |
| C 2761 | -20+50% 10NF | 4822 122 31414 | C 4026 | 0.25PF 3.9PF | 5322 122 34107 |
| C 2762 | -20+50% 10NF | 4822 122 31414 | C 4027 | 2% 100PF | 4822 122 31316 |
| C 2764 | -20+50% 10NF | 4822 122 31414 | C 4028 | 2% 100PF | 4822 122 31316 |
| C 2771 | -20+50% 10NF | 4822 122 31414 | C 4029 | 2% 100PF | 4822 122 31316 |
| C 2772 | -10+50% 150UF | 4822 124 20672 | C 4101 | -20+50% 10NF | 4822 122 31414 |
| C 2773 | -20+50% 10NF | 4822 122 31414 | C 4103 | -20+50% 10NF | 4822 122 31414 |
| C 2774 | -10+50% 68UF | 4822 124 20689 | C 4105 | 63V 10% 100NF | 5322 121 43083 |
| C 2776 | -20+50% 10NF | 4822 122 31414 | C 4106 | -10+50% 150UF | 4822 124 20672 |
| C 2777 | 63V 10% 100NF | 5322 121 43083 | C 4107 | -20+50% 10NF | 4822 122 31414 |
| C 2781 | -20+50% 10NF | 4822 122 31414 | C 4108 | 2% 100PF | 4822 122 31316 |
| C 3001 | -20+50% 10NF | 4822 122 31414 | C 4109 | -20+50% 10NF | 4822 122 31414 |
| C 3002 | 10% 1.5NF | 4822 122 31169 | C 4110 | 63V 10% 470NF | 5322 121 43085 |
| C 3003 | 10% 1.5NF | 4822 122 31169 | C 4112 | -20+50% 10NF | 4822 122 31414 |
| C 3004 | 7-10.0 PF MUR | 5322 125 11013 | C 4113 | 630V 1% 1NF | 4822 121 50591 |
| C 3005 | 2-20PF MUR | 5322 125 50296 | C 4114 | 100V 10% 10UF | 5322 121 41727 |
| C 3007 | 7-10.0 PF MUR | 5322 125 11013 | C 4116 | 10% 1.5NF | 4822 122 31169 |
| C 3009 | 2% 12PF | 4822 122 31056 | C 4117 | 2% 100PF | 4822 122 31316 |
| C 3011 | 2% 68PF | 4822 122 31349 | C 4118 | -20+50% 10NF | 4822 122 31414 |
| C 3013 | 0.25PF 2.7PF | 4822 122 31038 | C 4120 | 100V 10% 47NF | 5322 121 43088 |
| C 3014 | 0.25PF 2.7PF | 4822 122 31038 | C 4122 | 63V 10% 100NF | 5322 121 43083 |
| C 3016 | 2-20PF MUR | 5322 125 50296 | C 4123 | -10+50% 47UF | 4822 124 20699 |
| C 3017 | -20+50% 10NF | 4822 122 31414 | C 4124 | -20+50% 10NF | 4822 122 31414 |
| C 3018 | 0.25PF 5.6PF | 5322 122 32163 | C 4126 | -10+50% 47UF | 4822 124 20699 |
| C 3021 | -20+50% 10NF | 4822 122 31414 | C 4201 | -20+50% 10NF | 4822 122 31414 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|----------------|----------------|--------|----------------|----------------|
| C 4209 | -20+50% 10NF | 4822 122 31414 | C 6006 | ME275 20% 1NF | 5322 121 42583 |
| C 4212 | -20+50% 10NF | 4822 122 31414 | C 6007 | -20+20% 68UF | 5322 124 21938 |
| C 4213 | 630V 1% 1NF | 4822 121 50591 | C 6008 | -20+20% 68UF | 5322 124 21938 |
| C 4214 | 63V 10% 100NF | 5322 121 43083 | C 6009 | 63V 10% 100NF | 5322 121 43083 |
| C 4216 | 10% 1.5NF | 4822 122 31169 | C 6011 | -10+50% 33UF | 4822 124 20712 |
| C 4217 | 2% 100PF | 4822 122 31316 | C 6012 | 2% 220PF | 4822 122 30094 |
| C 4301 | 63V 10% 100NF | 5322 121 43083 | C 6013 | 10% 4.7NF | 4822 122 31125 |
| C 4302 | -10+50% 4.7UF | 4822 124 20726 | C 6014 | 160V 1% 33NF | 5322 121 50997 |
| C 4303 | 100V 10% 10NF | 5322 121 43086 | C 6017 | 2000V 5% 1.5NF | 4822 121 40541 |
| C 4304 | 2% 330PF | 4822 122 31353 | C 6018 | 10% 4.7NF | 4822 122 31125 |
| C 4306 | -20+50% 10NF | 4822 122 31414 | C 6031 | 10% 2.2NF | 4822 122 30114 |
| C 4307 | -20+50% 10NF | 4822 122 31414 | C 6032 | 63V 10% 220NF | 5322 121 43084 |
| C 4311 | 2% 100PF | 4822 122 31316 | C 6033 | 10% 4.7NF | 4822 122 31125 |
| C 4400 | 10% 1NF | 4822 122 30027 | C 6041 | 63V 10% 100NF | 5322 121 43083 |
| C 4401 | -20+50% 10NF | 4822 122 31414 | C 6042 | 63V 10% 100NF | 5322 121 43083 |
| C 4402 | 10% 1NF | 4822 122 30027 | C 6100 | 20% 6800UF | 4822 124 40692 |
| C 4403 | 63V 10% 100NF | 5322 121 43083 | C 6101 | 20% 6800UF | 4822 124 40692 |
| C 4404 | 63V 10% 100NF | 5322 121 43083 | C 6102 | -10+50% 680UF | 4822 124 20685 |
| C 4405 | -20+50% 10NF | 4822 122 31414 | C 6103 | -10+50% 680UF | 4822 124 20685 |
| C 4406 | 63V 10% 100NF | 5322 121 43083 | C 6104 | -10+50% 220UF | 4822 124 20681 |
| C 4407 | 63V 10% 100NF | 5322 121 43083 | C 6106 | -10+50% 470UF | 4822 124 20695 |
| C 4408 | 63V 10% 100NF | 5322 121 43083 | C 6107 | -10+50% 150UF | 4822 124 20691 |
| C 4409 | -20+50% 10NF | 4822 122 31414 | C 6108 | -10+50% 470UF | 4822 124 20695 |
| C 4411 | -20+50% 10NF | 4822 122 31414 | C 6109 | -10+50% 150UF | 4822 124 20691 |
| C 4412 | -20+50% 10NF | 4822 122 31414 | C 6111 | -10+50% 220UF | 4822 124 20704 |
| C 4413 | -20+50% 10NF | 4822 122 31414 | C 6112 | -10+50% 100UF | 4822 124 20701 |
| C 4414 | -20+50% 10NF | 4822 122 31414 | C 6113 | -10+50% 100UF | 4822 124 20701 |
| C 4416 | 10% 680PF | 4822 122 30053 | C 6114 | -10+50% 100UF | 4822 124 20701 |
| C 4418 | 63V 10% 100NF | 5322 121 43083 | C 6116 | -10+50% 68UF | 4822 124 20734 |
| C 4419 | -20+50% 10NF | 4822 122 31414 | C 6117 | -10+50% 22UF | 4822 124 20731 |
| C 4421 | 63V 10% 100NF | 5322 121 43083 | C 6119 | -10+50% 22UF | 4822 124 20731 |
| C 4501 | -20+50% 10NF | 4822 122 31414 | C 6120 | -20+50% 10NF | 4822 124 31414 |
| C 4502 | -20+50% 10NF | 4822 122 31414 | C 6121 | -10+50% 22UF | 4822 124 20731 |
| C 4503 | 0.25PF 3.9PF | 5322 122 34107 | C 6122 | 630V 1% 680PF | 5322 121 51214 |
| C 4521 | 63V 10% 100NF | 5322 121 43083 | C 6131 | 63V 10% 470NF | 5322 121 43085 |
| C 4522 | 63V 10% 100NF | 5322 121 43083 | C 6132 | -10+50% 100UF | 4822 124 20679 |
| C 4601 | 63V 10% 100NF | 5322 121 43083 | C 6133 | 63V 10% 100NF | 5322 121 43083 |
| C 4602 | 0.25PF 8.2PF | 4822 122 31052 | C 6134 | 10% 1NF | 4822 122 30027 |
| C 4603 | 0.25PF 8.2PF | 4822 122 31052 | C 6135 | -20+50% 10NF | 4822 122 31414 |
| C 4611 | -20+50% 10NF | 4822 122 31414 | C 6201 | 100V 10% 47NF | 5322 121 43088 |
| C 4612 | -20+50% 10NF | 4822 122 31414 | C 6202 | 2% 47PF | 4822 122 31072 |
| C 4613 | 2% 10PF | 4822 122 32185 | C 6203 | 63V 10% 220NF | 5322 121 43084 |
| C 4701 | 10% 1NF | 4822 122 30027 | C 6204 | 63V 10% 100NF | 5322 121 43083 |
| C 4702 | 63V 10% 100NF | 5322 121 43083 | C 6205 | 100V 10% 22NF | 5322 121 43087 |
| C 4703 | 10% 1NF | 4822 122 30027 | C 6206 | 10% 1NF | 4822 122 30027 |
| C 4704 | -20+50% 10NF | 4822 122 31414 | C 6207 | 10% 4.7NF | 4822 122 31125 |
| C 4804 | -10+50% 150UF | 4822 124 20672 | C 6208 | -10+50% 68UF | 4822 124 20734 |
| C 4807 | -20+50% 10NF | 4822 122 31414 | C 6209 | -20+50% 2.2NF | 5322 122 50093 |
| C 4808 | -10+50% 68UF | 4822 124 20689 | C 6211 | -20+50% 10NF | 5322 122 50091 |
| C 4811 | -20+50% 10NF | 4822 122 31414 | C 6212 | -10+10% 33PF | 5322 122 33081 |
| C 4812 | -10+50% 47UF | 4822 124 20699 | C 6213 | 10% 4.7NF | 4822 122 31125 |
| C 4813 | -20+50% 10NF | 4822 122 31414 | C 6214 | 20% 470PF | 5322 122 50086 |
| C 4815 | -20+50% 10NF | 4822 122 31414 | C 6311 | -20+50% 10NF | 4822 122 31414 |
| C 4816 | -20+50% 10NF | 4822 122 31414 | C 6312 | -20+50% 10NF | 4822 122 31414 |
| C 4817 | -20+50% 10NF | 4822 122 31414 | C 6401 | 63V 10% 100NF | 5322 121 43083 |
| C 4818 | -20+50% 10NF | 4822 122 31414 | C 6402 | -10+50% 68UF | 4822 124 20689 |
| C 4819 | -20+50% 10NF | 4822 122 31414 | C 6500 | -10+50% 68UF | 4822 124 20689 |
| C 4820 | -20+50% 10NF | 4822 122 31414 | C 6501 | -20+50% 10NF | 4822 122 31414 |
| C 4821 | -20+50% 10NF | 4822 122 31414 | C 6502 | 100V 10% 10NF | 5322 121 43086 |
| C 4822 | -20+50% 10NF | 4822 122 31414 | C 6503 | 2% 100PF | 4822 122 31316 |
| C 4824 | -20+50% 10NF | 4822 122 31414 | C 6506 | 2% 100PF | 4822 122 31316 |
| C 4825 | -20+50% 10NF | 4822 122 31414 | C 7001 | 63V 10% 220NF | 5322 121 43084 |
| C 4826 | -20+50% 10NF | 4822 122 31414 | C 7002 | 2% 39PF | 4822 122 31069 |
| C 4828 | -20+50% 10NF | 4822 122 31414 | C 7003 | 2% 39PF | 4822 122 31069 |
| C 4829 | -20+50% 10NF | 4822 122 31414 | C 7004 | -20+50% 10NF | 4822 122 31414 |
| C 4830 | -20+50% 10NF | 4822 122 31414 | C 7005 | 63V 10% 100NF | 5322 121 43083 |
| C 4831 | -20+50% 10NF | 4822 122 31414 | C 7006 | -20+50% 10NF | 4822 122 31414 |
| C 4832 | -10+50% 47UF | 4822 124 20699 | C 7007 | 63V 10% 100NF | 5322 121 43083 |
| C 4833 | -20+50% 10NF | 4822 122 31414 | C 7008 | 10% 680PF | 4822 122 30053 |
| C 4835 | -20+50% 10NF | 4822 122 31414 | C 7009 | 63V 10% 100NF | 5322 121 43083 |
| C 4836 | -20+50% 10NF | 4822 122 31414 | C 7011 | -20+50% 10NF | 4822 122 31414 |
| C 4837 | -10+50% 47UF | 4822 124 20699 | C 7012 | -20+50% 10NF | 4822 122 31414 |
| C 4838 | -10+50% 47UF | 4822 124 20699 | C 7013 | -20+50% 10NF | 4822 122 31414 |
| C 4839 | 2% 12PF | 4822 122 31056 | C 7017 | -20+50% 10NF | 4822 122 31414 |
| C 4841 | 2% 12PF | 4822 122 31056 | C 7018 | -20+50% 10NF | 4822 122 31414 |
| C 5001 | -20+50% 10NF | 4822 122 31414 | C 7019 | -20+50% 10NF | 4822 122 31414 |
| C 5002 | -20+50% 10NF | 4822 122 31414 | C 7100 | -20+50% 10NF | 4822 122 31414 |
| C 5003 | -20+50% 10NF | 4822 122 31414 | C 7101 | 63V 10% 100NF | 5322 121 43083 |
| C 5004 | -20+50% 10NF | 4822 122 31414 | C 7102 | 63V 10% 220NF | 5322 121 43084 |
| C 5006 | -20+50% 10NF | 4822 122 31414 | C 7103 | -20+50% 10NF | 4822 122 31414 |
| C 6001 | 250V 10% 220NF | 5322 121 44142 | C 7104 | -10+50% 68UF | 4822 124 20689 |
| C 6002 | ME275 20% 1NF | 5322 121 42583 | C 7106 | -10+50% 68UF | 4822 124 20689 |
| C 6003 | 63V 10% 100NF | 5322 121 43083 | | | |
| C 6004 | 63V 10% 100NF | 5322 121 43083 | | | |
| C 6005 | -20+50% 1.5NF | 5322 122 50092 | | | |

16.4.2 RESISTORS

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|
| R 201 | 0.3W 25% 2K2 | 5322 105 20033 |
| R 202 | MRS25 1% 16K2 | 5322 116 53589 |
| R 203 | MRS25 1% 1K33 | 5322 116 53512 |
| R 204 | MRS25 1% 1K33 | 5322 116 53512 |
| R 206 | MRS25 1% 100E | 5322 116 53126 |
| R 207 | MRS25 1% 100E | 5322 116 53126 |
| R 208 | MRS25 1% 7K5 | 4822 116 53028 |
| R 209 | 0.3W 25% 2K2 | 5322 105 20033 |
| R 211 | MRS25 1% 348E | 5322 116 53591 |
| R 213 | MRS25 1% 51E1 | 5322 116 53213 |
| R 214 | MRS25 1% 23K7 | 5322 116 53537 |
| R 216 | MRS25 1% 287E | 5322 116 53221 |
| R 217 | MRS25 1% 287E | 5322 116 53221 |
| R 218 | MRS25 1% 100E | 5322 116 53126 |
| R 219 | MRS25 1% 825E | 5322 116 53541 |
| R 221 | MRS25 1% 6K19 | 5322 116 53263 |
| R 222 | MRS25 1% 1K78 | 5322 116 53208 |
| R 223 | 0.3W 1% 470E | 5322 105 20028 |
| R 224 | MRS25 1% 10E | 4822 116 52891 |
| R 226 | MRS25 1% 825E | 5322 116 53541 |
| R 227 | MRS25 1% 1K33 | 5322 116 53512 |
| R 228 | MRS25 1% 287E | 5322 116 53221 |
| R 229 | MRS25 1% 51E1 | 5322 116 53213 |
| R 231 | MRS25 1% 1K21 | 4822 116 52956 |
| R 232 | MRS25 1% 1K | 4822 116 53108 |
| R 233 | MRS25 1% 348E | 5322 116 53591 |
| R 251 | MRS25 1% 5E11 | 4822 116 52999 |
| R 252 | MRS25 1% 5E11 | 4822 116 52999 |
| R 253 | MRS25 1% 5E11 | 4822 116 52999 |
| R 401 | MRS25 1% 10E | 4822 116 52891 |
| R 402 | MRS25 1% 10E | 4822 116 52891 |
| R 403 | MRS25 1% 100E | 5322 116 53126 |
| R 404 | MRS25 1% 100E | 5322 116 53126 |
| R 406 | MRS25 1% 1E | 4822 116 52976 |
| R 407 | MRS25 1% 10E | 4822 116 52891 |
| R 408 | MRS25 1% 5K11 | 5322 116 53494 |
| R 409 | MRS25 1% 5K11 | 5322 116 53494 |
| R 411 | MRS25 1% 100E | 4822 116 53108 |
| R 421 | MRS25 1% 5E11 | 4822 116 52999 |
| R 422 | MRS25 1% 5E11 | 4822 116 52999 |
| R 423 | MRS25 1% 5E11 | 4822 116 52999 |
| R 1001 | MRS25 1% 1K | 4822 116 53108 |
| R 1002 | MRS25 1% 42E2 | 5322 116 53515 |
| R 1003 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1004 | 0.25% 10K1 | 5322 116 53404 |
| R 1006 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1007 | 0.25% 900K | 5322 116 53414 |
| R 1008 | MRS25 1% 10K | 4822 116 53022 |
| R 1009 | MRS25 1% 21K5 | 5322 116 53241 |
| R 1011 | 0.25% 111K | 5322 116 53409 |
| R 1012 | 0.25% 750K | 5322 116 53588 |
| R 1013 | 0.25% 1M | 5322 116 53398 |
| R 1014 | MRS25 1% 10K | 4822 116 53022 |
| R 1016 | MRS25 1% 21K5 | 5322 116 53241 |
| R 1017 | 0.25% 250K | 5322 116 53587 |
| R 1018 | MRS25 1% 10E | 4822 116 52891 |
| R 1019 | 0.25% 990K | 5322 116 53415 |
| R 1022 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1023 | VR25 10% 22M | 5322 116 51785 |
| R 1024 | MRS25 1% 10E | 4822 116 52891 |
| R 1026 | MRS25 1% 51E1 | 5322 116 53213 |
| R 1027 | VR25 10% 22M | 5322 116 51785 |
| R 1028 | MRS25 1% 10E | 4822 116 52891 |
| R 1029 | 0.25% 1M | 5322 116 53398 |
| R 1031 | VR25 10% 22M | 5322 116 51785 |
| R 1032 | MRS25 1% 10E | 4822 116 52891 |
| R 1033 | VR25 10% 22M | 5322 116 51785 |
| R 1034 | MRS25 1% 1M | 4822 116 52843 |
| R 1035 | MRS25 1% 100E | 5322 116 53126 |
| R 1036 | 0.3W 25% 22K | 5322 105 20033 |
| R 1037 | MRS25 1% 100K | 4822 116 52973 |
| R 1038 | VR25 10% 22M | 5322 116 51785 |
| R 1039 | MRS25 1% 1K96 | 5322 116 53237 |
| R 1040 | MRS25 1% 287E | 5322 116 53221 |
| R 1041 | MRS25 1% 1K96 | 5322 116 53237 |
| R 1043 | MRS25 1% 100E | 5322 116 53126 |
| R 1044 | MRS25 1% 825E | 5322 116 53541 |
| R 1045 | MRS25 1% 100E | 5322 116 53126 |
| R 1046 | MRS25 1% 511E | 5322 116 53135 |
| R 1047 | MRS25 1% 2K15 | 5322 116 53239 |
| R 1048 | MRS25 1% 5K11 | 5322 116 53494 |
| R 1049 | MRS25 1% 1K47 | 5322 116 53185 |
| R 1050 | MRS25 1% 100E | 5322 116 53126 |
| R 1051 | MRS25 1% 681E | 4822 116 53123 |
| R 1052 | MRS25 1% 1K78 | 5322 116 53208 |
| R 1053 | 0.25% 250E | 5322 116 53406 |
| R 1054 | MRS25 1% 100E | 5322 116 53126 |

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|
| R 1055 | MRS25 1% 1K78 | 5322 116 53208 |
| R 1056 | 0.25% 375E | 5322 116 53407 |
| R 1057 | 0.25% 150E | 5322 116 53399 |
| R 1058 | 0.25% 150E | 5322 116 53399 |
| R 1061 | MRS25 1% 237E | 5322 116 53259 |
| R 1062 | MRS25 1% 133E | 5322 116 53424 |
| R 1063 | MRS25 1% 26K1 | 5322 116 53261 |
| R 1064 | 0.3W 25% 10K | 4822 105 10455 |
| R 1066 | MRS25 1% 16K2 | 5322 116 53589 |
| R 1067 | MRS25 1% 12K1 | 4822 116 52957 |
| R 1068 | MRS25 1% 133E | 5322 116 53424 |
| R 1069 | 0.3W 25% 100E | 5322 105 20029 |
| R 1071 | MRS25 1% 26K1 | 5322 116 53261 |
| R 1072 | 0.3W 25% 10K | 4822 105 10455 |
| R 1073 | MRS25 1% 4K64 | 5322 116 53212 |
| R 1074 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1076 | 0.3W 25% 100E | 5322 105 20029 |
| R 1077 | MRS25 1% 31E6 | 5322 116 54964 |
| R 1078 | MRS25 1% 12K1 | 4822 116 52957 |
| R 1079 | MRS25 1% 1K62 | 5322 116 53257 |
| R 1081 | MRS25 1% 511E | 5322 116 53135 |
| R 1082 | MRS25 1% 100K | 4822 116 52973 |
| R 1083 | MRS25 1% 11K | 4822 116 52907 |
| R 1084 | MRS25 1% 82K5 | 5322 116 53581 |
| R 1086 | MRS25 1% 12K1 | 4822 116 52957 |
| R 1087 | MRS25 1% 1M | 4822 116 52843 |
| R 1088 | MRS25 1% 100E | 5322 116 53126 |
| R 1089 | MRS25 1% 422E | 5322 116 53592 |
| R 1091 | 0.3W 25% 100E | 5322 105 20029 |
| R 1092 | MRS25 1% 10E | 4822 116 52891 |
| R 1093 | MRS25 1% 422E | 5322 116 53592 |
| R 1094 | MRS25 1% 100E | 5322 116 53126 |
| R 1096 | MRS25 1% 100E | 5322 116 53126 |
| R 1097 | MRS25 1% 100E | 5322 116 53126 |
| R 1098 | MRS25 1% 1K21 | 4822 116 52956 |
| R 1099 | MRS25 1% 1K21 | 4822 116 52956 |
| R 1101 | MRS25 1% 1K | 4822 116 53108 |
| R 1102 | MRS25 1% 42E2 | 5322 116 53515 |
| R 1103 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1104 | 0.25% 10K1 | 5322 116 53404 |
| R 1106 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1107 | 0.25% 900K | 5322 116 53414 |
| R 1108 | MRS25 1% 10K | 4822 116 53022 |
| R 1109 | MRS25 1% 21K5 | 5322 116 53241 |
| R 1111 | 0.25% 111K | 5322 116 53409 |
| R 1112 | 0.25% 750K | 5322 116 53588 |
| R 1113 | 0.25% 1M | 5322 116 53398 |
| R 1114 | MRS25 1% 10K | 4822 116 53022 |
| R 1116 | MRS25 1% 21K5 | 5322 116 53241 |
| R 1117 | 0.25% 250K | 5322 116 53587 |
| R 1118 | MRS25 1% 10E | 4822 116 52891 |
| R 1119 | 0.25% 990K | 5322 116 53415 |
| R 1122 | MRS25 1% 61E9 | 5322 116 53645 |
| R 1123 | VR25 10% 22M | 5322 116 51785 |
| R 1124 | MRS25 1% 10E | 4822 116 52891 |
| R 1126 | MRS25 1% 51E1 | 5322 116 53213 |
| R 1127 | VR25 10% 22M | 5322 116 51785 |
| R 1128 | MRS25 1% 10E | 4822 116 52891 |
| R 1129 | 0.25% 1M | 5322 116 53398 |
| R 1131 | VR25 10% 22M | 5322 116 51785 |
| R 1132 | MRS25 1% 10E | 4822 116 52891 |
| R 1133 | VR25 10% 22M | 5322 116 51785 |
| R 1134 | MRS25 1% 1M | 4822 116 52843 |
| R 1135 | MRS25 1% 100E | 5322 116 53126 |
| R 1136 | 0.3W 25% 22K | 5322 105 20035 |
| R 1137 | MRS25 1% 100K | 4822 116 52973 |
| R 1138 | VR25 10% 22M | 5322 116 51785 |
| R 1139 | MRS25 1% 1K96 | 5322 116 53237 |
| R 1140 | MRS25 1% 287E | 5322 116 53221 |
| R 1141 | MRS25 1% 1K96 | 5322 116 53237 |
| R 1143 | MRS25 1% 100E | 5322 116 53126 |
| R 1144 | MRS25 1% 825E | 5322 116 53541 |
| R 1145 | MRS25 1% 100E | 5322 116 53126 |
| R 1146 | MRS25 1% 511E | 5322 116 53135 |
| R 1147 | MRS25 1% 2K15 | 5322 116 53239 |
| R 1148 | MRS25 1% 5K11 | 5322 116 53494 |
| R 1149 | MRS25 1% 1K47 | 5322 116 53185 |
| R 1150 | MRS25 1% 100E | 5322 116 53126 |
| R 1151 | MRS25 1% 681E | 4822 116 53123 |
| R 1152 | MRS25 1% 1K78 | 5322 116 53208 |
| R 1153 | 0.25% 250E | 5322 116 53406 |
| R 1154 | MRS25 1% 100E | 5322 116 53126 |
| R 1155 | MRS25 1% 1K78 | 5322 116 53208 |
| R 1156 | 0.25% 375E | 5322 116 53407 |
| R 1157 | 0.25% 150E | 5322 116 53399 |
| R 1158 | 0.25% 150E | 5322 116 53399 |
| R 1161 | MRS25 1% 237E | 5322 116 53259 |
| R 1162 | MRS25 1% 133E | 5322 116 53424 |
| R 1163 | MRS25 1% 26K1 | 5322 116 53261 |
| R 1164 | 0.3W 25% 10K | 4822 105 10455 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|--------|---------------|----------------|
| R 1166 | MRS25 1% 16K2 | 5322 116 53589 | R 2221 | MRS25 1% 19K6 | 5322 116 53258 |
| R 1167 | MRS25 1% 12K1 | 4822 116 52957 | R 2222 | MRS25 1% 1K96 | 5322 116 53237 |
| R 1168 | MRS25 1% 133E | 5322 116 53424 | R 2225 | MRS25 1% 23K7 | 5322 116 53537 |
| R 1169 | 0.3W 25% 100E | 5322 105 20029 | R 2230 | MRS25 1% 316E | 5322 116 53514 |
| R 1171 | MRS25 1% 26K1 | 5322 116 53261 | R 2231 | MRS25 1% 261E | 5322 116 53549 |
| R 1172 | 0.3W 25% 10K | 4822 105 10455 | R 2232 | MRS25 1% 383E | 5322 116 53332 |
| R 1173 | MRS25 1% 4K64 | 5322 116 53212 | R 2234 | MRS25 1% 42E2 | 5322 116 53515 |
| R 1174 | MRS25 1% 5K62 | 5322 116 53495 | R 2236 | MRS25 1% 681E | 4822 116 53123 |
| R 1176 | 0.3W 25% 100E | 5322 105 20029 | R 2237 | MRS25 1% 383E | 5322 116 53332 |
| R 1177 | MRS25 1% 31E6 | 5322 116 54964 | R 2239 | MRS25 1% 348E | 5322 116 53591 |
| R 1178 | MRS25 1% 12K1 | 4822 116 52957 | R 2241 | MRS25 1% 1K | 4822 116 53108 |
| R 1179 | MRS25 1% 1K62 | 5322 116 53257 | R 2242 | MRS25 1% 383E | 5322 116 53332 |
| R 1181 | MRS25 1% 511E | 5322 116 53135 | R 2243 | MRS25 1% 681E | 4822 116 53123 |
| R 1182 | MRS25 1% 100K | 4822 116 52973 | R 2244 | MRS25 1% 42E2 | 5322 116 53515 |
| R 1183 | MRS25 1% 11K | 4822 116 52907 | R 2246 | MRS25 1% 261E | 5322 116 53549 |
| R 1184 | MRS25 1% 82K5 | 5322 116 53581 | R 2247 | MRS25 1% 383E | 5322 116 53332 |
| R 1186 | MRS25 1% 12K1 | 4822 116 52957 | R 2251 | MRS25 1% 75E | 5322 116 53339 |
| R 1187 | MRS25 1% 1M | 4822 116 52843 | R 2252 | MRS25 1% 750E | 5322 116 53265 |
| R 1188 | MRS25 1% 100E | 5322 116 53126 | R 2253 | MRS25 1% 750E | 5322 116 53265 |
| R 1189 | MRS25 1% 422E | 5322 116 53592 | R 2254 | MRS25 1% 75E | 5322 116 53339 |
| R 1191 | 0.3W 25% 100E | 5322 105 20029 | R 2255 | MRS25 1% 287E | 5322 116 53221 |
| R 1192 | MRS25 1% 10E | 4822 116 52891 | R 2301 | MRS25 1% 19K6 | 5322 116 53258 |
| R 1193 | MRS25 1% 422E | 5322 116 53592 | R 2302 | MRS25 1% 19K6 | 5322 116 53258 |
| R 1194 | MRS25 1% 100E | 5322 116 53126 | R 2303 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1196 | MRS25 1% 100E | 5322 116 53126 | R 2304 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1197 | MRS25 1% 100E | 5322 116 53126 | R 2311 | MRS25 1% 2K87 | 5322 116 53513 |
| R 1198 | MRS25 1% 1K21 | 4822 116 52956 | R 2317 | MRS25 1% 681E | 4822 116 53123 |
| R 1199 | MRS25 1% 1K21 | 4822 116 52956 | R 2318 | MRS25 1% 681E | 4822 116 53123 |
| R 1201 | MRS25 1% 1K | 4822 116 53108 | R 2319 | MRS25 1% 5E11 | 4822 116 52999 |
| R 1202 | MRS25 1% 61E9 | 5322 116 53645 | R 2324 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1203 | 0.1% 1M | 5322 116 51605 | R 2325 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1204 | VR25 10% 22M | 5322 116 51785 | R 2326 | MRS25 1% 2K87 | 5322 116 53513 |
| R 1206 | MRS25 1% 1K96 | 5322 116 53237 | R 2327 | MRS25 1% 3K83 | 4822 116 53079 |
| R 1207 | MRS25 1% 100E | 5322 116 53126 | R 2328 | MRS25 1% 2K87 | 5322 116 53513 |
| R 1208 | MRS25 1% 825E | 5322 116 53541 | R 2329 | MRS25 1% 825E | 5322 116 53541 |
| R 1209 | MRS25 1% 1M | 4822 116 52843 | R 2330 | 0.3W 25% 10K | 4822 105 10455 |
| R 1211 | MRS25 1% 100E | 5322 116 53126 | R 2333 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1213 | MRS25 1% 1M | 4822 116 52843 | R 2334 | MRS25 1% 5K62 | 5322 116 53495 |
| R 1217 | 0.3W 25% 22K | 5322 105 20035 | R 2335 | MRS25 1% 10K | 4822 116 53022 |
| R 1218 | MRS25 1% 100K | 4822 116 52973 | R 2336 | MRS25 1% 31E6 | 5322 116 54964 |
| R 1219 | MRS25 1% 1K47 | 5322 116 53185 | R 2337 | MRS25 1% 162E | 5322 116 53523 |
| R 1221 | MRS25 1% 681E | 4822 116 53123 | R 2338 | MRS25 1% 2K61 | 5322 116 53327 |
| R 1222 | MRS25 1% 2K87 | 5322 116 53513 | R 2339 | MRS25 1% 237E | 5322 116 53259 |
| R 1223 | MRS25 1% 1K33 | 5322 116 53512 | R 2341 | MRS25 1% 31E6 | 5322 116 54964 |
| R 1224 | MRS25 1% 1K | 4822 116 53108 | R 2342 | MRS25 1% 162E | 5322 116 53523 |
| R 1226 | MRS25 1% 5K11 | 5322 116 53494 | R 2344 | MRS25 1% 511E | 5322 116 53135 |
| R 1227 | MRS25 1% 1K33 | 5322 116 53512 | R 2345 | MRS25 1% 100E | 5322 116 53126 |
| R 1228 | MRS25 1% 100E | 5322 116 53126 | R 2346 | MRS25 1% 681E | 4822 116 53123 |
| R 1229 | MRS25 1% 750E | 5322 116 53265 | R 2348 | MRS25 1% 8K25 | 5322 116 53267 |
| R 1231 | MRS25 1% 750E | 5322 116 53265 | R 2350 | MRS25 1% 4K22 | 5322 116 53246 |
| R 1232 | MRS25 1% 1E | 4822 116 52976 | R 2351 | MRS25 1% 562E | 5322 116 53214 |
| R 1233 | MRS25 1% 348E | 5322 116 53591 | R 2352 | MRS25 1% 825E | 5322 116 53541 |
| R 1234 | MRS25 1% 100E | 5322 116 53126 | R 2357 | MRS25 1% 681E | 4822 116 53123 |
| R 1236 | MRS25 1% 162E | 5322 116 53523 | R 2358 | MRS25 1% 511E | 5322 116 53135 |
| R 1237 | MRS25 1% 2K61 | 5322 116 53327 | R 2360 | MRS25 1% 100E | 5322 116 53126 |
| R 1238 | MRS25 1% 100E | 5322 116 53126 | R 2361 | MRS25 1% 4K22 | 5322 116 53246 |
| R 1239 | MRS25 1% 7K5 | 4822 116 53028 | R 2365 | MRS25 1% 23K7 | 5322 116 53537 |
| R 1401 | MRS25 1% 5E11 | 4822 116 52999 | R 2366 | MRS25 1% 10K | 4822 116 53022 |
| R 1402 | MRS25 1% 5E11 | 4822 116 52999 | R 2367 | MRS25 1% 16K2 | 5322 116 53589 |
| R 1403 | MRS25 1% 5E11 | 4822 116 52999 | R 2369 | MRS25 1% 68K1 | 5322 116 53338 |
| R 1404 | MRS25 1% 5E11 | 4822 116 52999 | R 2371 | MRS25 1% 422E | 5322 116 53592 |
| R 1421 | MRS25 1% 5E11 | 4822 116 52999 | R 2372 | MRS25 1% 511E | 5322 116 53135 |
| R 1422 | MRS25 1% 5E11 | 4822 116 52999 | R 2373 | MRS25 1% 75K | 5322 116 53266 |
| R 1423 | MRS25 1% 5E11 | 4822 116 52999 | R 2374 | MRS25 1% 511E | 5322 116 53135 |
| R 1424 | MRS25 1% 5E11 | 4822 116 52999 | R 2375 | MRS25 1% 23K7 | 5322 116 53537 |
| R 1441 | MRS25 1% 100E | 5322 116 53126 | R 2376 | VR25 10% 22M | 5322 116 51785 |
| R 1442 | MRS25 1% 5E11 | 4822 116 52999 | R 2377 | VR25 10% 22M | 5322 116 51785 |
| R 1443 | MRS25 1% 5E11 | 4822 116 52999 | R 2378 | VR25 10% 22M | 5322 116 51785 |
| R 2001 | MRS25 1% 10E | 4822 116 52891 | R 2379 | VR25 10% 22M | 5322 116 51785 |
| R 2002 | MRS25 1% 10E | 4822 116 52891 | R 2380 | MRS25 1% 750E | 5322 116 53265 |
| R 2003 | MRS25 1% 51E1 | 5322 116 53213 | R 2381 | MRS25 1% 2K61 | 5322 116 53327 |
| R 2004 | MRS25 1% 51E1 | 5322 116 53213 | R 2382 | MRS25 1% 2K61 | 5322 116 53327 |
| R 2101 | MRS25 1% 10E | 4822 116 52891 | R 2383 | MRS25 1% 1K | 4822 116 53108 |
| R 2102 | MRS25 1% 10E | 4822 116 52891 | R 2384 | MRS25 1% 750E | 5322 116 53265 |
| R 2103 | MRS25 1% 51E1 | 5322 116 53213 | R 2386 | MRS25 1% 1K | 4822 116 53108 |
| R 2104 | MRS25 1% 51E1 | 5322 116 53213 | R 2387 | MRS25 1% 750E | 5322 116 53265 |
| R 2201 | MRS25 1% 75K | 5322 116 53266 | R 2388 | MRS25 1% 1K | 4822 116 53108 |
| R 2202 | MRS25 1% 12K1 | 4822 116 52957 | R 2389 | MRS25 1% 1K | 4822 116 53108 |
| R 2203 | MRS25 1% 215K | 5322 116 53425 | R 2391 | MRS25 1% 42E2 | 5322 116 53515 |
| R 2204 | MRS25 1% 10K | 4822 116 53022 | R 2393 | MRS25 1% 3K48 | 4822 116 53315 |
| R 2205 | MRS25 1% 2K15 | 5322 116 53239 | R 2394 | MRS25 1% 100E | 5322 116 53126 |
| R 2206 | MRS25 1% 75K | 5322 116 53266 | R 2395 | 0.3W 25% 220E | 5322 105 20031 |
| R 2207 | MRS25 1% 12K1 | 4822 116 52957 | R 2396 | MRS25 1% 3K48 | 4822 116 53315 |
| R 2208 | MRS25 1% 215K | 5322 116 53425 | R 2397 | MRS25 1% 42E2 | 5322 116 53515 |
| R 2209 | MRS25 1% 10K | 4822 116 53022 | R 2398 | MRS25 1% 237E | 5322 116 53259 |
| R 2210 | MRS25 1% 2K15 | 5322 116 53239 | R 2403 | MRS25 1% 42E2 | 5322 116 53515 |
| R 2211 | MRS25 1% 5K62 | 5322 116 53495 | R 2404 | MRS25 1% 619E | 5322 116 53337 |
| R 2212 | 0.3W 25% 10K | 4822 105 10455 | R 2406 | MRS25 1% 1K62 | 5322 116 53257 |
| R 2213 | MRS25 1% 23K7 | 5322 116 53537 | R 2407 | 0.3W 25% 220E | 5322 105 20031 |
| R 2214 | MRS25 1% 10K | 4822 116 53022 | R 2408 | MRS25 1% 1K33 | 5322 116 53512 |
| R 2215 | MRS25 1% 2K15 | 5322 116 53239 | R 2409 | MRS25 1% 1K62 | 5322 116 53257 |
| R 2216 | MRS25 1% 5K62 | 5322 116 53495 | R 2410 | 0.3W 25% 1K | 5322 105 20032 |
| R 2217 | MRS25 1% 100K | 4822 116 52973 | R 2411 | MRS25 1% 42E2 | 5322 116 53515 |
| R 2218 | MRS25 1% 4K64 | 5322 116 53212 | R 2412 | MRS25 1% 619E | 5322 116 53337 |
| R 2219 | MRS25 1% 316K | 4822 116 53058 | R 2416 | MRS25 1% 1K | 4822 116 53108 |

| POSNR | DESCRIPTION | ORDERING | CODE | POSNR | DESCRIPTION | ORDERING | CODE |
|--------|---------------|----------|-------|--------|---------------|----------|-------|
| R 2418 | MRS25 1% 4K22 | 5322 116 | 53246 | R 3023 | MRS25 1% 348E | 5322 116 | 53591 |
| R 2419 | MRS25 1% 1K1 | 5322 116 | 53473 | R 3024 | MRS25 1% 750E | 5322 116 | 53265 |
| R 2420 | MRS25 1% 825E | 5322 116 | 53541 | R 3025 | MRS25 1% 10E | 4822 116 | 52891 |
| R 2421 | MRS25 1% 4K22 | 5322 116 | 53246 | | | | |
| R 2422 | MRS25 1% 1K | 4822 116 | 53108 | R 3026 | MRS25 1% 464E | 5322 116 | 53232 |
| | | | | R 3027 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2430 | MRS25 1% 100K | 4822 116 | 52973 | R 3028 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2431 | MRS25 1% 100K | 4822 116 | 52973 | R 3029 | MRS25 1% 3K16 | 4822 116 | 53021 |
| R 2432 | MRS25 1% 100K | 4822 116 | 52973 | R 3031 | MRS25 1% 402E | 5322 116 | 53639 |
| R 2433 | MRS25 1% 100K | 4822 116 | 52973 | | | | |
| R 2434 | MRS25 1% 10K | 4822 116 | 53022 | R 3032 | MRS25 1% 31E6 | 5322 116 | 54964 |
| | | | | R 3033 | MRS25 1% 100E | 5322 116 | 53126 |
| R 2435 | MRS25 1% 10K | 4822 116 | 53022 | R 3034 | MRS25 1% 162E | 5322 116 | 53523 |
| R 2501 | MRS25 1% 19K6 | 5322 116 | 53258 | R 3036 | 0.3W 25% 100E | 5322 105 | 20029 |
| R 2502 | MRS25 1% 19K6 | 5322 116 | 53258 | R 3037 | MRS25 1% 100E | 5322 116 | 53126 |
| R 2503 | MRS25 1% 5K62 | 5322 116 | 53495 | | | | |
| R 2504 | MRS25 1% 2K87 | 5322 116 | 53513 | R 3038 | 0.3W 25% 470E | 5322 105 | 20028 |
| | | | | R 3039 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2522 | MRS25 1% 5K62 | 5322 116 | 53495 | R 3041 | MRS25 1% 31E6 | 5322 116 | 53514 |
| R 2523 | MRS25 1% 5K62 | 5322 116 | 53495 | R 3042 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2527 | MRS25 1% 100K | 4822 116 | 52973 | R 3043 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2528 | MRS25 1% 12K1 | 4822 116 | 52957 | | | | |
| R 2529 | MRS25 1% 316K | 4822 116 | 53058 | R 3044 | MRS25 1% 110E | 4822 116 | 52906 |
| | | | | R 3046 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2541 | MRS25 1% 162E | 5322 116 | 53523 | R 3047 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2542 | MRS25 1% 1K62 | 5322 116 | 53257 | R 3048 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2543 | MRS25 1% 681E | 4822 116 | 53123 | R 3049 | MRS25 1% 100K | 4822 116 | 52973 |
| R 2544 | MRS25 1% 121E | 4822 116 | 52955 | | | | |
| R 2547 | MRS25 1% 511E | 5322 116 | 53135 | R 3050 | MRS25 1% 42E2 | 5322 116 | 53515 |
| | | | | R 3051 | MRS25 1% 100K | 4822 116 | 52973 |
| R 2548 | MRS25 1% 1K21 | 4822 116 | 52956 | R 3052 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2549 | MRS25 1% 1K33 | 5322 116 | 53512 | R 3060 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2551 | MRS25 1% 162E | 5322 116 | 53523 | R 3061 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2552 | MRS25 1% 681E | 4822 116 | 53123 | | | | |
| R 2553 | MRS25 1% 1K62 | 5322 116 | 53257 | R 3062 | MRS25 1% 110E | 4822 116 | 52906 |
| | | | | R 3063 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2554 | MRS25 1% 42E2 | 5322 116 | 53515 | R 3064 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2555 | MRS25 1% 8K25 | 5322 116 | 53267 | R 3066 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2556 | MRS25 1% 42E2 | 5322 116 | 53515 | R 3067 | MRS25 1% 110E | 4822 116 | 52906 |
| R 2557 | MRS25 1% 4K22 | 5322 116 | 53246 | | | | |
| R 2558 | MRS25 1% 4K22 | 5322 116 | 53246 | R 3068 | MRS25 1% 110E | 4822 116 | 52906 |
| | | | | R 3100 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2559 | MRS25 1% 100E | 5322 116 | 53126 | R 3101 | MRS25 1% 5K62 | 5322 116 | 53495 |
| R 2601 | MRS25 1% 3K48 | 4822 116 | 53315 | R 3102 | MRS25 1% 562E | 5322 116 | 53214 |
| R 2602 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3103 | MRS25 1% 1K21 | 4822 116 | 52956 |
| R 2603 | MRS25 1% 5K11 | 5322 116 | 53494 | | | | |
| R 2604 | MRS25 1% 5K11 | 5322 116 | 53494 | R 3104 | MRS25 1% 6K81 | 5322 116 | 53252 |
| | | | | R 3106 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2605 | MRS25 1% 12K1 | 4822 116 | 52957 | R 3107 | MRS25 1% 2K87 | 5322 116 | 53513 |
| R 2606 | MRS25 1% 1E | 4822 116 | 52976 | R 3108 | MRS25 1% 825E | 5322 116 | 53541 |
| R 2610 | MRS25 1% 10K | 4822 116 | 53022 | R 3109 | MRS25 1% 6K19 | 5322 116 | 53263 |
| R 2611 | MRS25 1% 1K | 4822 116 | 53108 | | | | |
| R 2621 | MRS25 1% 422E | 5322 116 | 53592 | R 3110 | MRS25 1% 42E2 | 5322 116 | 53515 |
| | | | | R 3111 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2622 | MRS25 1% 681E | 4822 116 | 53123 | R 3112 | MRS25 1% 7K5 | 4822 116 | 53028 |
| R 2623 | MRS25 1% 1K1 | 5322 116 | 53473 | R 3113 | MRS25 1% 1K21 | 4822 116 | 52956 |
| R 2624 | MRS25 1% 3K48 | 4822 116 | 53315 | R 3114 | MRS25 1% 5K62 | 5322 116 | 53495 |
| R 2625 | MRS25 1% 681E | 4822 116 | 53123 | | | | |
| R 2626 | MRS25 1% 6K81 | 5322 116 | 53252 | R 3115 | MRS25 1% 42E2 | 5322 116 | 53515 |
| | | | | R 3116 | MRS25 1% 562E | 5322 116 | 53214 |
| R 2627 | MRS25 1% 287E | 5322 116 | 53221 | R 3117 | MRS25 1% 4K64 | 5322 116 | 53212 |
| R 2628 | MRS25 1% 2K37 | 5322 116 | 53536 | R 3118 | 0.3W 25% 1K | 5322 105 | 20032 |
| R 2629 | MRS25 1% 10K | 4822 116 | 53022 | R 3119 | MRS25 1% 4K64 | 5322 116 | 53212 |
| R 2631 | MRS25 1% 10K | 4822 116 | 53022 | | | | |
| R 2632 | MRS25 1% 383E | 5322 116 | 53332 | R 3120 | MRS25 1% 42E2 | 5322 116 | 53515 |
| | | | | R 3121 | MRS25 1% 46K4 | 5322 116 | 53314 |
| R 2635 | MRS25 1% 10K | 4822 116 | 53022 | R 3122 | MRS25 1% 6K81 | 5322 116 | 53252 |
| R 2701 | MRS25 1% 1E | 4822 116 | 52976 | R 3124 | MRS25 1% 619E | 5322 116 | 53337 |
| R 2702 | MRS25 1% 10E | 4822 116 | 52891 | R 3125 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2703 | MRS25 1% 5E11 | 4822 116 | 52999 | | | | |
| R 2704 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3126 | MRS25 1% 14K7 | 4822 116 | 53531 |
| | | | | R 3127 | MRS25 1% 1K33 | 5322 116 | 53512 |
| R 2712 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3128 | MRS25 1% 825E | 5322 116 | 53541 |
| R 2713 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3129 | MRS25 1% 1K1 | 5322 116 | 53473 |
| R 2714 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3130 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 2721 | MRS25 1% 5E11 | 4822 116 | 52999 | | | | |
| R 2722 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3131 | MRS25 1% 1K33 | 5322 116 | 53512 |
| | | | | R 3132 | MRS25 1% 825E | 5322 116 | 53541 |
| R 2723 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3133 | MRS25 1% 6K19 | 5322 116 | 53263 |
| R 2724 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3134 | MRS25 1% 14K7 | 4822 116 | 53531 |
| R 2731 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3136 | MRS25 1% 1K | 4822 116 | 53108 |
| R 2732 | MRS25 1% 5E11 | 4822 116 | 52999 | | | | |
| R 2733 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3137 | MRS25 1% 46K4 | 5322 116 | 53314 |
| | | | | R 3138 | MRS25 1% 6K81 | 5322 116 | 53252 |
| R 2740 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3139 | MRS25 1% 619E | 5322 116 | 53337 |
| R 2741 | MRS25 1% 31E6 | 5322 116 | 54964 | R 3141 | MRS25 1% 31E6 | 5322 116 | 53514 |
| R 2742 | MRS25 1% 5E11 | 4822 116 | 52999 | R 3142 | MRS25 1% 31E6 | 5322 116 | 53514 |
| R 3001 | MRS25 1% 147E | 5322 116 | 53569 | | | | |
| R 3002 | MRS25 1% 31E6 | 5322 116 | 53514 | R 3143 | MRS25 1% 10E | 4822 116 | 52891 |
| | | | | R 3144 | MRS25 1% 10E | 4822 116 | 52891 |
| R 3003 | MRS25 1% 1K47 | 5322 116 | 53185 | R 3147 | 0.5W 10% 3K3 | 5322 116 | 30234 |
| R 3004 | MRS25 1% 422E | 5322 116 | 53592 | R 3148 | MRS25 1% 9K09 | 5322 116 | 53253 |
| R 3006 | MRS25 1% 2K37 | 5322 116 | 53536 | R 3200 | MRS25 1% 6K81 | 5322 116 | 53252 |
| R 3007 | 0.3W 25% 2K2 | 5322 105 | 20033 | | | | |
| R 3008 | MRS25 1% 121E | 4822 116 | 52955 | R 3201 | MRS25 1% 1K21 | 4822 116 | 52956 |
| | | | | R 3202 | MRS25 1% 100E | 5322 116 | 53126 |
| R 3009 | MRS25 1% 3K83 | 4822 116 | 53079 | R 3203 | MRS25 1% 16K2 | 5322 116 | 53589 |
| R 3011 | MRS25 1% 121E | 4822 116 | 52955 | R 3204 | MRS25 1% 562E | 5322 116 | 53214 |
| R 3012 | MRS25 1% 31E6 | 5322 116 | 53514 | R 3205 | MRS25 1% 4K64 | 5322 116 | 53212 |
| R 3013 | 0.3W 25% 10K | 4822 105 | 10455 | | | | |
| R 3014 | MRS25 1% 2K87 | 5322 116 | 53513 | R 3206 | MRS25 1% 4K64 | 5322 116 | 53212 |
| | | | | R 3207 | MRS25 1% 82K5 | 5322 116 | 53581 |
| R 3015 | MRS25 1% 31E6 | 5322 116 | 53514 | R 3208 | MRS25 1% 7K5 | 4822 116 | 53028 |
| R 3016 | MRS25 1% 2K37 | 5322 116 | 53536 | R 3209 | MRS25 1% 1K | 4822 116 | 53108 |
| R 3017 | 0.3W 25% 22K | 5322 105 | 20035 | R 3210 | MRS25 1% 42E2 | 5322 116 | 53515 |
| R 3018 | MRS25 1% 8K25 | 5322 116 | 53267 | | | | |
| R 3020 | MRS25 1% 10E | 4822 116 | 52891 | R 3211 | MRS25 1% 10K | 4822 116 | 53022 |
| | | | | R 3212 | MRS25 1% 1K47 | 5322 116 | 53185 |
| R 3021 | MRS25 1% 464E | 5322 116 | 53232 | R 3213 | MRS25 1% 23K7 | 5322 116 | 53537 |
| R 3022 | MRS25 1% 750E | 5322 116 | 53265 | R 3214 | MRS25 1% 31K6 | 5322 116 | 53262 |
| | | | | R 3215 | MRS25 1% 4K64 | 5322 116 | 53212 |

| POSNR | DESCRIPTION | ORDERING | CODE | POSNR | DESCRIPTION | ORDERING | CODE |
|--------|---------------|----------|-----------|--------|---------------|----------|-----------|
| R 3216 | MRS25 1% 178K | 5322 | 116 53555 | R 4117 | MRS25 1% 3K16 | 4822 | 116 53021 |
| R 3217 | MRS25 1% 511E | 5322 | 116 53135 | R 4118 | 0.25% 50E | 5322 | 116 53405 |
| R 3218 | MRS25 1% 61K9 | 5322 | 116 53233 | R 4119 | 0.25% 50E | 5322 | 116 53405 |
| R 3219 | MRS25 1% 1M | 4822 | 116 52843 | R 4120 | MRS25 1% 1K | 4822 | 116 53108 |
| R 3221 | MRS25 1% 100E | 5322 | 116 53126 | R 4121 | 0.25% 150E | 5322 | 116 53399 |
| R 3222 | MRS25 1% 100K | 4822 | 116 52973 | R 4122 | 0.25% 250E | 5322 | 116 53406 |
| R 3223 | MRS25 1% 38K3 | 4822 | 116 53526 | R 4123 | 0.25% 500E | 5322 | 116 53408 |
| R 3224 | MRS25 1% 2K37 | 5322 | 116 53536 | R 4124 | 0.25% 1K5 | 5322 | 116 53401 |
| R 3226 | MRS25 1% 100E | 5322 | 116 53126 | R 4125 | MRS25 1% 100E | 5322 | 116 53126 |
| R 3250 | MRS25 1% 2K37 | 5322 | 116 53536 | R 4126 | MRS25 1% 9K09 | 5322 | 116 53253 |
| R 3251 | MRS25 1% 1M | 4822 | 116 52843 | R 4127 | MRS25 1% 1K62 | 5322 | 116 53257 |
| R 3253 | MRS25 1% 75K | 5322 | 116 53266 | R 4128 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 3254 | MRS25 1% 1K | 4822 | 116 53108 | R 4129 | MRS25 1% 1M | 4822 | 116 52843 |
| R 3256 | MRS25 1% 178K | 5322 | 116 53555 | R 4130 | MRS25 1% 1K | 4822 | 116 53108 |
| R 3257 | MRS25 1% 825K | 5322 | 116 53341 | R 4131 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 3258 | VR25 5% 3M3 | 4822 | 110 72201 | R 4132 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 3259 | VR25 5% 3M3 | 4822 | 110 72201 | R 4133 | MRS25 1% 1K | 4822 | 116 53108 |
| R 3261 | VR25 5% 3M3 | 4822 | 110 72201 | R 4134 | MRS25 1% 10K | 4822 | 116 53022 |
| R 3262 | VR25 5% 7M5 | 5322 | 116 60131 | R 4135 | MRS25 1% 1K | 4822 | 116 53108 |
| R 3263 | VR25 5% 3M3 | 4822 | 110 72201 | R 4136 | MRS25 1% 10K | 4822 | 116 53022 |
| R 3267 | 25% 47K | 5322 | 105 20037 | R 4137 | MRS25 1% 14K7 | 4822 | 116 53531 |
| R 3268 | MRS25 1% 681K | 5322 | 116 53593 | R 4138 | MRS25 1% 5E11 | 4822 | 116 52999 |
| R 3269 | MRS25 1% 15K4 | 5322 | 116 53234 | R 4139 | MRS25 1% 10K | 4822 | 116 53022 |
| R 3270 | MRS25 1% 23K7 | 5322 | 116 53537 | R 4140 | MRS25 1% 10K | 4822 | 116 53022 |
| R 3271 | MRS25 1% 14K7 | 4822 | 116 53531 | R 4141 | MRS25 1% 14K7 | 4822 | 116 53531 |
| R 3273 | MRS25 1% 215K | 5322 | 116 53425 | R 4142 | MRS25 1% 100E | 5322 | 116 53126 |
| R 3301 | MRS25 1% 10E | 4822 | 116 52891 | R 4143 | 0.1% 20K | 5322 | 116 52697 |
| R 3302 | MRS25 1% 1E | 4822 | 116 52976 | R 4144 | 0.1% 202E | 5322 | 116 53413 |
| R 3303 | MRS25 1% 5E11 | 4822 | 116 52999 | R 4145 | MRS25 1% 1K | 4822 | 116 53108 |
| R 3304 | MRS25 1% 5E11 | 4822 | 116 52999 | R 4146 | MRS25 1% 10K | 4822 | 116 53022 |
| R 3306 | MRS25 1% 2K87 | 5322 | 116 53513 | R 4147 | MRS25 1% 511E | 5322 | 116 53135 |
| R 3308 | MRS25 1% 10E | 4822 | 116 52891 | R 4148 | MRS25 1% 21K5 | 5322 | 116 53241 |
| R 3309 | MRS25 1% 5E11 | 4822 | 116 52999 | R 4149 | MRS25 1% 31E6 | 5322 | 116 54964 |
| R 3311 | MRS25 1% 5E11 | 4822 | 116 52999 | R 4150 | MRS25 1% 9E09 | 5322 | 116 53516 |
| R 3312 | MRS25 1% 5E11 | 4822 | 116 52999 | R 4151 | MRS25 1% 2K61 | 5322 | 116 53327 |
| R 3313 | MRS25 1% 10E | 4822 | 116 52891 | R 4152 | MRS25 1% 162E | 5322 | 116 53523 |
| R 4000 | MRS25 1% 51E1 | 5322 | 116 53213 | R 4153 | MRS25 1% 1K1 | 5322 | 116 53473 |
| R 4001 | MRS25 1% 619E | 5322 | 116 53337 | R 4154 | MRS25 1% 1K78 | 5322 | 116 53208 |
| R 4002 | MRS25 1% 511E | 5322 | 116 53135 | R 4155 | MRS25 1% 2K15 | 5322 | 116 53239 |
| R 4003 | MRS25 1% 511E | 5322 | 116 53135 | R 4156 | MRS25 1% 1M | 4822 | 116 52843 |
| R 4004 | MRS25 1% 6K19 | 5322 | 116 53263 | R 4157 | MRS25 1% 1E | 4822 | 116 52976 |
| R 4005 | MRS25 1% 100E | 5322 | 116 53126 | R 4158 | MRS25 1% 1M | 4822 | 116 52843 |
| R 4006 | MRS25 1% 51E1 | 5322 | 116 53213 | R 4159 | MRS25 1% 2K15 | 5322 | 116 53239 |
| R 4007 | MRS25 1% 1K47 | 5322 | 116 53185 | R 4160 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4008 | MRS25 1% 100E | 5322 | 116 53126 | R 4161 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4009 | 0.3W 25% 1K | 5322 | 105 20032 | R 4162 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4010 | MRS25 1% 511E | 5322 | 116 53135 | R 4163 | MRS25 1% 5E11 | 4822 | 116 52999 |
| R 4011 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4207 | 0.3W 25% 10K | 4822 | 105 10455 |
| R 4012 | MRS25 1% 1K78 | 5322 | 116 53208 | R 4208 | 0.3W 25% 10K | 4822 | 105 10455 |
| R 4013 | MRS25 1% 1M | 4822 | 116 52843 | R 4209 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 4014 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4211 | MRS25 1% 12K1 | 4822 | 116 52957 |
| R 4015 | MRS25 1% 1K | 4822 | 116 53108 | R 4217 | MRS25 1% 3K16 | 4822 | 116 53021 |
| R 4016 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4218 | 0.25% 50E | 5322 | 116 53405 |
| R 4017 | MRS25 1% 2K87 | 5322 | 116 53513 | R 4219 | 0.25% 50E | 5322 | 116 53405 |
| R 4018 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4221 | 0.25% 150E | 5322 | 116 53399 |
| R 4019 | MRS25 1% 681K | 5322 | 116 53593 | R 4222 | 0.25% 250E | 5322 | 116 53406 |
| R 4020 | MRS25 1% 1K62 | 5322 | 116 53257 | R 4223 | 0.25% 500E | 5322 | 116 53408 |
| R 4021 | MRS25 1% 10K | 4822 | 116 53022 | R 4224 | 0.25% 1K5 | 5322 | 116 53401 |
| R 4022 | MRS25 1% 4K22 | 5322 | 116 53246 | R 4239 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4023 | MRS25 1% 12K1 | 4822 | 116 52957 | R 4240 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4024 | MRS25 1% 1K | 4822 | 116 53108 | R 4242 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4025 | MRS25 1% 1K | 4822 | 116 53108 | R 4243 | 0.1% 20K | 5322 | 116 52697 |
| R 4026 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4244 | 0.1% 202E | 5322 | 116 53413 |
| R 4030 | MRS25 1% 51E1 | 5322 | 116 53213 | R 4245 | MRS25 1% 1K | 4822 | 116 53108 |
| R 4031 | MRS25 1% 619E | 5322 | 116 53337 | R 4246 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4032 | MRS25 1% 511E | 5322 | 116 53135 | R 4247 | MRS25 1% 511E | 5322 | 116 53135 |
| R 4033 | MRS25 1% 511E | 5322 | 116 53135 | R 4248 | MRS25 1% 21K5 | 5322 | 116 53241 |
| R 4034 | MRS25 1% 1K78 | 5322 | 116 53208 | R 4249 | MRS25 1% 31E6 | 5322 | 116 54964 |
| R 4035 | MRS25 1% 100E | 5322 | 116 53126 | R 4250 | MRS25 1% 9E09 | 5322 | 116 53516 |
| R 4036 | MRS25 1% 51E1 | 5322 | 116 53213 | R 4251 | MRS25 1% 2K61 | 5322 | 116 53327 |
| R 4037 | MRS25 1% 1K78 | 5322 | 116 53208 | R 4252 | MRS25 1% 162E | 5322 | 116 53523 |
| R 4038 | MRS25 1% 100E | 5322 | 116 53126 | R 4253 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 4040 | MRS25 1% 511E | 5322 | 116 53135 | R 4254 | MRS25 1% 6K81 | 5322 | 116 53252 |
| R 4042 | MRS25 1% 1K78 | 5322 | 116 53208 | R 4258 | MRS25 1% 1M | 4822 | 116 52843 |
| R 4043 | MRS25 1% 51K1 | 4822 | 116 53121 | R 4259 | MRS25 1% 2K15 | 5322 | 116 53239 |
| R 4044 | MRS25 1% 51K1 | 4822 | 116 53121 | R 4260 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4045 | MRS25 1% 681K | 5322 | 116 53593 | R 4261 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4046 | MRS25 1% 10K | 4822 | 116 53022 | R 4262 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4047 | MRS25 1% 4K22 | 5322 | 116 53246 | R 4301 | MRS25 1% 51K1 | 4822 | 116 53121 |
| R 4048 | MRS25 1% 2K61 | 5322 | 116 53327 | R 4302 | MRS25 1% 51K1 | 4822 | 116 53121 |
| R 4051 | MRS25 1% 10K | 4822 | 116 53022 | R 4303 | MRS25 1% 6K81 | 5322 | 116 53252 |
| R 4052 | MRS25 1% 10K | 4822 | 116 53022 | R 4304 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 4101 | MRS25 1% 100K | 4822 | 116 52973 | R 4305 | MRS25 1% 51K1 | 4822 | 116 53121 |
| R 4102 | MRS25 1% 4K64 | 5322 | 116 53212 | R 4306 | MRS25 1% 681E | 4822 | 116 53123 |
| R 4103 | MRS25 1% 11K | 4822 | 116 52907 | R 4307 | MRS25 1% 5K11 | 5322 | 116 53494 |
| R 4104 | MRS25 1% 46K4 | 5322 | 116 53314 | R 4308 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4106 | MRS25 1% 422E | 5322 | 116 53592 | R 4309 | MRS25 1% 8K25 | 5322 | 116 53267 |
| R 4107 | 0.3W 25% 10K | 4822 | 105 10455 | R 4310 | MRS25 1% 100E | 5322 | 116 53126 |
| R 4108 | 0.3W 25% 10K | 4822 | 105 10455 | R 4311 | MRS25 1% 10K | 4822 | 116 53022 |
| R 4109 | MRS25 1% 5K11 | 5322 | 116 53494 | R 4312 | MRS25 1% 9K09 | 5322 | 116 53253 |
| R 4111 | MRS25 1% 12K1 | 4822 | 116 52957 | | | | |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------|----------------|--------|---------------|----------------|
| R 4314 | MRS25 1% 8K25 | 5322 116 53267 | R 4719 | MRS25 1% 100E | 5322 116 53126 |
| R 4330 | MRS25 1% 5K11 | 5322 116 53494 | R 4721 | 0.3W 25% 1K | 5322 105 20032 |
| R 4331 | MRS25 1% 21K5 | 5322 116 53241 | R 4722 | MRS25 1% 46K4 | 5322 116 53314 |
| R 4332 | MRS25 1% 4K22 | 5322 116 53246 | R 4723 | MRS25 1% 681K | 5322 116 53593 |
| R 4334 | MRS25 1% 2K15 | 5322 116 53239 | R 4724 | MRS25 1% 42E2 | 5322 116 53515 |
| R 4401 | MRS25 1% 2K61 | 5322 116 53327 | R 4725 | MRS25 1% 4K22 | 5322 116 53246 |
| R 4402 | MRS25 1% 82E5 | 5322 116 53538 | R 4726 | MRS25 1% 100K | 4822 116 52973 |
| R 4403 | MRS25 1% 681E | 4822 116 53123 | R 4727 | MRS25 1% 6K81 | 5322 116 53252 |
| R 4404 | MRS25 1% 2K37 | 5322 116 53536 | R 4728 | MRS25 1% 562E | 5322 116 53214 |
| R 4406 | 0.3W 25% 22K | 5322 105 20035 | R 4801 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4407 | MRS25 1% 215K | 5322 116 53425 | R 4804 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4408 | 0.3W 25% 22K | 5322 105 20035 | R 4807 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4409 | MRS25 1% 10K | 4822 116 53022 | R 4809 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4411 | MRS25 1% 2K37 | 5322 116 53536 | R 4816 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4412 | MRS25 1% 100E | 5322 116 53126 | R 4818 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4413 | MRS25 1% 6K81 | 5322 116 53252 | R 4819 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4414 | MRS25 1% 4K64 | 5322 116 53212 | R 4820 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4417 | MRS25 1% 1K | 4822 116 53108 | R 4821 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4419 | MRS25 1% 511E | 5322 116 53135 | R 4822 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4420 | MRS25 1% 1K21 | 4822 116 52956 | R 4824 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4421 | MRS25 1% 10K | 4822 116 53022 | R 4825 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4422 | MRS25 1% 2K87 | 5322 116 53513 | R 4826 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4423 | MRS25 1% 9K09 | 5322 116 53253 | R 4828 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4427 | MRS25 1% 1K96 | 5322 116 53237 | R 4829 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4428 | MRS25 1% 100E | 5322 116 53126 | R 4830 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4501 | MRS25 1% 13K3 | 5322 116 53489 | R 4831 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4502 | MRS25 1% 4K22 | 5322 116 53246 | R 4833 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4503 | MRS25 1% 6K81 | 5322 116 53252 | R 4835 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4504 | MRS25 1% 13K3 | 5322 116 53489 | R 4836 | MRS25 1% 5E11 | 4822 116 52999 |
| R 4505 | MRS25 1% 511E | 5322 116 53135 | R 4838 | MRS25 1% 100E | 5322 116 53126 |
| R 4506 | MRS25 1% 2K15 | 5322 116 53239 | R 4839 | MRS25 1% 100E | 5322 116 53126 |
| R 4507 | MRS25 1% 750E | 5322 116 53265 | R 4841 | MRS25 1% 10K | 4822 116 53022 |
| R 4508 | MRS25 1% 11K | 4822 116 52907 | R 4902 | MRS25 1% 1E | 4822 116 52976 |
| R 4509 | MRS25 1% 2K15 | 5322 116 53239 | R 4903 | MRS25 1% 1E | 4822 116 52976 |
| R 4513 | MRS25 1% 1K47 | 5322 116 53185 | R 4904 | MRS25 1% 1E | 4822 116 52976 |
| R 4521 | MRS25 1% 16K2 | 5322 116 53589 | R 5001 | PP17 20% 10K | 5322 101 30546 |
| R 4522 | MRS25 1% 23K7 | 5322 116 53537 | R 5002 | PP17 20% 10K | 5322 101 30547 |
| R 4523 | MRS25 1% 16K2 | 5322 116 53589 | R 5003 | PP17 20% 10K | 5322 101 30546 |
| R 4524 | MRS25 1% 14K7 | 4822 116 53531 | R 5004 | PP17 20% 10K | 5322 101 30546 |
| R 4526 | MRS25 1% 2K37 | 5322 116 53536 | R 6001 | 1.7A 20% 82E | 4822 116 30069 |
| R 4527 | MRS25 1% 19K6 | 5322 116 53258 | R 6002 | MRS25 1% 383K | 5322 116 53576 |
| R 4528 | MRS25 1% 5K62 | 5322 116 53495 | R 6003 | MRS25 1% 383K | 5322 116 53576 |
| R 4529 | MRS25 1% 21K5 | 5322 116 53241 | R 6004 | MRS25 1% 316E | 5322 116 53514 |
| R 4531 | MRS25 1% 10K | 4822 116 53022 | R 6005 | MRS25 1% 464E | 5322 116 53232 |
| R 4532 | MRS25 1% 10K | 4822 116 53022 | R 6006 | MRS25 1% 10K | 4822 116 53022 |
| R 4533 | MRS25 1% 3K48 | 4822 116 53315 | R 6007 | MRS25 1% 10K | 4822 116 53022 |
| R 4601 | MRS25 1% 2K37 | 5322 116 53536 | R 6008 | MRS25 1% 316E | 5322 116 53514 |
| R 4602 | MRS25 1% 26K1 | 5322 116 53261 | R 6009 | 0.5W 10% 1K5 | 4822 116 30248 |
| R 4603 | MRS25 1% 23K7 | 5322 116 53537 | R 6010 | MRS25 1% 14K7 | 4822 116 53531 |
| R 4604 | MRS25 1% 100K | 4822 116 52973 | R 6011 | MRS25 1% 237E | 5322 116 53259 |
| R 4606 | MRS25 1% 909E | 4822 116 53533 | R 6012 | MRS25 1% 178E | 5322 116 53572 |
| R 4607 | MRS25 1% 100E | 5322 116 53126 | R 6013 | MRS25 1% 100E | 5322 116 53126 |
| R 4608 | MRS25 1% 1K | 4822 116 53108 | R 6014 | MRS25 1% 3E16 | 4822 116 52993 |
| R 4609 | MRS25 1% 42E2 | 5322 116 53515 | R 6016 | MRS25 1% 10K | 4822 116 53022 |
| R 4611 | MRS25 1% 10K | 4822 116 53022 | R 6017 | MRS25 1% 1E | 4822 116 52976 |
| R 4612 | MRS25 1% 7K5 | 4822 116 53028 | R 6018 | MRS25 1% 1E | 4822 116 52976 |
| R 4613 | MRS25 1% 7K5 | 4822 116 53028 | R 6019 | MRS25 1% 10K | 4822 116 53022 |
| R 4614 | MRS25 1% 8K25 | 5322 116 53267 | R 6020 | MRS25 1% 21E5 | 5322 116 53426 |
| R 4616 | 0.3W 25% 1K | 5322 105 20032 | R 6021 | MRS25 1% 10K | 4822 116 53022 |
| R 4617 | MRS25 1% 6K81 | 5322 116 53252 | R 6022 | MRS25 1% 10K | 4822 116 53022 |
| R 4618 | MRS25 1% 11K | 4822 116 52907 | R 6031 | MRS25 1% 383E | 5322 116 53332 |
| R 4619 | MRS25 1% 51K1 | 4822 116 53121 | R 6032 | 0.25% 5K62 | 5322 116 80473 |
| R 4620 | MRS25 1% 10K | 4822 116 53022 | R 6033 | 0.25% 7K5 | 5322 116 80474 |
| R 4621 | MRS25 1% 909E | 4822 116 53533 | R 6034 | MRS25 1% 6K19 | 5322 116 53263 |
| R 4622 | MRS25 1% 100E | 5322 116 53126 | R 6036 | MRS25 1% 7K5 | 4822 116 53028 |
| R 4625 | MRS25 1% 100E | 5322 116 53126 | R 6037 | MRS25 1% 31K6 | 5322 116 53262 |
| R 4626 | MRS25 1% 100E | 5322 116 53126 | R 6038 | MRS25 1% 100E | 5322 116 53126 |
| R 4627 | MRS25 1% 10K | 4822 116 53022 | R 6039 | MRS25 1% 10E | 4822 116 52891 |
| R 4628 | MRS25 1% 100E | 5322 116 53126 | R 6041 | MRS25 1% 3K83 | 4822 116 53079 |
| R 4629 | MRS25 1% 8K25 | 5322 116 53267 | R 6042 | MRS25 1% 3K83 | 4822 116 53079 |
| R 4631 | MRS25 1% 1K | 4822 116 53108 | R 6043 | MRS25 1% 100K | 4822 116 52973 |
| R 4632 | MRS25 1% 100E | 5322 116 53126 | R 6044 | MRS25 1% 100K | 4822 116 52973 |
| R 4633 | MRS25 1% 1K | 4822 116 53108 | R 6101 | MRS25 1% 100E | 5322 116 53126 |
| R 4634 | MRS25 1% 1K | 4822 116 53108 | R 6102 | MRS25 1% 100E | 5322 116 53126 |
| R 4636 | MRS25 1% 1M | 4822 116 52843 | R 6103 | MRS25 1% 1K | 4822 116 53108 |
| R 4639 | MRS25 1% 383E | 5322 116 53332 | R 6131 | MRS25 1% 10E | 4822 116 52891 |
| R 4701 | MRS25 1% 42E2 | 5322 116 53515 | R 6132 | MRS25 1% 100K | 4822 116 52973 |
| R 4703 | MRS25 1% 562E | 5322 116 53214 | R 6133 | MRS25 1% 100K | 4822 116 52973 |
| R 4705 | MRS25 1% 1K | 4822 116 53108 | R 6134 | MRS25 1% 1K | 4822 116 53108 |
| R 4706 | MRS25 1% 100E | 5322 116 53126 | R 6136 | MRS25 1% 4K64 | 5322 116 53212 |
| R 4707 | MRS25 1% 511E | 5322 116 53135 | R 6137 | MRS25 1% 316E | 5322 116 53514 |
| R 4708 | MRS25 1% 2K87 | 5322 116 53513 | R 6138 | MRS25 1% 1K | 4822 116 53108 |
| R 4709 | MRS25 1% 681E | 4822 116 53123 | R 6139 | MRS25 1% 100E | 5322 116 53126 |
| R 4711 | MRS25 1% 6K19 | 5322 116 53263 | R 6201 | 0.25% 160K | 5322 116 53412 |
| R 4712 | MRS25 1% 511E | 5322 116 53135 | R 6202 | VR37 1% 31M6 | 5322 116 64103 |
| R 4713 | MRS25 1% 1M | 4822 116 52843 | R 6203 | MRS25 1% 100K | 4822 116 52973 |
| R 4714 | MRS25 1% 1M | 4822 116 52843 | R 6204 | MRS25 1% 10K | 4822 116 53022 |
| R 4716 | MRS25 1% 6K81 | 5322 116 53252 | R 6205 | MRS25 1% 1K | 4822 116 53108 |
| R 4717 | MRS25 1% 8K25 | 5322 116 53267 | R 6206 | MRS25 1% 16K2 | 5322 116 53589 |
| R 4718 | MRS25 1% 1K | 4822 116 53108 | R 6207 | MRS25 1% 51E1 | 5322 116 53213 |

| POSNR | DESCRIPTION | ORDERING CODE |
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| R 6208 | MRS25 1% 464E | 5322 116 53232 |
| R 6209 | MRS25 1% 4K64 | 5322 116 53212 |
| R 6211 | MRS25 1% 46K4 | 5322 116 53314 |
| R 6212 | MRS25 1% 4K64 | 5322 116 53212 |
| R 6213 | MRS25 1% 215E | 5322 116 53325 |
| R 6214 | VR25 5% 10M | 4822 110 72214 |
| R 6216 | MRS25 1% 100E | 5322 116 53126 |
| R 6217 | MRS25 1% 1E | 4822 116 52976 |
| R 6300 | MRS25 1% 2K61 | 5322 116 53327 |
| R 6301 | MRS25 1% 464E | 5322 116 53232 |
| R 6302 | MRS25 1% 909E | 4822 116 53533 |
| R 6303 | MRS25 1% 3K83 | 4822 116 53079 |
| R 6304 | MRS25 1% 6K81 | 5322 116 53252 |
| R 6311 | MRS25 1% 750E | 5322 116 53265 |
| R 6312 | MRS25 1% 4K22 | 5322 116 53246 |
| R 6313 | MRS25 1% 1K1 | 5322 116 53473 |
| R 6401 | MRS25 1% 1K78 | 5322 116 53208 |
| R 6402 | MRS25 1% 178K | 5322 116 53555 |
| R 6403 | MRS25 1% 215E | 5322 116 53325 |
| R 6404 | MRS25 1% 6K81 | 5322 116 53252 |
| R 6406 | MRS25 1% 26K1 | 5322 116 53261 |
| R 6407 | MRS25 1% 3K48 | 4822 116 53315 |
| R 6408 | MTP10 20% 10K | 5322 100 10113 |
| R 6501 | MRS25 1% 511E | 5322 116 53135 |
| R 6502 | MRS25 1% 100K | 4822 116 52973 |
| R 6503 | MRS25 1% 5K11 | 5322 116 53494 |
| R 6504 | MRS25 1% 19K6 | 5322 116 53258 |
| R 6506 | MRS25 1% 5K62 | 5322 116 53495 |
| R 6507 | MRS25 1% 511E | 5322 116 53135 |
| R 6508 | 0.25% 3K67 | 5322 116 53411 |
| R 6509 | 0.25% 500E | 5322 116 53408 |
| R 6511 | MRS25 1% 562E | 5322 116 53214 |
| R 7005 | PP17 20% 10K | 5322 101 30546 |
| R 7006 | PP17 20% 10K | 5322 101 30546 |
| R 7007 | PP17 20% 10K | 5322 101 30546 |
| R 7008 | PP17 20% 10K | 5322 101 30546 |
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| R 7011 | PP17 20% 10K | 5322 101 30546 |
| R 7012 | PP17 20% 10K | 5322 101 30546 |
| R 7013 | PP17 20% 10K | 5322 101 30546 |
| R 7014 | PP17 20% 10K | 5322 101 30546 |
| R 7021 | MRS25 1% 11K | 4822 116 52907 |
| R 7022 | MRS25 1% 10K | 4822 116 53022 |
| R 7023 | MRS25 1% 90K9 | 5322 116 53582 |
| R 7024 | MRS25 1% 1K | 4822 116 53108 |
| R 7025 | MRS25 1% 1K | 4822 116 53108 |
| R 7026 | MRS25 1% 4K64 | 5322 116 53212 |
| R 7027 | MRS25 1% 3K83 | 4822 116 53079 |
| R 7028 | MRS25 1% 3K83 | 4822 116 53079 |
| R 7029 | MRS25 1% 1K | 4822 116 53108 |
| R 7031 | MRS25 1% 1K | 4822 116 53108 |
| R 7032 | MRS25 1% 75K | 5322 116 53266 |
| R 7033 | MRS25 1% 5K11 | 5322 116 53494 |
| R 7034 | MRS25 1% 162E | 5322 116 53523 |
| R 7036 | 0.5W 10% 2K2 | 4822 116 30254 |
| R 7037 | MRS25 1% 1K1 | 5322 116 53473 |
| R 7038 | MRS25 1% 1M | 4822 116 52843 |
| R 7041 | MRS25 1% 3K83 | 4822 116 53079 |
| R 7042 | MRS25 1% 3K83 | 4822 116 53079 |
| R 7102 | MRS25 1% 100E | 5322 116 53126 |
| R 8001 | MCR18 1% 10K | 4822 111 90249 |

16.4.3 COILS

| | | |
|--------|------------|----------------|
| L 1001 | 0.22UH 10% | 5322 157 53284 |
| L 1101 | 0.22UH 10% | 5322 157 53284 |
| L 1401 | 1500UH | 4822 156 21293 |
| L 1402 | 1500UH | 4822 156 21293 |
| L 1403 | 1500UH | 4822 156 21293 |
| L 1421 | 1500UH | 4822 156 21293 |
| L 1422 | 1500UH | 4822 156 21293 |
| L 1423 | 1500UH | 4822 156 21293 |
| L 3001 | 2.2UH 10% | 5322 157 53509 |
| L 3002 | 2.2UH 10% | 5322 157 53509 |
| L 3003 | 2.7UH 10% | 5322 157 53511 |
| L 4101 | 2.2UH | 4822 157 51757 |
| L 6000 | 100UH | 5322 157 52363 |
| L 6001 | 100UH | 5322 157 52363 |
| L 6002 | 100UH | 5322 157 52363 |
| L 6003 | 5.6UH | 4822 157 52259 |
| L 6004 | 1000UH | 5322 157 52718 |
| L 6006 | 1000UH | 5322 157 52718 |
| L 6101 | 10UH | 5322 157 52513 |
| L 6102 | 27UH | 4822 158 10551 |
| L 6103 | 100UH | 5322 157 52363 |
| L 6104 | 100UH | 5322 157 52363 |
| L 6106 | 82UH | 4822 158 10563 |
| L 6107 | 82UH | 4822 158 10563 |
| L 6108 | 82UH | 4822 158 10563 |
| L 6109 | 82UH | 4822 158 10563 |
| L 6111 | 15UH | 5322 157 52539 |
| L 6201 | 82UH | 4822 158 10563 |
| L 6501 | 82UH | 4822 158 10563 |
| L 7101 | 15UH | 5322 157 52539 |

16.4.4 SEMI-CONDUCTORS

| POSNR | DESCRIPTION | ORDERING CODE |
|--------|--------------|----------------|
| V 201 | BAW62 | 4822 130 30613 |
| V 202 | BAW62 | 4822 130 30613 |
| V 203 | BF324 SELECT | 5322 693 90465 |
| V 204 | BAW62 | 4822 130 30613 |
| V 206 | BF370 | 4822 130 42589 |
| V 401 | BC558B | 4822 130 44197 |
| V 402 | BC548C | 4822 130 44196 |
| V 1000 | BA483 | 4822 130 32656 |
| V 1001 | BF324 | 4822 130 41448 |
| V 1002 | BF324 | 4822 130 41448 |
| V 1003 | BF410C | 4822 130 41482 |
| V 1004 | BA483 | 4822 130 32656 |
| V 1005 | BA483 | 4822 130 32656 |
| V 1006 | BF410C | 4822 130 41482 |
| V 1007 | BA483 | 4822 130 32656 |
| V 1008 | BA483 | 4822 130 32656 |
| V 1009 | BA483 | 4822 130 32656 |
| V 1010 | BZX79-C8V2 | 4822 130 34382 |
| V 1011 | BF410C | 4822 130 41482 |
| V 1012 | BA483 | 4822 130 32656 |
| V 1013 | BA483 | 4822 130 32656 |
| V 1014 | BA483 | 4822 130 32656 |
| V 1016 | BF410C | 4822 130 41482 |
| V 1017 | BA483 | 4822 130 32656 |
| V 1019 | BF199 | 4822 130 44154 |
| V 1021 | BF199 | 4822 130 44154 |
| V 1022 | BF324 | 4822 130 41448 |
| V 1023 | BZX79-C5V6 | 4822 130 34173 |
| V 1024 | BF370 | 4822 130 42589 |
| V 1061 | BAW62 | 4822 130 30613 |
| V 1062 | BAW62 | 4822 130 30613 |
| V 1063 | BF324 | 4822 130 41448 |
| V 1064 | BF324 | 4822 130 41448 |
| V 1100 | BA483 | 4822 130 32656 |
| V 1101 | BF324 | 4822 130 41448 |
| V 1102 | BF324 | 4822 130 41448 |
| V 1103 | BF410C | 4822 130 41482 |
| V 1104 | BA483 | 4822 130 32656 |
| V 1105 | BA483 | 4822 130 32656 |
| V 1106 | BF410C | 4822 130 41482 |
| V 1107 | BA483 | 4822 130 32656 |
| V 1108 | BA483 | 4822 130 32656 |
| V 1109 | BA483 | 4822 130 32656 |
| V 1110 | BZX79-C8V2 | 4822 130 34382 |
| V 1111 | BF410C | 4822 130 41482 |
| V 1112 | BA483 | 4822 130 32656 |
| V 1113 | BA483 | 4822 130 32656 |
| V 1114 | BA483 | 4822 130 32656 |
| V 1116 | BF410C | 4822 130 41482 |
| V 1117 | BA483 | 4822 130 32656 |
| V 1119 | BF199 | 4822 130 44154 |
| V 1121 | BF199 | 4822 130 44154 |
| V 1122 | BF324 | 4822 130 41448 |
| V 1123 | BZX79-C5V6 | 4822 130 34173 |
| V 1124 | BF370 | 4822 130 42589 |
| V 1161 | BAW62 | 4822 130 30613 |
| V 1162 | BAW62 | 4822 130 30613 |
| V 1163 | BF324 | 4822 130 41448 |
| V 1164 | BF324 | 4822 130 41448 |
| V 1200 | BZV46-C1V5 | 5322 130 34865 |
| V 1201 | BF410C | 4822 130 41482 |
| V 1202 | BA483 | 4822 130 32656 |
| V 1203 | BA483 | 4822 130 32656 |
| V 1204 | BF199 | 4822 130 44154 |
| V 1205 | BZX79-C8V2 | 4822 130 34382 |
| V 1206 | BF199 | 4822 130 44154 |
| V 1207 | BF324 | 4822 130 41448 |
| V 1208 | BZX79-C5V6 | 4822 130 34173 |
| V 1209 | BF199 | 4822 130 44154 |
| V 1211 | BF324 | 4822 130 41448 |
| V 1212 | BF324 | 4822 130 41448 |
| V 1213 | BF324 | 4822 130 41448 |
| V 2001 | BZV46-C2V0 | 4822 130 31248 |
| V 2002 | BZV46-C2V0 | 4822 130 31248 |
| V 2003 | BZX79-C3V0 | 4822 130 31881 |
| V 2101 | BZV46-C2V0 | 4822 130 31248 |
| V 2102 | BZV46-C2V0 | 4822 130 31248 |
| V 2103 | BZX79-C3V0 | 4822 130 31881 |
| V 2305 | BZV46-C1V5 | 5322 130 34865 |
| V 2306 | BZV46-C1V5 | 5322 130 34865 |
| V 2308 | BZX79-C4V3 | 4822 130 31554 |
| V 2309 | BZX79-C4V3 | 4822 130 31554 |
| V 2310 | BC558B | 4822 130 44197 |
| V 2311 | BC558B | 4822 130 44197 |
| V 2313 | BAW62 | 4822 130 30613 |
| V 2314 | BAW62 | 4822 130 30613 |
| V 2314 | BC558B | 4822 130 44197 |
| V 2316 | BF324 | 4822 130 41448 |
| V 2317 | BC548C | 4822 130 44196 |
| V 2318 | BF324 | 4822 130 41448 |
| V 2319 | BF324 | 4822 130 41448 |
| V 2321 | BF324 | 4822 130 41448 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|-------------|----------------|--------|-------------|----------------|
| V 2325 | BAW62 | 4822 130 30613 | V 4006 | BF763 | 5322 130 61148 |
| V 2326 | BAW62 | 4822 130 30613 | V 4007 | BAW62 | 4822 130 30613 |
| V 2327 | BC558B | 4822 130 44197 | V 4008 | BAW62 | 4822 130 30613 |
| V 2328 | BZX79-C5V1 | 4822 130 34233 | V 4009 | BC548C | 4822 130 44196 |
| V 2329 | BZX79-C9V1 | 4822 130 30862 | V 4011 | BZX79-C5V1 | 4822 130 34233 |
| V 2331 | BC558B | 4822 130 44197 | V 4012 | BC548C | 4822 130 44196 |
| V 2332 | BC558B | 4822 130 44197 | V 4013 | BZX79-C3V6 | 5322 130 34834 |
| V 2333 | BC558B | 4822 130 44197 | V 4014 | BAW62 | 4822 130 30613 |
| V 2334 | BC558B | 4822 130 44197 | V 4016 | BC548C | 4822 130 44196 |
| V 2341 | BF199 | 4822 130 44154 | V 4017 | BC548C | 4822 130 44196 |
| V 2342 | BF199 | 4822 130 44154 | V 4018 | BC548C | 4822 130 44196 |
| V 2347 | BF199 | 4822 130 44154 | V 4031 | BF199 | 4822 130 44154 |
| V 2349 | BF199 | 4822 130 44154 | V 4032 | BF199 | 4822 130 44154 |
| V 2356 | BC548C | 4822 130 44196 | V 4033 | BF199 | 4822 130 44154 |
| V 2357 | BC548C | 4822 130 44196 | V 4034 | BC548C | 4822 130 44196 |
| V 2366 | BAW62 | 4822 130 30613 | V 4036 | BF763 | 5322 130 61148 |
| V 2367 | BAW62 | 4822 130 30613 | V 4037 | BAW62 | 4822 130 30613 |
| V 2368 | BAW62 | 4822 130 30613 | V 4038 | BC548C | 4822 130 44196 |
| V 2369 | BAW62 | 4822 130 30613 | V 4039 | BC548C | 4822 130 44196 |
| V 2370 | BC548C | 4822 130 44196 | V 4101 | BC558B | 4822 130 44197 |
| V 2371 | BC558B | 4822 130 44197 | V 4102 | BAW62 | 4822 130 30613 |
| V 2507 | BAW62 | 4822 130 30613 | V 4103 | BAW62 | 4822 130 30613 |
| V 2508 | BAW62 | 4822 130 30613 | V 4104 | BC548C | 4822 130 44196 |
| V 2509 | BC558B | 4822 130 44197 | V 4106 | BAW62 | 4822 130 30613 |
| V 2510 | BC558B | 4822 130 44197 | V 4107 | BC327 | 4822 130 40854 |
| V 2511 | BC548C | 4822 130 44196 | V 4108 | BC548C | 4822 130 44196 |
| V 2512 | BF324 | 4822 130 41448 | V 4109 | BC558B | 4822 130 44197 |
| V 2513 | BF324 | 4822 130 41448 | V 4110 | BAW62 | 4822 130 30613 |
| V 2514 | BF324 | 4822 130 41448 | V 4111 | BC558B | 4822 130 44197 |
| V 2516 | BF324 | 4822 130 41448 | V 4112 | BSX20 | 4822 130 41705 |
| V 2601 | BZX79-C6V2 | 4822 130 34167 | V 4113 | BZV46-C1V5 | 5322 130 34865 |
| V 2602 | BC548C | 4822 130 44196 | V 4114 | BSX20 | 4822 130 41705 |
| V 2611 | BF199 | 4822 130 44154 | V 4115 | BZX79-C6V2 | 4822 130 34167 |
| V 2612 | BF199 | 4822 130 44154 | V 4116 | BAW62 | 4822 130 30613 |
| V 2615 | BC548C | 4822 130 44196 | V 4117 | BC548C | 4822 130 44196 |
| V 2616 | BZV46-C1V5 | 5322 130 34865 | V 4118 | BC548C | 4822 130 44196 |
| V 3001 | BF324 | 4822 130 41448 | V 4119 | BF199 | 4822 130 44154 |
| V 3002 | BF324 | 4822 130 41448 | V 4120 | BAW62 | 4822 130 30613 |
| V 3003 | BC558B | 4822 130 44197 | V 4121 | BC548C | 4822 130 44196 |
| V 3004 | BF324 | 4822 130 41448 | V 4122 | BAW62 | 4822 130 30613 |
| V 3006 | BF324 | 4822 130 41448 | V 4123 | BAW62 | 4822 130 30613 |
| V 3007 | BC548C | 4822 130 44196 | V 4209 | BC558B | 4822 130 44197 |
| V 3008 | BF370 | 4822 130 42589 | V 4211 | BC558B | 4822 130 44197 |
| V 3009 | BF370 | 4822 130 42589 | V 4212 | BSX20 | 4822 130 41705 |
| V 3011 | 2N3866-01 | 5322 130 41799 | V 4213 | BAW62 | 4822 130 30613 |
| V 3012 | 2N3866-01 | 5322 130 41799 | V 4214 | BSX20 | 4822 130 41705 |
| V 3013 | BZX79-C27 | 4822 130 34379 | V 4215 | BZX79-C6V2 | 4822 130 34167 |
| V 3014 | BZX79-C27 | 4822 130 34379 | V 4216 | BAW62 | 4822 130 30613 |
| V 3016 | BAW62 | 4822 130 30613 | V 4217 | BC548C | 4822 130 44196 |
| V 3101 | BF324 | 4822 130 41448 | V 4218 | BC548C | 4822 130 44196 |
| V 3102 | BF324 | 4822 130 41448 | V 4219 | BF199 | 4822 130 44154 |
| V 3103 | BF324 | 4822 130 41448 | V 4300 | BZX79-C6V2 | 4822 130 34167 |
| V 3104 | BC558B | 4822 130 44197 | V 4301 | BC558B | 4822 130 44197 |
| V 3106 | BF324 | 4822 130 41448 | V 4302 | BC548C | 4822 130 44196 |
| V 3108 | BF472 | 5322 130 42535 | V 4304 | BC558B | 4822 130 44197 |
| V 3109 | BF370 | 4822 130 42589 | V 4305 | BZX79-C9V1 | 4822 130 30862 |
| V 3111 | BF370 | 4822 130 42589 | V 4306 | BAW62 | 4822 130 30613 |
| V 3112 | 2N5551 | 5322 130 44491 | V 4307 | BC548C | 4822 130 44196 |
| V 3113 | BZX79-B5V6 | 4822 130 34173 | V 4308 | BZV46-C1V5 | 5322 130 34865 |
| V 3114 | 2N5551 | 5322 130 44491 | V 4309 | BC548C | 4822 130 44196 |
| V 3116 | BF472 | 5322 130 42535 | V 4321 | BAW62 | 4822 130 30613 |
| V 3200 | BF370 | 4822 130 42589 | V 4322 | BC548C | 4822 130 44196 |
| V 3201 | BF370 | 4822 130 42589 | V 4323 | BC548C | 4822 130 44196 |
| V 3202 | 2N5401 | 5322 130 42534 | V 4400 | BZV46-C1V5 | 5322 130 34865 |
| V 3203 | 2N5551 | 5322 130 44491 | V 4401 | BF324 | 4822 130 41448 |
| V 3204 | BF423 | 4822 130 41646 | V 4402 | BZX79-C6V2 | 4822 130 34167 |
| V 3205 | BZX79-B5V6 | 4822 130 34173 | V 4500 | BAW62 | 4822 130 30613 |
| V 3206 | BAW62 | 4822 130 30613 | V 4501 | BC548C | 4822 130 44196 |
| V 3207 | BC548C | 4822 130 44196 | V 4502 | BC548C | 4822 130 44196 |
| V 3208 | BF423 | 4822 130 41646 | V 4503 | BC548C | 4822 130 44196 |
| V 3209 | BAW62 | 4822 130 30613 | V 4504 | BC548C | 4822 130 44196 |
| V 3211 | BAW62 | 4822 130 30613 | V 4505 | BAW62 | 4822 130 30613 |
| V 3212 | BZX79-C68 | 4822 130 30864 | V 4506 | BC548C | 4822 130 44196 |
| V 3213 | BC548C | 4822 130 44196 | V 4510 | BC558B | 4822 130 44197 |
| V 3214 | BAW62 | 4822 130 30613 | V 4511 | BC558B | 4822 130 44197 |
| V 3215 | BAW62 | 4822 130 30613 | V 4512 | BC558B | 4822 130 44197 |
| V 3216 | BZX79-C9V1 | 4822 130 30862 | V 4513 | BC558B | 4822 130 44197 |
| V 3217 | BAW62 | 4822 130 30613 | V 4514 | BC558B | 4822 130 44197 |
| V 3251 | BF423 | 4822 130 41646 | V 4516 | BAW62 | 4822 130 30613 |
| V 3252 | BZX79-C6V2 | 4822 130 34167 | V 4517 | BAW62 | 4822 130 30613 |
| V 3253 | BF423 | 4822 130 41646 | V 4518 | BAW62 | 4822 130 30613 |
| V 3254 | BF423 | 4822 130 41646 | V 4519 | BAW62 | 4822 130 30613 |
| V 3256 | BF423 | 4822 130 41646 | V 4521 | BAW62 | 4822 130 30613 |
| V 3257 | BAV21 | 4822 130 30842 | V 4522 | BAW62 | 4822 130 30613 |
| V 3301 | BZX79-C6V2 | 4822 130 34167 | V 4523 | BC548C | 4822 130 44196 |
| V 4001 | BF199 | 4822 130 44154 | V 4601 | BAW62 | 4822 130 30613 |
| V 4002 | BF199 | 4822 130 44154 | V 4602 | BAW62 | 4822 130 30613 |
| V 4003 | BF199 | 4822 130 44154 | V 4611 | BF199 | 4822 130 44154 |
| V 4004 | BC548C | 4822 130 44196 | V 4612 | BF199 | 4822 130 44154 |
| V 4005 | BC558B | 4822 130 44197 | V 4613 | BAW62 | 4822 130 30613 |

| POSNR | DESCRIPTION | ORDERING CODE | POSNR | DESCRIPTION | ORDERING CODE |
|--------|---------------------|----------------|--------|----------------------|----------------|
| V 4614 | BAW62 | 4822 130 30613 | D 2501 | PLIFIER | 5322 209 80991 |
| V 4616 | BC548C | 4822 130 44196 | D 2502 | PLIFIER | 5322 209 80991 |
| V 4702 | BF324 | 4822 130 41448 | D 2601 | HEF4053BP | 5322 209 10576 |
| V 4703 | BAW62 | 4822 130 30613 | D 2602 | TEA1017/N8 | 5322 209 70023 |
| V 4704 | BAW62 | 4822 130 30613 | D 2603 | OQ 0200 | 5322 209 82924 |
| V 4706 | BF324 | 4822 130 41448 | D 4001 | TEA1017/N8 | 5322 209 70023 |
| V 4707 | BC558B | 4822 130 44197 | D 4002 | TEA1017/N8 | 5322 209 70023 |
| V 4708 | BF324 | 4822 130 41448 | D 4101 | HEF4053BP | 5322 209 10576 |
| V 4709 | BC558B | 4822 130 44197 | D 4102 | HEF4051BP | 4822 209 10262 |
| V 4710 | BC548C | 4822 130 44196 | D 4202 | HEF4051BP | 4822 209 10262 |
| V 4711 | BAW62 | 4822 130 30613 | D 4401 | TDA1540P | 4822 209 81453 |
| V 4712 | BF324 | 4822 130 41448 | D 6201 | HT MULTIPLIER | 5322 321 21597 |
| V 4713 | BAW62 | 4822 130 30613 | D 6501 | HEF4066BP | 5322 209 10357 |
| V 4801 | BZV46-C1V5 | 5322 130 34865 | D 7001 | UP 8052 AH | 5322 209 11349 |
| V 4806 | BAX12 | 5322 130 34605 | D 7002 | HEF4053BP | 5322 209 10576 |
| V 4807 | BAX12 | 5322 130 34605 | D 7003 | PC74HCT259P | 5322 209 11115 |
| V 4808 | BAX12 | 5322 130 34605 | D 7006 | SN74LS244N | 5322 209 86017 |
| V 4809 | BAX12 | 5322 130 34605 | D 8001 | PCF8577T | 5322 209 70024 |
| V 6001 | BYV96E | 5322 130 34979 | D 8002 | PCF8577T | 5322 209 70024 |
| V 6002 | BYV96E | 5322 130 34979 | D 8003 | PCF8577T | 5322 209 70024 |
| V 6003 | BYV96E | 5322 130 34979 | N 201 | CA3127E | 5322 130 42627 |
| V 6004 | BYV96E | 5322 130 34979 | N 1001 | UA714TC | 5322 209 70275 |
| V 6007 | BAX12 | 5322 130 34605 | N 1101 | UA714TC | 5322 209 70275 |
| V 6008 | BAX12 | 5322 130 34605 | N 1201 | LF356N | 5322 209 86422 |
| V 6009 | BC337 | 4822 130 40855 | N 4101 | LM324N | 4822 209 80587 |
| V 6011 | BAX12 | 5322 130 34605 | N 4102 | UA714TC | 5322 209 70275 |
| V 6012 | BZX79-C15 | 4822 130 34281 | N 4103 | TL080CP | 5322 209 72464 |
| V 6013 | BRV39 | 5322 130 40482 | N 4202 | UA714TC | 5322 209 70275 |
| V 6014 | BUZ80 | 5322 130 43926 | N 4203 | TL080CP | 5322 209 72464 |
| V 6016 | BYV27-150 | 4822 130 31628 | N 4402 | CA3086 | 5322 209 11225 |
| V 6017 | BYV27-150 | 4822 130 31628 | N 4601 | TCA240 | 4822 209 80629 |
| V 6018 | BUW12A | 5322 130 42114 | N 6001 | LM358N | 4822 209 70672 |
| V 6019 | BYV26C | 4822 130 32343 | N 6002 | LM358N | 4822 209 70672 |
| V 6021 | BZX79-C3V0 | 4822 130 31881 | N 7001 | LM339AN | 4822 209 80631 |
| V 6031 | BZX79-C3V6 | 5322 130 34834 | | | |
| V 6101 | BYV43-45 | 5322 130 33656 | 16.4.6 | CATHODE RAY TUBE | |
| V 6102 | BYV28-150 | 5322 130 32043 | V 0001 | D14-372GH | 5322 131 20169 |
| V 6103 | BYV27-150 | 4822 130 31628 | V 0001 | CRT D14-372GM/123 | 5322 131 20171 |
| V 6104 | BYV28-150 | 5322 130 32043 | | | |
| V 6106 | BYV27-150 | 4822 130 31628 | 16.4.7 | MISCELLANEOUS | |
| V 6107 | BYV95C | 4822 130 41487 | E 0001 | T13/4 28V 80MA | 5322 134 40534 |
| V 6108 | BYV27-150 | 4822 130 31628 | E 8001 | 60MA MGG9012 | 5322 134 40849 |
| V 6109 | BYV95C | 4822 130 41487 | G 7001 | KYO | 5322 242 71444 |
| V 6110 | BYV27-150 | 4822 130 31628 | H 6001 | CNX35 | 5322 130 90137 |
| V 6112 | BT151-500R | 5322 130 24081 | K 1001 | EED-RELAIS 12V | 5322 280 20125 |
| V 6113 | BYV95C | 4822 130 41487 | K 1002 | EED-RELAIS 12V | 5322 280 20125 |
| V 6115 | BYV27-150 | 4822 130 31628 | K 1003 | EED-RELAIS 12V | 5322 280 20125 |
| V 6116 | BYV27-150 | 4822 130 31628 | K 1004 | EED-RELAIS 12V | 5322 280 20125 |
| V 6131 | BAX12 | 5322 130 34605 | K 1006 | EED-RELAIS 12V | 5322 280 20125 |
| V 6132 | BAW62 | 4822 130 30613 | K 1007 | EED-RELAIS 12V | 5322 280 20125 |
| V 6133 | BZX79-C6V2 | 4822 130 34167 | K 1008 | EED-RELAIS 12V | 5322 280 20125 |
| V 6134 | BC337 | 4822 130 40855 | K 1101 | EED-RELAIS 12V | 5322 280 20125 |
| V 6136 | BF423 | 4822 130 41646 | K 1102 | EED-RELAIS 12V | 5322 280 20125 |
| V 6137 | BF423 | 4822 130 41646 | K 1103 | EED-RELAIS 12V | 5322 280 20125 |
| V 6138 | BZX79-C5V6 | 4822 130 34173 | K 1104 | EED-RELAIS 12V | 5322 280 20125 |
| V 6201 | BC327 | 4822 130 40854 | K 1106 | EED-RELAIS 12V | 5322 280 20125 |
| V 6202 | BZX79-C15 | 4822 130 34281 | K 1107 | EED-RELAIS 12V | 5322 280 20125 |
| V 6203 | BAV21 | 4822 130 30842 | K 1108 | EED-RELAIS 12V | 5322 280 20125 |
| V 6204 | BAV21 | 4822 130 30842 | K 1201 | EED-RELAIS 12V | 5322 280 20125 |
| V 6206 | BAV21 | 4822 130 30842 | K 4101 | EED-RELAIS 12V | 5322 280 20125 |
| V 6207 | BYV27-150 | 4822 130 31628 | K 4201 | EED-RELAIS 12V | 5322 280 20125 |
| V 6208 | BUV26A | 5322 130 42722 | S 6001 | | 5322 276 11859 |
| V 6209 | BY509 | 4822 130 41485 | S 7002 | BR | 5322 277 10878 |
| V 6211 | BC337 | 4822 130 40855 | S 7004 | BR | 5322 277 10878 |
| V 6301 | BC548C | 4822 130 44196 | S 7006 | BR | 5322 277 10878 |
| V 6302 | BC558B | 4822 130 44197 | S 7008 | BE | 5322 277 10879 |
| V 6303 | BC337 | 4822 130 40855 | S 7010 | BE | 5322 277 10879 |
| V 6304 | BC327 | 4822 130 40854 | S 7012 | | 5322 276 11857 |
| V 6311 | BC337 | 4822 130 40855 | S 7013 | | 5322 276 11856 |
| V 6312 | BDX78 | 5322 130 44278 | S 7014 | | 5322 276 11856 |
| V 6401 | BZV11 | 5322 130 34294 | S 7015 | | 5322 276 11856 |
| V 6402 | BAX12 | 5322 130 34605 | S 7016 | | 5322 276 11856 |
| V 6403 | BC337 | 4822 130 40855 | S 7017 | | 5322 276 11856 |
| V 7001 | BAW62 | 4822 130 30613 | S 7018 | | 5322 276 11856 |
| V 7002 | BC548C | 4822 130 44196 | S 7019 | | 5322 276 11856 |
| V 7101 | BAW62 | 4822 130 30613 | 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 7027 | | 5322 276 11858 |
| | | | S 7028 | | 5322 276 11858 |
| | | | S 7029 | | 5322 276 11856 |
| | | | S 7030 | | 5322 276 11856 |
| | | | S 7031 | | 5322 276 11856 |
| | | | S 7032 | | 5322 276 11856 |
| | | | T 0001 | T 5X20 1,6A | 4822 253 30024 |
| | | | T 6001 | EDT-39 TRANSFORMER | 5322 146 30591 |
| | | | T 6201 | PG1 TFE30 TRANSFORM. | 5322 146 30592 |
| 16.4.5 | INTEGRATED CIRCUITS | | | | |
| D 401 | PC74HCT132P | 4822 209 83044 | | | |
| D 1001 | TEA1017/N8 | 5322 209 70023 | | | |
| D 1061 | OQ 0203 | 5322 209 70393 | | | |
| D 1101 | TEA1017/N8 | 5322 209 70023 | | | |
| D 1161 | OQ 0203 | 5322 209 70393 | | | |
| D 2002 | OQ 0205 | 5322 209 70392 | | | |
| D 2102 | OQ 0205 | 5322 209 70392 | | | |
| D 2201 | PLIFIER | 5322 209 80991 | | | |
| D 2202 | PLIFIER | 5322 209 80991 | | | |
| D 2203 | ARRAY OQ 0127 | 5322 209 80992 | | | |
| D 2301 | OQ 0205 | 5322 209 70392 | | | |
| D 2302 | PLIFIER | 5322 209 80991 | | | |
| D 2303 | PLIFIER | 5322 209 80991 | | | |
| D 2304 | OQ 0128 | 5322 209 82925 | | | |

17. OPTIONS

17.1 Y-OUT

17.1.1 Characteristics

| CHARACTERISTICS | SPECIFICATION | ADDITIONAL INFORMATION |
|-----------------------------|------------------------|---|
| * Y-out | via channel A | |
| Defl. coeff. | 100 mV/div. +/- 10% | at $R_{load} > 10 \text{ k}\Omega$ |
| | 50 mV/div. +/- 10% | at $R_{load} = 50 \text{ }\Omega$ |
| * Bandwidth | > 50 MHz | |
| * Pulse aberrations | | |
| LF pulse drop or | < 2% | at $R_{load} = 50 \text{ }\Omega$ |
| tilt | < 3% | at $R_{load} > 10 \text{ k}\Omega$ |
| | | 5 div. pulse; +/- 2,5 div. from screen centre. |
| * HF pulse aberrations | < 6% | 5 div. pulse (ac coupled) |
| * Dyn. range | +/- 12 div. > 6 div | at 10 MHz at 50 MHz |
| * DC output level | 0 V | |
| Output drift (10°C-40°C) | < 50 mV | |

17.1.2 Circuit description

The Y-OUT circuit receives its input current from the signal splitter D2002, pin 6 and 11 on the pre-amplifier unit. The symmetrical input is buffered by two common-base amplifiers V203. These two transistors are matched for a common V_{be} to compensate temperature drift. The symmetrical current signals are then converted into the asymmetrical Y-OUT voltage via the short-feedback amplifier N201-6,7,8. The amplitude of this Y-OUT voltage is the summation of the voltage across resistor R219 and R226. The offset can be adjusted to 0 V by means of potentiometer R201. Transistor V206 serves as the current source of this final stage.

17.1.3 Adjusting and checking procedure

Refer to figure 17.1 for location of the adjusting points.

NOTE: Be sure that the oscilloscope is well adjusted before starting this adjusting procedure.

Gain adjustment:

- Apply a 100 mV/2 kHz calibrated square-wave signal to input A.
- Connect the Y OUT output to input B by means of a coax cable.
- Press AUTO SET key.
- Set UP-DOWN ch. A to 20 mV.
- Set UP-DOWN ch. B to 0,1 V.
- Press AC/DC key ch. A for DC input coupling.
- Press AC/DC key ch. B for DC input coupling.
- Press ALT/CHOP key for chopped display.
- Press ADD/INVERT key for B-INV display.
- Adjust R209 for an equal amplitude of ch. A and ch. B (tolerance: +or- 1,5 subdiv.)

Offset adjustment:

- Press AUTO SET key.
- Press 0 key ch. A.
- Connect a digital multimeter to the Y-OUT connection of the BNC socket and the BNC-ground.
- Adjust R201 so that the output voltage is 0 V (tolerance: +or- 10 mV)

Checking the gain:

- Press AUTO SET key.
- Set UP-DOWN ch. A to 20 mV.
- Set UP-DOWN ch. B to 0,1 V.
- Press AC/DC key ch. A for DC input coupling.
- Press AC/DC key ch. B for DC input coupling.
- Press A/B key for only ch. B display.
- Ensure that the amplitude of the displayed signal is 5 div. (tolerance: +or- 1,5 subdiv.)
- Terminate ch. B with 50 Ohm.
- Set UP-DOWN ch. B to 50 mV.
- Ensure that the amplitude of the displayed signal is 5 div. (tolerance: +or- 1,5 subdiv.)

HF square-wave response adjustment:

- Apply a 120 mV/1 MHz calibrated square-wave signal with rise time faster than 1 nsec to input A.
- Connect the Y OUT output to a PM3295 oscilloscope means of a coax cable. (Input: 50 Ohm, sensitivity: 50 mV/div)
- Press AUTO SET key
- Set UP-DOWN ch. A to 20 mV.
- Press AC/DC key ch. A for DC input coupling.
- Ensure that the PM3295 displays a square wave signal of 6 div p-p approx.
- Adjust R223 and C203 for an optimal square-wave response.

Y-OUT bandwidth check:

- Apply a 120 mV/1 MHz sine-wave to input A.
- Connect the Y-OUT output to a PM3295 oscilloscope by means of a coax cable. (input: 50 Ohm, sensitivity: 50 mV/div).
- Press AUTO SET key.
- Set UP-DOWN ch. A to 20 mV.
- Press AC/DC key ch. A for DC input coupling.
- Ensure that the amplitude of the displayed signal is 6 div.; if necessary, readjust the amplitude of the input signal.
- Now, increase the frequency of the input signal to 50 MHz.
- Ensure that the amplitude of the displayed signal on the PM3295 is at least 5 div. p-p.

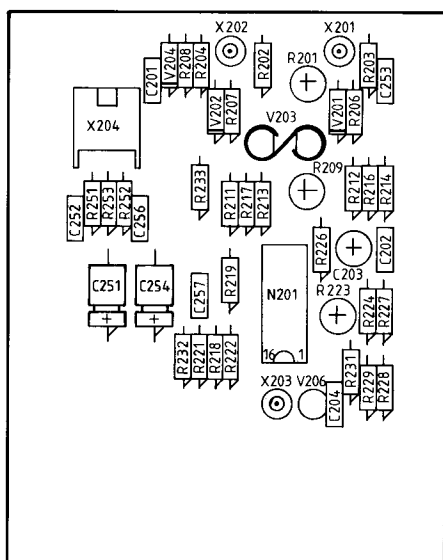
Checking the dynamic range:

- Apply a 0,25 mV/50 MHz sine-wave to input A.
- Connect the Y-OUT output to PM3295 oscilloscope by means of a coax cable. (input: 50 Ohm, sensitivity: 200 mV/div).
- Press AUTO SET key.
- Set UP-DOWN ch. A to 20 mV.
- Press AC/DC key ch. A for DC input coupling.
- Ensure that the displayed signal is shown without distortion or clipping.
- Change the input signal to 0,52 V/10 MHz sine wave.
- Change UP/DOWN ch. A to 0,1 V.
- Ensure that the displayed signal is shown without distortion or clipping.

17.1.4 Parts list

| POS.NR | DESCRIPTION | ORDERING CODE |
|--------|--------------------|----------------|
| C201 | 10nF -20+150% 100V | 4822 122 31414 |
| C202 | 100pF -2% 100V | 4822 122 31316 |
| C203 | 10pF TRIM CAP | 5322 125 11013 |
| C204 | 1nF -10% 100V | 4822 122 30027 |
| C251 | 68uF -10+50% 16V | 4822 124 20689 |
| C252 | 10nF -20+50% 100V | 4822 122 31414 |
| C253 | 10nF -20+50% 100V | 4822 122 31414 |
| C254 | 68uF -10+50% 16V | 4822 124 20689 |
| C256 | 10nF -20+50% 100V | 4822 122 31414 |
| C257 | 10nF -20+50% 100V | 4822 122 31414 |
| R201 | 2K2 25% 0,3W | 5322 105 20033 |
| R202 | 16K2 1% MRS25 | 5322 116 53589 |
| R203 | 1K33 1% MRS25 | 5322 116 53512 |
| R204 | 1K33 1% MRS25 | 5322 116 53512 |
| R206 | 100E 1% MRS25 | 5322 116 53126 |
| R207 | 100E 1% MRS25 | 5322 116 53126 |
| R208 | 7K5 1% MRS25 | 5322 116 53028 |
| R209 | 2K2 25% 0,3W | 5322 105 20033 |
| R211 | 348E 1% MRS25 | 5322 116 53591 |
| R212 | 51E1 1% MRS25 | 5322 116 53213 |

| POS.NR | DESCRIPTION | ORDERING CODE |
|--------|------------------|----------------|
| R213 | 51E1 1% MRS25 | 5322 116 53213 |
| R214 | 23K7 1% MRS25 | 5322 116 53537 |
| R216 | 287E 1% MRS25 | 5322 116 53221 |
| R217 | 287E 1% MRS25 | 5322 116 53221 |
| R218 | 100E 1% MRS25 | 5322 116 53126 |
| R219 | 825E 1% MRS25 | 5322 116 53541 |
| R221 | 6K19 1% MRS25 | 5322 116 53263 |
| R222 | 1K78 1% MRS25 | 5322 116 53208 |
| R223 | 470E 25% 0,3W | 5322 105 20028 |
| R224 | 10E 1% MRS25 | 5322 116 52891 |
| R226 | 825E 1% MRS25 | 5322 116 53541 |
| R227 | 1K33 1% MRS25 | 5322 116 53512 |
| R228 | 287E 1% MRS25 | 5322 116 53221 |
| R229 | 51E1 1% MRS25 | 5322 116 53213 |
| R231 | 1K21 1% MRS25 | 5322 116 52956 |
| R232 | 1K 1% MRS25 | 5322 116 53108 |
| R233 | 348E 1% MRS25 | 5322 116 53591 |
| R251 | 5E11 1% MRS25 | 4822 116 52999 |
| R252 | 5E11 1% MRS25 | 4822 116 52999 |
| R253 | 5E11 1% MRS25 | 4822 116 52999 |
| V201 | BAW62 | 4822 130 30613 |
| V202 | BAW62 | 4822 130 30613 |
| V203 | BF324 select | 5322 693 90465 |
| V204 | BAW62 | 4822 130 30613 |
| V206 | BF370 | 4822 130 42589 |
| N201 | CA3127E | 5322 130 42627 |
| X204 | 3-P SNG-90° | 5322 265 30433 |
| 3x | 50 Ohm bus conn. | 5322 268 24116 |
| 3x | 50 Ohm pen conn. | 5322 268 14141 |



MAT2371

Figure 17.1 Y-OUT p.c.b.

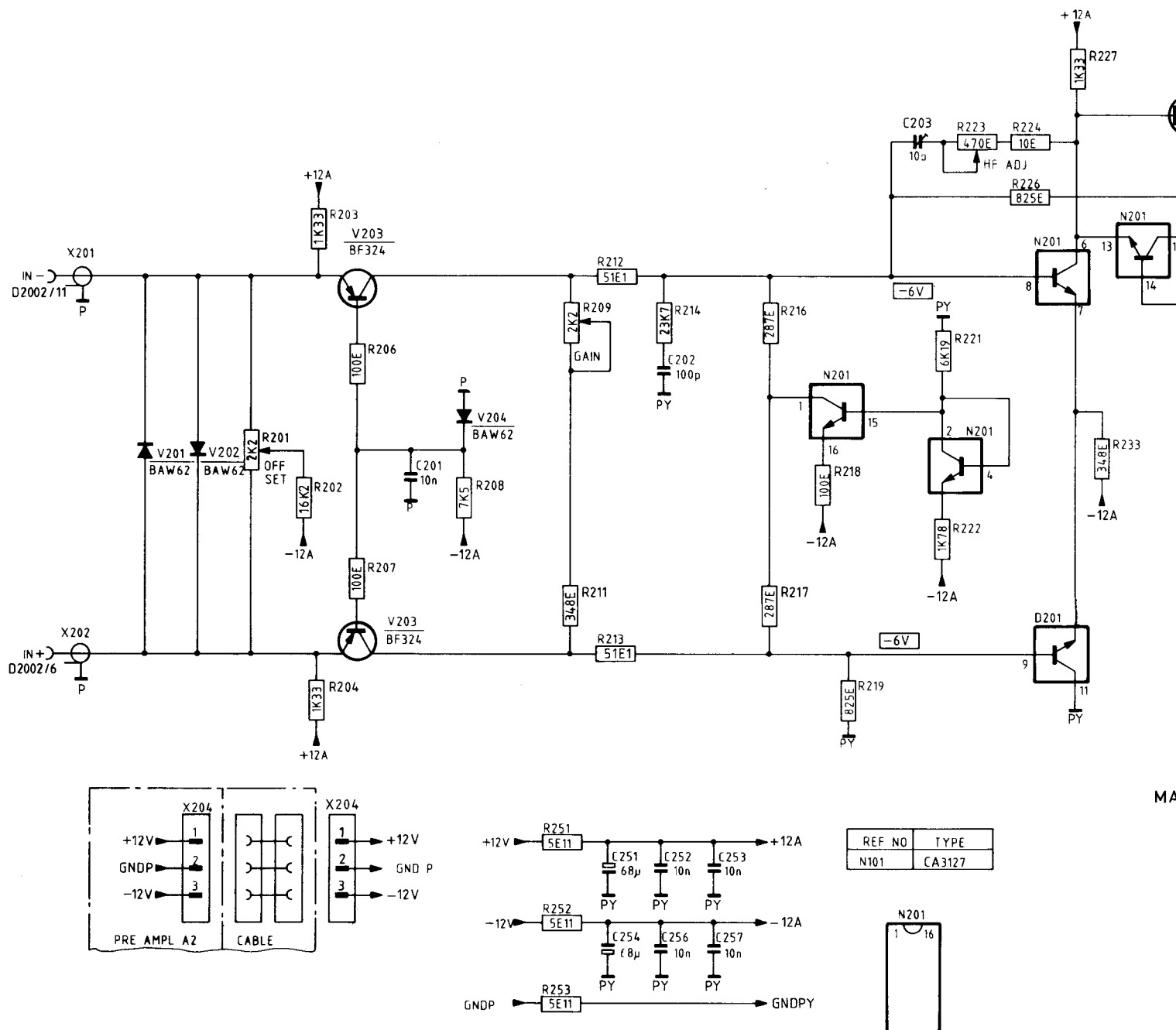
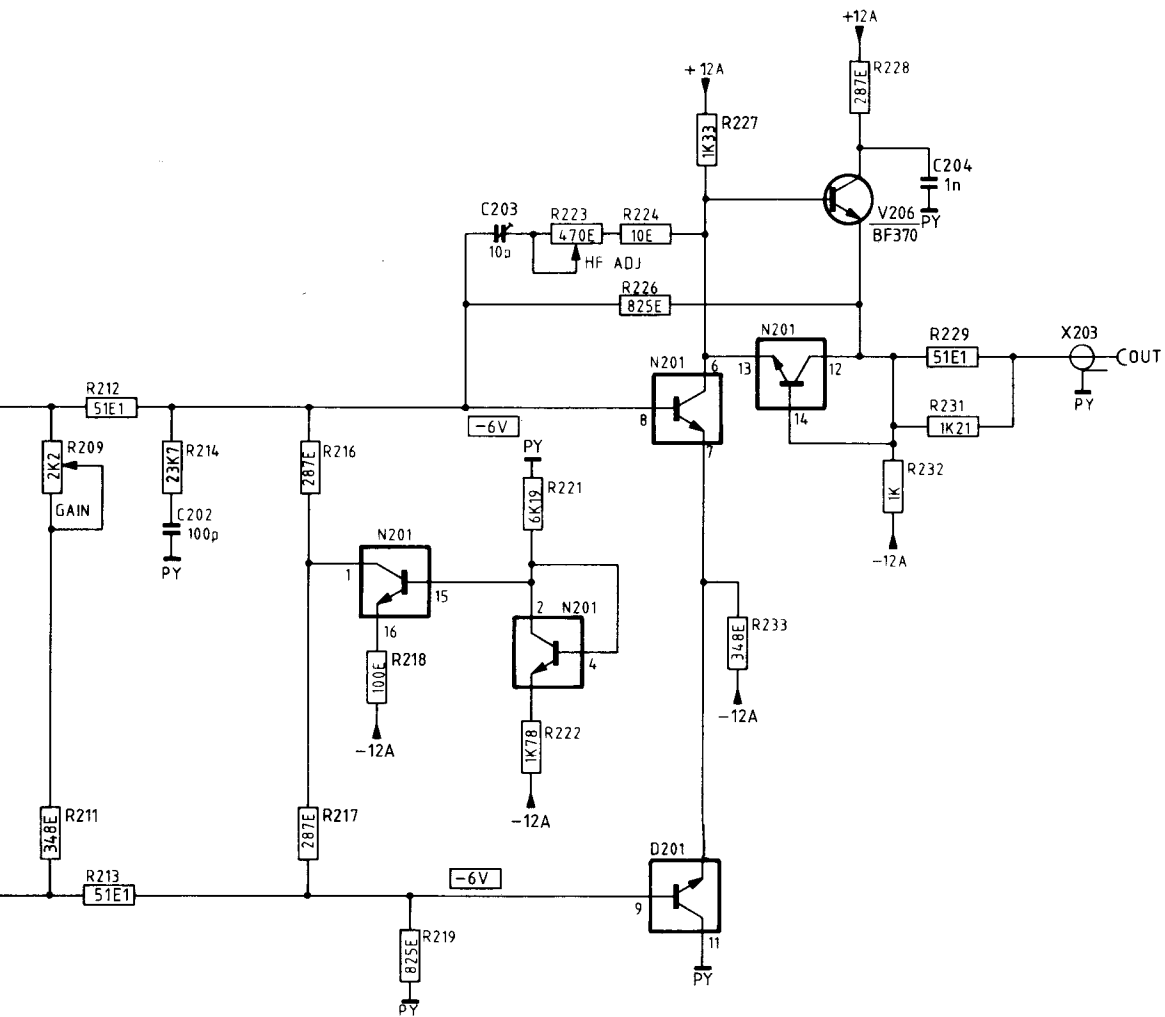
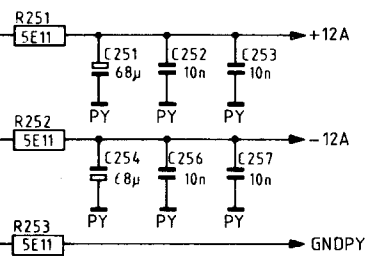


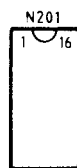
Figure 17.2 Circuit diagram of Y-OUT option



MAT 2370A



| REF NO | TYPE |
|--------|--------|
| N101 | CA3127 |



17.2 MTB GATE, DTB GATE AND MTB SWEEP

17.2.1 MTB gate

The BNC output socket gives a TTL-compatible signal, which is HIGH during the MTB sweep and LOW for other conditions.

| Characteristics | Specification | Additional information |
|-----------------------|---------------|------------------------|
| * Output voltage LOW | < 0,4 V | at +4 mA |
| * Output voltage HIGH | > 2,4 V | at -4 mA |

17.2.2 DTB gate

The BNC output socket gives a TTL-compatible signal, which is HIGH during the DTB sweep and LOW for other conditions.

| Characteristics | Specification | Additional information |
|-----------------------|---------------|------------------------|
| * Output voltage LOW | < 0,4 V | at +4 mA |
| * Output voltage HIGH | > 2,4 V | at -4 mA |

17.2.3 MTB sweep

The BNC output socket gives the MTB sawtooth signal.

| Characteristics | Specification | Additional information |
|--------------------|---------------------|---|
| * Output voltage | 0,5 V/div. +or-2,5% | at $R_{load} \geq 1$ Meg-Ohm |
| * Linearity | < 3% | for definition, see MTB spec. in this manual. |
| * Output impedance | 1 kOhm +or-2% | |
| * Offset voltage | < 250 mV | |

17.2.4 Parts list

| POS.NR | DESCRIPTION | ORDERING CODE |
|---------------|---------------------|----------------|
| C421 | 10 nF -20+50% 100 V | 4822 122 31414 |
| C422 | 10 nF -20+50% 100 V | 4822 122 31414 |
| C423 | 10 nF -20+50% 100 V | 4822 122 31414 |
| R401 | 10 E 1% MRS25 | 4822 116 52891 |
| R402 | 10 E 1% MRS25 | 4822 116 52891 |
| R403 | 100 E 1% MRS25 | 5322 116 53126 |
| R404 | 100 E 1% MRS25 | 5322 116 53126 |
| R406 | 1 E 1% MRS25 | 4822 116 52976 |
| R407 | 10 E 1% MRS25 | 4822 116 52891 |
| R408 | 5k11 1% MRS25 | 5322 116 53494 |
| R409 | 5k11 1% MRS25 | 5322 116 53494 |
| R411 | 1 K 1% MRS25 | 4822 116 53108 |
| R421 | 5E11 1% MRS25 | 4822 116 52999 |
| R422 | 5E11 1% MRS25 | 4822 116 52999 |
| R423 | 5E11 1% MRS25 | 4822 116 52999 |
| V401 | BC558B | 4822 130 44197 |
| V402 | BC548C | 4822 130 44196 |
| D401 | PC74HCT132P | 4822 209 83044 |
| 3x 50 Ohm bus | | 5322 268 24116 |
| 3x 50 Ohm pin | | 5322 268 14141 |

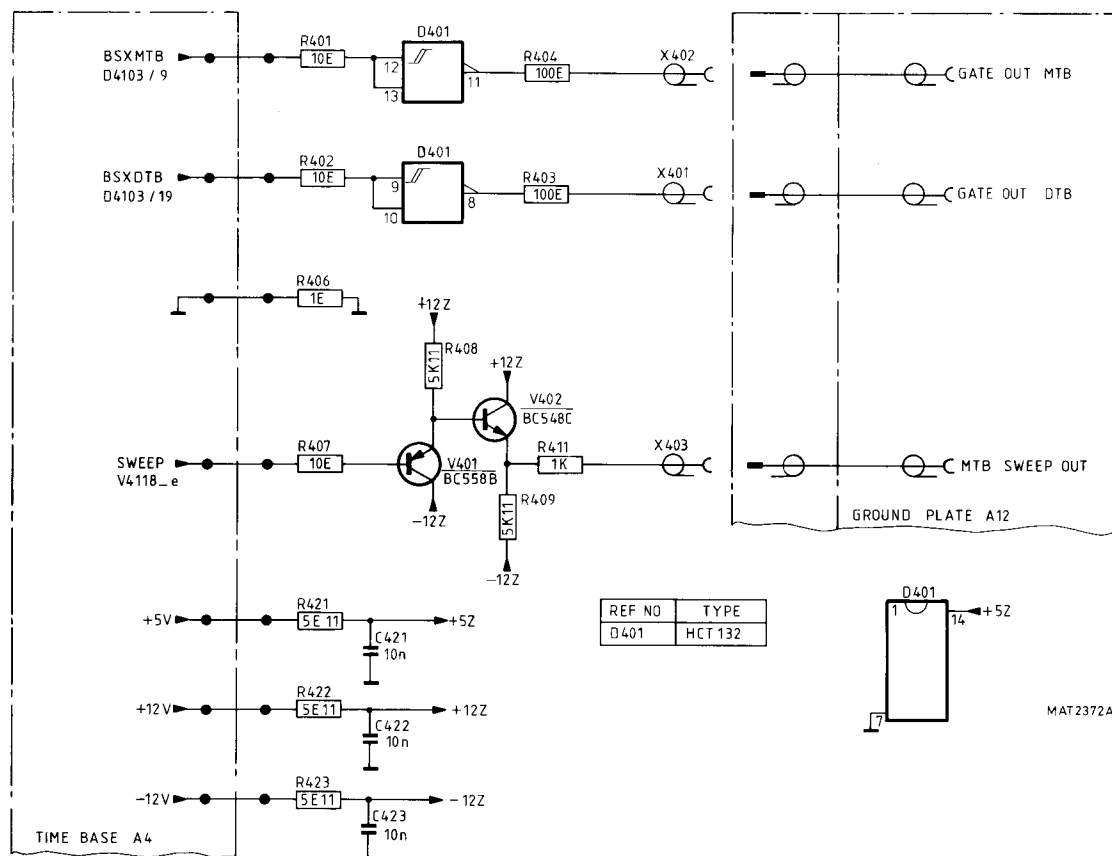


Figure 17.3 Circuit diagram of MTB gate, DTB gate and MTB sweep options

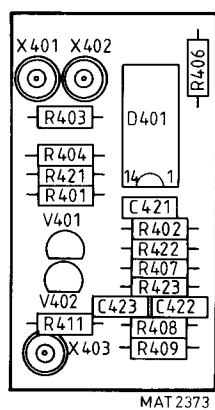


Figure 17.4 P.c.b. for MTB gate, DTB gate and MTB sweep