

# 50 MHz Portable Four Channel Oscilloscope PM 3244

Instruction Manual/Gerätehandbuch/Notice d'emploi et d'entretien

9499 443 00702

791212/1/08



**S&i**  
Scientific & Industrial equipment division



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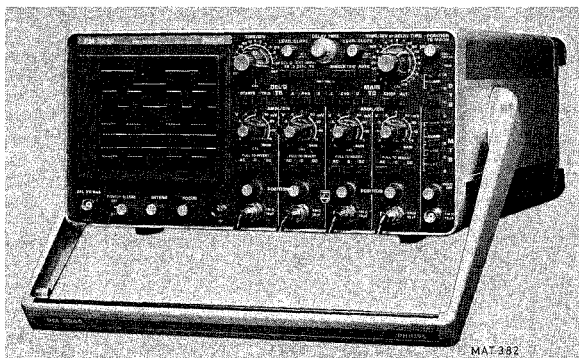


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**IMPORTANT**

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

**WICHTIG**

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

**IMPORTANT****RECHANGE DES PIÈCES DÉTACHÉES (Réparations)**

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série sont marqués sur la plaquette de caractéristiques.

**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.*

**BEMERKUNG:** *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

**REMARQUES:** *Cet appareil est l'objet de développements et améliorations continus. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*



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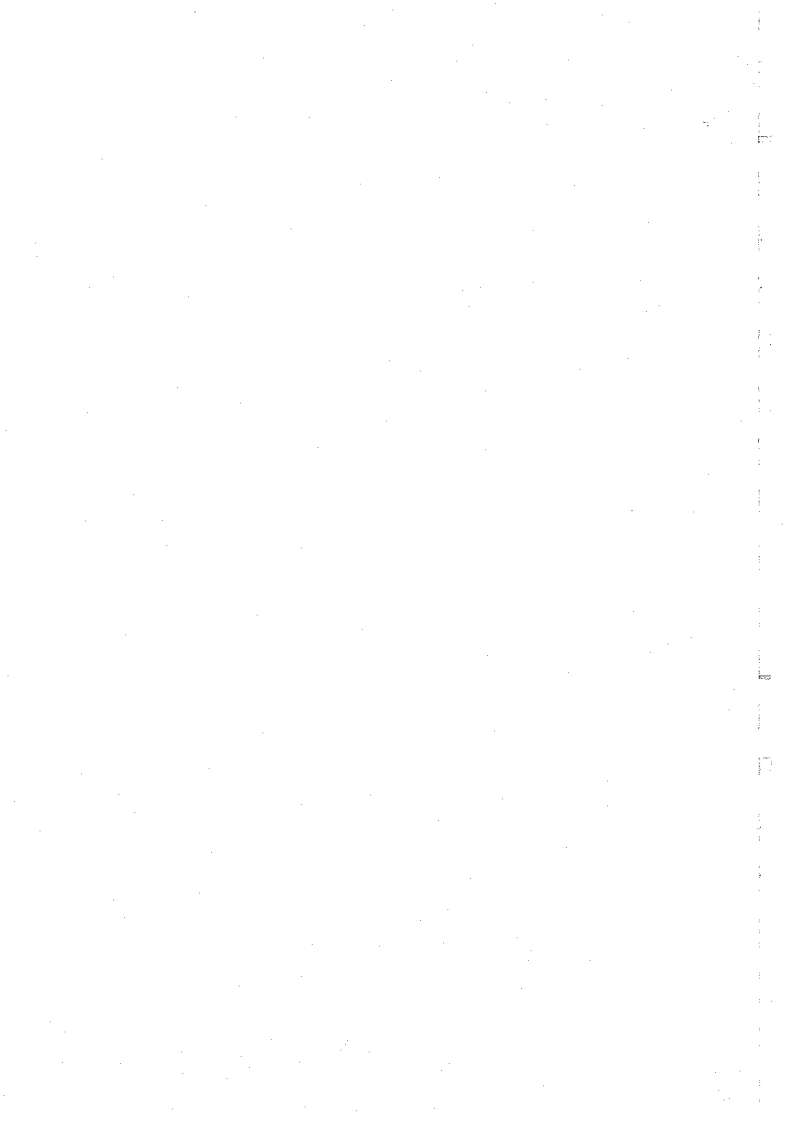
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## Operating manual



## 1. General information

### 1.1. Introduction

The PM 3244 portable h.f. oscilloscope features four identical vertical deflection channels with high sensitivity (5 mV/div.) over a large bandwidth of 50 MHz.

There is a wide choice of vertical deflection possibilities, such as one, two, three or four channels (alternately or chopped) Also adding of the first two channels and of the last two channels is possible. The polarity of each channel can be inverted.

Horizontal deflection possibilities are: main time base (with or without intensified delay time base), delayed time base, or external deflection.

Except the normal trigger source choice the PM 3244 also features composite triggering.

This oscilloscope has a low dissipation tapless power supply, working on any a.c. line voltage between 90 V and 270 V, or any d.c. voltage between 100 V and 350 V.

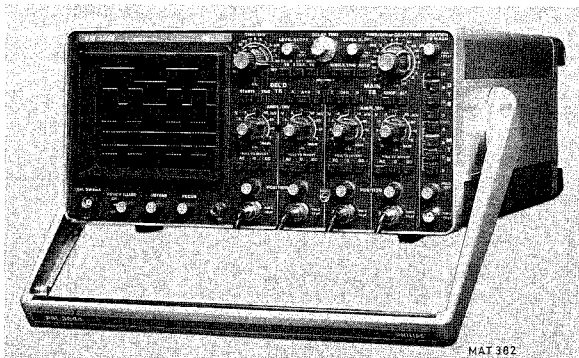


Fig. 1.1. Portable four channel H.F. oscilloscope PM 3244

## 1.2. CHARACTERISTICS

This specification is valid after the instrument has warmed up for 30 minutes.

Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.

Numerical values without tolerances are typical and represent the characteristics of an average instrument.

This instrument has been designed and tested in accordance with IEC Publication 348 for Class I instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

| <i>Designation</i>                       | <i>Specification</i>   | <i>Additional Information</i>   |
|--|--|---|
| <b>1.2.1. C.R.T.</b>                     |  |   |
| Type                                     | D14-125 GH/37  | Rectangular tube face, mesh type, post accelerator, metal backed phosphor.  |
| Measuring area                           | 80 mm x 100 mm   | Divided in 8x10 divisions.  |
| Screen phosphor                          | P31 (GH)   | P11 (BE) and P7 (GM) phosphor optional.   |
| Photographic writing speed               | 750 cm/ $\mu$ s  | Measured with Steinheil Oscillophot M5 camera<br>Aperture 1:1,2<br>Object to image ratio 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>No pre-fogging<br>Phosphor P31 (GH) |
| Total acceleration voltage               | 10 kV  |   |
| Graticule                                | 8x10 cm divisions with sub-divisions of 2 mm along the central axes.   | Dotted lines indicate 10 % and 90 % of measuring lattice for rise-time measurements.  |
| Graticule illumination                   | Continuous variable  | Maximum brightness clearly visible under normal lab. type light conditions.   |
| <b>1.2.2. Vertical deflection (Y)</b>    |  |   |
| Number of channels                       | 4  | Four identical channels, marked A, B, C en D  |
| Display modes                            | Channel A only<br>Channel B only<br>Channel C only<br>Channel D only<br>Channels A+B added<br>Channels C+D added<br>either of these modes in any combination, chopped or alternatively displayed.<br>All channels can be inverted. |   |
| Display time per channel in chopped mode | Approx. 0.5 $\mu$ s  | From /03 version: switchable between 0.5 $\mu$ s and 2 $\mu$ s (see Fig. 3.47)  |
| Frequency range                          | d.c. ... 50 MHz<br>10 Hz ... 50 MHz  | d.c. coupled<br>Upper bandwidth limit -3 dB<br>a.c. coupled<br>-3 dB bandwidth limit  |
| Rise time                                | $\approx$ 7 ns   |   |
| Aberations                               | $\pm$ 2 % max.   | Measured with test pulse of 6 div. deflection / 1 ns rise time and 1 $\mu$ s repetition time.   |

| <i>Designation</i>                                      | <i>Specification</i>   | <i>Additional Information</i>  |
|---|--|--|
| Deflection coefficients                                 | 5 mV/DIV ... 2 V/DIV   | Nine calibrated positions in 1-2-5 sequence. Uncalibrated, continuous control 1 : $\geq 2,5$ .   |
| Accuracy  | $\pm 3 \%$   |  |
| Input voltage   | $\pm 400 \text{ V max.}$   | d.c. + a.c. peak<br>In the 5 mV/DIV ... 20 mV/DIV positions of the input attenuator derating at frequencies over 500 kHz. Refer to Fig. 1.2. |
| Max. deflection   | 24 div.<br>$\geq 6 \text{ div.}$   | For sine waves up to 15 MHz.<br>For sine waves from 15 MHz up to 50 MHz.   |
| Max. total signal amplitude in A-B and C-D modes        | 24 x attenuator-setting  | Attenuators in CAL. positions.   |
| Positioning range                                       | 16 div.  |  |
| Common-mode rejection                                   | $\geq 100:1$ at 1 MHz  | After adjusting  |
| Cross talk between channels                             | 35 dB max.   | For all attenuator combinations.<br>Reference is 6 div. signal amplitude (0 ... 50 MHz) Chopped mode.  |
| Trace stability D.C. drift                              | $\leq 0,3 \text{ div/h}$ at 20 °C  | After 15 min. warm-up  |
| Temp. drift   | $\leq 60 \mu\text{V}/^\circ\text{C}$ typical   |  |
| Attenuator balance                                      | $\leq 0,3 \text{ div.}$  | When switching between any of the attenuator positions.  |
| Input Impedance   | 1 Mohm//15 pF  |  |
| Coupling  | AC-0-DC  | Coupling switch in AC position.  |
| RC time   | 22 ms  |  |
| Visible signal delay                                    | 20 ns  |  |
| <b>1.2.3. Horizontal deflection (X)</b>                 |  |  |
| Display modes   | <ul style="list-style-type: none"> <li>- Main time base</li> <li>- Main time base intensified by delayed time base</li> <li>- Delayed time base</li> <li>- X/Y mode</li> </ul> | Up to four trace X/Y operation with X deflection by one of the four vertical channels, or an external signal, or the line signal.            |
| <b>Horizontal deflection amplifier</b>                  |  |  |
| Bandwidth   | d.c. ... 1 MHz   | over 6 div's<br>- 3 dB upper bandwidth limit   |
| Deflection coefficient                                  | 450 mV/div<br>Vertical attenuator coefficients   | using EXT input<br>apply when one of the vertical channels is used for horizontal deflection   |
| Accuracy  | $\pm 10 \%$  | Using one of the vertical channels for horizontal deflection.  |
| Input impedance   | 1 Mohm//15 pF  |  |
| Phase difference between Vert. and Hor. defl. amplifier | less than 3°   | at 100 kHz   |

| <i>Designation</i>                             | <i>Specification</i>  | <i>Additional Information</i>   |
|--|---|---|
| Deflection by line voltage                     | 8 div's   | The deflection depends on the line voltage and has been factory-adjusted to 8 DIV at a line voltage of 220 V. |
| <b>1.2.4. Main time base</b>                   |   |   |
| Operation                                      | Automatic<br>Triggered<br>Single shot   | In the AUTO mode the time base is free-running approx. 100 ms. after disappearance of the trigger signal.     |
| Time coefficients                              | 0,5 s/DIV ... 50 ns/DIV.  | Twenty-two calibrated positions in 1-2-5 sequence.<br>Uncalibrated, continuous control<br>1 : $\geq$ 2,5      |
| Accuracy                                       | $\pm$ 3 %   | $\pm$ 5 % for 0.5 s/DIV and 0.2 s/DIV<br>$\pm$ 5 % for 100 ns/DIV and 50 ms/DIV                               |
| <b>1.2.5. Delayed time base</b>                |   |   |
|  | Direct running after delay time or triggerable after delay time                               |   |
| Time coefficients                              | 1 ms./DIV ... 50 ns./DIV  | Fourteen calibrated positions in 1-2-5 sequence.<br>Uncalibrated, continuous control<br>1 : $\geq$ 2,5        |
| Accuracy                                       | $\pm$ 3 %   | $\pm$ 5 % for 100 ns./DIV and 50 ns./DIV  |
| <b>Time Base Magnifier</b>                     |   |   |
| Magnification                                  | x5  |   |
| Highest effective sweep speed                  | 10 ns./div.   |   |
| Additional tolerance                           | $\pm$ 2 %   |   |
| <b>1.2.6. Triggering of M.T.B.</b>             |   |   |
| Source   | Internal<br>Composite<br>Line<br>External   | From ch. A, B, C or D   |
| Trigger bandwidth                              | d.c. ... 50 MHz   | Upper bandwidth limit -15 dB  |
| Trigger sensitivity                            | Internal $\leq$ 0,5 div.<br>External $\leq$ 250 mV  | 0,3 div. typical<br>150 mV typical  |
| Slope selection                                | + or -  |   |
| Ext. trigger input impedance                   | 1 Mohm//15 pF   | Identical to any vertical deflection input  |
| Input voltage                                  | $\pm$ 400 V max.  | d.c. + a.c. peak  |
| <b>1.2.7. Triggering of D.T.B.</b>             |   |   |
| Identical to main time base triggering except: |   |   |
| Source   | Internal<br>Composite   | From ch. A, B, C or D   |
| <b>Sweep delay</b>                             |   |   |
| Delay time                                     | Continuously variable between 0.3x and $\geq$ 10x the time-coefficient of the main time base. | Adjustable with calibrated ten turn dial knob.  |
| Incremental delay time error                   | 0,5 %   |   |
| Delay time jitter                              | $\leq$ 1 : 20 000   |   |



| <i>Designation</i>  | <i>Specification</i>  | <i>Additional Information</i>   |
|---|---|---|
| <b>1.2.8. Calibration unit</b>  |   |   |
| Voltage   | 3 V <sub>p-p</sub>  | Square wave, base-line zero volts                                       |
| Current   | 6 mA  | Through current loop  |
| Accuracy  | ± 1 %   | For both voltage and current  |
| Frequency   | 2 kHz ± 2 %   |   |
| Protection  | The output is short-circuit-proof   |   |
| <b>1.2.9. Power supply</b>  |   |   |
| Line voltages   | 90 ... 270 V AC or<br>100 ... 350 V DC  | In one range  |
| Line frequency  | 46 ... 440 Hz or DC   |   |
| Build-in line fuse  | 1,6 amp. delayed-action   | For all line voltages   |
| Power consumption   | 29 W  |   |
| <b>1.2.10. Environmental characteristics</b>  |   |   |
| The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND. |   |   |
| Ambient temperature   | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C                              | Rated range of use<br>Limit range of operation<br>Storage and transport |
| Altitude  | 5000 m (15000')<br>15000 m (45000')   | Operating<br>Non operating  |
| Humidity  | The instrument meets the requirements of the IEC 68 Db recommendations.                 |   |
| Bump  | 1000 bumps of 10 g, ½ sine, 6 ms duration, in each of 3 directions                      | IEC 68 E b  |
| Vibration   | 30 minutes in each of three directions, 10-150 Hz; 0,7 mm p-p and 5 g max. acceleration | IEC 68 F  |
| Recovery time   | 30 minutes for normal operation   | Coming from -10 °C and going to +20 °C at 60 % relative humidity.       |
| Electromagnetic interference  | The instrument meets the VDE, Störgrad K, requirements.                                 |   |
| <b>1.2.11. Mechanical data</b>  |   |   |
| Dimensions  | Length 410 mm (16 1/4")<br>Width 316 mm (12 1/4")<br>Height 154 mm ( 6 1/8")            | Excl. controls, cover and feet  |
| Weight  | 9,7 kg  |   |
| <b>1.2.12. Delivered accessories</b>  |   |   |
| Contrast filter   |   |   |
| Front cover   |   |   |
| Collapsible viewing hood PM 9366  |   |   |
| BNC-banana adaptor PM 9051  |   |   |
| Cal. terminal to BNC adaptor  |   |   |
| Operating and service manual  |   |   |

## 1.2.13. Optional accessories

|                 |  |                |   |
|-----------------|--|----------------|---|
| <b>PM 9335</b>  | Passive probe set<br>1 : 1 (1.5 m)                                 | <b>PM 9355</b> | Current probe;<br>1 mA/div. ... 1 A/div.; |
| <b>PM 9335L</b> | Passive probe set<br>1 : 1 (2.5 m)                                 |                | 12 Hz ... 70 MHz                          |
| <b>PM 9350</b>  | Passive probe set<br>10 : 1 11 pF (1.5 m)                          | <b>PM 9346</b> | Power supply for active<br>probes         |
| <b>PM 9350L</b> | Passive probe set<br>10 : 1 14 pF (2.5 m)                          | <b>PM 8960</b> | 19 inch rack mount adaptor                |
| <b>PM 8927</b>  | Passive probe set<br>10 : 1 (1.5 m)                                | <b>PM 8992</b> | Accessory pouch                           |
| <b>PM 8927L</b> | Passive probe set<br>10 : 1 (2.5 m)                                | <b>PM 9380</b> | Oscilloscope camera                       |
| <b>PM 9358</b>  | Passive probe set<br>100 : 1; max. voltage<br>5600 V; 2 pF (1.5 m) | <b>PM 8971</b> | Adapter for oscilloscope<br>camera        |
| <b>PM 9347</b>  | Active TV triggering probe<br>10 : 1 11 pF (1.5 m)                 | <b>PM 8910</b> | Polaroid anti-glare filter                |
| <b>PM 9352</b>  | Micro miniature probe<br>10 : 1 6 pF (2.5 m)                       | <b>PM 8980</b> | Long type viewing hood                    |
| <b>PM 9353</b>  | Active FET probe<br>1 : 1; 10 : 1; 100 : 1,<br>3.5 pF (1.5 m)      | <b>PM 8901</b> | Battery pack 24 V dc and<br>330 V dc      |
|                 |  | <b>PM 8991</b> | Oscilloscope trolley                      |

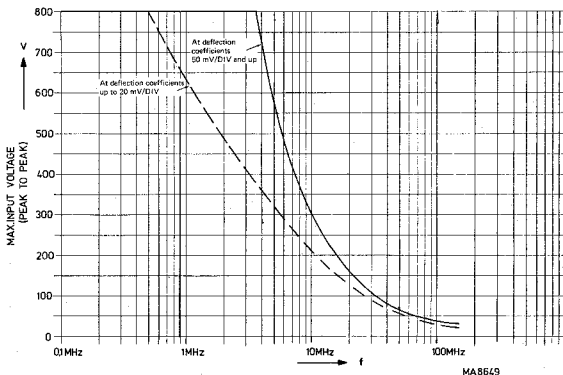


Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency



## 2.Directions for use

### 2.1. INSTALLATION

#### 2.1.1. Removing and fitting the front cover (see fig. 2.1.)

**Removing:**

- Turn the knob in the centre of the cover a quarter of a turn anti-clockwise to the UNLOCKED position.
- Take the cover off.

**Fitting:**

- Align the key of the locking knob with the slot in the text plate of the instrument.
- Fit the cover over the front of the oscilloscope.
- Press the knob and turn it a quarter of a turn clockwise to the LOCKED position.

*Remark: The handle can be rotated if the push-buttons on its bearings are depressed.*

**WARNING:** This instrument generates high voltages and should not be operated with the cabinet plates removed. The line plug must be removed before attempting any maintenance work, and any relevant high-voltage points discharged.

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section *earthing*).


#### 2.1.2. Mains adaption and fuse

The ability of the instrument to operate at any mains voltage between 90 and 270 V a.c. or between 100 and 350 V d.c. obviates the need of adaption to the local mains voltage.

The fuse holder is mounted on the rear panel. The 1,6 A delayed action fuse is used at all mains voltages. Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided. The instrument shall be disconnected from all voltage sources when a fuse is to be replaced.

#### 2.1.3. Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- Via the protective earth terminal (identified by the symbol ).
- Via the three-core line cable. The line plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

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

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

#### 2.1.4. Dismantling

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 a skilled person who is aware of the danger involved.

Replacing the mains plug is at the user's own risk. After replacing a mains plug, a high-voltage test in accordance with IEC Publication 348 is strongly recommended.

Bear in mind that capacitors inside the instrument may still be charged, even if the instrument has been separated from all voltage sources.

#### 2.1.5. Switching on

The POWER switch is incorporated in the graticule ILLUMINATION control on the front panel, immediately below the screen bezel. The oscilloscope must never be switched on whilst any circuit board has been removed. Never remove a circuit board until at least one minute after the oscilloscope has been switched off.

## 2.2. FUNCTION OF CONTROLS AND INPUT SOCKETS

### 2.2.1. Vertical deflection

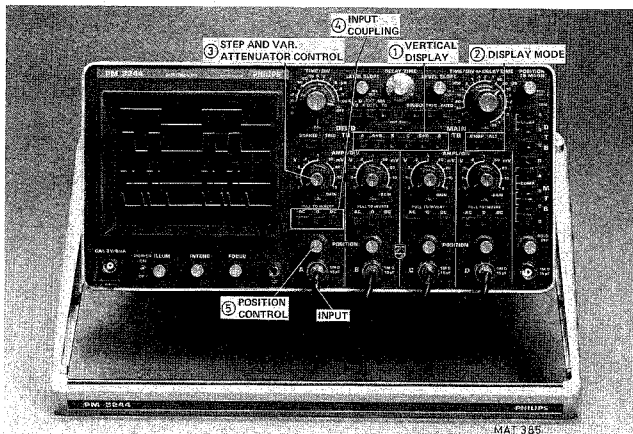


Fig. 2.3. Vertical deflection

#### 1. Vertical deflection mode switch.

|            |                                      |
|------------|--------------------------------------|
| Button A   | channel A                            |
| Button A+B | channels A and B algebraically added |
| Button B   | channel B                            |
| Button C   | channel C                            |
| Button C+D | channels C and D algebraically added |
| Button D   | channel D                            |

Any combination of above displays is possible (if no button depressed, channel A is on).

#### 2. CHOP-ALT switch

The under point 1 mentioned channel displays, can be in the chopped- or the alternated mode, depending of this switch (if no button depressed and two or more channels are on, the display is in the chopped mode).

#### 3. Attenuator controls

|          |   |
|----------|---|
| AMPL/DIV | Step control of the deflection coefficients combined with:    |
| AMPL/CAL | Continuously variable control of the deflection coefficients. |
|          | If this knob is pulled-out the channel polarity is inverted.  |

#### 4. Input coupling switch

|    |  |
|----|--|
| AC | Signal coupling via a blocking capacitor.            |
| 0  | Channel input connected to earth; signal-load open.  |
| DC | Direct coupling.                                     |
|    | (If no button is depressed, the AC situation is on). |

#### 5. POSITION

Continuously variable control giving vertical shift of the relevant channel.

#### PRE-SET CONTROLS:

|      |  |
|------|--|
| BAL  | Step attenuator balance                |
| GAIN | Step attenuator amplitude calibration. |

## 2.2.2. Horizontal deflection (x)

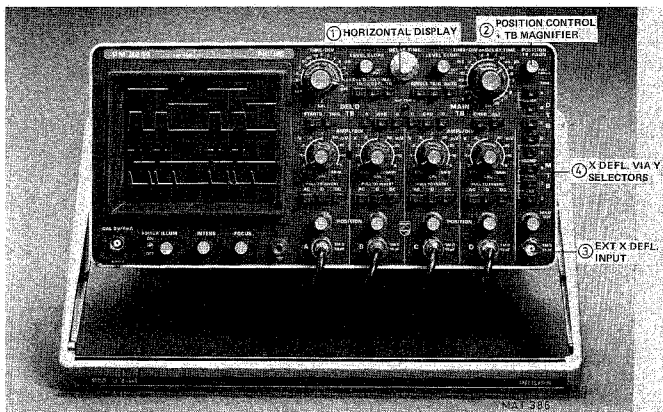


Fig. 2.4. Horizontal deflection.

## 1. Horizontal deflection mode switch.

|            |   |
|------------|---|
| MAIN TB    | The horizontal deflection is provided by the main time base generator. A part of the display is intensified when the delayed time base is on.   |
| EXT X DEFL | Horizontal deflection is achieved by an external signal coming from: <ul style="list-style-type: none"> <li>- Input socket of the horizontal amplifier (3)</li> <li>- One of the vertical deflection channels (4)</li> <li>- The line (4).</li> </ul> |
| DEL'D TB   | The horizontal deflection is provided by the delayed time base generator (if no button is depressed, the main tb is on).  |

## 2. Position and TB magnifier

|          |  |
|----------|--|
| POSITION | Continuously variable control giving horizontal shift of the display.  |
| TB MAGN  | Push-pull switch which increases the time-base coefficients by a factor of 5. Not operative in the EXT X DEFL. mode. |

## 2.2.3. Main time base

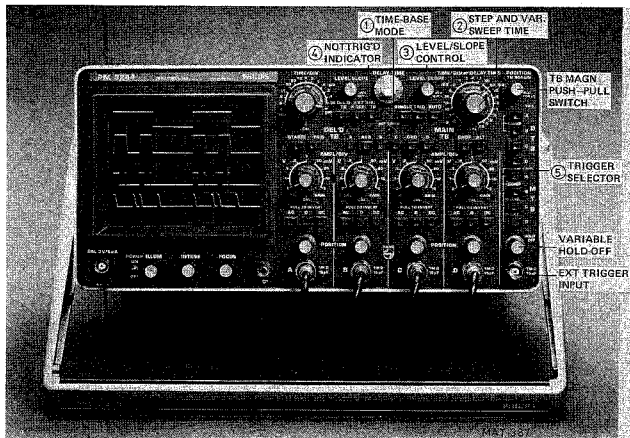


Fig. 2.5. Main time base

## 1. Main time-base mode switch

AUTO  
TRIG  
SINGLE

The main time-base generator is free-running when no trigger pulses are present.

The main time-base is normally triggered.

Single sweep time-base. After operating the SINGLE button, the main time-base generator runs only once upon receipt of a trigger pulse. (If no button is depressed the time-base is in the single sweep mode.)

## 2. TIME/DIV or DELAY switch

TIME/DIV CAL

Step control of the main time-base time coefficients: 22-way rotary switch. If the delayed time-base is operating, the delay time after which the delayed time-base starts, is the product of the DELAY TIME calibrated dial setting and the TIME/DIV coefficient of this switch.

Continuously variable control of the time coefficients.

## 3. LEVEL/SLOPE

Continuously variable control to select the trigger level at which the time-base generator starts.

The push-pull switch enables choice of triggering on the positive- or negative-going slope of the signal.

## 4. NOT TRIG'D indicator

Lights up when the main time-base generator is not triggered.

## 5. MTB Trigger source selector switch

This switch consists of four buttons (A, B, C and D) to select the trigger signal from one of the vertical deflection channels.

When both buttons A and B are depressed, the composite trigger signal is selected.

When both buttons B and C are depressed, part of the line voltage is used as a trigger signal.

When both buttons C and D are depressed, the signal applied to the EXT connector is used as a trigger signal.

(If no button is depressed, the A trigger signal is on.)

## 2.2.4. Delayed time base

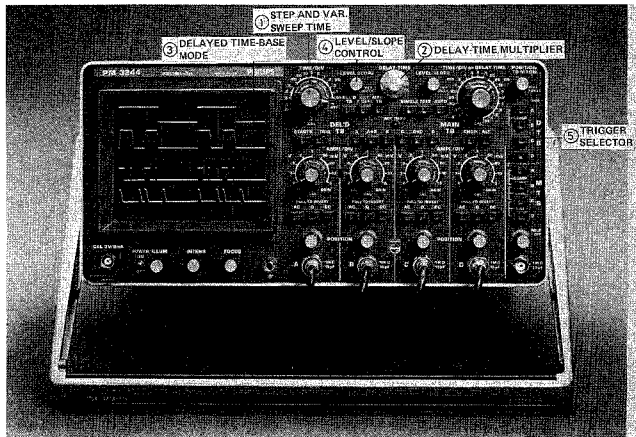


Fig. 2.6. Delayed time base.

- |                                       |   |
|---------------------------------------|---|
| 1. TIME/DIV switch                    | Step control of the delayed time-base time coefficients; 14-way rotary switch. In the OFF position the delayed time-base is not operating.  |
| TIME/DIV CAL                          | Continuously variable control of the time-base coefficients.  |
| 2. DELAY TIME                         | Calibrated ten-turn dial knob to adjust the delay time after which the delayed time base becomes operative. This delay time is the product of the DELAY TIME dial setting and the TIME/DIV coefficient switch of the main time-base.  |
| 3. STARTS/TRIG                        | If the STARTS button has been depressed, the delayed time-base starts immediately after the delay-time (the delayed time-base requires then no trigger signal).<br>If the TRIG. button has been depressed the delayed time-base starts after the delay-time upon receipt of a trigger pulse.<br>(No button depressed has the same effect as the STARTS button depressed.) |
| 4. LEVEL/SLOPE                        | Continuously variable control to select the trigger level at which the delayed time-base generator triggers.<br>The push-pull switch enables choice of triggering on the positive- or negative-going slope of the signal.   |
| 5. DTB Trigger source selector switch | This switch consists of four buttons (A, B, C and D) to select the trigger signal from one of the vertical deflection channels.<br>When both buttons A and B are depressed, the composite trigger signal is selected.<br>(If no button depressed, the A trigger signal is on).  |



## 2.2.5. C.R.T. display section

- |                |  |
|----------------|--|
| 1. POWER/ILLUM | Continuously variable control of the graticule illumination combined with power on-off switch.<br>Pilot lamp indicates the ON state. |
| 2. INTENS      | Continuously variable control of the display-brightness.   |
| 3. FOCUS       | Continuously variable control of the electron-beam focussing.  |

### Miscellaneous

- |        |  |
|--------|--|
| 1. CAL | Output socket for calibration of: <ul style="list-style-type: none"> <li>- The gain of the vertical deflection amplifier and,</li> <li>- The frequency compensation of attenuator probes.</li> </ul> Suited for voltage probes and current probes. |
|--------|--|

## 2.3. PRELIMINARY SETTINGS

Before measurements with this oscilloscope are carried out, check that the step-attenuator balance and the gain calibration for all channels are well adjusted.

If necessary proceed as follows:

1. Adjusting the step attenuator d.c. balance
  - Depress the MAIN TB button of the horizontal deflection mode switch.
  - Depress the AUTO button of the main time-base mode switch.
  - Set the INTENSITY and FOCUS controls for a sharp, well-defined trace.
  - Depress the relevant channel button of the vertical deflection mode switch.
  - Depress the 0 button of the input coupling switch.
  - Set the POSITION knob so that the trace is somewhere about in the centre of the screen.
  - Set the AMPL continuous control to position CAL.
  - Check that the trace does not jump when the AMPL switch knob is rotated.
  - If necessary, adjust the BAL control.
  - Repeat for each channel.

### 2. Gain calibrations

Unless otherwise stated, the controls occupy the same positions as in the previous procedure.

- Set the AC-0-DC switch to AC.
- Set the AMPL switch knob to .5 V and the continuous control to CAL.
- Connect the channel input to the CAL output.
- Check the vertical deflection is exactly 6 divisions.
- If necessary adjust the GAIN control.
- Also an attenuator probe can be included in this calibration. The probe attenuation factor must then be taken into account with respect to the AMPL switch position.
- Repeat for each channel.

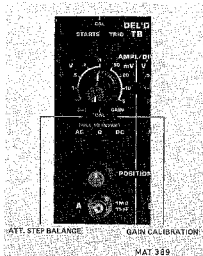


Fig. 2.7.

## 2.4. OPERATING INSTRUCTIONS

### 2.4.1. General

Before switching-on, ensure that the oscilloscope has been correctly installed in accordance to the INSTALLATION RECOMMENDATIONS (Chapter 2.1.) and the precautions outlined have been observed.

### 2.4.2. Vertical deflection

To display the desired channels depress the corresponding buttons of the vertical deflection mode switch. If two or more traces are displayed, the display can be in the alternate- or the chopped mode.

In the alternate mode the channels are displayed successively; during fly-back of the main time-base sweep the display is switched-over from one channel to another.

In the chopped mode the channels are switched-over from one to another during the time-base sweep. The display time in the chopped mode is approx. 500 ns per channel. From /03 version switchable between 0.5 and 2  $\mu$ s, see fig. 3.4.7.

To obtain a steady display generally the alternate mode is used at the higher sweep speeds and the chopped mode at the lower sweep speeds.

Note that in the composite trigger mode, the alternate display mode must be chosen, otherwise the chopper pulses will influence the trigger circuit.

The signals under observation are fed to input socket(s) A ... D and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifiers are d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shift in the DC position of the AC/0/DC switch.

This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. component. Some pulse droop, however, will occur when i.f. square-wave signals are displayed.

The 0 position interrupts the signal-path and earths the amplifier-input for quickly determining the 0 V level. With the position controls the display can be shifted in vertical direction. Note that in the composite trigger mode the trigger start point also is influenced by the vertical position control.

#### 2.4.3. Horizontal deflection

Depending on the position of the horizontal display switch the horizontal deflection can be:

- Main time-base
- Ext. X defl.
- Delayed time-base.

With the position control, combined with time-base magnifier, the display can be shifted in horizontal direction.

If the MAIN TB or DEL'D TB button is depressed, the horizontal deflection is effected by the main time-base or the delayed time-base respectively. If the EXT X DEFL button is depressed the horizontal deflection can be taken from:

- One of the vertical deflection channels A, B, C or D
- Line voltage (mains)
- Externally via EXT connector

#### 2.4.4. Main time base

Linear horizontal deflection is obtained when the MAIN TB button of the horizontal display switch is depressed.

The time-base mode can be chosen with the time-base mode switch:

- |        |   |
|--------|---|
| AUTO   | <ul style="list-style-type: none"> <li>- Time-base is running, also if no trigger pulses are present. The trace is, therefore, always visible.</li> <li>The AUTO mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower than 10 Hz, or pulse trains with an off-time exceeding 100 ms. As soon as trigger pulses are present, the free-running state of the time-base is automatically terminated and the time-base generator is normally triggered.</li> </ul> |
| TRIG   | <ul style="list-style-type: none"> <li>- The time-base is visible when trigger pulses are present and trigger-level control is correct.</li> </ul>  |
| SINGLE | <ul style="list-style-type: none"> <li>- The time-base makes only one sweep after receipt of a trigger pulse. After this sweep the time-base must be reset by depressing the SINGLE button once again.</li> <li>When effects which occur only once, have to be observed (usually photographed), it is often desirable to ensure that only one sweep is generated, even though several trigger pulses might be produced after the phenomenon of interest.</li> </ul>   |

#### 2.4.5. Triggering

If one or more signals must be displayed, the time-base sweep must always be started on one fixed point of the signal, in order to obtain a stationary display.

The time-base generator is, therefore, started by trigger pulses which are derived from the following signal sources, depending on the main time-base trigger selector switch:

- One of the vertical deflection channels A, B, C or D
- Composite signal
- Line voltage
- External voltage

The amplitudes of the trigger signals from one of the vertical deflection channels, or from the composite signal are proportional to the vertical deflection of the display, hence depending on the input attenuator settings.

For composite triggering buttons A and B must be depressed, in this mode the trigger signal is taken from the common vertical deflection amplifier. Composite signal triggering features:

- a. Triggering by differential signals if e.g. the instrument is in the A+B mode, with one of the input voltages inverted.
- b. Two up to four signals with different, non-related frequencies can be displayed.  
In this case the trigger points of the various signals must be in the same trigger level range.

*Note:* — When triggering in the composite mode, the display must always be in the ALT mode.  
In the CHOP mode the chopper pulses will function as trigger pulses hence the display will be unstable.  
— In the composite triggering mode the trigger point of the signal depends also on the vertical POSITION control. A small modification for "AC" composite triggering described in part 3.2.2. solves this problem.

Line triggering is realised by depressing both buttons B and C.

The main time-base is triggered by part of the line voltage (mains). The coupling with the line voltage is obtained by a build-in opto-isolator circuit, hence the instrument remains isolated from the line voltage.

External triggering is realized by depressing both buttons C and D.

The main time-base is now triggered by an external signal applied via the EXT connector.

With the LEVEL control the point of triggering on the slope of the signal can be chosen.

The SLOPE push-pull switch permits selection of the positive- or negative going slope.

If the main time-base generator gets no trigger pulses the NOT TRIG'D indicator lights up.

In the SINGLE sweep mode this indicator lights up if the time-base generator has been reset and is waiting for the next trigger pulse.

The sweep time of the main time-base is set with the knob TIME/DIV or DELAY TIME. If the delayed time base is switched on, the time between starting of the main time-base and delayed time-base-sweep, is the product of the settings of the DELAY TIME 10-turn knob and the main time-base sweep time switch. With the centre knob time-base sweep times between the steps can be adjusted. For time-measurements this knob must always be in the CAL position.

The TIME/DIV coefficient of the time-base can be increased by a factor of 5, by pulling the TB MAGN push-pull knob.

With the HOLD OFF control, the hold-off time of the main time-base generator can be varied. This is the time the time-base generator needs to be ready for receipt of the next trigger pulse. The HOLD OFF control permits steady display of more complicated signals e.g. periodic double-pulses.

Fully clockwise is the normal position of the HOLD OFF control. Turning anti-clockwise the hold-off time is extended.

#### 2.4.6. Delayed time base

If the MAIN TB button of the horizontal display switches is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.

The moment the delayed time-base is starting is determined by the settings of the main time-base TIME/DIV knob and the DELAY TIME 10-turn knob. If the STARTS button of the delayed time-base mode switch is depressed, the delayed time-base starts immediately after this delay time.

If the TRIG button is depressed the delayed time-base will start after this delay time and upon receipt of a trigger pulse.

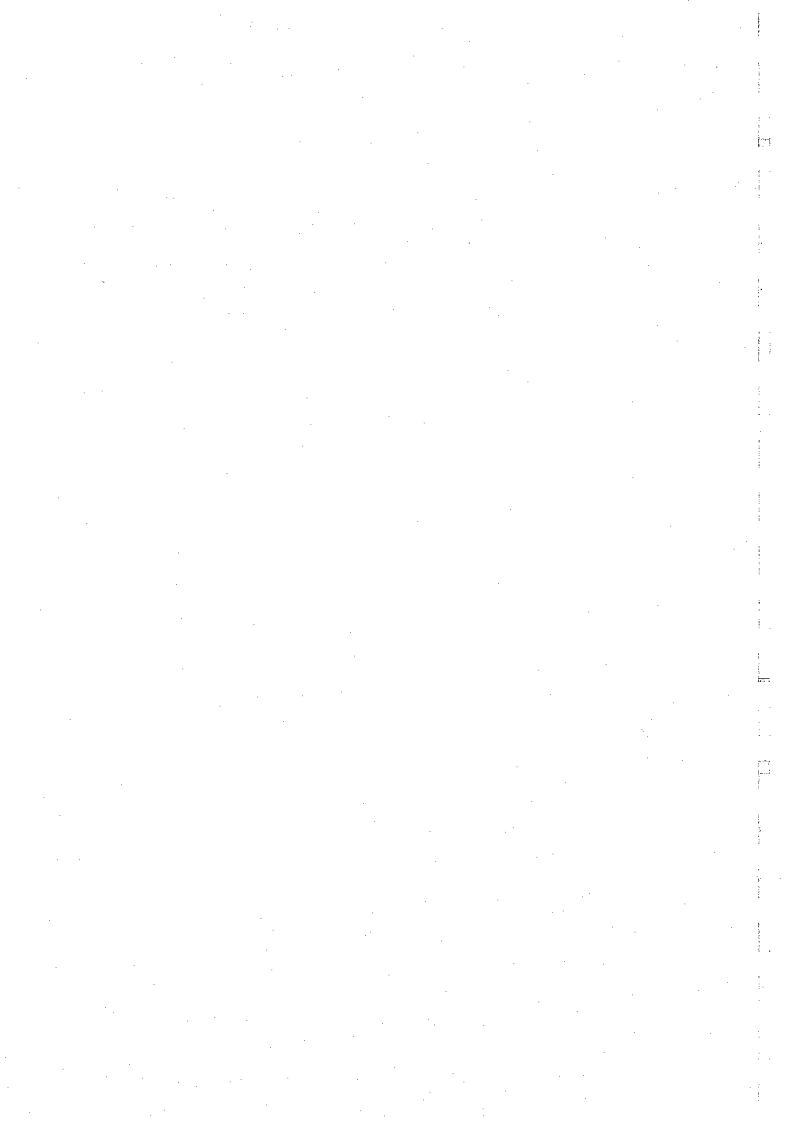
The delayed time-base trigger selector has the same possibilities as the main time-base trigger selector except line and ext. triggering.

The LEVEL/SLOPE control function is the same as described for the main time-base.

The sweep time of the intensified part of the main time-base sweep depends on the setting of the delayed time-base TIME/DIV knob.

With the centre knob sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

If the DEL'D TB button of the horizontal mode switch is depressed the intensified part of the main time-base sweep is displayed over the whole screen.



## Gebrauchsanleitung



## 1. Allgemeines

### 1.1. EINLEITUNG

Der tragbare H.F. Oszillograf PM 3244 verfügt über vier identische Vertikalablenkungskanäle mit höchster Empfindlichkeit ( $5 \text{ mV/Teil}$ ) über eine grosse Bandbreite von 50 MHz.

Das Gerät bietet vielseitige Vertikalablenkmöglichkeiten, wie ein, zwei, drei und vier Kanäle (alternierend oder gehopped). Es gestattet auch Addition der ersten zwei und der letzten zwei Kanäle.

Die Polarität jedes Kanals kann invertiert werden.

Horizontalablenkmöglichkeiten sind: Hauptzeitbasisablenkung (mit oder ohne aufgehellter verzögerter Zeitbasis), verzögerte Zeitbasisablenkung oder externe Ablenkung.

Ausser der normalen Triggerquelle-Einstellung ermöglicht der PM 3244 auch zusammengesetzte Triggerung.

Der PM 3244 hat eine Speisung mit niedriger Verlustleistung die bei jeder beliebigen Wechselspannung zwischen 90 V und 270 V und bei jeder beliebigen Gleichspannung zwischen 100 V und 350 V betriebsfähig ist.

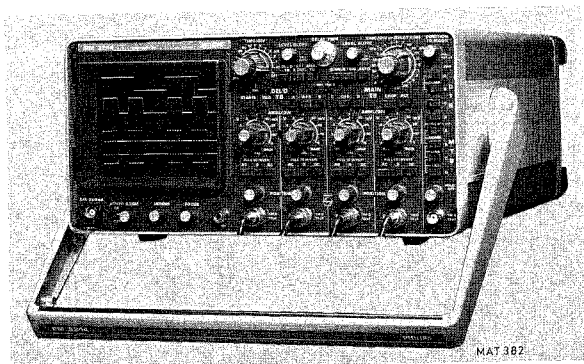


Abb. 1.1. Tragbarer Vierstrahl Hochfrequenz-Oszillograf PM 3244

## 1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in dem vorliegenden Gerätehandbuch enthalten sind.

Nur Angaben mit Toleranzen oder Grenzwerten können als garantierte Daten angesehen werden. Daten ohne Toleranzen, d.h. ohne Fehlergrenzen, sind informative Daten und werden nicht garantiert.

Fehlerangaben gelten nach einer Anwärmszeit von 30 Minuten nach dem Einschalten.

Prozentuale und absolute Fehler sind auf den jeweils angegebenen Referenzwert bezogen.

| <i>Benennung</i>                              | <i>Beschreibung</i>  | <i>Nähere Angaben</i>  |
|---|--|--|
| <b>1.2.1. Elektronenstrahlröhre</b>           |  |  |
| Typ   | PHILIPS D14-125 GH/37  | Rechteckiger Schirm, mit Netzelektrode und Nachbeschleunigung, metallhinterlegter Leuchtschirm.  |
| Ausnutzbare Schirmfläche                      | 80 mm x 100 mm   |  |
| Schirmtyp                                     | P31 (GH) Phosphor  | P11 (BE) und P7 (GM) Phosphor auf Wunsch lieferbar.  |
| Photografische Schreibgeschwindigkeit         | 750 cm/ $\mu$ s  | Gemessen mit Steinheil Oscillophot M5 Kamera.<br>Blende: 1:1,2<br>Bildausschnitt Verhältnis: 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>Keine Vorbelichtung<br>Phosphor Typ P31 (GH) |
| Gesamte Beschleunigungsspannung               | 10 kV  | Gestrichelte Linien  |
| Raster  | 8 x 10 cm Teilung mit Unterteilung von 2 mm an den mittleren Achsen  | bei 10 % und 90 % des Messrasters, zur Messung von Anstiegszeiten.   |
| Rasterbeleuchtung                             | Stetig regelbar  | Max. Helligkeit bei normalen Laborbeleuchtungsbedingungen deutlich sichtbar.   |
| <b>1.2.2. Vertikalablenkung (Y)</b>           |  |  |
| Anzahl Kanäle                                 | 4  | Vier mit A, B, C und D bezeichnete Kanäle  |
| Darstellungsarten                             | Kanal A allein<br>Kanal B allein<br>Kanal C allein<br>Kanal D allein<br>Kanäle A+B addiert<br>Kanäle C+D addiert<br>jede dieser Arten in beliebiger Kombination, gehoppert oder alternierend dargestellt.<br>Alle Kanäle können invertiert werden. |  |
| Darstellungszeit pro Kanal in Chopper-Betrieb | ca. 500 ns.  | Ab /03 Version: schaltbar zwischen 0,5 and 2 $\mu$ s (siehe Fig. 3.47).  |
| Frequenzbereich                               | DC ... 50 MHz<br><br>10 Hz ... 50 MHz  | Gleichspannungsgekoppelt<br>Obere Bandbreitegrenze -3 dB<br>Wechselspannungsgekoppelt<br>-3 dB Bandbreitegrenze  |



| <i>Benennung</i>  | <i>Beschreibung</i>             | <i>Nähere Angaben</i>   |
|---|---------------------------------|---|
| Anstiegszeit  | $\approx 7$ ns                  |   |
| Überschwingen   | $\pm 2\%$ maximal               | Gemessen mit einem Prüfpuls mit 6 Div. Auslenkung / 1 ns. Anstiegszeit und 1 $\mu$ s Wiederholungszeit.   |
| Ablenkkoeffizienten   | 5 mV/DIV ... 2 V/DIV            | In neun kalibrierten Stufen in 1-2-5 Folge. Nichtkalibriert, kontinuierlich einstellbar 1 : $\geq 2.5$  |
| Fehlergrenze  | $\pm 3\%$                       |   |
| Eingangsspannung  | $\pm 400$ V maximal             | Gleichspannung + Spitzenwert einer Wechselfspannung. In den 5 mV/DIV ... 20 mV/DIV Stufen des Eingangsabschwächer, Minderung bei Frequenzen über 500 kHz. Siehe Abb. 1.2. |
| Maximale Ablenkung  | 24 DIV<br>$\geq 6$ DIV          | Für sinusförmige Signale bis 15 MHz<br>Für sinusförmige Signale von 15 MHz bis 50 MHz   |
| Maximale Gesamtsignalamplitude in Betriebsarten A-B und C-D | 24x Abschwächer Einstellung     | Abschwächer in CAL Stellungen   |
| Verschiebungsbereich  | 16 DIV                          |   |
| Gleichtakunterdrückung                                      | $\geq 100:1$ bei 1 MHz          | Nach Abgleich   |
| Übersprechen zwischen Kanälen                               | 35 dB maximal                   | Für alle Abschwächerkombinationen Bezogen auf 6 DIV. Signalamplitude (0 ... 50 MHz) Chopper-Betrieb   |
| Bild-Instabilität DC Drift                                  | $\leq 0,3$ DIV/Stunde bei 20 °C | Nach 15 Minuten Anwärmzeit  |
| Temperaturdrift   | $\leq 60$ $\mu$ V/°C typisch    |   |
| Abschwächungsgleichgewicht                                  | $\leq 0,3$ DIV                  | Beim Umschalten zwischen beliebigen Abschwächer-Einstellungen.  |
| Eingangsimpedanz  | 1 Mohm//15 pF                   |   |
| Kopplung  | AC-0-DC                         |   |
| RC-Zeit des Eingangs  | 22 ms                           | Kopplung-Schalter auf AC  |
| Sichtbare Signalverzögerung                                 | 20 ns                           |   |

### 1.2.3. Horizontalablenkung (X)

|  |   |   |
|--|---|---|
| Darstellungsarten                                    | <ul style="list-style-type: none"> <li>— Hauptzeitbasis</li> <li>— Hauptzeitbasis aufgeheilt durch verzögerte Zeitbasis</li> <li>— verzögerte Zeitbasis</li> <li>— X/Y Betrieb</li> </ul> | Bis zu vier X/Y Darstellungen. Betrieb mit X-Ablenkung durch einen der vier Kanäle, ein externes Signal oder das Netzsignal |
| Frequenzbereich des Horizontalablenkungs-Verstärkers | DC ... 1 MHz  | über 6 DIV<br>-3 dB obere Bandbreitegrenze  |
| Ablenkkoeffizient                                    | 450 mV/DIV<br>Vertikalaabschwächkoeffizienten   | Bei Anwendung von Eingang EXT Zutreffend wenn einer der vertikalen Kanäle für Horizontalablenkung angewandt wird.           |
| Fehlergrenze   | $\pm 10\%$  | Bei Anwendung eines der vertikalen Kanäle für Horizontalablenkung   |

| <i>Benennung</i>   | <i>Beschreibung</i> | <i>Nähere Angaben</i>   |
|--|---------------------|---|
| Eingangsimpedanz   | 1 Mohm//15 pF       |   |
| Phasendifferenz zwischen Vertikal- und Horizontalabl. Verstärker | weniger als 3°      | bei 100 kHz   |
| Ablenkung durch Netzspannung                                     | 8 DIV               | Die Ablenkung ist abhängig von der Netzspannung und ist ab Fabrik eingestellt auf 8 DIV bei 220 V Netzspannung. |

#### 1.2.4. Hauptzeitablenkung

|               |                                       |  |
|---------------|---------------------------------------|--|
| Betrieb       | Automatisch<br>Getriggert<br>Einmalig | Bei Betriebsart AUTO ist die Zeitbasis etwa 100 ms nach Verschwinden des Triggersignals freilaufend. |
| Zeitmassstäbe | 0,5 s/DIV ... 50 ns/DIV               | 22 kalibrierte Stufen in 1-2-5 Folge.<br>Nichtkalibriert: kontinuierliche Einstellung 1 : $\geq$ 2,5 |
| Fehlergrenze  | $\pm$ 3 %                             | $\pm$ 5 % für 0,5 s/DIV und 0,2 s/DIV<br>$\pm$ 5 % für 100 ns/DIV und 50 ms/DIV                      |

#### 1.2.5. Verzögerte Zeitablenkung

|   |  |  |
|---|--|--|
|   | Sofort nach Verzögerungszeit laufend oder triggerbar nach Verzögerungszeit |  |
| Zeitmassstäbe                             | 1 ms/DIV ... 50 ns/DIV   | 14 kalibrierte Stufen in 1-2-5 Folge<br>Nichtkalibriert, Stufenlose Einstellung 1 : $\geq$ 2,5 |
| Fehlergrenze                              | $\pm$ 3 %  | $\pm$ 5 % für 100 ns/DIV und 50 ns/DIV   |
| Dehnung der Zeitbasis                     | x 5  |  |
| Maximale effektive Schreibgeschwindigkeit | 10 ns/DIV  |  |
| Zuzügliche Toleranz                       | $\pm$ 2 %  |  |

#### 1.2.6. Triggerung der Hauptzeitablenkung

|                             |   |   |
|-----------------------------|---|---|
| Triggerquelle               | Intern<br>Zusammengesetzt<br>Netz<br>Extern   | von Kanal A, B, C oder D                              |
| Trigger-Bandbreite          | DC ... 50 MHz                                 | Obere Bandbreitegrenze -15 dB                         |
| Trigger-Empfindlichkeit     | Intern $\leq$ 0,5 DIV<br>Extern $\leq$ 250 mV | 0,3 DIV typisch<br>150 mV typisch                     |
| Flankenwahl                 | + oder -                                      |   |
| Ext. Triggeringangsimpedanz | 1 Mohm//15 pF                                 | Gleich dem Eingang einer beliebigen Vertikalablenkung |
| Eingangsspannung            | $\pm$ 400 V max.                              | DC + AC Spitze  |

#### 1.2.7. Triggerung der verzögerten Zeitablenkung

|  |  |                          |
|--|--|--------------------------|
| Gleich der Hauptzeitablenkungstriggerung ausser: |  |                          |
| Triggerquelle                                    | Intern<br>Zusammengesetzt  | Von Kanal A, B, C oder D |
| <b>Verzögerte Ablenkung</b>                      |  |                          |
| Verzögerungszeit                                 | Stufenlos regelbar zwischen 0,3x und 10x der Zeitmassstab der Hauptzeitablenkung mit Hellpotentiometer |                          |

| <i>Benennung</i>   | <i>Beschreibung</i>  | <i>Nähere Angaben</i>   |
|--|--|---|
| Zusätzlicher Verzögerungszeitfehler  | 0,5 %  |   |
| Verzögerungszeitjitter   | ≤ 1 : 20 000   |   |
| <b>1.2.8. Kalibriereinheit</b>   |  |   |
| Spannung   | 3 V <sub>S-S</sub>   | Rechtecksignal, Grundlinie ist Nullspannung                                 |
| Strom  | 6 mA   | Durch Stromkreis  |
| Fehlergrenze   | ± 1 %  | Für Spannung und Strom  |
| Frequenz   | 2 kHz  | ± 2 %   |
| Sicherung  | Der Ausgang ist kurzschlussfest  |   |
| <b>1.2.9. Speisung</b>   |  |   |
| Netzspannungen   | 90 ... 270 V Wechselfspannung (AC) oder<br>100 ... 350 V Gleichspannung (DC)                               | In einem Bereich  |
| Netzfrequenz   | 46 ... 440 Hz oder DC  |   |
| Eingebaute Sicherung   | 1,6 A, träge   | Für alle Netzspannungen   |
| Leistungsaufnahme  | 29 W   |   |
| <b>1.2.10. Einflussgrößen</b>  |  |   |
| Die angegebenen Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergranzkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden. |  |   |
| Umgebungstemperaturen  | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C   | Betrieb innerhalb Spezifikation<br>Arbeitsbereich<br>Lagerung und Transport |
| Höhe   | 5000 m<br>15000 m  | Betriebsfähig<br>Nicht Betriebsfähig  |
| Feuchtigkeit   | Das Gerät entspricht den Anforderungen gemäss IEC 68 Db Standard   |   |
| Stossfestigkeit  | 1000 Stösse von 10 g, ½ Sinus, Dauer 6 ms, in allen 3 Richtungen   | I EC 68 E b   |
| Vibration  | 30 Minuten in jeder der drei Richtungen, 10-150 Hz; 0,7 mm (Spitze-Spitze) und 5 g maximale Beschleunigung | I EC 68 F   |
| Akklimationszeit   | 30 Minuten für Normalbetrieb   | Kommend von -10 °C nach +20 °C bei 60 % relativer Feuchtigkeit              |
| Störgrad   | Das Gerät entspricht den Anforderungen gemäss VDE Störgrad K   |   |
| <b>1.2.11. Mechanische Daten</b>   |  |   |
| Abmessungen  | Länge 410 mm<br>Breite 316 mm<br>Höhe 154 mm   | Ohne Bedienungsorgane, Deckel und Füsse                                     |
| Gewicht  | 9,7 kg   |   |

| Benennung | Beschreibung | Nähere Angaben |
|-----------|--------------|----------------|
|-----------|--------------|----------------|

## 1.2.12. Standardzubehör

Kontrastfilterscheibe  
 Abdeckhaube mit Aufbewahrungsraum  
 Faltbarer Lichtschutztubus PM 9366  
 BNC Übergangstecker PM 9051  
 CAL Anschlussklemme - BNC Adapter  
 Anleitung

## 1.2.13. Wahlzubehör

|          |   |         |   |
|----------|---|---------|---|
| PM 9335  | 1:1 Messkopf<br>1,5 m Kabel                           | PM 9355 | 12 Hz ... 70 MHz Strom-Messkopf<br>(1 mA/div. ... 1 A/div.) |
| PM 9335L | 1:1 Messkopf<br>2,5 m Kabel                           | PM 9346 | Stromversorgung für aktive<br>Messköpfe                     |
| PM 9350  | 10:1 Messkopf, 11 pF<br>1,5 m Kabel                   | PM 8960 | 19" Gestelleinbausatz                                       |
| PM 9350L | 10:1 Messkopf, 14 pF<br>2,5 m Kabel                   | PM 8992 | Zubehörtasche   |
| PM 8927  | 10:1 Messkopf<br>1,5 m Kabel                          | PM 9380 | Oszillografenkamera   |
| PM 8927L | 10:1 Messkopf<br>2,5 m Kabel                          | PM 8971 | Kamera Adapter für PM 9380                                  |
| PM 9358  | 100:1 Messkopf,<br>5600 V maks., 2 pF,<br>1,5 m Kabel | PM 8910 | Polaroid Anti-Reflex Filter                                 |
| PM 9347  | Aktiver T.V. Messkopf, 10:1, 11 pF                    | PM 8980 | Langer Einblicktubus  |
| PM 9352  | Aktiver 10:1 Miniaturmesskopf<br>100 kohm/6 pF        | PM 8901 | Batteriespeisung 24 V und<br>330 V Gleichspannung           |
| PM 9353  | Aktiver FET-Messkopf, 10:1, 100:1<br>1 Mohm//3,5 pF   | PM 8991 | Rollwagen   |

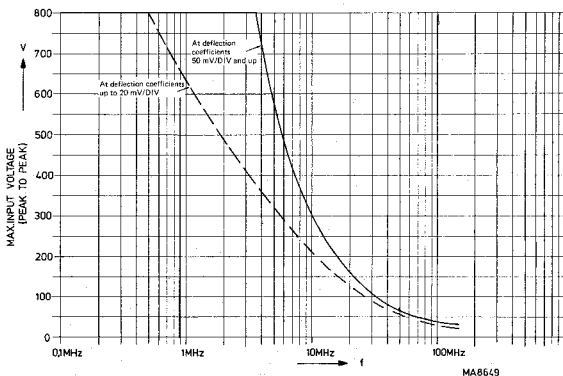


Abb. 1.2. Minderung der höchstzulässigen Eingangsspannung als Funktion der Frequenz

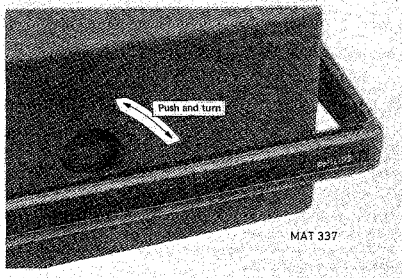


Abb. 2.1. Abnehmen der Abdeckhaube

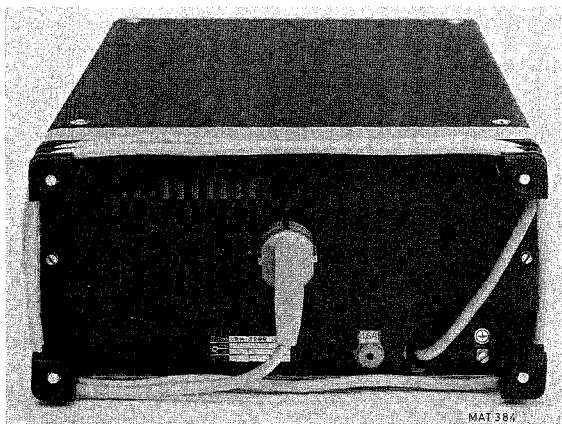


Abb. 2.2. Rückansicht des Gerätes

## 2. Gebrauchsanleitung

### 2.1. INBETRIEBNAHME

#### 2.1.1. Abnehmen und Aufsetzen der Abdeckhaube (Abb. 2.1.)

Abnehmen:

- Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen (Stellung UNLOCKED).
- Deckel abnehmen.

Aufsetzen:

- Den Verriegelungsknopf in Stellung UNLOCKED drehen.
- Deckel an der Vorderseite des Oszillografen befestigen.
- Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

*Bemerkung: Der Handgriff lässt sich drehen wenn die Druckknöpfe auf ihren Lagern eingedrückt werden.*


**WARNUNG:** In diesem Gerät werden hohe Spannungen erzeugt, deshalb darf es niemals in geöffnetem Zustand eingeschaltet werden.  
Vor Wartungsarbeiten ist der Netzstecker zu ziehen und ist darauf zu achten dass alle Hochspannung führenden Teile entladen sind.  
Bevor irgend eine Verbindung ausgeführt wird muss die Erdanschlussklemme an einen Schutzleiter angeschlossen werden (siehe Abschnitt "Erdung").

#### 2.1.2. Netzspannungseinstellungen und Sicherung

Da das Gerät bei jeder Netzspannung zwischen 90 und 270 V Wechselspannung und zwischen 100 und 350 V Gleichspannung betriebsfähig ist, erübrigt sich das Umschalten auf die örtliche Netzspannung. Der Sicherungshalter ist an der Rückwand angebracht. Die Sicherung 1,6 A, trägt wird bei allen Netzspannungen angewandt.  
Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalter sind nicht zulässig. Das Gerät muss von allen Spannungsquellen getrennt sein wenn eine Sicherung ersetzt wird.

#### 2.1.3. Erdung

Vor dem Einschalten muss das Gerät auf eine der folgenden Weisen mit einem Erdschutzleiter verbunden werden:

- über den Erdanschluss (gekennzeichnet ).
- über das dreidrädrige Netzkabel. Der Netzstecker darf nur in eine Schutzkontaktdose eingeführt werden. Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch Verwendung einer Verlängerungsleitung ohne Schutzleiter.

**WARNUNG:** Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Gerätes ist unzulässig.  
Wenn ein Gerät von kalter in warme Umgebung gebracht wird, kann dies zu einem sicherheitstechnisch gefährlichen Zustand führen. Deshalb sind alle Erdungsvorschriften sorgfältig zu beachten.

#### 2.1.4. Öffnen des Geräts

Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein. Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundenen Gefahren kennt.

Ersetzen des Netzsteckers geschieht auf eigene Gefahr. Nach dem Ersetzen des Netzsteckers ist es ratsam einen Hochspannungstest IEC 348 vorzunehmen.

Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde.

#### 2.1.5. Einschalten

Der Netzschalter POWER ist gekoppelt mit der Rasterbeleuchtungseinstellung ILLUM und befindet sich an der Vorderseite des Gerätes unter dem Bildröhrenrahmen.

Der Oszillograf darf niemals eingeschaltet werden, wenn eine Leiterplatte oder Baustein entfernt wurde. Eine Leiterplatte oder Baustein darf nicht früher als eine Minute nach Ausschaltung des Gerätes entfernt werden.

## 2.2. BEDIENUNGSORGANE UND BUCHSEN

### 2.2.1. Vertikalablenkung (Y)

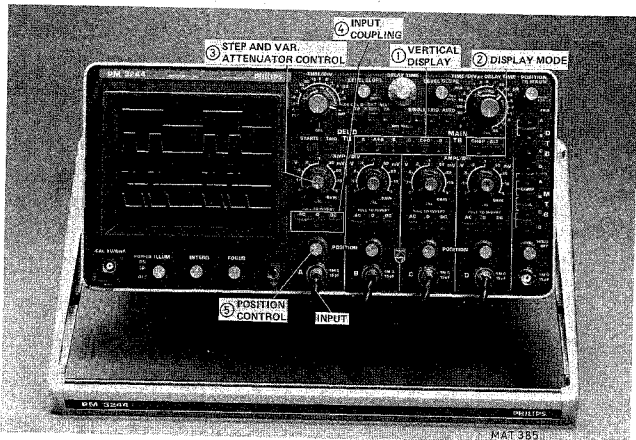


Abb. 2.3. Vertikalablenkung

#### 1. Vertikalablenkungsart-Schalter

|            |                                    |
|------------|------------------------------------|
| Taste A    | Kanal A                            |
| Tasten A+B | Kanäle A und B algebraisch addiert |
| Taste B    | Kanal B                            |
| Taste C    | Kanal C                            |
| Tasten C+D | Kanäle C und D algebraisch addiert |
| Taste D    | Kanal D                            |

Jede Kombination obiger Darstellungsarten ist möglich.  
Wenn keine Taste gedrückt ist, ist Kanal A eingeschaltet.

#### 2. Darstellungsart-Schalter CHOP/ALT

Die in Punkt 1 erwähnten Kanäle können gehopped oder alternierend dargestellt werden. Wenn keine Taste gedrückt ist und zwei oder mehr Kanäle eingeschaltet sind, dann ist die Darstellung gehopped.

#### 3. Abschwächer-Einsteller

|          |   |
|----------|---|
| AMPL/DIV | Stufenweise Einstellung der Ablenkoeffizienten, kombiniert mit: |
| AMPL/CAL | Stufenlose Einstellung der Ablenkoeffizienten.                  |

#### 4. Eingangskopplung-Schalter

|    |  |
|----|--|
| AC | Signalkopplung über einen Sperrkondensator |
| O  | Kanaleingang geerdet, Signalleerlauf       |
| DC | Direkte Kopplung                           |

(Wenn keine Taste eingedrückt ist, ist Einstellung AC wirksam.)

#### 5. POSITION

Stufenlose Einstellung bewirkt vertikale Verschiebung des betreffenden Kanals.

#### VOREINSTELL-BEDIENUNGSORGANE

|      |  |
|------|--|
| BAL  | Ausgleich des Stufenabschwächergleichgewichtes |
| GAIN | Verstärkereinstellung des Stufenabschwächers   |

## 2.2.2. Horizontalablenkung (X)

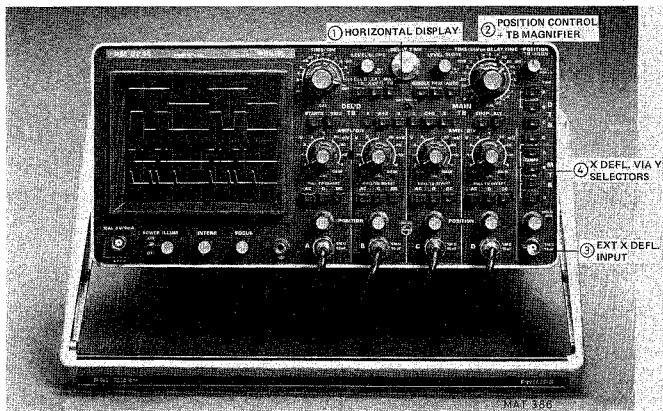


Abb. 2.4. Horizontalablenkung

## 1. Horizontalablenkungsart-Schalter

|            |   |
|------------|---|
| MAIN TB    | Die Horizontalablenkung wird vom Hauptzeitablenkgenerator bewirkt. Ein Teil der Darstellung wird aufgehellt wenn die verzögerte Zeitablenkung eingeschaltet ist.  |
| EXT X DEFL | Horizontalablenkung wird bewirkt durch ein Signal kommend von: <ul style="list-style-type: none"> <li>- der Eingangsbuchse des Horizontalverstärkers (3)</li> <li>- einem der vertikalen Kanäle (4)</li> <li>- dem Netz (4).</li> </ul> |
| DEL'D TB   | Die Horizontalablenkung wird vom verzögerten Zeitablenkgenerator bewirkt. Wenn keine Taste eingedrückt ist, dann gilt MAIN TB.  |

## 2. Position und Dehnung der Zeitablenkung

|          |   |
|----------|---|
| POSITION | Stufenlose Einstellung der horizontalen Verschiebung der Darstellung. |
| TB MAGN  | Zug-Druck Schalter für 5-fache Steigerung der Zeitablenkoeffizienten. |



## 2.2.3. Hauptzeitablenkung

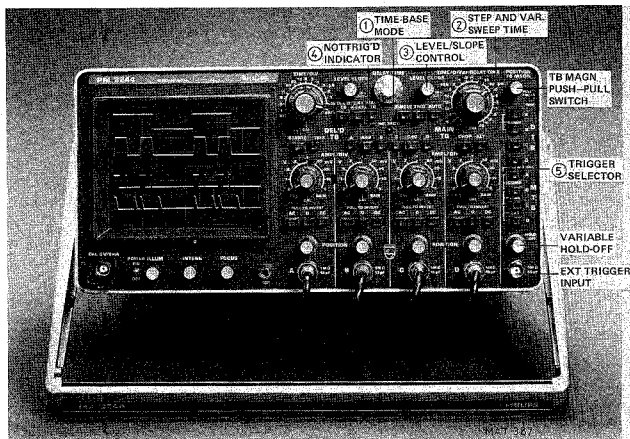


Abb. 2.5. Hauptzeitablenkung

## 1. Hauptzeitablenkung-Wahlschalter

AUTO

Wenn keine Triggerimpulse vorhanden sind, ist der Hauptzeitablenkungs-generator freilaufend.

TRIG

Die Hauptzeitablenkung wird auf normale Weise getriggert.

SINGLE

Single sweep Zeitablenkung. Nach Betätigung der Taste Single läuft der Hauptzeitablenkungs-generator nur einmal ab. Wenn keine Taste eingedrückt ist, arbeitet die Zeitablenkung in Betriebsart Single Sweep.

## 2. Schalter TIME/DIV or DELAY

TIME/DIV CAL

Stufenweise Einstellung der Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 22 Stellungen. Wenn die verzögerte Zeitablenkung wirksam ist, dann ist die Verzögerungszeit nach der die verzögerte Zeitablenkung startet gegeben durch die Einstellung der Helipotentiometer "DELAY TIME" mal TIME/DIV Koeffizient dieses Schalters.

Stufenlose Einstellung des Zeitkoeffizienten.

## 3. LEVEL/SLOPE

Stufenlose Einstellung zur Wahl des Triggerpegels bei welchem der Zeitablenkungs-generator startet. Der Zug-Druckschalter gestattet Wahl der Triggerrichtung auf der positiv oder negativ gerichteten Flanke des Signals.

## 4. Anzeige NOT TRIG'D

Leuchtet auf wenn keine Triggerrichtung des Hauptzeitablenkungs-generators erfolgt ist.

## 5. Hauptzeitablenkung Triggerquelle-Wahlschalter

Dieser Schalter besteht aus vier Tasten (A, B, C, D) für die Wahl des Triggersignals von einem der Vertikalablenkungs-kanäle. Wenn die beiden Tasten A und B eingedrückt sind, wird das zusammengesetzte Triggersignal gewählt. Wenn die beiden Tasten B und C eingedrückt sind, wird ein Teil der Netzspannung als Triggersignal verwendet.

Wenn die beiden Tasten C und D eingedrückt sind, wird das Signal welches an Buchse EXT liegt als Triggersignal verwendet. Falls keine Taste eingedrückt ist, ist Signal A eingeschaltet.

## 2.2.4. Verzögerte Zeitablenkung

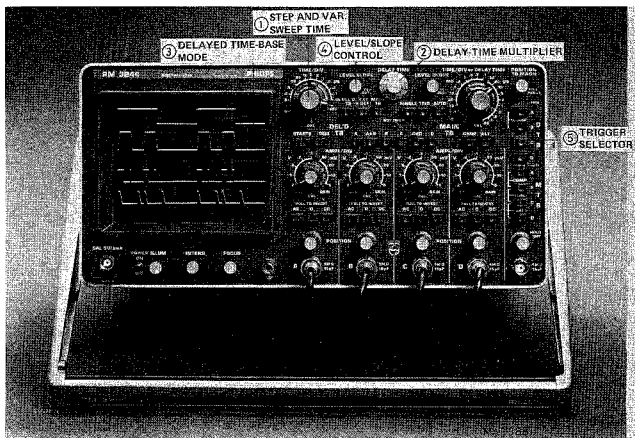


Abb. 2.6. Verzögerte Zeitablenkung

## 1. Schalter TIME/DIV

Stufenweise Einstellung der Zeitkoeffizienten der verzögerten Zeitablenkung; Drehschalter mit 14 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.

## TIME/DIV CAL

Stufenlose Einstellung der Zeitkoeffizienten der Zeitablenkung.

## 2. DELAY TIME

Kalibrierter Helipotentiometer zur Einstellung der Verzögerungszeit, nach welcher der verzögerte Zeitablenkgenerator wirksam wird. Diese Verzögerungszeit ist gegeben durch die Einstellung DELAY TIME mal TIME/DIV Koeffizient der Hauptzeitablenkung.

## 3. STARTS/TRIG

Wenn Taste STARTS eingedrückt ist, startet sofort nach der Verzögerungszeit die verzögerte Zeitablenkung (die verzögerte Zeitablenkung erfordert in diesem Falle kein Triggersignal). Wenn Taste TRIG eingedrückt ist startet die verzögerte Zeitablenkung nach der Verzögerungszeit nach Empfang eines Triggerimpulses. Keine Taste gedrückt hat die gleiche Wirkung wie Taste STARTS gedrückt.

## 4. LEVEL/SLOPE

Stufenlose Einstellung zur Wahl des Triggerpegels bei welchem der verzögerte Zeitablenkgenerator getriggert wird. Der Zug-Druck Schalter gestattet Wahl der Triggerrichtung auf der positiv oder negativ gerichteten Flanke des Signals.

5. Verzögerte Zeitablenkung  
Triggerquelle-Wahlschalter

Dieser Schalter besteht aus vier Tasten (A, B, C und D) für die Wahl des Triggersignals von einem der Vertikalablenkkanäle. Wenn die beiden Tasten A und B eingedrückt sind, wird das zusammengesetzte Triggersignal gewählt.

Falls keine Taste eingedrückt ist, ist Signal A eingeschaltet.

## 2.2.5. Bildteil

- |                |   |
|----------------|---|
| 1. POWER/ILLUM | Stufenlose Einstellung der Rasterbeleuchtung, kombiniert mit Ein/Aus-Netzschalter. Signallampe zeigt Betriebszustand (ON) an. |
| 2. INTENS      | Stufenlose Einstellung der Bildhelligkeit   |
| 3. FOCUS       | Stufenlose Einstellung der Fokussierung des Elektronenstrahls.  |

### Verschiedenes

- |        |  |
|--------|--|
| 1. CAL | Ausgangsbuchse für die Kalibrierung:<br>– der Verstärkung des Vertikalablenkverstärkers<br>– der Frequenzkompensation von Abschwächer-Messköpfen.<br>Geeignet für Spannungsmessköpfe und Strommessköpfe. |
|--------|--|

## 2.3. GRUNDEINSTELLUNGEN

Bevor mit dem Oszillografen Messungen ausgeführt werden, muss man sich überzeugen dass der Stufenabschwächer-Ausgleich und die Verstärkungskalibrierung für alle Kanäle einwandfrei eingestellt sind. Falls erforderlich, wie folgt handeln:

- Einstellen des Stufenabschwächer-Gleichspannungsgleichgewichts
  - Taste MAIN TB des Horizontalablenkungsschalters eindrücken.
  - Taste AUTO des Hauptzeitablenkungsschalters eindrücken.
  - Mit Einstellern INTENSITY und FOCUS die Bildschärfe adjustieren.
  - Die entsprechende Kanalaste des Vertikalablenkungsschalters eindrücken.
  - Taste 0 des Eingangskopplungsschalters eindrücken.
  - Mit Knopf POSITION das Bild derart einstellen, dass es sich ungefähr in der Mitte des Schirms befindet.
  - Den stufenlosen Einsteller AMPL auf CAL stellen.
  - Es ist darauf zu achten dass beim Drehen des Stufenschalters AMPL das Bild nicht springt.
  - Wenn nötig, Regler BAL einstellen.
  - Den Vorgang für jeden Kanal wiederholen.
- Verstärkungskalibrierung
 

Wenn nicht anders erwähnt befinden sich die Einstellelemente in den gleichen Stellungen wie beim vorgehenden Verfahren.

  - Schalter AC-0-DC auf AC stellen.
  - Schalter AMPL auf 0,5 V und den stufenlosen Einsteller auf CAL stellen.
  - Kanaleingang mit Ausgang CAL verbinden.
  - Kontrollieren ob die Vertikalablenkung genau 6 Div. beträgt.
  - Nötigenfall Regler GAIN adjustieren.
  - In diese Kalibrierung kann ein Abschwächer-Messkopf einbezogen werden. Der Abschwächfaktor des Messkopfs muss in Bezug auf die Stellung des Schalters AMPL in Betracht gezogen werden.
  - Den Vorgang für jeden Kanal wiederholen.



Abb. 2.7.

## 2.4. BEDIENUNGSANLEITUNGEN

### 2.4.1. Allgemeines

Vor dem Einschalten überzeuge man sich ob der Oszillograf einwandfrei den INBETRIEBNAHME Vorschriften gemäss (Abschnitt 2.1.) installiert ist und dass die erwähnten Sicherheitsmassnahmen eingehalten wurden.

### 2.4.2. Vertikalablenkung

Zur Darstellung der gewünschten Kanäle die entsprechenden Tasten des Vertikalablenkungsschalters eindrücken. Wenn zwei oder mehr Bildsignale dargestellt werden, kann die Darstellung in alternierender oder gepochpter Betriebsart erfolgen. In der alternierenden Betriebsart werden die Kanäle hintereinander dargestellt; beim Rücklauf der Hauptzeitablenkung wird die Darstellung von einem Kanal auf den anderen umgeschaltet.

In der gepchoppten Betriebsart werden die Kanäle während der Zeitablenkung von einem auf den anderen umgeschaltet. In der gepchoppten Betriebsart ist die Darstellungszeit ca. 500 ns pro Kanal. Ab /03 Version; 0,5 und 2  $\mu$ s, schaltbar, siehe Abb. 3.47.

Für eine gute Darstellung ist es üblich bei höheren Ablenkgeschwindigkeiten die alternierende Betriebsart anzuwenden und bei niedrigeren Ablenkgeschwindigkeiten die gepchoppte.

Es ist zu beachten dass bei zusammengesetzter Triggerungsart die alternierende Darstellung gewählt wird, weil sonst die Chopperimpulse die Triggerschaltung beeinflussen.

Die zu beobachtenden Signale sind an die Buchse (n) A ... D zu legen und der AC/0/DC Schalter ist abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.

Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein. Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechselspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz-Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen. Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

Mit Hilfe der Einsteller POSITION lässt sich die Darstellung in vertikaler Richtung verschieben. Es ist zu beachten, dass bei zusammengesetzter Triggerungsart der Trigger-Startpunkt von der vertikalen Verschiebung beeinflusst wird.

#### 2.4.3. Horizontalablenkung

Abhängig von der Stellung des Horizontalablenkungsschalters ist folgende Horizontalablenkung möglich:

- Hauptzeitablenkung
- Ext. X-Ablenkung
- Verzögerte Zeitablenkung

Mit Einsteller POSITION kombiniert mit der Dehnung der Zeitablenkung kann die Darstellung in horizontaler Richtung verschoben werden.

Wenn Taste MAIN TB oder DEL'D TB eingedrückt ist, wird die Horizontalablenkung von der Hauptzeitablenkung bzw. der verzögerten Zeitablenkung bewirkt. Wenn Taste EXT X DEFL eingedrückt ist, wird Horizontalablenkung bewirkt durch:

- Einen der Vertikalablenkungsanäle A, B, C oder D
- Netzspannung
- Extern über Buchse EXT

#### 2.4.4. Hauptzeitablenkung

Lineare Horizontalablenkung ist verfügbar wenn Taste MAIN TB der Horizontaldarstellungsschalter eingedrückt ist.

Die Betriebsart der Zeitablenkung ist mit den folgenden Schaltern wählbar:

- AUTO
  - Zeitablenkung freilaufend, auch wenn keine Triggerimpulse anliegen. Folglich ist das Bild immer sichtbar. Betriebsart AUTO kann in allen Fällen verwendet werden, in welchen auch Betriebsart TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit einer "AUS" Zeit über 100 ms. Sobald Triggerimpulse vorhanden sind, wird der Freilauf der Zeitablenkung automatisch beendet und wird der Zeitablenkengenerator normal getriggert.
- TRIG
  - Die Zeitablenkung wird sichtbar sobald Triggerimpulse vorhanden sind und die Triggerpegeleinstellung korrekt ist.
- SINGLE
  - Die Zeitablenkung läuft nach Empfang eines Triggerimpulses nur einmal ab. Nach diesem "Sweep" muss die Zeitablenkung durch Eindrücken der Taste SINGLE erneut eingestellt werden. Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden.

#### 2.4.5. Triggerung

Wenn ein oder mehrere Signale dargestellt werden sollen, muss um ein stillstehendes Bild zu erhalten, die Zeitablenkung immer an einem festen Punkt des Signals gestartet werden.

Der Zeitablenkungs-generator wird deshalb von Triggerimpulsen gestartet, die abhängig von der Stellung des Hauptzeitbasis-Triggerquelle-Wahlschalter, folgenden Signalquellen entstammen:

- Einer der Vertikalablenkungskanäle A, B, C oder D
- Zusammengesetztes Signal
- Netzspannung
- Externe Spannung

Die Amplitude der Triggersignale von einem der Vertikalablenkungskanäle, oder vom zusammengesetzten Signal ist proportional zur Vertikalablenkung des Bildes und daher von der Einstellung des Eingangsabschwächer abhängig.

Für zusammengesetzte Triggerung müssen die Taste A und B eingedrückt werden. Bei dieser Betriebsart wird das Triggersignal dem gemeinsamen Vertikalablenkungsverstärker entnommen.

Zusammengesetzte Triggerung ermöglicht:

- a. Triggerung durch Differenzsignale, mit beispielsweise dem Gerät in Betriebsart A+B und mit einer der Eingangsspannungen invertiert.
- b. Darstellung von zwei bis vier Signalen mit verschiedenen Frequenzen ohne Beziehung zueinander.  
In diesem Fall müssen die Triggerpunkte der verschiedenen Signale im gleichen Triggerpegelbereich liegen.

*Bemerkung:* - Bei Triggerung in der zusammengesetzten Betriebsart, muss die Darstellung immer in Betriebsart ALT erfolgen.  
In Betriebsart CHOP wirken die Chopper-Impulse als Triggerimpulse und verursachen dadurch ein unstabiles Bild.

- Bei zusammengesetzter Triggerung wird der Triggerpunkt des Signals auch vom Vertikal-einsteller POSITION bestimmt. Eine kleine Modifikation für "AC" zusammengesetzte Triggerung löst dieses Problem. Beschreibung (nur in Englisch) im Abschnitt 3.2.2.

Netztriggerung wird durch Eindrücken der beiden Tasten B und C bewirkt.

Die Hauptzeitablenkung wird von einem Teil der Netzspannung getriggert. Die Kopplung mit der Netzspannung wird mit Hilfe einer optischen Trennschaltung erlangt, dadurch bleibt das Gerät von der Netzspannung isoliert.

Externe Triggerung wird durch Eindrücken der beiden Tasten C und D bewirkt.

Die Hauptzeitablenkung wird nun von einem an BUCHSE EXT angelegten externen Signal getriggert.

Mit Einsteller LEVEL ist der Triggerpunkt auf der Flanke des Signals wählbar.

Der Zug-Druck Schalter SLOPE erlaubt die Wahl der positiv oder negativ gerichteten Flanke.

Wenn der Hauptzeitbasisgenerator keine Triggerimpulse erhält, dann leuchtet Anzeige NOT TRIG'D auf.

Im SINGLE SWEEP-Betrieb leuchtet diese Anzeige wenn der Zeitablenkungs-generator erneut eingestellt wurde und das Erscheinen des nächsten Triggerimpulses erwartet.

Die Ablenkezeit der Hauptzeitablenkung wird mit Knopf TIME/DIV or DELAY TIME eingestellt. Wenn die verzögerte Zeitablenkung eingeschaltet ist, dann ist die Zeit zwischen dem Start der Hauptzeitablenkung und der verzögerten Zeitablenkung vom Produkt der Einstellung des 10-Drehungsknopfes DELAY TIME mal der Einstellung des Ablenkezeitwählers MAIN TB gegeben.

Mit dem inneren Knopf lassen sich Zeitablenkzeiten zwischen den Stufen einstellen. Für Zeitmessungen muss dieser Knopf immer auf CAL stehen.

Der Koeffizient TIME/DIV der Zeitablenkung lässt sich durch Ziehen des Zug-Druck Schalters TB MAGN 5-fach dehnen.

Mit Einsteller HOLD OFF lässt sich die Sperrzeit des Hauptzeitablenkungs-generators variieren. Dies ist die Zeit die der Zeitablenkungs-generator benötigt bis er zum Empfang des nächsten Triggerimpulses bereit ist. Einsteller HOLD OFF ermöglicht eine stabile Darstellung von komplizierteren Signalen, z.B. periodische Doppelpulse. Der normale Stand des Einstellers HOLD OFF ist Rechtsanschlag. Linksdrehung erweitert die Sperrzeit.

#### 2.4.6. Verzögerte Zeitablenkung

Wenn Taste MAIN TB des Schalters für die horizontale Darstellung eingedrückt ist und der Knopf TIME/DIV der verzögerten Zeitablenkung nicht in Stellung OFF ist, wird ein Teil der Hauptzeitablenkungslinie zusätzlich aufgehellt.

Der Zeitpunkt des Starts der verzögerten Zeitablenkung wird von den Einstellungen des Knopfes TIME/DIV der Hauptzeitablenkung und des 10-Drehungsknopfes DELAY TIME bestimmt. Wenn Taste STARTS des Schalters

der verzögerten Zeitablenkungsart eingedrückt ist, dann startet die verzögerte Zeitablenkung sofort nach der Verzögerungszeit.

Wenn Taste TRIG eingedrückt ist startet die verzögerte Zeitablenkung nach der Verzögerungszeit und nach Erhalt eines Triggerimpulses.

Der Triggerwähler der verzögerten Zeitablenkung besitzt die gleichen Möglichkeiten wie der Triggerwähler der Hauptzeitablenkung mit Ausnahme von LINE und EXT Triggerart.

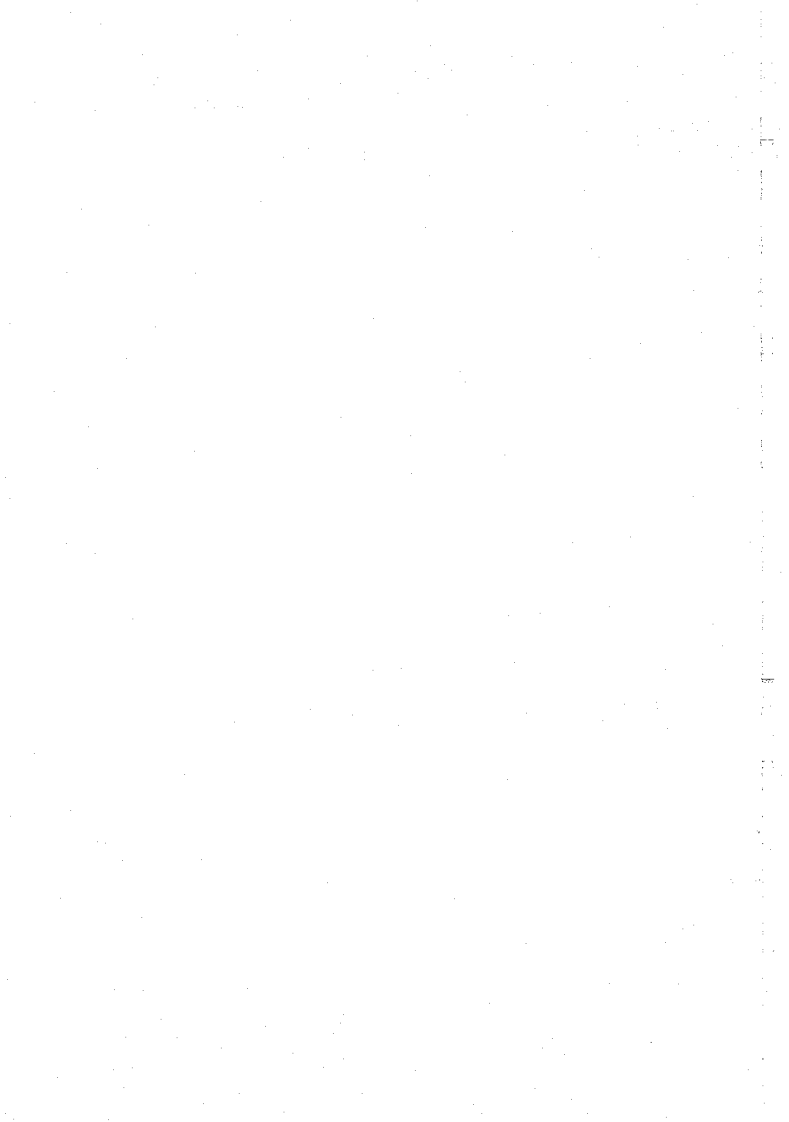
Die Funktion des Einstellers LEVEL/SLOPE ist die gleiche wie für die Hauptzeitablenkung beschrieben.

Die Zeitdauer des zusätzlich aufgehellten Teils der Hauptzeitablenkung wird von der Einstellung des Knopfs TIME/DIV der verzögerten Zeitablenkung bestimmt.

Mit dem inneren Knopf lassen sich die Ablenkzeiten zwischen den Stufen einstellen. Für Zeitmessungen muss dieser Knopf immer auf CAL gestellt werden.

Wenn Taste DEL'D TB der horizontalen Darstellung eingedrückt ist wird der zusätzlich aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht.

## Notice d'emploi





# 1.Generalites

## 1.1. INTRODUCTION

L'oscilloscope portatif haute fréquence PM 3244 présente quatre voies identiques de déviation verticale à haute sensibilité (5 mV/div) et sur une largeur de bande étendue de 50 MHz.

Il y a un large choix de déviations verticales possibles: une, deux, trois ou quatre voies (alternées ou découpées). De plus, les deux premières voies peuvent être additionnées et aussi les deux dernières voies. La polarité de chaque voie peut être inversée.

Pour ce qui est des déviations horizontales possibles, on distingue: la déviation de base de temps principale (avec ou sans base de temps retardée intensifiée), la déviation de base de temps retardée ou la déviation externe.

Si l'on excepte la source de déclenchement normal, le PM 3244 offre un déclenchement composite.

Cet oscilloscope se caractérise par une alimentation à faible dissipation fonctionnant pour une tension alternative entre 90 et 270 V ou pour une tension continue entre 100 et 350 V.

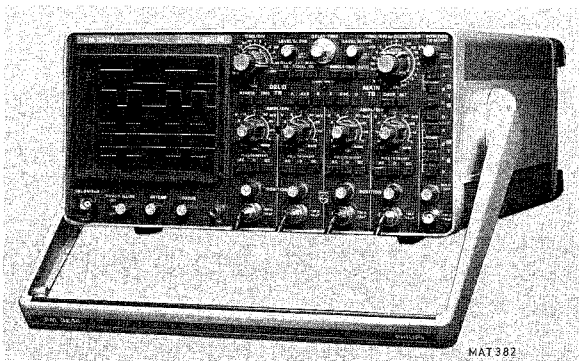


Fig. 1.1. Oscilloscope portatif à quatre voies PM 3244

## 1.2. CARACTERISTIQUES TECHNIQUES

Les spécifications sont valables après que l'appareil a été préchauffé pendant 30 minutes. Les valeurs indiquées avec tolérance sont garanties. Les chiffres sans tolérance ne servent qu'à titre d'information et correspondent aux caractéristiques d'un appareil moyen.

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe I. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

| <i>Désignation</i>                         | <i>Spécification</i>  | <i>Information supplémentaire</i>   |
|--|---|---|
| <b>1.2.1. Tube à rayons cathodiques</b>    |   |   |
| Type                                       | PHILIPS D14-125 GH/37   | Tube à face rectangulaire, type domed mesh, post-accélérateur, couche phosphore doublée de métal<br>8 x 10 divisions  |
| Aire de mesure                             | 80 mm x 100 mm  |   |
| Type d'écran                               | Phosphore P31 (GH)  | en option, couche phosphore P11 (BE) ou P7 (GM)   |
| Vitesse d'écriture photographique          | 750 cm/μs   | Mesuré avec un appareil photographique Steinheil Oscillophot M5<br>Ouverture: 1:1,2<br>Rapport objet/image: 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>pas de pré-voilage<br>Phosphore du type P31 (GH) |
| Tension d'accélération totale              | 10 kV   |   |
| Graticule                                  | Divisions 8 x 10 cm avec subdivisions de 2 mm sur les axes centraux.  | Les lignes interrompues indiquent les points 10 % et 90 % pour la mesure du temps de montée.  |
| Illumination de graticule                  | Continuellement variable  | Luminosité maximale nettement visible dans les conditions d'éclairage normales de laboratoire.  |
| <b>1.2.2. Déviation verticale (Y)</b>      |   |   |
| Nombre de voies                            | 4   | Quatre voies identiques, A, B, C et D   |
| Modes d'affichage                          | Voie A seulement<br>Voie B seulement<br>Voie C seulement<br>Voie D seulement<br>Voies A+B additionnées<br>Voies C+D additionnées<br>Ces modes peuvent tous être découpés ou alternés.<br>Toutes les voies peuvent être inversées. |   |
| Temps d'affichage par voie en mode découpé | Environ 500 ns  | A partir de la version /03: 0,5 ou 2 μs, commutable. (Voir fig. 3.47).  |
| Gamme de fréquence                         | Continu à 50 MHz<br><br>10 Hz à 50 MHz  | Couplage continu<br>Largeur de bande supérieure -3 dB<br>Couplage capacitif<br>Largeur de bande supérieure -3 dB  |
| Temps de montée                            | ≈ 7 ns  |   |
| Dépassement                                | ± 2 % max.  | Impulsion d'essai avec temps de montée 1 ns, déviation de 6 divisions et temps de répétition de 1 μs  |

| <i>Désignation</i>                        | <i>Spécification</i>                         | <i>Information supplémentaire</i>  |
|---|--|--|
| Coefficients de déviation                 | 5 mV/DIV à 2 V/DIV                           | En 9 positions étalonnées (progression 1-2-5), avec commande non-calibrée continue 1: $\geq 2,5$ par potentiomètre   |
| Précision                                 | $\pm 3 \%$                                   |  |
| Tension d'entrée                          | $\pm 400$ V max.                             | Tension continue + crête de tension alternative. En positions 5 mV/DIV à 20 mV/DIV de l'atténuateur d'entrée réduction de la tension d'entrée maximale admise à fréquences $> 500$ kHz. Voir Fig. 1.2. |
| Déviati on maximale                       | 24 divisions<br>$\geq 6$ divisions           | Pour tensions sinusoïdales jusqu'à 15 MHz<br>Pour tensions sinusoïdales de 15 MHz à 50 MHz   |
| Amplitude totale maxi en modes A-B et C-D | 24x réglage d'atténuateur                    | Atténuateurs en position CAL   |
| Gamme de décadrage                        | 16 divisions                                 |  |
| Réjection en mode commun                  | $\geq 100:1$ à 1 MHz                         | Après de réglage   |
| Diaphonie entre voies                     | 35 dB max.                                   | Pour toutes combinaisons d'atténuateurs. La référence est 6 div. d'amplitude (0 à 50 MHz), mode découpé.   |
| Instabilité, dérive de trace              | $\leq 0,3$ div/h à 20 °C                     | Après 15 min. de pré-chauffage   |
| Dérive de température                     | $\leq 60 \mu\text{V}/^\circ\text{C}$ typique |  |
| Balance d'atténuateur                     | $\leq 0,3$ div                               | En commutant entre positions d'atténuateur   |
| Entrée                                    |  |  |
| Impédance                                 | 1 Mohm//15 pF                                |  |
| Couplage                                  | AC-0-DC                                      |  |
| Temps RC                                  | 22 msec                                      | Commutateur de couplage sur "AC"   |
| Retard de signal visible                  | 20 nsec                                      |  |

### 1.2.3. Déviation horizontale (X)

|                   |  |   |
|-------------------|--|---|
| Modes d'affichage | <ul style="list-style-type: none"> <li>- Base de temps principale</li> <li>- Base de temps principale intensifiée par base de temps de retardée</li> <li>- Base de temps retardée</li> <li>- Fonctionnement X/Y</li> </ul> | Fonctionnement X/Y quatre traces avec déviation X par une des 4 voies verticales, un signal externe ou le signal d'alimentation |
|-------------------|--|---|

#### Amplificateur de déviation horizontale

|                          |   |  |
|--------------------------|---|--|
| Largeur de bande         | Continue à 1 MHz                                  | Sur 6 divisions<br>Limite supérieure -3 dB   |
| Coefficient de déviation | 450 mV/div<br>Coefficients d'atténuateur vertical | A l'aide de l'entrée EXT<br>S'appliquent lorsqu'une des voies verticales est utilisée à la déviation horizontale |
| Précision                | $\pm 10 \%$                                       | Utilisant un canal vertical pour déviation horizontal  |
| Impédance d'entrée       | 1 Mohm//15 pF                                     |  |

| <i>Désignation</i>   | <i>Spécification</i>  | <i>Information supplémentaire</i>   |
|--|---|---|
| Différence de phase entre ampl. de déviation vert. et ampl. de déviation horizontale | inférieure à 3°   | à 100 kHz   |
| Déviaton par tension secteur   | 8 divisions   | La déviation dépend de la tension secteur et est réglé sur 8 DIV pour tension secteur 220 V à l'usine                           |
| <b>1.2.4. Base de temps principale</b>   |   |   |
| Fonctionnement   | Automatique<br>Déclenché<br>Balayage unique   | En mode automatique, la base de temps est en fonctionnement libre env. 100 ms. après la disparition du signal de déclenchement. |
| Coefficients de temps  | 0,5 s./DIV ... 50 ns./DIV   | En 22 positions étalonnées (progression 1-2-5)<br>Commande continue non-étalonnée<br>1 : ≥ 2,5                                  |
| Précision  | ± 3 %   | ± 5 % pour 0,5 s/DIV et 0,2 s/DIV<br>± 5 % pour 100 ns./DIV et 50 ms./DIV   |
| <b>1.2.5. Base de temps retardée</b>   |   |   |
|  | Démarre immédiatement après le temps de retard ou est déclenchable après le temps de retard |   |
| Coefficients de temps  | 1 ms./DIV ... 50 ns./DIV  | En 14 positions étalonnées (progression 1-2-5)<br>Commande continue non-étalonnée<br>1 : ≥ 2,5                                  |
| Précision  | ± 3 %   | ± 5 % pour 100 ns./DIV et 50 ns./DIV  |
| <b>Agrandisseur de base de temps</b>   |   |   |
| Agrandissement   | x5  |   |
| Vitesse de balayage efficace maximale  | 10 nsec/DIV   |   |
| Tolérance supplémentaire   | ± 2 %   |   |
| <b>1.2.6. Déclenchement de la base de temps principale</b>                           |   |   |
| Source   | Interne<br>Composite<br>Secteur<br>Externe  | A partir de la voie A, B, C ou D  |
| Largeur de bande de déclenchement  | Continu à 50 MHz  | Limite supérieure -15 dB  |
| Sensibilité de déclenchement   | Interne ≤ 0,5 DIV<br>Externe ≤ 250 mV   | 0,3 DIV typique<br>150 mV typique   |
| Sélection de pente   | + ou -  |   |
| Impédance d'entrée pour déclenchement externe  | 1 Mohm//15 pF   | Identique pour chaque entrée de déviation verticale   |
| Tension d'entrée   | ± 400 V max.  | Tension continue + crête de tension alternative   |

**1.2.7. Déclenchement de la base de temps retardée**

Identique au déclenchement de la base principale sauf:

|        |                      |                                  |
|--------|----------------------|----------------------------------|
| Source | Interne<br>Composite | A partir de la voie A, B, C ou D |
|--------|----------------------|----------------------------------|

**Retard de balayage**

|                 |  |   |
|-----------------|--|---|
| Temps de retard | Continuellement variable entre 0,3x et $\geq 10x$ le coefficient de temps de la base de temps principale | Réglable à l'aide d'un potentiomètre 10-tours |
|-----------------|--|---|

Erreur supplémentaire du temps de retard

0,5 %

Jitter du temps de retard

 $\leq 1 : 20.000$ **1.2.8. Unité d'étalonnage**

|            |   |                                |
|------------|---|--------------------------------|
| Tension    | 3 V <sub>CC</sub>                         | Onde carrée, ligne de base 0 V |
| Courant    | 6 mA                                      | Par le boucle de courant       |
| Précision  | $\pm 1 \%$                                | Pour la tension et le courant  |
| Fréquence  | 2 kHz $\pm 2 \%$                          |                                |
| Protection | La sortie est exempte de courts-circuits. |                                |

**1.2.9. Alimentation**

|                           |   |                              |
|---------------------------|---|------------------------------|
| Tensions secteur          | 90 ... 270 V en alternatif<br>ou 100 ... 350 V en continu | En une gamme                 |
| Fréquence secteur         | 46 ... 440 Hz ou continu                                  |                              |
| Fusible secteur incorporé | 1,6 A action différée                                     | Pour toutes tensions secteur |
| Consommation              | 29 W  |                              |

**1.2.10. Données d'environnement**

Les données d'environnement ne s'appliquent que lorsque l'appareil est contrôlé conformément aux processus officiels. Pour plus de détails sur ces processus et les critères de panne, s'adresser à l'organisation Philips locale ou à N.V. Philips' Gloeilampenfabrieken, Test and Measuring Department, Eindhoven, Holland.

|                                |   |  |
|--------------------------------|---|--|
| Température ambiante           | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C  | Gamme nominale d'utilisation<br>Gamme limite de fonctionnement<br>Gamme d'emmagasinement et de transport |
| Altitude                       | 5 000 m<br>15 000 m   | Fonctionnement<br>A l'arrêt  |
| Humidité                       | L'appareil répond aux normes IEC 68 Db  |  |
| Choc                           | 1000 chocs de 10 g, ½ sinusoïde, durée 6 ms, dans chacune des trois directions                          | I EC 68 E b  |
| Vibration                      | 30 min. dans chacune des trois directions, 10-150 Hz; 0,7 mm crête-à-crête et 5 g accélération maximale | I EC 68 F  |
| Temps de rétablissement        | 30 minutes (en fonctionnement normal)   | quand l'appareil passe de -10 °C à +20 °C à 60 % d'humidité relative                                     |
| Perturbation électromagnétique | L'appareil répond aux normes VDE, Störgrad K  |  |

## 1.2.11. Caractéristiques mécaniques

|            |                 |
|------------|-----------------|
| Dimensions | Longueur 410 mm |
|            | Largeur 316 mm  |
|            | Hauteur 154 mm  |
| Poids      | 9,7 kg          |

Non compris commandes, couvercle et pieds

## 1.2.12. Accessoires livrés avec l'appareil

Filtre de contraste  
Couvercle frontale avec remplacements pour accessoires  
Visière pliante PM 9386  
Adaptateur BNC banane PM 9051  
Borne CAL - Adaptateur BNC  
Notice d'emploi et d'entretien

## 1.2.13. Accessoires en option

|          |  |         |   |
|----------|--|---------|---|
| PM 9335  | Sonde 1:1, câble 1,5 m                               | PM 9353 | Sonde FET active 10:1, 100:1<br>1 Mohm/3,5 pF (1,5 m) |
| PM 9335L | Sonde 1:1, câble 2,5 m                               | PM 9355 | Sonde de courant 12 Hz ... 70 MHz                     |
| PM 9350  | Sonde 10:1, câble 1,5 m, 11 pF                       | PM 9346 | Alimentation de sonde                                 |
| PM 9350L | Sonde 10:1, câble 2,5 m, 14 pF                       | PM 8960 | Jeu pour montage en rack 19"                          |
| PM 8927  | Sonde 10:1, câble 1,5 m                              | PM 8992 | Sacoche pour accessoires                              |
| PM 8927L | Sonde 10:1, câble 2,5 m                              | PM 9380 | Appareil de photographie<br>d'oscillogrammes          |
| PM 9358  | Sonde 100:1, 5,6 kV max.<br>200 Mohm/2 pF (1,5 m)    | PM 8971 | Adaptateur de caméra pour PM 9380                     |
| PM 9347  | Sonde T.V. active, 10:1, 11 pF (1,5 m)               | PM 8910 | Filtre Polaroid                                       |
| PM 9352  | Sonde miniature active 10:1<br>100 kohm/6 pF (2,5 m) | PM 8980 | Visière longue  |
|          |  | PM 8901 | Jeu de batteries, 24 V dc et 330 V dc                 |
|          |  | PM 8991 | Chariot   |

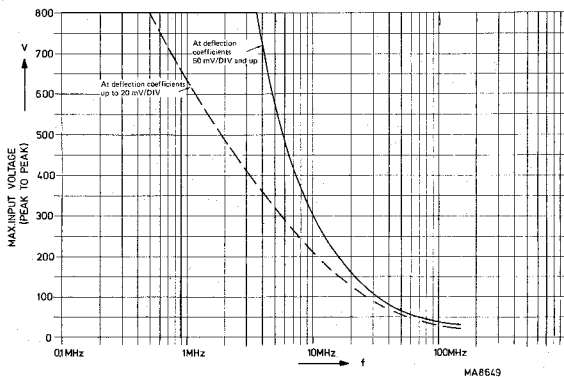


Fig. 1.2. Réduction de la tension d'entrée maximale en fonction de la fréquence

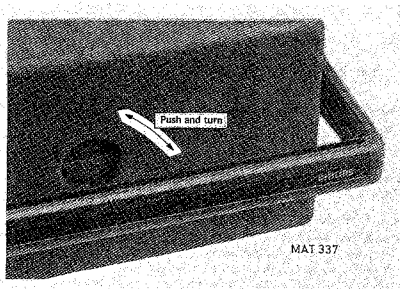


Fig. 2.1. Dépose du couvercle frontal

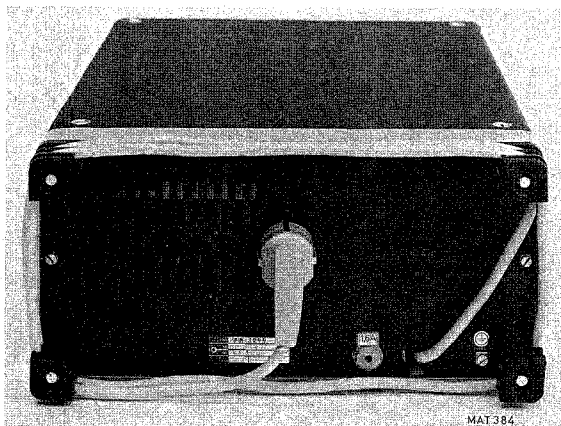


Fig. 2.2. Vue arrière de l'appareil

## 2. NOTICE d'EMPLOI

### 2.1. INSTALLATION

#### 2.1.1. Démontage et montage du couvercle frontal (voir fig. 2.1.)

##### Démontage:

- Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED).
- Enlever le couvercle.

##### Montage:

- Tourner le bouton de verrouillage vers position UNLOCKED
- Fixer le couvercle sur la partie avant de l'oscilloscope.
- Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

*Remarque: Pour faire pivoter la poignée, il faut enfoncer les boutons-poussoirs aux étriers.*

**ATTENTION:** Le présent appareil produit des tensions élevées et ne peut donc pas être utilisé avec les plaques du châssis déposées. La fiche secteur doit être enlevée et tous les points haute tension déchargés avant de procéder à n'importe quel travail d'entretien.

Avant de procéder à toute autre connexion, la borne de terre de l'appareil doit être reliée à la ligne de terre du réseau (voir mise à la terre).

#### 2.1.2. Adaption à la tension secteur et fusible

La capacité d'utilisation à toute tension secteur comprise entre 90 et 270 V alternatif ou entre 100 et 350 V continu supprime la nécessité d'adapter le PM 3244 à la tension secteur locale.


La porte-fusible monté sur le panneau arrière porte un fusible à action retardée de 1,6 A (pour toute tension réseau).

S'assurer que des fusibles correctement calibrés et du modèle convenable sont utilisés en cas de remplacement.

Il faut éviter d'utiliser des fusibles réparés et de court-circuiter des porte-fusibles. En cas de remplacement d'un fusible l'appareil doit être débranché de toutes sources de tension.

#### 2.1.3. Mise à la terre

Avant toute mise sous tension, l'appareil doit être connecté à la terre de l'une des manières suivantes:

- Par la borne de terre de l'appareil (symbole ).
- Par le cordon secteur à trois conducteurs. La fiche secteur ne doit être introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre.

**ATTENTION:** Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.

Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

#### 2.1.4. Démontage

L'ouverture des capots ou la dépose d'organes, à l'exception de ceux directement accessibles à la main sont susceptibles de mettre à jour des composants et des connecteurs sous tension.

L'appareil doit être débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d'entretien ou une réparation demandant l'ouverture de l'appareil.

Au cas où le réglage, l'entretien ou la réparation de l'appareil ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.

Le remplacement d'une fiche secteur se fait aux risques et périls de l'utilisateur. Après le remplacement d'une fiche secteur, un test haute tension conforme à la norme CEI 348 est fortement recommandé.

Ne pas oublier que les condensateurs à l'intérieur de l'appareil peuvent être chargés, même si l'appareil est déconnecté de toute source de tension.

#### 2.1.5. Enclenchement

Le commutateur POWER est incorporé dans la commande d'illumination de graticule ILLUM (panneau avant), juste sous le bord de l'écran.

L'oscilloscope ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé. Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'oscilloscope.



## 2.2. BOUTONS, DOUILLES ET LEURS FONCTIONS

### 2.2.1. Déviation verticale

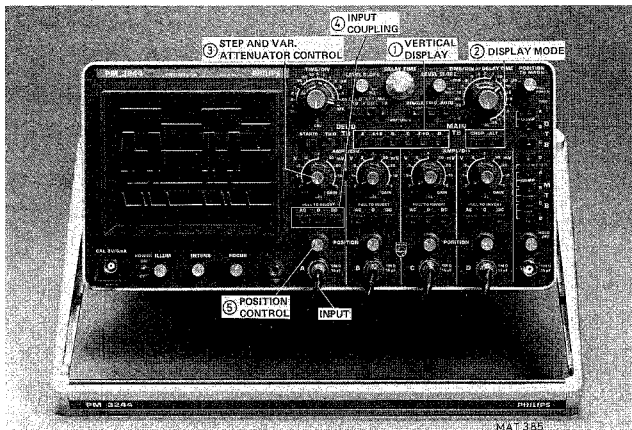


Fig. 2.3. Déviation verticale

#### 1. Sélecteur de déviation verticale

|             |   |
|-------------|---|
| Bouton A    | voie A                                  |
| Boutons A+B | voies A et B additionnés algébriquement |
| Bouton B    | voie B                                  |
| Bouton C    | voie C                                  |
| Boutons C+D | voies C et D additionnés algébriquement |
| Bouton D    | voie D                                  |

Toute combinaison des affichages précités est possible. Si aucun bouton n'est enfoncé, la voie A est enclenchée.

#### 2. CHOP-ALT commutateur

Les affichages mentionnés en peuvent être utilisés en mode découpé ou alterné, en fonction de la position du commutateur CHOP-ALT. Si aucun bouton n'est enfoncé et que deux voies ou plus sont enclenchées, l'affichage est en mode découpé.

#### 3. Commandes d'atténuateur

|          |   |
|----------|---|
| AMPL/DIV | Commande échelonnée des coefficients de déviation combinée avec:  |
| AMPL/CAL | Commande continûment variable des coefficients de déviation. Si ce bouton est tiré, la polarité de voie est inversée. |

#### 4. Commutateur de couplage d'entrée

|    |   |
|----|---|
| AC | Couplage de signal par l'intermédiaire d'un condensateur de blocage |
| 0  | Entrée de voie connectée à la terre; charge interrompue             |
| DC | Couplage direct   |

Si aucun bouton n'est enfoncé, AC est obtenu.

#### 5. POSITION

Commande continûment variable indiquant le décalage vertical de la voie en question.

#### COMMANDES DE PRE-REGLAGE

|      |  |
|------|--|
| BAL  | Equilibrage de l'atténuateur par échelons            |
| GAIN | Etalonnage d'amplitude de l'atténuateur par échelons |

## 2.2.2. Déviation horizontale (x)

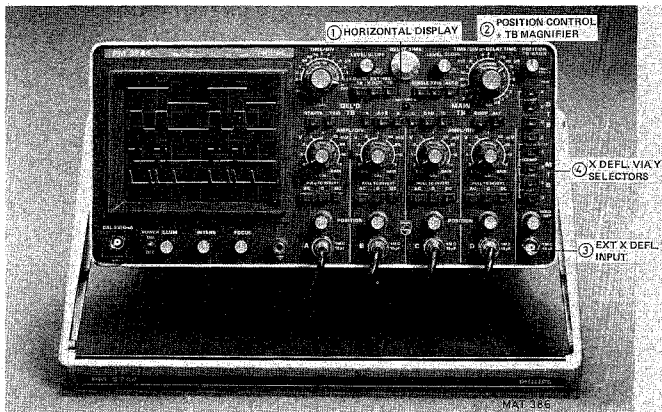


Fig. 2.4. Déviation horizontale

## 1. Sélecteur de déviation horizontale

MAIN TB

La déviation horizontale est fournie par le générateur de base de temps principale. Une partie de l'affichage est intensifié lorsque la base de temps retardée est mise en service.

EXT X DEFL

La déviation horizontale est obtenue à partir d'un signal externe provenant:

- de la borne d'entrée de l'amplificateur horizontal (3)
- d'une des voies de déviation verticale (4)
- du réseau (4)

DEL'D TB

La déviation horizontale est fournie par le générateur de base de temps retardée. Si aucun bouton n'est enfoncé, la base de temps principale est enclenchée.

## 2. Positionnement et agrandisseur de base de temps

POSITION

Commande continûment variable pour décadrage horizontal de l'affichage

TB MAGN

Commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 5. Cet effet est nul en mode EXT X DEFL.

## 2.2.3. Base de temps principale

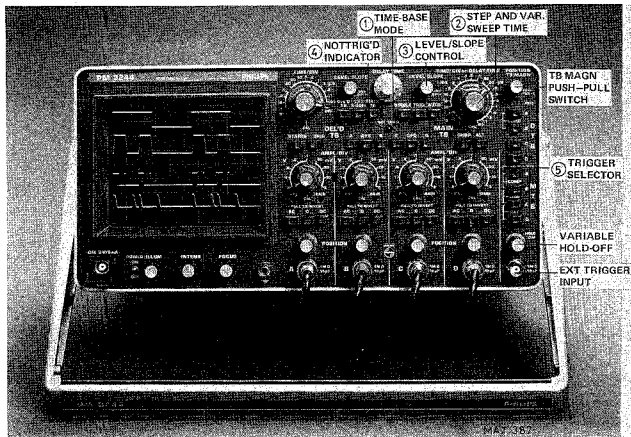


Fig. 2.5. Base de temps principale

## 1. Sélecteur de base de temps principale

AUTO

Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.

TRIG

Le générateur de base de temps est déclenché normalement.

SINGLE

Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulsion de déclenchement.

Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.

## 2. Commutateur TIME/DIV or DELAY

Commande par échelons des coefficients de temps pour la base de temps principale; commutateur rotatif à 22 positions.

Si la base de temps retardée est en service, le temps de retard, à l'issue duquel la base de temps démarre, est égal au réglage étalonné DELAY TIME x le coefficient TIME/DIV de ce commutateur.

TIME/DIV CAL

Commande continûment variable des coefficients de temps.

## 3. LEVEL/SLOPE

Commande continûment variable pour sélectionner le niveau de déclenchement auquel le générateur de base de temps démarre.

Le commutateur "push-pull" permet de choisir le déclenchement soit sur la pente positive, soit sur la pente négative du signal.

## 4. Indicateur NOT TRIG'D

S'allume lorsque le générateur de base de temps principale n'est pas déclenché.

## 5. Sélecteur de source de déclenchement de la base de temps principale

Ce commutateur comporte quatre boutons (A, B, C et D) servant à sélectionner le signal de déclenchement en provenance d'une des voies de déviation verticale. Lorsque les boutons A et B sont enfoncés, le signal de déclenchement composite est sélectionné. Lorsque les boutons B et C sont enfoncés, une partie de la tension réseau sert de signal de déclenchement. Lorsque les boutons C et D sont enfoncés, le signal appliqué au connecteur EXT sert de signal de déclenchement. Si aucun bouton n'est enfoncé, le signal de déclenchement A est disponible.

## 2.2.4. Base de temps retardée

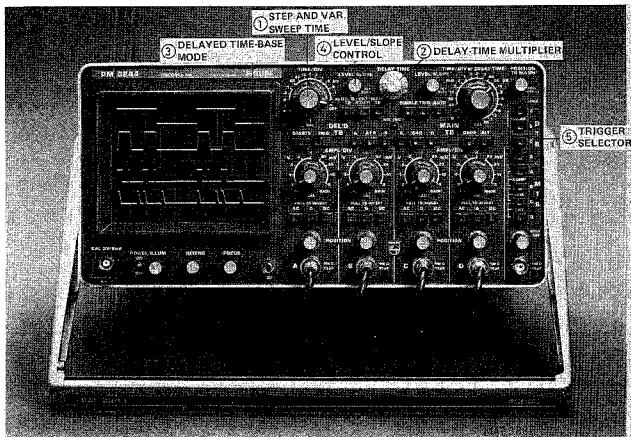


Fig. 2.6. Base de temps retardée

## 1. Commutateur TIME/DIV

TIME/DIV CAL

## 2. DELAY TIME

## 3. STARTS/TRIG

## 4. LEVEL/SLOPE

## 5. Sélecteur de source de déclenchement de la base de temps retardée

Commande par échelons des coefficients de temps pour la base de temps retardée; commutateur rotatif à 14 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclenchée.

Commande continûment variable des coefficients de la base de temps.

Potentiomètre étalonné à 10 tours pour ajuster le temps de retard, après quoi la base de temps retardée est mis hors service. Ce temps de retard est égal au réglage DELAY TIME x le coefficient TIME/DIV de la base de temps principale.

Lorsque le bouton STARTS est enfoncé, la base de temps retardée démarre immédiatement après le temps de retard, car elle ne requiert aucun signal de déclenchement.

Lorsque le bouton TRIG est enfoncé, la base de temps retardée démarre à la réception d'une impulsion de déclenchement après le temps de retard. Si aucun bouton n'est enfoncé, on obtient le même effet que STARTS enfoncé.

Commande continûment variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement.

Ce commutateur comporte quatre boutons (A, B, C et D) servant à sélectionner le signal de déclenchement en provenance d'une des voies de déviation verticale. Lorsque les boutons A et B sont enfoncés, le signal de déclenchement composite est sélectionné.

Si aucun bouton n'est enfoncé, le signal de déclenchement A est disponible.

### 2.2.5. Tube à rayons cathodiques

#### 1. POWER/ILLUM

Commande continûment variable de l'illumination de graticule; comprend le commutateur secteur. La lampe témoin indique la position ON.

#### 2. INTENS

Commande continûment variable pour la brillance de la trace.

#### 3. FOCUS

Commande continûment variable pour la focalisation du faisceau.

#### Divers

#### 1. CAL

Douille de sortie pour étalonnage:

- du gain de l'amplificateur de déviation verticale
  - de la compensation de fréquence des sondes atténuatrices
- Appropriée pour sondes de tension et de courant.

### 2.3. REGLAGES PRELIMINAIRES

Avant de procéder à des mesures à l'aide du présent oscilloscope, vérifier si l'équilibrage et l'étalonnage de gain de l'atténuateur par échelons sont adéquatement ajustés pour toutes les voies.

Au besoin, procéder comme suit:

#### 1. Equilibrage continu de l'atténuateur par échelons

- Enfoncer le bouton MAIN TB du sélecteur de déviation horizontale.
  - Enfoncer le bouton AUTO du sélecteur de base de temps principale.
  - Régler les commandes INTENSITY et FOCUS afin d'obtenir une trace nette et fine.
  - Enfoncer le bouton de voie appropriée du sélecteur de déviation verticale.
  - Enfoncer le bouton 0 du commutateur de couplage d'entrées.
  - Régler le bouton POSITION de telle sorte que la trace se trouve quelque part au centre de l'écran.
  - Mettre la commande continue AMPL sur CAL.
  - Vérifier si la trace ne saute pas lorsque le commutateur AMPL est tourné.
- Au besoin, ajuster la commande BAL.
- Répéter ce processus pour chaque voie.

#### 2. Etalonnages du gain

A moins qu'indiqué différemment, les commandes occupent les mêmes positions que pendant le processus décrit ci-avant.

- Mettre le commutateur AC-0-DC en position AC.
  - Régler la commande AMPL sur .5V et la commande continue sur CAL.
  - Connecter l'entrée de voie à la sortie CAL.
  - Vérifier si la déviation verticale est de 6 divisions exactement.
- Au besoin, régler la commande GAIN.
- Une sonde atténuatrice peut également être incluse à cet étalonnage.
- Dans ce cas, il faut tenir compte du facteur d'atténuation de la sonde en fonction de la position du commutateur AMPL.
- Répéter ce processus pour chaque voie.

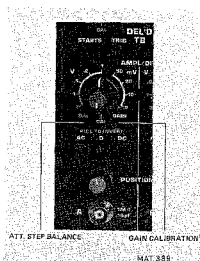


Fig. 2.7.

### 2.4. INSTRUCTIONS DE COMMANDE

#### 2.4.1. Généralités

Avant d'enclencher l'appareil, s'assurer que l'oscilloscope est réglé conformément aux recommandations d'installation (section 2.1.) et que les précautions décrites ont été observées.

#### 2.4.2. Déviation verticale

Pour représenter les voies requises, il faut enfoncer les boutons correspondants du sélecteur de déviation verticale. Si deux traces ou plus sont affichées, l'affichage peut se faire soit en mode découpé, soit en mode alterné.

En mode alterné, les voies sont affichées successivement; pendant le retour du spot de la base de temps principale, l'affichage est commuté d'une voie à l'autre. En mode découpé, les voies sont commutées de l'une à l'autre pendant le balayage de la base de temps.

Le temps d'affichage en mode découpé est d'environ 500 ns. A partir de la version /03: 0,5 ou 2  $\mu$ s, commutable, voir fig. 3.47

Pour obtenir un affichage constant on utilise généralement le mode alterné à grandes vitesses de balayage et le mode découpé à petites vitesses de balayage.

A remarquer qu'en mode de déclenchement composite, il faut choisir le mode alterné, si non les impulsions de découpage exerceraient une certaine influence sur le circuit de déclenchement.

Les signaux observés sont appliqués aux prises d'entrées A ... D et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.

Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

Les commandes de positionnement permettent de décadrer l'affichage en sens vertical. A remarquer qu'en mode de déclenchement composite le point de démarrage du déclenchement est également influencé par la commande de position verticale.

#### 2.4.3. Déviation horizontale

Selon la position du sélecteur de déviation horizontale, la déviation peut être fournie par:

- la base de temps principale
- une source de signal externe
- la base de temps retardée

La commande de positionnement avec agrandisseur de base de temps permet de décadrer l'affichage en sens horizontal.

Si le bouton MAIN TB or DEL'D TB est enfoncé, la déviation horizontale est déterminée par la base de temps principale ou par la base de temps retardée. Au cas où le bouton EXT X DEFL est enfoncé, la déviation horizontale peut être obtenue à partir:

- d'une des voies de déviation verticale A, B, C ou D
- de la tension réseau (secteur)
- d'une source externe par l'intermédiaire du connecteur EXT.

#### 2.4.4. Base de temps principale

La déviation horizontale linéaire est obtenue lorsque le bouton MAIN TB de l'affichage horizontal commuté est enfoncé.

Le mode de base de temps est choisi à l'aide du sélecteur de base de temps principale.

AUTO

- La base de temps fonctionne librement, même si aucune impulsion de déclenchement n'est disponible.

La trace reste visible.

Le mode AUTO peut être choisi dans tous les cas où le mode TRIG est applicable, sauf pour des fréquences inférieures à 10 Hz ou des trains d'impulsions ayant un temps supérieur à 100 ms.

Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre de la base de temps est automatiquement achevé et le générateur est déclenché normalement.

TRIG

- La base de temps est visible lorsque des impulsions de déclenchement sont disponibles et que le niveau de déclenchement est exact.

SINGLE

- La base de temps n'effectue qu'un balayage à la réception d'une impulsion de déclenchement. Ensuite, la base de temps doit être remise à zéro en enfonçant à nouveau le bouton SINGLE. Lorsque des effets uniques sont observés (par exemple par photographie), il faut s'assurer qu'un seul balayage est engendré, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question.

#### 2.4.5. Déclenchement

Si un ou plusieurs signaux doivent être affichés, le balayage de la base de temps doit toujours être démarré en un point fixe du signal afin d'obtenir un affichage stationnaire.

A cet effet, le générateur de base de temps est démarré par des impulsions de déclenchement dérivées des sources suivantes, en fonction de la position du sélecteur de source de déclenchement pour base de temps principale:

- une des voies de déviation verticale A, B, C ou D
- un signal composite
- la tension réseau
- une source de tension externe.

Les amplitudes des signaux de déclenchement provenant d'une des voies de déviation verticale ou du signal composite sont proportionnelles à la déviation verticale de l'affichage, car dépendant des réglages de l'atténuateur d'entrée.

Pour le déclenchement composite, les boutons A et B doivent être enfoncés. Dans ce mode, le signal de déclenchement est pris de l'amplificateur de déviation verticale commune. Le déclenchement de signal composite se caractérise par:

- a. Le déclenchement par signaux différentiels, par ex. si l'appareil est en mode A+B, l'une des tensions d'entrée étant inversées.
- b. Deux à quatre signaux de fréquences différentes et sans rapport, qui peuvent être affichés.

Dans ce cas, les points de déclenchement des différents signaux doivent se trouver dans la même gamme de niveau de déclenchement.

*Remarque: — Lorsque le déclenchement est en mode composite, l'affichage doit toujours se faire en mode alterné. En mode découpé, les impulsions de découpage fonctionnent comme impulsions de déclenchement et l'affichage est instable.*

- *En mode de déclenchement composite, le point de déclenchement du signal dépend également de la commande POSITION verticale. Pour déclenchement composite en alternatif (AC) une petite modification décrite à la section 3.2.2. (seulement en Anglais) résout ce problème.*

Le déclenchement réseau s'effectue en enfonçant les boutons B et C.

La base de temps principale est déclenchée par une partie de la tension réseau (secteur). Le couplage avec la tension réseau est obtenue par un circuit opto-isolateur incorporé, de sorte que l'appareil reste isolé de la tension réseau.

Le déclenchement externe s'effectue en enfonçant les boutons C et D.

La base de temps principale est alors déclenchée par un signal externe appliqué par l'intermédiaire du connecteur EXT.

La commande LEVEL permet de sélectionner le point de déclenchement sur la pente du signal.

Le commutateur "push-pull" SLOPE permet de sélectionner la pente positive ou négative.

Si le générateur de base de temps principale ne reçoit aucune impulsion de déclenchement, le témoin NOT TRIG'D s'allume. En mode de balayage SINGLE, ce témoin s'allume lorsque le générateur de base de temps a été remis à zéro et est en position d'attente (impulsion de déclenchement suivante).

Le temps de balayage de la base de temps principale est réglé à l'aide du bouton TIME/DIV or DELAY TIME. Si la base de temps retardée est enclenchée, le temps entre le démarrage du balayage de base de temps principale et celui de la base de temps retardée est déterminé par le bouton à 10 tours DELAY TIME (1) et le commutateur du temps de balayage pour la base de temps principale (2): temps = réglage (1) x réglage (2). Le bouton central permet d'ajuster les temps de balayage de la base de temps entre les échelons. Pour les mesures de temps, ce bouton doit toujours être en position CAL.

Le coefficient TIME/DIV de la base de temps peut être accru d'un facteur 5 en tirant le bouton "push-pull" TB MAGN.

La commande HOLD OFF permet de faire varier le temps de blocage du générateur de base de temps principale. Il s'agit du temps dont le générateur a besoin pour être prêt à la réception de l'impulsion de déclenchement suivante. La commande HOLD OFF permet l'affichage constant de signaux plus complexes, comme par exemple les impulsions périodiques doubles.

La position extrême droite est considérée comme la position normale de la commande HOLD OFF. En position extrême gauche, le temps de blocage est étendu.

#### 2.4.6. Base de temps retardée

Si le bouton MAIN TB pour affichage horizontal est enfoncé et que le bouton TIME/DIV de la base de temps retardée n'est pas en position OFF, une partie de la ligne de balayage pour base de temps principale est affichée à intensité accrue.

Le moment de démarrage de la base de temps retardée est déterminé par les réglages du bouton TIME/DIV de la base de temps principale et du bouton à 10 tours DELAY TIME. Si le bouton STARTS du sélecteur de base de temps retardée est enfoncé, la base de temps retardée démarre immédiatement après ce temps de retard.

Si le bouton TRIG est enfoncé, la base de temps retardée est démarrée après ce temps de retard et à la réception d'une impulsion de déclenchement.

Le sélecteur de déclenchement de la base de temps retardée présente les mêmes possibilités que le sélecteur de la base de temps principale sauf pour le déclenchement secteur et externe.

La commande LEVEL/SLOPE a la même fonction que décrite pour la base de temps principale.

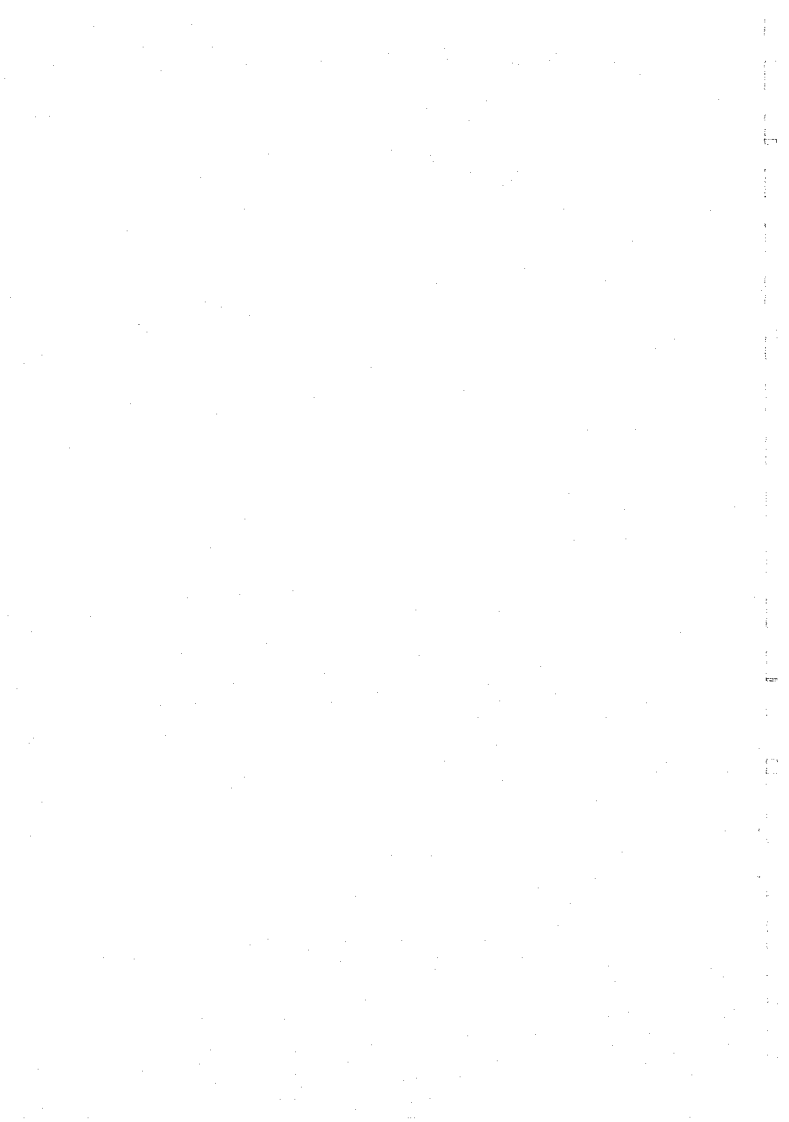
Le temps de balayage de la partie intensifiée du balayage de base de temps principale dépend de la position du bouton TIME/DIV de la base de temps retardée.

Le bouton central permet d'ajuster le temps de balayage entre les échelons. Pour les mesures de temps, ce bouton doit toujours être en position CAL.

Si le bouton DEL'D TB du sélecteur de déviation horizontale est enfoncé, la partie intensifiée du balayage de base de temps principale est représentée sur l'écran tout entier.



## Service data



## 3. Service data

### 3.1. DESCRIPTION OF THE BLOCK DIAGRAM (Fig. 3.1)

#### 3.1.1. General information

The PM 3244 oscilloscope comprises the following parts:

- a four channel vertical deflection system
- a channel selection logic
- a main time base
- a delayed time base
- a trigger source selector
- an X amplifier
- a Z-amplifier and c.r.t. circuit
- a stabilized power supply

#### 3.1.2. Four channel vertical deflection system

The four vertical channels A, B, C and D are complete identical. They all have a facility for signal inversion. The input of each channel is fed via a three-position coupling switch AC/0/DC to the input attenuator. In the AC position a capacitor is switched in series with the signal path.

In the 0 position the input signal path is interrupted and attenuator input is earthed.

The input attenuator, controlled by the AMPL switch via reed relays, enables the adjustment of the vertical deflection sensitivity in calibrated steps. This attenuator consists of a high and low impedance part separated by a low-drift impedance converter. The d.c. balance of the entire channel is set by a BAL potentiometer which compensates for the d.c. offset voltage of the impedance converter.

The output signal of the attenuator is, via a 50- $\Omega$ -coaxial cable, applied to a pre-amplifier stage in the intermediate amplifier where it is transformed into a push-pull current signal. The GAIN control varies the emitter current of the following stage, which is direct-coupled to a cascode voltage amplifying stage. This cascode amplifier provides the following functions:

- shift for the Y trace by means of the POSITION controls
- electronic switching of the selected channel modes
- phase inversion by means of the PULL TO INVERT switches

A trigger signal from each preamplifier stage is fed to the trigger source selector.

The channel selector enables or inhibits the Y-signals as dictated by the channel selection logic.

#### 3.1.3. Channel selection logic

In the ALT mode the channel selection logic is controlled by pulses derived from the sweep-gating multivibrator of the main time base generator.

In this way, the complete trace of every selected channel is alternately displayed on the c.r.t. screen.

In CHOP mode the channel control pulses are derived from an oscillator running at one of the two fixed frequencies (selected with SK201).

These pulses cause an electronic switch in the channel selector which selects on the chopper frequency portions of the selected channels repetitively.

The channel selection logic is operated by six independent push-buttons which enable the selection of the display modes:

Channel A, channel B, channel C, channel D, channel A+B and channel C+D added.

A common output of the four channels is connected with the delay line which delays the vertical signals sufficiently to permit the steep leading edges of fast signals to be displayed. A delay-line correction circuit compensates for the distortion introduced by the delay line. A final stage feeds the Y signals to the vertical deflection plates of the c.r.t.

### 3.1.4. Main time base

The main time base can be triggered on:

- channel A, B, C or D
- A and B composite
- line frequency (push-buttons B and C depressed)
- external (push-buttons C and D depressed)

These trigger sources can be selected with four push-buttons.

From the selector stage, the signal is fed to either the X preamplifier for horizontal deflection (when external X signal is employed), or the trigger amplifier for starting the time-base generator. The input of the trigger differential amplifier stage is connected with the trigger source selector.

The trigger LEVEL adjustment and SLOPE selection switch are also incorporated in this stage. The SLOPE selector switches the differential amplifier to invert the polarity of the trigger signal to enable triggering of the input signals on either positive- or negative-going slopes.

The output of the trigger amplifier is applied to the trigger multivibrator, which produces well-defined trigger pulses. These trigger pulses are used to switch the sweep-gating multivibrator and, when the AUTO pushbutton has been selected, for driving the automatic circuit.

The sweep-gating multivibrator controls the starting and stopping of the integrator circuit that produces the sawtooth waveform required for the horizontal deflection. The integrator circuit consists of charging capacitors switched by transistors, and the resistors selected by the TIME/DIV switch to set the time coefficients in calibrated steps. Continuous control of these time coefficients is obtained by varying the charging current of the time-determining capacitors by means of the TIME/DIV potentiometer.

The hold-off circuit prevents the sweep gating multivibrator from responding to trigger pulses before the time-base capacitor has completely discharged. The hold-off time can be varied by means of potentiometer VARIABLE HOLD OFF. This facility enables suppression of trigger pulses within the hold-off time.

The resulting sawtooth signal of the integrator is fed to the X deflection selector, the hold-off multivibrator and the comparator which is part of the delayed time-base unit. The hold-off multivibrator resets the sweep-gating multivibrator and inhibits its input during the flyback period of the sawtooth waveform. The hold-off circuit also incorporates the single-sweep circuit which causes the main time-base to produce a single sawtooth waveform after the SINGLE pushbutton has been depressed and on receipt of a trigger pulse.

The automatic free-run circuit or auto-circuit makes the time-base free-running when no trigger pulses are applied.

### 3.1.5. Delayed time base

In principle, the delayed trigger unit and time-base generator use similar circuits to those of the main trigger-unit and time-base generator. The delayed time-base always operates in the single-shot mode. The sweep is initiated by the main time-base generator which also serves as hold-off circuit for the delayed time-base.

The DELAY TIME control in conjunction with the comparator and reset multivibrator determine the delay time for the delayed time-base generator. The delayed time-base is operative unless its TIME/DIV switch is in the OFF position. It starts immediately after the delay time, or upon receipt of the first trigger pulse after the delay time.

This can be selected with the pushbuttons STARTS and TRIG.

When pushbutton MAIN TB of the horizontal deflection mode controls is selected, the part of the trace coinciding with the delayed sweep is intensified.

The delay time calibration unit enables adjustment of the DELAY TIME control range.

### 3.1.6. Trigger source selector

The TRIGGER SOURCE SELECTOR enables the choice of the following MTB trigger sources: channel A, B, C and D, the composite trigger amplifier, and external input.

For the DTB the following sources can be selected: channel A, B, C and D and the composite trigger amplifier. The trigger signal is DC-coupled.

### 3.1.7. X-Amplifier

The X deflection selector couples the external X deflection signal from the X preamplifier, the output of the main time-base generator or the output of the delayed time-base generator to the X amplifier and from there to the horizontal deflection plates. The X amplifier comprises the horizontal trace positioning and 5x magnification controls.

The blanking pulse selector supplies blanking pulses to the Z amplifier. These pulses blank the trace at the end of the sweep of the main time-base and provide the extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. The blanking pulses during the switching of the traces in the chopped mode go direct from the channel selector logic to the Z amplifier.

**3.1.8. Z-amplifier and c.r.t. circuit**

The Z amplifier receives two input signals. One originates in the time-base generator and is, via the switching circuit, applied to the Z amplifier to blank the trace during flyback. The other one is supplied by the channel selector logic to blank the trace during switching from channel to channel in chopped mode.

The INTENS potentiometer determines the amount of input current fed to the Z amplifier. At the output of the amplifier, the signal is split into two parts: an l.f. + d.c. part and an h.f. part. The h.f. part is fed direct to the Wehnelt cylinder of the c.r.t. The l.f. + d.c. part is modulated on to an oscillator signal and afterwards detected in a peak-to-peak detector. Both signal parts are combined again on the Wehnelt cylinder. The c.r.t. circuits comprise the FOCUS control and preset potentiometers for trace rotation, astigmatism and distortion.

The high voltage for the post-acceleration anode of the c.r.t. is supplied by a stabilised oscillator whose output voltage is rectified and multiplied by a factor of 5.

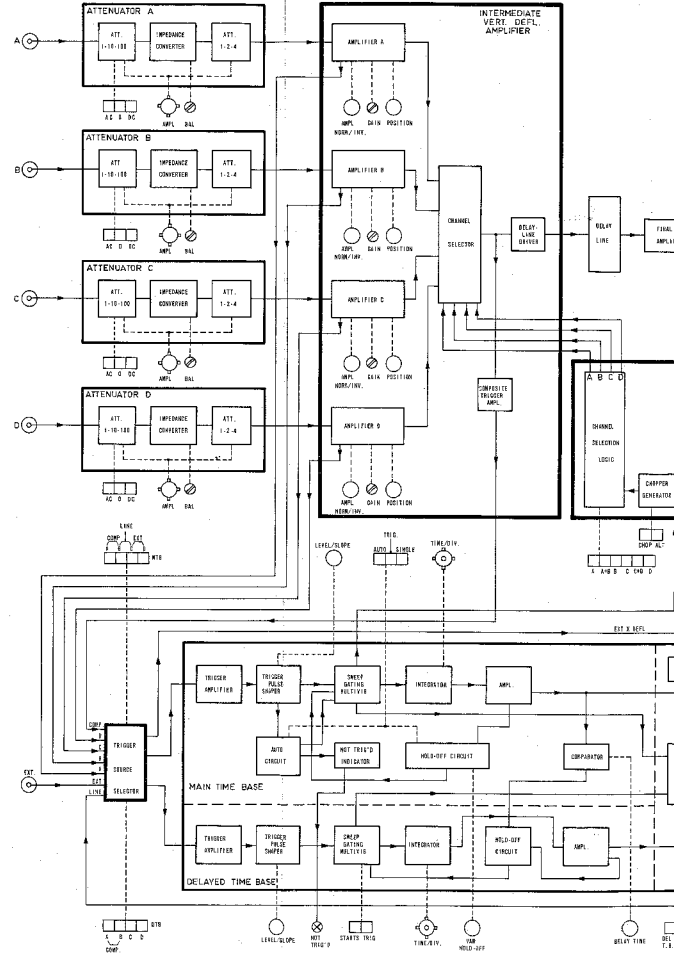
The calibrator, an integral part of the oscilloscope, is a square-wave generator which supplies an accurate voltage and current for calibration purposes.

The graticule illumination lamps receive current from the illumination circuit. The amount of supplied current depends on the position of the ILLUM potentiometer.

**3.1.9. Stabilized power supply**

The mains voltage is full-wave rectified and fed to a voltage regulator. The voltage regulator contains a current sensor which controls in such a way that the output voltages of the power supply stay within specified limits. The rectified mains voltage controls a blocking oscillator which generates a voltage at a frequency of approximately 20 kHz. This voltage is applied to the primary winding of a transformer. The secondary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The MAINS triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuits at a safe level, completely isolated from the mains.



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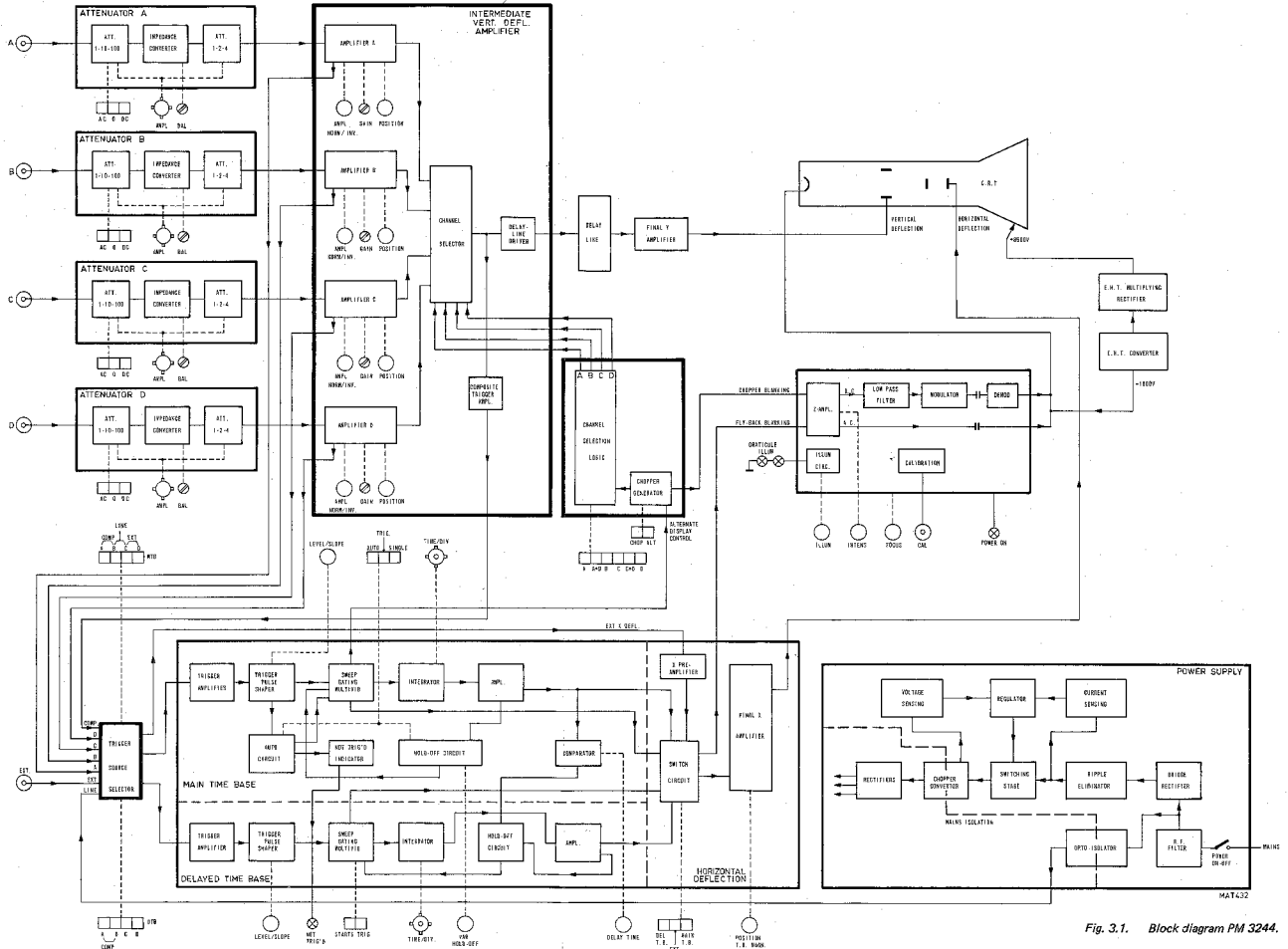


Fig. 3.1. Block diagram PM 3244.

3.2.

3.2.1.

3.2.1.1.

3.2.1.2.

### 3.2. CIRCUIT DESCRIPTION

#### 3.2.1. Vertical deflection system

##### 3.2.1.1. Input attenuator (fig. 3.17)

As the four input attenuators are completely identical only channel A is described.

The attenuator consists of a triple high-ohmic and a triple low-ohmic voltage divider stage separated by an impedance converter with an a.c. and d.c. path.

The d.c. path is used for drift correction.

The overall attenuation is determined by the combination of the selected sections of both voltage dividers. The various combinations are selected by reed relays that are controlled by the front panel switch SK19.

The high-ohmic voltage divider sections divide 1x, 10x or 100x, each section being switched by 2 reed relays. The low-ohmic voltage divider sections, incorporated in IC 102, divide 1x, 2x or 4x. With the overall combinations of attenuation 9 Y-deflection coefficients are realized from 5 mV/div to 2 V/div in a 1-2-5 sequence.

Constant input capacitance for the various attenuator positions is achieved by the trimmers C107, C102 and C111. In the high-ohmic voltage divider sections the capacitive attenuation for a.c. signals can be adjusted to the resistive attenuation for d.c. signals by means of the trimmers C108, C101 and C109.

The a.c. component of the input signals is fed to the gate of TS101. This gate is protected against excessive negative voltages by means of GR101. The d.c. component developed across R131 is fed to non inverting input 3 of differential amplifier IC101. R129 influences the d.c. voltage on this input and enables adjusting of the 0-DC BALANCE. A part of the impedance converter output signal (on the emitter of TS103) is used as a feedback signal applied to inverting input 2 of the differential amplifier. IC101 compares the voltages on R131 and on the emitter of TS103 and compensates for possible differences. The controls LF GAIN (R132), ATTENUATOR BALANCE (R8) and C122 are incorporated in the feedback circuit. C122 compensates for the stray capacitance in the other input circuit of IC101 and makes 100 kHz SQUARE WAVE ADJUSTMENT possible.

Any d.c. drift in the attenuator circuit, for instance due to temperature changes, is fed to the differential amplifier to provide a correcting d.c. feedback voltage via the output of the differential amplifier (pin 6) to the impedance converter.

The output impedance of the attenuator unit is 50 ohms in all positions, thus presenting a correct impedance match for the coaxial cable link to the succeeding intermediate amplifier. R141 allows compensation of d.c. offset voltages at the output of the attenuator.

Input coupling switch SK22 (pushbuttons AC-0-DC) forms part of the attenuator input stage. When the a.c. position is selected, capacitor C104 is connected in series with the input and reduces the lower frequency limit to 10 Hz. When the d.c. position is selected RE106 is energised and C104 is bypassed via resistors R109 and R111 in series. Selection of the 0 pushbutton de-energises all reed relays, except RE108, in order to block the input signal. RE108 provides an earth path for the impedance converter via R116.

##### 3.2.1.2. Intermediate amplifier (fig. 3.19 and 3.20)

As the four channels of the intermediate amplifier are completely identical, only channel A is described.

The intermediate amplifier comprises integrated circuits wherever there is the need for greater stability to safeguard against drift.

The output signal from the channel A attenuator is applied via R406 to point 9 of IC401. This portion of the integrated circuit block consists of a differential amplifier using discrete transistor TS401 in the common-emitter tail circuit as a constant-current source to achieve high rejection. The RC network R408, C402 and C403 constitutes the h.f. response correction filter with C402 as the adjusting element. In this part of the circuit, the overall gain of the channel is adjustable by means of the front-panel preset GAIN control, R9 and the AMPL continuous control, R7, of the Y deflection coefficients. These control the signal current to the emitters of two transistors in common-base mode, which are also part of IC401.

This stage is followed by two discrete pnp transistors, TS402 and TS403, connected in common-base mode, which lower the d.c. potential. The collector outputs are resistor-coupled to the bases of an amplifier forming part of IC402. The emitters of this stage are fed from a constant-current source transistor, TS404. An h.f. correction network is also part of the common-emitter circuit, the adjusting elements of which are R442 and C416.



Each of the four channels has a normal/invert switch, which controls the normal/invert circuit via one wire. In channel A, the normal/invert function is achieved with TS413, TS412, TS411 and TS409. The bases of TS409 and TS413 are held at a fixed voltage level determined by voltage divider R464 and R466. The bases of the two other transistors are connected to voltage divider R461, R465 and R463. Dependent on the position of SK20A, this divider provides two fixed voltages. In the normal position the potential on the base of TS413 and TS409 exceeds the potential on the base of the other two transistors. The signal is now routed via TS413 and TS409. In the invert position, the potential on the base of TS412 and TS411 is higher and the signal is routed via these transistors and inversion takes place.

Possible unbalance between the normal and invert position can be compensated by the preset potentiometer R448 between the +12 V and earth.

The front-panel POSITION potentiometer, R10 controls the position of the A display by dividing the output from a current-source from TS417 between two transistors, TS414 and TS416. These, in turn, control the direct currents of the transistors in the channel selector, which causes a voltage change over the collector resistors R554 and R561.

The trigger signal is derived from IC401 via transistors TS379 and TS376 which are thermally coupled to reduce drift.

Transistor TS377 is the adjustable current source for this amplifier stage.

The use of this adjustment is the trigger balance between the channels.

The symmetrical amplifier stage of TS379/TS376 is connected to an asymmetrical stage TS378.

The collector of this stage feeds the trigger source selector.

Diode GR401 compensates for changes in the base-emitter voltage of TS378 due to changes of ambient temperature.

The signal for composite triggering is picked off after the channel selector (Fig. 3.20) by means of a symmetrical amplifier stage comprising transistors TS506, TS508, which are thermally coupled to reduce drift, and adjustable current source TS507.

This current source can be adjusted with R531 and compensates the trigger balance.

The amplifier, stage TS506 and TS508, feeds the asymmetrical stage, TS509.

The collector of this transistor feeds the trigger source selector. Diode GR501 compensates for changes in the base emitter voltage of TS509, due to changes of ambient temperature.

A small modification of the composite trigger pick-off amplifier enables AC coupling of the composite triggering. This modification is explained in section 3.2.2.

### 3.2.2. Modification for AC Coupling of Composite Triggering

The standard trigger bandwidth of the PM 3244 is d.c. ... 50 MHz. When two or more different signals are displayed with composite triggering, the displayed waveforms will partly overlap each other due to the fact that the trigger gap of the signals coincide.

The following modification enables the d.c. component of the composite trigger signal to be blocked with a capacitor. As a result of this, different signals can be displayed on the screen without overlapping each other. The basic composite trigger circuit and the modified circuit are indicated in Fig. 3.22 and Fig. 3.23.

The lower cut-off frequency of the composite trigger signal depends on the value of the block capacitor.

A low-value capacitor will give bad triggering on low frequencies but good separation on the display.

A capacitor with a higher value will give good composite triggering on lower frequencies but will allow only a small distance between the displayed waveforms on the screen.

The relation between the value of the capacitor and the cut-off frequency is indicated in the following table. The working voltage of this capacitor must be at least 16 V.

| $C_x$       | Cross-over frequency comp. trig. |
|-------------|----------------------------------|
| 10 $\mu$ F* | 5 Hz                             |
| 100 nF      | 500 Hz                           |
| 10 nF       | 5 kHz                            |
| 3.3 nF      | 15 kHz                           |

\* If an electrolytic capacitor is used, connect the "+" of this capacitor to diode GR501.

The circuit to modify, is located on the intermediate amplifier board. Figure 3.23 gives the component layout after the modification.

**Required parts:**

- Capacitor C<sub>x</sub>, refer to table.
- Preset potentiometer 2,2 kohm linear 5322 101 14008
- Resistor 511 ohm, MR25 5322 116 54525
- Resistor 2,26 kohm, MR25 5322 116 50675
- Resistor 4,42 kohm, MR25 5322 116 50556

**Proceed as follows:**

Refer to Fig. 3.21 for the basic component lay-out of the intermediate amplifier.

- Remove R529 (10,2 kohm).
- Replace potentiometer R531 (47 kohm) by a 2.2 kohm type.
- Replace R538 (1,27 kohm) by a 511 ohm resistor.
- Unsolder the anode of GR501 from the p.c. board.  
Connect the additional capacitor (C<sub>x</sub>) between both separated points.
- Connect a 4,42 kohm resistor between the connection C<sub>x</sub>/anode of GR501, and the +12 V.
- Connect a 2,26 kohm resistor between the slider contact of R531 and the collector of TS509.
- The adjustment procedure of potentiometer R531 is the same as in the basic circuit. In the EXT X DEFL mode with no input signals, the spot must be in the centre of the screen; refer also to section 3.7.6.4. "Trigger balance adjustment".

**3.2.3. Introduction — Channel Selection Logic**

The circuit is located on a separate printed-circuit board and is built up with Low-Power Schottky TTL circuits. The block diagram of the logic (Fig. 3.2) indicates that there are four outputs that drive the channel switches in the vertical intermediate amplifiers of the four channels. A channel is switched on if the relevant logic output is "high", and switched off when "low".

In this circuit description "high" is defined as a voltage level between 2 and 5 V; "low", a voltage level between 0 and 0.8 V.

The heart of the channel selection logic is formed by six D-type flip-flops, which are connected in cascade.

They are housed in three integrated circuits, type SN74LS74N, indicated IC206, 209 and 214 on the schematic diagram (Fig. 3.24). A brief explanation of their operation is as follows:

Every flip-flop has two outputs: Q (pin 5 or 9) and the inverse of Q (pin 6 or 8). The information applied to the D (= data) input (pin 2 or 12) is transferred to output Q on the positive transition of the clock input (pin 3 or 11). The flip-flop is set in the case where Q is high, and therefore contains a "1". The flip-flop is reset in the case where Q is low, and contains a "0". The clear input (pin 1 or 13) is active when low and makes Q low independently of the clock or D input signal. The preset input is not used and is connected to +5 V.

The row of the six flip-flops represents the six modes: channel A, channel A and B added, channel B, channel C, channel C and D added, channel D. For identification, these flip-flops are marked in the block diagram FFa, FFa+b, FFb, FFc, FFc+d, FFd. All flip-flops receive the same clock-pulses. The flip-flops can be selected with the corresponding display mode switches SK12B ... SK17B. As these switches function independently, any display combination is possible. When one channel is selected, the corresponding flip-flop is continuously set. When more channels are selected, the "1" jumps-on every positive clock transition of the clock inputs, to the next selected flip-flop in the row. From the last selected flip-flop the "1" jumps to the first selected flip-flop in the row. The channel selection logic has provisions to eliminate errors such as an unwanted set or reset of a flip-flop due to interference.

**3.2.4. Block Diagram Description — Channel Selection Logic**

The flip-flops can be selected with SK12B ... SK17B. Except for SK12B, these switches produce directly in their OFF position a "clear" command to the associated flip-flops so that their inverse output is high. The clear for FFa is given by the block CLEAR CIRCUIT FFa. The six inputs of this block are connected with the display mode switches SK12B ... SK17B.

This block only produces a clear signal for FFa if SK12B is in the OFF position and at least one of the other switches SK13B ... SK17B is in the ON position. This provision activates channel A if none of the display mode switches is depressed.

The six flip-flops are connected in cascade. The D inputs of FF (a+b) ... FFd are connected to the inverse outputs of the preceding flip-flops via five identical blocks SET/RESET FF(a+b) ... SET/RESET FFd. The function of such a block is explained for the block SET/RESET FFc for the two possible situations:

- a. The preceding FFb is not selected (SK14B closed): the signal on the D input of FFb is routed to the D input of FFc.

b. The preceding FFb is selected (SK14B open): the signal on the D input of FFb is not routed to the D input of FFc. The signal on the D input of FFc now depends on the condition of FFb. If FFb is set, the D input of FFc is high and if FFb is reset the D input of FFc is low.  
Because of this provision the "1" jumps on every positive clock transition, to the next selected flip-flop in the row.

From the last selected flip-flop the "1" jumps to the first selected flip-flop in the row by means of the block SET/RESET FFA. As this block incorporates the elimination of errors facility it is rather complex.

It has twelve inputs that are connected to:

- The output of FFA
- The inverse outputs of FF (a+b), FFb, FFc, FF (c+d)
- SK13B ... SK17B and the inverse of SK13B ... SK16B.

The block generates a high output signal in order to set FFA under the following conditions:

- At the end of a cycle when the last selected flip-flop in the row will be reset at the next positive clock transition to appear.
- In the case where a flip-flop is reset by unwanted interference signals: i.e. if a "1" is lost.
- In the case where more than one flip-flop in the selected row has been set due to interference and the "1" will leave the last selected at the next clock-pulse.

Because of the above-mentioned provisions a potential error has been eliminated when the first selected flip-flop is set at the start of a new cycle.

The inverse outputs of the six flip-flops control the channels via four 2-input Nand gates. These Nand gates are designated CH. A, CH. B, CH. C and CH. D after the channels they control.

When FFA, FFb, FFc or FFd is set, one input of the relevant Nand gate becomes low; so its output becomes high and respectively switches channel A, B, C or D on.

When FF(a+b) or FF(c+d) is set, two Nand gate outputs become high together to achieve the addition of two channels.

The clock inputs of the six flip-flops are connected to the output of the CLOCK PULSE SELECTOR.

Depending on the position of the chopped/alternate switch SK18A, this block selects either the output signal of the CHOPPER OSCILLATOR or the output signal of the block ALTERNATE PULSE ON/OFF.

Moreover, in the chopped mode, the selector sends the inverted clock-pulses to the input of the BLANKING PULSE SHAPER. This block now generates a positive blanking pulse during the low-to-high transition of the clock inputs of the flip-flops, so that during the switching from one channel to another the display is blanked. The CHOPPER OSCILLATOR produces a square-wave of about 2 MHz if SK201 is open and 0.5 MHz if SK201 is closed. The oscillator is switched off by means of SK18A in the alternate mode. Present from /03 version: older versions have a fixed 2 MHz frequency.

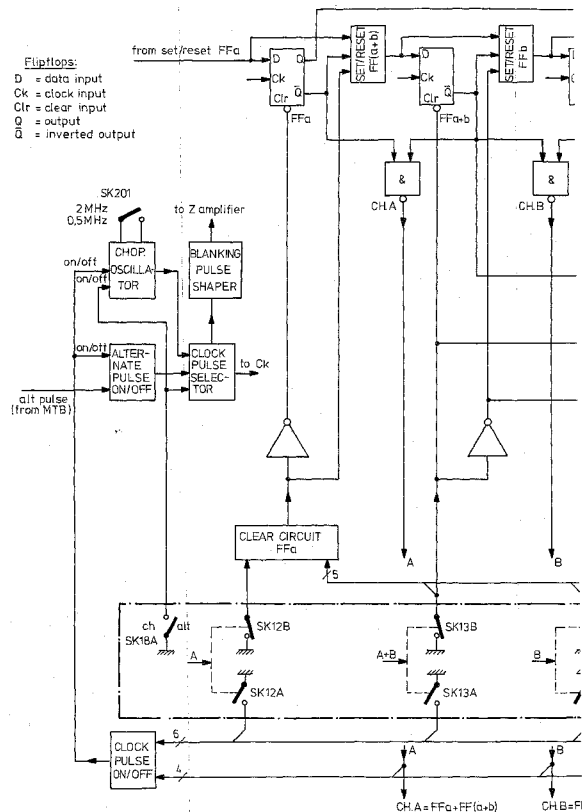
Both the blocks CHOPPER OSCILLATOR and ALTERNATE PULSE ON/OFF can be switched off by the block CLOCK PULSE ON/OFF. The output depends on the inputs as follows:

- Six inputs are connected to SK12A ... SK17A. As indicated in the block diagram these contacts are operated by the same front-panel push-buttons as SK12B ... SK17B. If more than one channel is selected, more than one input is connected to earth and the output becomes high, so that the clock-pulses are switched on.
- Four inputs are connected to the outputs of the Nand gates that drive the channel switches in the vertical intermediate amplifiers. If none of the flip-flops is set, no channel is selected and the four inputs are low. If in this situation only 1 channel has been selected, the situation remains unless clock-pulses are applied to the flip-flops in order to set the selected flip-flop. So if all four inputs are low the clock-pulses are switched on. They are switched off if one input becomes high because the selected flip-flop has been set.

As discussed, the chopper oscillator and alternate pulses are switched off if they are not needed. This is done to limit transmission of interference caused by these signals.

### 3.2.5. Circuit Description — Channel Selection Logic (Fig. 3.24)

This circuit description explains how the various blocks work and outlines their contents in relation to the schematic diagram.



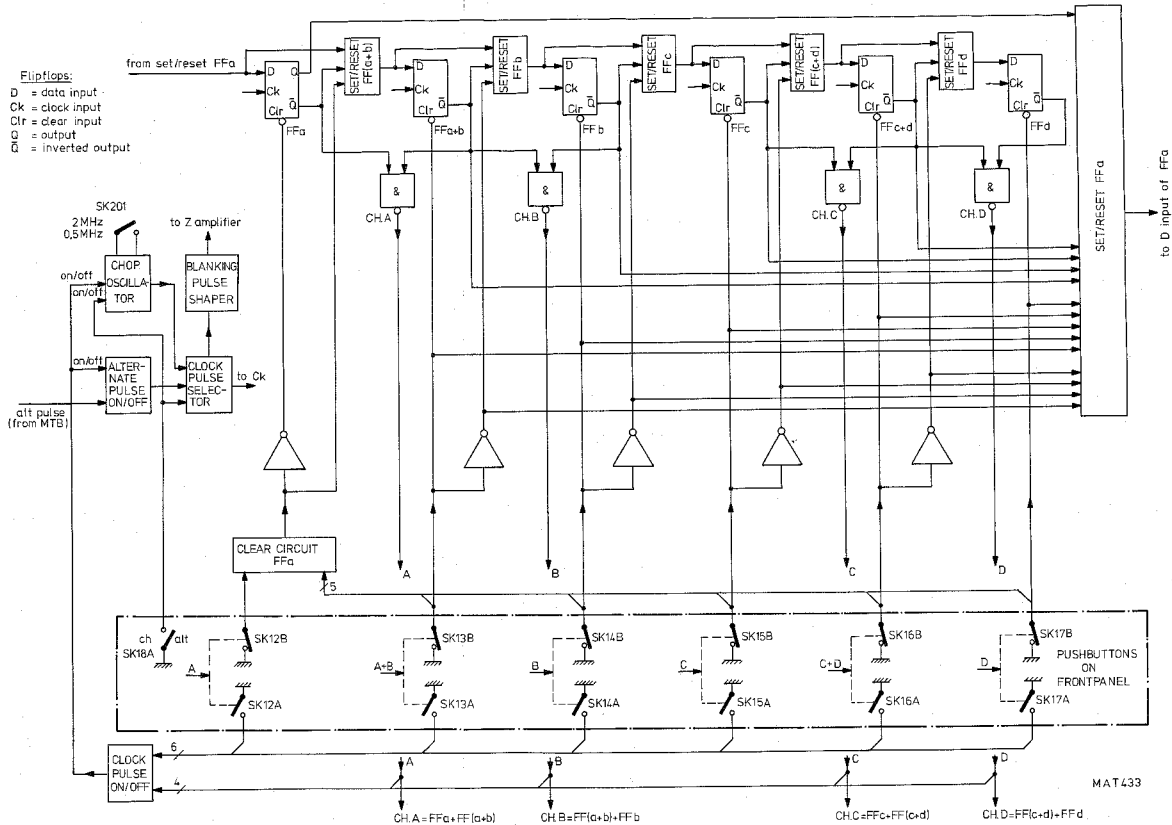


Fig. 3.2 Block diagram, Channel selection logic

I  
V  
F  
EC  
T  
T  
F  
S  
E  
L  
A

E

S  
T  
L  
M  
I  
T  
M  
T  
e  
e  
T  
dC  
T  
W  
S  
f  
T  
IA  
T  
P  
iC  
T  
I  
C  
I  
P

**Test hint**

When troubleshooting it may be easy in some cases to observe the change of voltage levels on certain gates and flip-flops after each clock-pulse. This can be done by using the instrument in alternate and single-shot mode. Every time the single-shot control is operated in clock-pulse is generated at the end of the MTB sweep (MTB triggered by mains unit).

**Clear Circuit FFa**

The "clear" signal for FFa is made by TS203, Nor gate IC217/8,9,10 and inverter IC203/3,4.

Transistor TS203 has a high collector voltage if the display mode switches SK13B ... SK17B are in the off position so that this transistor does not receive any base current.

SET/RESET FF(a+b) ... SET/RESET FFd: every block contains two Nand gates: as there are five identical blocks, ten Nand gates are needed. These Nand gates are located in the circuit diagram just above the row of six flip-flops. The block SET/RESET FFc, which is built up with the Nand gates IC207/9,10,8 and IC211/4,5,6 operates as follows:

- a. With SK14B in the off position (closed) both Nand gates function as an inverter and the voltage level on the D input of FFb is fed through to the D input of FFc.
- b. With SK14B in the on position (open) output 8 of IC207 is high. Now IC211/4,5,6 inverts the inverse output of FFb. Consequently, if FFb is set, output 6 of IC211 is high and if FFb is reset, output 6 of IC211 is low.

**SET/RESET FFa**

The heart of this circuit is formed by five Nand gates of the open collector type with one common collector load resistor R203. These Nand gates form a so-called wired Or, which makes the D input signal for FFa. The Nand gates, which are marked RN (= resistor not), are IC208/1,2,3, IC208/4,5,6, IC208/9,10,8, IC208/12,13,11 and IC213/9,10,8.

The output of this wired-Or is only high if the output of all separate Nand gates are high. One input of each Nand gate is directly controlled by one of the switches SK13B ... SK17B.

The remaining input of IC208/1,2,3 is controlled by the output of FFa. The remaining other four inputs are controlled by two Nand gates each. They are located on the schematic diagram just below the five open collector Nand gates.

The conditions under which the output of the block SET/RESET FFa becomes high, have already been detailed in the block diagram description.

**Chopper oscillator**

The Nand gates IC202/1,2,3 and IC202/4,5,6 form the chopper oscillator because of the RC feedback circuit with R201, R202, C201, C202 and C200. Capacitor C200 can be connected in parallel with C202 by means of SK201. The oscillator frequency is 2 MHz (SK201 open) or 0,5 MHz (SK201 closed). Described as present from /03 version. Older versions: C200 and SK201 not present.

The oscillator can be switched off by applying a low level to input 2 of IC202 (in alternate mode) or to input 5 of IC202 (in single channel mode).

**Alternate pulse ON/OFF**

This block is formed by Nand gate IC201/4,5,6. The alternate pulse which is low during the MTB hold-off period is applied to input 4 of IC201. The pulse can be blocked by applying a low level to input 5 of IC201 (in single channel mode).

**Clock pulse selector**

This block contains three Nand gates IC202/12,13,11, IC201/1,2,3 and IC201/12,13,11.

In the chopped mode, a low level is applied to input 1 of IC201 so that alternate pulses are blocked.

Output 11 of IC201 sends chopper pulses to the clock inputs of the flip-flops. In the alternate mode a low level is applied to input 13 of IC202 so that chopper pulses are blocked. Output 11 of IC201 sends alternate pulses to the clock inputs of the flip-flops.

*Blanking pulse shaper*

Transistor TS202 and matched components form this block.

The transistor normally conducts and its collector voltage is therefore low. Via R204 and C204, TS202 receives a negative pulse on its base during the low-to-high transition of the clock pulse. Now this transistor is non-conductive for a period determined by R204 and C204 and its collector voltage is high. Present from /03 version.

Older versions: pulse shaper contains 2 capacitor coupled amplifier stages. The input of this pulse shaper is connected to output 6 of IC202.

*Clock pulse ON/OFF*

This circuit is located in the lower left hand corner of the schematic diagram. When two or more channels (SK12A ... SK17A) are selected (switches closed) the base of transistor TS204 is so low that it is blocked. Its collector then becomes high. This collector signal is inverted by means of IC217/11,12,13. Resistors R233 ... R239 are located on the switch unit SK12A ... SK17A (see Fig. 3.50).

The output of this Nand gate is low if two or more channels are switched on, and causes output 8 of Nand gate IC201 to be high. If this output is high clock-pulses are applied to the flip-flops.

Independent of the number of chosen display modes, there is another command which switches the clock-pulses on. This command is made by the Nor gates IC217/5,6,4 and IC217/2,3,1 and the Nand gate IC213/12,13,11. It becomes active if all outputs of the channel selection logic are low (if all flip-flops are reset).

In this case output 11 of IC213 is low, and the clock-pulses are switched on.

**3.2.6. Final Y amplifier (fig. 3.27)**

The final Y amplifier basically comprises two common-base mode transistors, TS601 and TS602 together with circuit block IC601, followed by circuit block IC602 coupled to output transistors TS606 and TS607.

The delay line output is applied to the emitters of TS601 and TS602 via 50 ohm coaxial cables. The collectors of TS601 and TS602 are resistor-coupled to IC601 (pins 6 and 9). This integrated circuit provides h.f. networks between pins 7 and 8 for correction of frequency distortion inherent in the delay line.

The correction networks comprise capacitors and resistors which constitute variable and fixed filters in the emitter circuit. Transistor TS603 provides a constant-current source for this stage.

Collector supplies are derived from the +12 V rail via the series diodes GR601 and GR602.

The inputs to the final amplifier block IC602 are via pins 6 and 9, the bases of two transistors. The potentiometer, R641, in the common emitter circuits provides a preset gain control to allow for changes in circuit parameters; e.g. if a c.r.t. is replaced. Two additional transistors in the circuit block provide constant-current sources. The outputs of the final amplifier are coupled to the output transistors by diodes GR603 and GR609 which provide d.c. voltage drop. Resistors R649 and R668 supply the normal feed current to the final amplifier from the +45 V rail when there is no signal input.

As the two halves of the output stage are identical, only the output feeding the Y1 deflection plate of the c.r.t. is described. Because of the +6 V feed to the emitter of TS606, the base stands at slightly more than +6 V. Therefore, due to the voltage drop across the series zener diodes GR604 and GR606, the junction of GR603 and GR604 stands at approximately 23 V, being connected via R649 to the +45 V rail. The potential at that junction is maintained at 23 V under signal and no-signal conditions. When the signal applied to pin 6 of the final amplifier demands more current from the 45 V supply, this current is drawn via R656 from the output transistor TS604 to maintain the junction potential of 23 V.

Hence, less current is available for TS606, since transistor TS604 provides constant current. When the signal applied to the final amplifier demands less current, then the current is reversed through R656 to maintain the 23 V potential constant.

In this way, the currents through the output transistors TS606 and TS607 vary in accordance with the signals applied to the bases of the final amplifier. Consequently, the potentials applied to the Y1 and Y2 plates of the c.r.t. are replicas of the signals applied to the Y input sockets.

Coupling capacitor C623 provides a bypass for h.f. signals, to improve the deflection properties at high frequencies.

### 3.2.7. Trigger source selector (fig. 3.29)

This unit switches the triggering signal from the desired source through to the MTB and DTB trigger amplifiers. These sources are the trigger pick-off amplifiers of the channels A, B, C, D and composite in the intermediate amplifier, the external input amplifier and the mains trigger amplifier. These are selected by SK21 for the MTB and SK10 for the DTB. The signals from the four channels and the composite signal are fed to five identical input circuits. The circuit explanation is given for channel A only.

The current from the pick-off amplifier in channel A is equally divided between the emitters of TS751 and TS752. Resistors R751 and R754 make the current division more independent of the emitter base voltages of TS751 and TS752.

Transistor TS751 is able to pass its collector signal to the base of TS704 if the diodes GR751 and GR753 conduct. These diodes conduct if their cathodes are connected via R753 and SK21 to  $-12$  V. Diode GR752 does not conduct in this situation. The base of TS704 is held at  $-6$  V by means of GR709 and R727. The collector signal of TS704 is applied to the MTB trigger amplifier by means of emitter-follower TS706. The output voltage of this emitter-follower is adjusted to earth potential by means of the adjustable current sources in the pick-off amplifiers.

If the cathodes of GR751 and GR753 are floating because SK21 does not apply R753 to any potential, the collector current flows through GR752 and the triggering signal of channel A does not reach the MTB trigger amplifier.

The circuit comprising TS752 is able to pass its collector signal to the base of TS707 in order to trigger the DTB. This happens if GR754 and GR757 are made conductive by applying their cathodes to  $-12$  V via R752 and SK10. The signal on the collector of TS707 is applied to the DTB trigger amplifier by means of emitter-follower TS708. The output voltage of this transistor is not separately adjustable to earth potential as described for TS706.

The signal on the external input (BU4) is applied to the base of emitter-follower TS701 via a voltage dividing network. This transistor is followed by TS702, which gives base current to TS704 if GR703 and GR704 conduct. These diodes conduct if their cathodes are applied to  $-12$  V by means of R714, R705 and SK21. Resistor R705 permits adjustment of the output voltage of TS706. Diode GR702 conducts if GR703 and GR704 are non-conductive.

The signal from the mains trigger unit on the power supply reaches the base of TS703. The collector signal of this transistor is applied to the base of TS704 if GR707 and GR708 are conducting. These diodes conduct if their cathodes are connected to  $-12$  V via TS705 and R720.

This occurs if TS705 receives base current via R719 and R715, which is connected to earth via SK21. Because of a limitation of SK21, only an earth potential command for mains triggering is available and it is converted by means of TS705 into a  $-12$  V command. Switch SK21 gives  $-12$  V to R773 in the mains trigger mode (SK21B and SK21C both depressed). Diode GR771 becomes conductive in this situation and channel C is not switched on.

The DTB trigger pulses are blocked in the STARTS mode, when they are not needed. This is done by applying  $-12$  V to R735, which is otherwise floating. Moreover, SK10A/2 is now floating; this contact is otherwise connected to  $-12$  V by SK11A/1 via SK11B/3.

The  $+6$  V supply for the trigger source selector is stabilised by means of TS709, GR712 and GR713. The changes in voltage due to variations of ambient temperature of these semiconductors compensate each other. This stabilisation prevents crosstalk of unselected trigger signals via the internal resistance of the power supply.

The signal sources used for triggering of the MTB can also be used for horizontal deflection when push-button EXT.X.DEFL. of switch SK8 is depressed.

#### 3.2.7.1. Trigger amplifier and multivibrator (fig. 3.31)

The m.t.b. trigger signal from the trigger source selector is fed to the base of the emitter follower TS801, which feeds the trigger amplifier.

This is a differential amplifier circuit TS802, TS804, with a constant-current load, TS803, in the common emitter circuit.

The trigger level is set by means of the front panel control R3, LEVEL, which controls the base of emitter follower TS806. This, in turn, controls the base of one of the differential amplifier transistors, TS804.

The collector loads of the differential amplifier include transistors TS807 and TS808 fed from the  $+12$  V rail. Switching diodes GR802, GR803, GR804 and GR806 form an electronic switching circuit which is operated by the SLOPE switch, SK2.



The SLOPE switch enables triggering on either the positive-going or the negative-going slope of the triggering signal depending upon the position of the switch. In the -ve position, diodes GR802 and GR803 conduct. Hence, the signal at the collector of TS807 is applied to the base of emitter follower TS809. In the +ve position of SK2, diodes GR804 and GR806 conduct and apply the signal at the collector of TS808 to the base of TS809.

Emitter follower TS809 is coupled to the trigger multivibrator TS811, TS812, which switches over in response to the trigger signals. The resulting square-wave pulses from R336 are differentiated by capacitor C856 on the time-base circuit.

The negative-going spikes cause TS851 to conduct and trigger the sweep-gating multivibrator of the main time-base via R871. The positive-going spikes switch TS852 to control the automatic triggering circuit.

### 3.2.7.2. Auto circuit (fig. 3.31)

Basically, the auto-circuit comprises electrolytic capacitor C858 across the complementary transistors TS853 and TS854. Positive-going trigger pulses at the base of TS854 cause it to start conducting. Likewise, TS853 starts to conduct and capacitor C858 discharges. The output voltage of the auto-circuit is then approximately -10 V. This voltage is applied to the diode GR851 to make it non-conductive. The sweep-gating multivibrator levels are, therefore, such that it is driven by the negative-going trigger pulses received via TS851.

When no trigger pulses are available, TS853 and TS854 are non-conducting and C858 charges. Hence, GR851 conducts and the sweep-gating multivibrator levels are set so that initiation of the sweep is dependent only on the sweep feedback voltage. The main time-base sweep generator is therefore free-running.

### 3.2.8. Main time base generator (fig. 3.31)

The main time-base generator comprises the sweep-gating multivibrator, TS857, TS858, feeding switching transistors TS869 and TS868, the latter being effectively in parallel with the time-base capacitors of the integrator circuit. Transistor TS871 is used as a current source to charge these capacitors. Selection of the appropriate timing capacitors is by means of the TIME/DIV switch SK6 via switching transistors TS874 and TS876. The sawtooth voltage is developed across the selected time-base capacitor(s) by charging it to a certain level from the constant-current source. The capacitor is then short-circuited very rapidly which results in the characteristic sawtooth waveform.

The sawtooth voltage is fed to the transistors TS881, TS882, in Darlington pair configuration. This stage feeds the sawtooth voltage to the X deflection selector stage and also back to the input of the sweep-gating multivibrator via the hold-off circuit.

The main time-base generator circuit also includes a stage which serves to indicate whether the main time-base generator is triggered or not (GR1).

The various stages of the main time-base generator circuit are now considered in some detail.

#### 3.2.8.1. Sweep-gating multivibrator

Sweep-gating multivibrator TS857 and TS858 is controlled by the following signals:

- the negative-going trigger spikes supplied by the main trigger multivibrator via the differentiating circuit,
- the voltage supplied by the hold-off multivibrator,
- the bias voltage supplied by the auto-circuit.

Potentiometer R873 provides a preset control of trigger stability. The collector circuit of TS857 includes TS856 which, as explained in the Y channel selection logic, provides the ALTERNATE control pulses. The output square-wave of the sweep-gating multivibrator is applied to the switching transistors TS868 and TS869.

#### 3.2.8.2. Switching transistors TS868, TS869 and TS870

These 3 transistors are controlled by TS858 in the sweep-gating multivibrator. TS868 takes over the current from the current source TS871 during the MTB hold-off period. TS870 discharges during this time the time-base capacitor. GR855 only conducts during the charging of the time-base capacitor. Because the voltage of the time-base capacitor comes close to the base voltage of current source TS871 at the end of the MTB sweep GR855 must have a low forward voltage. Therefore, this diode is a germanium type. TS869 conducts during the MTB sweep and provides unblanking via R903 and GR1062.

### 3.2.8.3. Sweep speeds

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.

The time-base capacitors are C866, C867 and C869. Capacitor C866 is always in circuit; the other two capacitors are selected by transistors TS874 and TS876. These operate as electronic switches and are either fully cut-off or fully-conducting. They are switched on by the application of a positive voltage to their bases from the TIME/DIV switch. According to the position of SK6, these transistors switch in the relevant capacitor in parallel with C866. As mentioned, the sweep speed is also dependent upon the magnitude of the constant-current charge supplied by transistor TS871. This current can be adjusted in steps by selecting the emitter resistance of TS871 by means of the TIME/DIV switch SK6. Continuous control of the charging current can be effected by varying the base drive to TS871 with the continuous sweep control, TIME/DIV potentiometer R6. In the CAL position of this potentiometer, switch SK7 closes and the charging current is solely determined by the calibrated emitter resistance.

To compensate for the temperature coefficient of the transistor (2 mV/degC) the base voltage of TS871 is supplied via transistor TS872. This also has the advantage of reducing the load on the TIME/DIV control potentiometer.

Electrolytic capacitor C868 suppresses any possible ripple and interference present on the supply voltage rail. This transistor, in turn, has its base controlled by preset R914 when SK6 is in position 1 ÷ 8. This provides a fine adjustment for the timing circuit since C867, 4.7  $\mu$ F, has  $\pm 10\%$  tolerance, whereas the other two timing capacitors have a  $\pm 1\%$  tolerance. In this position, the preset R914 provides an additional measure of control over the base voltage of TS871. In the positions of SK6 when C867 is not in circuit, the diode GR856 is blocked and the preset control R914 is inoperative.

### 3.2.8.4. Sawtooth take-off circuit

The sawtooth waveform generated by the time-base is applied to the Darlington pair, TS882 and TS881, the emitter output of the latter being coupled to the X deflection selector via GR1058 and GR1057, to the comparator circuit via R937 and to the hold-off circuit of the main time-base via GR857.

### 3.2.8.5. Hold-off circuit

The hold-off circuit prevents the sweep-gating multivibrator from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington pair is applied via diode GR857 to the base of emitter follower TS879.

Switching transistors TS877 and TS878 select the appropriate hold-off capacitor, according to the position of SK6, in a similar manner to that described for the main time-base integrator timing capacitors. Capacitor C862 is always in circuit irrespective of the TIME/DIV switch position.

Charging current for the hold-off capacitors flows via transistor TS879. When TS879 cuts off, the discharge current flows through the circuit with R925 and variable hold-off control R11. R11 allows adjusting of the desired hold-off time and is calibrated in its minimum resistance position. The voltage across the selected hold-off capacitors drives the Schmitt trigger, TS864, TS866, the hold-off multivibrator. The output signal from the hold-off multivibrator is applied to emitter follower TS863 which, in turn, feeds the input of the sweep-gating multivibrator. The emitter-follower TS863 buffers the hold-off multivibrator from the triggering spikes of the trigger pulse-shaping circuits.

Switch SK9 in the base circuit of TS867 is normally open when AUTO and TRIG of the trigger-mode push-button switch are selected. However, when SINGLE mode is selected, SK9 provides via R896 and C864 (mounted on SK9) an earth to the base circuit of TS867 to reset the hold-off multivibrator. Furthermore, since AUTO is not selected, TS879 is cut off via R927 and SK9; consequently, the hold-off multivibrator is no longer reset by the sweep voltage.

When the oscilloscope is used with an external X deflection signal, the internal time-base generator is switched off by depressing the EXT X DEFL pushbutton of SK8. This feeds a +12 V supply via R892 and GR854 to the base of TS867. This transistor holds the hold-off multivibrator so that its output prevents the sweep-gating multivibrator from responding to trigger pulses.

### 3.2.8.6. "NOT TRIG'D" indicator

Light-emitting diode GR1 in the collector circuit of transistor TS861 serves two purposes:

- it provides a front-panel indication when the time-base generator is not triggered in the AUTO and TRIG modes; i.e., it indicates the absence of trigger pulses. In this condition, TS853 and TS854 are switched off and electrolytic capacitor C858 in the auto-circuit of the main trigger circuit charges. Consequently, the emitter of TS859 becomes less negative and the transistor cuts off. The earth applied via R882 switches on TS861 and the NOT TRIG'D diode, GR1, lights. On receipt of trigger pulses, C858 is discharged, TS859 conducts and cuts off TS861, thus extinguishing GR1, the current being taken over by TS862.
- in the SINGLE mode, the NOT TRIG'D lamp also serves as a reset indicator. On selection of the SINGLE pushbutton, the lamp remains on until the sweep is initiated by a trigger pulse. In this mode, the trigger pulses drives the base of TS859 dependent on the state of the hold-off multivibrator TS864, TS866.

*Note: The instrument also operates in the SINGLE mode if none of the trigger-mode pushbuttons is depressed.*

### 3.2.8.7. Delay-time function

The function of the DELAY TIME potentiometer R2 is to provide an adjustable d.c. voltage for comparison with the sweep voltage of the main time-base generator.

This comparison voltage is then used to start the delayed time-base generator at a pre-determined time during the sweep of the main time-base. The comparator circuit is described in the delayed time-base generator section (3.2.10.3.). The DELAY TIME potentiometer is a 10-turn front-panel control.

### 3.2.9. Delayed time-base triggering

The trigger unit of the delayed time-base is almost identical to that of the main time-base trigger unit, the circuits of which are described in section 3.2.7. Unlike the main time-base trigger unit, the delayed time-base trigger unit has provision for neither external X deflection, nor triggering from the mains frequency. There is, however, provision for triggering by the main time-base (see section 3.2.10.2).

### 3.2.10. Delayed time-base generator (fig. 3.31)

As the delayed time-base generator is basically similar to the main time-base generator (section 3.2.8.), only the essential differences are described.

#### 3.2.10.1. Sweep speeds

The delayed time-base integrator circuit is a simplified version of the main time-base generator as there are fewer TIME/DIV ranges. Preset potentiometer R1097 provides a measure of control of the charging current to obtain exactly the same sweep speeds of main time-base and delayed time-base.

#### 3.2.10.2. Hold-off circuit

The sawtooth voltage is coupled via the Darlington pair TS1066, and TS1067, and diode GR1052 to the hold-off multivibrator TS1057 and TS1058. Emitter follower, TS1056 provides the hold-off pulse for the input of the delayed sweep-gating multivibrator, TS1052 and TS1053. Transistor TS1054 is set by means of the comparator output signal direct-coupled to its base. This, in turn, resets the hold-off multivibrator, and thus the sweep-gating multivibrator via TS1056.

The delayed time base starts immediately after the delay time and does not need any trigger signal when push-button STARTS of SK11 is depressed.

This is because SK11A point 5 gives an earth potential to R1071.

When no push-button of SK11 is depressed, R1071 is also on earth potential (STARTS mode).

When TRIG is depressed starts the delayed time base after the delay time only after a trigger signal.

Switch SK11A point 5 gives in this case not any potential to R1071.

In the OFF position of the TIME/DIV switch SK4, the sweep-gating multivibrator is switched so that it no longer responds to either the trigger pulses or the reset pulses of the hold-off multivibrator.

Similarly, when X-EXT deflection mode is selected on SK8 a +12 V supply is supplied on R1122 and this inhibits the delayed sweep-gating multivibrator via diode GR1064.

### 3.2.10.3. Comparator

Transistors TS883 and TS884, connected as a long-tailed pair with TS886 as current source, form the comparator circuit. In this circuit, the d.c. voltage set by the DELAY TIME potentiometer R2 is compared with the sawtooth voltage generated by the main time-base.

When the amplitude of the sawtooth at the base of TS883 exceeds the set d.c. voltage applied to the base of TS884, the collector voltage of TS883 goes more negative and, via emitter-follower TS1054, resets the hold-off multivibrator and delayed sweep-gating multivibrator as previously described.

### 3.2.10.4. Delay time calibration unit

The DTB start at the end of the MTB sweep is adjusted by means of R979 which influences the base voltage of emitter follower TS887.

The DTB start at the beginning of the MTB sweep is adjusted by means of R987 which influences the base voltage of the emitter follower TS888. The combinations of the base-emitter voltages and diode voltages of TS887/GR862 and TS888/GR863 compensate for possible changes of the base-emitter voltage of TS881 and TS882 due to changes in ambient temperature.

## 3.2.11. X Deflection selector and blanking switching circuits (fig. 3.31)

These circuits are part of the main time-base printed-circuit board.

### 3.2.11.1. X Deflection source selector

Depending on the selected position of SK8 the circuit provides for X deflection by the main time-base signal, the delayed time-base signal or the signal from an external source.

The source selector circuit is described according to the pushbutton mode selected.

- |            |  |
|------------|--|
| MAIN TB    | — In this position of SK8 the +12 V supply is routed via the contacts and R1118 to the junction of diodes GR1057 and GR1058. These diodes conduct and provide a path for the output sawtooth of the main time-base via R1229 to the X amplifier. With the switch in this position, the diode networks, GR1053, GR1054 and GR1066, GR1067 are blocked. Consequently, signals from the delayed time-base and external X deflection preamplifier are not transmitted.             |
| DEL'D TB   | — In this position of SK8 the +12 V supply is routed via the switch contact and R1108 to the junction of diodes GR1053 and GR1054. These diodes now conduct and provide a path for the output sawtooth of the delayed time-base via R1229 to the X amplifier. With DEL'D TB selected, the signals from the main time-base and external X preamplifier are blocked by the diode networks.   |
| EXT X DEFL | — In this position of SK8 the +12 V supply is routed via R1121 to the junction of diodes GR1066 and GR1067. These diodes now conduct and provide a path for the emitter output of TS1072 of the external X preamplifier. Similarly, the diode networks block the main and delayed time-base signals in this position. Another switch contact of SK8 (X-EXT.) removes an earth from the PULL FOR x5 switch, SK3, as this facility is not available when EXT X DEFL is selected. |

### 3.2.11.2. Blanking pulse switching circuit

The switching transistors for blanking pulses for the main and delayed time-base are TS869 and TS1059 respectively.

These transistors conduct during the sweep period of their respective time-bases; i.e. during the unblanking periods. Diodes GR1063 and GR1062 connect the collectors of these transistors to the Z amplifier via R1312. During blanking these transistors are switched off and a current of 3 mA for complete blanking of the trace is fed to the Z amplifier. This current is injected via R1116 and GR1063 (because TS869 is switched off) and via GR1059, R1117 and GR1062 (because TS1059 is switched off) to the Z amplifier.

During the sweep of the main time-base generator 3 mA flows into the main time-base generator via R903 so there is no current for R1312 and the trace is unblanked. If the delayed time-base TIME/DIV switch is at the OFF position, 3 mA flows into the delayed time-base via R1084, R1112. These currents are derived from the +12 V supply, and the potential developed across R1112 prevents TS1088 from being cut off and cuts off GR1063.

The switching is described in accordance with the signal selected by SK8.

**MAIN TB**

- With the TIME/DIV switch of the delayed time-base in the OFF position, TS1059 is permanently on; therefore, GR1063 is blocked. The current step from 0 to 3 mA is then applied to the Z amplifier, via GR1062 during main time-base blanking.

With the TIME/DIV switch of the delayed time-base operative; i.e., not in the OFF position, then bright-up of the main time-base trace by the delayed time-base occurs after the delay time selected. During the part of the sweep where only the main time-base is running (TS1059 cut off), no current flows to the Z amplifier via GR1062; i.e. trace unblanking.

However, the Z amplifier receives a small current from the delayed time-base via GR1063, dependent on the bias of TS1068 and the setting of R1116. Therefore, the trace is not completely unblanked. Immediately the delayed time-base starts TS1059 conducts and the emitter of TS1068 goes negative. Therefore, both TS1068 and GR1063 are cut off.

The Z amplifier intensifies the entire trace. At the end of the delayed sweep, the small current flows through GR1063 again and the trace is once again completely unblanked. Potentiometer R1115 allows adjustment of the base potential of TS1068, in order to vary the current through R1116 and GR1063 during the time that TS1059 is cut off. Thus, the brightness of the intensified part of the trace can be varied.

Via R1109 this change is also transferred to the INTENS potentiometer R13 (see section 3.2.14.1.).

**DEL'D TB**

- If the delayed time-base is selected, GR1059 and GR1062 are non-conductive since the +12 V supply of GR1059 ceases. The current for TS869 in the main time-base is supplied by GR1061. Transistor TS1068 is switched off by the conduction of diode GR1056 and the 0 to 3 mA bright-up information is fed to the Z amplifier via diode GR1063.

**EXT X DEFL**

- If the EXT X DEFL pushbutton is depressed, the MTB and also the DTB are switched off. Therefore, there is no current through R1312 and the trace is unblanked.

### 3.2.12. Pre-amplifier for external X deflection (fig. 3.31)

Transistors TS1069, TS1071 and TS1072, located on the main time-base printed-circuit board, form a pre-amplifier circuit for external X deflection signals. The input signal from R731 on the trigger source unit is routed to the base of transistor TS1071. The input signal may be one of the triggering signals; namely, a signal on the EXT input socket BU4, the channels A, B, C or D, channels A and B composite or the signal derived from the mains if SK21 push-buttons B and C are depressed.  
(see section 3.2.7.)

When the EXT X DEFL position of SK8 is selected the +12 V supply is routed via GR1085 to the emitter of transistor TS1069. TS1071 and TS1069 form a series-shunt feedback configuration: the gain can be adjusted by means of feedback resistor R1131 and the d.c. output level can be adjusted by means of resistor R1132. This series-shunt feedback configuration is followed by emitter follower TS1072. Since diodes GR1066 and GR1067 are conductive because of the +12 V via R1121, the emitter output signal from TS1072 is passed via R1229 to the X amplifier. In this position, the main and delayed time-base are inhibited from the +12 V supply, routed via GR854 and GR1064 respectively.

### 3.2.13. X-Amplifier (fig. 3.32)

The X amplifier is part of the time-base printed-circuit board U8. The X amplifier receives the input selected by mode switch SK8. This asymmetrical input voltage is fed to the base of transistor TS1201. Transistor TS1204 provides an anti-phase signal, variable by means of the front panel X POSITION potentiometer R4 to give a symmetrical signal to the next stage. The potentiometer R4 varies the base bias of TS1204 which unbalances the push-pull amplifier resulting in horizontal trace shift on the c.r.t. screen.

The nominal gain of the amplifier can be increased by a factor of 5 by switching the current-source supply, using transistors TS1202 and TS1203 controlled by the front panel PULL FOR x5 switch, SK3.

Normally, current source TS1203 supplies the emitters of transistors TS1201 and TS1204 via the higher value resistors R1224 and R1222 and the diodes GR1203 and GR1204. However, when the PULL FOR x5 switch is selected, the base of TS1202 becomes less negative by the application of an earth (from SK8) via R1231 and SK3. Consequently, TS1202 conducts and TS1203 switches off. The current source is now via GR1201, GR1202 and the lower value resistors R1211 and R1213, which pass the additional current for the x5 gain increase.

Preset control of the gain is provided in the x1 position by R1223 and in the x5 position by R1209.

The x5 position is inoperative when the EXT X DEFL pushbutton of SK8 is depressed. In this position, the earth is disconnected from the SK8 contact that is coupled to SK3.

The two symmetrical output currents of TS1201 and TS1204 are fed to the final amplifier stages with feedback, for each defl. plate. Since these are identical, only one half is described. Basically, the amplifier comprises a cascode circuit using transistors TS1209, TS1211, with feedback via R1237 and R1242.

The cascode circuit is fed via transistor TS1206 in common-base configuration. Transistor TS1208 provides a constant-current source for the final amplifier stage. Zener diodes, GR1208 and GR1209 maintain the average voltage on the deflection plate X1 of c.r.t. B1 at +15 V. Capacitor C1204 improves the h.f. response and the trimming capacitor C1203 provides phase compensation over the feedback path.

### 3.2.14. C.R.T. Circuits

#### 3.2.14.1. Z-modulator circuit (fig. 3.36)

Basically, the Z unit comprises an amplifier and a modulator/demodulator circuit for the d.c. and low frequency components of the blanking signal. The latter circuit isolates the Z unit from the high potential (-1600 V) present on the c.r.t. cathode and Wehnelt cylinder.

Input signals to the Z amplifier are received from two sources:

- the blanking pulses from the time-base via R1312.
- the chopper blanking pulses from the channel selection logic via R1313.

As stated in section 3.2.11.2. the blanking current is 3 mA and the unblanking current 0 mA. Transistor TS1302, connected in common-base configuration, feeds the current pulses to the amplifier stage, TS1303, TS1304. Front panel control R13, the INTENS potentiometer, provides an adjustment of trace brilliance by regulating the base bias of TS1301.

The slider of R13 is also coupled to the delayed time-base bright-up circuit via a R1109 to maintain the desired intensity ratio for all settings of R13.

A portion of the input current is drained off via TS1301 depending on the setting of R13, the larger the current drain, the more brilliant the trace. Conversely, the more brilliant the trace, the less the common-base transistor TS1302 conducts.

Since TS1302 is cut-off, GR1301 is also non-conductive and a small current flows through R1307 and prevents TS1303 and TS1304 from bottoming.

The blanking signal is passed by TS1302 to the base of TS1303 via GR1301. The diode GR1302 in the collector circuit of TS1302 clamps the black level of the blanking current fed to the amplifier at 3 mA.

The output of the amplifier stage TS1303, TS1304 is coupled to emitter follower TS1306, the output of which switches between 4 V and 40 V approximately for blanking and unblanking respectively. At this point, the a.c. and d.c. components of the blanking signal are routed along different paths. The high frequency components of the signal are passed via capacitor C1308 to the Wehnelt cylinder of the c.r.t. The d.c. and low frequency components of the signal are passed via the low-pass filter R1325, C1306 and R1323 to the emitter of TS1308. Together with TS1307, TS1308 forms a multivibrator, the frequency of which is approximately 100 kHz.

The oscillator output on the collector of TS1308 is therefore modulated by the Z amplifier, the peak-to-peak value depending on the d.c. and i.f. components fed to the emitter of TS1308. The black level can be adjusted by the preset pot. meter R1327. Capacitor C1309 feeds this modulated signal to a peak-to-peak detector and also serves to isolate the high potential present on the c.r.t. cathode circuit. After demodulation by the detector circuit GR1307, GR1308, C1311, R1333, the d.c. and i.f. components are recombined with the h.f. component via R1334 and routed to the Wehnelt cylinder of the c.r.t. via R1336.

### 3.2.14.2. Focussing circuit (fig. 3.36)

The voltage for the focussing electrode, GR3 of the c.r.t. is derived from a potential divider network between the -1600 V supply from the H.T. converter and earth. The slider of the front-panel FOCUS potentiometer R14 is direct-coupled to the focussing electrode.

The cathode bias for the c.r.t. is also obtained from this divider network, the voltage drop across the neon tube B1301 providing the necessary voltage between cathode and Wehnelt cylinder G1 for complete blanking.

### 3.2.14.3. H.T. Converter (fig. 3.38)

The -1600 V supply for the cathode, Wehnelt cylinder and focus electrode, and the +8 kV supply for the post-acceleration anode G8 are derived from the h.t. converter circuit.

Transistor TS1402 together with transformer T1401 forms an oscillator, operating at a frequency of between 25 kHz and 30 kHz. An a.c. waveform of 1600 V is developed across the secondary winding of the transformer. This voltage is rectified by diode GR1403 and smoothed by the filter network C1406, R1409 and C1407, to provide the -1600 V supply.

Regulation is obtained by rectifying (GR1402/C1402) the collector signal of TS1402. The d.c. potential of approx. 85 V thus obtained is compared with the +45 V supply voltage (R1401-R1402) in TS1401. If the voltage on the collector of TS1402 tends to drop (i.e. the output voltage decreases), TS1402 will start conducting more current and the output voltage increases.

Overload protection is provided by diode GR1402 which switches off if there is excessive current drain throughout GR1403 to the cathode circuit of the c.r.t. This results in the base of TS1401 going positive which reduces its collector current and switches off the oscillator.

The low-pass filter, L1401, C1401, prevents spurious oscillator pulses being fed back into the +45 V supply line.

### 3.2.14.4. Calibration unit (fig. 3.36)

The calibration unit comprises a built-in square-wave generator using an operational amplifier with feedback loops. The frequency-determining components are resistor R1371 and capacitor C1318.

Point 3 of the operational amplifier IC1301 is kept equal to the average output voltage by capacitor C1317. In this way, the generator is independent of supply voltage fluctuations. Zener diode GR1316 determines the amplitude of the square-wave output, and potentiometer R1362 allows accurate adjustment of output voltage and current. The calibration unit gives an output of 3 V<sub>p-p</sub>, 6 mA at a frequency of 2 kHz  $\pm$  2%. The output is protected against continuous short-circuits.

### 3.2.14.5. Graticule illumination control circuit (fig. 3.36)

This circuit comprises the constant current source TS1309/TS1311 that feeds the graticule illumination lamps LA1 and LA2. TS1317 drains away an amount of current from LA1 and LA2, depending on the position of front panel control R12.

### 3.2.15. Power Supply (fig. 3.40)

The power supply is designed on the switching regulator principle, thus permitting the PM 3244 oscilloscope to be connected to any a.c. mains voltage between 90 V and 270 V, or any d.c. voltage between 100 V and 350 V, without the need for mains voltage adaptors. All voltage output rails are stabilised and a current-limiting circuit protects against overloads.

The basic circuit functions of the power supply are as follows:

- mains rectifier and ripple elimination circuit
- switching series regulator
- chopper circuit
- error sensing and regulator circuit
- current-limiting circuit
- voltage sensing circuit
- secondary supply voltage circuits.

In principle, the power supply operates as follows. After rectification and elimination of the ripple, the smoothed voltage (between 100 V and 370 V) is fed to the switching series regulator. A pulse width modulated switching transistor and commutating diode supply a filter network which averages the voltage output to a fixed d.c. level. This voltage provides the supply for the chopper. The chopper provides the necessary alternating waveform for the supply transformer. In addition, part of the chopper square-wave output is rectified, compared with a reference voltage and is fed back to control the on-off ratio of the switching transistor.

### 3.2.15.1. Mains rectifier and ripple eliminator

The mains voltage or an alternative source of supply is applied to the mains filter unit F11801 via the front panel POWER switch SK23 and fuse VL 1.

The output of this filter feeds a second filter consisting of L1800, R1801 and C1804. These filters suppress mains-borne interference to the instrument and also interference from the instrument; e.g. switching transients, to the mains supply.

The mains rectifier GR1801 comprises four diodes in a bridge circuit. The ripple that remains after full-wave rectification is eliminated by the action of transistors TS1801 and TS1802 and their associated components.

The ripple elimination circuit operates as follows. The buffer capacitors C1806 and C1808 are charged to approximately the peak voltage of the mains supply. Assume that the output voltage across capacitor C1808 tends to rise with the instantaneous value of the ripple. Transistor TS1802 then draws less current as its emitter goes more positive. Therefore, less base current is applied to transistor TS1801; consequently, its collector voltage drops and counteracts the tendency for the output voltage to rise. By this means, the d.c. output level coincides with the lower level of the ripple voltage superimposed on the unsmoothed rectified voltage, and the ripple is effectively eliminated.

### 3.2.15.2. Switching series regulator

Transistor TS1807 is the switching transistor, the base of which is driven by the pulse-width modulated rectangular waveform. The filter network comprises the choke L1803 and the capacitor C1809. A constant current flows through L1803 during the turn-on time of TS1807 via its collector. During the turn-off time, the back e.m.f. of L1803 provides a constant current via the commutating diode GR1804. This action is repeated at a frequency of approximately 20 kHz, the chopper frequency. The output voltage across C1809 is thus dependent upon the turn-on/turn-off ratio of the switching transistor TS1807. Resistor R1800 in series with capacitor C1809 provides a constant regulation. To facilitate starting, a small base current is fed to transistor TS1807 via resistors R1803, R1804 and R1817.

Note that the value of R1817 depends on the current gain TS1807; refer to chapter "Checking and Adjusting" 3.7.3.1.

### 3.2.15.3. Chopper circuit

The chopper circuit is formed by the two selected transistors TS1804 together with the base drive transformer T1801, form a push-pull oscillator. The primary windings 3-4-5 of the converter transformer T1802 provide the collector loads for the chopper transistors. Winding 7-8 supplies the feedback winding of the driver transformer. As the driver transformer T1801 saturates easily, a square-wave signal is generated. As soon as the instrument is connected to the supply, the small base current applied to TS1807 via resistors R1803, R1804 and R1817 causes the transistor to turn on. Capacitor C1809 is thus charged by the collector current as described, and its voltage rises. After some time the voltage on GR1806 will be 75 volt and the voltage on trigger device GR1825 approx. 32 volt (the "fire voltage"). Now GR1825 will trigger and has a "breakback voltage" of about 6 volt. This voltage is divided over C1811 and C1812 and the voltage on C1812 becomes so high that one of the transistors TS1804 becomes conductive and the chopper starts. As soon as the chopper starts, the voltage across C1809 drops until TS1807 conducts, controlled by the regulator circuit and the potential across C1809 rises again to  $\approx 95$  V. During oscillation, a voltage is developed on the centre tap of the driver transformer T1801 of approximately 1 V negative with respect to the anode of GR1808. This negative potential on the base circuit prevents the conduction of both selected transistors TS1804 due to holestorage capacitance.

Resistor R1800 in series with C1809 prevents parasitic ringing of the circuit.

Resistor R1823 provides for a better start of the power supply in a cold environment.



### 3.2.15.4. Error sensing and regulator circuit

Regulation of the chopper output is achieved by comparing a portion of its output voltage against a stable reference and feeding the error voltage back via an operational amplifier to control the on/off ratio of the switching transistor. The basic components of the sensing and regulating circuit are primary winding 7-8 of T1802, voltage-regulator integrated circuit IC1801, potentiometer R1834 and transistor TS1809.

The circuit operates as follows. The square-wave voltage of approximately  $9 V_{p-p}$  across winding 7-8 of T1802 is half-wave rectified by GR1812 and produces a d.c. voltage of approximately  $-8 V$  with a superimposed ripple of about  $250 mV_{p-p}$  across capacitor C1817. This ripple voltage is the sensing voltage used for comparison, and is fed to the inverting input 2 of the operational amplifier IC1801 via capacitor C1821. Input 2 is also connected to point 4 of the integrated circuit via R1829. An internal stabilising network between points 4 and 5 results in an input voltage at point 2 of approximately  $-1 V$  together with the superimposed ripple of  $400 mV_{p-p}$ . The non-inverting input 3 of IC1801 is connected to the wiper of R1834, the potentiometer that samples the output voltage across C1817 via R1836, R1833 and diode GR1813. Diode GR1813 conducts via R1832 because of the potential across C1816. The ripple voltage is eliminated from the non-inverting input 3 by capacitor C1818 which is coupled between the wiper of R1834 and the positive side of C1817. Although the ripple at the inverting input 3 approximates to a sawtooth waveform, because of the high gain of the amplifier, the output on point 6 is a rectangular waveform.

The on/off ratio of this rectangular waveform is dependent upon the amplitude of the ripple compared with the reference voltage. The frequency of the rectangular waveform is synchronous with the chopper frequency. The rectangular waveform on point 6 is applied to the base of TS1809 which, in turn, controls the on/off time of the switching transistor TS1807.

The overall function of the voltage sensing and regulator circuit is best considered by assuming a change in output. Any tendency for the output to increase would produce an increase in voltage across C1817. The voltage on input 2 of IC1801 will go more negative as result. Likewise, the voltage on input 3 will go more negative, but to a lesser extent because of the limiting action of the potentiometer R1834 and its associated circuit. Because of this differential, input 3 will be more positive with respect to input 2. In terms of the output on point 6, this means that the positive part of the rectangular waveform will be of longer duration over the duty-cycle. This signal is inverted by transistor TS1809, which results in transistor TS1807 being blocked for a longer period. Consequently, the output of the switching series regulator decreases and restores circuit equilibrium. Conversely, any tendency for the output to decrease would result in the switching transistor TS1807 being on for a longer period. The output of the switching series regulator would increase to restore circuit equilibrium.

In addition to output sensing, anticipatory control is provided from the mains voltage. Input 3 of IC1801 is also coupled to the rectified mains voltage via resistor R1806. Any variation in mains voltage will be reflected at the input 3 of IC1801. The resulting differential with respect to input 2 will produce a compensating regulating action as described.

### 3.2.15.5. Current limiting circuit

A current sensor circuit automatically cuts off the series regulator if excessive current is demanded by the circuit. The current-limiting circuit comprises transistor TS1808, trigger device TS1811 and their associated components.

The current supplied by the power unit flows through the series resistor R1819 and the potential drop across this resistor is used to control transistor TS1808. If the supply current becomes excessive, transistor TS1808 starts to conduct. In turn TS1811 fires and pulls the base of TS1812 to  $-8 V$ . TS1809 is now continuously conducting by the base current delivered via R1816 (the output of IC1801 does not draw any current as this is an emitter follower output). By the current through TS1809, the switching transistor TS1807 is then continuously blocked. Consequently, the chopper stops operating. However, the small base current fed to TS1807 via resistors R1803, R1804 and R1817 enables C1809 to charge slowly. When the Z-voltage of GR1806 and GR1825 is reached, the chopper restarts and is switched off again immediately if the overload or short-circuit persists. Depending on the mains voltage, this cycle is repeated approximately every second so long as the fault condition persists.

### 3.2.15.6. *Switching-on voltage-sensing circuit*

In similar manner to the current limiting circuit, a voltage sensing circuit cuts off the switching series regulator if, for any reason, the output voltage of the power supply is too low for the operational amplifier IC1801 to give satisfactory control. Voltage sensing is performed by transistor TS1812. During initial switch-on of the instrument, if the output across winding 7-8 is too low, TS1812 is cut off because Z-diode GR1835 is not yet conducting. Consequently, the positive potential developed across C1814 is applied via R1816 to the base of TS1809. This transistor conducts and turns off switching transistor TS1807. The circuit prevents damage to the switching transistor, which could occur if it were operated with insufficient base current.

### 3.2.15.7. *Secondary supply voltages*

The primary windings of the supply transformer T1802, as previously stated, are the collector load circuits of the chopper transistors. The secondary windings providing the voltages for the various circuits in the instrument are completely isolated from the mains power supply.

The filament of the c.r.t. is supplied by the voltage across secondary winding 17-18, rectified by GR1822 and smoothed by electrolytic capacitor C1827. The winding is a.c. coupled to earth via C1830. All other supply feeds are derived from tapping points on a single secondary winding, earthed at a single point to the transformer screen to reduce interference. Each supply is individually rectified and smoothed.

### 3.2.15.8. *Mains opto-isolator*

The trigger/deflection source derived from the mains supply is completely isolated from dangerous a.c. voltages by an opto-isolator TS1813. This consists of a light-emitting diode and photo-transistor combined in one envelope.

The a.c. mains derived from the mains filters is rectified by diode GR1819 and smoothed by C1823 to provide d.c. current through the light-emitting diode. R1838 and R1840 are connected in series and have such a value that their dissipation stays within the permissible limits when using a d.c. mains voltage of 350 V. GR1815 protects the LED in TS1813 against too high reverse voltages. A portion of the a.c. mains is superimposed on this d.c. current, the magnitude depending on the setting of preset resistor R1841. The output is routed to the trigger-source selector (unit 16) R716 via capacitor C1824 and BU806 of the time base and X-amplifier p.c.b. (unit B).

### 3.3. OPTIONAL M.T.B. GATE OUTPUT, D.T.B. GATE OUTPUT AND EXTERNAL Z-MODULATION (Fig. 3.42, 3.43 and 3.44)

#### 3.3.1. General

The circuits for these 3 options can be mounted on a printed circuit board. The unit must be installed according to Fig. 3.43 on the side profile of the instrument beside the Z-unit. The lay-out of this unit after the components have been assembled is indicated in Fig. 3.42.

The necessary 3 BNC sockets can be mounted in any of the 5 holes provided in the rear frame of the instrument.

Only in the rear cover plate 3 holes must be drilled.

Supply voltages: the wires for the necessary +6, +12 and -12 volt supply voltages are directly soldered to Stocko plug BU503 at the bottom side of the power supply unit.

#### 3.3.2. Main time base gate output

The circuit comprises one transistor BC549C, which is driven by one of the transistors of the MTB sweep gating multivibrator. The collector of this BC549C transistor is the M.T.B. gate output. The output voltage level is about +6 volt during the M.T.B. sweep and about 0 volt during the hold-off period.

##### Installation:

Replace resistor R869 (on the T.B. unit next to the ALT pulse output) by a series circuit consisting of a 5,36 kOhm resistor and a 261 Ohm resistor. From the junction of both series resistors a 1 kOhm resistor and a coaxial 50 Ohm cable lead the signal to the amplifier stage on the additional printed circuit board (see Fig. 3.44). The output of the amplifier stage is connected to the BNC connector at the rear panel via a coaxial 50 Ohm cable.

##### Required material:

|  |                   |                |
|--|-------------------|----------------|
| 1 resistor                               | 5.36 kOhm/MR25    | 5322 116 54597 |
| 1 resistor                               | 261 Ohm/MR25      | 5322 116 54502 |
| 3 resistors                              | 1 kOhm/MR25       | 5322 116 54549 |
| 1 capacitor                              | 10 nF, cer. plate | 4822 122 30043 |
| 1 transistor                             | BC549C            | 5322 130 44246 |
| 1 metre coaxial 50 Ohm cable (per metre) |                   | 5322 320 10003 |
| 1 BNC connector                          |                   | 5322 267 10004 |

#### 3.3.3. Delayed time base output

The circuit comprises one transistor BC549C, which is driven by one of the transistors of the D.T.B. sweep gating multivibrator. The collector of this BC549C is the D.T.B. gate output. The output voltage level is about +6 volt during the D.T.B. sweep and 0 volt if the D.T.B. does not run.

##### Installation:

Replace resistor R1063 (on the T.B. unit next to contact 7 of Stocko plug BU808) by a series circuit consisting of a 5,36 kOhm resistor and 261 Ohm resistor. From the junction of both series resistors a 1 kOhm resistor and a coaxial 50 Ohm cable lead the signal to the amplifier stage on the additional printed circuit board (see Fig. 3.44). The output of the amplifier stage is connected to the BNC connector at the rear panel via a coaxial 50 Ohm cable.

##### Required material:

The same as used for the M.T.B. gate output.

#### 3.3.4. External Z-modulation input, suitable for logic analysers

The circuit (see Fig. 3.44) comprises 2 transistors, that both function as a emitter follower. The input circuit consists of 2 resistors and 2 capacitors in order to obtain the same input impedance as the vertical channels (1 MOhm/15 pF) and to obtain the right voltage level at which the display is blanked. This voltage level is approx. +4,5 volt, which is suitable for use with logic analysers.

The input circuit feeds the first emitter follower BC549C. The second emitter follower BC559 feeds TS1302 in the Z-amplifier.

##### Installation:

The BNC connector to be mounted on the rear of the oscilloscope is connected to the input of the Z-modulation circuit via a 50 Ohm coaxial cable. The output of the Z-modulation circuit is connected to the emitter of transistor TS1302 via another 50 Ohm coaxial cable.

##### Required material:

|  |                   |                |
|--|-------------------|----------------|
| 1 resistor                               | 560 kOhm, CR37    | 4822 110 53181 |
| 1 resistor                               | 680 kOhm, CR37    | 4822 110 53183 |
| 1 resistor                               | 10 MOhm, CR37     | 4822 110 53214 |
| 1 resistor                               | 33,2 kOhm, MR25   | 5322 116 50482 |
| 1 resistor                               | 33,2 Ohm, MR25    | 5322 116 50527 |
| 1 resistor                               | 1 kOhm, MR25      | 5322 116 54549 |
| 1 resistor                               | 750 Ohm, MR25     | 5322 116 54536 |
| 2 capacitors                             | 10 nF, cer. plate | 4822 122 30043 |
| 1 capacitor                              | 27 pF, cer. plate | 4822 122 30045 |
| 1 capacitor                              | 33 pF, cer. plate | 4822 122 31067 |
| 1 transistor                             | BC549C            | 5322 130 44246 |
| 1 transistor                             | BC559             | 5322 130 40963 |
| 1 metre coaxial 50 Ohm cable (per metre) |                   | 5322 320 10003 |
| 1 BNC connector                          |                   | 5322 267 10004 |

##### Adjustments:

After completion of the mounting procedure, the spot intensity must be readjusted in accordance with the adjusting procedure as described in section 3.7.4.2.

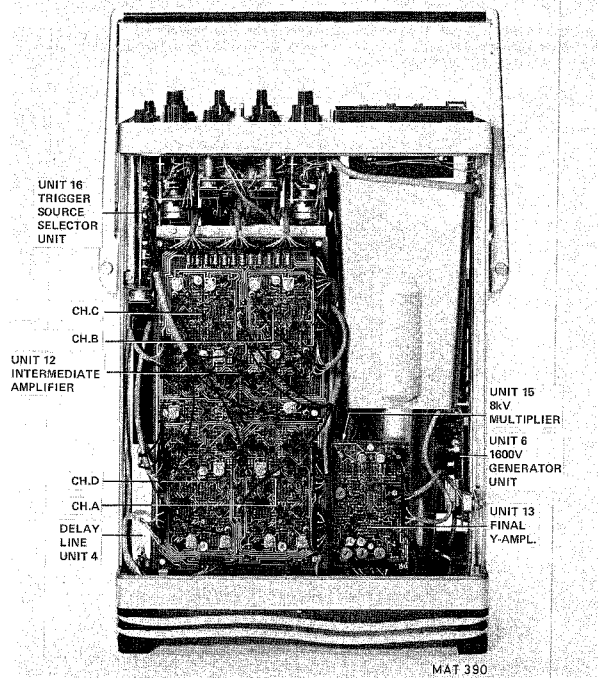


Fig. 3.4. Unit location, top view

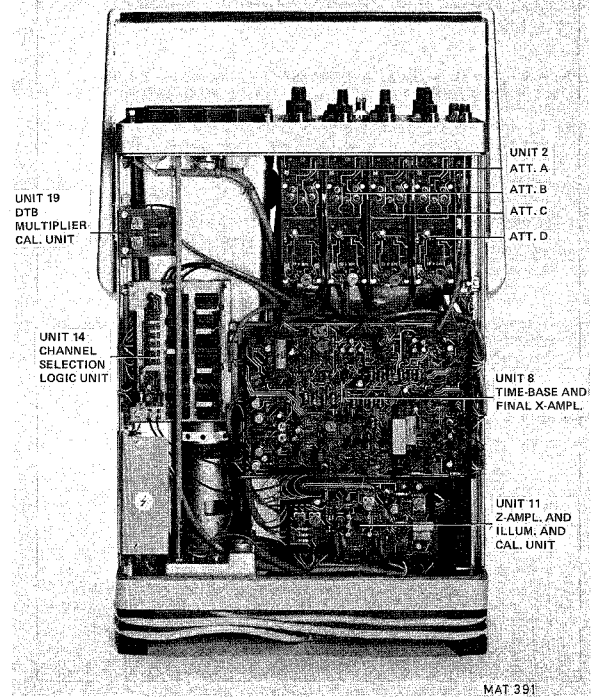


Fig. 3.5. Unit location, bottom view

### 3.4. DISMANTLING THE INSTRUMENT

#### 3.4.1. General information

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During dismantling procedures, a careful note of all leads disconnected must be made so that they may be reconnected to their correct terminals during assembly. For unit-location refer to Fig. 3.4 and 3.5.

Always ensure that the mains supply is disconnected before removing any instrument cover plates.

When removing the E.H.T. cable from the post-acceleration anode of the c.r.t. both the cable connector and the c.r.t. anode contact must be discharged immediately by shorting them to chassis for several seconds with a well-insulated screwdriver.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute of switching off the instrument. In Fig. 3.4B, 3.49 and 3.50 the cables lay-out between the various units is given.

#### 3.4.2. Instrument cover plates and screen bezel

Both upper and lower cover plates can be removed after the four quick-release fasteners at the corners of each plate have been slackened; do not slacken more than two turns, otherwise the fasteners may come apart. The screen bezel can be detached by pulling its upper or lower edge.

#### 3.4.3. Removing the knobs

##### 3.4.3.1. Single knobs (fig. 3.3)

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

##### 3.4.3.2. Double knob (fig. 3.3)

- Prise off cap A and slacken screw B.
  - Pull the inner knob from the spindle.
  - Slacken nut C and pull the outer knob from the spindle.
- When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

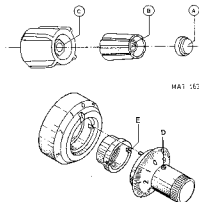


Fig. 3.3. Removing the knobs.

##### 3.4.3.3. Delay-time multiplier knob (fig. 3.3)

- Slacken screw D using a hexagonal key and pull the knob from the spindle.
- Remove the nut E and withdraw the ring from the spindle.

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

#### 3.4.4. Removing the attenuator unit (fig. 3.5)

- For cable lay-out see fig. 3.50.
- Remove the appropriate AMPL/DIV knobs as described in section 3.4.3.2.
  - Remove the nut under these knobs.
  - Remove the appropriate POSITION knob as described in section 3.4.3.1.
  - Remove the nut which secure this potentiometer to the front panel.
  - Unplug the two multipole connectors and the coaxial plug on the intermediate amplifier from the appropriate attenuator.
  - Unsolder the earth connections.
  - Remove the two screws that secure the lower part of the attenuator unit to the front panel.
  - Carefully lift the attenuator unit out of the oscilloscope.

**3.4.5. Removing the time-base and X amplifier circuit board (fig. 3.5)**

This unit is the large rectangular printed-circuit board on the underside of the instrument adjacent to the c.r.t. For cable lay-out see fig. 3.48.

- Unplug the ten multipole connectors.
- Unplug the two coaxial plugs on the board.
- Unsolder two connections to the Z amplifier
- Unsolder two trigger input connections.
- Unplug the X1 and X2 leads from the c.r.t.
- Remove the five screws securing the circuit board to the chassis.

**3.4.6. Removing the Z amplifier circuit board (fig. 3.5)**

This unit is the small rectangular printed-circuit board located on the underside, and towards the rear of the instrument.

For cable lay-out see fig. 3.48.

- Unplug the six multipole connectors.
- Unplug the two connections to the time-base.
- Unplug the coaxial connector to the channel selection logic.
- Remove the four retaining screws.

**3.4.7. Removing the channel selection logic circuit board**

This unit is the small rectangular printed-circuit board located on the underside of the instrument, under the c.r.t.

For cable lay-out see fig. 3.48.

- Unplug the coaxial cable on the Z unit and on the time base unit which are connected to the channel selection logic p.c.b.
- Unplug the three multipole connectors.
- Unplug the four coaxial cables on the intermediate amplifier unit which are connected to the channel selection logic p.c.b.
- Remove the two retaining screws.

**3.4.8. Removing the intermediate amplifier circuit board (fig. 3.4)**

This unit is the large rectangular printed-circuit board located on the upper side of the instrument.

For cable lay-out see fig. 3.50.

- Unplug the twelve coaxial plugs.
- Unplug the twelve multipole connectors.
- Unsolder the two coaxial cables from the delay line.
- Remove the six retaining screws.

**3.4.9. Removing the final Y amplifier circuit board (fig. 3.4)**

This unit is the small rectangular p.c.b. located on the upper side of the instrument above the gun assembly of the c.r.t.

For cable lay-out see fig. 3.50.

- Unplug the three multipole connectors.
- Unsolder the two coaxial cables from the delay line.
- Unplug the Y1 and Y2 connectors from the c.r.t.
- Remove the three retaining screws.

**3.4.10. Removing the trigger source selector circuit board (fig. 3.4)**

This unit is situated on the right side of the instrument.

- Remove the knob of the HOLD OFF potentiometer.
- Remove the shaft of this potentiometer by removing the coupling piece (underside of the instrument).
- Unsolder seven leads connected on the p.c.b. on the underside.
- Remove the screw with which the push-button support is mounted on the front plate.
- Remove the screw from the hold off potentiometer support.
- Remove the knob of the POSITION potentiometer (TB MAGN.).
- Remove the shaft of this potentiometer by removing the coupling piece (upper side of the instrument).
- Remove the support of the POSITION potentiometer by removing the two retaining screws.
- Unsolder the six leads and the five coaxial cables from the upper side of the p.c.b.
- Remove the screw and clamping piece with which the push-button support is mounted on the front plate.

**3.4.11. Removing the delay line (fig. 3.4)**

This unit is located on the upper side of the instrument under the intermediate amplifier p.c.b. (fig. 3.50).

- First remove the intermediate amplifier p.c.b. as described in section 3.4.8.
- Unsolder the four coaxial cables: two on the intermediate amplifier p.c.b. and two on the final Y amplifier p.c.b.
- Remove the retaining screws.

**3.4.12. Removing the 1600 V converter circuit board (fig. 3.5)**

This unit is located on the left side of the instrument.

A metal housing gives protection against the high potentials developed in this circuit.

- Remove the metal protective housing.
  - Unplug the multipole connector.
  - Unsolder the e.h.t. lead and remove the clip.
  - Remove the two retaining screws from the rail-mounting.
- For reassembly ensure that the protective housing is re-fitted.

**3.4.13. Removing the 8 kV multiplier (fig. 3.4)**

This is a scaled unit located on the right of the c.r.t. gun (underside of the instrument).

- Discharge the c.r.t. post-acceleration anode and the e.h.t. connector (see section 3.4.1.) after disconnection from the c.r.t.
- Unsolder the coaxial cable from the 1600 V converter and remove the clip.
- Remove the final Y amplifier p.c.b. as described in section 3.4.9.
- Spring the 8 kV unit retaining clips from the instrument frame (if necessary remove the power supply unit, see section 3.4.15, from the rear to obtain access to the retaining clips).

**3.4.14. Removing the cathode ray tube**

- Remove all side connections, carefully, to avoid bending the pins.
- Unplug the multipole connector BU1303 on the final Y amplifier.
- Discharge the e.h.t. connector and c.r.t. post-acceleration anode (see section 3.4.1.) after disconnection from the c.r.t.
- Remove the two rear cover plate screws.
- Carefully remove the tube base (pull backwards).
- Slacken the brace round the neck of the c.r.t.
- Slacken the four screws of the front panel clamping buffers (on the under and upper side of the instrument).
- Remove the bezel by pulling its lower edge.
- Carefully withdraw the c.r.t. through the front panel out of instrument.

When fitting a c.r.t., the inside of the rubber sleeve should be sprinkled with industrial talc to facilitate insertion.

**3.4.15. Removing the power supply circuit board (fig. 3.41)**

This unit is located in a compartment accessible from the rear of the instrument.

- Unscrew the rear cover plate of the instrument.
- Remove the two screws securing the circuit board to the rear panel.
- Unplug the five multipole connectors and the two wires.
- Carefully withdraw the circuit board out of its compartment.

**3.4.16. Removing the push-button switches**

First remove the top cover plate for access to these switch units. As these switch units and the DELAY TIME multiplier are interconnected by means of several wires, care should be taken when removing these controls to ensure that these interconnections are not damaged.

- Remove the knobs of both LEVEL potentiometers (see section 3.4.3.1).
- Unscrew, with the tool indicated in fig. 3.9, the two nuts behind these knobs.
- Remove the LEVEL potentiometers.
- Remove the DELAY TIME multiplier knob.
- Remove the DELAY TIME potentiometer.
- Remove the switches SK8 and SK9 by unscrewing the two screws and removing the two clamping pieces (see fig. 3.7).

In this situation it is also possible to remove the NOT TRIG'D LED indicator GR1.

- Remove the knobs of the m.t.b. TIME/DIV and d.t.b. TIME/DIV switches as indicated in section 3.4.3.2.
- Remove these switches (unplug the multipole plugs on the time base and X amplifier p.c.b. connected with these switches).
- Remove the switches SK11 ... SK18 by unscrewing four screws and removing four clamping pieces (see fig. 3.7).

To remove a push-button switch, the hexagon screws that secure it to the front panel must be removed. To replace one switch-section of a push-button set, refer to fig. 3.6.

To remove a push-button switch which is mounted on a p.c. board:

- Remove the printed-circuit board for replacing a switch in this unit.
- Straighten the 4 retaining lugs of the relevant switch as shown in fig. 3.6.
- Break the body of the relevant switch by means of a pair of plier and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-circuit board.
- Band the 4 retaining lugs back to their original positions.

Before a push-button switch is refitted to the front panel, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate replacement, refer to fig. 3.7.

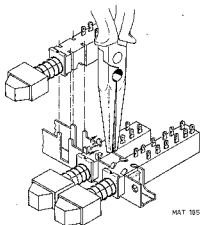


Fig. 3.6. Replacing a switch-segment of a push-button set

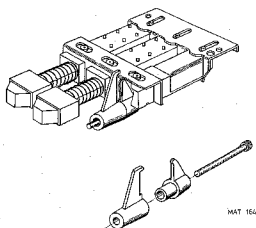
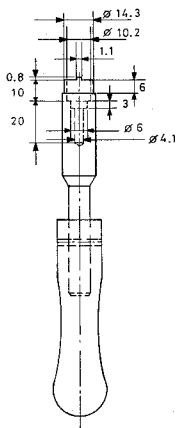


Fig. 3.7. Push-button set clamping device

### 3.4.17. Removing the carrying handle

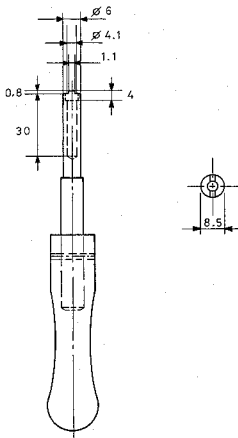
- Remove the upper and lower instrument cover plates.
- Remove the plastic strip which is snapped on to the grip by slight leverage under one edge.
- Remove the four hexagon screws which secure the grip to the brackets.
- Depress the push-buttons in the brackets and turn the carrying handle vertically above the upper side of the oscilloscope.
- Keep the push-button of the right-hand bracket depressed and pull the bracket from its bearing.
- Remove the grip from the remaining bracket.
- Depress the push-button of the left-hand bracket and turn the latter vertically below the base of the instrument.
- Keep the push-button depressed and pull the bracket from its bearing.





MAT 138

Fig. 3.8. Tool for attenuator switches



MAT 139

Fig. 3.9. Tool for Position and Level potentiometers

### 3.4.18. Special tools

#### *Special tool for the slotted nuts of attenuator switches*

A tool can be made for this purpose as shown in Fig. 3.8. All dimensions are given in millimetres. The material is silver-steel N094, tempered 40-45 Rc. Service order code 5322 396 54023.

#### *Special tool for the slotted nuts of the POSITION and LEVEL/SLOPE potentiometers*

A tool can be made for this purpose as shown in Fig. 3.9. All dimensions are given in millimetres. The material is silver-steel N094, tempered 40-45 Rc. Service order code 5322 396 54024.



### 3.6. TEST AND REPAIR HINTS

#### 3.6.1. General information

- Use an isolating transformer when measurements must be made in the power supply.
- For measuring on the printed-wiring boards, test-pins with sharp points must be used. Be careful not to cause a short-circuit by letting the test-pin slip from the test point.
- Use an appropriate soldering iron and solder with a low melting point, if micro-miniature semi-conductors must be replaced it is essential to earth the tip of the soldering iron to the mass of the oscilloscope.
- Be very careful not to bend the pins on the neck of the c.r.t., since this is likely to result in a gas-leak.
- Do not remove any transistor, when the oscilloscope is switched-on.
- Do not plug and unplug connectors when the instrument is switched on.
- Do not touch any trim potentiometers or trimmers before a fault has been located.
- If internal coaxial cables have been taken loose, take care not to make earth-short-circuit if the connector might slip over the p.c. board.
- If the H.T. plug of the c.r.t. is taken loose, carefully discharge both the H.T. cable and the H.T. connection of the c.r.t. for at least several seconds, to avoid the risk of electrical shocks.

#### 3.6.2. Y-amplifier

If there is a fault in one of the Y channels, it can easily be traced to a certain unit by combining the attenuator of one channel and the intermediate amplifier part of the other channel.  
This is simply a matter of plugging coaxial cables.

Be careful if a reed relay in the attenuators must be replaced. Such a relay consists of a glass tube, containing the contact points, and a coil. The coil is fitted around the glass tube, with a piece of foil in between for shielding. Since the glass tube is rather fragile, the connection wire of the relay must be bent and soldered with caution. Do not twist the connection wires, as this may cause broken glass-metal seal and unreliable contact inside the glass-tube.

To locate an instability problem in the Y amplifier, both input- or both output cables of the delay-line may be taken loose. The trace must then be approx. in the middle of the screen.

Check also the c.r.t. side-connection pins on corrosion.

#### 3.6.3. Time-base and X-amplifier

- The easiest way to test the time-base generator (we refer here to the main time-base generator, but a similar procedure applies to the delayed time-base) is to remove transistor TS868, switch in a low sweep speed and short-circuit the collector of TS871 to earth. During the time that this short-circuit is open, the time-base capacitor (869) is charged. The charging process can be traced through the time-base unit, where the changing level must be measured in all circuits.

A fault is then located at a point which does not follow the changing level.

The final stage of the X-amplifier can be checked by interconnecting both emitters of TS1206 and TS1207. The displayed dot must then be approx. in the middle of the screen.

#### 3.6.4. Instability

Instability of the display could be caused by bad contacts in the multipole- or the miniature coaxial connectors. If necessary check also the wire clamping in the multipole plugs (good contact of the multipole earth connections of the power supply output is very important).

The inner female contact of the miniature coaxial connectors could be cleaned with a dia 0,75 mm twist drill.

#### 3.6.5. Maintenance

After removal, the cabinet plates may be cleaned with a mild non-abrasive household detergent. Do not use chemical solutions such as trichlorethylene and acetone.

The 3M company has developed a new cleansing pad (White Cleansing Pad, Catalogue No. 8440) which when soaked in water, ethanol or a common household cleansing agent will also penetrate holes and pores. This method is similar to that of abrasive cleaning pads but lacks their abrasive action.

Abrasive cleaning pads should not be used, otherwise surfacescratches will result.

The text plate may be cleaned with the same detergent, with alcohol or with white spirit. Always use a soft cloth or cotton wool.

### 3.7. CHECKING AND ADJUSTING

#### Introduction

The following information provides the complete checking and adjusting procedure for the PM 3244 oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary. The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment. Before any adjustment or check, the instrument must attain its normal operating temperature. Under average conditions this will be approximately 30 minutes after switching on.

All controls which are mentioned without item numbers are located on the front panel of the oscilloscope.

#### 3.7.1. Recommended test equipment

| Recommended instrument  | Specifications  | Example of recommended instrument      |
|---|---|--|
| Square wave generator   | 100 Hz - 500 kHz<br>Constant amplitude of 50 mV - 10 V<br>Rise time $\leq$ 1 nsec<br>Duty cycle 50% | Tektronix PG506                        |
| Square wave generator   | 10 kHz - 500 kHz<br>Constant amplitude of 5 mV - 2 V<br>Rise time $\leq$ 200 nsec<br>Duty cycle 50% | Philips PM 5127 or PM 5771             |
| Sine wave generator   | 10 Hz - 50 MHz<br>Constant amplitude of 100 mV - 15 V   | Tektronix SG503                        |
| Time marker generator   | 0.5 sec - 0.05 $\mu$ sec in 22 calibrated positions in a 1-2-5 sequence                             | Tektronix TG501                        |
| Digital multimeter  | Wide voltage, current and resistance ranges   | Philips PM 2527                        |
| Oscilloscope<br>Dummy probe<br>Low capacitance trimming tools | 100 MHz<br>2:1, R = 1 M $\Omega$ , C = 15 pF  | Philips PM 3262<br>—<br>Philips 80DNTX |

#### 3.7.2. Preliminary control settings

- Set the POWER switch to OFF.
  - Connect the instrument to the mains.
  - Depress the ALT button of the vertical display mode switch.
  - Depress the MAIN TB button of horizontal deflection switch.
  - Depress the AUTO button of the trigger mode switch.
  - Set the MAIN TIME/DIV switch to .1 ms.
  - Set the DEL'D TIME/DIV switch to OFF.
  - Set the AMPL switches to .1 V/DIV.
  - Depress pushbuttons A of the m.t.b. and d.t.b. trigger source switches.
  - Depress pushbutton A of the vertical display mode switches.
  - Set the TIME/DIV and AMPL/DIV continuous controls to CAL.
  - Set the POSITION potentiometers to their mid-positions.
  - Push the TB MAGN switch to 1x.
  - Turn the INTENS potentiometer clockwise.
- Controls not mentioned may remain in any position. For subsequent tests, unless otherwise stated, controls should be left in the same position as in the previous check.
- Set the POWER switch to ON.
  - Check that the POWER ON lamp lights up.
  - Check that the time base line appears on the screen.
  - Check the working of the graticule illumination control.

## 3.7.2.1. Survey of adjusting elements and auxiliary equipment

| Adjustment   | Adjusting element                        | Adjusting result   | Recommended instrument and input signals                                       | Example of measuring instrument                        | Chapter  | Figures |
|--|--|--|--|--|----------|---------|
| <b>Power Supply</b>  |  |  |  |  |          |         |
| Current gain of the switching regulator transistor           |  | Remove transistor TS1808 mains voltage = 40V voltage across C1809 must be $\pm 5\text{V}$  | Isolated transformer<br>22 $\Omega$ (25W)<br>digital multimeter                | 2422 529 00005<br>8322 115 60006<br>PM2517 or PM2527   | 3.7.3.1. |         |
| Value of the base resistor R1817                             | R1817 is selected with transistor TS1807 | Adjust mains voltage so that the voltage across C1809 is $\pm 50\text{V}$<br>1k $\Omega$ in parallel with C1809 voltage across C1809 must be approximately 4V                    | Isolated transformer<br>1k $\Omega$ (0,5W) resistor<br>digital multimeter      | 2422 629 00005<br>PM2517 or PM2527                     | 3.7.3.1. |         |
| Checking power supply with regulating circuit out of service |  | When the chopper is started: (mains: 40V) point 5 of T1802 a square wave of $\pm 70\text{V}_{pp}$ 18kHz<br>Voltage across resistor of 22 $\Omega$ must be 1,5V                   | 50k $\Omega$ (0,5W)<br>oscilloscope<br>22 $\Omega$ (25W)<br>digital multimeter | PM3243 or PM3262<br>5322 115 60006<br>PM2517 or PM2527 | 3.7.3.1. |         |
| Regulating circuit   | R1834                                    | Increase mains voltage until the voltage over C1809 is $\pm 95\text{V}$<br>Pulse on the base of TS1807 can be varied with R1834<br>Power consumption must be $\pm 25\text{W}$    | oscilloscope<br>watt-meter   | PM3243 or PM3262                                       | 3.7.3.1. | 3.48.   |
| Current limitation   |  | +45V: load 200 $\Omega$ (25W)<br>current limitation becomes active when the power output exceeds 30-35W.<br>+45V output: when short-circuited then power supply in "hiccup" mode | 200 $\Omega$ (25W)<br>digital multimeter                                       | PM2517 or PM2527                                       | 3.7.3.1. |         |
| Power supply   | R1834                                    | Mains input: local voltage<br>Adjust +45V output to +45V $\pm 100\text{mV}$<br>point 5 of T1802: square wave 18-22kHz with an ampl. of $\pm 200\text{V}_{pp}$                    | Digital multimeter<br>oscilloscope   | PM2517 or PM2527<br>PM3243 or PM3262                   | 3.7.3.1. | 3.48.   |
| <b>Cathode-ray tube circuit</b>                              |  |  |  |  |          |         |
| Trace rotation   | R684                                     | Time-base line parallel with horizontal lines of the graticule   | —  | —  | 3.7.4.1. | 3.48.   |
| Brilliance   | R1327                                    | A barely visible dot   | —  | —  | 3.7.4.2. | 3.47.   |
| Brilliance ratio   | R1115                                    | Ratio of intensity between MTB and DTB   | —  | —  | 3.7.4.3. | 3.47.   |
| Astigmatism  | R1344                                    | A sharp trace with FOCUS potentiometer   | Sine-wave 10kHz  | PM5127 or PM5771                                       | 3.7.4.4. | 3.47.   |
| Geometry   | R1346                                    | Vertical lines must be straight  | Sine-wave 10kHz 12V $_{pp}$  | PM5127   | 3.7.4.5. | 3.47.   |
| <b>Vertical Deflection</b>                                   |  |  |  |  |          |         |
| Gain adjustment  | R9 (front panel)                         | A trace height of exactly 6 divisions  | Square wave 60mV $_{pp}$<br>rise time 1n sec.                                  | Tektronix PG506  | 3.7.5.1. | 3.15.   |
| LF gain  | R132                                     | A well adjusted attenuator for 100Hz   | Square wave 100Hz<br>100MHz oscilloscope                                       | PM5127 or PM5771<br>PM3262                             | 3.7.5.2. | 3.47.   |
| Balance  | R8 (front panel)                         | Minimum trace-jump when switching alternately between 5mV/div. and 10mV/div.   | —  | —  | 3.7.5.3. | 3.15.   |
| DC/O balance   | R129                                     | Minimum trace-jump when alternately DC and O depressed   | —  | —  | 3.7.5.4. | 3.47.   |
| Variable gain balance  | R141                                     | Minimum time-base line jump when var. GAIN control is operated   | —  | —  | 3.7.5.5. | 3.47.   |
| Square-wave response   |  | Square-wave free from overshoot and rounding and amplitude as indicated below:   | 20kHz square-wave<br>rise time $\leq 200\text{n}$ sec.                         | PM5127   | 3.7.5.6. | 3.47.   |
|  | C108                                     | AMPL./DIV. switch<br>{ 5mV<br>10mV<br>20mV   | Trace height<br>{ 8 div. $\pm 2\%$<br>6 div. $\pm 2\%$<br>6 div. $\pm 2\%$     | Amplitude<br>{ 30mV<br>60mV<br>120mV                   |          |         |
|  | C101                                     | { 50mV<br>100mV<br>200mV   | { 6 div. $\pm 2\%$<br>6 div. $\pm 2\%$<br>6 div. $\pm 2\%$                     | { 300mV<br>600mV<br>1,2V                               |          |         |
|  | C109                                     | { 500mV<br>1V<br>2V  | { 6 div. $\pm 2\%$<br>6 div. $\pm 2\%$<br>8 div. $\pm 2\%$                     | { 3V<br>6V<br>12V                                      |          |         |

| Adjustment                            | Adjusting element  | Adjusting result   | Recommended instrument and input signals   | Example of measuring instrument                                       | Chapter  | Figures  |       |
|---------------------------------------|--|--|--|---|--|----------|-------|
| 100kHz square-wave response           | C122   | A well adjusted attenuator for 100kHz. in all attenuator positions   | Square-wave 100kHz<br>100mV oscilloscope   | PM5127 or PM5771<br>PM3262  | 3.7.5.7.   | 3.47.    |       |
| Input capacitance                     | C107   | Square-wave free from overshoot and rounding and with an amplitude as indicated below:<br>AMPL./DIV switch   | Trace height<br>5mV 3 div. $\pm$ 2%<br>10mV 3 div. $\pm$ 2%<br>20mV 3 div. $\pm$ 2%                              | 100kHz square-wave<br>via RC standardizer<br>to input of oscilloscope | PM5127<br>and dummy<br>probe 2 : 1 (1M $\Omega$ -15pF) | 3.7.5.8. | 3.47. |
|                                       | C102   |  | 50mV 3 div. $\pm$ 2%<br>100mV 3 div. $\pm$ 2%<br>200mV 3 div. $\pm$ 2%   | Amplitude<br>30mV<br>60mV<br>120mV<br>300mV<br>600mV<br>1.2V          |  |          |       |
|                                       | C111   |  | 500mV 3 div. $\pm$ 2%<br>1V 3 div. $\pm$ 2%<br>2V 3 div. $\pm$ 2%  | 3V<br>6V<br>12V   |  |          |       |
| <i>Intermediate and final Y-ampl.</i> |  |  |  |   |  |          |       |
| Normal/Invert balance                 | Channel A : R448<br>Channel B : R2648<br>Channel C : R2648<br>Channel D : R2448  | Minimum trace jump when NORMAL/INVERT is operated  | —  | —   | 3.7.6.1.   | 3.46.    |       |
| A+B balance adjustment                | R548   | The trace must be on the horizontal centre-line of the graticule   | —  | —   | 3.7.6.2.   | 3.46.    |       |
| Square-wave response                  | Intermediate ampl.:<br>Channel A :<br>C402 - C416/R442<br>Channel B :<br>C2802 - C2816/R2642<br>Channel C :<br>C2802 - C2816/R2642<br>Channel D :<br>C2402 - C2416/R2442<br>Final Y-amplifier:<br>C603/R619<br>C606/R621<br>R622 | Pulse top as straight as possible<br>Maximum pulse top error<br>0,1 division<br>AMPL./DIV. switch to 20mV/div.<br>AMPL./DIV. switch to 0,1V/div.<br>AMPL./DIV. switch to 0,5V/div. | 100kHz square-wave<br>Rise time $\leq$ 1n sec.<br>120mV <sub>pp</sub><br>600mV <sub>pp</sub><br>3V <sub>pp</sub> | Tektronix PG506   | 3.7.6.3.   | 3.46.    |       |
| Trigger balance                       | Intermediate amplifier:<br>R379 (A)<br>R2579 (B)<br>R2778 (C)<br>R2378 (D)   | Spot in the centre of the screen<br>Spot in the centre of the screen<br>Spot in the centre of the screen<br>Spot in the centre of the screen                                       | —  | —   | 3.7.6.4.   | 3.46.    |       |
| Composite trigger balance             | R531   | Spot in the centre of the screen   | —  | —   | 3.7.6.4.   | 3.46.    |       |
| EXT. trigger balance                  | R705   | Spot in the centre of the screen   | —  | —   | 3.7.6.4.   | 3.46.    |       |
| LINE triggering                       | R715   | Main deflection must be symmetrical around the centre of the graticule   | —  | —   | 3.7.6.4.   | 3.46.    |       |
| Y-amplifier gain adjustment           | R641 (R645)  | Gain control R9 (front panel) in its mid-position<br>Then gain must be readjusted with R641  | Square-wave<br>60mV <sub>pp</sub><br>Rise time 1n sec.   | Tektronix PG506   | 3.7.6.5.   | 3.46.    |       |
| <i>Horizontal deflection</i>          |  |  |  |   |  |          |       |
| <i>Main time base</i>                 |  |  |  |   |  |          |       |
| Stability                             | R873   | R873: 20° past the point where the time-base line ceases to be displayed   | —  | —   | 3.7.7.5.   | 3.47.    |       |
| Time coefficients                     | R1223  | X1—8 centre periods exactly 8 divisions  | Time-marker signal<br>1m sec-ampl. 600mV   | Tektronix TG501   | 3.7.7.6.   | 3.47.    |       |
|                                       | R1208  | X5—8 centre periods exactly 8 divisions  | 200 $\mu$ sec. — 600mV   |   |  |          |       |
|                                       | R914   | X1—8 centre periods exactly 8 divisions  | 10msec. — 600mV  |   |  |          |       |
| Linearity and horizontal positioning  | C1203<br>C1208   | 8 centre-cycles must be 1 cycle/division   | Time-marker signal<br>0,01 $\mu$ sec.  | Tektronix TG501   | 3.7.7.7.   | 3.47.    |       |
| <i>Delayed time-base</i>              |  |  |  |   |  |          |       |
| Stability                             | R1064  | R1064: 20° past the point where the time base line ceases to be displayed  | —  | —   | 3.7.7.10.  | 3.47.    |       |
| Time coefficients                     | R1097  | 8 centre periods exactly 8 divisions $\times$ 2,5%   | Time-marker signal<br>1msec., ampl. 600mV  | Tektronix TG501   | 3.7.7.11.  | 3.47.    |       |
| Delay-time calibration                | R987   | Dial knob to 1.00—intensified part on the beginning of the second period   | Square-wave 1kHz   | PM5127 or PM5771  | 3.7.7.13.  | 3.47.    |       |
|                                       | R979   | Dial knob to 9.00—intensified part on the beginning of the 9th period.   | Square-wave 1kHz   |   |  |          |       |

| <i>Adjustment</i>   | <i>Adjusting element</i> | <i>Adjusting result</i>  | <i>Recommended instrument and input signals</i> | <i>Example of measuring instrument</i> | <i>Chapter</i> | <i>Figures</i> |
|---|--------------------------|--|---|--|----------------|----------------|
| Gain adjustment of the preamplifier for ext. X-deflection | R1131                    | Horizontal deflection via Ya (6 div.)<br>X deflection must be 6 div. ( $\pm 10\%$ )                                | Sine-wave 50kHz<br>6 divisions height           | PM5127 or PM5771                       | 3.7.7.14.      | 3.47.          |
| DC output level of the preamplifier for ext. X-deflection | R1132                    | Base of TS1071 to earth potential then the spot must be in the horizontal centre of the screen ( $\pm 1$ division) | —   | —                                      | 3.7.7.14.      | 3.47.          |
| X-deflection with mains signal                            | R1041                    | Trace-width must be 10 div.<br>$\pm 1$ div.  | —   | —                                      | 3.7.7.16.      | 3.46.          |
| <i>Calibration</i>  |                          |  |   |  |                |                |
| Calibration voltage                                       | R1362                    | Square-wave signal of 3V <sub>pp</sub> ,<br>frequency 2kHz $\pm 2\%$<br>Cal. current 6mA $\pm 1\%$                 | Oscilloscope                                    | PM3262                                 | 3.7.8.         | 3.47.          |

### 3.7.3. Power supply

**Warning:** Use an isolating mains transformer when working in the power supply unit. Bear in mind that the main part of this unit is connected direct to the mains. As it is preferred to check the proper function of the power supply with adjustable mains voltage, use of a variable transformer (insulated version) is recommended.

**Attention:** The power supply unit is provided with a pre-set potentiometer R1834 which controls the d.c. output of the circuit. **DO NOT READJUST THIS POTENTIOMETER UNLESS IT IS STRICTLY NECESSARY.**

A consequence of readjusting this potentiometer is that all d.c. output voltages change, so that several circuits of the oscilloscope (e.g. time base sweep) must be recalibrated.

In the factory this potentiometer has been adjusted to the nominal value of the +45 V output. This voltage must be +45 V, + or -100 mV.

#### General

The best way to check the power supply is, when this unit is connected to the normal circuitry of the PM 3244.

Provisions have been taken that the unit, after being taken out, remains connected to the instrument.

To facilitate the removal, first disconnect the various connections of the power supply unit.

The supply currents can be measured on each contact of the power supply output connectors. To disconnect one contact of a connector carefully press (twice) the spring at the side of the contact and lift the contact out. Inserting an additional contact provided with a piece of extension wire simplifies current measurement. After replacing the original contact check the spring locking-action to prevent the contact from coming loose later-on.

When the power supply unit is overloaded, the current limitation is actuated. As a result of this, the power supply goes in the "hiccup" mode (2 seconds cycle time approx.). This is caused by, successively, slow charging of the capacitor C1809, starting of the chopper, activation of current limiting transistor TS1808, discharging of the regulator circuit capacitor and so on.

Another reason for the power supply going in the "hiccup" mode is, when the switching transistor TS1807 gets no base current from the regulator circuit. In this case capacitor C1809 is slowly charged until the chopper circuit starts which causes the discharge of the capacitor in a short time, and so on.

If necessary, the power supply unit only, can be checked with the aid of a dummy load, consisting of load resistors and capacitors, see fig. 3.45.

If a fault is suspected in the power supply, the following procedure may help you to find what is wrong.

*Note: The power supply must always be loaded with the nominal load.*

#### Required instruments

- Variable mains transformer with isolated windings (e.g. Philips bench model 2422 529 00006 or panel model 2422 529 00006; input 220 V, output 0-248 V/3A).
- Watt meter (to measure mains power input).
- Oscilloscope (5 MHz bandwidth) e.g. PM 3243.
- Resistor 100  $\Omega$ , 25 W (5322 115 50015).
- Resistor 22  $\Omega$ , 25 W (5322 115 50006).
- Resistor of 1 k $\Omega$  and 50 k $\Omega$ , 0,5 W.

#### 3.7.3.1. Checking procedure

In the first part of this procedure the current gain of the switching regulator transistor is checked (and the value of the base resistor R1817).

Then the power supply circuit is checked while the regulating circuit is out of service (switching regulator transistor short-circuited). In this case always check that the voltage across C1809 never exceeds the sum of the voltage across GR1806 and GR1807.

Next the regulating circuit and current limitation is checked.



Proceed as follows:

- Connect the isolating/variable transformer to the mains.
  - Connect the power supply unit in series with a 22 ohm, 25 W resistor and via a Watt-meter to the isolating/variable transformer.
  - Remove current sensing transistor TS1808.
  - Set the variable transformer to 0 volt.
  - Switch on the oscilloscope and increase the variable transformer output to 40 V.
  - Check that the voltage across C1809 amounts to approx. 56 V (the chopper circuit is not oscillating).
  - If this voltage across C1809 does not appear, check the ripple eliminator circuit (TS1801 and TS1802), R1819 and check the chopper circuit on short-circuit.
  - Switch-off the instrument.
  - After the voltage across C1809 has completely disappeared, switch-on again and check that the voltage across C1809 is present again after approx. 2 seconds.
- (The speed of charging depends on the current gain of TS1807 and the value of R1817).

#### R1817

- Increase the power supply input voltage until the voltage across C1809 amounts to 90 V.
- Connect a 1 kohm (0,5 W) resistor in parallel to C1809.
- The voltage across C1809 must now be approximately 4 V.
- If this 4 V can not be reached, change unit TS1807.
- Remove the resistor 1 kohm (0,5 W).

The unit comprises a transistor BDY93 or BUX82 and a selected resistor R1817. This transistor and resistor is selected according to the following procedure.

First the transistor is preheated during 100 hours in an oven at 125 °C. The reason for this is that under the influence of heat the current gain of this transistor decreases to a certain value. This phenomena formerly caused that the power supply of a new instrument did not start (especially in a cold environment) after the instrument had been used for some time.

Now the power transistors are preheated, the problem mentioned above has been abolished.

After 100 hours of preheating the transistors are selected for current gain (hfe). A current of 0,3 mA is applied to the base and the collector current is measured:

IC = 2,4 ... 3,6 mA; R1817 must be 27,4 k,

IC = 3,6 ... 5,4 mA; R1817 must be 36,5 k,

IC = 5,4 ... 8,1 mA; R1817 must be 56,2 k.

After that a current of 10 mA is applied to be base and if the collector current is less than 250 mA (at a collector voltage of 50 Volt) the transistor is rejected.

The production of the present TS1807 transistor type BDY93 is stopped within some time.

The successor for this transistor will be the type BUX82. In future this transistor will be delivered together with a selected resistor R1817 under the same code number as the BDY93 (5322 130 44707).

The selection procedure for the new type will be the same as used for the old type except for the 0,3 mA base current selection. The collector current ranges are:

IC = 2,4 ... 3,6 mA, R1817 must be 27,4 k,

IC = 3,6 ... 5,4 mA, R1817 must be 36,5 k,

IC = 5,4 ... 8,1 mA, R1817 must be 56,2 k,

IC = 8,1 ... 11,4 mA, R1817 must be 78,4 k.

- Adjust the mains input voltage to 40 V.
- Short-circuit emitter-collector of TS1807.
- Start the chopper circuit (TS1804, TS1806) by connecting for a short moment the base of TS1804 via a 50 kohm (0,5 W) resistor to point 4 of transformer T1802.
- Check the voltage on point 5 of T1802. This must be a square wave of approx. 70 V<sub>pp</sub>, frequency approx. 18 kHz.
- The voltage across the 22 ohm series resistor in the mains input must be 1,5 V.
- If the chopper does not oscillate, check the chopper circuit itself.
- If the chopper goes in the "hiccup" mode when the 50 kohm resistor remains connected, check the d.c. output circuits and the circuit connected to points 7 and 8 of T1802.
- Remove the 22 ohm resistor in the mains input.

- Increase the mains input voltage until the voltage over C1809 amounts to 100 V (not higher, otherwise the Z-diodes GR1806 and GR1807 will blow up).  
The chopper must start automatically.
- Check the pulse on the base of TS1807.  
Adjust with the variable transformer the voltage across C1809 to  $\pm 95$  V check that this pulse can be varied with R1834. If not check the regulator circuit (see fig. 3.46).
- The power consumption must be 25 W approx.
- Remove the short-circuit across TS1807; check that the pulse on the base of TS1807 changes at this moment.
- Fit current sensing transistor TS1808.
- Check that the chopper circuit cuts out (goes in the "hiccup" mode) when the load of the power supply is increased by approx. 50%. To this end connect a 200 ohm 25 W resistor to the +45 V output. The current limitation goes "on" when the power output exceeds 30-35 W.  
Also when the +45 V output is short-circuited, the power supply goes in the "hiccup" mode.
- Adjust the mains input voltage with the variable transformer to the nominal local voltage.
- If necessary adjust the +45 V output voltage (+ or -100 mV is allowed) with the aid of R1834 (fig. 3.46).
- Check again the voltage on point 5 of T1802 with an oscilloscope. The frequency must be 18-22 kHz; check the shape of the chopper voltage; this must be a square wave of  $\pm 200$  V<sub>pp</sub>.
- Vary the mains voltage between 90 and 248 V.  
Check that the +45 V output remains constant (between + or -200 mV).  
Check the 50% overload current limitation at 248 V.

### 3.7.3.2. Waveforms in the power supply unit (fig. 3.11)

(Photographs taken from storage oscilloscope PM 3243 with a 10 : 1 attenuator probe).

#### 1. Mains ripple eliminator (TS1801)

- a. A.C. Voltage on the emitter of TS1801.
- b. A.C. Voltage on the collector of TS1801.

Both voltages are measured with respect to the negative pole of electrolytic capacitor C1806.

Mains voltage 220 V.

PM 3243 settings: 0,5 V/DIV; 5 ms/DIV; triggering from the mains.

#### 2. Regulator input voltage versus voltage across switching transistor TS1807

- a. Voltage on p3 with respect to p2 of IC1801.
- b. Collector-emitter voltage of TS1801; lower line is 0 V.

Mains voltage 220 V.

PM 3243 settings: 20 mV/DIV for A; 100 V/DIV for B (100 : 1 attenuator probe and 1 V/DIV) 20 ms/DIV; external triggering from p5 of T1802.

#### 3. Chopper

- a. Voltage between p2 and p3 of transformer T1801.
- b. Voltage between p7 and p8 of transformer T1802

Mains voltage 220 V.

PM 3243 settings: 0,5 V/DIV; 10  $\mu$ s/DIV; external triggering from p5 of T1802.

#### 4. Switching transistor TS1807

Current flowing through R1819.

- a. Mains voltage 110 V.
- b. Mains voltage 220 V.

PM 3243 settings: 50 mV/DIV (=25 mA/DIV); 20  $\mu$ s/DIV; external triggering from p5 of T1802.

#### 5. Regulator input voltage at 220 V and 110 V mains voltage

Voltage on p3 with respect to p2 of IC1801.

- a. at 220 V.
- b. at 110 V.

PM 3243 settings: 20 mV/DIV; 20 ms/DIV; external triggering from p5 of T1802.

### 6. Switching-on period

- a. Voltage across R1819.
- b. Voltage on p8 of IC1801 with respect to p1 and p10.

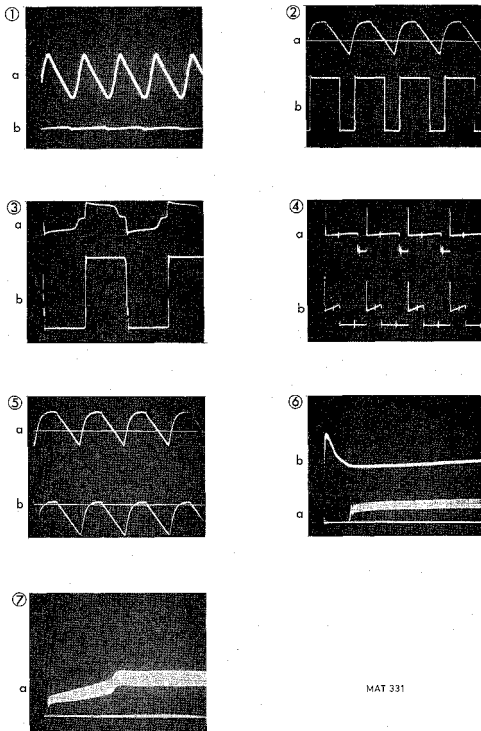
Lower line is 0 V.

Mains voltage 220 V.

PM 3243 settings: 5 ms/DIV; 20 mV/DIV for A; 0,1 V/DIV for B; external triggering from p5 of T1802; single shot.

### 7. Switching-on period

As photograph 6a, but with PM 3243 setting of 50 ms/DIV.



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Fig. 3.11. Waveforms in the power-supply unit.

### 3.7.4. Cathode-ray tube circuit

#### 3.7.4.1. Trace rotation, R684 (see fig. 3.46)

- Set the INTENS and FOCUS controls for a sharp, well-defined trace.
- Depress button A of the vertical-display mode switches.
- Depress button MAIN TB of the horizontal-deflection controls.
- Centre the time-base line, using the POSITION controls.
- Check that the time-base line runs exactly parallel with the horizontal lines of the graticule; if necessary readjust TRACE ROT. potentiometer R684.

#### 3.7.4.2. Intensity, R1327 (see fig. 3.47)

- No vertical deflection.
- Depress button EXT X DEFL of the horizontal-deflection controls (no horizontal-deflection).
- Turn the INTENS potentiometer  $90^\circ$  from left-hand stop.
- Set the horizontal POSITION control in its mid-position.
- Check that the dot is barely visible.  
If necessary, readjust potentiometer R1327 on the Z-unit.

#### 3.7.4.3. Intensity ratio, R1115 (see fig. 3.47)

- Depress button A of the vertical-display mode switches.
- Depress button MAIN TB of the horizontal-deflection controls.
- Turn the DELAY TIME control to its mid-position.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to .2 ms.
- Set the INTENS potentiometer to a position  $180^\circ$  from its anti-clockwise stop.
- Check that the trace of the main time-base generator is just visible over the entire screen and that the portion determined by the delayed time-base generator is brighter. If necessary, readjust the INTENS RATIO potentiometer R1115 on time base unit.

#### 3.7.4.4. Focus and astigmatism, R1344 (see fig. 3.47)

- Depress button A of the vertical-display mode switches.
- Depress button MAIN TB of the horizontal-deflection controls.
- Set the delayed time-base TIME/DIV switch to OFF.
- Apply a sinewave signal at a frequency of 10 kHz to input socket A.
- Adjust the trace height to 6 divisions, using the AMPL switch and vernier.
- Set the MAIN TIME/DIV switch and the LEVEL potentiometer to such a position that several complete cycles are displayed.
- Set the INTENS potentiometer for normal brilliance.
- Check that a reasonably sharp trace can be obtained with the aid of the FOCUS potentiometer. If necessary readjust astigmatism potentiometer R1344 on Z-unit.

#### 3.7.4.5. Geometry, R1346 (see fig. 3.47)

- Depress button A of the vertical-display mode switches.
- Depress button MAIN TB of the horizontal-deflection controls.
- Set the DEL'D TIME/DIV switch to OFF.
- Apply a sinewave voltage of  $12 V_{pp}$ , frequency approximately 10 kHz to input socket A.
- Set the channel A AMPL switch to .1 V/DIV.
- Set the MAIN TIME/DIV switch to .2 ms.
- Check that the displayed vertical lines are straight; if necessary, readjust potentiometer R1346 on Z-unit.
- Remove the input signal.

### 3.7.5. Vertical deflection

The four input attenuators are completely identical. Therefore, only one channel is described.

#### 3.7.5.1. Gain adjustment (front panel)

- Depress push-button A of the vertical display mode switches.
- Depress push-button DC of the AC-0-DC switch.
- Depress the PULL TO INVERT switch, incorporated in the AMPL/DIV continuous control.
- Set the AMPL step attenuator to 10 mV/DIV.
- Set the AMPL continuous controls to CAL position.
- Apply a square-wave signal with a maximum rise-time of 1 ns, a peak-to-peak value of exactly 60 mV and a frequency of 1 kHz to input socket A.
- Set the MAIN TB switch to a suitable position.
- Obtain a stationary trace with the aid of the LEVEL potentiometer.
- Check that the trace height is 6 divisions. If necessary, adjust the GAIN potentiometer on the front panel.

#### 3.7.5.2. LF gain adjustment, R132 (see fig. 3.47)

To be sure that the attenuator is well adjusted connect an oscilloscope e.g. PHILIPS PM 3262 to its output.

- Apply a 100 Hz square wave signal to the input of the attenuator.
  - Readjust R132 if the gain is not well adjusted.
- The attenuator has in the 5 mV/div. position an attenuation of 1,25x.  
The attenuator output must have its normal load of approximately 50 ohms e.g. the intermediate amplifier.

#### 3.7.5.3. Balance adjustment (front panel)

- Depress the A button of the vertical-display mode switches.
- Depress the 0 button of the AC-0-DC switch.
- Switch the AMPL step attenuator between positions 5 mV/DIV and 10 mV/DIV.
- Check that the trace does not jump. If necessary, readjust the BAL potentiometer on the front panel.

#### 3.7.5.4. DC/0 balance, R129 (see fig. 3.47)

- Set R141 (output DC offset compensation) to its mid position.
- Set the AMPL/DIV switch to 5 mV/div.
- Depress alternately the DC and 0 coupling switches and adjust R129 to minimum time-base line jump.

#### 3.7.5.5. Variable gain balance, R141 (see fig. 3.47)

- Centre the time-base line, using the POSITION control.
- Adjust R141 (output DC offset compensation) to minimum time-base line jump when operating the var. GAIN control.

#### 3.7.5.6. 20 kHz square wave response adjustment, C108, C109, C101 (see fig. 3.47)

- Depress button A of the vertical-display mode switches.
- Set the MAIN TIME/DIV switch to 20  $\mu$ s.
- Depress button DC of the AC-0-DC switch.
- Apply a square-wave signal, frequency approximately 20 kHz, rise time  $\leq$  200 ns and amplitude as indicated in the table below, to input socket A.
- Check that the displayed square-wave is free from overshoot and rounding.

| AMPL/DIV switch SK19                | Input signal on channel A BU3 | Adjustment | Trace height    |
|-------------------------------------|-------------------------------|------------|-----------------|
| 5 mV                                | 30 mV                         | C108       | 8 div. $\pm$ 2% |
| 10 mV                               | 60 mV                         |            | 6 div. $\pm$ 2% |
| 20 mV                               | 120 mV                        |            | 6 div. $\pm$ 2% |
| 50 mV                               | 300 mV                        | C101       | 6 div. $\pm$ 2% |
| 100 mV                              | 600 mV                        |            | 6 div. $\pm$ 2% |
| 200 mV                              | 1,2 V                         |            | 6 div. $\pm$ 2% |
| 500 mV                              | 3 V                           | C109       | 6 div. $\pm$ 2% |
| 1 V                                 | 6 V                           |            | 6 div. $\pm$ 2% |
| 2 V                                 | 12 V                          |            | 6 div. $\pm$ 2% |
| Max. admissible pulse-top error: 2% |                               |            |                 |

### 3.7.5.7. 100 kHz square-wave response adjustment, C122 (see fig. 3.47)

Besides the 100 kHz adjustment points in the intermediate amplifier the attenuators have a 100 kHz adjustment trimmer C122. This trimmer works on all attenuator positions. To be sure that the attenuator unit is well adjusted, connect an oscilloscope with a bandwidth of 50 MHz or more e.g. PHILIPS PM 3262 to the output of the attenuator and set C122 to maximum square-wave response. The attenuator output must have its normal load of approx. 50 ohms (for instance the intermediate amplifier). The attenuator has in the 5 mV/div position an attenuation of 1,25x.

### 3.7.5.8. Input capacitance adjustment (see fig. 3.47)

- Apply a 100 kHz square-wave signal with the voltages mentioned in the table above via an input RC Standardizer of 1 MOhm/15 pF to input socket A.
- Check that the displayed square-wave is free of rounding and overshoot; maximum admissible pulse-top error: 2%; if necessary, readjust in accordance with table below.

| AMPL/DIV switch SK19 | Via Standardizer Input to BU3 | Adjustment | Trace height    |
|----------------------|-------------------------------|------------|-----------------|
| 5 mV                 | 30 mV                         | C107       | 3 div. $\pm$ 2% |
| 10 mV                | 60 mV                         |            | 3 div. $\pm$ 2% |
| 20 mV                | 120 mV                        |            | 3 div. $\pm$ 2% |
| 50 mV                | 300 mV                        | C102       | 3 div. $\pm$ 2% |
| 100 mV               | 600 mV                        |            | 3 div. $\pm$ 2% |
| 200 mV               | 1,2 V                         |            | 3 div. $\pm$ 2% |
| 500 mV               | 3 V                           | C111       | 3 div. $\pm$ 2% |
| 1 V                  | 6 V                           |            | 3 div. $\pm$ 2% |
| 2 V                  | 12 V                          |            | 3 div. $\pm$ 2% |

### 3.7.5.9. Bandwidth

- Depress push-button A of the vertical display mode switches.
- Set the AMPL/DIV control to .1V/DIV and the continuous control to CAL.
- Apply a sine wave signal of 800 mV<sub>pp</sub>, 50 kHz to the input of channel A.
- Trace height must be 8 divisions.
- Increase the generator frequency to 50 MHz while retaining the amplitude of the input signal at 800 mV<sub>pp</sub>.
- Check that the trace height is at least 5,6 divisions.

### 3.7.5.10. Common mode rejection channel A+B (C+D)

- Depress push-button A+B (C+D) of the vertical display mode switches.
- Set the channel A (C) and B (D) AMPL/DIV switch to .1V/DIV and the continuous controls to CAL.
- Push the NORM/INVERT switch of channel A to NORMAL.
- Pull the NORM/INVERT switch of channel B to INVERT.
- Apply a sine wave signal of  $2,4 V_{pp}$  to the inputs of channels A (C) and B (D) simultaneously.
- Check the rejection rate in accordance with the following table:

| Input frequency | Max. trace height | Rejection factor |
|-----------------|-------------------|------------------|
| 100 kHz         | 0,24 DIV          | 100              |
| 1 MHz           | 0,24 DIV          | 100              |

- Remove the input signals.

### 3.7.5.11. Chopped mode (see fig. 3.47)

A display of  $0,5 \mu s$  or  $2 \mu s$  can be selected with the miniature slider switch SK201 on the channel selection unit.

The  $0,5 \mu s$  position gives high resolution at fast single-shot displays.

The  $2 \mu s$  position gives increased brightness at high sweep speeds.

- Set the m.t.b. TIME/DIV switch to 10 msec.
- Depress all push-buttons of the vertical display mode switches.
- Depress push-button CHOP and 0 of the AC-0-DC input signal coupling switches of channels A, B, C and D.
- Six lines must be displayed on the screen without any background light.

### 3.7.5.12. Alternate mode

- Depress push-button ALT.
- Set the m.t.b. TIME/DIV switch to 10  $\mu s$ .
- Six lines must be displayed on the screen alternately.
- Check that the six channels are switched over after every sweep of the sawtooth voltage (set the m.t.b. TIME/DIV switch to 50 msec).

### 3.7.5.13. Effective signal delay

- Depress push-button A of the vertical display mode switches.
- Depress push-button A of the m.t.b. trigger source switches.
- Pull the TB MAGN switch to x5.
- Set the AMPL/DIV switch to .2 V/DIV.
- Apply a square-wave of approx.  $600 mV_{pp}$ , frequency 100 kHz with a rise time  $\leq 1$  nsec to the input.
- Adjust the m.t.b. LEVEL potentiometer for a stable, stationary display.
- Set the AMPL/DIV switch to .1 V/DIV.
- Turn the INTENS control to maximum intensity.
- Check that the effective delay time T is larger than 1 DIV (see fig. 3.12).

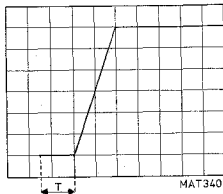


Fig. 3.12. Effective signal delay.

### 3.7.5.14. Dynamic range and position range

- Set the TB MAGN to 1x.
- Set the m.t.b. TIME/DIV switch to 0.05  $\mu$ sec/div.
- Depress push-button A of the vertical display mode switches.
- Apply a sine wave of 2,4 V<sub>pp</sub>, frequency 15 MHz to the input.
- Set the AMPL/DIV switch to .1 V/DIV and the continuous control to CAL.
- Check that the top and bottom parts of the sine wave can be displayed by turning the vertical POSITION control.
- Check that the displayed sine wave shows no distortion over the whole vertical POSITION range.

### 3.7.6. Intermediate and final Y amplifier

#### 3.7.6.1. Normal/Invert balance (see fig. 3.46)

- Depress buttons A, B, C, D of the vertical display switches.
  - Adjust the following potentiometers so that the corresponding trace does not jump when the 'PULL TO INVERT' switch is operated.
- |       |         |
|-------|---------|
| ch. A | : R448  |
| ch. B | : R2648 |
| ch. C | : R2848 |
| ch. D | : R2448 |

These potentiometers are located on the intermediate amplifier unit.

#### 3.7.6.2. A + B balance adjustment (see fig. 3.46.)

- Depress buttons A, A+B and B of the vertical display switches
- Shift the three traces so that they are superimposed on each other, using the ch. A and ch. B POSITION controls on the front panel.
- Adjust potentiometer R548 (located on the intermediate amplifier unit) so that the trace is on the horizontal centre-line of the graticule.

The C+D balance is now also correct.

#### 3.7.6.3. Square-wave response (see fig. 3.46.)

- Depress push-button A of the vertical display mode switches.
- Set the AMPL/DIV switch to 20 mV/div.
- Set the m.t.b. TIME/DIV switch to .05  $\mu$ sec.
- Apply a square wave signal of 120 mV<sub>pp</sub>, rise time  $\leq$  1 nsec, frequency 100 kHz to the input of the channel to be measured.
- Check that the pulse-top is as straight as possible.  
Maximum pulse-top error including ringing and overshoot 0,1 division.
- Adjustments on the intermediate amplifier for:
 

|       |                     |
|-------|---------------------|
| ch. A | : C402-C416/R442    |
| ch. B | : C2602-C2616/R2642 |
| ch. C | : C2802-C2816/R2842 |
| ch. D | : C2402-C2416/R2442 |
- Adjustments on the final Y amplifier:
 

|           |
|-----------|
| C603/R619 |
| C606/R621 |
| R622      |
- Check the square-wave response also with an input voltage of 0,6 V (AMPL/DIV switch to 0,1 V/div) and with an input voltage of 3 V (AMPL/DIV switch to 0,5 V/div).



#### 3.7.6.4. Trigger balance adjustments (see fig. 3.46)

- Depress pushbutton A of the vertical display switches.
- Depress pushbutton MAIN TB of the horizontal display switches.
- Set TB MAGN. to x1 position.
- Depress pushbutton AUTO of the main timebase mode switches.
- Set main time-base sweep to 0.5 ms/DIV.
- Depress pushbutton A of the main time-base trigger source switches.
- Set input coupling switches of all vertical deflection channels in position DC.
- Adjust horizontal POSITION control on the front panel so that the trace starts at the extreme left-hand graticule line.
- Adjust channel A POSITION so that the trace is on the horizontal centre graticule line.
- Depress button EXT X DEFL of the horizontal display switches.
- Adjust potentiometer R379 (intermediate amplifier unit) so that the spot is in the centre of the graticule.
- Depress pushbutton B of the main time-base trigger source switches.
- Adjust potentiometer R2579 (intermediate amplifier unit) so that the spot is in the centre.
- Depress pushbutton C of the main time-base trigger source switches.
- Adjust potentiometer R2779 (intermediate amplifier unit) so that the spot is in the centre.
- Depress pushbutton D of the main time-base trigger source switches.
- Adjust potentiometer R2379 (intermediate amplifier unit) so that the spot is in the centre.

#### Composite trigger balance adjustment, R531 (see fig. 3.46)

- Depress both push-buttons A and B of the m.t.b. trigger source switches for composite triggering.
- Adjust potentiometer R531 so that the spot is in the centre of the screen.

#### EXT. trigger balance, R705 (see fig. 3.47)

- Depress both push-buttons C and D of the m.t.b. trigger source switches.
- Adjust potentiometer R705 so that the spot is in the centre of the screen.

#### LINE adjustment, R715 (see fig. 3.28)

- Depress both push-buttons B and C of the m.t.b. trigger source switches.
- Select the value for R715 (7.15 k ... 9,53 kohms) so that the mains deflection is symmetrical around the centre of the graticule.

#### 3.7.6.5. Y-amplifier gain adjustment R641 (see fig. 3.46)

After adjusting the GAIN control on the front panel (see 3.7.5.1.) this potentiometer should be in his mid-position.

If not, adjust potentiometer R641.

If the setting cannot be reached with R641, change R645 to a suitable resistance value between 249 ohm and 1 kohm.

Check that the control range of the AMPL/DIV continuous control is at least 1:2,6 to 1:3,5.

### 3.7.7. Horizontal deflection

Main time base.

#### 3.7.7.1. Trigger slope and level

- Depress button A of the vertical-display mode switches.
- Set the channel A AMPL switch to .2 V/DIV.
- Depress the AC button of the channel A AC-0-DC switch.
- Apply a sinewave signal with an amplitude of 1,6 V to input socket A, frequency approximately 30 kHz.
- Set the MAIN TIME/DIV switch to such a position that a few cycles of the input sinewave are displayed.
- Push the SLOPE switch to its + position.
- Check that the time-base generator starts on the positive-going part of the sinewave and moves upwards when the LEVEL potentiometer is turned clockwise.
- Pull the SLOPE switch to its - position.
- Check that the time-base generator starts on the negative-going part of the sinewave.
- Set the AMPL switch to .1 V/DIV.
- Position the trace in such a way that the trigger point is visible.
- Check that it is possible to shift the starting point of the sinewave over 16 divisions, by means of the LEVEL control.
- Push the SLOPE switch to its + position.
- Position the trace in such a way that the trigger point is visible.
- Check that it is possible to shift the starting point of the sinewave over 16 divisions, by means of the LEVEL control.
- Check that the maximum control range of the LEVEL potentiometer does not exceed 32 divisions.

#### 3.7.7.2. Trigger sensitivity

- Adjust the main time-base LEVEL potentiometer for a stationary display.
- Set the MAIN TIME/DIV switch to such a position that a reasonable number of sinewaves is written on the screen.
- Set the trigger sensitivity in accordance with the table below.

| Input signal on | Frequency | MTB trigger selector SK9 | Vertical display mode SK12 ... 17 | MTB trigger source SK21 | Trace height |
|-----------------|-----------|--------------------------|-----------------------------------|-------------------------|--------------|
| BU3A            | 10 Hz     | TRIG                     | A                                 | A                       | 0,4 div.     |
| BU3A            | 10 kHz    | TRIG                     | A                                 | A                       | 0,4 div.     |
| BU3A            | 50 MHz    | TRIG                     | A                                 | A                       | 0,8 div.     |
| BU3A            | 50 MHz    | AUTO                     | A                                 | A                       | 0,8 div.     |
| BU3B            | 10 Hz     | TRIG                     | B                                 | B                       | 0,4 div.     |
| BU3B            | 50 MHz    | TRIG                     | B                                 | B                       | 0,8 div.     |
| BU3B            | 50 MHz    | TRIG                     | B                                 | A+B                     | 0,8 div.     |
| BU3C            | 10 Hz     | TRIG                     | C                                 | C                       | 0,4 div.     |
| BU3C            | 50 MHz    | TRIG                     | C                                 | C                       | 0,8 div.     |
| BU3D            | 10 Hz     | TRIG                     | D                                 | D                       | 0,4 div.     |
| BU3D            | 50 MHz    | TRIG                     | D                                 | D                       | 0,8 div.     |
| BU3D            | 50 MHz    | TRIG                     | D                                 | A+B                     | 0,8 div.     |
| BU3D            | 50 Hz     | TRIG                     | D                                 | B+C                     | 0,2 div.     |
| BU4(EXT.)       | 10 Hz     | TRIG                     |                                   | C+D                     | 140 mV       |
| BU4             | 50 MHz    | TRIG                     |                                   | C+D                     | 600 mV       |

#### 3.7.7.3. Hold off control

- Remove the input signal.
- Set the m.t.b. TIME/DIV switch to 5  $\mu$ sec./div.
- The intensity of the time base line must be adjustable with the HOLD OFF control.

#### 3.7.7.4. Single-sweep operation

- Set the AMPL switch to .2 V/DIV.
- Set the LEVEL control to mid-range.
- Set the MAIN TIME/DIV switch to .1 s.
- Apply a signal that gives a trace height of approximately 8 divisions to input socket YA.
- Depress push-button A of the vertical display mode switches
- Depress the 0 button of the channel A AC-0-DC switch.
- Push the SINGLE button of the trigger-mode controls.
- Check that the NOT TRIG'D lamp lights up.
- Depress button AC of the channel A AC-0-DC switch.
- Check that the trace is written once and that the NOT TRIG'D lamp is extinguished at the start of the sweep.

#### 3.7.7.5. Stability R873 (see fig. 3.47)

- Depress push-button 0 of the AC-0-DC switch.
- Depress button MAIN TB of the horizontal-deflection controls.
- Depress button TRIG of the trigger-mode controls.
- Set the DEL'D TIME/DIV switch to OFF.
- Set the m.t.b. TIME/DIV switch to 0.2 msec/div.
- Rotate the main time-base LEVEL control fully anti-clockwise.
- Turn STAB potentiometer R873 fully anti-clockwise.
- Check that there is a time-base line written.
- Rotate STAB potentiometer R873 approximately 20° past the point where the time-base line ceases to be displayed.
- Depress button AUTO of the trigger-mode controls.
- Check that there is a time-base line written again.

#### 3.7.7.6. Time coefficients, R1223, R1209, R914 (see fig. 3.47)

As the power supply may affect the sweep times, it must be checked before readjusting the sweep times, refer to 3.7.3.

- Depress button A of the vertical-display mode switches.
- Set the AMPL switch to .1 V/DIV.
- Depress button DC of the AC-0-DC switch.
- Depress button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN switch to position x1.
- Depress button AUTO of the trigger-mode controls.
- Set the MAIN TIME/DIV vernier control to CAL.
- Set the MAIN TIME/DIV switch to 1 msec.
- Depress button A of the trigger-source controls.
- Apply a time-marker signal at a repetition rate of 1 ms to input socket A, amplitude approximately 600 mV.
- Check that the 8 centre periods cover exactly 8 divisions; if necessary, readjust potentiometer R1223.
- Pull the TB MAGN switch to position x5.
- Set the time-marker generator to 200  $\mu$ s.
- Check that the 8 centre cycles cover exactly 8 divisions; if necessary, readjust potentiometer R1209.
- Push the TB MAGN control to position x1.
- Set the MAIN TIME/DIV switch to 10 ms.
- Set the time-marker generator to 10 ms.
- Check that the 8 centre cycles cover exactly 8 divisions; if necessary, readjust potentiometer R914.
- Check that the control range of the TIME/DIV continuous control is 1:2.6 to 1:3.5.
- Check the remaining positions of the TIME/DIV switch; the centre 8 periods should always cover exactly 8 divisions,  $\pm$  2.5%. On the end positions .5 s, .2 s, 1  $\mu$ s and .05  $\mu$ s the tolerance is  $\pm$  3.5%.
- Also check that the length of the time-base line always exceeds 10 divisions.

#### 3.7.7.7. Linearity and horizontal positioning, C1203, C1208 (see fig. 3.47)

- Set the MAIN TIME/DIV control to .05  $\mu$ s.
- Pull the TB MAGN switch to its x5 position.
- Apply a time-marker signal with a pulse repetition frequency of .01  $\mu$ s to input socket A.
- Check that the 8 centre cycles cover exactly 8 divisions.

- Check also that for the 8 centre cycles a display of 1 cycle/division is obtained; if necessary, readjust trimmer capacitors C1203 and C1208.
- Check that all other cycles have a width of 1 division by shifting the whole train of pulses across the screen. Do not take into account the first and last five cycles.
- Also check that with the X POSITION potentiometer fully anti-clockwise and fully clockwise the beginning and the end of the trace is written within the measuring graticule.

#### Delayed time base

##### 3.7.7.8. Trigger slope and level

- Depress button DEL'D TB of the horizontal-deflection switch.
- Depress button A of the del'd time-base trigger-source controls.
- Set the channel A-AMPL switch to .2 V/DIV.
- Depress the AC button of the channel A AC-0-DC switch.
- Depress push-button TRIG of the d.t.b. trigger mode switches.
- Turn the DELAY TIME multiplier knob fully anti-clockwise.
- Set the MAIN TIME/DIV switch to 20  $\mu$ s and the DEL'D TIME/DIV switch to 10  $\mu$ s.
- Apply a sinewave signal with an amplitude of 1,6 V to input socket A, frequency approximately 30 kHz.
- Push the SLOPE switch of the delayed time-base generator to its + position.
- Check that the time-base generator starts on the positive-going part of the sinewave and shifts upwards when the LEVEL potentiometer is turned clockwise.
- Pull the SLOPE switch of the delayed time-base generator to its - position.
- Check that the time-base generator starts on the negative-going part of the sinewave.
- Set the AMPL switch to .1 V/DIV.
- Position the trace in such a way that the trigger point is visible.
- Check that it is possible to shift the starting point of the sinewave over 16 divisions by means of the delayed time-base LEVEL control.
- Push the SLOPE switch of the delayed time-base generator to its + position.
- Position the trace in such a way that the trigger point is visible.
- Check that it is possible to shift the starting point of the sinewave over 16 divisions by means of the delayed time-base LEVEL control.
- Check that the maximum control range of the LEVEL potentiometer does not exceed 32 divisions.

##### 3.7.7.9. Trigger sensitivity

- Depress button DEL'D TB of the horizontal-deflection controls.
- Set the delayed time-base LEVEL potentiometer to obtain a stationary display.
- Set the MAIN TIME/DIV switch one position lower (longer sweep time) than the DEL'D TIME/DIV switch.
- Adjust the DEL'D TIME/DIV switch to such a position that a reasonable number of sinewaves is written on the screen (not for 20 Hz).
- Check the trigger sensitivity in accordance with the table below.

| Input signal on | Frequency | Trigger mode SK11 | Vertical display mode SK12 ... 17 | DTB trigger source SK10 | Trace height |
|-----------------|-----------|-------------------|-----------------------------------|-------------------------|--------------|
| BU3A            | 100 Hz    | STARTS            | A                                 | A                       | 0,4 div.     |
| BU3A            | 10 kHz    | STARTS            | A                                 | A                       | 0,4 div.     |
| BU3A            | 50 MHz    | STARTS            | A                                 | A                       | 0,8 div.     |
| BU3B            | 100 Hz    | STARTS            | B                                 | B                       | 0,4 div.     |
| BU3B            | 50 MHz    | STARTS            | B                                 | B                       | 0,8 div.     |
| BU3B            | 50 MHz    | STARTS            | B                                 | A+B                     | 0,8 div.     |
| BU3C            | 100 Hz    | STARTS            | C                                 | C                       | 0,4 div.     |
| BU3C            | 50 MHz    | STARTS            | C                                 | C                       | 0,8 div.     |
| BU3D            | 100 Hz    | STARTS            | D                                 | D                       | 0,4 div.     |
| BU3D            | 50 MHz    | STARTS            | D                                 | D                       | 0,8 div.     |

### 3.7.7.10. Stability, R1064 (see fig. 3.47)

- Depress button DEL'D TB of the horizontal-deflection controls.
- Depress button A of the delayed time-base trigger-source controls.
- Depress button D of the channel A AC-0-DC switches.
- Set the MAIN TIME/DIV switch to .5 ms.
- Set the DEL'D TIME/DIV switch to .2 ms.
- Depress pushbutton TRIG of the d.t.b. trigger mode switches.
- Turn the delayed time-base LEVEL control fully anti-clockwise.
- Turn STAB potentiometer R1064 fully clockwise
- Check that a time-base line is displayed.
- Rotate STAB potentiometer R1064 approximately 20° beyond the point where the time-base line ceases to be displayed.
- Depress push-button STARTS of the d.t.b. trigger mode switches.
- Check that the time base line is displayed again.

### 3.7.7.11. Time coefficients, R1097 (see fig. 3.47)

- Depress button A of the vertical-display mode switches.
- Set the AMPL switch to .1 V/DIV.
- Depress button DC of the AC-0-DC switch.
- Rotate the DELAY TIME control fully anti-clockwise.
- Depress button DEL'D TB of the horizontal-deflection controls.
- Depress button AUTO of the main time-base trigger-mode controls.
- Depress button A of the delayed time-base trigger-source controls.
- Set the TIME/DIV continuous controls to the CAL positions.
- Set the m.t.b. and d.t.b. TIME/DIV switch to 1 msec/div.
- Apply a time-marker signal at a repetition rate of 1 ms and an amplitude of approximately 600 mV to input socket A.
- Check that the 8 centre periods cover exactly 8 divisions; if necessary, readjust potentiometer R1097.
- Check that the control range of the delayed time-base TIME/DIV contin. control is 1:2,6 to 1:3,5.
- Check the remaining positions of the DEL'D TIME/DIV switch.
- Keep the DELAY TIME control fully anti-clockwise during this check, and the MAIN TIME/DIV switch one position lower than the DEL'D TIME/DIV switch. In this way, the delayed time-base can complete an entire sweep.
- Check that the 8 centre periods always cover 8 divisions,  $\pm 2,5\%$  except in the positions .1  $\mu$ s and .05  $\mu$ s, where the tolerance is  $\pm 3,5\%$ .
- Check that in all positions of the DEL'D TIME/DIV switch the length of the time-base line exceeds 10 divisions.
- Check that no time-base line is written when the DEL'D TIME/DIV switch occupies the OFF position.
- Remove the input signal.

### 3.7.7.12. Delay time control

- Depress button A of the vertical-display mode switches.
- Depress button DC of the AC-0-DC switches.
- Depress button MAIN TB of the horizontal-deflection controls.
- Depress button AUTO and MAIN TB of the trigger-mode controls.
- Set the DEL'D TIME/DIV switch to 0,1 msec.
- Set the MAIN TIME/DIV switch to 1 ms.
- Depress push-button A of the m.t.b. and d.t.b. trigger source switches.
- Depress button A of the trigger-source controls.
- Rotate the TIME/DIV cont. controls to CAL.
- Apply a time-marker signal at a repetition rate of 1 ms.
- Set the LEVEL control of the main time-base for a triggered display.
- Check that the intensity modulation by the delayed time-base is visible over the entire range of the INTENS potentiometer.
- Check that the starting point of the delayed time-base can be continuously shifted along the main time-base line with the aid of the DELAY TIME control. Ignore the first and last half-divisions.

### 3.7.7.13. Delay-time calibration (see fig. 3.47)

(Start- and stop pot. meters R987 and R979; located on the small p.c. board underneath the c.r.t.)

- Set the delayed timebase sweep to .1 ms/DIV.
- Set the main timebase sweep to 1 ms/DIV.
- Depress pushbutton MAIN TB of the horizontal display switches.
- Depress pushbutton STARTS of the delayed timebase mode switches.
- Depress pushbutton A of the vertical display switches.
- Depress pushbutton A of the main timebase trigger source switches.
- Apply a 1 ms squarewave signal to the channel A input.
- Set the DELAY TIME multiplier dial knob to 1.00.
- Adjust 'start' potentiometer R987 (front-panel side) so that the beginning of the intensified part of the trace coincides with the beginning of the 2nd period.
- Set the DELAY TIME multiplier dial knob to 9.00.
- Adjust 'stop' potentiometer R979 so that the beginning of the intensified part of the trace coincides with the beginning of the 9th period.
- Repeat both adjustments for optimum results.

### 3.7.7.14. Gain and balance adjustment of the preamplifier for ext. X-deflection

*Gain adjustment, R1131 (see fig. 3.47)*

This adjustment must be carried out after the gain adjustment of the four channels and of the final Y-amplifier.

- Depress the push-button EXT.X deflection of the horizontal deflection controls.
- Set the d.t.b. TIME/DIV switch to OFF.
- Apply a sine wave of 6 divisions height and a frequency of 50 kHz to the input of channel A.
- Check that the horizontal deflection is about the same (6 div.  $\pm$  10 %) as the vertical deflection.
- If necessary, change R1131 to a resistance value between 18,7 and 21,5 kOhm to obtain the right X-deflection.
- Note that R1131 also influences the horizontal shift. Therefore, adjust R1131 first and afterwards R1132.

*DC output level adjustment, R1132 (see fig. 3.47)*

This adjustment must be carried out after the gain adjustment.

- Set the HORIZONTAL POSITION control so that the MTB line starts at the most left line of the graticule.
- Connect the base of TS1071 to earth potential.
- Depress the button EXT. X DEFL. of the horizontal-deflection controls.
- Check that the display shows a spot in the horizontal centre of the graticule ( $\pm$  1 div.).
- If necessary, change R1132 to a resistance value between 31,6 and 40,2 kOhm to obtain the right X position of the spot.
- Remove the earth potential from the base of TS1071.

### 3.7.7.15. External X deflection

- Depress both push-buttons C and D of the m.t.b. trigger source switches.
- Apply a sine wave voltage of exactly 3 V<sub>pp</sub>, frequency 10 kHz to the EXT input socket.
- Check that the trace-width is 6,5 to 10 divisions.

*Bandwidth of the EXT X deflection*

- Adjust the amplitude of the input signal to obtain a trace width of 6 divisions.
- Increase the frequency of the input signal to 1 MHz.
- Check that the trace width is at least 4,2 divisions.

### 3.7.7.16. X-deflection with the mains signal, R1841 (see fig. 3.46)

- Apply a sine wave (mains frequency) to the input of channel A.
- Depress push-button A of the vertical display mode switches.
- Depress push-button EXT X DEFL of the horizontal-deflection controls.
- Depress both push-buttons B and C (line) of the m.t.b. trigger source switches.
- Check that the trace width is 10 divisions,  $\pm$  1 div.; if necessary, readjust potentiometer R1841.

### 3.7.7.17. Phase difference

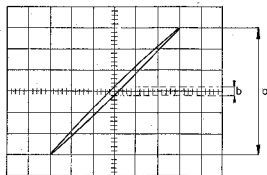
- Depress push-button A of the vertical display mode switches.
- Set the AMPL/DIV switch to 0,5 V/div.
- Depress push-button EXT X DEFL of the horizontal deflection controls.
- Depress push-button A of the m.t.b. trigger source switches.
- Depress push-button DC of the AC-0-DC switches.
- Apply a sine wave voltage of 3 V<sub>pp</sub>, frequency 10 kHz to the input of channel A.
- Check that a solid line, at an angle of 45° is displayed.
- Increase the frequency of the input signal to 100 kHz.
- Check that the phase-error does not exceed 3°.
- See fig. 3.13, in which  $\frac{b}{a}$  equals the sine of the phase error angle.

### 3.7.8. Calibration unit, R1362 (see fig. 3.47)

- Check the calibration voltage for irregularities.
- Check that the amplitude of the square-wave voltage is 3 V<sub>pp</sub> ± 0.7 %; if necessary, readjust R1362.
- Check that the frequency is 2 kHz ± 2 %.
- Check that the CAL current is 6 mA ± 1 %.

### 3.7.9. Mains voltage fluctuations

- Depress both push-buttons A and B of the vertical display mode switches.
- Depress CHOP of the display mode controls.
- Set the channel A and B AMPL/DIV switches to .5 V/div.
- Set the m.t.b. TIME/DIV switch and the m.t.b. LEVEL control for a stable, stationary display.
- Depress the push-buttons AC of the signal input coupling controls.
- Pull the TB MAGN switch to x5.
- Interconnect the CAL socket with the channel A and B input.
- Check that neither the trace width nor the trace height changes when the mains voltage is varied between 90 V and 260 V. Also check that the trace intensity does not change.



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Fig. 3.13. Phase difference in X-Y mode

## 3.8. PARTS LIST

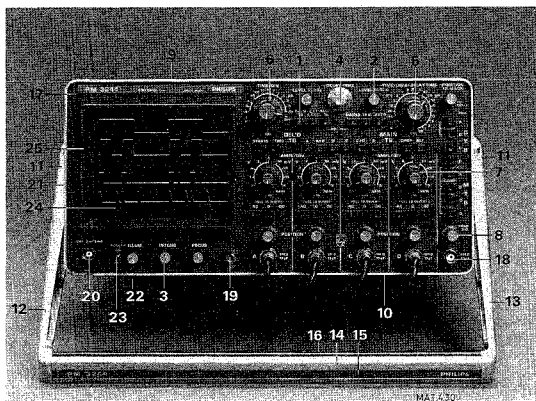


Fig. 3.14. Mechanical parts, front view

## 3.8.1. Mechanical parts front view

| Item | Ordering number | Description                               |
|------|-----------------|---|
| 1    | 5322 414 14011  | Knob for push-button switches             |
| 2    | 5322 414 31091  | Knob, dia 10 mm                           |
| 3    | 5322 414 31134  | Knob, dia 10 mm (clamping)                |
|      | 5322 492 64337  | Clamping spring                           |
|      | 5322 414 74015  | Cover, grey with dash                     |
| 4    | 5322 414 34147  | Ten turn dial                             |
| 5    | 5322 414 34119  | Knob, dia 14 mm, shaft 4 mm               |
|      | 5322 414 74016  | Cover, blue with dash                     |
| 6    | 5322 414 34081  | Knob, dia 24 mm, shaft 6 mm               |
| 7    | 5322 414 34079  | Knob, dia 18,7 mm, shaft 6 mm             |
| 8    | 5322 414 31091  | Knob, dia 10 mm                           |
|      | 5322 414 74028  | Nutcover                                  |
|      | 5322 414 74029  | Cover, blue with dash                     |
| 9    | 5322 447 94147  | Upper cabinet plate                       |
|      | 5322 417 24024  | Quick-fastener complete                   |
| 10   | 5322 447 94146  | Lower cabinet plate                       |
| 11   | 5322 498 54082  | Grip brackets left and right and grip bar |
|      | 5322 528 34113  | Ratchet block (of bracket)                |
|      | 5322 535 74401  | Locking pin                               |
|      | 5322 492 54155  | Spring                                    |



| <i>Item</i> | <i>Ordering number</i> | <i>Description</i>                        |
|-------------|------------------------|---|
| 12          | 5322 498 54044         | Bracket left hand side                    |
| 13          | 5322 498 54043         | Bracket right hand side                   |
| 14          | 5322 498 54045         | Grip                                      |
| 15          | 5322 455 84072         | Text strip in grip bar                    |
| 16          | 5322 498 54042         | Plastic strip at the rear of the grip bar |
| 17          | 5322 455 84064         | Text plate                                |
| 18          | 5322 267 10004         | BNC socket                                |
| 19          | 5322 535 80523         | Earth socket                              |
|             | 5322 505 14178         | Serrated nut for earth socket             |
| 20          | 5322 267 14014         | Cal. socket (complete)                    |
|             | 5322 263 54003         | BNC-cal. socket adapter                   |
| 21          | 5322 447 94145         | Aluminium side strip of cabinet           |
|             | 4822 502 30047         | Self tapping screw for side strip         |
| 22          | 5322 462 44297         | Rubber foot (on lower cabinet plate)      |
| 23          | 5322 255 44088         | Holder for LED                            |
| 24          | 5322 480 34046         | Contrast filter, grey                     |
|             | 5322 480 37074         | Contrast filter, blue                     |
| 25          | 5322 466 74059         | Bezel                                     |

### 3.8.2. Mechanical parts rear view

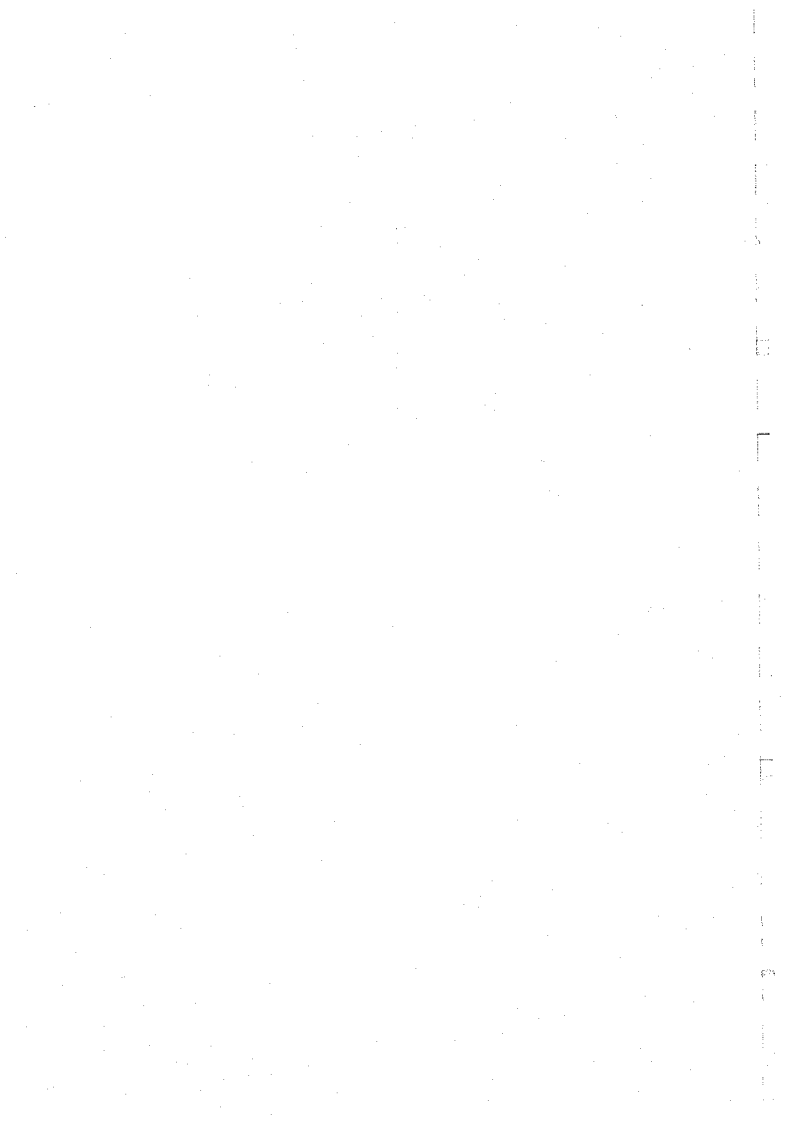
|                       |                |
|-----------------------|----------------|
| Rear cabinet plate    | 5322 447 94148 |
| Mains cable with plug | 5322 321 14001 |
| Fuse holder           | 5322 256 34081 |
| Cable cleat           | 5322 325 60119 |
| Earth terminal        | 5322 405 94046 |
| Foot, complete        | 5322 462 44154 |

### 3.8.3. Mechanical parts top view

|   |                |
|---|----------------|
| Cast aluminium front plate                                  | 5322 459 24071 |
| Cast aluminium rear plate<br>for PM 3244/00 .... PM 3244/04 | 5322 447 94144 |
| Cast aluminium rear plate<br>for PM 3244/05 and following   | 5322 447 94504 |
| Clamping buffer for c.r.t. front                            | 5322 381 14151 |
| Socket for lamps (gratucule)                                | 5322 255 24015 |
| Mu-metal c.r.t. shield                                      | 5322 462 54138 |
| Square nut in side strip (M3)                               | 4822 505 10029 |
| Rubber sleeve of c.r.t.                                     | 5322 532 74014 |
| C.r.t. socket   | 5322 255 70159 |

#### Miscellaneous

|   |                |
|---|----------------|
| Plastic spindle for R12 (power on)                  | 5322 535 94656 |
| Heatsink for TS604 and TS608<br>(final Y-amplifier) | 5322 255 44031 |
| Nut for knobs of attenuator                         | 5322 505 14186 |
| Tool for attenuator nuts (item 7)                   | 5322 395 54023 |
| Tool for time base switch nuts (item 6)             | 5322 395 54024 |
| Nut for mounting the attenuator to the front        | 5322 505 14186 |



*Front cover box*

|                           |                |
|---------------------------|----------------|
| Front cover box, complete | 5322 447 94169 |
| Locking key               | 5322 535 94761 |
| Inner plate               | 5322 459 84021 |
| Spring                    | 5322 492 34453 |
| Circlip                   | 4822 530 70126 |

**3.8.4. Various mechanical parts***Switches*

|       |                          |                |
|-------|--------------------------|----------------|
| SK4   | DTB TIME/DIV. switch     | 5322 273 64057 |
| SK6   | MTB TIME/DIV. switch     | 5322 273 54061 |
| SK19  | PULL TO INVERT switch    | 5322 273 44043 |
| SK201 | CHOPPER FREQUENCY switch | 5322 277 24053 |

*Push button switches*

|                       |                |
|-----------------------|----------------|
| Male clamping piece   | 5322 405 94074 |
| Female clamping piece | 5322 405 94075 |
| Screw M3 x 20         | 5322 502 11142 |

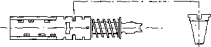

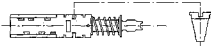
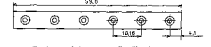

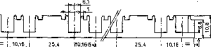
|   |                |   | Sk8 | Sk9 | Sk10 | Sk21 | Sk11 | Sk18 | Sk22 |
|---|----------------|---|-----|-----|------|------|------|------|------|
| Two-change over switch  | 5322 276 14101 |  | 3   | 2   | 4    | 4    | 4    | 4x3  |      |
| Two-change over switch<br>push on – push off (SK11, ÷ SK18)   | 5322 276 14117 |  |     |     |      |      | 6    |      |      |
| Two-change over switch<br>used as single shot switch          | 5322 276 14359 |  |     | 1   |      |      |      |      |      |
| Reset bar (for 6 switches)                                    | 5322 278 74007 |  |     | 1   |      |      | 1    | 4    |      |
| Support for max. 11 switches<br>(10 x 10, 16 mm)              | 5322 466 85843 |  |     | 1   |      | 1    |      |      | 2    |
| Support for max. 10 switches<br>(7 x 10, 16 mm) (2 x 25,4 mm) | 5322 466 85839 |  |     |     |      |      | 1    |      |      |

Fig. 3.14A

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Note: the reset bar and the supports mentioned above must be sawn to the required size.

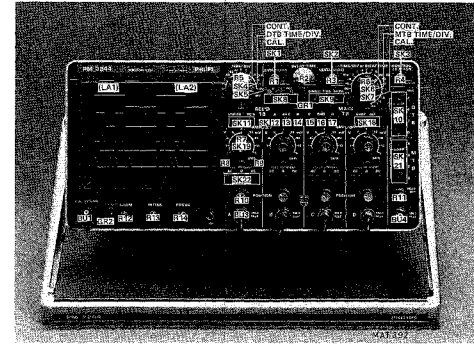


Fig. 3.15. Electrical item numbers, front panel.

*Coaxial cables*

500 mm cable with plugs 5322 320 14027  
for PM 3244/00 ÷ PM 3244/04

For the PM3244/05 and following versions a new more reliable type of 50 ohm connector is used.  
In future the units that are delivered by service also will be equipped with this new type of connector.  
If such a unit is used in an instrument with old 50 ohm connectors the following parts are available to facilitate unit interconnection.

— The old 50 ohm coax connectors on the p.c.b. can be replaced by a new type.

This new type consists of:

socket 5322 268 24116  
contact pin 5322 268 14141

— Set with new coaxial cables 5322 320 14102

The set contains:

a) cables with one connector

2 x 24 cm and 1 x 25 cm

b) cables with a connector on each end

2 x 29 cm, 1 x 30 cm, 1 x 50 cm and 1 x 85 cm

*Multipole plugs and socket (Stocko)*

|                           |                |
|---------------------------|----------------|
| 3 pole plug (at cable)    | 4822 266 30071 |
| 3 pole socket (on p.c.b.) | 4822 265 30121 |
| 4 pole plug               | 4822 266 30072 |
| 4 pole socket             | 4822 265 30119 |
| 5 pole plug               | 4822 266 30073 |
| 6 pole socket             | 4822 265 30117 |
| 7 pole plug               | 4822 266 40057 |
| 7 pole socket             | 4822 265 40119 |

## 3.8.5. Electrical parts

## Capacitors

| ITEM  | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS         |
|-------|-----------------|-------|---------|-------|-----------------|
| C 1   | 5322 122 14018  | 10PF  | 2       |       | CERAMIC TUBULAR |
| C 2   | 5322 125 54003  | 60PF  |         | 300   | TRIMMER         |
| C 101 | 5322 125 64009  | 3PF   |         | 500   | TRIMMER         |
| C 102 | 5322 125 64015  | 4,6PF |         | 500   | TRIMMER         |
| C 103 | 5322 123 34001  | 30PF  | 10      | 300   | MICA            |
| C 104 | 4822 121 40278  | 22NF  | 10      | 400   | POLYESTER FOIL  |
| C 105 | 4822 122 31047  | 5,6PF | 0,25PF  | 100   | CERAMIC PLATE   |
| C 106 | 4822 122 31072  | 47PF  | 2       | 500   | CERAMIC PLATE   |
| C 107 | 5322 125 64012  | 1,6PF |         | 400   | TRIMMER         |
| C 108 | 5322 125 64015  | 4,6PF |         | 500   | TRIMMER         |
| C 109 | 5322 125 64009  | 3PF   |         | 500   | TRIMMER         |
| C 110 | 4822 122 31182  | 1PF   | 0,25PF  | 500   | CERAMIC PLATE   |
| C 111 | 5322 125 64015  | 4,6PF |         | 500   | TRIMMER         |
| C 112 | 5322 123 10158  | 300PF | 10      | 300   | MICA            |
| C 113 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 114 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 116 | 4822 122 31173  | 220PF | 2       | 300   | CERAMIC PLATE   |
| C 117 | 4822 122 31047  | 5,6PF | 0,25PF  | 100   | CERAMIC PLATE   |
| C 118 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 121 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 122 | 5322 125 50049  | 10PF  |         | 300   | TRIMMER         |
| C 123 | 4822 122 30027  | 1NF   | -20+80  | 40    | CERAMIC PLATE   |
| C 128 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 129 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 130 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 200 | 4822 122 31116  | 2,2NF | 10      | 100   | CERAMIC PLATE   |
| C 201 | 4822 122 30099  | 3,3NF | 10      | 100   | CERAMIC PLATE   |
| C 202 | 4822 122 30034  | 470PF | 10      | 100   | CERAMIC PLATE   |
| C 204 | 4822 122 31085  | 150PF | 2       | 100   | CERAMIC PLATE   |
| C 205 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 206 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC    |
| C 207 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 208 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 209 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 211 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 212 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 213 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL  |
| C 214 | 4822 122 31173  | 220PF | 2       | 100   | CERAMIC PLATE   |
| C 216 | 4822 122 31173  | 220PF | 2       | 100   | CERAMIC PLATE   |
| C 217 | 4822 122 31173  | 220PF | 2       | 100   | CERAMIC PLATE   |
| C 218 | 4822 122 31173  | 220PF | 2       | 100   | CERAMIC PLATE   |
| C 376 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 377 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 379 | 4822 122 30048  | 1,8NF | 10      | 100   | CERAMIC PLATE   |
| C 381 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE   |
| C 382 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 401 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 402 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER         |
| C 403 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE   |
| C 404 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 405 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 406 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 407 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE   |
| C 408 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 409 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 410 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 411 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 412 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 413 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE   |
| C 414 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 415 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE   |
| C 416 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER         |
| C 417 | 4822 122 31861  | 18PF  | 2       | 100   | CERAMIC PLATE   |
| C 420 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE   |
| C 423 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 424 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |
| C 425 | 4822 122 30099  | 3,3NF | 10      | 100   | CERAMIC PLATE   |
| C 426 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE   |

| ITEM  | ORDERING NUMBER | FARAD  | TOL (%) | VOLTS | REMARKS        |
|-------|-----------------|--------|---------|-------|----------------|
| C 427 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 428 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 429 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 432 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 501 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 504 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 506 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 507 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 508 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 509 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 511 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 514 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 516 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 517 | 4822 122 30045  | 27PF   | 2       | 100   | CERAMIC PLATE  |
| C 518 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 521 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 522 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 523 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 524 | 4822 122 31863  | 22PF   | 2       | 100   | CERAMIC PLATE  |
| C 526 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 527 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 531 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 532 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 533 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 534 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 536 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 537 | 4822 124 20687  | 15UF   | -10+50  | 16    | ELECTROLYTIC   |
| C 601 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 602 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 603 | 4822 125 50045  | 22PF   |         | 250   | TRIMMER        |
| C 604 | 4822 122 31074  | 56PF   | 2       | 100   | CERAMIC PLATE  |
| C 605 | 4822 122 30045  | 27PF   | 2       | 100   | CERAMIC PLATE  |
| C 606 | 4822 125 50045  | 22PF   |         | 250   | TRIMMER        |
| C 607 | 4822 122 30103  | 22NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 608 | 4822 122 30027  | 1NF    | 10      | 100   | CERAMIC PLATE  |
| C 609 | 4822 122 31116  | 2, 2NF | 10      | 100   | CERAMIC PLATE  |
| C 614 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 616 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 618 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 619 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 621 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 622 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 623 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL |
| C 624 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 626 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 627 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 628 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 629 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 631 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 632 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL |
| C 633 | 4822 122 31054  | 10PF   | 2       | 100   | CERAMIC PLATE  |
| C 634 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 636 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 652 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 653 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 701 | 4822 122 31202  | 33PF   | 2       | 500   | CERAMIC PLATE  |
| C 702 | 4822 122 30099  | 3, 3NF | 10      | 100   | CERAMIC PLATE  |
| C 703 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 704 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 705 | 4822 122 31195  | 10PF   | 2       | 500   | CERAMIC PLATE  |
| C 706 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 707 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 708 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 709 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 711 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 712 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 713 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 714 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 715 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |
| C 716 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE  |

| ITEM   | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS               |
|--------|-----------------|-------|---------|-------|-----------------------|
| C 717  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 751  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 752  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 761  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 762  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 771  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 772  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 781  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 782  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 791  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 792  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 801  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 802  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 803  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 804  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 805  | 4822 122 31036  | 2,2PF | 0,25PF  | 100   | CERAMIC PLATE         |
| C 806  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 807  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 808  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 809  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 850  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 851  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 852  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 853  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 854  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 855  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 856  | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE         |
| C 857  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 858  | 4822 124 20707  | 6,8UF | -10+50  | 40    | ELECTROLYTIC          |
| C 859  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 860  | 4822 122 31047  | 5,6PF | 0,25PF  | 100   | CERAMIC PLATE         |
| C 861  | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE         |
| C 862  | 4822 122 30114  | 2,2NF | 10      | 100   | CERAMIC PLATE         |
| C 863  | 4822 124 20677  | 22UF  | -10+50  | 10    | ELECTROLYTIC          |
| C 864  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 865  | 4822 122 30103  | 22NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 866  | 4822 121 50549  | 442PF | 1       | 250   | POLYSTYRENE FOIL      |
| C 867  | 5322 121 40224  | 4,7UF | 10      | 100   | POLYESTER FOIL        |
| C 868  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 869  | 5322 121 54108  | 47NF  | 1       | 63    | POLYSTYRENE FOIL      |
| C 871  | 5322 124 14158  | 330NF | 10      | 50    | ELECTROLYTIC TANTALUM |
| C 872  | 4822 122 30034  | 470PF | 10      | 100   | CERAMIC PLATE         |
| C 873  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 874  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 876  | 4822 122 30103  | 22NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 878  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 879  | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 881  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 882  | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1001 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1002 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1003 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1004 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1005 | 4822 122 31036  | 2,2PF | 0,25PF  | 100   | CERAMIC PLATE         |
| C 1006 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1007 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1008 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1009 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1051 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1052 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1053 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1054 | 4822 124 20687  | 15UF  | -10+50  | 16    | ELECTROLYTIC          |
| C 1056 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE         |
| C 1057 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |
| C 1058 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE         |
| C 1059 | 5322 121 54076  | 453PF | 1       | 250   | POLYSTYRENE FOIL      |
| C 1060 | 4822 122 31047  | 5,6PF | 0,25PF  | 100   | CERAMIC PLATE         |
| C 1061 | 5322 121 54108  | 47NF  | 1       | 63    | POLYSTYRENE FOIL      |
| C 1062 | 4822 122 30034  | 470PF | 10      | 100   | CERAMIC PLATE         |
| C 1063 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE         |

| ITEM   | ORDERING NUMBER | FARAD  | TOL (%) | VOLTS | REMARKS          |
|--------|-----------------|--------|---------|-------|------------------|
| C 1064 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1066 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1067 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1068 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1069 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1201 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1202 | 4822 122 31215  | 0.68PF | 0.25PF  | 100   | CERAMIC PLATE    |
| C 1203 | 4822 125 50077  | 5.5PF  |         | 250   | TRIMMER          |
| C 1204 | 4822 122 31116  | 2.2NF  | 10      | 500   | CERAMIC PLATE    |
| C 1205 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1206 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1207 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1208 | 4822 125 50077  | 5.5PF  |         | 250   | TRIMMER          |
| C 1209 | 4822 122 31215  | 0.68PF | 0.25PF  | 100   | CERAMIC PLATE    |
| C 1211 | 4822 122 31116  | 2.2NF  | 10      | 500   | CERAMIC PLATE    |
| C 1212 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1213 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1214 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1216 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1301 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1302 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1303 | 4822 122 30104  | 1PF    | 0.25PF  | 100   | CERAMIC PLATE    |
| C 1304 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1306 | 4822 122 30054  | 1.2NF  | 10      | 100   | CERAMIC PLATE    |
| C 1307 | 4822 122 30098  | 3.9NF  | 10      | 100   | CERAMIC PLATE    |
| C 1308 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1309 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1310 | 4822 121 40406  | 15NF   | 10      | 250   | POLYESTER FOIL   |
| C 1311 | 4822 122 31081  | 100PF  | 2       | 100   | CERAMIC PLATE    |
| C 1312 | 5322 122 54006  | 3.3NF  | -20+50  | 3K    | CERAMIC DISK     |
| C 1313 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1314 | 5322 122 54006  | 3.3NF  | -20+50  | 3K    | CERAMIC DISK     |
| C 1316 | 4822 124 20468  | 33UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1317 | 5322 121 40233  | 680NF  |         | 100   | POLYESTER FOIL   |
| C 1318 | 4822 121 50611  | 20NF   | 1       | 63    | POLYSTYRENE FOIL |
| C 1319 | 4822 124 20468  | 33UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1401 | 4822 124 20497  | 15UF   | -10+50  | 63    | ELECTROLYTIC     |
| C 1402 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1403 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1404 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1406 | 5322 122 54006  | 3.3NF  | -20+50  | 3K    | CERAMIC DISK     |
| C 1407 | 4822 121 40363  | 10NF   | 10      | 1600  | POLYESTER FOIL   |
| C 1416 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1417 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1418 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1419 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1421 | 5322 122 54004  | 470PF  |         | 20    | CERAMIC DISK     |
| C 1804 | 5322 121 44142  | 220NF  | 10      | 250   | POLYESTER FOIL   |
| C 1806 | 4822 124 40066  | 2x50UF | -10+30  | 400   | ELECTROLYTIC     |
| C 1807 | 4822 124 20324  | 4UF    | -10+30  | 400   | ELECTROLYTIC     |
| C 1808 | 4822 124 20324  | 4UF    | -10+30  | 400   | ELECTROLYTIC     |
| C 1809 | 4822 124 20306  | 50UF   | -10+30  | 100   | ELECTROLYTIC     |
| C 1810 | 4822 124 20681  | 220UF  | -10+50  | 4     | ELECTROLYTIC     |
| C 1811 | 4822 121 40427  | 220NF  | 10      | 100   | POLYESTER FOIL   |
| C 1812 | 4822 124 20722  | 1UF    | -10+50  | 63    | ELECTROLYTIC     |
| C 1814 | 4822 124 20484  | 15UF   | -10+50  | 40    | ELECTROLYTIC     |
| C 1816 | 4822 124 20461  | 47UF   | -10+50  | 10    | ELECTROLYTIC     |
| C 1817 | 4822 121 40443  | 680NF  | 10      | 100   | POLYESTER FOIL   |
| C 1818 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1819 | 4822 122 30099  | 3.3NF  | 10      | 100   | CERAMIC PLATE    |
| C 1821 | 4822 121 41161  | 22UF   | -10+50  | 10    | POLYESTER FOIL   |
| C 1822 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1823 | 4822 124 20587  | 100UF  | -10+50  | 25    | ELECTROLYTIC     |
| C 1824 | 4822 121 41169  | 220NF  | 10      | 250   | POLYESTER FOIL   |
| C 1826 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1827 | 4822 124 20457  | 470UF  | -10+50  | 6,3   | ELECTROLYTIC     |
| C 1828 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1829 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1830 | 4822 121 40298  | 4.7NF  | 10      | 1600  | POLYESTER FOIL   |
| C 1831 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1832 | 4822 121 41161  | 100NF  | 10      | 250   | POLYESTER FOIL   |
| C 1833 | 4822 124 20497  | 15UF   | -10+50  | 63    | ELECTROLYTIC     |
| C 1834 | 4822 124 20497  | 15UF   | -10+50  | 63    | ELECTROLYTIC     |
| C 1836 | 4822 124 20469  | 68UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1837 | 4822 124 20469  | 68UF   | -10+50  | 16    | ELECTROLYTIC     |



| ITEM   | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| C 1838 | 4822 124 20469  | 68UF  | -10+50  | 16    | ELECTROLYTIC  |
| C 1839 | 4822 124 20469  | 68UF  | -10+50  | 16    | ELECTROLYTIC  |
| C 1841 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1842 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1843 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1844 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1846 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1847 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1848 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 1849 | 4822 124 20454  | 150UF | -10+50  | 6,3   | ELECTROLYTIC  |
| C 2376 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2377 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2379 | 4822 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE |
| C 2381 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2382 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2401 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2402 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2403 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2404 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2405 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2406 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2407 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2408 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2409 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2410 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2411 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2412 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2413 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2414 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2415 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2416 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2417 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2420 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2423 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2424 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2425 | 4822 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE |
| C 2426 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2427 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2428 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2429 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2432 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2576 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2577 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2579 | 4822 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE |
| C 2580 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2581 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2582 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2601 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2602 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2603 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2604 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2605 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2606 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2607 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2608 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2609 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2610 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2611 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2612 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2613 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2614 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2615 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2616 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2617 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2620 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2623 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2624 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2625 | 4822 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE |
| C 2626 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2627 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |

| ITEM   | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| C 2628 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2629 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2632 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2776 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2777 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2779 | 4822 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE |
| C 2781 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2782 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2801 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2802 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2803 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2804 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2805 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2806 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2807 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2808 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2809 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2810 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2811 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2812 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2813 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2814 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2815 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2816 | 4822 125 50045  | 22PF  |         | 250   | TRIMMER       |
| C 2817 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2820 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2823 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2824 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2825 | 4822 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE |
| C 2826 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2827 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2828 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2829 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2832 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |

## Resistors

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE   | REMARKS                     |
|-------|-----------------|-------|---------|--------|-----------------------------|
| R 1   | 5322 101 44014  | 100K  | 20      |        | CARBON POTM LIN + SWITCH    |
| R 2   | 5322 103 54027  | 5K    | 5       | 2W     | MULTITURN W-W POTENTIOMETER |
| R 3   | 5322 101 44014  | 100K  | 20      |        | CARBON POTM LIN + SWITCH    |
| R 4   | 5322 101 44015  | 50K   | 20      |        | CARBON POTM LIN + SWITCH    |
| R 5   | 5322 101 40041  | 4,7K  | 20      | 0.25W  | CARBON POTM LIN + SWITCH    |
| R 6   | 5322 101 40041  | 4,7K  | 20      | 0.25W  | CARBON POTM LIN + SWITCH    |
| R 7   | 5322 101 64027  | 10K   | 20      | 0.1W   | CARBON POTM LIN + SWITCH    |
| R 8   | 5322 101 24099  | 10K   | 20      | 0.1W   | CARBON POTM LIN             |
| R 9   | 5322 101 34016  | 47K   | 20      | 0.1W   | CARBON POTM LOG             |
| R 10  | 5322 101 24108  | 500   |         | 0.5W   | CARBON POTM LIN             |
| R 11  | 5322 101 24091  | 47K   | 20      | 0.1W   | CARBON POTM LIN             |
| R 12  | 5322 101 24055  | 25K   | 20      |        | CARBON POTM LIN             |
| R 13  | 5322 101 34018  | 4,7K  | 20      | 0.1W   | CARBON POTM LOG             |
| R 14  | 5322 101 24062  | 2,2M  | 20      | 0.1W   | CARBON POTM LOG             |
| R 101 | 5322 116 64048  | 56    | 5       | 0.125W | METAL OXIDE                 |
| R 102 | 5322 116 55218  | 920K  | 0,5     | MR30   | METAL FILM                  |
| R 103 | 5322 116 64052  | 39    | 5       | 0.125W | METAL FILM                  |
| R 104 | 5322 116 55067  | 88,9K | 0,25    | MR24C  | METAL FILM                  |
| R 106 | 5322 116 64046  | 51    | 5       | 0.125W | METAL OXIDE                 |
| R 107 | 5322 116 55239  | 200K  | 0,5     | MR25   | METAL FILM                  |
| R 108 | 5322 116 64045  | 10    | 5       | 0.125W | METAL OXIDE                 |
| R 109 | 5322 116 64047  | 560   | 5       | 0.125W | METAL OXIDE                 |
| R 111 | 5322 116 64047  | 560   | 5       | 0.125W | METAL OXIDE                 |
| R 112 | 5322 116 64048  | 56    | 5       | 0.125W | METAL OXIDE                 |
| R 113 | 5322 116 55153  | 992K  | 0,5     | SPEC   | METAL FILM                  |
| R 114 | 5322 116 64049  | 47    | 5       | 0.125W | METAL OXIDE                 |
| R 116 | 5322 116 55066  | 8,08K | 0,25    | MR24C  | METAL FILM                  |
| R 117 | 5322 116 64051  | 15    | 5       | 0.125W | METAL OXIDE                 |
| R 118 | 5322 116 64051  | 15    | 5       | 0.125W | METAL OXIDE                 |
| R 119 | 5322 111 30376  | 100M  | 5       | 0.125W | CARBON                      |
| R 120 | 4822 111 30324  | 100   | 5       | CR16   | CARBON                      |
| R 121 | 5322 116 50729  | 4,22K | 1       | MR25   | METAL FILM                  |
| R 122 | 5322 116 54012  | 6,81K | 1       | MR25   | METAL FILM                  |
| R 123 | 5322 116 54519  | 402   | 1       | MR25   | METAL FILM                  |
| R 124 | 5322 116 54208  | 210K  | 1       | MR25   | METAL FILM                  |
| R 126 | 5322 116 54774  | 590K  | 1       | MR30   | METAL FILM                  |
| R 127 | 5322 116 54038  | 221K  | 1       | MR25   | METAL FILM                  |
| R 128 | 4822 110 42214  | 10M   | 5       | VR37   | CARBON                      |
| R 129 | 5322 100 10143  | 1K    | 20      | 0.75W  | TRIMMING POTM               |
| R 131 | 5322 116 54208  | 210K  | 1       | MR25   | METAL FILM                  |
| R 132 | 5322 100 10141  | 10K   | 20      | 0.75W  | TRIMMING POTM               |
| R 133 | 5322 116 54689  | 82,5K | 1       | MR25   | METAL FILM                  |
| R 134 | 4822 110 42227  | 33M   | 5       | VR37   | CARBON                      |
| R 139 | 5322 116 50672  | 51,1K | 1       | MR25   | METAL FILM                  |
| R 140 | 4822 110 63047  | 5,6   | 5       | CR25   | CARBON                      |
| R 141 | 5322 100 10141  | 10K   | 20      | 0.75W  | TRIMMING POTM               |
| R 148 | 5322 116 50592  | 442   | 1       | MR25   | METAL FILM                  |
| R 149 | 5322 116 50592  | 442   | 1       | MR25   | METAL FILM                  |
| R 201 | 5322 116 54466  | 90,9  | 1       | MR25   | METAL FILM                  |
| R 202 | 5322 116 54466  | 90,9  | 1       | MR25   | METAL FILM                  |
| R 203 | 5322 116 54571  | 1,96K | 1       | MR25   | METAL FILM                  |
| R 204 | 5322 116 50417  | 162   | 1       | MR25   | METAL FILM                  |
| R 208 | 5322 116 50414  | 2,87K | 1       | MR25   | METAL FILM                  |
| R 209 | 5322 116 50586  | 1,54K | 1       | MR25   | METAL FILM                  |
| R 211 | 5322 116 50675  | 2,26K | 1       | MR25   | METAL FILM                  |
| R 212 | 5322 116 50568  | 4,99  | 1       | MR25   | METAL FILM                  |
| R 213 | 5322 116 54012  | 6,81K | 1       | MR25   | METAL FILM                  |
| R 214 | 5322 116 54012  | 6,81K | 1       | MR25   | METAL FILM                  |
| R 216 | 5322 116 54012  | 6,81K | 1       | MR25   | METAL FILM                  |
| R 217 | 5322 116 54012  | 6,81K | 1       | MR25   | METAL FILM                  |
| R 218 | 5322 116 50481  | 22,6K | 1       | MR25   | METAL FILM                  |
| R 219 | 5322 116 50556  | 4,42K | 1       | MR25   | METAL FILM                  |
| R 221 | 5322 116 50481  | 22,6K | 1       | MR25   | METAL FILM                  |
| R 222 | 5322 116 50556  | 4,42K | 1       | MR25   | METAL FILM                  |
| R 223 | 5322 116 50481  | 22,6K | 1       | MR25   | METAL FILM                  |
| R 224 | 5322 116 50556  | 4,42K | 1       | MR25   | METAL FILM                  |
| R 226 | 5322 116 50481  | 22,6K | 1       | MR25   | METAL FILM                  |
| R 227 | 5322 116 50556  | 4,42K | 1       | MR25   | METAL FILM                  |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|-------|-----------------|-------|---------|------|---------------|
| R 228 | 5322 116 50481  | 22,6K | 1       | MR25 | METAL FILM    |
| R 229 | 5322 116 50556  | 4,42K | 1       | MR25 | METAL FILM    |
| R 231 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 232 | 5322 116 54619  | 10K   | 1       | MR25 | METAL FILM    |
| R 233 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 234 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 236 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 237 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 238 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 239 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM    |
| R 241 | 5322 116 50556  | 4,42K | 1       | MR25 | METAL FILM    |
| R 242 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 376 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 377 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 378 | 5322 116 50558  | 18,7K | 1       | MR25 | METAL FILM    |
| R 379 | 5322 101 14048  | 47K   | 20      | 0.5W | TRIMMING POTM |
| R 381 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 382 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 383 | 5322 116 54557  | 1,21K | 1       | MR25 | METAL FILM    |
| R 387 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 388 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 389 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 390 | 5322 116 54541  | 825   | 1       | MR25 | METAL FILM    |
| R 391 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 392 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 393 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 394 | 5322 116 54439  | 35,7  | 1       | MR25 | METAL FILM    |
| R 396 | 5322 116 54548  | 976   | 1       | MR25 | METAL FILM    |
| R 397 | 5322 116 54439  | 35,7  | 1       | MR25 | METAL FILM    |
| R 398 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 401 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 402 | 5322 116 54508  | 301   | 1       | MR25 | METAL FILM    |
| R 403 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 404 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 405 | 5322 116 54464  | 86,6  | 1       | MR25 | METAL FILM    |
| R 406 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 407 | 5322 116 50492  | 46,4  | 1       | MR25 | METAL FILM    |
| R 408 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 409 | 5322 116 50492  | 46,4  | 1       | MR25 | METAL FILM    |
| R 410 | 5322 116 34036  | 47    | 5       | 0.5W | NTC           |
| R 411 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 412 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 413 | 5322 116 50515  | 1,78K | 1       | MR25 | METAL FILM    |
| R 414 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 416 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 417 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 418 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 419 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 420 | 5322 116 54464  | 86,6  | 1       | MR25 | METAL FILM    |
| R 421 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 422 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 423 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 424 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 426 | 5322 116 54587  | 3,65K | 1       | MR25 | METAL FILM    |
| R 427 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 428 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 429 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 431 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 432 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 433 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 434 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 436 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 437 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 438 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 439 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 440 | 5322 116 54581  | 2,94K | 1       | MR25 | METAL FILM    |
| R 441 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |
| R 442 | 5322 100 10112  | 1K    | 20      | 0.5W | TRIMMING POTM |
| R 443 | 5322 116 54515  | 348   | 1       | MR25 | METAL FILM    |
| R 444 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|-------|-----------------|-------|---------|------|---------------|
| R 445 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 446 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 447 | 5322 116 50442  | 48,7K | 1       | MR25 | METAL FILM    |
| R 448 | 5322 100 10113  | 10K   | 20      | 0,5W | TRIMMING POTM |
| R 461 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 463 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 464 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 465 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 466 | 5322 116 54585  | 3,48K | 1       | MR25 | METAL FILM    |
| R 467 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 468 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 469 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 471 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 472 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 473 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 474 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 476 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 477 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 478 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 479 | 5322 116 50621  | 536   | 1       | MR25 | METAL FILM    |
| R 481 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 482 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 483 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 484 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 486 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 487 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 488 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 500 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 501 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 502 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 503 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 504 | 5322 116 50511  | 48,7  | 1       | MR25 | METAL FILM    |
| R 505 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 506 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 507 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 511 | 5322 116 54258  | 9,53  | 1       | MR25 | METAL FILM    |
| R 512 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 513 | 5322 116 54258  | 9,53  | 1       | MR25 | METAL FILM    |
| R 514 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 516 | 5322 116 54258  | 9,53  | 1       | MR25 | METAL FILM    |
| R 517 | 5322 116 54258  | 9,53  | 1       | MR25 | METAL FILM    |
| R 520 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 521 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 522 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 523 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 524 | 5322 116 50511  | 48,7  | 1       | MR25 | METAL FILM    |
| R 525 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 526 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 527 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 528 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 529 | 5322 116 54621  | 10,2K | 1       | MR25 | METAL FILM    |
| R 531 | 5322 101 14048  | 47K   | 20      | 0,5W | TRIMMING POTM |
| R 532 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 533 | 5322 116 54643  | 20,5K | 1       | MR25 | METAL FILM    |
| R 534 | 5322 111 44156  | 510   | 5       | CR16 | CARBON        |
| R 536 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 537 | 5322 116 55273  | 196   | 1       | MR25 | METAL FILM    |
| R 538 | 5322 116 50555  | 1,27K | 1       | MR25 | METAL FILM    |
| R 539 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 541 | 5322 116 55273  | 196   | 1       | MR25 | METAL FILM    |
| R 542 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 543 | 5322 116 50593  | 16,2K | 1       | MR25 | METAL FILM    |
| R 544 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 546 | 5322 111 44156  | 510   | 5       | CR16 | CARBON        |
| R 547 | 5322 116 54541  | 825   | 1       | MR25 | METAL FILM    |
| R 548 | 5322 101 14069  | 22K   | 20      | 0,5W | TRIMMING POTM |
| R 549 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 551 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 552 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 553 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|-------|-----------------|-------|---------|------|--------------------|
| R 554 | 5322 116        | 50506 | 154     | 1    | MR25 METAL FILM    |
| R 556 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 557 | 5322 116        | 50511 | 48,7    | 1    | MR25 METAL FILM    |
| R 558 | 5322 116        | 54561 | 1,33K   | 1    | MR25 METAL FILM    |
| R 559 | 5322 116        | 50569 | 95,3    | 1    | MR25 METAL FILM    |
| R 560 | 4822 111        | 30324 | 100     | 5    | CR16 CARBON        |
| R 561 | 5322 116        | 50506 | 154     | 1    | MR25 METAL FILM    |
| R 562 | 5322 116        | 50311 | 48,7    | 1    | MR25 METAL FILM    |
| R 563 | 5322 116        | 54561 | 1,33K   | 1    | MR25 METAL FILM    |
| R 564 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 566 | 5322 116        | 50452 | 10      | 1    | MR25 METAL FILM    |
| R 567 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 568 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 569 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 571 | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 572 | 5322 116        | 54258 | 9,53    | 1    | MR25 METAL FILM    |
| R 573 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 574 | 5322 116        | 54258 | 9,53    | 1    | MR25 METAL FILM    |
| R 576 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 577 | 5322 116        | 54258 | 9,53    | 1    | MR25 METAL FILM    |
| R 578 | 5322 116        | 54258 | 9,53    | 1    | MR25 METAL FILM    |
| R 579 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 581 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 601 | 5322 116        | 50926 | 40,2    | 1    | MR25 METAL FILM    |
| R 602 | 5322 116        | 54506 | 287     | 1    | MR25 METAL FILM    |
| R 603 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 604 | 5322 116        | 54492 | 178     | 1    | MR25 METAL FILM    |
| R 606 | 5322 116        | 55273 | 196     | 1    | MR25 METAL FILM    |
| R 607 | 5322 116        | 54519 | 402     | 1    | MR25 METAL FILM    |
| R 608 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 609 | 5322 116        | 54492 | 178     | 1    | MR25 METAL FILM    |
| R 610 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 611 | 5322 116        | 50926 | 40,2    | 1    | MR25 METAL FILM    |
| R 612 | 5322 116        | 54506 | 287     | 1    | MR25 METAL FILM    |
| R 613 | 5322 116        | 50506 | 154     | 1    | MR25 METAL FILM    |
| R 614 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 615 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 616 | 5322 116        | 54444 | 53,6    | 1    | MR25 METAL FILM    |
| R 617 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 618 | 5322 116        | 54444 | 53,6    | 1    | MR25 METAL FILM    |
| R 619 | 5322 100        | 14009 | 220     | 20   | 0,5W TRIMMING POTM |
| R 621 | 5322 100        | 10114 | 4,7K    | 20   | 0,5W TRIMMING POTM |
| R 622 | 5322 100        | 10113 | 10K     | 20   | 0,5W TRIMMING POTM |
| R 623 | 5322 116        | 54613 | 8,66K   | 1    | MR25 METAL FILM    |
| R 624 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 627 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 628 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 629 | 5322 116        | 54608 | 7,5K    | 1    | MR25 METAL FILM    |
| R 630 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 631 | 5322 116        | 50596 | 4,42K   | 1    | MR25 METAL FILM    |
| R 632 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 633 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 634 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 636 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 637 | 5322 116        | 50457 | 215     | 1    | MR25 METAL FILM    |
| R 638 | 5322 116        | 50669 | 205     | 1    | MR25 METAL FILM    |
| R 639 | 5322 116        | 54451 | 61,9    | 1    | MR25 METAL FILM    |
| R 641 | 5322 101        | 14047 | 470     | 20   | 0,5W TRIMMING POTM |
| R 642 | 5322 116        | 50457 | 215     | 1    | MR25 METAL FILM    |
| R 644 | 5322 116        | 50669 | 205     | 1    | MR25 METAL FILM    |
| R 646 | 5322 116        | 54451 | 61,9    | 1    | MR25 METAL FILM    |
| R 647 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 648 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 649 | 5322 116        | 50515 | 1,78K   | 1    | MR25 METAL FILM    |
| R 650 | 5322 116        | 55277 | 9,09K   | 1    | MR25 METAL FILM    |
| R 651 | 5322 116        | 54585 | 3,48K   | 1    | MR25 METAL FILM    |
| R 652 | 5322 116        | 50474 | 42,2K   | 1    | MR25 METAL FILM    |
| R 653 | 5322 116        | 50417 | 162     | 1    | MR25 METAL FILM    |
| R 654 | 5322 116        | 54011 | 5,62K   | 1    | MR25 METAL FILM    |
| R 655 | 5322 116        | 50904 | 30,1    | 1    | MR25 METAL FILM    |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS         |
|-------|-----------------|-------|---------|------|-----------------|
| R 656 | 5322 116 54557  | 1,21K | 1       | MR25 | METAL FILM      |
| R 657 | 5322 116 50579  | 3,16K | 1       | MR25 | METAL FILM      |
| R 658 | 5322 116 54516  | 365   | 1       | MR25 | METAL FILM      |
| R 659 | 4822 111 30067  | 33    | 5       | CR16 | CARBON          |
| R 660 | 5322 116 54516  | 365   | 1       | MR25 | METAL FILM      |
| R 661 | 5322 116 50509  | 4,87K | 1       | MR25 | METAL FILM      |
| R 662 | 5322 116 50579  | 3,16K | 1       | MR25 | METAL FILM      |
| R 663 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM      |
| R 664 | 5322 116 54557  | 1,21K | 1       | MR25 | METAL FILM      |
| R 665 | 5322 116 55277  | 9,09K | 1       | MR25 | METAL FILM      |
| R 666 | 5322 116 54011  | 5,62K | 1       | MR25 | METAL FILM      |
| R 667 | 4822 111 30245  | 47    | 5       | CR16 | CARBON          |
| R 668 | 5322 116 50515  | 1,78K | 1       | MR25 | METAL FILM      |
| R 669 | 5322 116 54585  | 3,48K | 1       | MR25 | METAL FILM      |
| R 671 | 5322 116 50474  | 42,2K | 1       | MR25 | METAL FILM      |
| R 672 | 5322 116 50417  | 162   | 1       | MR25 | METAL FILM      |
| R 681 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM      |
| R 682 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM      |
| R 683 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM      |
| R 684 | 5322 101 20408  | 100K  | 20      | 0.1W | CARBON POTM LIN |
| R 700 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 701 | 5322 116 54743  | 301K  | 1       | MR25 | METAL FILM      |
| R 702 | 5322 116 54038  | 221K  | 1       | MR25 | METAL FILM      |
| R 703 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM      |
| R 704 | 5322 116 54263  | 681K  | 1       | MR30 | METAL FILM      |
| R 705 | 5322 101 14051  | 220   | 20      | 0.5W | TRIMMING POTM   |
| R 706 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 707 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 708 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM      |
| R 709 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 711 | 5322 116 54676  | 56,2K | 1       | MR25 | METAL FILM      |
| R 712 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 713 | 5322 116 54585  | 3,48K | 1       | MR25 | METAL FILM      |
| R 714 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM      |
| R 716 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 717 | 5322 116 54567  | 3,65K | 1       | MR25 | METAL FILM      |
| R 718 | 5322 116 50515  | 1,78K | 1       | MR25 | METAL FILM      |
| R 719 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM      |
| R 720 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM      |
| R 721 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM      |
| R 722 | 5322 116 54536  | 750   | 1       | MR25 | METAL FILM      |
| R 723 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 724 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 725 | 5322 116 50954  | 38,3  | 1       | MR25 | METAL FILM      |
| R 726 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 727 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM      |
| R 728 | 5322 116 50636  | 2,74K | 1       | MR25 | METAL FILM      |
| R 729 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 731 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM      |
| R 732 | 5322 116 50664  | 2,05K | 1       | MR25 | METAL FILM      |
| R 733 | 5322 116 54536  | 750   | 1       | MR25 | METAL FILM      |
| R 734 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 735 | 5322 116 50635  | 1,47K | 1       | MR25 | METAL FILM      |
| R 736 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 737 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM      |
| R 738 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM      |
| R 739 | 5322 116 50636  | 2,74K | 1       | MR25 | METAL FILM      |
| R 740 | 5322 116 50954  | 38,3  | 1       | MR25 | METAL FILM      |
| R 741 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 742 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 743 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 751 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM      |
| R 752 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 753 | 5322 116 54554  | 1,1K  | 1       | MR25 | METAL FILM      |
| R 754 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM      |
| R 756 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 757 | 5322 116 54554  | 1,1K  | 1       | MR25 | METAL FILM      |
| R 761 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM      |
| R 762 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM      |
| R 763 | 5322 116 54554  | 1,1K  | 1       | MR25 | METAL FILM      |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS    |
|-------|-----------------|-------|---------|------|------------|
| R 764 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 766 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 767 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 771 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 772 | 5322 116 50452  | 100   | 1       | MR25 | METAL FILM |
| R 773 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 774 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 776 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 777 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 781 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 782 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 783 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 784 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 786 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 787 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 791 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 792 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 793 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 794 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM |
| R 796 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM |
| R 797 | 5322 116 54554  | 1.1K  | 1       | MR25 | METAL FILM |
| R 801 | 4822 111 30324  | 100   | 5       | CR16 | CARBON     |
| R 802 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 803 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM |
| R 804 | 4822 111 30263  | 3,3K  | 5       | CR16 | CARBON     |
| R 806 | 5322 116 54586  | 1,54K | 1       | MR25 | METAL FILM |
| R 807 | 5322 116 50895  | 18,7  | 1       | MR25 | METAL FILM |
| R 808 | 5322 116 50895  | 18,7  | 1       | MR25 | METAL FILM |
| R 809 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 811 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM |
| R 812 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM |
| R 813 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 814 | 5322 116 54592  | 4,02K | 1       | MR25 | METAL FILM |
| R 816 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 817 | 5322 116 50415  | 1,15K | 1       | MR25 | METAL FILM |
| R 818 | 5322 116 50415  | 1,15K | 1       | MR25 | METAL FILM |
| R 819 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 821 | 4822 110 63054  | 10    | 5       | CR25 | CARBON     |
| R 822 | 5322 116 54683  | 68,1K | 1       | MR25 | METAL FILM |
| R 823 | 5322 116 50636  | 2,74K | 1       | MR25 | METAL FILM |
| R 824 | 5322 116 54683  | 68,1K | 1       | MR25 | METAL FILM |
| R 826 | 5322 116 54552  | 1,05K | 1       | MR25 | METAL FILM |
| R 827 | 5322 116 50635  | 1,47K | 1       | MR25 | METAL FILM |
| R 828 | 5322 116 50635  | 1,47K | 1       | MR25 | METAL FILM |
| R 829 | 5322 116 54552  | 1,05K | 1       | MR25 | METAL FILM |
| R 831 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 832 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 833 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM |
| R 834 | 5322 116 50506  | 154   | 1       | MR25 | METAL FILM |
| R 836 | 5322 116 54508  | 301   | 1       | MR25 | METAL FILM |
| R 837 | 5322 116 54552  | 1,05K | 1       | MR25 | METAL FILM |
| R 838 | 5322 111 30396  | 22    | 5       | CR16 | CARBON     |
| R 839 | 5322 116 54552  | 1,05K | 1       | MR25 | METAL FILM |
| R 840 | 4822 111 30067  | 33    | 5       | CR16 | CARBON     |
| R 841 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM |
| R 842 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM |
| R 843 | 4822 110 63054  | 10    | 5       | CR25 | CARBON     |
| R 844 | 4822 110 63054  | 10    | 5       | CR25 | CARBON     |
| R 851 | 4822 110 63036  | 2,2   | 5       | CR25 | CARBON     |
| R 852 | 4822 110 63036  | 2,2   | 5       | CR25 | CARBON     |
| R 853 | 4822 110 63036  | 2,2   | 5       | CR25 | CARBON     |
| R 854 | 4822 110 63036  | 2,2   | 5       | CR25 | CARBON     |
| R 856 | 5322 116 54564  | 1,5K  | 1       | MR25 | METAL FILM |
| R 857 | 5322 111 44156  | 510   | 5       | CR16 | CARBON     |
| R 858 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM |
| R 859 | 5322 116 54619  | 10K   | 1       | MR25 | METAL FILM |
| R 861 | 5322 116 54629  | 10K   | 1       | MR25 | METAL FILM |
| R 862 | 5322 111 34094  | 620   | 5       | CR16 | CARBON     |
| R 863 | 4822 111 30303  | 8,2K  | 5       | CR16 | CARBON     |
| R 864 | 4822 111 30119  | 3K    | 5       | CR16 | CARBON     |



| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|-------|-----------------|-------|---------|------|--------------------|
| R 867 | 5322 116        | 50561 | 590     | 1    | MR25 METAL FILM    |
| R 868 | 5322 116        | 54011 | 5,62K   | 1    | MR25 METAL FILM    |
| R 869 | 5322 116        | 54585 | 3,48K   | 1    | MR25 METAL FILM    |
| R 871 | 5322 111        | 44153 | 15      | 5    | CR16 CARBON        |
| R 872 | 5322 116        | 54474 | 110     | 1    | MR25 METAL FILM    |
| R 873 | 5322 101        | 14069 | 22K     | 20   | 0,5W TRIMMING POTM |
| R 874 | 5322 116        | 54643 | 20,5K   | 1    | MR25 METAL FILM    |
| R 876 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 877 | 5322 116        | 54597 | 5,36K   | 1    | MR25 METAL FILM    |
| R 878 | 5322 116        | 50415 | 1,15K   | 1    | MR25 METAL FILM    |
| R 879 | 5322 116        | 54481 | 130     | 1    | MR25 METAL FILM    |
| R 880 | 5322 116        | 54585 | 3,48K   | 1    | MR25 METAL FILM    |
| R 881 | 5322 116        | 55273 | 196     | 1    | MR25 METAL FILM    |
| R 882 | 5322 116        | 54696 | 100K    | 1    | MR25 METAL FILM    |
| R 883 | 5322 116        | 54632 | 14,7K   | 1    | MR25 METAL FILM    |
| R 884 | 5322 116        | 54632 | 14,7K   | 1    | MR25 METAL FILM    |
| R 885 | 5322 116        | 50583 | 5,9K    | 1    | MR25 METAL FILM    |
| R 886 | 5322 116        | 50481 | 22,6K   | 1    | MR25 METAL FILM    |
| R 887 | 5322 116        | 59459 | 422     | 1    | MR25 METAL FILM    |
| R 888 | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 889 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 890 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 891 | 5322 116        | 50675 | 2,26K   | 1    | MR25 METAL FILM    |
| R 892 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 893 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 894 | 5322 116        | 50509 | 4,87K   | 1    | MR25 METAL FILM    |
| R 895 | 5322 116        | 50586 | 1,54K   | 1    | MR25 METAL FILM    |
| R 896 | 5322 116        | 50636 | 2,74K   | 1    | MR25 METAL FILM    |
| R 897 | 5322 116        | 54519 | 402     | 1    | MR25 METAL FILM    |
| R 898 | 5322 116        | 54534 | 681     | 1    | MR25 METAL FILM    |
| R 899 | 5322 116        | 50452 | 10      | 1    | MR25 METAL FILM    |
| R 900 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 901 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 902 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 903 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 904 | 5322 116        | 50636 | 2,74K   | 1    | MR25 METAL FILM    |
| R 905 | 5322 116        | 54587 | 3,65K   | 1    | MR25 METAL FILM    |
| R 906 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 907 | 5322 116        | 50556 | 4,42K   | 1    | MR25 METAL FILM    |
| R 908 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 909 | 5322 116        | 55236 | 898     | 0,5  | MR25 METAL FILM    |
| R 910 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 911 | 5322 116        | 50579 | 3,16K   | 1    | MR25 METAL FILM    |
| R 912 | 5322 116        | 50556 | 4,42K   | 1    | MR25 METAL FILM    |
| R 913 | 5322 116        | 50664 | 2,05K   | 1    | MR25 METAL FILM    |
| R 914 | 5322 100        | 10114 | 4,7K    | 20   | 0,5W TRIMMING POTM |
| R 915 | 5322 116        | 54624 | 11,5K   | 1    | MR25 METAL FILM    |
| R 916 | 5322 116        | 50481 | 22,6K   | 1    | MR25 METAL FILM    |
| R 917 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 918 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 919 | 5322 116        | 50559 | 27,4K   | 1    | MR25 METAL FILM    |
| R 920 | 5322 116        | 54466 | 90,9    | 1    | MR25 METAL FILM    |
| R 921 | 5322 116        | 50559 | 27,4K   | 1    | MR25 METAL FILM    |
| R 922 | 5322 116        | 50556 | 4,42K   | 1    | MR25 METAL FILM    |
| R 923 | 5322 116        | 50556 | 4,42K   | 1    | MR25 METAL FILM    |
| R 925 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 926 | 5322 116        | 54011 | 5,62K   | 1    | MR25 METAL FILM    |
| R 927 | 5322 116        | 54011 | 5,62K   | 1    | MR25 METAL FILM    |
| R 928 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 929 | 5322 116        | 55276 | 13,3K   | 1    | MR25 METAL FILM    |
| R 931 | 4822 111        | 30352 | 82      | 5    | CR16 CARBON        |
| R 932 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 933 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 934 | 5322 111        | 30279 | 33K     | 5    | CR16 CARBON        |
| R 936 | 5322 116        | 54565 | 1,62K   | 1    | MR25 METAL FILM    |
| R 937 | 5322 111        | 44156 | 510     | 5    | CR16 CARBON        |
| R 939 | 5322 111        | 44156 | 510     | 5    | CR16 CARBON        |
| R 941 | 4822 111        | 30327 | 220     | 5    | CR16 CARBON        |
| R 942 | 5322 116        | 54632 | 14,7K   | 1    | MR25 METAL FILM    |
| R 944 | 5322 116        | 50664 | 2,05K   | 1    | MR25 METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| R 946  | 5322 116        | 54608 | 7,5K    | 1    | MR25 METAL FILM    |
| R 947  | 5322 116        | 50508 | 487     | 1    | MR25 METAL FILM    |
| R 948  | 5322 116        | 54617 | 9,53K   | 1    | MR25 METAL FILM    |
| R 949  | 5322 116        | 54576 | 2,37K   | 1    | MR25 METAL FILM    |
| R 961  | 5322 116        | 54408 | 909K    | 1    | MR30 METAL FILM    |
| R 962  | 5322 116        | 54762 | 365K    | 1    | MR30 METAL FILM    |
| R 963  | 5322 116        | 55234 | 35,2K   | 0,5  | MR25 METAL FILM    |
| R 964  | 5322 116        | 55232 | 17,2K   | 0,5  | MR25 METAL FILM    |
| R 966  | 5322 116        | 55235 | 8,16K   | 0,5  | MR25 METAL FILM    |
| R 967  | 4822 116        | 51283 | 2,71K   | 0,5  | MR25 METAL FILM    |
| R 968  | 5322 116        | 55236 | 898     | 0,5  | MR25 METAL FILM    |
| R 969  | 5322 116        | 54722 | 182K    | 1    | MR25 METAL FILM    |
| R 971  | 5322 116        | 55237 | 89,8K   | 0,5  | MR25 METAL FILM    |
| R 976  | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 977  | 5322 116        | 50729 | 4,22K   | 1    | MR25 METAL FILM    |
| R 978  | 5322 116        | 50451 | 21,5K   | 1    | MR25 METAL FILM    |
| R 979  | 5322 101        | 14069 | 22K     | 20   | 0.5W TRIMMING POTM |
| R 981  | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 982  | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 983  | 5322 116        | 50484 | 4,64K   | 1    | MR25 METAL FILM    |
| R 984  | 5322 116        | 50664 | 2,05K   | 1    | MR25 METAL FILM    |
| R 986  | 5322 116        | 50451 | 21,5K   | 1    | MR25 METAL FILM    |
| R 987  | 5322 101        | 14069 | 22K     | 20   | 0.5W TRIMMING POTM |
| R 1001 | 4822 111        | 30324 | 100     | 5    | CR16 CARBON        |
| R 1002 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1003 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 1004 | 4822 111        | 30263 | 3,3K    | 5    | CR16 CARBON        |
| R 1006 | 5322 116        | 50586 | 1,54K   | 1    | MR25 METAL FILM    |
| R 1007 | 5322 116        | 50895 | 18,7    | 1    | MR25 METAL FILM    |
| R 1008 | 5322 116        | 50895 | 18,7    | 1    | MR25 METAL FILM    |
| R 1009 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1011 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 1012 | 5322 116        | 54525 | 511     | 1    | MR25 METAL FILM    |
| R 1013 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1014 | 5322 116        | 54592 | 4,02K   | 1    | MR25 METAL FILM    |
| R 1016 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1017 | 5322 116        | 50415 | 1,15K   | 1    | MR25 METAL FILM    |
| R 1018 | 5322 116        | 50415 | 1,15K   | 1    | MR25 METAL FILM    |
| R 1019 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1021 | 4822 110        | 63054 | 10      | 5    | CR25 CARBON        |
| R 1022 | 5322 116        | 54683 | 68,1K   | 1    | MR25 METAL FILM    |
| R 1023 | 5322 116        | 50636 | 2,74K   | 1    | MR25 METAL FILM    |
| R 1024 | 5322 116        | 54683 | 68,1K   | 1    | MR25 METAL FILM    |
| R 1026 | 5322 116        | 54552 | 1,05K   | 1    | MR25 METAL FILM    |
| R 1027 | 5322 116        | 50635 | 1,47K   | 1    | MR25 METAL FILM    |
| R 1028 | 5322 116        | 50635 | 1,47K   | 1    | MR25 METAL FILM    |
| R 1029 | 5322 116        | 54552 | 1,05K   | 1    | MR25 METAL FILM    |
| R 1031 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1032 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1033 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 1034 | 5322 116        | 50506 | 154     | 1    | MR25 METAL FILM    |
| R 1036 | 5322 116        | 54508 | 301     | 1    | MR25 METAL FILM    |
| R 1037 | 5322 116        | 54552 | 1,05K   | 1    | MR25 METAL FILM    |
| R 1038 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1039 | 5322 116        | 54552 | 1,05K   | 1    | MR25 METAL FILM    |
| R 1040 | 5322 111        | 30396 | 22      | 5    | CR16 CARBON        |
| R 1041 | 5322 116        | 54576 | 2,37K   | 1    | MR25 METAL FILM    |
| R 1042 | 5322 116        | 54519 | 402     | 1    | MR25 METAL FILM    |
| R 1043 | 4822 110        | 63054 | 10      | 5    | CR25 CARBON        |
| R 1044 | 4822 110        | 63054 | 10      | 5    | CR25 CARBON        |
| R 1051 | 4822 110        | 63036 | 2,2     | 5    | CR25 CARBON        |
| R 1052 | 4822 110        | 63036 | 2,2     | 5    | CR25 CARBON        |
| R 1053 | 4822 110        | 63063 | 22      | 5    | CR25 CARBON        |
| R 1054 | 4822 110        | 63036 | 2,2     | 5    | CR25 CARBON        |
| R 1056 | 5322 116        | 54576 | 2,37K   | 1    | MR25 METAL FILM    |
| R 1057 | 5322 116        | 54525 | 511     | 1    | MR25 METAL FILM    |
| R 1058 | 5322 116        | 54474 | 110     | 1    | MR25 METAL FILM    |
| R 1059 | 5322 111        | 44153 | 15      | 5    | CR16 CARBON        |
| R 1061 | 5322 116        | 54532 | 649     | 1    | MR25 METAL FILM    |
| R 1062 | 5322 116        | 50729 | 4,22K   | 1    | MR25 METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 1063 | 5322 116 54011  | 5,62K | 1       | MR25 | METAL FILM    |
| R 1064 | 5322 101 14069  | 22K   | 20      | 0.5W | TRIMMING POTM |
| R 1065 | 5322 116 50636  | 2,74K | 1       | MR25 | METAL FILM    |
| R 1066 | 5322 116 54629  | 14K   | 1       | MR25 | METAL FILM    |
| R 1067 | 5322 116 54597  | 5,36K | 1       | MR25 | METAL FILM    |
| R 1068 | 5322 116 54597  | 5,36K | 1       | MR25 | METAL FILM    |
| R 1069 | 5322 116 50415  | 1,15K | 1       | MR25 | METAL FILM    |
| R 1070 | 5322 116 54516  | 365   | 1       | MR25 | METAL FILM    |
| R 1071 | 5322 116 54648  | 24,9K | 1       | MR25 | METAL FILM    |
| R 1072 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 1073 | 5322 116 54545  | 909   | 1       | MR25 | METAL FILM    |
| R 1075 | 5322 111 30396  | 22    | 5       | CR16 | CARBON        |
| R 1076 | 5322 116 54597  | 5,36K | 1       | MR25 | METAL FILM    |
| R 1077 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 1078 | 5322 116 54603  | 6,49K | 1       | MR25 | METAL FILM    |
| R 1079 | 5322 116 50767  | 2,15K | 1       | MR25 | METAL FILM    |
| R 1081 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1082 | 5322 116 54698  | 7,5K  | 1       | MR25 | METAL FILM    |
| R 1083 | 5322 116 54635  | 16,9K | 1       | MR25 | METAL FILM    |
| R 1084 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1086 | 5322 116 55236  | 898   | 0,5     | MR25 | METAL FILM    |
| R 1087 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1088 | 5322 116 50579  | 3,16K | 1       | MR25 | METAL FILM    |
| R 1089 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 1091 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1092 | 5322 116 54587  | 3,65K | 1       | MR25 | METAL FILM    |
| R 1093 | 5322 116 50556  | 4,42K | 1       | MR25 | METAL FILM    |
| R 1094 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 1096 | 5322 116 50479  | 15,4K | 1       | MR25 | METAL FILM    |
| R 1097 | 5322 101 14069  | 22K   | 20      | 0.5W | TRIMMING POTM |
| R 1098 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 1099 | 5322 111 30278  | 27K   | 5       | CR16 | CARBON        |
| R 1101 | 4822 111 30352  | 82    | 5       | CR16 | CARBON        |
| R 1102 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 1103 | 5322 111 30396  | 22    | 5       | CR16 | CARBON        |
| R 1104 | 5322 111 30396  | 22    | 5       | CR16 | CARBON        |
| R 1106 | 5322 111 30279  | 33K   | 5       | CR16 | CARBON        |
| R 1107 | 5322 116 54565  | 1,62K | 1       | MR25 | METAL FILM    |
| R 1108 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 1109 | 5322 116 50514  | 64,9K | 1       | MR25 | METAL FILM    |
| R 1111 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 1112 | 5322 116 50586  | 1,54K | 1       | MR25 | METAL FILM    |
| R 1113 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 1114 | 5322 116 54557  | 1,21K | 1       | MR25 | METAL FILM    |
| R 1115 | 5322 100 10113  | 10K   | 20      | 0.5W | TRIMMING POTM |
| R 1116 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 1117 | 5322 116 54561  | 1,33K | 1       | MR25 | METAL FILM    |
| R 1118 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 1119 | 5322 116 54617  | 9,53K | 1       | MR25 | METAL FILM    |
| R 1121 | 5322 116 54561  | 1,33K | 1       | MR25 | METAL FILM    |
| R 1122 | 5322 116 50526  | 3,01K | 1       | MR25 | METAL FILM    |
| R 1123 | 5322 116 54561  | 1,33K | 1       | MR25 | METAL FILM    |
| R 1124 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1126 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1127 | 5322 116 54617  | 9,53K | 1       | MR25 | METAL FILM    |
| R 1128 | 5322 116 50583  | 5,9K  | 1       | MR25 | METAL FILM    |
| R 1129 | 5322 116 54592  | 4,02K | 1       | MR25 | METAL FILM    |
| R 1163 | 5322 116 55234  | 35,2K | 0,5     | MR25 | METAL FILM    |
| R 1164 | 5322 116 55232  | 17,2K | 0,5     | MR25 | METAL FILM    |
| R 1166 | 5322 116 55235  | 8,16K | 0,5     | MR25 | METAL FILM    |
| R 1167 | 4822 116 51283  | 2,71K | 0,5     | MR25 | METAL FILM    |
| R 1168 | 5322 116 55236  | 898   | 0,5     | MR25 | METAL FILM    |
| R 1169 | 5322 116 54722  | 182K  | 1       | MR25 | METAL FILM    |
| R 1171 | 5322 116 55237  | 89,8K | 0,5     | MR25 | METAL FILM    |
| R 1201 | 5322 116 54598  | 8,25K | 1       | MR25 | METAL FILM    |
| R 1202 | 5322 116 50479  | 15,4K | 1       | MR25 | METAL FILM    |
| R 1203 | 5322 116 50484  | 4,64K | 1       | MR25 | METAL FILM    |
| R 1204 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 1206 | 5322 116 54619  | 10K   | 1       | MR25 | METAL FILM    |
| R 1207 | 5322 116 50579  | 3,16K | 1       | MR25 | METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| R 1208 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1209 | 5322 101        | 14008 | 2,2K    | 20   | 0.5W TRIMMING POTM |
| R 1211 | 5322 116        | 50621 | 536     | 1    | MR25 METAL FILM    |
| R 1212 | 5322 116        | 54524 | 499     | 1    | MR25 METAL FILM    |
| R 1213 | 5322 116        | 50621 | 536     | 1    | MR25 METAL FILM    |
| R 1214 | 5322 116        | 50511 | 48,7    | 1    | MR25 METAL FILM    |
| R 1216 | 5322 116        | 50457 | 215     | 1    | MR25 METAL FILM    |
| R 1217 | 4822 111        | 30333 | 1M      | 10   | CR16 CARBON        |
| R 1218 | 4822 111        | 30333 | 1M      | 10   | CR16 CARBON        |
| R 1219 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1221 | 5322 116        | 50511 | 48,7    | 1    | MR25 METAL FILM    |
| R 1222 | 5322 116        | 50579 | 3,16K   | 1    | MR25 METAL FILM    |
| R 1223 | 5322 100        | 10113 | 10K     | 20   | 0.5W TRIMMING POTM |
| R 1224 | 5322 116        | 50579 | 3,16K   | 1    | MR25 METAL FILM    |
| R 1225 | 5322 116        | 50728 | 1,87K   | 1    | MR25 METAL FILM    |
| R 1226 | 5322 116        | 55277 | 9,09K   | 1    | MR25 METAL FILM    |
| R 1227 | 5322 116        | 54545 | 909     | 1    | MR25 METAL FILM    |
| R 1228 | 5322 116        | 54545 | 909     | 1    | MR25 METAL FILM    |
| R 1229 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1231 | 5322 116        | 50583 | 5,9K    | 1    | MR25 METAL FILM    |
| R 1232 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 1233 | 5322 116        | 50555 | 1,27K   | 1    | MR25 METAL FILM    |
| R 1234 | 5322 116        | 54716 | 162K    | 1    | MR25 METAL FILM    |
| R 1235 | 5322 116        | 50673 | 147K    | 1    | MR30 METAL FILM    |
| R 1236 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1237 | 5322 116        | 54661 | 34,8K   | 1    | MR25 METAL FILM    |
| R 1238 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1239 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 1241 | 5322 116        | 54337 | 332K    | 1    | MR30 METAL FILM    |
| R 1242 | 5322 116        | 54661 | 34,8K   | 1    | MR25 METAL FILM    |
| R 1243 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1244 | 5322 116        | 55277 | 9,09K   | 1    | MR25 METAL FILM    |
| R 1246 | 5322 116        | 54592 | 4,02K   | 1    | MR25 METAL FILM    |
| R 1247 | 5322 116        | 54587 | 3,65K   | 1    | MR25 METAL FILM    |
| R 1248 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1249 | 5322 116        | 54661 | 34,8K   | 1    | MR25 METAL FILM    |
| R 1251 | 5322 116        | 54661 | 34,8K   | 1    | MR25 METAL FILM    |
| R 1252 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 1253 | 5322 116        | 54188 | 1M      | 1    | MR30 METAL FILM    |
| R 1254 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1256 | 5322 116        | 54716 | 162K    | 1    | MR25 METAL FILM    |
| R 1257 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1258 | 5322 116        | 50555 | 1,27K   | 1    | MR25 METAL FILM    |
| R 1301 | 5322 116        | 54534 | 681     | 1    | MR25 METAL FILM    |
| R 1302 | 5322 116        | 50586 | 1,54K   | 1    | MR25 METAL FILM    |
| R 1303 | 5322 116        | 54532 | 649     | 1    | MR25 METAL FILM    |
| R 1304 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 1306 | 5322 116        | 54571 | 1,96K   | 1    | MR25 METAL FILM    |
| R 1307 | 5322 116        | 50572 | 12,1K   | 1    | MR25 METAL FILM    |
| R 1308 | 5322 116        | 50767 | 2,15K   | 1    | MR25 METAL FILM    |
| R 1309 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 1311 | 5322 116        | 50635 | 1,47K   | 1    | MR25 METAL FILM    |
| R 1312 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 1313 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 1314 | 5322 116        | 54592 | 4,02K   | 1    | MR25 METAL FILM    |
| R 1316 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 1317 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1318 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 1319 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 1321 | 5322 116        | 50452 | 10      | 1    | MR25 METAL FILM    |
| R 1322 | 5322 116        | 54694 | 90,9K   | 1    | MR25 METAL FILM    |
| R 1323 | 5322 116        | 54624 | 11,5K   | 1    | MR25 METAL FILM    |
| R 1324 | 5322 116        | 50581 | 2,49K   | 1    | MR25 METAL FILM    |
| R 1325 | 5322 116        | 55276 | 13,3K   | 1    | MR25 METAL FILM    |
| R 1326 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 1327 | 5322 100        | 10113 | 10K     | 20   | 0.5W TRIMMING POTM |
| R 1328 | 5322 116        | 50536 | 464     | 1    | MR25 METAL FILM    |
| R 1329 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1330 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 1331 | 5322 116        | 50442 | 48,7K   | 1    | MR25 METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE  | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| R 1332 | 5322 116 50442  | 48.7K | 1       | MR25  | METAL FILM    |
| R 1333 | 4822 110 63187  | 1M    | 5       | CR25  | CARBON        |
| R 1334 | 4822 110 63187  | 1M    | 5       | CR25  | CARBON        |
| R 1336 | 5322 116 54525  | 511   | 1       | MR25  | METAL FILM    |
| R 1337 | 4822 110 63161  | 100K  | 5       | CR25  | CARBON        |
| R 1338 | 4822 110 42189  | 1.2M  | 5       | VR37  | CARBON        |
| R 1339 | 4822 110 42196  | 2.2M  | 5       | VR37  | CARBON        |
| R 1340 | 5322 116 54071  | 10.5  | 1       | MR25  | METAL FILM    |
| R 1341 | 4822 110 42207  | 5.6M  | 5       | VR37  | CARBON        |
| R 1342 | 5322 116 54689  | 82.5K | 1       | MR25  | METAL FILM    |
| R 1343 | 5322 116 54721  | 178K  | 1       | MR25  | METAL FILM    |
| R 1344 | 5322 101 14071  | 100K  | 20      | 0.5W  | TRIMMING POTM |
| R 1346 | 5322 101 14094  | 1M    | 20      | 0.5W  | TRIMMING POTM |
| R 1347 | 5322 116 54704  | 121K  | 1       | MR25  | METAL FILM    |
| R 1348 | 5322 116 54743  | 301K  | 1       | MR25  | METAL FILM    |
| R 1349 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1350 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1351 | 5322 116 54619  | 10K   | 1       | MR25  | METAL FILM    |
| R 1352 | 5322 116 54502  | 261   | 1       | MR25  | METAL FILM    |
| R 1353 | 5322 116 54502  | 261   | 1       | MR25  | METAL FILM    |
| R 1354 | 5322 116 54516  | 365   | 1       | MR25  | METAL FILM    |
| R 1356 | 5322 116 50583  | 5.9K  | 1       | MR25  | METAL FILM    |
| R 1357 | 5322 116 54549  | 1K    | 1       | MR25  | METAL FILM    |
| R 1361 | 5322 116 54469  | 100   | 1       | MR25  | METAL FILM    |
| R 1362 | 5322 100 10114  | 4.7K  | 20      | 0.5W  | TRIMMING POTM |
| R 1363 | 5322 116 50635  | 1.47K | 1       | MR25  | METAL FILM    |
| R 1364 | 5322 116 50608  | 6.19K | 1       | MR25  | METAL FILM    |
| R 1366 | 5322 116 54536  | 750   | 1       | MR25  | METAL FILM    |
| R 1367 | 5322 116 55008  | 499   | 0.1     | MR24E | METAL FILM    |
| R 1368 | 5322 116 54639  | 19.1K | 1       | MR25  | METAL FILM    |
| R 1369 | 5322 116 54502  | 261   | 1       | MR25  | METAL FILM    |
| R 1371 | 5322 116 50608  | 6.19K | 1       | MR25  | METAL FILM    |
| R 1372 | 5322 116 54469  | 100   | 1       | MR25  | METAL FILM    |
| R 1401 | 5322 116 54665  | 40.2K | 1       | MR25  | METAL FILM    |
| R 1402 | 5322 116 50442  | 48.7K | 1       | MR25  | METAL FILM    |
| R 1403 | 5322 116 54683  | 68.1K | 1       | MR25  | METAL FILM    |
| R 1404 | 5322 116 50474  | 42.2K | 1       | MR25  | METAL FILM    |
| R 1406 | 5322 116 54549  | 1K    | 1       | MR25  | METAL FILM    |
| R 1407 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1408 | 5322 116 54632  | 14.7K | 1       | MR25  | METAL FILM    |
| R 1409 | 5322 116 50672  | 51.1K | 1       | MR25  | METAL FILM    |
| R 1416 | 5322 111 50345  | 8.2M  | 5       | 1W    | CARBON        |
| R 1800 | 4822 110 63041  | 3.3   | 5       | CR25  | CARBON        |
| R 1801 | 5322 113 60064  | 2.7   | 10      | 2W    | WIRE-WOUND    |
| R 1802 | 5322 116 54643  | 20.5K | 1       | MR25  | METAL FILM    |
| R 1803 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1804 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1805 | 5322 116 54469  | 100   | 1       | MR25  | METAL FILM    |
| R 1806 | 4822 110 63198  | 2.7M  | 10      | CR25  | CARBON        |
| R 1807 | 5322 116 50442  | 48.7K | 1       | MR25  | METAL FILM    |
| R 1808 | 5322 116 54696  | 100K  | 1       | MR25  | METAL FILM    |
| R 1811 | 4822 110 63041  | 3.3   | 5       | CR25  | CARBON        |
| R 1814 | 5322 116 50766  | 147   | 1       | MR25  | METAL FILM    |
| R 1815 | 5322 116 50557  | 46.4K | 1       | MR25  | METAL FILM    |
| R 1816 | 5322 116 54005  | 3.32K | 1       | MR25  | METAL FILM    |
| R 1818 | 5322 116 50417  | 162   | 1       | MR25  | METAL FILM    |
| R 1819 | 5322 110 50035  | 2     | 5       | CR37  | CARBON        |
| R 1820 | 5322 116 34028  | 150K  | 5       | 0.5W  | NTC           |
| R 1821 | 5322 116 55149  | 24.9K | 1       | MR30  | METAL FILM    |
| R 1822 | 5322 116 54549  | 1K    | 1       | MR25  | METAL FILM    |
| R 1823 | 5322 116 50452  | 10    | 1       | MR25  | METAL FILM    |
| R 1824 | 5322 116 50731  | 10.5K | 1       | MR25  | METAL FILM    |
| R 1826 | 5322 116 54549  | 1K    | 1       | MR25  | METAL FILM    |
| R 1827 | 5322 116 54564  | 1.5K  | 1       | MR25  | METAL FILM    |
| R 1828 | 5322 116 50636  | 2.74K | 1       | MR25  | METAL FILM    |
| R 1829 | 5322 116 50767  | 2.15K | 1       | MR25  | METAL FILM    |
| R 1830 | 5322 116 54619  | 10K   | 1       | MR25  | METAL FILM    |
| R 1831 | 5322 116 54549  | 1K    | 1       | MR25  | METAL FILM    |
| R 1832 | 5322 116 54558  | 8.25K | 1       | MR25  | METAL FILM    |
| R 1833 | 5322 116 50515  | 1.78K | 1       | MR25  | METAL FILM    |
| R 1834 | 5322 100 10112  | 1K    | 20      | 0.5W  | TRIMMING POTM |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 1835 | 5322 116 54192  | 5.11  | 1       | MR25 | METAL FILM    |
| R 1836 | 5322 116 54558  | 8.25K | 1       | MR25 | METAL FILM    |
| R 1837 | 4822 110 63178  | 470K  | 1       | CR25 | CARBON        |
| R 1838 | 5322 116 54629  | 14K   | 1       | MR25 | METAL FILM    |
| R 1839 | 5322 116 54592  | 4.02K | 1       | MR25 | METAL FILM    |
| R 1840 | 4822 110 23156  | 68K   | 5       | CR68 | CARBON        |
| R 1841 | 5322 101 14144  | 470K  | 20      | 0.5W | TRIMMING POTM |
| R 1842 | 5322 116 54655  | 30.1K | 1       | MR25 | METAL FILM    |
| R 1843 | 5322 116 54643  | 20.5K | 1       | MR25 | METAL FILM    |
| R 1844 | 5322 116 54643  | 20.5K | 1       | MR25 | METAL FILM    |
| R 1845 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 1846 | 5322 116 54696  | 100K  | 1       | MR25 | METAL FILM    |
| R 1847 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 1848 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 1849 | 5322 116 54619  | 10K   | 1       | MR25 | METAL FILM    |
| R 1851 | 5322 116 54648  | 24.9K | 1       | MR25 | METAL FILM    |
| R 2376 | 5322 116 54012  | 6.81K | 1       | MR25 | METAL FILM    |
| R 2377 | 5322 116 54595  | 5.11K | 1       | MR25 | METAL FILM    |
| R 2378 | 5322 116 50558  | 16.7K | 1       | MR25 | METAL FILM    |
| R 2379 | 5322 101 14048  | 47K   | 20      | 0.5W | TRIMMING POTM |
| R 2381 | 5322 116 50527  | 33.2  | 1       | MR25 | METAL FILM    |
| R 2382 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2383 | 5322 116 54557  | 1.21K | 1       | MR25 | METAL FILM    |
| R 2387 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2388 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 2389 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2390 | 5322 116 54541  | 825   | 1       | MR25 | METAL FILM    |
| R 2391 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 2392 | 5322 116 50527  | 33.2  | 1       | MR25 | METAL FILM    |
| R 2393 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 2394 | 5322 116 54439  | 35.7  | 1       | MR25 | METAL FILM    |
| R 2396 | 5322 116 54548  | 976   | 1       | MR25 | METAL FILM    |
| R 2397 | 5322 116 54439  | 35.7  | 1       | MR25 | METAL FILM    |
| R 2398 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 2401 | 5322 116 50524  | 3.01K | 1       | MR25 | METAL FILM    |
| R 2402 | 5322 116 54508  | 30.   | 1       | MR25 | METAL FILM    |
| R 2403 | 4822 111 30367  | 33    | 5       | CR16 | CARBON        |
| R 2404 | 5322 116 50524  | 3.01K | 1       | MR25 | METAL FILM    |
| R 2405 | 4822 111 30347  | 86.6  | 1       | MR25 | METAL FILM    |
| R 2406 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2407 | 5322 116 50492  | 46.4  | 1       | MR25 | METAL FILM    |
| R 2408 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 2409 | 5322 116 50492  | 46.4  | 1       | MR25 | METAL FILM    |
| R 2410 | 5322 116 34036  | 47    | 5       | 0.5W | NTC           |
| R 2411 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2412 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2413 | 5322 116 50515  | 1.78K | 1       | MR25 | METAL FILM    |
| R 2414 | 5322 116 54005  | 3.32K | 1       | MR25 | METAL FILM    |
| R 2416 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2417 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 2418 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2419 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2420 | 5322 116 54464  | 86.6  | 1       | MR25 | METAL FILM    |
| R 2421 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2422 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 2423 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2424 | 5322 116 54576  | 2.37K | 1       | MR25 | METAL FILM    |
| R 2426 | 5322 116 54587  | 3.65K | 1       | MR25 | METAL FILM    |
| R 2427 | 5322 116 50527  | 33.2  | 1       | MR25 | METAL FILM    |
| R 2428 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2429 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 2431 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2432 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 2433 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2434 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2436 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2437 | 5322 116 54613  | 8.66K | 1       | MR25 | METAL FILM    |
| R 2438 | 5322 116 54005  | 3.32K | 1       | MR25 | METAL FILM    |
| R 2439 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2440 | 5322 116 54581  | 2.94K | 1       | MR25 | METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| R 2441 | 5322 116        | 50926 | 40,2    | 1    | MR25 METAL FILM    |
| R 2442 | 5322 100        | 10112 | 1K      | 20   | 0,5W TRIMMING POTM |
| R 2443 | 5322 116        | 54515 | 348     | 1    | MR25 METAL FILM    |
| R 2444 | 5322 116        | 50926 | 40,2    | 1    | MR25 METAL FILM    |
| R 2445 | 5322 116        | 54595 | 5,11K   | 1    | MR25 METAL FILM    |
| R 2446 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2447 | 5322 116        | 50442 | 48,7K   | 1    | MR25 METAL FILM    |
| R 2448 | 5322 100        | 10113 | 10K     | 20   | 0,5W TRIMMING POTM |
| R 2461 | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 2463 | 5322 116        | 54576 | 2,37K   | 1    | MR25 METAL FILM    |
| R 2464 | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 2465 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 2466 | 5322 116        | 54585 | 3,48K   | 1    | MR25 METAL FILM    |
| R 2467 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2468 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2469 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2471 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2472 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2473 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2474 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2476 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2477 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2478 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 2479 | 5322 116        | 50621 | 536     | 1    | MR25 METAL FILM    |
| R 2481 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2482 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 2483 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2484 | 5322 116        | 54613 | 8,66K   | 1    | MR25 METAL FILM    |
| R 2486 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 2487 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 2488 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 2576 | 5322 116        | 54012 | 6,81K   | 1    | MR25 METAL FILM    |
| R 2577 | 5322 116        | 54595 | 5,11K   | 1    | MR25 METAL FILM    |
| R 2578 | 5322 116        | 50558 | 18,7K   | 1    | MR25 METAL FILM    |
| R 2579 | 5322 101        | 14048 | 47K     | 20   | 0,5W TRIMMING POTM |
| R 2581 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 2582 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2583 | 5322 116        | 54557 | 1,21K   | 1    | MR25 METAL FILM    |
| R 2587 | 5322 116        | 50452 | 10      | 1    | MR25 METAL FILM    |
| R 2588 | 5322 116        | 54519 | 402     | 1    | MR25 METAL FILM    |
| R 2589 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 2590 | 5322 116        | 54541 | 825     | 1    | MR25 METAL FILM    |
| R 2591 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 2592 | 5322 116        | 50527 | 33,2    | 1    | MR25 METAL FILM    |
| R 2593 | 4822 111        | 30324 | 100     | 5    | CR16 CARBON        |
| R 2594 | 5322 116        | 54439 | 35,7    | 1    | MR25 METAL FILM    |
| R 2596 | 5322 116        | 54548 | 976     | 1    | MR25 METAL FILM    |
| R 2597 | 5322 116        | 54439 | 35,7    | 1    | MR25 METAL FILM    |
| R 2598 | 4822 111        | 30324 | 100     | 5    | CR16 CARBON        |
| R 2601 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 2602 | 5322 116        | 54508 | 301     | 1    | MR25 METAL FILM    |
| R 2603 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2604 | 5322 116        | 50524 | 3,01K   | 1    | MR25 METAL FILM    |
| R 2605 | 5322 116        | 54464 | 86,6    | 1    | MR25 METAL FILM    |
| R 2606 | 4822 111        | 30347 | 10      | 5    | CR16 CARBON        |
| R 2607 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 2608 | 5322 116        | 50568 | 4,99    | 1    | MR25 METAL FILM    |
| R 2609 | 5322 116        | 50492 | 46,4    | 1    | MR25 METAL FILM    |
| R 2610 | 5322 116        | 34036 | 47      | 5    | 0,5W NTC           |
| R 2611 | 4822 111        | 30347 | 10      | 5    | CR16 CARBON        |
| R 2612 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2613 | 5322 116        | 50515 | 1,78K   | 1    | MR25 METAL FILM    |
| R 2614 | 5322 116        | 54005 | 3,32K   | 1    | MR25 METAL FILM    |
| R 2616 | 5322 116        | 50452 | 10      | 1    | MR25 METAL FILM    |
| R 2617 | 5322 116        | 50571 | 715     | 1    | MR25 METAL FILM    |
| R 2618 | 4822 111        | 30245 | 47      | 5    | CR16 CARBON        |
| R 2619 | 4822 111        | 30347 | 10      | 5    | CR16 CARBON        |
| R 2620 | 5322 116        | 54464 | 86,6    | 1    | MR25 METAL FILM    |
| R 2621 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 2622 | 5322 116        | 54492 | 178     | 1    | MR25 METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 2623 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2624 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 2627 | 5322 116 54587  | 3,65K | 1       | MR25 | METAL FILM    |
| R 2627 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2628 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2629 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 2631 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2632 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 2633 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2634 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2636 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2637 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 2638 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2639 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2640 | 5322 116 54581  | 2,94K | 1       | MR25 | METAL FILM    |
| R 2641 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |
| R 2642 | 5322 100 10112  | 1K    | 20      | 0,5W | TRIMMING POTM |
| R 2643 | 5322 116 54515  | 348   | 1       | MR25 | METAL FILM    |
| R 2644 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |
| R 2645 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 2646 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2647 | 5322 116 50442  | 48,7K | 1       | MR25 | METAL FILM    |
| R 2648 | 5322 100 10113  | 10K   | 20      | 0,5W | TRIMMING POTM |
| R 2661 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2663 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 2664 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2665 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 2666 | 5322 116 54585  | 3,48K | 1       | MR25 | METAL FILM    |
| R 2667 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2668 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2669 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2671 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2672 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2673 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2674 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2676 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2677 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2678 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2679 | 5322 116 50821  | 536   | 1       | MR25 | METAL FILM    |
| R 2681 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2682 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2683 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2684 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 2686 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 2687 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2688 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2776 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 2777 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 2778 | 5322 116 50558  | 18,7K | 1       | MR25 | METAL FILM    |
| R 2779 | 5322 101 14048  | 47K   | 20      | 0,5W | TRIMMING POTM |
| R 2781 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2782 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2783 | 5322 116 54557  | 1,21K | 1       | MR25 | METAL FILM    |
| R 2787 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2788 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 2789 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2790 | 5322 116 54541  | 825   | 1       | MR25 | METAL FILM    |
| R 2791 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 2792 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2793 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 2794 | 5322 116 54439  | 35,7  | 1       | MR25 | METAL FILM    |
| R 2796 | 5322 116 54548  | 976   | 1       | MR25 | METAL FILM    |
| R 2797 | 5322 116 54439  | 35,7  | 1       | MR25 | METAL FILM    |
| R 2798 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 2801 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 2802 | 5322 116 54508  | 301   | 1       | MR25 | METAL FILM    |
| R 2803 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2804 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 2805 | 5322 116 54464  | 86,6  | 1       | MR25 | METAL FILM    |
| R 2806 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |



| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 2807 | 5322 116 50492  | 46,4  | 1       | MR25 | METAL FILM    |
| R 2808 | 5322 116 50568  | 4,99  | 1       | MR25 | METAL FILM    |
| R 2809 | 5322 116 50492  | 46,4  | 1       | MR25 | METAL FILM    |
| R 2810 | 5322 116 30036  | 47    | 5       | 0,5W | NTC           |
| R 2811 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2812 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2813 | 5322 116 50515  | 1,78K | 1       | MR25 | METAL FILM    |
| R 2814 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2816 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2817 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 2818 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2819 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2820 | 5322 116 54464  | 86,6  | 1       | MR25 | METAL FILM    |
| R 2821 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2822 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 2823 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2824 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 2826 | 5322 116 54587  | 3,65K | 1       | MR25 | METAL FILM    |
| R 2827 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2828 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2829 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 2831 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2832 | 5322 116 50571  | 715   | 1       | MR25 | METAL FILM    |
| R 2833 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2834 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 2836 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2837 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 2838 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2839 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2840 | 5322 116 54581  | 2,94K | 1       | MR25 | METAL FILM    |
| R 2841 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |
| R 2842 | 5322 100 10112  | 1K    | 20      | 0,5W | TRIMMING POTM |
| R 2843 | 5322 116 54515  | 348   | 1       | MR25 | METAL FILM    |
| R 2844 | 5322 116 50926  | 40,2  | 1       | MR25 | METAL FILM    |
| R 2845 | 5322 116 54595  | 5,11K | 1       | MR25 | METAL FILM    |
| R 2846 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2847 | 5322 116 50442  | 48,7K | 1       | MR25 | METAL FILM    |
| R 2848 | 5322 100 10113  | 10K   | 20      | 0,5W | TRIMMING POTM |
| R 2861 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2863 | 5322 116 54576  | 2,37K | 1       | MR25 | METAL FILM    |
| R 2864 | 5322 116 54005  | 3,32K | 1       | MR25 | METAL FILM    |
| R 2865 | 5322 116 54012  | 6,81K | 1       | MR25 | METAL FILM    |
| R 2866 | 5322 116 54585  | 3,48K | 1       | MR25 | METAL FILM    |
| R 2867 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2868 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2869 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2871 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2872 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2873 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2874 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2876 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2877 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2878 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2879 | 5322 116 50621  | 536   | 1       | MR25 | METAL FILM    |
| R 2881 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2882 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 2883 | 4822 111 30067  | 33    | 1       | CR16 | CARBON        |
| R 2884 | 5322 116 54613  | 8,66K | 1       | MR25 | METAL FILM    |
| R 2886 | 5322 116 50524  | 3,01K | 1       | MR25 | METAL FILM    |
| R 2887 | 5322 116 50527  | 33,2  | 1       | MR25 | METAL FILM    |
| R 2888 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |

## Diodes

| ITEM  | ORDERING NUMBER | TYPE/DESCRIPTION |    |
|-------|-----------------|------------------|----|
| GR1   | 4822 130 31144  | CQY24B-III       | PH |
| GR2   | 5322 130 34595  | CQY24A-I         | PH |
| GR101 | 5322 130 34037  | BAV45            |    |
| GR102 | 5322 130 30283  | AAZ17            |    |
| GR401 | 4822 130 30613  | BAW62            |    |
| GR501 | 4822 130 30613  | BAW62            |    |
| GR502 | 4822 130 34278  | BZX79-C6V8       |    |
| GR601 | 5322 130 30644  | BA182            |    |
| GR602 | 5322 130 30644  | BA182            |    |
| GR603 | 4822 130 30862  | BZX79-C9V1       |    |
| GR604 | 4822 130 30861  | BZX79-B7V5       | PH |
| GR606 | 4822 130 34382  | BZX79-B8V2       |    |
| GR607 | 4822 130 34382  | BZX79-B8V2       |    |
| GR608 | 4822 130 30861  | BZX79-B7V5       | PH |
| GR609 | 4822 130 30862  | BZX79-C9V1       |    |
| GR701 | 4822 130 30613  | BAW62            |    |
| GR702 | 4822 130 30613  | BAW62            |    |
| GR703 | 4822 130 30613  | BAW62            |    |
| GR704 | 4822 130 30613  | BAW62            |    |
| GR706 | 4822 130 30613  | BAW62            |    |
| GR707 | 4822 130 30613  | BAW62            |    |
| GR708 | 4822 130 30613  | BAW62            |    |
| GR709 | 4822 130 30613  | BAW62            |    |
| GR710 | 4822 130 30613  | BAW62            |    |
| GR711 | 4822 130 30613  | BAW62            |    |
| GR712 | 4822 130 30613  | BAW62            |    |
| GR713 | 4822 130 34173  | BZX79-B5V6       |    |
| GR751 | 4822 130 30613  | BAW62            |    |
| GR752 | 4822 130 30613  | BAW62            |    |
| GR753 | 4822 130 30613  | BAW62            |    |
| GR754 | 4822 130 30613  | BAW62            |    |
| GR756 | 4822 130 30613  | BAW62            |    |
| GR757 | 4822 130 30613  | BAW62            |    |
| GR761 | 4822 130 30613  | BAW62            |    |
| GR762 | 4822 130 30613  | BAW62            |    |
| GR763 | 4822 130 30613  | BAW62            |    |
| GR764 | 4822 130 30613  | BAW62            |    |
| GR766 | 4822 130 30613  | BAW62            |    |
| GR767 | 4822 130 30613  | BAW62            |    |
| GR771 | 4822 130 30613  | BAW62            |    |
| GR772 | 4822 130 30613  | BAW62            |    |
| GR773 | 4822 130 30613  | BAW62            |    |
| GR774 | 4822 130 30613  | BAW62            |    |
| GR776 | 4822 130 30613  | BAW62            |    |
| GR777 | 4822 130 30613  | BAW62            |    |
| GR781 | 4822 130 30613  | BAW62            |    |
| GR782 | 4822 130 30613  | BAW62            |    |
| GR783 | 4822 130 30613  | BAW62            |    |
| GR784 | 4822 130 30613  | BAW62            |    |
| GR786 | 4822 130 30613  | BAW62            |    |
| GR787 | 4822 130 30613  | BAW62            |    |
| GR791 | 4822 130 30613  | BAW62            |    |
| GR792 | 4822 130 30613  | BAW62            |    |
| GR793 | 4822 130 30613  | BAW62            |    |
| GR794 | 4822 130 30613  | BAW62            |    |
| GR796 | 4822 130 30613  | BAW62            |    |
| GR797 | 4822 130 30613  | BAW62            |    |
| GR801 | 4822 130 34048  | BZX75-C2V8       |    |
| GR802 | 4822 130 30613  | BAW62            |    |
| GR803 | 4822 130 30613  | BAW62            |    |
| GR804 | 4822 130 30613  | BAW62            |    |
| GR806 | 4822 130 30613  | BAW62            |    |
| GR807 | 4822 130 30229  | AAZ15            |    |
| GR851 | 4822 130 30613  | BAW62            |    |
| GR853 | 4822 130 30613  | BAW62            |    |
| GR854 | 4822 130 30613  | BAW62            |    |
| GR855 | 4822 130 30229  | AAZ15            |    |
| GR856 | 4822 130 30613  | BAW62            |    |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| GR857  | 4822 130 30613  | BAW62            |
| GR858  | 4822 130 34174  | BZX79-C4V7       |
| GR861  | 4822 130 30613  | BAW62            |
| GR862  | 4822 130 30613  | BAW62            |
| GR863  | 4822 130 30613  | BAW62            |
| GR1001 | 4822 130 34048  | BZX75-C2V8       |
| GR1002 | 4822 130 30613  | BAW62            |
| GR1003 | 4822 130 30613  | BAW62            |
| GR1004 | 4822 130 30613  | BAW62            |
| GR1006 | 4822 130 30613  | BAW62            |
| GR1051 | 4822 130 30613  | BAW62            |
| GR1052 | 4822 130 30613  | BAW62            |
| GR1053 | 4822 130 30613  | BAW62            |
| GR1054 | 4822 130 30613  | BAW62            |
| GR1056 | 4822 130 30613  | BAW62            |
| GR1057 | 4822 130 30613  | BAW62            |
| GR1058 | 4822 130 30613  | BAW62            |
| GR1059 | 4822 130 30613  | BAW62            |
| GR1061 | 4822 130 30613  | BAW62            |
| GR1062 | 4822 130 30613  | BAW62            |
| GR1063 | 4822 130 30613  | BAW62            |
| GR1064 | 4822 130 30613  | BAW62            |
| GR1065 | 4822 130 30613  | BAW62            |
| GR1066 | 4822 130 30613  | BAW62            |
| GR1067 | 4822 130 30613  | BAW62            |
| GR1201 | 4822 130 30613  | BAW62            |
| GR1202 | 4822 130 30613  | BAW62            |
| GR1203 | 4822 130 30613  | BAW62            |
| GR1204 | 4822 130 30613  | BAW62            |
| GR1207 | 4822 130 34173  | BZX79-C5V6       |
| GR1208 | 4822 130 34384  | BZX79-B62        |
| GR1209 | 4822 130 34383  | BZX79-B47        |
| GR1211 | 4822 130 34384  | BZX79-B62        |
| GR1212 | 4822 130 34173  | BZX79-C5V6       |
| GR1301 | 4822 130 30613  | BAW62            |
| GR1302 | 4822 130 30613  | BAW62            |
| GR1303 | 5322 130 30392  | BZX8-C3V3        |
| GR1304 | 4822 130 30613  | BAW62            |
| GR1306 | 4822 130 30842  | BAV21            |
| GR1307 | 4822 130 30842  | BAV21            |
| GR1308 | 4822 130 30842  | BAV21            |
| GR1309 | 4822 130 30842  | BAV21            |
| GR1311 | 4822 130 30613  | BAW62            |
| GR1312 | 4822 130 30613  | BAW62            |
| GR1316 | 4822 130 34173  | BZX79-C5V6       |
| GR1317 | 4822 130 34173  | BZX79-C5V6       |
| GR1401 | 4822 130 30842  | BAV21            |
| GR1402 | 4822 130 30842  | BAV21            |
| GR1403 | 5322 130 34594  | BY409-A          |
| GR1416 | 5322 130 34594  | BY409-A          |
| GR1417 | 5322 130 34594  | BY409-A          |
| GR1418 | 5322 130 34594  | BY409-A          |
| GR1419 | 5322 130 34594  | BY409-A          |
| GR1421 | 5322 130 34594  | BY409-A          |
| GR1801 | 4822 130 30521  | BY179            |
| GR1802 | 5322 130 34197  | BZX61-C13        |
| GR1803 | 5322 130 34297  | BZX79-C10        |
| GR1804 | 4822 130 30817  | BYX55-600        |
| GR1805 | 5322 130 34605  | BAX12            |
| GR1806 | 5322 130 34934  | BZX61-C75        |
| GR1807 | 5322 130 30565  | BZX61-C47        |
| GR1808 | 4822 130 30613  | BAW62            |
| GR1809 | 4822 130 30839  | BY206            |
| GR1811 | 4822 130 30839  | BY206            |
| GR1812 | 4822 130 30839  | BY206            |
| GR1813 | 4822 130 30613  | BAW62            |
| GR1815 | 4822 130 30613  | BAW62            |
| GR1816 | 4822 130 34047  | BZX75-C1V4       |
| GR1817 | 4822 130 30613  | BAW62            |
| GR1818 | 4822 130 30613  | BAW62            |
| GR1819 | 4822 130 30195  | BYX10            |
| GR1820 | 4822 130 30613  | BAW62            |
| GR1821 | 5322 130 34297  | BZX79-C10        |
| GR1822 | 5322 130 34605  | BAX12            |
| GR1823 | 4822 130 30839  | BY206            |

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| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| GR1824 | 4822 130 30839  | BY206 PH         |
| GR1825 | 4822 130 20039  | BR100-03         |
| GR1826 | 4822 130 30839  | BY206 PH         |
| GR1827 | 4822 130 30839  | BY206 PH         |
| GR1828 | 4822 130 30839  | BY206 PH         |
| GR1829 | 4822 130 30839  | BY206 PH         |
| GR1830 | 4822 130 30613  | BAW62            |
| GR1831 | 5322 130 34605  | BAX12            |
| GR1832 | 5322 130 34605  | BAX12            |
| GR1833 | 5322 130 34605  | BAX12            |
| GR1834 | 5322 130 34605  | BAX12            |
| GR1835 | 4822 130 30765  | BZX75-C3V6       |
| GR1836 | 5322 130 34605  | BAX12            |
| GR1837 | 5322 130 34605  | BAX12            |
| GR1838 | 5322 130 34605  | BAX12            |
| GR1839 | 5322 130 34605  | BAX12            |
| GR1841 | 5322 130 34605  | BAX12            |
| GR1842 | 5322 130 34605  | BAX12            |
| GR1843 | 5322 130 34605  | BAX12            |
| GR1844 | 5322 130 34605  | BAX12            |
| GR2401 | 4822 130 30613  | BAW62            |
| GR2601 | 4822 130 30613  | BAW62            |
| GR2801 | 4822 130 30613  | BAW62            |

## Transistors

| ITEM  | ORDERING NUMBER | TYPE/DESCRIPTION |
|-------|-----------------|------------------|
| TS101 | 5322 130 44797  | 0N471            |
| TS102 | 5322 130 44459  | BFT25R           |
| TS103 | 5322 130 44606  | BFR92R           |
| TS202 | 5322 130 40417  | BSX20            |
| TS203 | 4822 130 40964  | BC549            |
| TS204 | 4822 130 40964  | BC549            |
| TS376 | 4822 130 44154  | BF199            |
| TS377 | 4822 130 40964  | BC549            |
| TS378 | 4822 130 41448  | BF324            |
| TS379 | 4822 130 44154  | BF199            |
| TS401 | 4822 130 40964  | BC549            |
| TS402 | 4822 130 41448  | BF324            |
| TS403 | 4822 130 41448  | BF324            |
| TS404 | 4822 130 40964  | BC549            |
| TS409 | 4822 130 40964  | BC549            |
| TS411 | 4822 130 40964  | BC549            |
| TS412 | 4822 130 40964  | BC549            |
| TS413 | 4822 130 40964  | BC549            |
| TS414 | 4822 130 40964  | BC549            |
| TS416 | 4822 130 40964  | BC549            |
| TS417 | 4822 130 40964  | BC549            |
| TS501 | 4822 130 40963  | BC559            |
| TS502 | 4822 130 40963  | BC559            |
| TS503 | 4822 130 40963  | BC559            |
| TS504 | 4822 130 40963  | BC559            |
| TS506 | 4822 130 44154  | BF199            |
| TS507 | 4822 130 40964  | BC549            |
| TS508 | 4822 130 44154  | BF199            |
| TS509 | 4822 130 41448  | BF324            |
| TS511 | 4822 130 40664  | BD137            |
| TS601 | 4822 130 41448  | BF324            |
| TS602 | 4822 130 41448  | BF324            |
| TS603 | 4822 130 40964  | BC549            |
| TS604 | 5322 130 40142  | FW5324           |
| TS606 | 5322 130 40673  | FW5497           |
| TS607 | 5322 130 40673  | FW5497           |
| TS608 | 5322 130 40142  | FW5324           |
| TS611 | 4822 130 44257  | BC547            |
| TS612 | 4822 130 44256  | BC557            |
| TS701 | 4822 130 44246  | BC549C           |
| TS702 | 4822 130 40963  | BC559            |
| TS703 | 4822 130 40963  | BC559            |
| TS704 | 4822 130 44154  | BF199            |
| TS705 | 4822 130 40964  | BC549            |
| TS706 | 4822 130 44154  | BF199            |
| TS707 | 4822 130 44154  | BF199            |
| TS708 | 4822 130 44154  | BF199            |
| TS709 | 4822 130 40854  | BC327            |
| TS751 | 4822 130 41448  | BF324            |
| TS752 | 4822 130 41448  | BF324            |
| TS761 | 4822 130 41448  | BF324            |
| TS762 | 4822 130 41448  | BF324            |
| TS771 | 4822 130 41448  | BF324            |
| TS772 | 4822 130 41448  | BF324            |
| TS781 | 4822 130 41448  | BF324            |
| TS782 | 4822 130 41448  | BF324            |
| TS791 | 4822 130 41448  | BF324            |
| TS792 | 4822 130 41448  | BF324            |
| TS801 | 4822 130 44246  | BC549C           |
| TS802 | 4822 130 40493  | BFY90            |
| TS803 | 4822 130 40964  | BC549            |
| TS804 | 4822 130 40493  | BFY90            |
| TS806 | 4822 130 40964  | BC549            |
| TS807 | 4822 130 40493  | BFY90            |
| TS808 | 4822 130 40493  | BFY90            |
| TS809 | 4822 130 40964  | BC549            |
| TS811 | 5322 130 44338  | BFS17R           |
| TS812 | 5322 130 40781  | BFS17            |
| TS851 | 5322 130 44338  | BFS17R           |
| TS852 | 5322 130 44743  | BSR12            |
| TS853 | 4822 130 40963  | BC559            |
| TS854 | 4822 130 40964  | BC549            |
| TS856 | 5322 130 40781  | BFS17            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| TS857  | 5322 130 40781  | BFS17            |
| TS858  | 5322 130 44338  | BFS17R           |
| TS859  | 4822 130 40964  | BC549            |
| TS861  | 4822 130 40964  | BC549            |
| TS862  | 4822 130 40964  | BC549            |
| TS863  | 4822 130 40493  | BFY90            |
| TS864  | 4822 130 40963  | BC559            |
| TS865  | 4822 130 40964  | BC549            |
| TS866  | 4822 130 40963  | BC559            |
| TS867  | 4822 130 40963  | BC559            |
| TS868  | 5322 130 40417  | BSX20            |
| TS869  | 4822 130 40964  | BC549            |
| TS870  | 5322 130 40417  | BSX20            |
| TS871  | 4822 130 40963  | BC559            |
| TS872  | 4822 130 40964  | BC549            |
| TS873  | 4822 130 40964  | BC549            |
| TS874  | 4822 130 44246  | BC549C           |
| TS876  | 4822 130 44246  | BC549C           |
| TS877  | 4822 130 40964  | BC549            |
| TS878  | 4822 130 40964  | BC549            |
| TS879  | 4822 130 40964  | BC549            |
| TS881  | 4822 130 40964  | BC549            |
| TS882  | 4822 130 40964  | BC549            |
| TS883  | 4822 130 41448  | BF324            |
| TS884  | 4822 130 41448  | BF324            |
| TS886  | 4822 130 40963  | BC559            |
| TS887  | 4822 130 44246  | BC549C           |
| TS888  | 4822 130 44246  | BC549C           |
| TS1001 | 4822 130 40964  | BC549            |
| TS1002 | 4822 130 40493  | BFY90            |
| TS1003 | 4822 130 40964  | BC549            |
| TS1004 | 4822 130 40493  | BFY90            |
| TS1006 | 4822 130 40964  | BC549            |
| TS1007 | 4822 130 40493  | BFY90            |
| TS1008 | 4822 130 40493  | BFY90            |
| TS1009 | 4822 130 40964  | BC549            |
| TS1011 | 5322 130 40781  | BFS17            |
| TS1012 | 5322 130 44338  | BFS17R           |
| TS1051 | 5322 130 40781  | BFS17            |
| TS1052 | 5322 130 40781  | BFS17            |
| TS1053 | 5322 130 44338  | BFS17R           |
| TS1054 | 4822 130 40963  | BC559            |
| TS1056 | 5322 130 40781  | BFS17            |
| TS1057 | 4822 130 40963  | BC559            |
| TS1058 | 4822 130 40963  | BC559            |
| TS1059 | 4822 130 40964  | BC549            |
| TS1061 | 5322 130 40417  | BSX20            |
| TS1062 | 4822 130 40963  | BC559            |
| TS1063 | 4822 130 40964  | BC549            |
| TS1064 | 4822 130 40964  | BC549            |
| TS1066 | 4822 130 40964  | BC549            |
| TS1067 | 4822 130 40964  | BC549            |
| TS1068 | 4822 130 40963  | BC559            |
| TS1069 | 4822 130 40963  | BC559            |
| TS1071 | 4822 130 40964  | BC549            |
| TS1072 | 4822 130 40963  | BC559            |
| TS1201 | 4822 130 40964  | BC549            |
| TS1202 | 4822 130 40964  | BC549            |
| TS1203 | 4822 130 40964  | BC549            |
| TS1204 | 4822 130 40964  | BC549            |
| TS1206 | 5322 130 44127  | 2N2894A          |
| TS1207 | 5322 130 44127  | 2N2894A          |
| TS1208 | 4822 130 40908  | BF336            |
| TS1209 | 5322 130 44603  | BFT45            |
| TS1211 | 5322 130 44127  | 2N2894A          |
| TS1212 | 5322 130 40417  | BSX20            |
| TS1213 | 4822 130 40908  | BF336            |
| TS1214 | 5322 130 44603  | BFT45            |
| TS1301 | 4822 130 40964  | BC549            |
| TS1302 | 5322 130 44127  | 2N2894A          |
| TS1303 | 5322 130 40321  | BSX21            |
| TS1304 | 5322 130 40321  | BSX21            |
| TS1306 | 5322 130 40321  | BSX21            |
| TS1307 | 5322 130 40373  | BCY71            |
| TS1308 | 5322 130 40321  | BSX21            |
| TS1309 | 4822 130 40712  | BD136            |
| TS1311 | 4822 130 40712  | BD136            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| TS1317 | 4822 130 40712  | BD136            |
| TS1401 | 5322 130 40373  | BCY71            |
| TS1402 | 5322 130 44788  | BSM68            |
| TS1801 | 5322 130 44357  | BD262            |
| TS1802 | 4822 130 44246  | BC549C           |
| TS1807 | 5322 130 44707  | GESELECTEERD     |
| TS1808 | 4822 130 44358  | BC559B           |
| TS1809 | 5322 130 44019  | BSX60            |
| TS1811 | 5322 130 40482  | BRY39            |
| TS1812 | 4822 130 44246  | BC549C           |
| TS1813 | 5322 130 44395  | CNY43            |
| TS2376 | 4822 130 44154  | BF199            |
| TS2377 | 4822 130 40964  | BC549            |
| TS2378 | 4822 130 41448  | BF324            |
| TS2379 | 4822 130 44154  | BF199            |
| TS2401 | 4822 130 40964  | BC549            |
| TS2402 | 4822 130 41448  | BF324            |
| TS2403 | 4822 130 41448  | BF324            |
| TS2404 | 4822 130 40964  | BC549            |
| TS2409 | 4822 130 40964  | BC549            |
| TS2411 | 4822 130 40964  | BC549            |
| TS2412 | 4822 130 40964  | BC549            |
| TS2413 | 4822 130 40964  | BC549            |
| TS2414 | 4822 130 40964  | BC549            |
| TS2416 | 4822 130 40964  | BC549            |
| TS2417 | 4822 130 40964  | BC549            |
| TS2576 | 4822 130 44154  | BF199            |
| TS2577 | 4822 130 40964  | BC549            |
| TS2578 | 4822 130 41448  | BF324            |
| TS2579 | 4822 130 44154  | BF199            |
| TS2601 | 4822 130 40964  | BC549            |
| TS2602 | 4822 130 41448  | BF324            |
| TS2603 | 4822 130 41448  | BF324            |
| TS2604 | 4822 130 40964  | BC549            |
| TS2609 | 4822 130 40964  | BC549            |
| TS2611 | 4822 130 40964  | BC549            |
| TS2612 | 4822 130 40964  | BC549            |
| TS2613 | 4822 130 40964  | BC549            |
| TS2614 | 4822 130 40964  | BC549            |
| TS2616 | 4822 130 40964  | BC549            |
| TS2617 | 4822 130 40964  | BC549            |
| TS2776 | 4822 130 44154  | BF199            |
| TS2777 | 4822 130 40964  | BC549            |
| TS2778 | 4822 130 41448  | BF324            |
| TS2779 | 4822 130 44154  | BF199            |
| TS2801 | 4822 130 40964  | BC549            |
| TS2802 | 4822 130 41448  | BF324            |
| TS2803 | 4822 130 41448  | BF324            |
| TS2804 | 4822 130 40964  | BC549            |
| TS2809 | 4822 130 40964  | BC549            |
| TS2811 | 4822 130 40964  | BC549            |
| TS2812 | 4822 130 40964  | BC549            |
| TS2813 | 4822 130 40964  | BC549            |
| TS2814 | 4822 130 40964  | BC549            |
| TS2816 | 4822 130 40964  | BC549            |
| TS2817 | 4822 130 40964  | BC549            |

## Integrated circuits

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| IC101  | 5322 209 85475  | LM208H           |
| IC102  | 5322 111 94032  | TF CIRCUIT       |
| IC201  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC202  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC203  | 5322 209 85486  | SN74LS04N-00 TI  |
| IC204  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC206  | 5322 209 84986  | SN74LS74N-00 TI  |
| IC207  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC208  | 5322 209 85265  | SN74LS03N-00     |
| IC209  | 5322 209 84986  | SN74LS74N-00 TI  |
| IC211  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC212  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC213  | 5322 209 85265  | SN74LS03N-00     |
| IC214  | 5322 209 84986  | SN74LS74N-00 TI  |
| IC216  | 5322 209 84823  | SN74LS00N-00 TI  |
| IC217  | 5322 209 85312  | SN74LS02N-00 TI  |
| IC401  | 5322 209 84355  | OC002            |
| IC402  | 5322 209 84355  | OC002            |
| IC501  | 5322 209 84355  | OC002            |
| IC601  | 5322 209 84355  | OC002            |
| IC602  | 5322 209 84355  | OC002            |
| IC1301 | 5322 209 84452  | UA709CH          |
| IC1801 | 5322 209 84655  | UA723CL          |
| IC2401 | 5322 209 84355  | OC002            |
| IC2402 | 5322 209 84355  | OC002            |
| IC2601 | 5322 209 84355  | OC002            |
| IC2602 | 5322 209 84355  | OC002            |
| IC2801 | 5322 209 84355  | OC002            |
| IC2802 | 5322 209 84355  | OC002            |

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## Miscellaneous

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION     |
|--------|-----------------|----------------------|
| L 401  | 5322 281 64154  | COIL                 |
| L 601  | 5322 466 14181  | DELAY LINE COIL      |
| L 1301 | 5322 150 14015  | ROTARY COIL          |
| L 1302 | 5322 526 14031  | CHOKER BEAD          |
| L 1303 | 5322 526 14031  | CHOKER BEAD          |
| L 1800 | 5322 281 64154  | COIL                 |
| L 1803 | 5322 152 24027  |                      |
| L 1804 | 5322 158 10052  | COIL                 |
| L 1806 | 5322 281 64154  | COIL                 |
| L 1807 | 5322 158 10052  | COIL                 |
| L 1808 | 5322 281 64154  | COIL                 |
| L 1809 | 5322 158 10052  | COIL                 |
| L 1811 | 5322 281 64154  | COIL                 |
| L 1812 | 5322 158 10052  | COIL                 |
| L 1813 | 5322 281 64154  | COIL                 |
| L 1814 | 5322 158 10052  | COIL                 |
| L 1816 | 5322 281 64154  | COIL                 |
| L 1817 | 5322 158 10052  | COIL                 |
| L 1818 | 5322 281 64154  | COIL                 |
| L 1819 | 5322 158 10052  | COIL                 |
| L 1821 | 5322 281 64154  | COIL                 |
| RE101  | 5322 280 24076  | RELAY COIL           |
| RE102  | 5322 280 24076  | RELAY COIL           |
| RE103  | 5322 280 24076  | RELAY COIL           |
| RE104  | 5322 280 24076  | RELAY COIL           |
| RE106  | 5322 280 24076  | RELAY COIL           |
| RE107  | 5322 280 24076  | RELAY COIL           |
| RE108  | 5322 280 24076  | RELAY COIL           |
| RE109  | 5322 280 24076  | RELAY COIL           |
| RE111  | 5322 280 24076  | RELAY COIL           |
| RE112  | 5322 280 24076  | RELAY COIL           |
| T 1401 | 5322 148 84023  | TFE 3015             |
| T 1801 | 5322 146 14069  | TRAFO FXC            |
| T 1802 | 5322 148 84026  | FXC e42              |
| RE101  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE102  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE103  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE104  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE106  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE107  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE108  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE109  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE111  | 5322 280 24126  | GLASS TUBE RELAY CT. |
| RE112  | 5322 280 24126  | GLASS TUBE RELAY CT. |

## Various electrical parts

| ITEM    | ORDERING NUMBER | TYPE/DESCRIPTION        |
|---------|-----------------|-------------------------|
| B1      | 5322 131 24054  | D14-125GH/37            |
| B1      | 5322 131 24049  | D14-125GM/08 (optional) |
| B1301   | 5322 131 90021  | NEON TUBE               |
| VL1     | 4822 253 30024  | FUSE 1,6A T             |
| FI 1801 | 5322 121 44261  | MAINS FILTER            |
| LA1     | 5322 134 44123  | 18V/40mA                |
| LA2     | 5322 134 44123  | 18V/40mA                |

## Units

| ITEM    | ORDERING NUMBER | TYPE/DESCRIPTION   |
|---------|-----------------|--|
| UNIT 2  | 5322 105 44001  | ATTENUATOR   |
| UNIT 3  | 5322 121 44283  | MAINS FILTER - used in PM 3244/05 and following versions). |
| UNIT 4  | 5322 320 44033  | DELAY LINE   |
| UNIT 5  | 5322 216 54116  | POWER SUPPLY   |
| UNIT 6  | 5322 216 54117  | 2KV CONVERTER  |
| UNIT 8  | 5322 216 64258  | TIME BASE-X AMPL   |
| UNIT 11 | 5322 216 54181  | Z-AMPLIFIER  |
| UNIT 12 | 5322 216 64261  | INTERM. AMPLIFIER  |
| UNIT 13 | 5322 216 54122  | FINAL Y AMPLIFIER  |
| UNIT 14 | 5322 216 64263  | CHANNEL SEL. LOGIC   |
| UNIT 15 | 5322 218 64056  | 8KV EHT MULTIPLIER   |
| UNIT 16 | 5322 216 64262  | TRIGGER SOURCE SEL   |
| UNIT 19 | 5322 216 64259  | DELAY TIME CALIBRAT.                                       |
| TS1804  | 5322 216 64257  | SEL. TRANS.W.HEATSINK                                      |
| TS1807  | 5322 130 44707  | SEL. TRANS.W.BASERES.                                      |



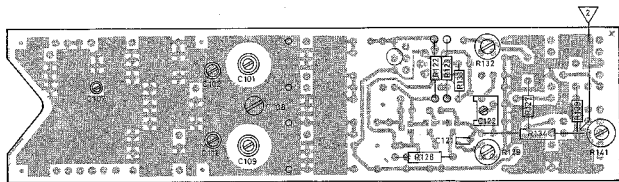
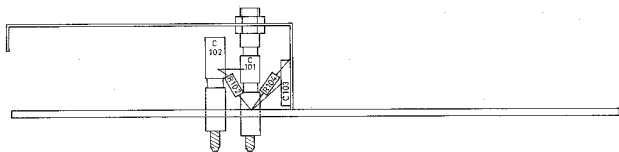
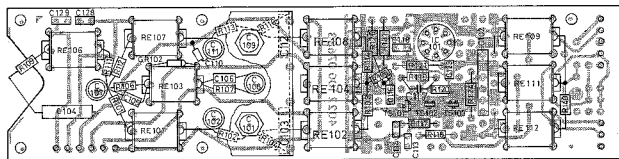


Fig. 3.16. Y-attenuator p.c.b (unit 2)

MAT 275

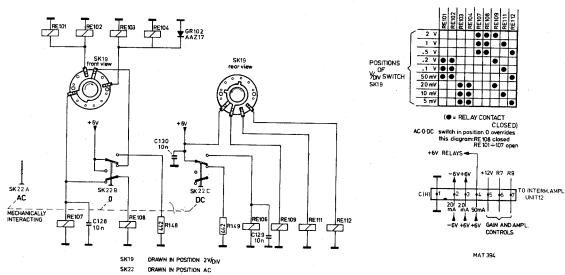
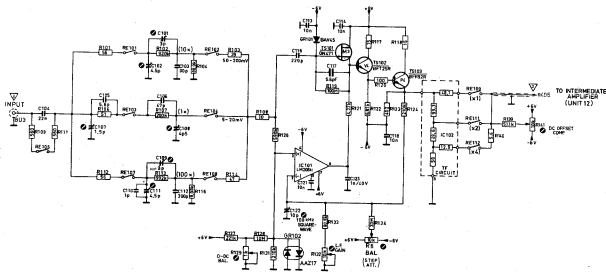


Fig. 3.17. Y-attenuator diagram (unit2)

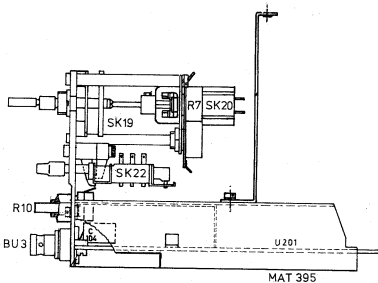
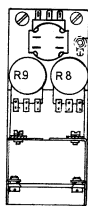


Fig. 3.18. Y-attenuator assembly

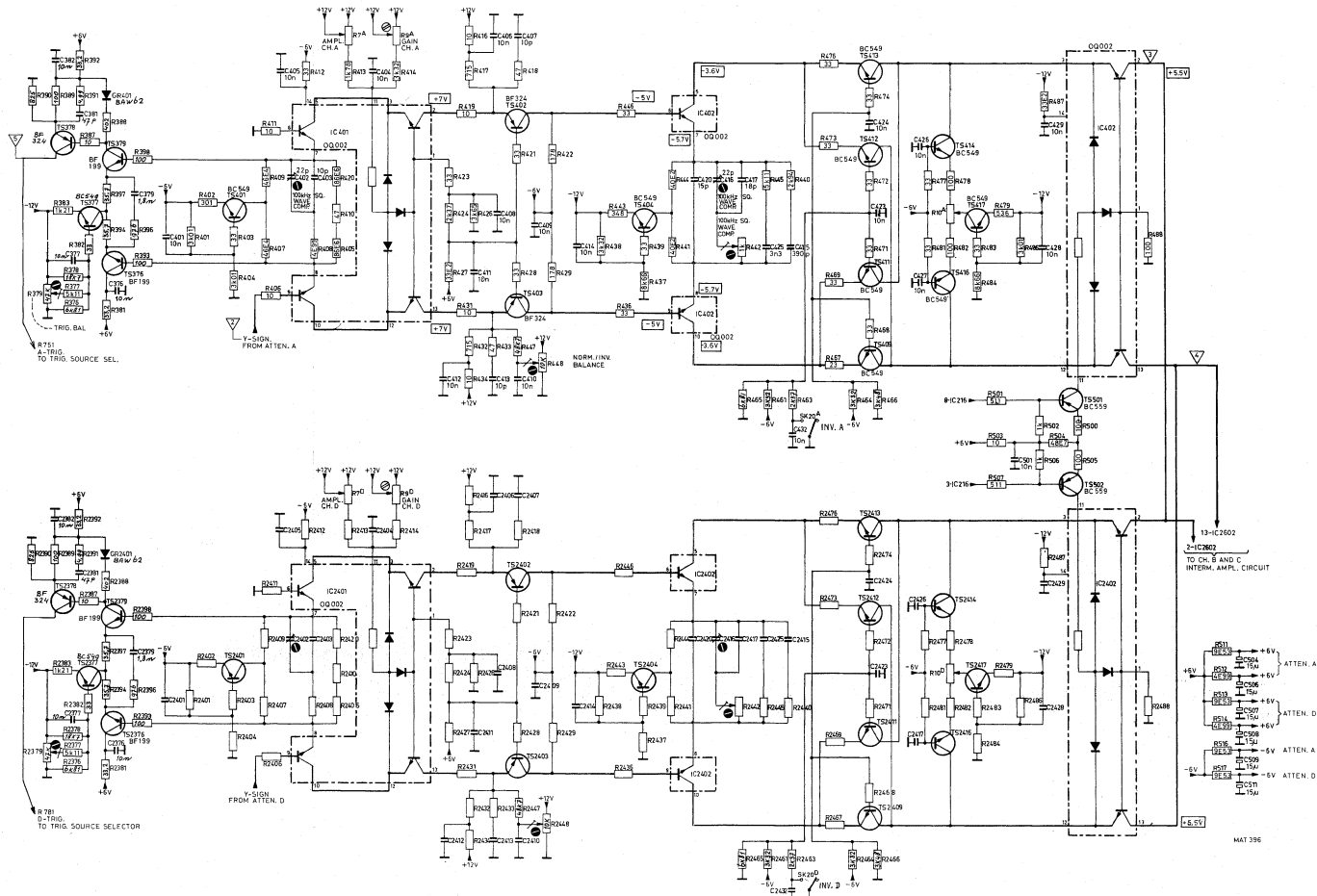
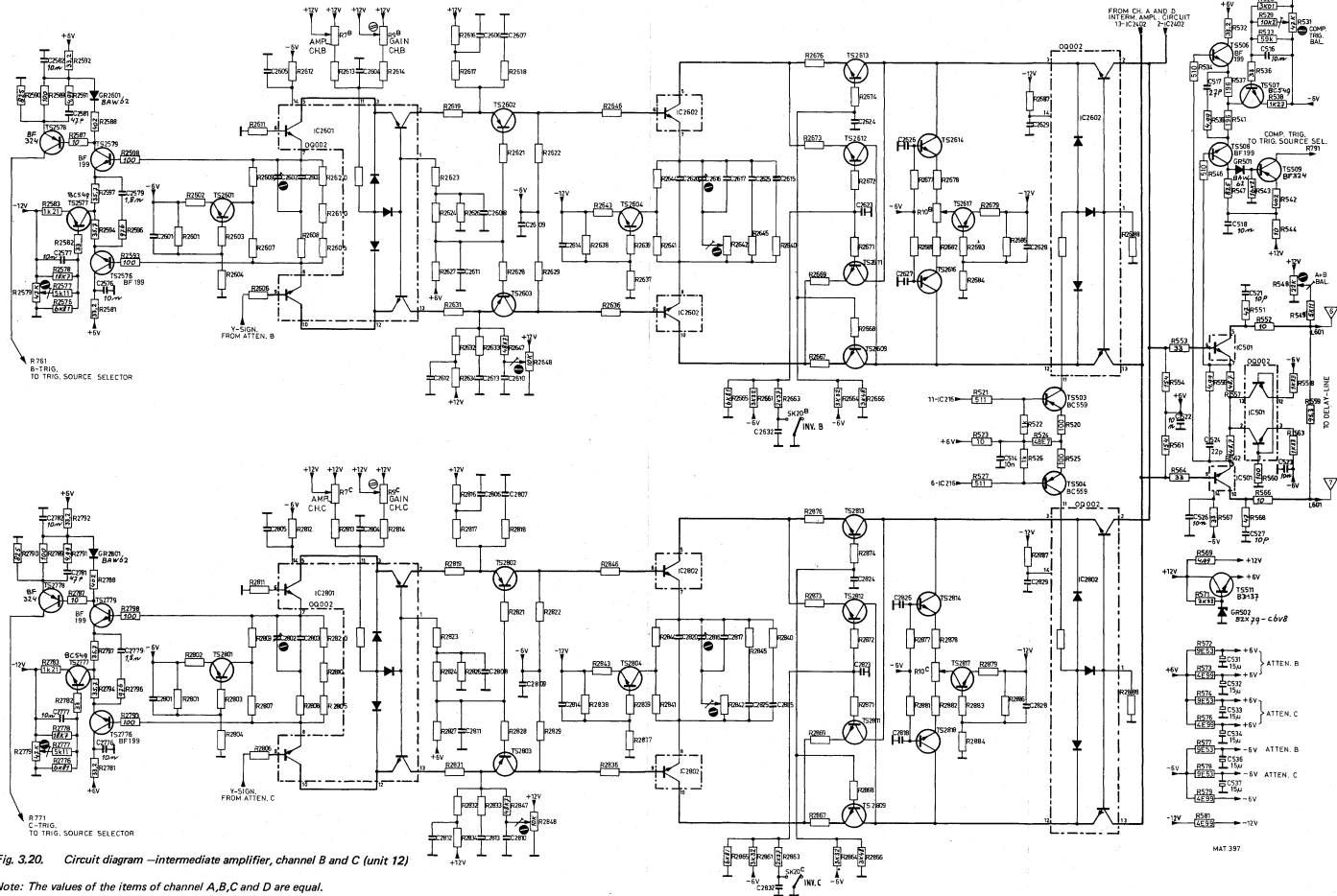


Fig. 3.19. Circuit diagram – intermediate amplifier, channel A and D (unit 12)

Note: The values of the items of channel A, B, C and D are equal.



MAT 397

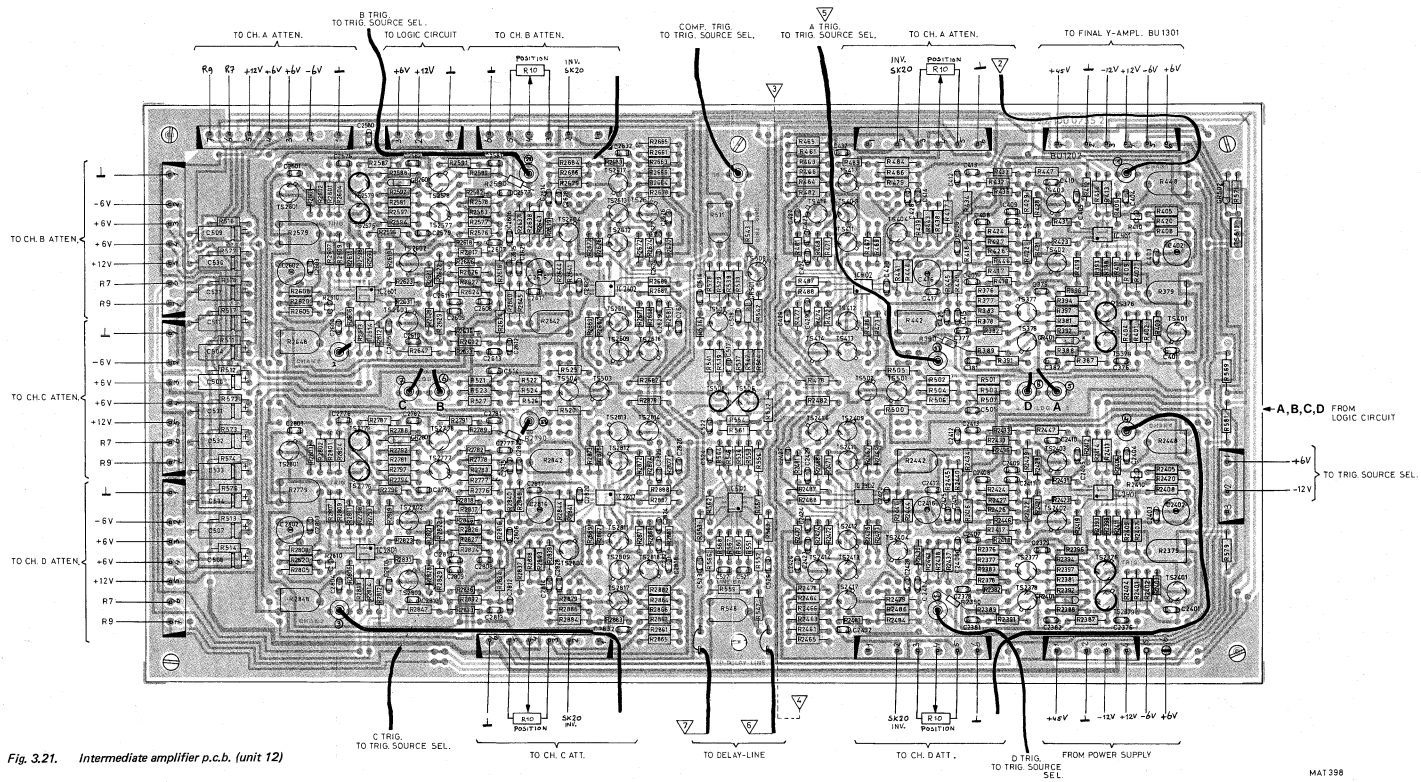


Fig. 3.21. Intermediate amplifier p.c.b. (unit 12)



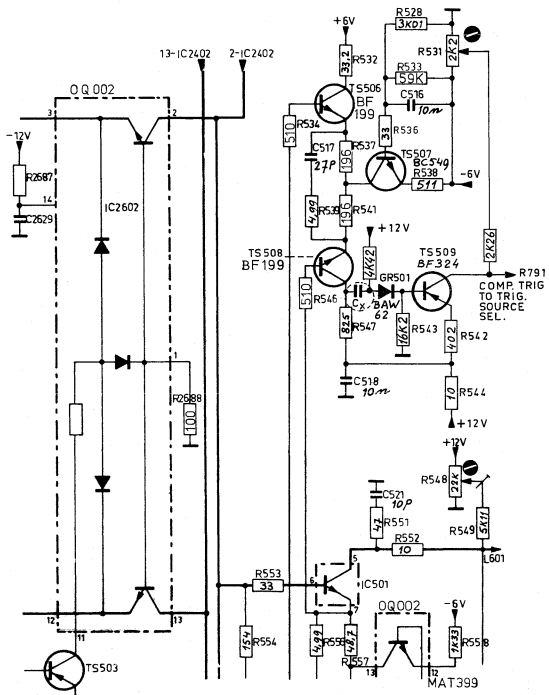
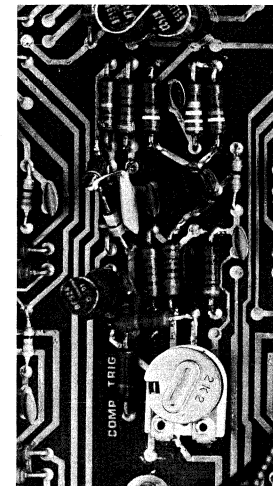
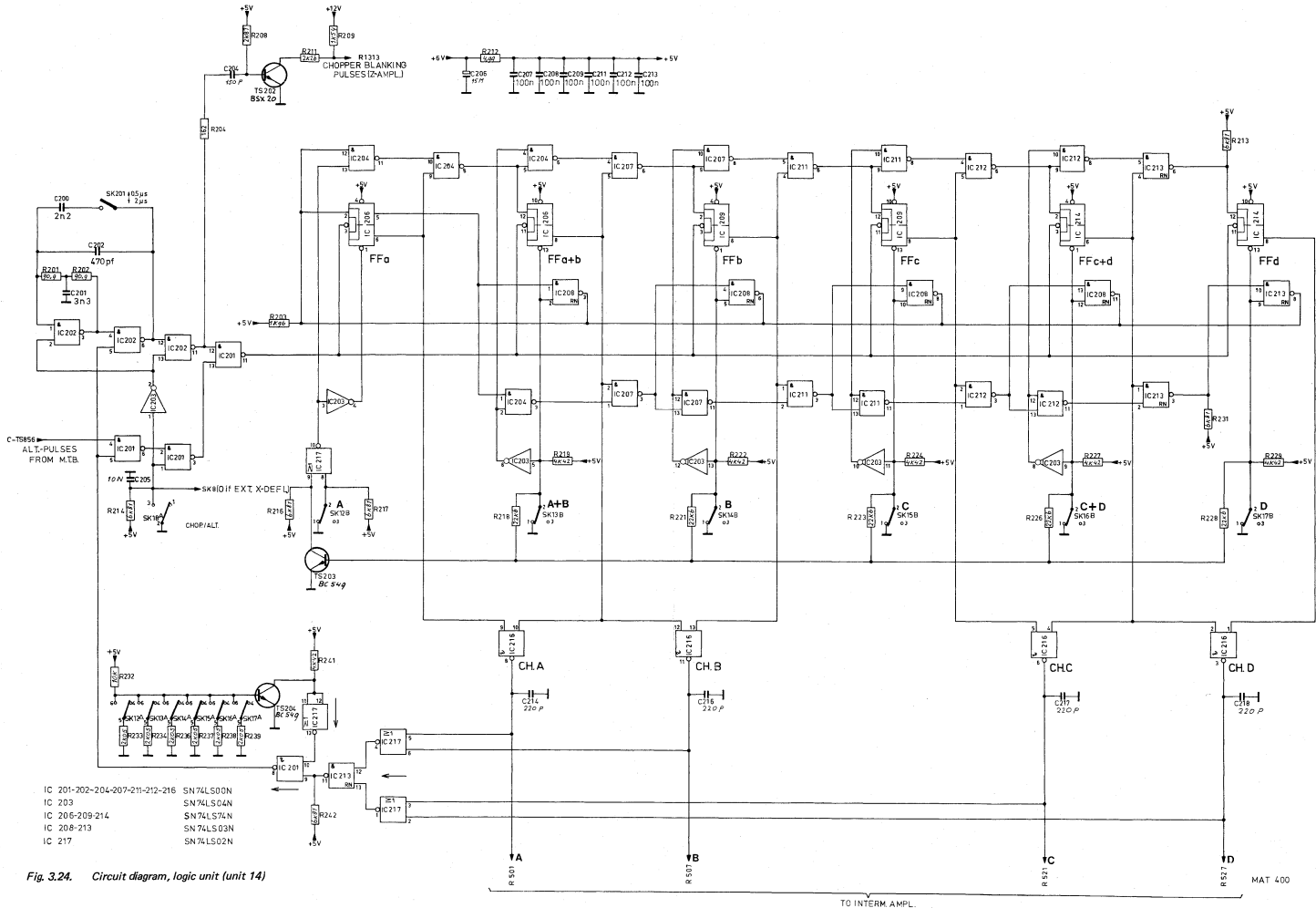


Fig. 3.22. Modified circuit for A.C. composite triggering (unit 12)



MAT 393

Fig. 3.23. Modified circuit lay out for A.C. composite triggering



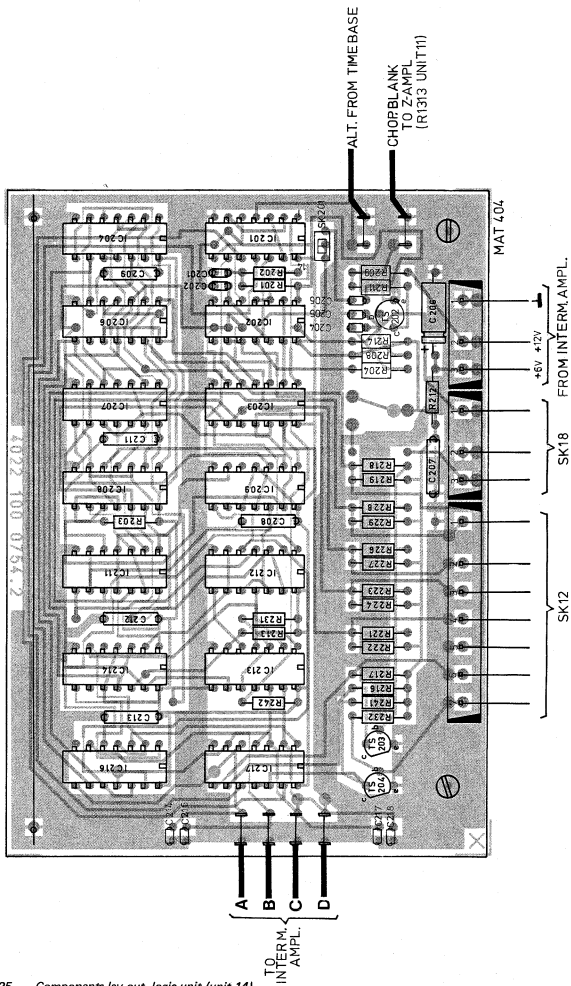


Fig. 3.25. Components lay out, logic unit (unit 14)

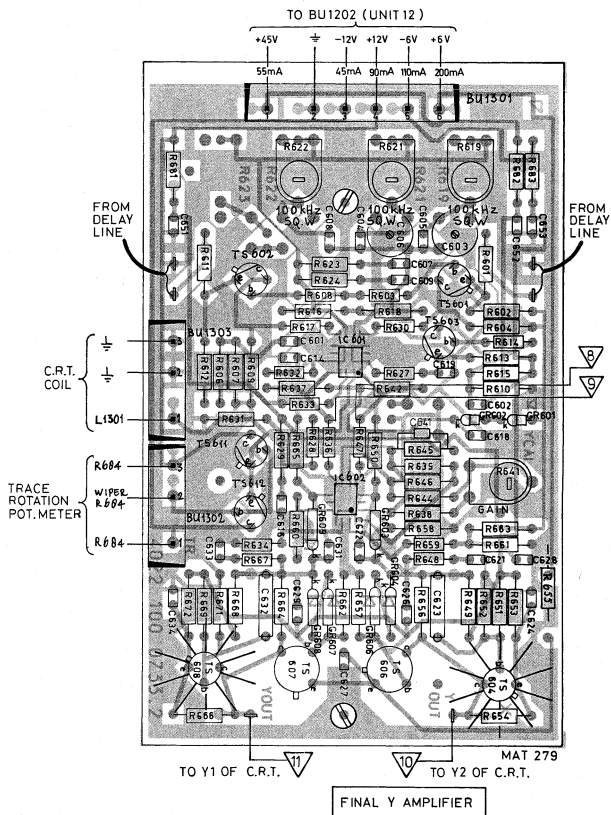


Fig. 3.26 Final Y amplifier p.c.b. (unit 13)

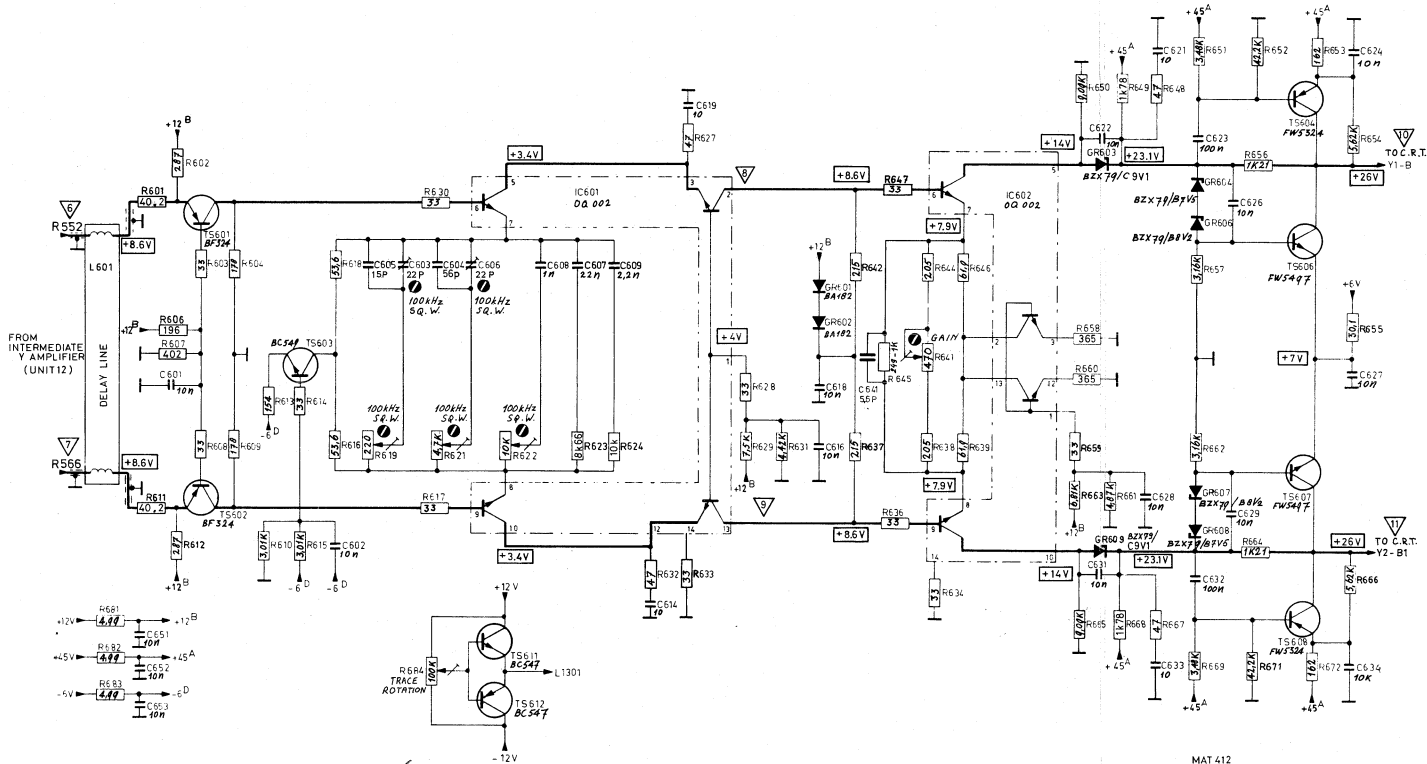


Fig. 3.27. Circuit diagram, final Y-amplifier (unit 13)

MAT 412

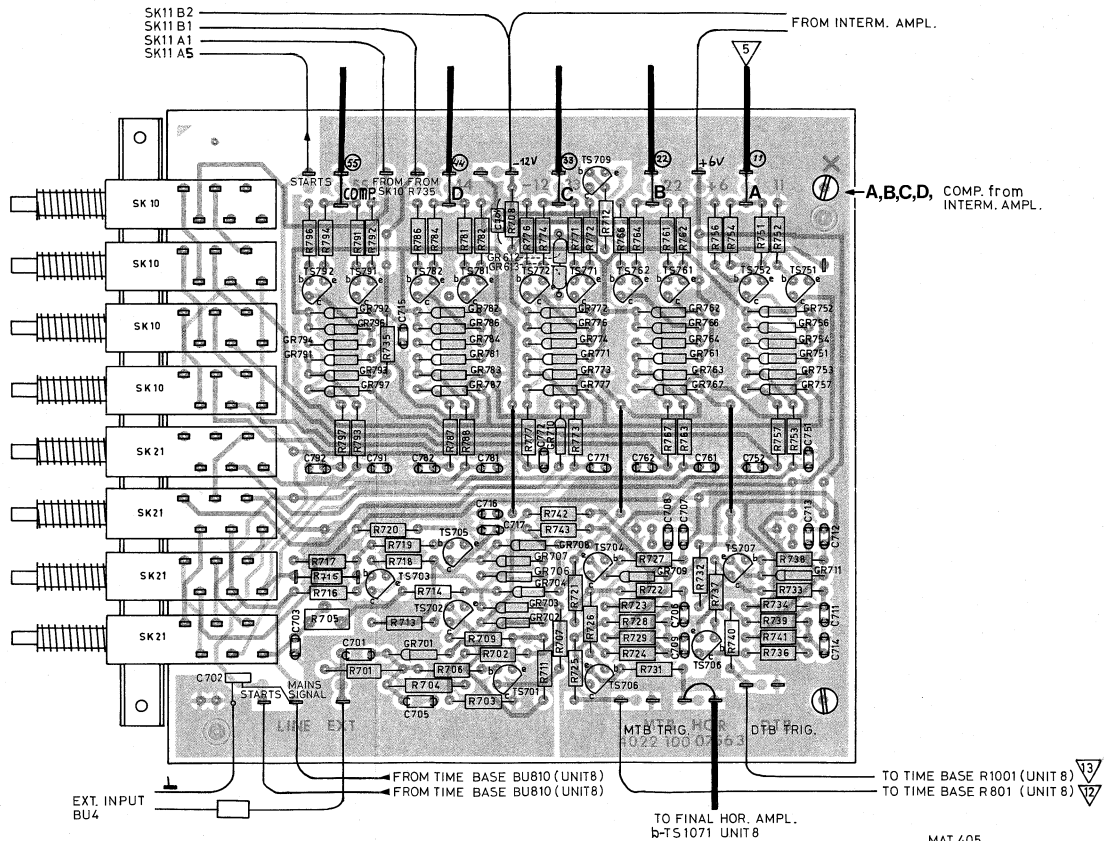


Fig. 3.28. Components lay out , trigger source selector (unit 16)

MAT 405

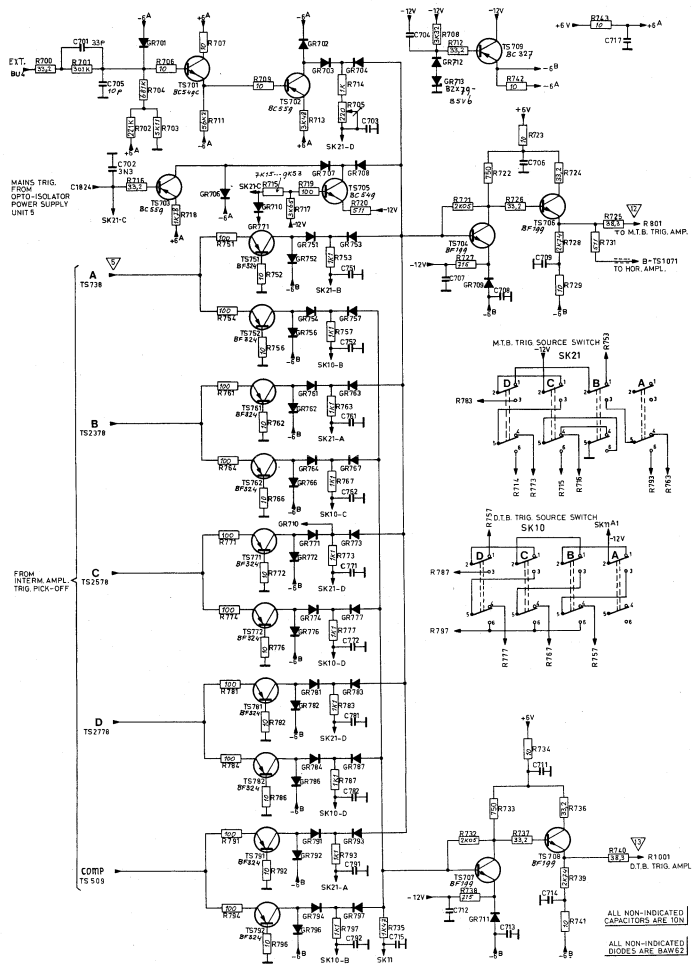
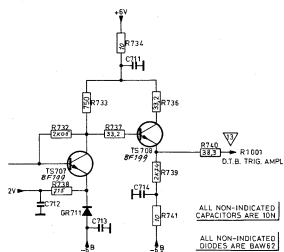
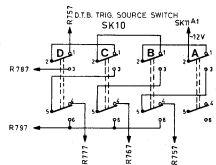
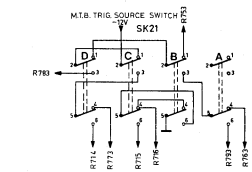
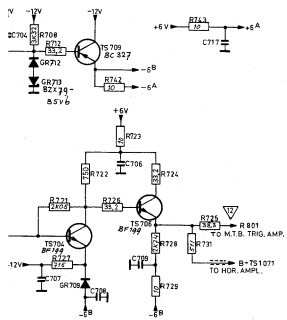


Fig. 3.29. Circuit diagram, trigger source selector (unit 16)



ALL NON-INDICATED  
CAPACITORS ARE 10N

ALL NON-INDICATED  
DIODES ARE BAW62Z



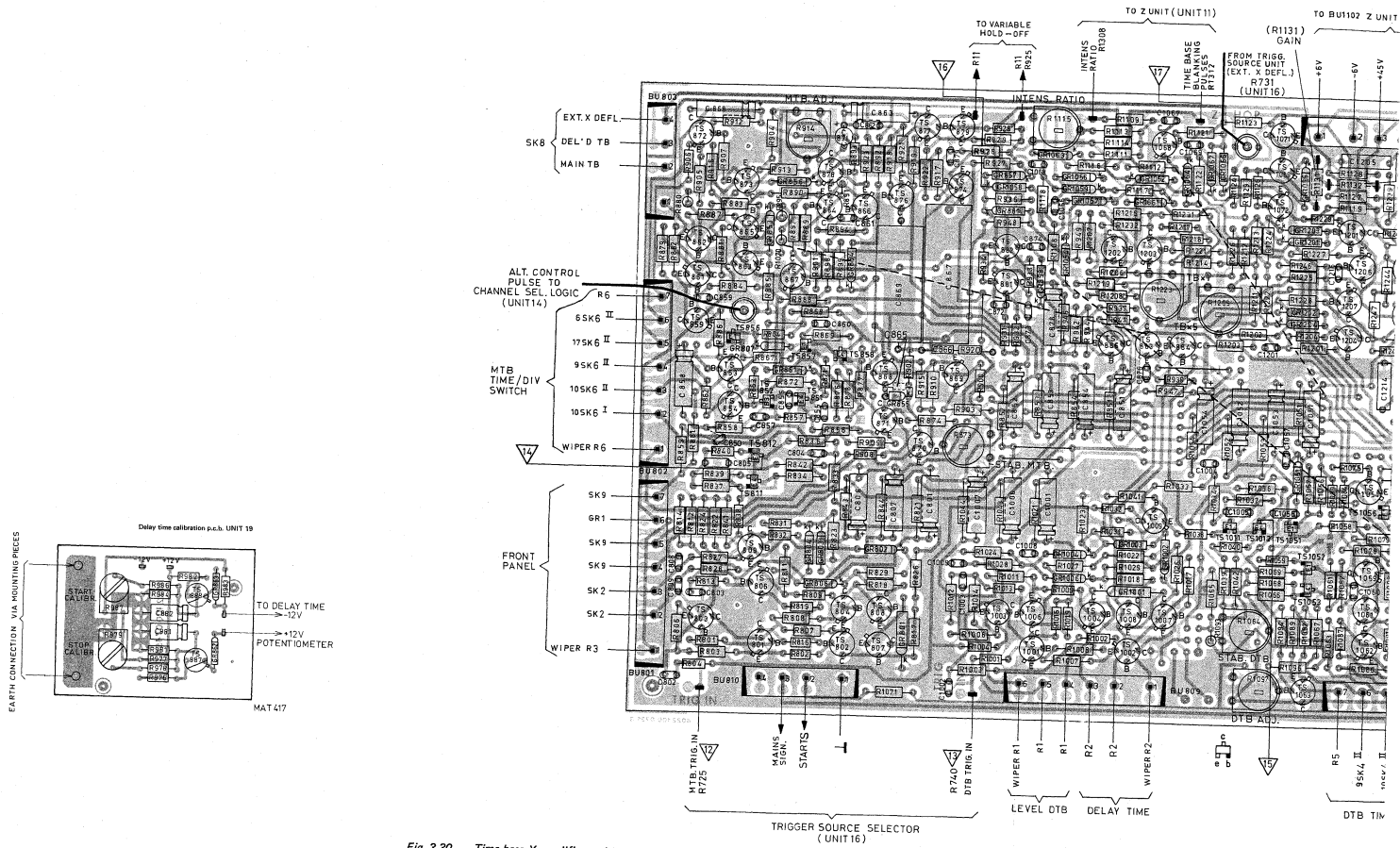


Fig. 3.30. Time base X-amplifier and calibration p.c.b. (unit 8 and 19)

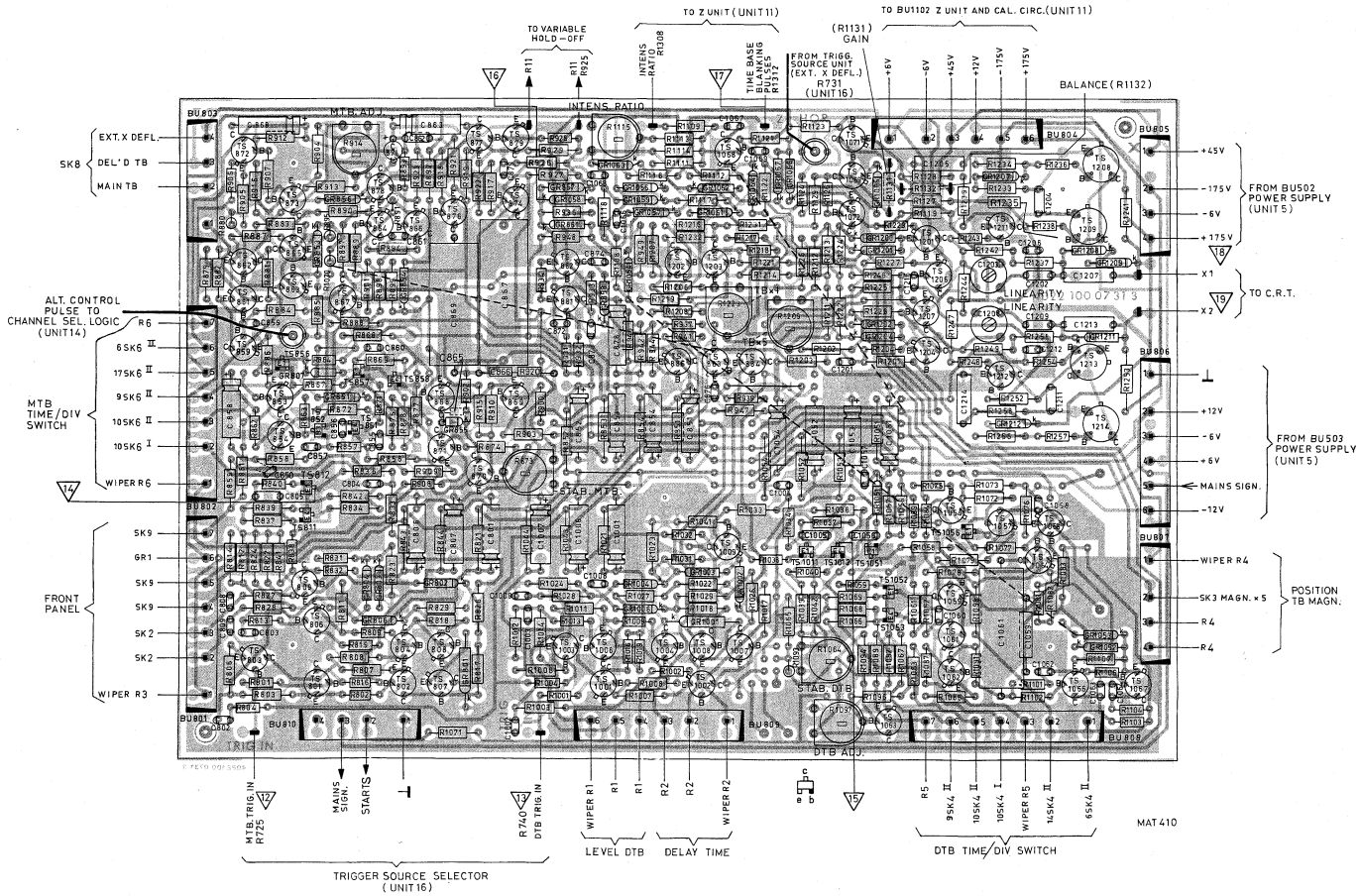
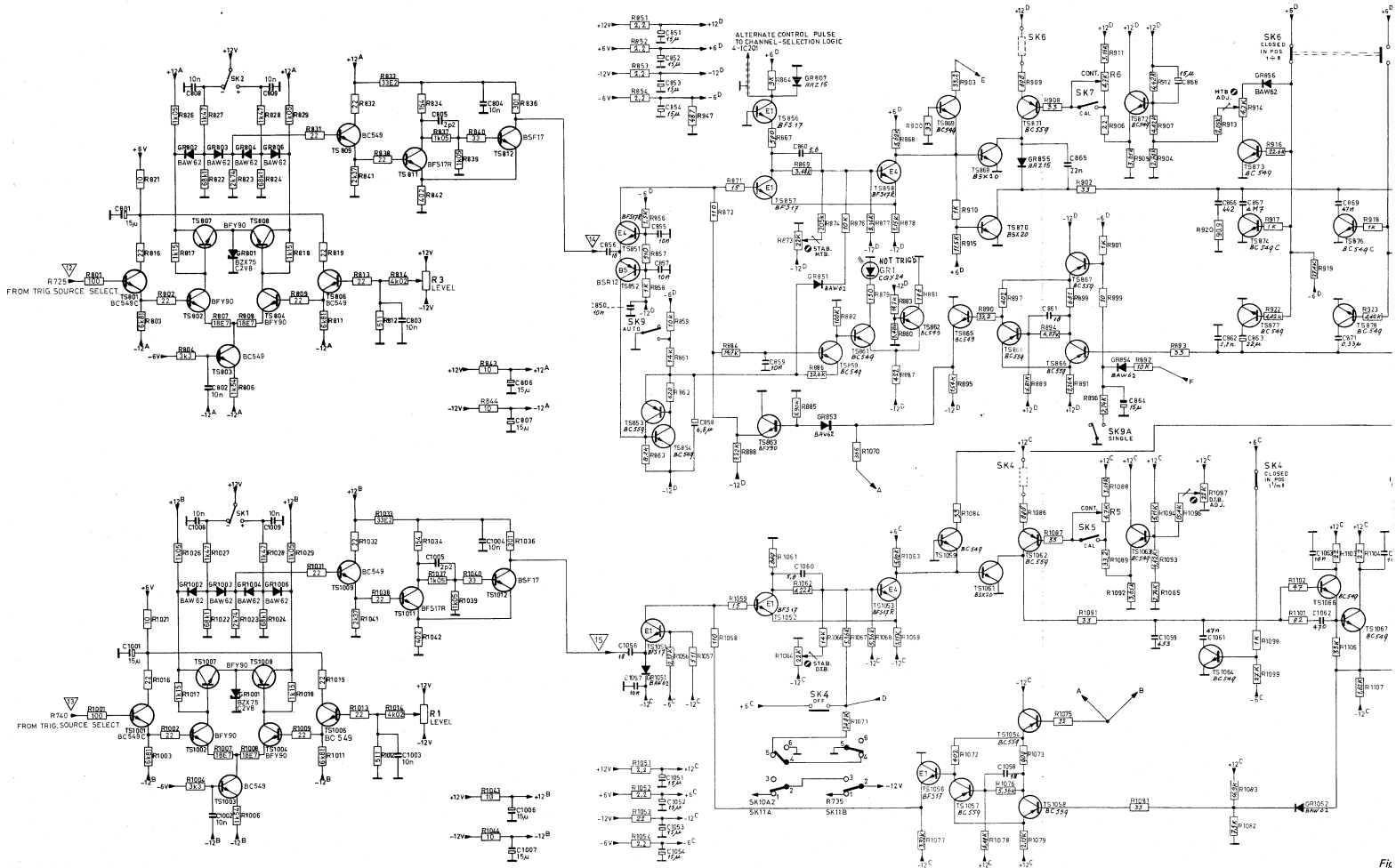


Fig. 3.30. Time base X-amplifier and calibration p.c.b. (unit 8 and 19)



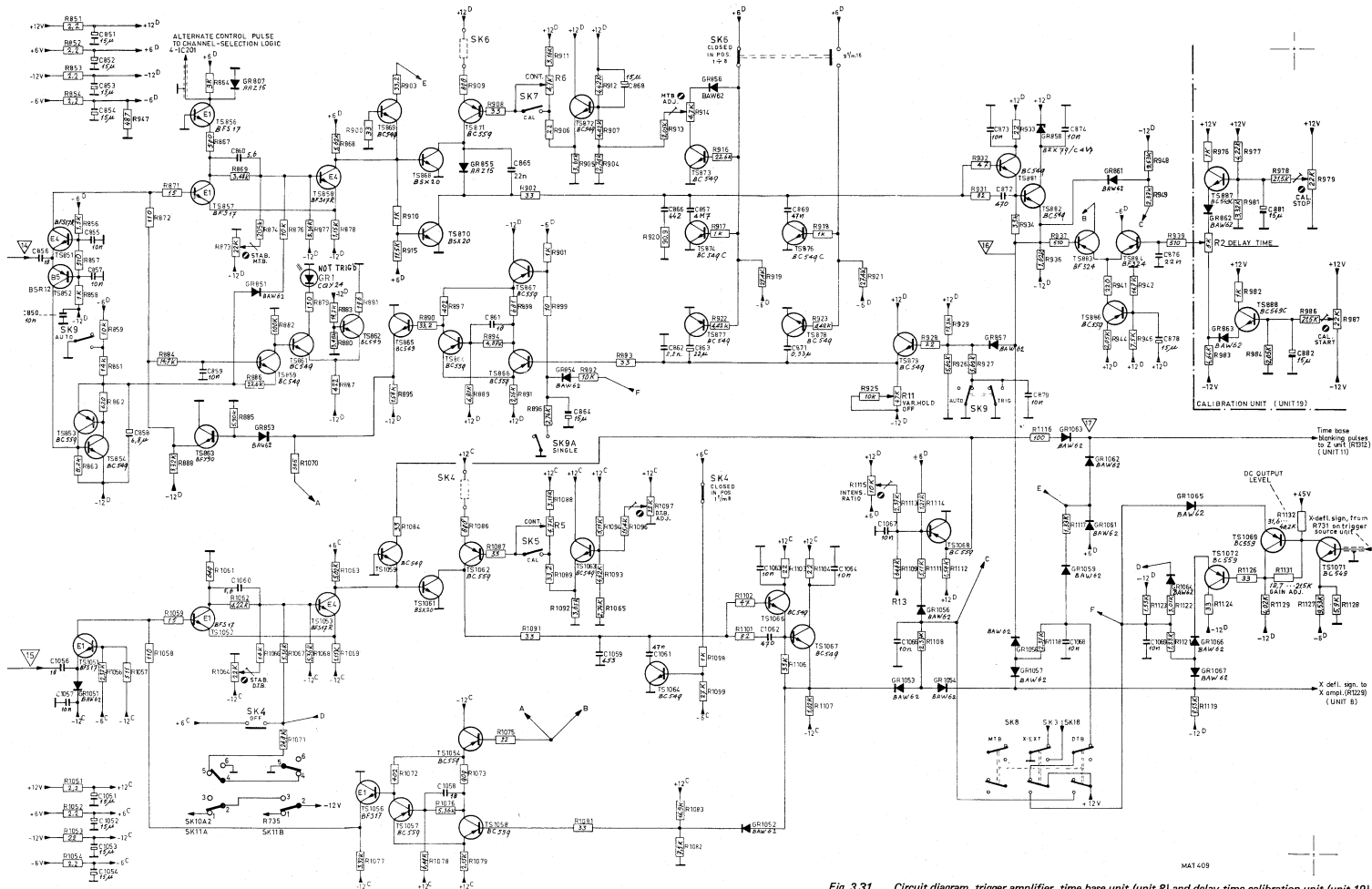


Fig. 3.31. Circuit diagram, trigger amplifier, time base unit (unit 8) and delay-time calibration unit (unit 9)

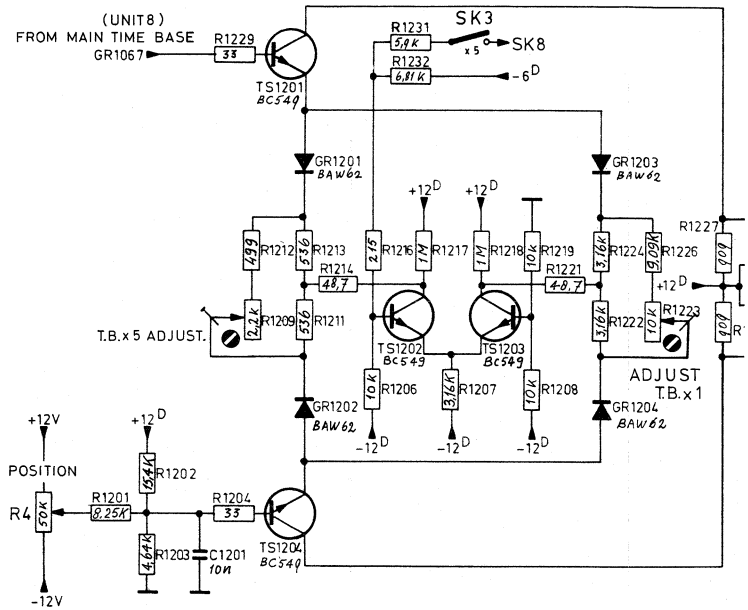


Fig. 3.3.

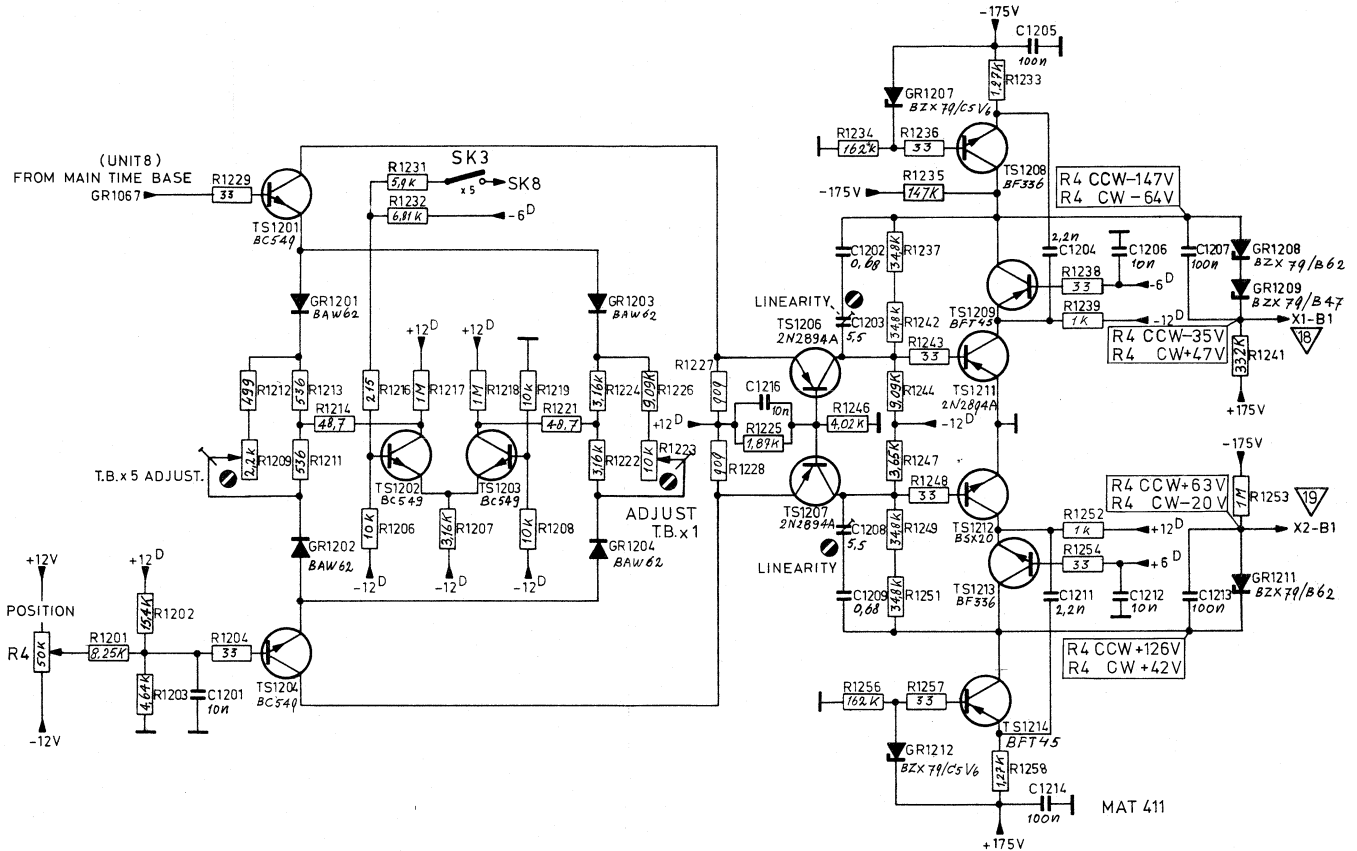
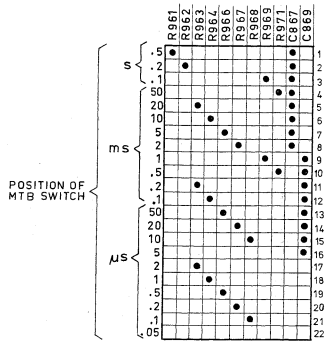
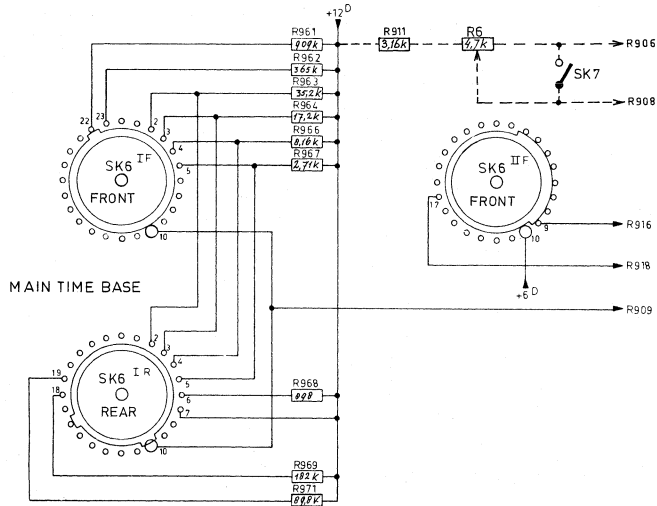


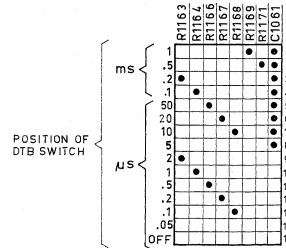
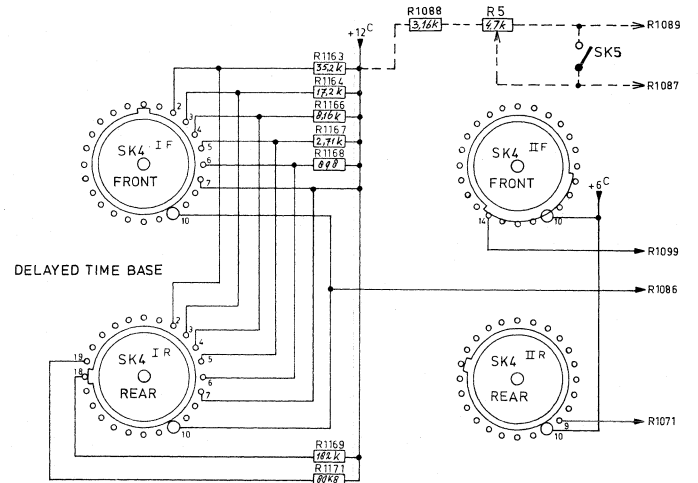
Fig. 3.32. Circuit diagram, X-amplifier (unit 8)



TIME BASE CAPACITOR AND CURRENT SOURCE RESISTOR TO BE ACTIVE AS A FUNCTION OF THE MTB KNOB POSITION

Fig. 3.33. Mains time base switch

MAT 413



TIME BASE CAPACITOR AND CURRENT SOURCE RESISTOR TO BE ACTIVE AS A FUNCTION OF THE DTB KNOB POSITION

MAT 414

Fig. 3.34. Delayed time base switch

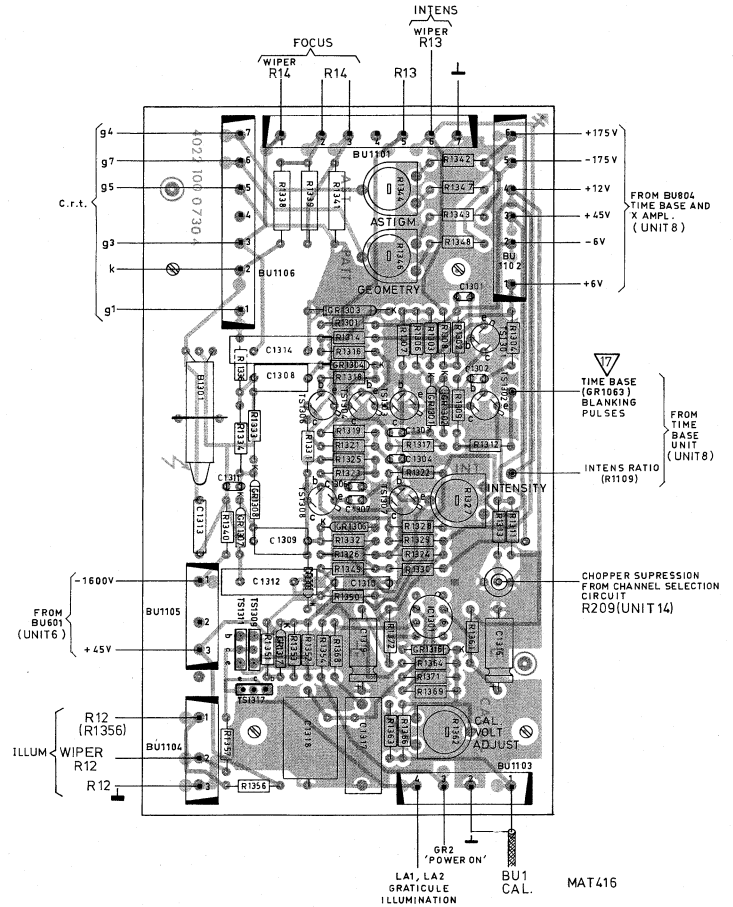


Fig. 3.35. Z-unit, illumination and calibration unit (unit 11)



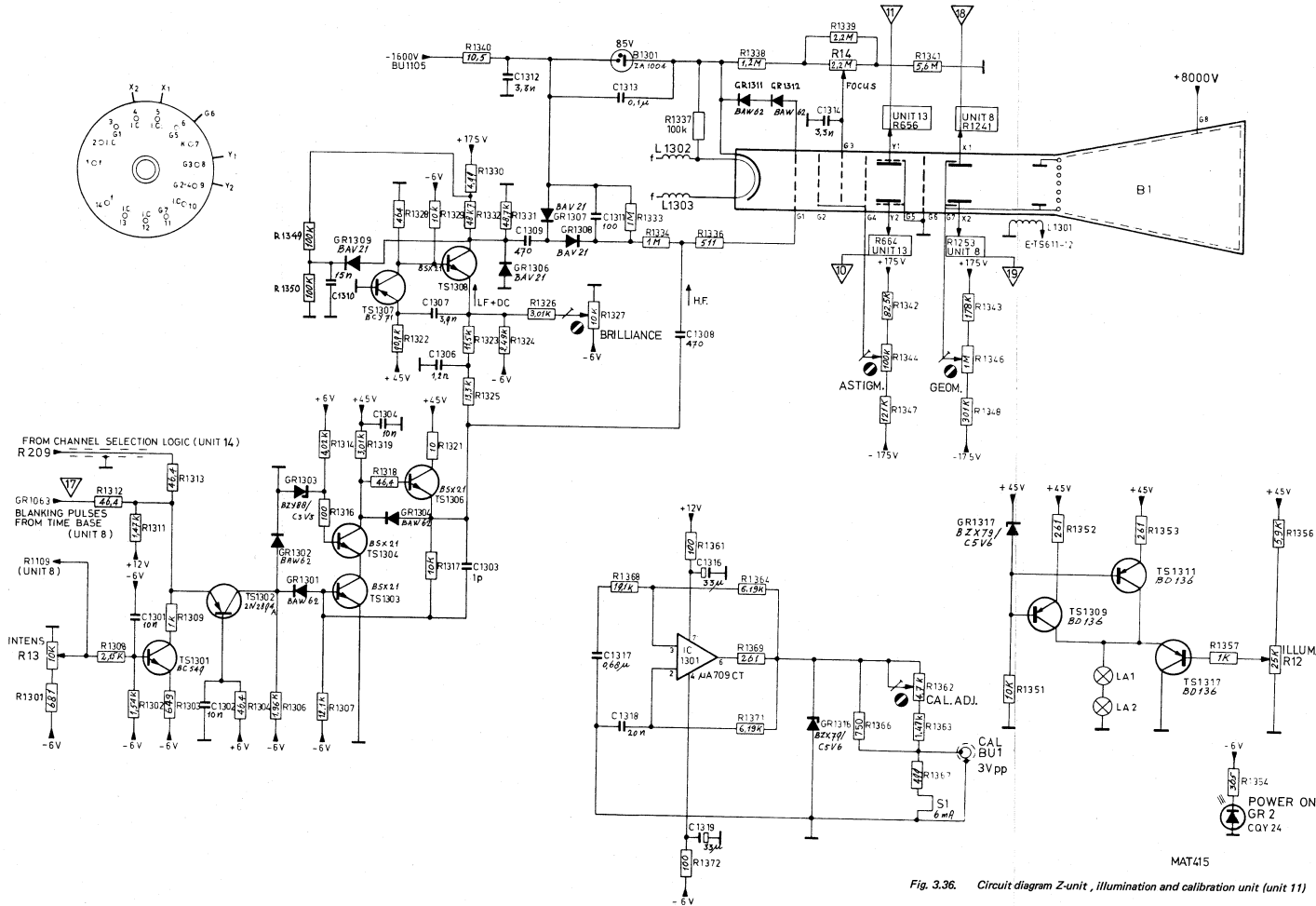


Fig. 3.36. Circuit diagram Z-unit, illumination and calibration unit (unit 11)

MAT415

POWER ON  
GR 2  
CGY 24

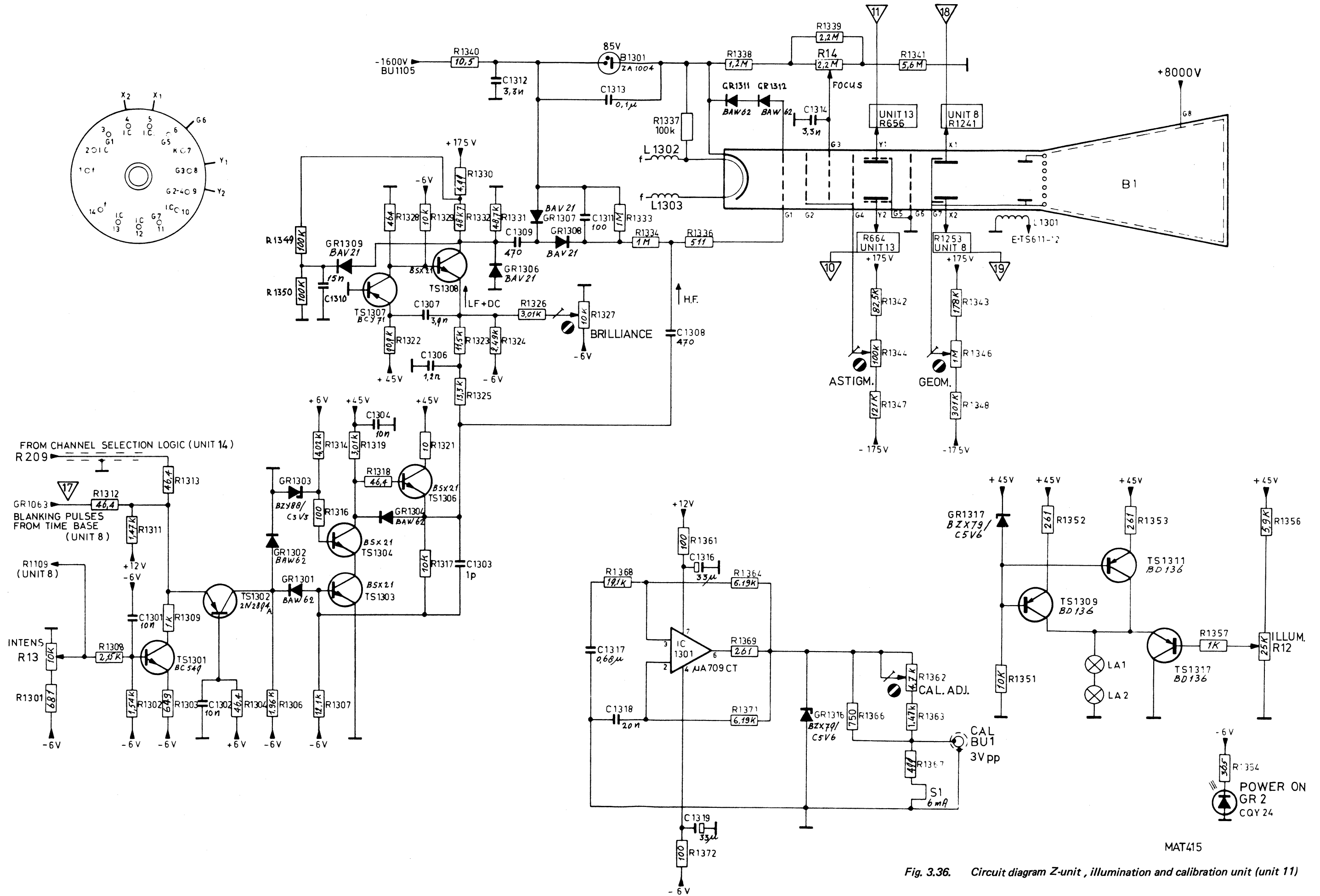


Fig. 3.36. Circuit diagram Z-unit, illumination and calibration unit (unit 11)

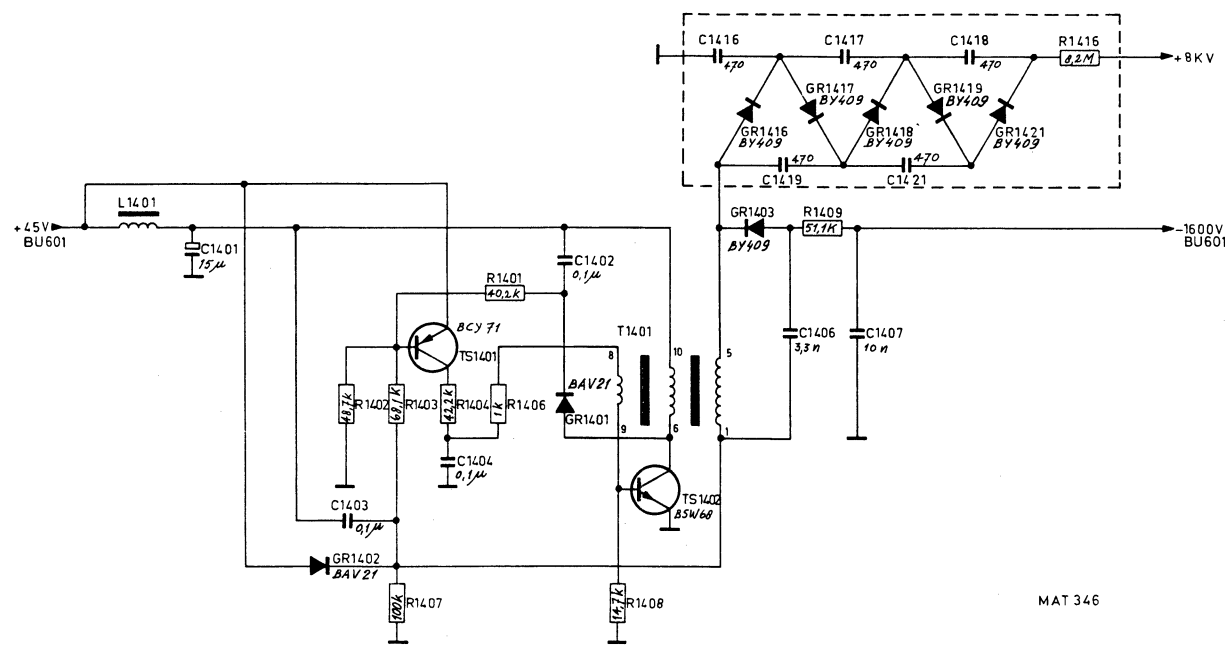


Fig. 3.38. Circuit diagram EHT converter (unit 6 and 15)

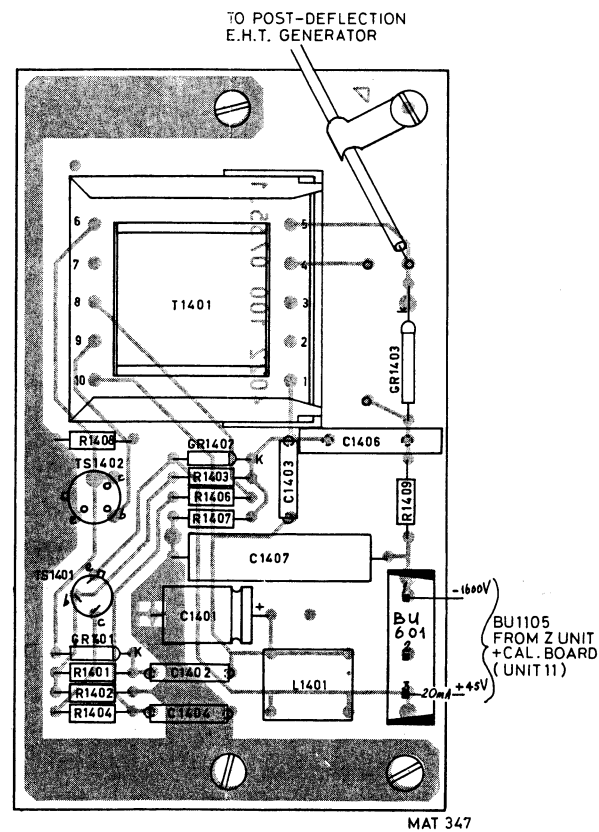


Fig. 3.39. EHT converter p.c.b. (unit 6)

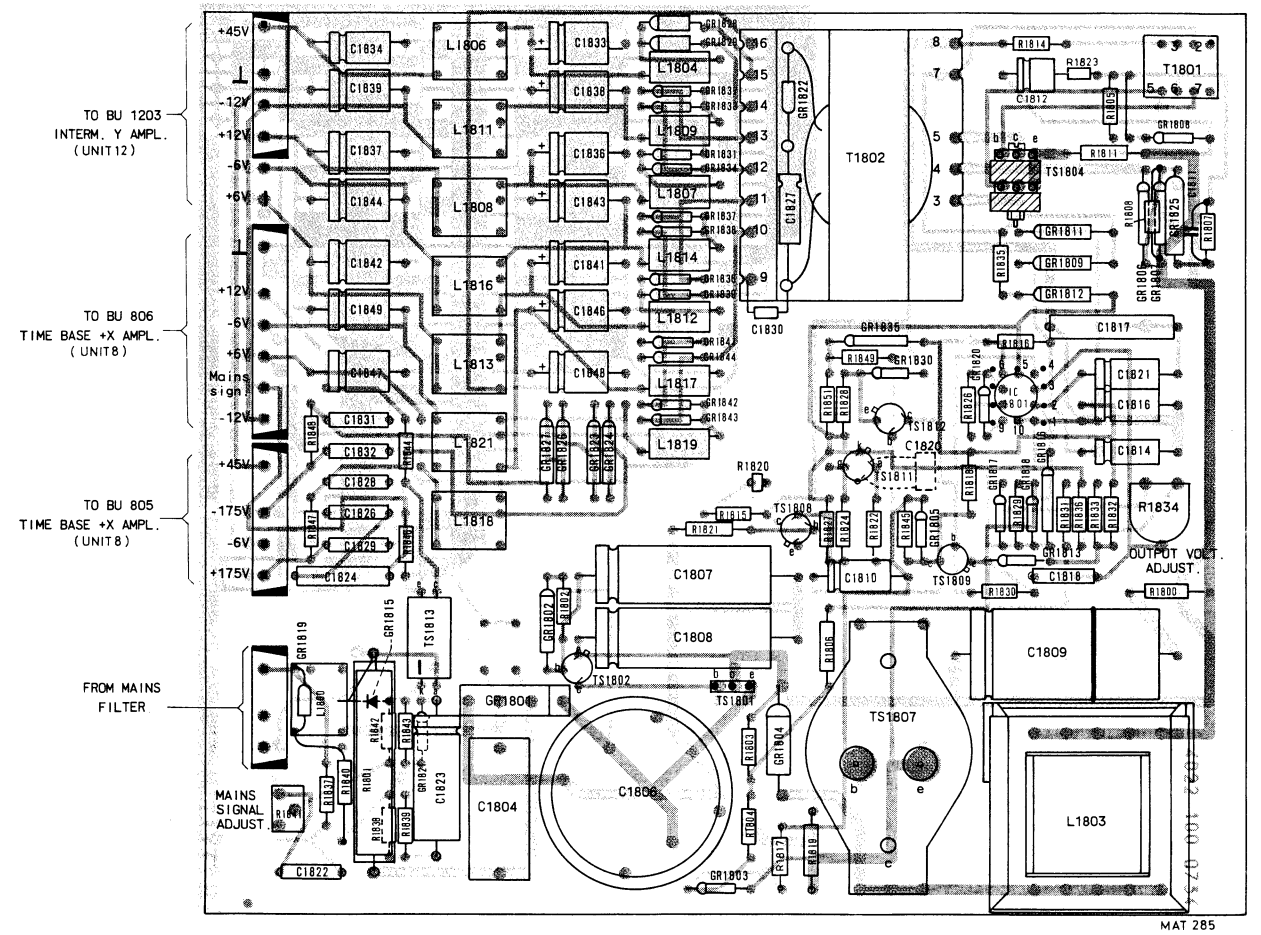
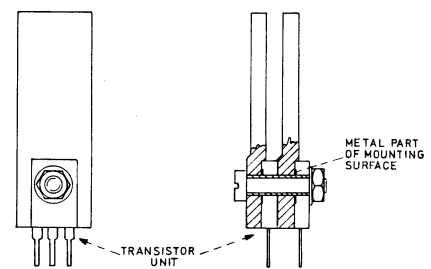
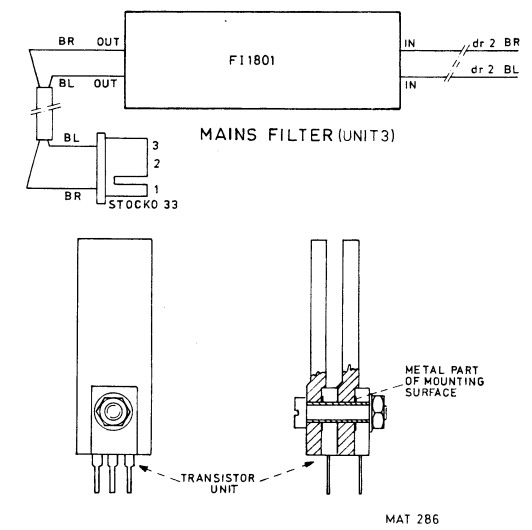


Fig. 3.37. Power supply p.c.b. (unit 5)



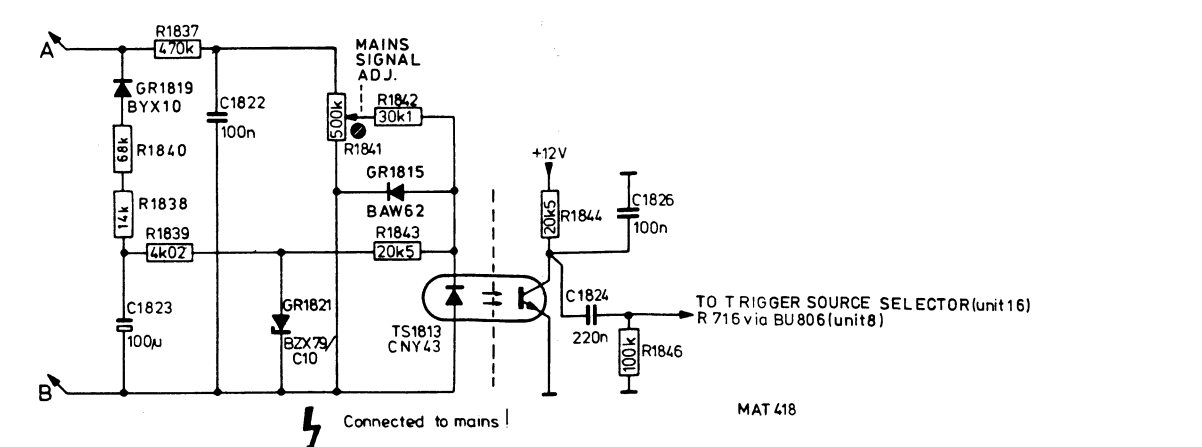
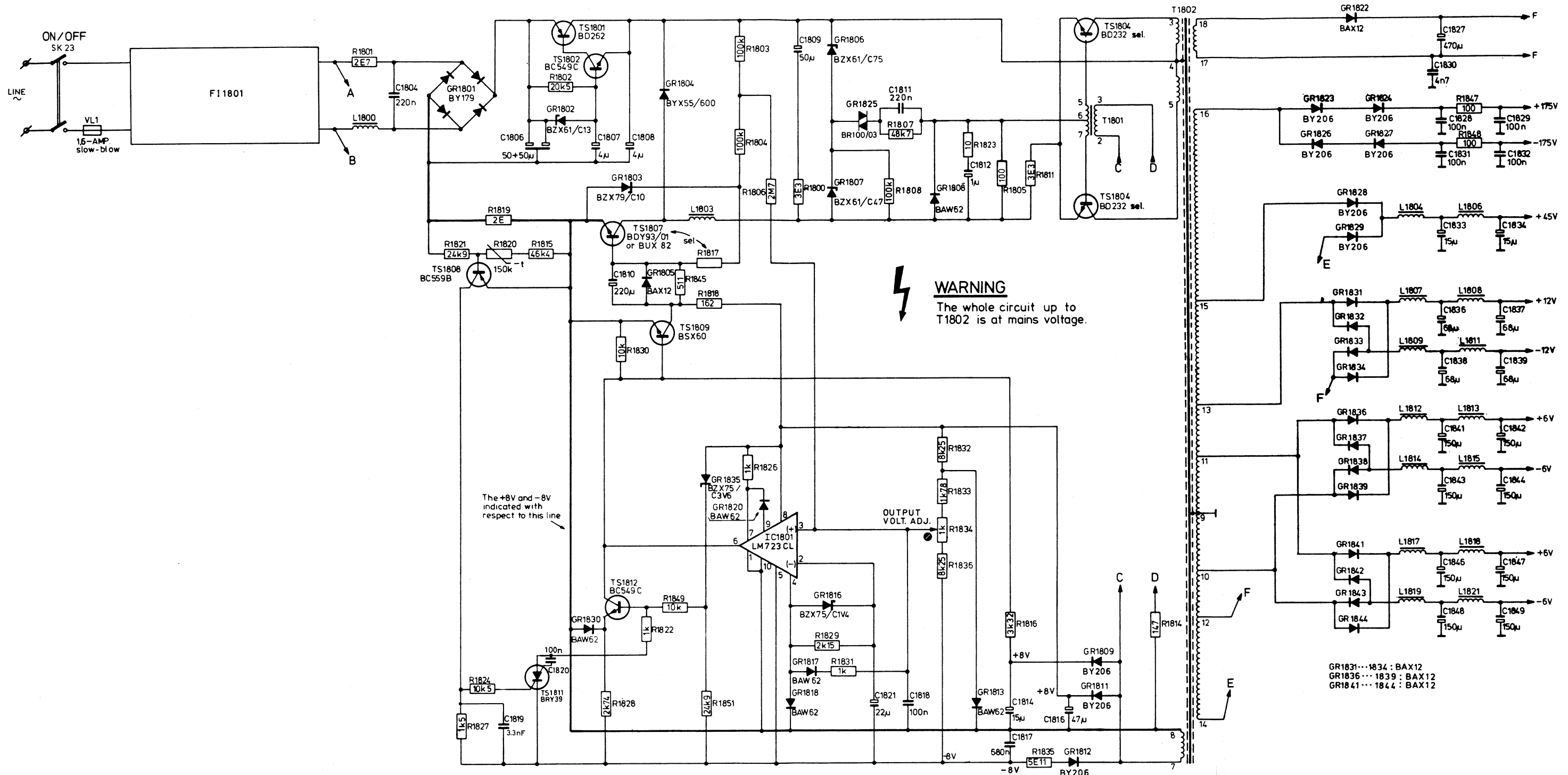


Fig. 3.40. Circuit diagram power supply (unit 3 and 5)

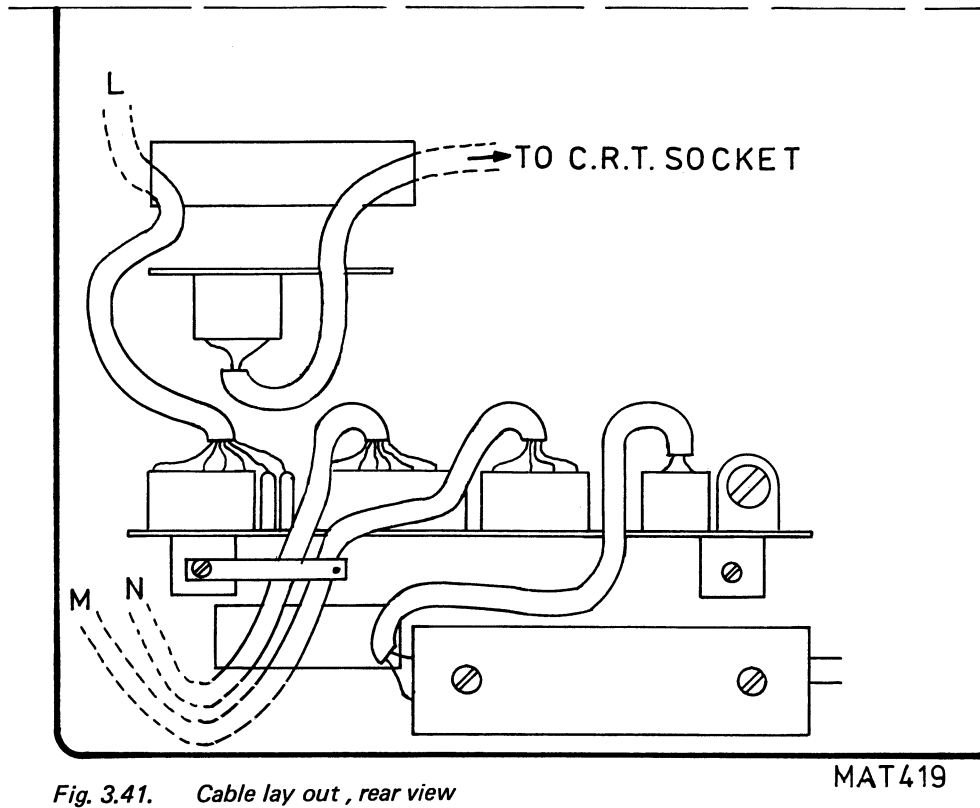


Fig. 3.41. Cable lay out, rear view

MAT419

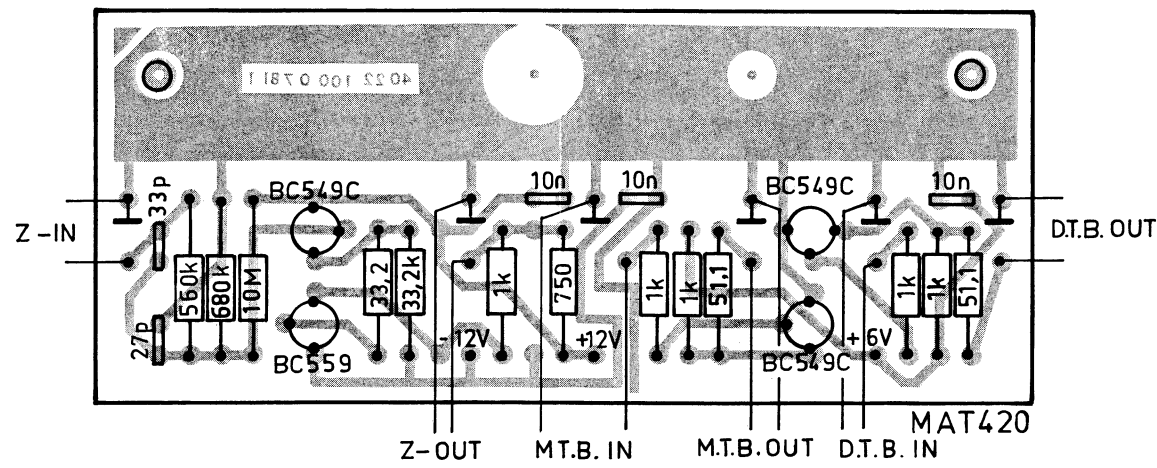


Fig. 3.42. Lay out additional p.c.b.

MAT420

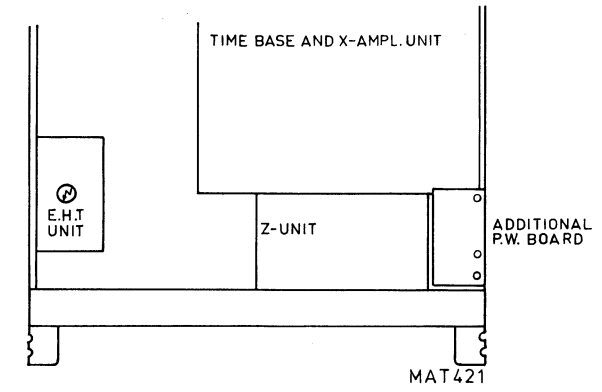


Fig. 3.43. Location of the additional p.c.b.

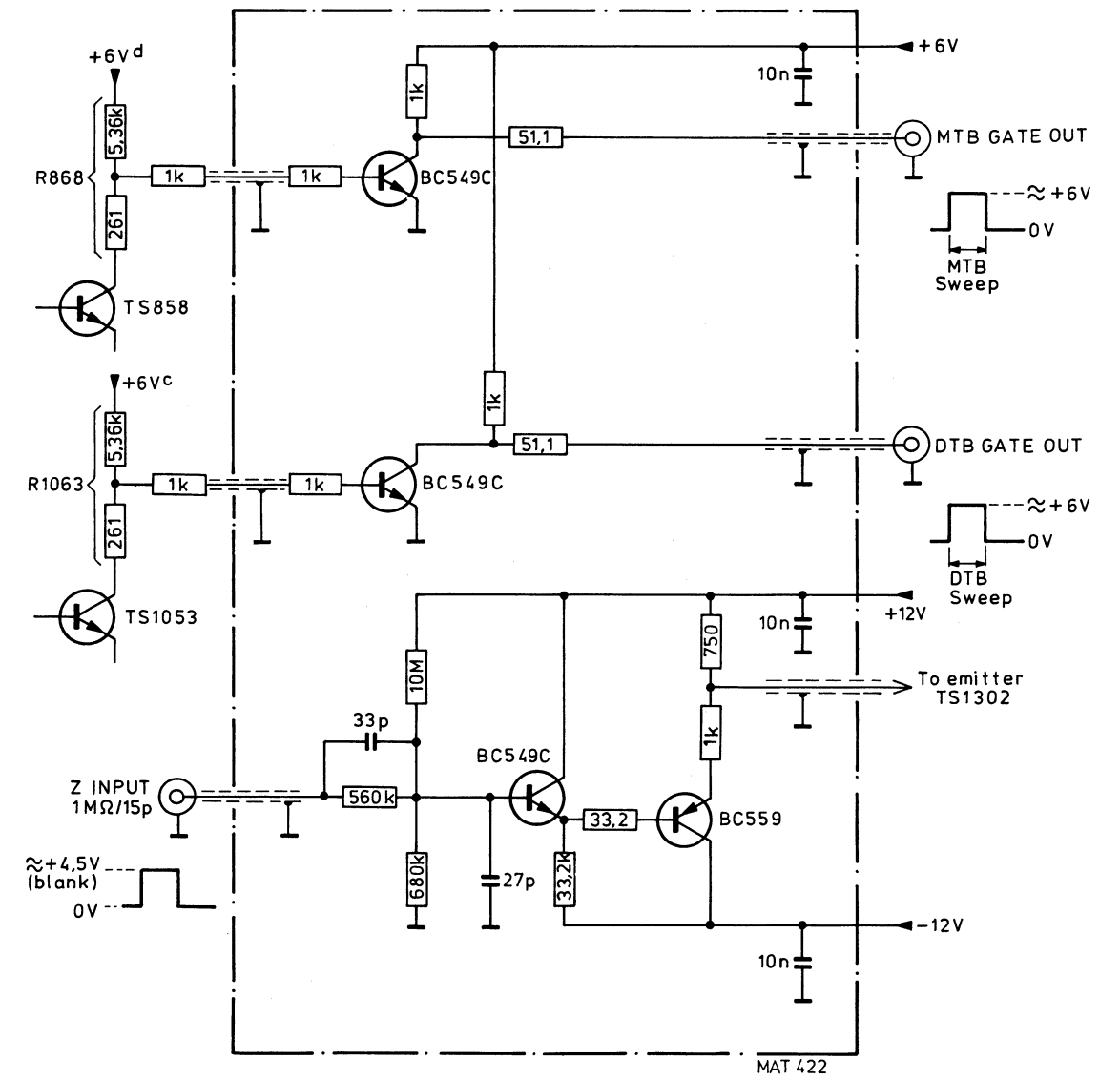
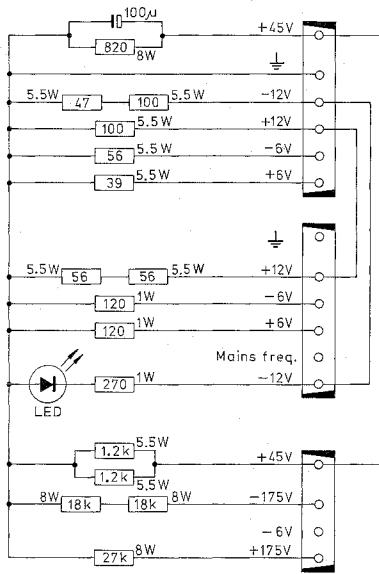


Fig. 3.44. Circuit diagram of additional unit

MAT 422



Connect a 6.3V-300mA lamp (4822 134 40021) to the output of the c.r.t. heater print

\* These interconnections are present on the power supply p.c. board

DUMMY LOAD FOR POWER SUPPLY

outlets power supply MAT423

Fig. 3.45. Dummy load for power supply

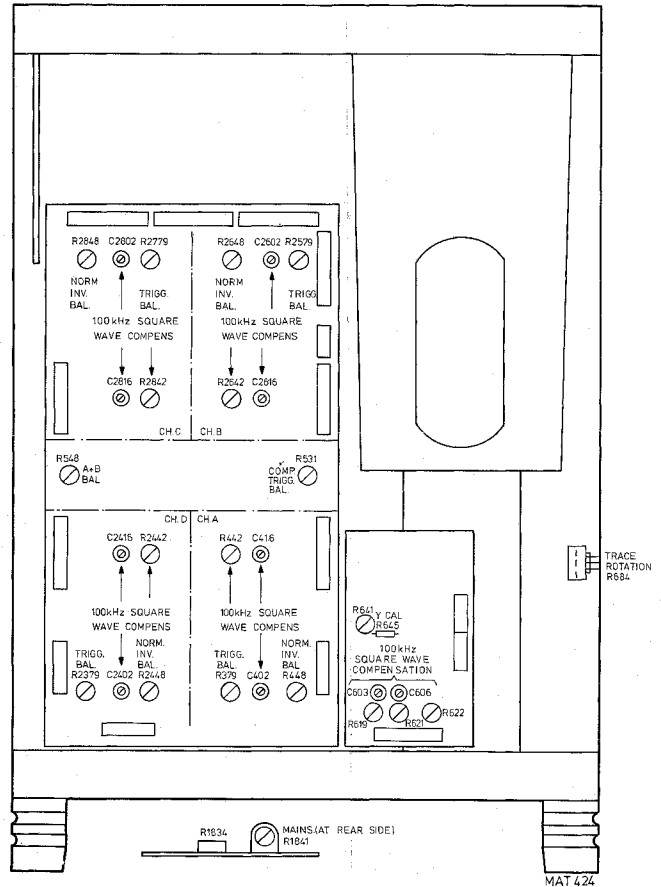


Fig. 3.46. Adjustment points, top view

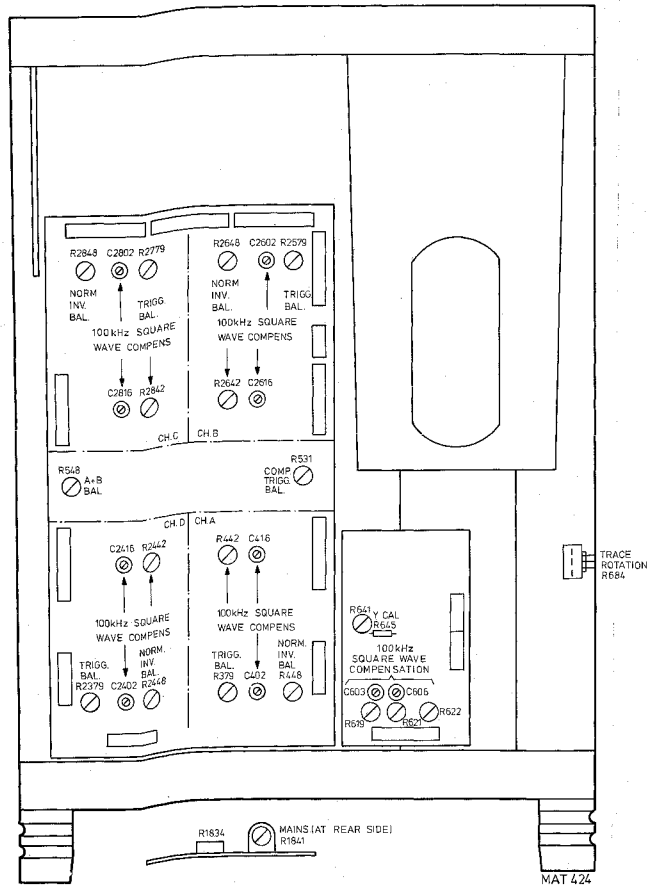


Fig. 3.46. Adjustment points, top view

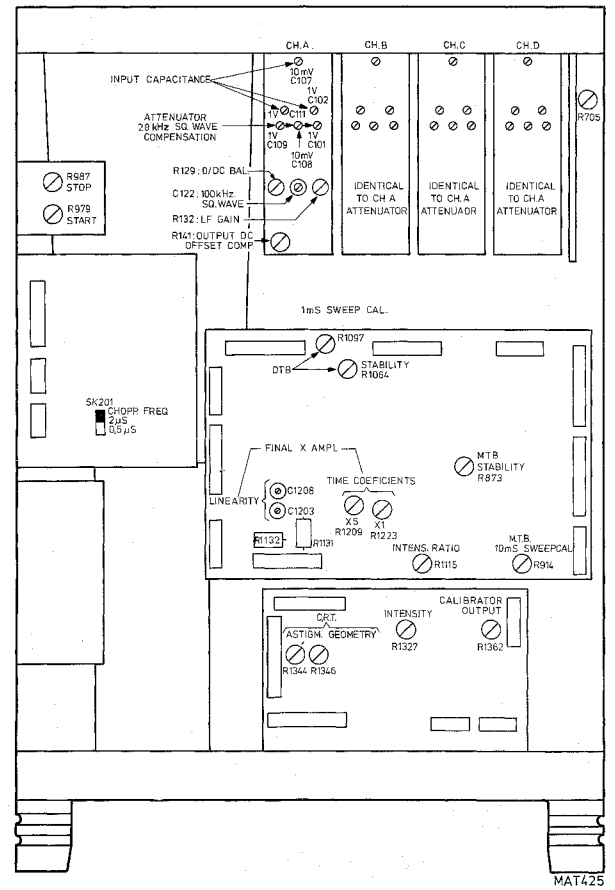


Fig. 3.47. Adjustment points, bottom view

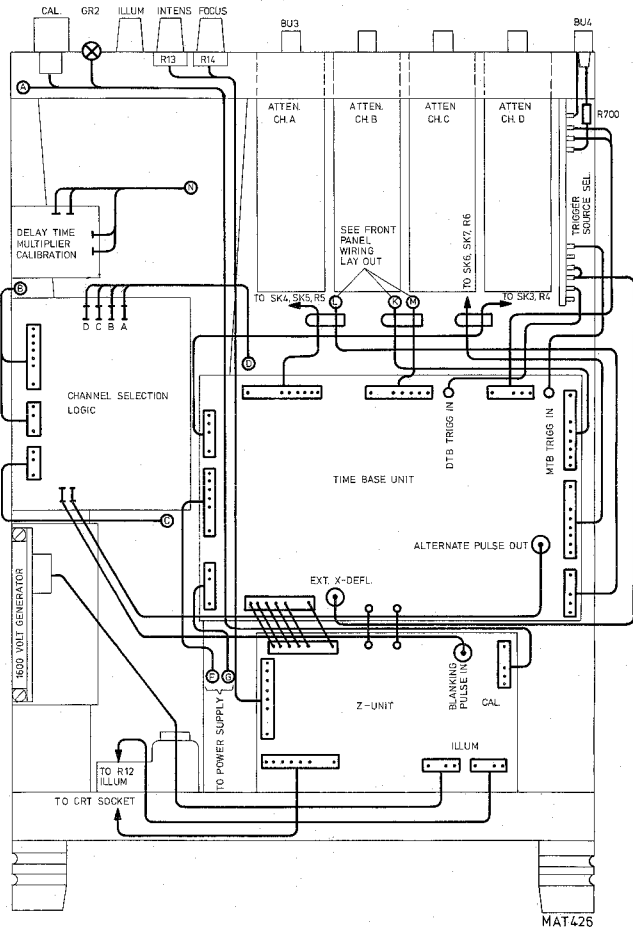


Fig. 3.48. Cable lay-out, bottom view

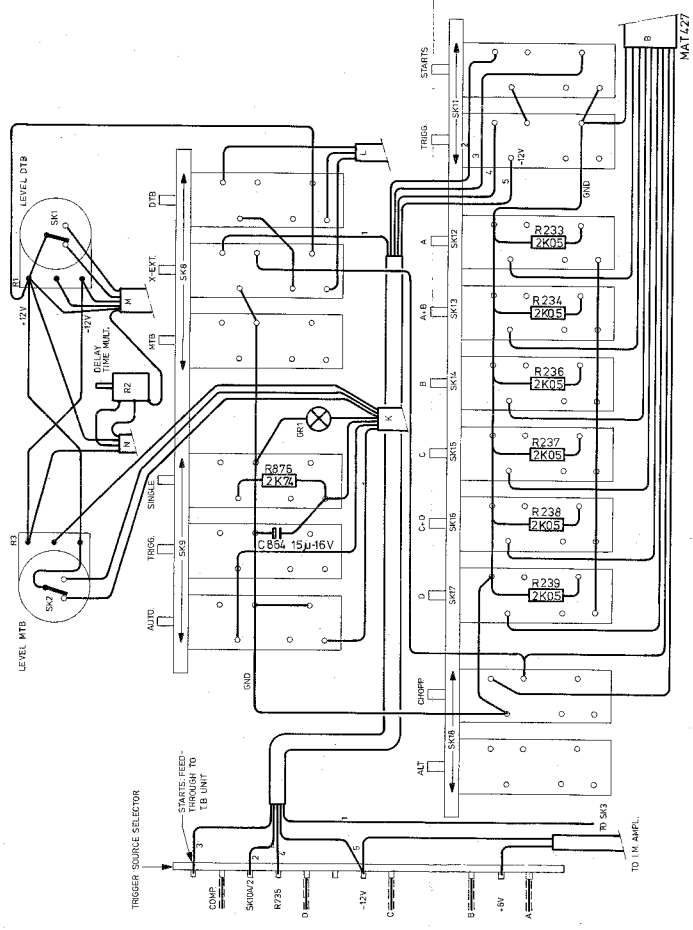


Fig. 3.49. Wiring lay-out, front panel

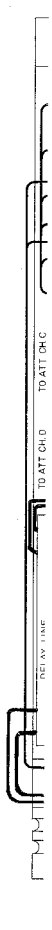


Fig. 3.



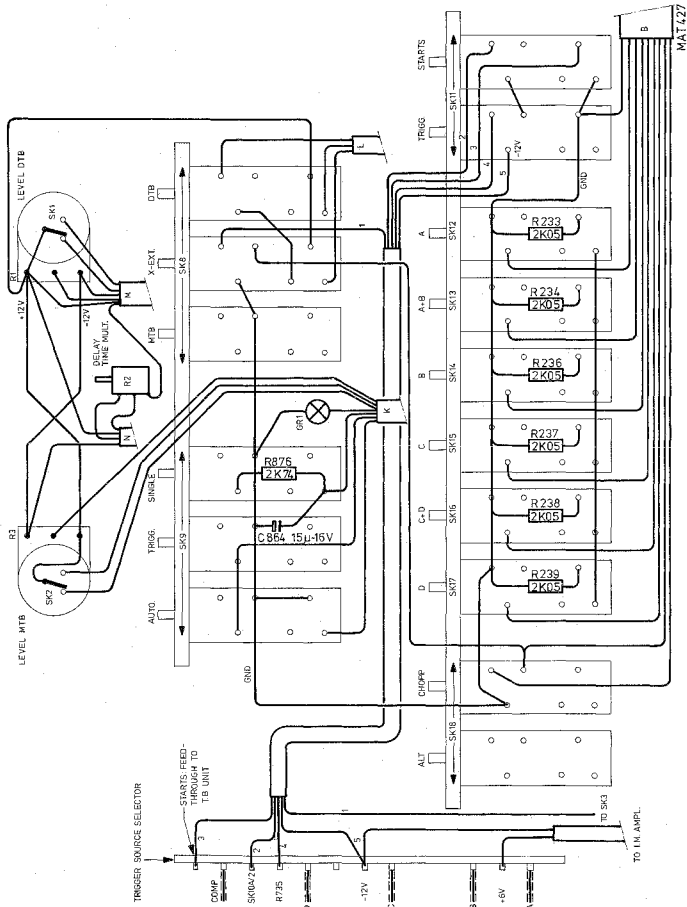


Fig. 3.49. Wiring layout, front panel

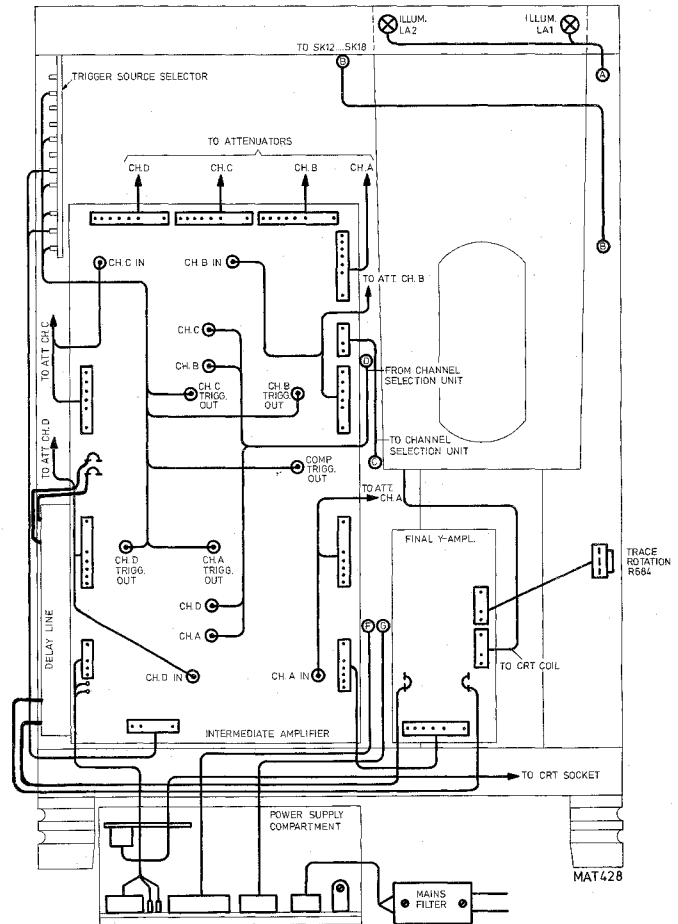


Fig. 3.50. Cable layout, top view and power supply compartment

### 3.9. D.C. VOLTAGES AND WAVEFORMS

The d.c. voltage levels and waveforms at the relevant points in the circuit diagrams are measured with the following control settings:

- Set all push-buttons in their not-depressed position.
- Depress push-button A of the vertical display mode switch (SK12);
- Depress push-button AUTO of the m.t.b. trigger mode switches (SK9).
- Depress push-button MAIN TB of the horizontal display mode switch (SK8).
- Set the horizontal POSITION control (R4) at mid-range and TB MAGN to 1X.
- Set the trace in the middle of the screen with the vertical POSITION Control (R10).
- Depress push-button A of the m.t.b. trigger source selector (SK21).
- Set the m.t.b. TIME/DIV. switch (SK6) to 0,2 msec/div. and R6 to CAL.
- Depress push-button AC of the signal input coupling switch (SK22).
- Set the d.t.b. TIME/DIV switch (SK4) to OFF and R5 to CAL.
- Set the channel A AMPL/DIV switch to 1 V/DIV and potentiometer R7 to CAL.
- Push the m.t.b. SLOPE switch (SK2) to +.
- Push the d.t.b. SLOPE switch (SK1) to +.
- Depress push-button A of the d.t.b. trigger source selector (SK10).
- Depress push-button STARTS of the d.t.b. switch SK11.
- Apply a square wave signal of 6 V pp, frequency 1 kHz to input socket A (BU3).
- Adjust the m.t.b. LEVEL potentiometer R3 for a stable, triggered display.

#### ATTENTION:

- As the four channels A, B, C and D are completely identical only the signals of channel A are measured.
- The oscilloscope for measuring the waveforms has the following control settings:
  - AC input signal coupling unless otherwise stated.
  - Triggered on the positive going slope of the input signal.

#### AUXILIARY EQUIPMENT:

|                    |  |
|--------------------|--|
| Digital multimeter | e.g. Philips PM 2517 or PM 2527                      |
| Oscilloscope       | e.g. Philips PM 3262 with an attenuator probe 10 : 1 |
| Function generator | e.g. Philips PM 5127                                 |

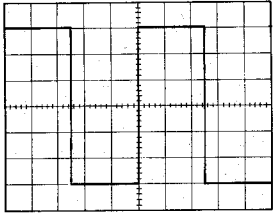


UNIT 2



0,1 V/div

0,2 m sec/div



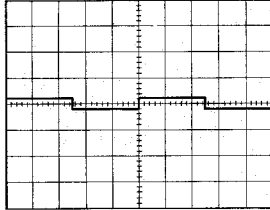
MAT 439

UNIT 12



5 mV/div

0,2 m sec/div



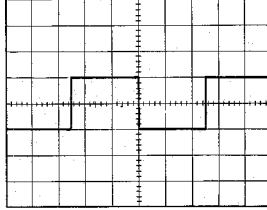
MAT 440

UNIT 12



5 mV/div

0,2 m sec/div



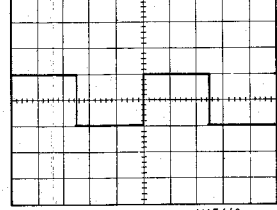
MAT 441

UNIT 12



5 mV/div

0,2 m sec/div



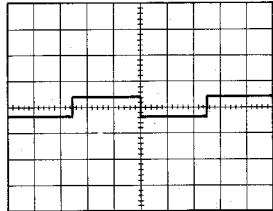
MAT 442

UNIT 16



5 mV/div

0,2 m sec/div



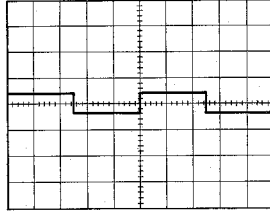
MAT 443

UNIT 12



5 mV/div

0,2 m sec/div



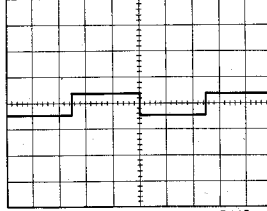
MAT 444

UNIT 12



5 mV/div

0,2 m sec/div



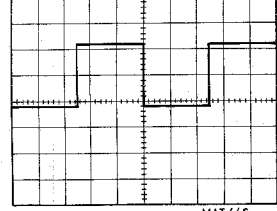
MAT 445

UNIT 13



20 mV/div

0,2 m sec/div



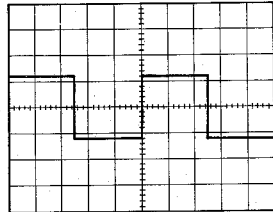
MAT 446

UNIT 13



20 mV/div

0,2 m sec/div



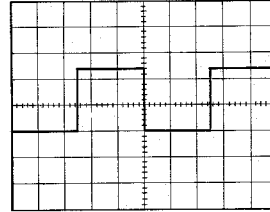
MAT 447

UNIT 13



0,5 V/div

0,2 m sec/div



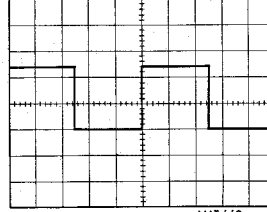
MAT 448

UNIT 13



0,5 V/div

0,2 m sec/div



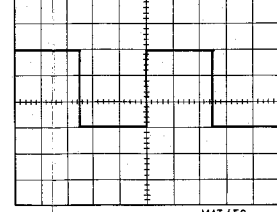
MAT 449

UNIT 16

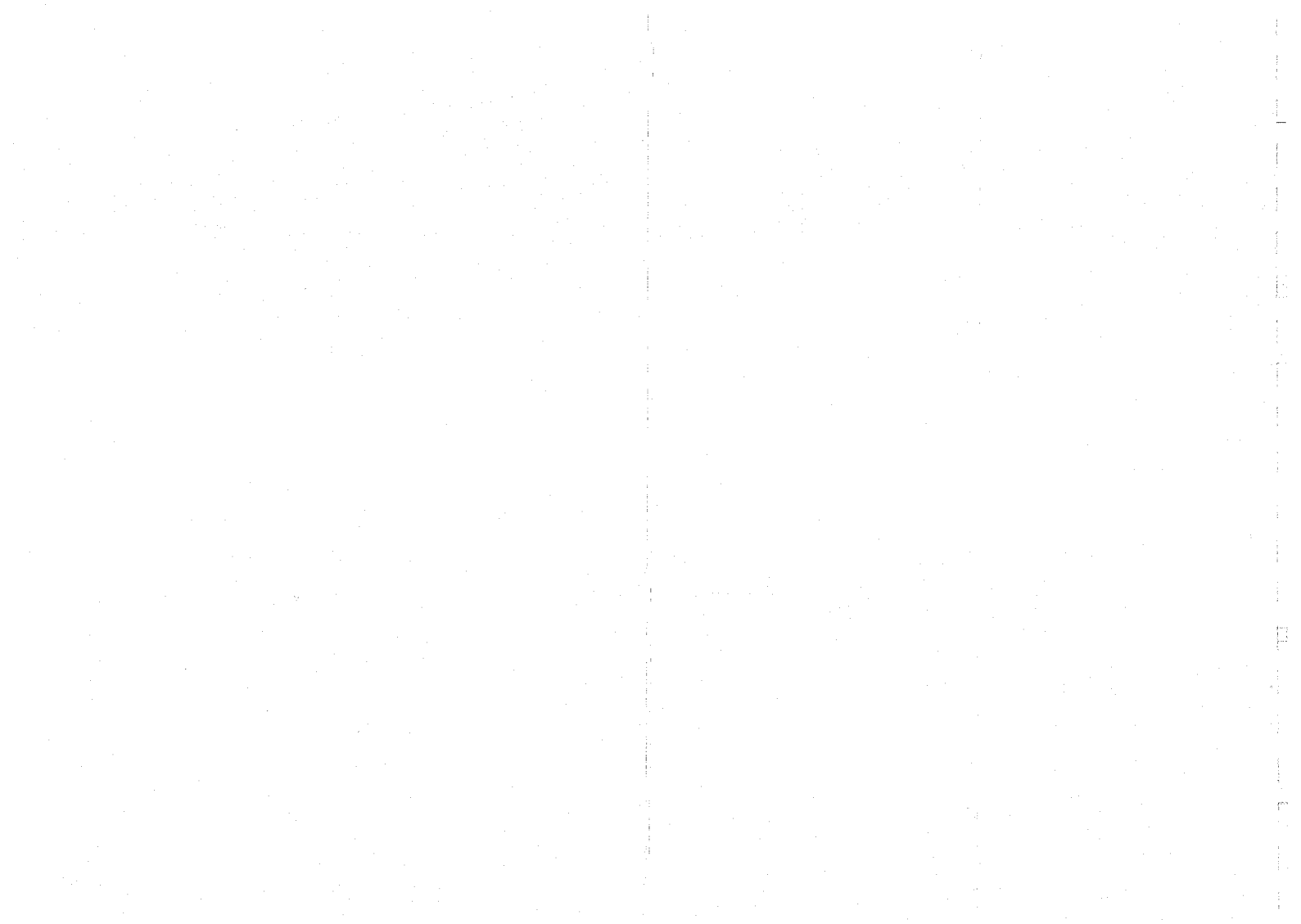


20 mV/div

0,2 m sec/div



MAT 450

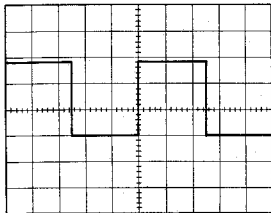


UNIT 16



20 mV/div

0,2 m sec/div



MAT 451

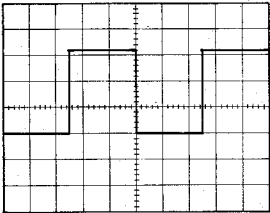
- push-button TRIG. (D.T.B.) depressed
- push-button STARTS (D.T.B.) depressed → 1,8 V d.c.

UNIT 8



0,1 V/div

0,2 m sec/div



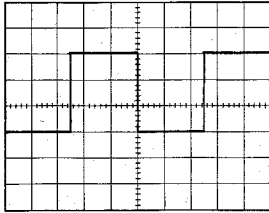
MAT 452

UNIT 8



0,1 V/div

0,2 m sec/div



MAT 453

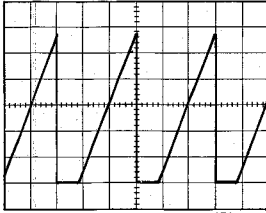
- push-button TRIG. (D.T.B.) depressed
- D.T.B. LEVEL potentiometer in its mid-position
- push-button STARTS (D.T.B.) depressed → 8Vd.c.

UNIT 8



0,1 V/div

1 m sec/div



MAT 454

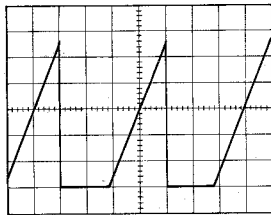
- M.T.B. TIME/DIV switch to 0,2 m sec/div
- HOLD OFF potentiometer fully clockwise

UNIT 8



2 V/div

1 m sec/div



MAT 455

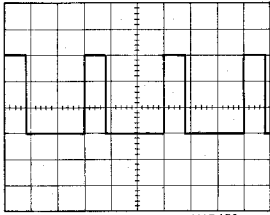
- HOLD OFF potentiometer counter-clockwise

UNIT 8



5 mV/div

1 m sec/div



MAT 456

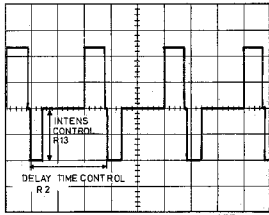
- D.T.B. TIME/DIV switch to OFF

UNIT 8



5 m V/div

1 m sec/div



MAT 457

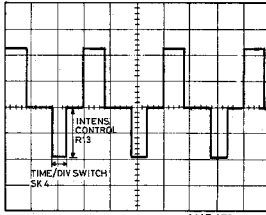
- D.T.B. TIME/DIV switch to 50μ sec/div
- push-button STARTS (D.T.B.) depressed

UNIT 8



5 mV/div

1 m sec/div



MAT 458

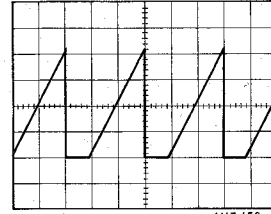
- D.T.B. TIME/DIV switch to 50μ sec/div
- D.T.B. LEVEL potentiometer to its mid-position
- push-button TRIG. (D.T.B.) depressed

UNIT 8



2 V/div

1 m sec/div



MAT 459

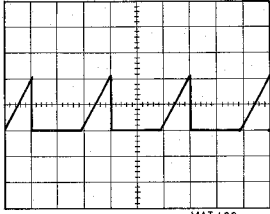
- X POSITION control in its mid-range

UNIT 8



2 V/div

1 m sec/div



MAT 460

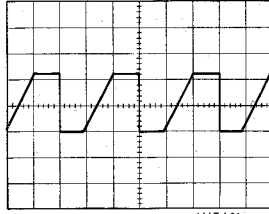
- X POSITION control fully counter clockwise

UNIT 8



0,1 V/div

1 m sec/div



MAT 461

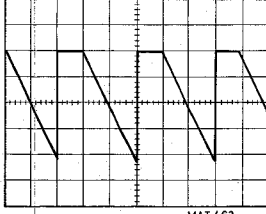
- X POSITION control fully clockwise

UNIT 8



2 V/div

1 m sec/div



MAT 462

- X POSITION control in its mid-range



**CODING SYSTEM OF FAILURE REPORTING FOR QUALITY  
ASSESSMENT OF T & M INSTRUMENTS**  
(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

|         |                |                   |          |                    |
|---------|----------------|-------------------|----------|--------------------|
| ①       | ②              | ③                 | /Version | ④                  |
| Country | Day Month Year | Typenumber        |          | Factory/Serial no. |
| 3 2     | 1 5 0 4 7 5    | 0 P M 3 2 6 0 0 2 |          | 0 0 0 0 7 8 3      |

CODED FAILURE DESCRIPTION

|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|--|---|------------------------|---|---|---|---|--|--|--|---|---|---|---|--|--|--|--|--|--|--|--|--|--|--|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|---|---|---|---|--|--|--|
| ⑤  | ⑥   | Component/sequence no. | ⑦   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| Nature of call   | Location  |                        | Category  |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| <input type="checkbox"/> Installation<br><input type="checkbox"/> Pre safe repair<br><input type="checkbox"/> Preventive maintenance<br><input checked="" type="checkbox"/> Corrective maintenance<br><input type="checkbox"/> Other | <table border="1"> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td>0</td><td>0</td><td>2</td><td>1</td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table> |                        |   |   |   |   |  |  |  | 0 | 0 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  | <table border="1"> <tr><td>T</td><td>S</td><td>0</td><td>6</td><td>0</td><td>7</td></tr> <tr><td>R</td><td>0</td><td>0</td><td>6</td><td>3</td><td>1</td></tr> <tr><td>9</td><td>9</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> | T | S | 0 | 6 | 0 | 7 | R | 0 | 0 | 6 | 3 | 1 | 9 | 9 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | <table border="1"> <tr><td>5</td></tr> <tr><td>2</td></tr> <tr><td>4</td></tr> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> </table> | 5 | 2 | 4 |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| 0  | 0   | 2                      | 1   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| T  | S   | 0                      | 6   | 0 | 7 |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| R  | 0   | 0                      | 6   | 3 | 1 |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| 9  | 9   | 0                      | 0   | 0 | 1 |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| 5  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| 2  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
| 4  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  |   |                        | <input checked="" type="checkbox"/> Job completed<br><input type="checkbox"/> Working time ⑧<br><table border="1"> <tr><td> </td><td>1</td><td>2</td></tr> </table> Hrs |   | 1 | 2 |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |
|  | 1   | 2                      |   |   |   |   |  |  |  |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |   |   |   |  |  |  |

Detailed description of the information to be entered in the various boxes:

① Country: 3 2 = Switzerland

② Day Month Year 1 5 0 4 7 5 = 15 April 1975

③ Type number/Version: 0 P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④ Factory/Serial number: 0 0 0 0 7 8 3 = 00 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

|  |  |  |  |  |   |  |  |  |  |  |  |  |  |
|--|--|--|--|--|---|--|--|--|--|--|--|--|--|
| <p>Location</p> <table border="1"> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table> <p>These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).<br/>Example: 0001 for Unit 1<br/>000A for Unit A<br/>0075 for item 75<br/>If units are not numbered, do not fill in the four boxes; see Example Job sheet.</p> |  |  |  |  | <p>Component/sequence no.</p> <table border="1"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> <p>These six boxes are intended to pinpoint the faulty component. A. Enter the component designation as used in the circuit diagram. If the designation is alpha-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes. B. Parts not identified in the circuit diagram:<br/>990000 Unknown/Not applicable<br/>990001 Cabinet or rack (text plate, emblem, grip, rail, gratules, etc.)<br/>990002 Knob (incl. dial knob, cap, etc.)<br/>990003 Probe (only if attached to instrument)<br/>990004 Leads and associated plugs<br/>990005 Holder (valve, transistor, fuse, board, etc.)<br/>990006 Complete unit (p.w. board, h.t. unit, etc.)<br/>990007 Accessory (only those without type number)<br/>990008 Documentation (manual, supplement, etc.)<br/>990009 Foreign object<br/>990099 Miscellaneous</p> |  |  |  |  |  |  | <p>Category</p> <table border="1"> <tr><td> </td></tr> </table> <p>0 Unknown, not applicable (fault not present, intermittent or disappeared)<br/>1 Software error<br/>2 Readjustment<br/>3 Electrical repair (wiring, solder joint, etc.)<br/>4 Mechanical repair (polishing, filing, remachining, etc.)<br/>5 Replacement (of transistor, resistor, etc.)<br/>6 Cleaning and/or lubrication<br/>7 Operator error<br/>8 Missing items (on pre-sale test)<br/>9 Environmental requirements are not met</p> |  |
|  |  |  |  |  |   |  |  |  |  |  |  |  |  |
|  |  |  |  |  |   |  |  |  |  |  |  |  |  |
|  |  |  |  |  |   |  |  |  |  |  |  |  |  |

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

|  |   |   |
|--|---|---|
|  | 1 | 2 |
|--|---|---|

 = 1,2 working hours (1 h 12 min.)



# Sales and service all over the world

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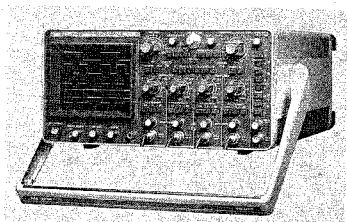
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T&M/790601

# PHILIPS



Instruction manual  
Gerätehandbuch  
Notice d'emploi et d'entretien

Portable Four Channel Oscilloscope  
Tragbarer Vierkanal Oszillograf  
Oscilloscope portatif à quatre voies

## PM3244

This insert must be used  
with the manual of the  
basic PM 3240 oscilloscope.

Order no. of  
this insert  
9499 440 15511



**IMPORTANT**

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

**WICHTIG**

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

**IMPORTANT****RECHANGE DES PIECES DETACHEES (Réparations)**

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série sont marqués sur la plaquette de caractéristiques.

*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.*

*BEMERKUNG: Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

*REMARQUES: Cet appareil est l'objet de développements et améliorations continus. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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## Instruction manual

## 1.2. CHARACTERISTICS

This specification is valid after the instrument has warmed up for 15 minutes. Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument. This instrument has been designed and tested in accordance with IEC Publication 348 for Class I instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

| <i>Designation</i>                       | <i>Specification</i>   | <i>Additional Information</i>   |
|--|--|---|
| <b>1.2.1. C.R.T.</b>                     |  |   |
| Type                                     | D14-125 GH/08  | Rectangular tube face, mesh type, post accelerator, metal backed phosphor.  |
| Measuring area                           | 80 mm x 100 mm   | Divided in 8x10 divisions.  |
| Screen phosphor                          | P31 (GH)   | P11 (BE) and P7 (GM) phosphor optional.   |
| Photographic writing speed               | $\geq 750$ cm/ $\mu$ s   | Measured with Steinheil Oscillophot M5 camera<br>Aperture 1:1,2<br>Object to image ratio 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>No pre-fogging<br>Phosphor P31 (GH) |
| Total acceleration voltage               | 10 kV  |   |
| Graticule                                | 8x10 cm divisions with subdivisions of 2 mm along the central axes.  | Dotted lines indicate 10 % and 90 % of measuring lattice for rise-time measurements.  |
| Graticule illumination                   | Continuous variable  | Maximum brightness clearly visible under normal lab. type light conditions.   |
| <b>1.2.2. Vertical deflection (Y)</b>    |  |   |
| Number of channels                       | 4  | Four identical channels, marked A, B, C en D  |
| Display modes                            | Channel A only<br>Channel B only<br>Channel C only<br>Channel D only<br>Channels A+B added<br>Channels C+D added<br>either of these modes in any combination, chopped or alternatively displayed.<br>All channels can be inverted. |   |
| Display time per channel in chopped mode | Approx. 0,5 $\mu$ s  | From /03 version: switchable between 0,5 $\mu$ s and 2 $\mu$ s (see Fig. 3.18).   |
| Frequency range                          | d.c. ... 50 MHz<br><br>10 Hz ... 50 MHz  | d.c. coupled<br>Upper bandwidth limit -3 dB<br>a.c. coupled<br>-3 dB bandwidth limit  |
| Rise time                                | 7 ns   |   |
| Aberrations                              | $\pm 2$ % max.   | Measured with test pulse of 6 div. deflection / 1 ns rise time and 1 $\mu$ s repetition time.   |

| <i>Designation</i>                               | <i>Specification</i>         | <i>Additional Information</i>  |
|--|------------------------------|--|
| Deflection coefficients                          | 5 mV/DIV ... 2 V/DIV         | Nine calibrated positions in 1-2-5 sequence. Uncalibrated, continuous control 1 : $\geq$ 2,5.  |
| Accuracy   | $\pm$ 3 %                    |  |
| Input voltage                                    | $\pm$ 400 V max.             | d.c. + a.c. peak<br>In the 5 mV/DIV ... 20 mV/DIV positions of the input attenuator derating at frequencies over 500 kHz. Refer to Fig. 1.2. |
| Max. deflection                                  | 24 div.<br>$\geq$ 6 div.     | For sine waves up to 15 MHz.<br>For sine waves from 15 MHz up to 50 MHz.   |
| Max. total signal amplitude in A-B and C-D modes | 24 x attenuator-setting      | Attenuators in CAL. positions.   |
| Positioning range                                | 16 div.                      |  |
| Common-mode rejection                            | $\geq$ 100:1 at 1 MHz        | After adjusting  |
| Cross talk between channels                      | 35 dB max.                   | For all attenuator combinations.<br>Reference is 6 div. signal amplitude (0 ... 50 MHz) Chopped mode.  |
| Trace stability D.C. drift                       | $\leq$ 0,3 div/h at 20 °C    | After 15 min. warm-up  |
| Temp. drift                                      | $\leq$ 60 $\mu$ V/°C typical |  |
| Attenuator balance                               | $\leq$ 0,3 div.              | When switching between any of the attenuator positions.  |
| Input  |                              |  |
| Impedance  | 1 Mohm//15 pF                |  |
| Coupling   | AC-0-DC                      |  |
| RC time  | 22 ms                        | Coupling switch in AC position.  |
| Visible signal delay                             | 20 ns                        |  |

### 1.2.3. Horizontal deflection (X)

|   |  |   |
|---|--|---|
| Display modes   | <ul style="list-style-type: none"> <li>- Main time base</li> <li>- Main time base intensified by delayed time base</li> <li>- Delayed time base</li> <li>- X/Y mode</li> </ul> | Up to four trace X/Y operation with X deflection by one of the four vertical channels, or an external signal, or the line signal. |
| <b>Horizontal deflection amplifier</b>                  |  |   |
| Bandwidth   | d.c. ... 1 MHz   | over 6 div's<br>- 3 dB upper bandwidth limit  |
| Deflection coefficient                                  | 450 mV/div<br>Vertical attenuator coefficients   | using EXT input<br>apply when one of the vertical channels is used for horizontal deflection                                      |
| Accuracy  | $\pm$ 10 %   | Using one of the vertical channels for horizontal deflection.   |
| Input impedance   | 1 Mohm//15 pF  |   |
| Phase difference between Vert. and Hor. defl. amplifier | less than 3°   | at 100 kHz  |

| <i>Designation</i>                             | <i>Specification</i>  | <i>Additional Information</i>   |
|--|---|---|
| Deflection by line voltage                     | 8 div's   | The deflection depends on the line voltage and has been factory-adjusted to 8 DIV at a line voltage of 220 V. |
| <b>1.2.4. Main time base</b>                   |   |   |
| Operation                                      | Automatic<br>Triggered<br>Single shot   | In the AUTO mode the time base is free-running approx. 100 ms. after disappearance of the trigger signal.     |
| Time coefficients                              | 0,5 s/DIV ... 50 ns/DIV   | Twenty-two calibrated positions in 1-2-5 sequence.<br>Uncalibrated, continuous control<br>1 : $\geq$ 2,5      |
| Accuracy                                       | $\pm$ 3 %   | $\pm$ 5 % for 0,5 s/DIV and 0,2 s/DIV<br>$\pm$ 5 % for 100 ns/DIV and 50 ns/DIV                               |
| <b>1.2.5. Delayed time base</b>                | Direct running after delay time<br>or triggerable after delay time                            |   |
| Time coefficients                              | 1 ms./DIV ... 50 ns./DIV  | Fourteen calibrated positions in 1-2-5 sequence.<br>Uncalibrated, continuous control<br>1 : $\geq$ 2,5        |
| Accuracy                                       | $\pm$ 3 %   | $\pm$ 5 % for 100 ns./DIV and 50 ns./DIV  |
| <b>Time Base Magnifier</b>                     |   |   |
| Magnification                                  | x5  |   |
| Highest effective sweep speed                  | 10 ns./div.   |   |
| Additional tolerance                           | $\pm$ 2 %   |   |
| <b>1.2.6. Triggering of M.T.B.</b>             |   |   |
| Source   | Internal<br>Composite<br>Line<br>External   | From ch. A, B, C or D   |
| Trigger bandwidth                              | d.c. ... 50 MHz   | Upper bandwidth limit -15 dB  |
| Trigger sensitivity                            | Internal $\leq$ 0,5 div.<br>External $\leq$ 250 mV  | 0,3 div. typical<br>150 mV typical  |
| Slope selection                                | + or -  |   |
| Ext. trigger input impedance                   | 1 Mohm//15 pF   | Identical to any vertical deflection input  |
| Input voltage                                  | $\pm$ 400 V max.  | d.c. + a.c. peak  |
| <b>1.2.7. Triggering of D.T.B.</b>             |   |   |
| Identical to main time base triggering except: |   |   |
| Source   | Internal<br>Composite   | From ch. A, B, C or D   |
| <b>Sweep delay</b>                             |   |   |
| Delay time                                     | Continuously variable between 0.3x and $\geq$ 10x the time-coefficient of the main time base. | Adjustable with calibrated ten turn dial knob.  |
| Incremental delay time error                   | 0,5 %   |   |
| Delay time jitter                              | $\leq$ 1 : 20 000   |   |

| <i>Designation</i>   | <i>Specification</i>  | <i>Additional Information</i>   |
|--|---|---|
| <b>1.2.8. Calibration unit</b>   |   |   |
| Voltage  | 3 V <sub>p-p</sub>  | Square wave, base-line zero volts                                       |
| Current  | 6 mA  | Through current loop  |
| Accuracy   | ± 1 %   | For both voltage and current  |
| Frequency  | 2 kHz ± 2 %   |   |
| Protection   | The output is short-circuit-proof   |   |
| <b>1.2.9. Power supply</b>   |   |   |
| Line voltages  | 90 ... 270 V AC or<br>100 ... 350 V DC  | In one range  |
| Line frequency   | 46 ... 440 Hz or DC   |   |
| Build-in line fuse   | 1,6 amp. delayed-action   | For all line voltages   |
| Power consumption  | 29 W  |   |
| <b>1.2.10. Environmental characteristics</b>   |   |   |
| The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEI/LAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND. |   |   |
| Ambient temperature  | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C                              | Rated range of use<br>Limit range of operation<br>Storage and transport |
| Altitude   | 5000 m (15000')<br>15000 m (45000')   | Operating<br>Non operating  |
| Humidity   | The instrument meets the requirements of the IEC 68 Db recommendations.                 |   |
| Bump   | 1000 bumps of 10 g, ½ sine, 6 ms duration, in each of 3 directions                      |   |
| Vibration  | 30 minutes in each of three directions, 10-150 Hz; 0,7 mm p-p and 5 g max. acceleration |   |
| Recovery time  | 30 minutes for normal operation   | Coming from -10 °C and going to +20 °C at 60 % relative humidity.       |
| Electromagnetic interference   | The instrument meets the VDE, Störgrad K, requirements.                                 |   |
| <b>1.2.11. Mechanical data</b>   |   |   |
| Dimensions   | Length 410 mm (16 1/4")<br>Width 316 mm (12 1/4")<br>Height 154 mm ( 6 1/8")            | Excl. controls, cover and feet  |
| Weight   | 9,7 kg  |   |
| <b>1.2.12. Delivered accessories</b>   |   |   |
| Contrast filter  |   |   |
| Front cover  |   |   |
| Collapsible viewing hood PM 9366   |   |   |
| BNC-banana adaptor PM 9051   |   |   |
| Cal. terminal to BNC adaptor   |   |   |
| Operating and service manual   |   |   |
| 4x 10 : 1 probe PM 9350/PM 8927  |   |   |

## 1.2.13. Optional accessories

|          |  |         |   |
|----------|--|---------|---|
| PM 9335  | Passive probe set<br>1 : 1 (1.5 m)                                 | PM 9355 | Current probe;<br>1 mA/div. ... 1 A/div.; |
| PM 9335L | Passive probe set<br>1 : 1 (2.5 m)                                 | PM 9346 | Power supply for active<br>probes         |
| PM 9350  | Passive probe set<br>10 : 1 11 pF (1.5 m)                          | PM 8960 | 19 inch rack mount adaptor                |
| PM 9350L | Passive probe set<br>10 : 1 14 pF (2.5 m)                          | PM 8992 | Accessory pouch                           |
| PM 8927  | Passive probe set<br>10 : 1 (1.5 m)                                | PM 9380 | Oscilloscope camera                       |
| PM 8927L | Passive probe set<br>10 : 1 (2.5 m)                                | PM 8971 | Adapter for oscilloscope<br>camera        |
| PM 9358  | Passive probe set<br>100 : 1; max. voltage<br>5600 V; 2 pF (1.5 m) | PM 8910 | Polaroid anti-glare filter                |
| PM 9347  | Active TV triggering probe<br>10 : 1 11 pF (1.5 m)                 | PM 8980 | Long type viewing hood                    |
| PM 9352  | Micro miniature probe<br>10 : 1 6 pF (2.5 m)                       | PM 8901 | Battery pack 24 V dc and<br>140 V dc      |
| PM 9353  | Active FET probe<br>1 : 1; 10 : 1; 100 : 1,<br>3.5 pF (1.5 m)      | PM 8991 | Oscilloscope trolley                      |

Steinheil Oscillophot system: Oscilloscope camera's M3, M4 and M5 can be mounted on oscilloscope using Steinheil adapter 1B20/50.

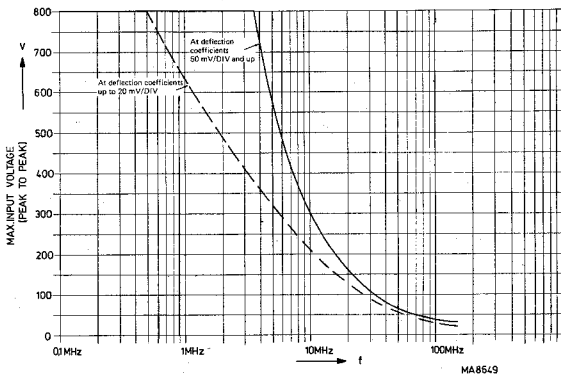
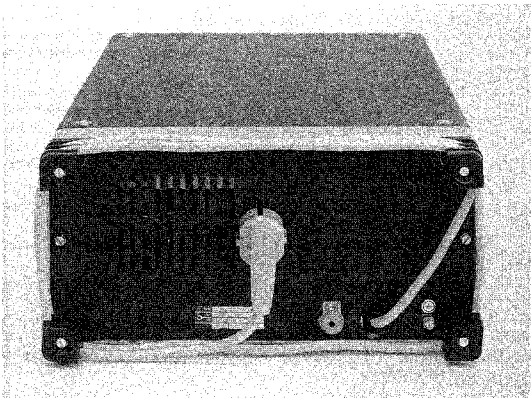


Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency



*Fig. 2.1. Removing the front cover.*



*Fig. 2.2. Rear view of the instrument.*



## 2. Directions for use

### 2.1. INSTALLATION

#### 2.1.1. Removing and fitting the front cover

Removing:

- Turn the knob in the centre of the cover a quarter of a turn anti-clockwise.
- Take the cover off.

Fitting:

- Align the key of the locking knob with the slot in the text plate of the instrument.
- Fit the cover over the front of the oscilloscope.
- Press the knob and turn it a quarter of a turn clockwise.

*Remark: The handle can be rotated if the push-buttons on its bearings are depressed.*

**WARNING:** This instrument generates high voltages and should not be operated with the cabinet plates removed. The line plug must be removed before attempting any maintenance work, and any relevant high-voltage points discharged.

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section *earthing*).


#### 2.1.2. Mains adaption and fuse

The ability of the instrument to operate at any line voltage between 90 and 270 V a.c. or between 100 and 350 V d.c. obviates the need of adaption to the local line voltage.

The fuse holder is mounted on the rear panel. The 1,6 A delayed action fuse is used at all line voltages. Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided. The instrument shall be disconnected from all voltage sources when a fuse is to be replaced.

#### 2.1.3. Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- Via the protective earth terminal (identified by the symbol ).
- Via the three-core line cable. The line plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

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

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

#### 2.1.4. Dismantling

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 a skilled person who is aware of the danger involved.

Replacing the mains plug is at the user's own risk. After replacing a mains plug, a high-voltage test in accordance with IEC Publication 348 is strongly recommended.

Bear in mind that capacitors inside the instrument may still be charged, even if the instrument has been separated from all voltage sources.

#### 2.1.5. Switching on

The POWER switch is incorporated in the graticule ILLUMINATION control on the front panel, immediately below the screen bezel. The oscilloscope must never be switched on whilst any circuit board has been removed. Never remove a circuit board until at least one minute after the oscilloscope has been switched off.

## 2.2. FUNCTION OF CONTROLS AND INPUT SOCKETS

### 2.2.1. Vertical deflection

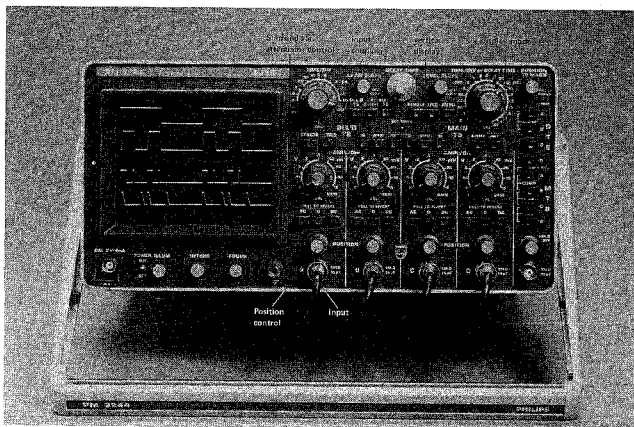


Fig. 2.3. Vertical deflection

#### 1. Vertical deflection mode switch.

|            |                                      |
|------------|--------------------------------------|
| Button A   | channel A                            |
| Button A+B | channels A and B algebraically added |
| Button B   | channel B                            |
| Button C   | channel C                            |
| Button C+D | channels C and D algebraically added |
| Button D   | channel D                            |

Any combination of above displays is possible (if no button depressed, channel A is on).

#### 2. CHOP-ALT switch

The under point 1 mentioned channel displays, can be in the chopped- or the alternated mode, depending of this switch (if no button depressed and two or more channels are on, the display is in the chopped model).

#### 3. Attenuator controls

|                       |   |
|-----------------------|---|
| AMPL/DIV              | Step control of the deflection coefficients combined with:    |
| AMPL/CAL              | Continuously variable control of the deflection coefficients. |
|                       | If this knob is pulled-out the channel polarity is inverted.  |
| Input coupling switch | AC Signal coupling via a blocking capacitor.                  |
|                       | 0 Channel input connected to earth; signal-load open.         |
|                       | DC Direct coupling.   |
|                       | (If no button is depressed, the AC situation is on).          |

POSITION Continuously variable control giving vertical shift of the relevant channel.

#### PRE-SET CONTROLS:

|      |  |
|------|--|
| BAL  | Step attenuator balance                |
| GAIN | Step attenuator amplitude calibration. |

## 2.2.2. Horizontal deflection

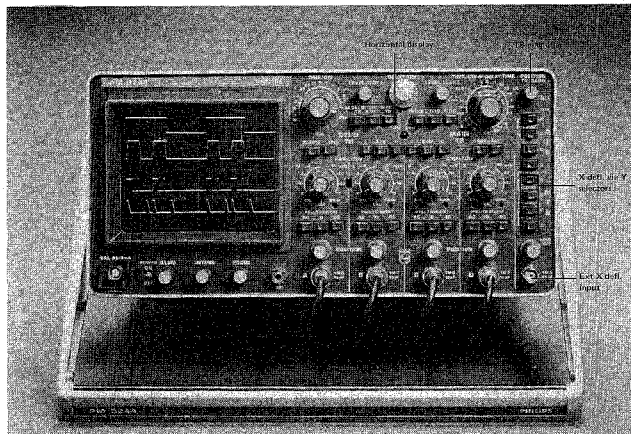


Fig. 2.4. Horizontal deflection.

## 1. Horizontal deflection mode switch.

MAIN TB

The horizontal deflection is provided by the main time base generator. A part of the display is intensified when the delayed time base is on.

EXT X DEFL

Horizontal deflection is achieved by an external signal coming from:

- Input socket of the horizontal amplifier, or
- One of the vertical deflection channels or
- The line.

DEL'D TB

The horizontal deflection is provided by the delayed time base generator (if no button is depressed, the main tb is on).

## 2. Position and TB magnifier

POSITION

Continuously variable control giving horizontal shift of the display.

TB MAGN

Push-pull switch which increases the time-base coefficients by a factor of 5. Not operative in the EXT X DEFL. mode.

## 2.2.3. Main time base

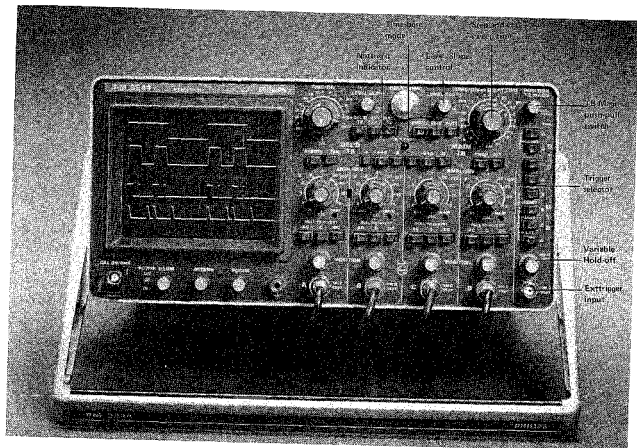


Fig. 2.5. Main time base

1. Main time-base mode switch
  - AUTO
  - TRIG
  - SINGLE

The main time-base generator is free-running when no trigger pulses are present. The main time-base is normally triggered.

Single sweep time-base. After operating the SINGLE button, the main time-base generator runs only once upon receipt of a trigger pulse. (If no button is depressed the time-base is in the single sweep mode.)
2. TIME/DIV or DELAY switch
 

Step control of the main time-base time coefficients: 22-way rotary switch. If the delayed time-base is operating, the delay time after which the delayed time-base starts, is the product of the DELAY TIME calibrated dial setting and the TIME/DIV coefficient of this switch.

Continuously variable control of the time coefficients.
3. LEVEL/SLOPE
 

Continuously variable control to select the trigger level at which the time-base generator starts.

The push-pull switch enables choice of triggering on the positive- or negative-going slope of the signal.
4. NOT TRIG'D indicator
 

Lights up when the main time-base generator is not triggered.
5. MTB Trigger source selector switch
 

This switch consists of four buttons (A, B, C and D) to select the trigger signal from one of the vertical deflection channels.

When both buttons A and B are depressed, the composite trigger signal is selected.

When both buttons B and C are depressed, part of the line voltage is used as a trigger signal.

When both buttons C and D are depressed, the signal applied to the EXT connector is used as a trigger signal.

(If no button is depressed, the A trigger signal is on.)

## 2.2.4. Delayed time base

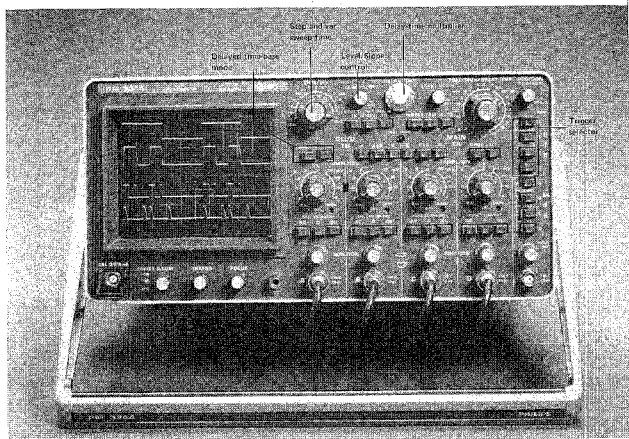


Fig. 2.6. Delayed time base.

- |                                       |  |
|---------------------------------------|--|
| 1. TIME/DIV switch                    | Step control of the delayed time-base time coefficients; 14-way rotary switch. In the OFF position the delayed time-base is not operating.   |
| TIME/DIV CAL                          | Continuously variable control of the time-base coefficients.   |
| 2. DELAY TIME                         | Calibrated ten-turn dial knob to adjust the delay time after which the delayed time base becomes operative. This delay time is the product of the DELAY TIME dial setting and the TIME/DIV coefficient switch of the main time-base.   |
| 3. STARTS/TRIG                        | <p>If the STARTS button has been depressed, the delayed time-base starts immediately after the delay-time (the delayed time-base requires then no trigger signal).</p> <p>If the TRIG. button has been depressed the delayed time-base starts after the delay-time upon receipt of a trigger pulse.</p> <p>(No button depressed has the same effect as the STARTS button depressed.)</p> |
| 4. LEVEL/SLOPE                        | <p>Continuously variable control to select the trigger level at which the delayed time-base generator triggers.</p> <p>The push-pull switch enables choice of triggering on the positive- or negative-going slope of the signal.</p>   |
| 5. DTB Trigger source selector switch | <p>This switch consists of four buttons (A, B, C and D) to select the trigger signal from one of the vertical deflection channels.</p> <p>When both buttons A and B are depressed, the composite trigger signal is selected.</p> <p>(If no button depressed, the A trigger signal is on).</p>  |

## 2.2.5. C.R.T. display section

- |                |  |
|----------------|--|
| 1. POWER/ILLUM | Continuously variable control of the graticule illumination combined with power on-off switch.<br>Pilot lamp indicates the ON state. |
| 2. INTENS      | Continuously variable control of the display-brightness.   |
| 3. FOCUS       | Continuously variable control of the electron-beam focussing.  |

### Miscellaneous

1. CAL
- Output socket for calibration of:
- The gain of the vertical deflection amplifier and,
  - The frequency compensation of attenuator probes.
- Suited for voltage probes and current probes.

## 2.3. PRELIMINARY SETTINGS

Before measurements with this oscilloscope are carried out, check that the step-attenuator balance and the gain calibration for all channels are well adjusted.

If necessary proceed as follows:

1. Adjusting the step attenuator d.c. balance
  - Depress the MAIN TB button of the horizontal deflection mode switch.
  - Depress the AUTO button of the main time-base mode switch.
  - Set the INTENSITY and FOCUS controls for a sharp, well-defined trace.
  - Depress the relevant channel button of the vertical deflection mode switch.
  - Depress the 0 button of the input coupling switch.
  - Set the POSITION knob so that the trace is somewhere about in the centre of the screen.
  - Set the AMPL continuous control to position CAL.
  - Check that the trace does not jump when the AMPL switch knob is rotated.

If necessary, adjust the BAL control.

  - Repeat for each channel.

### 2. Gain calibrations

Unless otherwise stated, the controls occupy the same positions as in the previous procedure.

- Set the AC-0-DC switch to AC.
  - Set the AMPL switch knob to .5 V and the continuous control to CAL.
  - Connect the channel input to the CAL output.
  - Check the vertical deflection is exactly 6 divisions.
- If necessary adjust the GAIN control.
- Also an attenuator probe can be included in this calibration. The probe attenuation factor must then be taken into account with respect to the AMPL switch position.
  - Repeat for each channel.

## 2.4. OPERATING INSTRUCTIONS

### 2.4.1. General

Before switching-on, ensure that the oscilloscope has been correctly installed in accordance to the INSTALLATION RECOMMENDATIONS (Chapter 2.1.) and the precautions outlined have been observed.

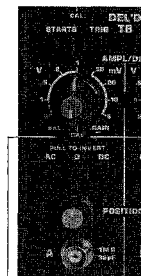
### 2.4.2. Vertical deflection

To display the desired channels depress the corresponding buttons of the vertical deflection mode switch. If two or more traces are displayed, the display can be in the alternate- or the chopped mode.

In the alternate mode the channels are displayed successively; during fly-back of the main time-base sweep the display is switched-over from one channel to another.

In the chopped mode the channels are switched-over from one to another during the time-base sweep. The display time in the chopped mode is approx. 500 ns per channel. From /03 version switchable between 0.5 and 2  $\mu$ s, see fig. 3.18).

To obtain a steady display generally the alternate mode is used at the higher sweep speeds and the chopped mode at the lower sweep speeds.



Att. step balance

Gain calibration

Note that in the composite trigger mode, the alternate display mode must be chosen, otherwise the chopper pulses will influence the trigger circuit.

The signals under observation are fed to input socket(s) A ... D and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifiers are d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shift in the DC position of the AC/0/DC switch.

This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. component. Some pulse droop, however, will occur when l.f. square-wave signals are displayed.

The 0 position interrupts the signal-path and earths the amplifier-input for quickly determining the 0 V level. With the position controls the display can be shifted in vertical direction. Note that in the composite trigger mode the trigger start point also is influenced by the vertical position control.

#### 2.4.3. Horizontal deflection

Depending on the position of the horizontal display switch the horizontal deflection can be:

- Main time-base
- Ext. X defl.
- Delayed time-base.

With the position control, combined with time-base magnifier, the display can be shifted in horizontal direction.

If the MAIN TB or DEL'D TB button is depressed, the horizontal deflection is effected by the main time-base or the delayed time-base respectively. If the EXT X DEFL button is depressed the horizontal deflection can be taken from:

- One of the vertical deflection channels A, B, C or D
- Line voltage (mains)
- Externally via EXT connector

#### 2.4.4. Main time base

Linear horizontal deflection is obtained when the MAIN TB button of the horizontal display switch is depressed.

The time-base mode can be chosen with the time-base mode switch:

- |        |  |
|--------|--|
| AUTO   | <ul style="list-style-type: none"> <li>- Time-base is running, also if no trigger pulses are present.</li> <li>The trace is, therefore, always visible.</li> <li>The AUTO mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower than 10 Hz, or pulse trains with an off-time exceeding 100 ms. As soon as trigger pulses are present, the free-running state of the time-base is automatically terminated and the time-base generator is normally triggered.</li> </ul> |
| TRIG   | <ul style="list-style-type: none"> <li>- The time-base is visible when trigger pulses are present and trigger-level control is correct.</li> </ul>   |
| SINGLE | <ul style="list-style-type: none"> <li>- The time-base makes only one sweep after receipt of a trigger pulse. After this sweep the time-base must be reset by depressing the SINGLE button once again.</li> <li>When effects which occur only once, have to be observed (usually photographed), it is often desirable to ensure that only one sweep is generated, even though several trigger pulses might be produced after the phenomenon of interest.</li> </ul>  |

#### 2.4.5. Triggering

If one or more signals must be displayed, the time-base sweep must always be started on one fixed point of the signal, in order to obtain a stationary display.

The time-base generator is, therefore, started by trigger pulses which are derived from the following signal sources, depending on the main time-base trigger selector switch:

- One of the vertical deflection channels A, B, C or D
- Composite signal
- Line voltage
- External voltage

The amplitudes of the trigger signals from one of the vertical deflection channels, or from the composite signal are proportional to the vertical deflection of the display, hence depending on the input attenuator settings.

For composite triggering buttons A and B must be depressed, in this mode the trigger signal is taken from the common vertical deflection amplifier. Composite signal triggering features:

- a. Triggering by differential signals if e.g. the instrument is in the A+B mode, with one of the input voltages inverted.
- b. Two up to four signals with different, non-related frequencies can be displayed.  
In this case the trigger points of the various signals must be in the same trigger level range.

*Note: — When triggering in the composite mode, the display must always be in the ALT mode.*

*In the CHOP mode the chopper pulses will function as trigger pulses hence the display will be unstable.*

- *In the composite triggering mode the trigger point of the signal depends also on the vertical POSITION control. A small modification for "AC" composite triggering described in part 3.2.2. solves this problem.*

Line triggering is realised by depressing both buttons B and C.

The main time-base is triggered by part of the line voltage (mains). The coupling with the line voltage is obtained by a built-in opto-isolator circuit, hence the instrument remains isolated from the line voltage.

External triggering is realized by depressing both buttons C and D.

The main time-base is now triggered by an external signal applied via the EXT connector.

With the LEVEL control the point of triggering on the slope of the signal can be chosen.

The SLOPE push-pull switch permits selection of the positive- or negative going slope.

If the main time-base generator gets no trigger pulses the NOT TRIG'D indicator lights up.

In the SINGLE sweep mode this indicator lights up if the time-base generator has been reset and is waiting for the next trigger pulse.

The sweep time of the main time-base is set with the knob TIME/DIV or DELAY TIME. If the delayed time base is switched on, the time between starting of the main time-base and delayed time-base-sweep, is the product of the settings of the DELAY TIME 10-turn knob and the main time-base sweep time switch. With the centre knob time-base sweep times between the steps can be adjusted. For time-measurements this knob must always be in the CAL position.

The TIME/DIV coefficient of the time-base can be increased by a factor of 5, by pulling the TB MAGN push-pull knob.

With the HOLD OFF control, the hold-off time of the main time-base generator can be varied. This is the time the time-base generator needs to be ready for receipt of the next trigger pulse. The HOLD OFF control permits steady display of more complicated signals e.g. periodic double-pulses.

Fully clockwise is the normal position of the HOLD OFF control. Turning anti-clockwise the hold-off time is extended.

#### 2.4.6. Delayed time base

If the MAIN TB button of the horizontal display switches is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.

The moment the delayed time-base is starting is determined by the settings of the main time-base TIME/DIV knob and the DELAY TIME 10-turn knob. If the STARTS button of the delayed time-base mode switch is depressed, the delayed time-base starts immediately after this delay time.

If the TRIG button is depressed the delayed time-base will start after this delay time and upon receipt of a trigger pulse.

The delayed time-base trigger selector has the same possibilities as the main time-base trigger selector except line and ext. triggering.

The LEVEL/SLOPE control function is the same as described for the main time-base.

The sweep time of the intensified part of the main time-base sweep depends on the setting of the delayed time-base TIME/DIV knob.

With the centre knob sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

If the DEL'D TB button of the horizontal mode switch is depressed the intensified part of the main time-base sweep is displayed over the whole screen.









# 1. Allgemeines

## 1.1. EINLEITUNG

Der tragbare H.F. Oszillograf PM 3244 verfügt über vier identische Vertikalablenkungskanäle mit höchster Empfindlichkeit (5 mV/Teil) über eine grosse Bandbreite von 50 MHz.

Das Gerät bietet vielseitige Vertikalablenkmöglichkeiten, wie ein, zwei, drei und vier Kanäle (alternierend oder gechopped). Es gestattet auch Addition der ersten zwei und der letzten zwei Kanäle.

Die Polarität jedes Kanals kann invertiert werden.

Horizontalablenkmöglichkeiten sind: Hauptzeitbasisablenkung (mit oder ohne aufgehellter verzögerter Zeitbasis), verzögerte Zeitbasisablenkung oder externe Ablenkung.

Ausser der normalen Triggerquelle-Einstellung ermöglicht der PM 3244 auch zusammengesetzte Triggerung.

Der PM 3244 hat eine Speisung mit niedriger Verlustleistung die bei jeder beliebigen Wechselspannung zwischen 90 V und 270 V und bei jeder beliebigen Gleichspannung zwischen 100 V und 350 V betriebsfähig ist.

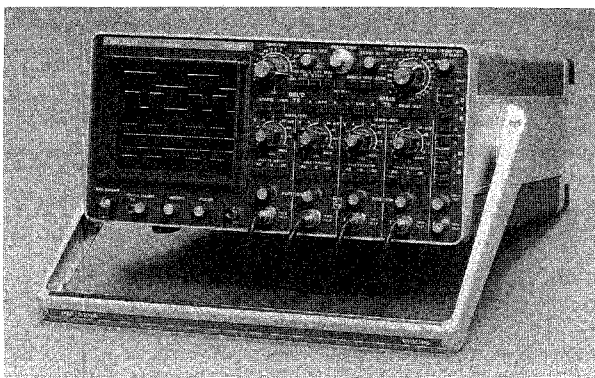


Abb. 1.1. Tragbarer Vierstrahl Hochfrequenz-Oszillograf PM 3244

## 1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in dem vorliegenden Gerätehandbuch enthalten sind.

Nur Angaben mit Toleranzen oder Grenzwerten können als garantierte Daten angesehen werden. Daten ohne Toleranzen, d.h. ohne Fehlergrenzen, sind informative Daten und werden nicht garantiert.

Fehlerangaben gelten nach einer Anwärmzeit von 15 Minuten nach dem Einschalten.

Prozentuale und absolute Fehler sind auf den jeweils angegebenen Referenzwert bezogen.

| <i>Benennung</i>                              | <i>Beschreibung</i>  | <i>Nähere Angaben</i>  |
|---|--|--|
| <b>1.2.1. Elektronenstrahlröhre</b>           |  |  |
| Typ   | PHILIPS D14-125 GH/08  | Rechteckiger Schirm, mit Netzelektrode und Nachbeschleunigung, metallhinterlegter Leuchtschirm.  |
| Ausnutzbare Schirmfläche                      | 80 mm x 100 mm   |  |
| Schirmtyp                                     | P31 (GH) Phosphor  | P11 (BE) und P7 (GM) Phosphor auf Wunsch lieferbar.  |
| Photografische Schreibgeschwindigkeit         | > 750 cm/ $\mu$ s  | Gemessen mit Steinheil Oscillophot M5 Kamera.<br>Blende: 1:1,2<br>Bildausschnitt Verhältnis: 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>Keine Vorbelichtung<br>Phosphor Typ P31 (GH) |
| Gesamte Beschleunigungsspannung               | 10 kV  | Gestrichelte Linien  |
| Raster  | 8 x 10 cm Teilung mit Unterteilung von 2 mm an den mittleren Achsen  | bei 10 % und 90 % des Messrasters, zur Messung von Anstiegszeiten.   |
| Rasterbeleuchtung                             | Stetig regelbar  | Max. Helligkeit bei normalen Laborbeleuchtungsbedingungen deutlich sichtbar.   |
| <b>1.2.2. Vertikalablenkung (Y)</b>           |  |  |
| Anzahl Kanäle                                 | 4  | Vier mit A, B, C und D bezeichnete Kanäle  |
| Darstellungsarten                             | Kanal A allein<br>Kanal B allein<br>Kanal C allein<br>Kanal D allein<br>Kanäle A+B addiert<br>Kanäle C+D addiert<br>jede dieser Arten in beliebiger Kombination, gechopped oder alternierend dargestellt.<br>Alle Kanäle können invertiert werden. |  |
| Darstellungszeit pro Kanal in Chopper-Betrieb | ca. 500 ns.  | Ab /03 Version: schaltbar zwischen 0,5 und 2 $\mu$ s (siehe Fig. 3.18.)  |
| Frequenzbereich                               | DC ... 50 MHz<br><br>10 Hz ... 50 MHz  | Gleichspannungsgekoppelt<br>Obere Bandbreitegrenze -3 dB<br>Wechselspannungsgekoppelt<br>-3 dB Bandbreitegrenze  |

| <i>Benennung</i>  | <i>Beschreibung</i>   | <i>Nähere Angaben</i>   |
|---|---|---|
| Anstiegszeit  | 7 ns  |   |
| Überschwingen   | ± 2 % maximal   | Gemessen mit einem Prüfpuls mit 6 Div. Auslenkung / 1 ns. Anstiegszeit und 1 µs Wiederholungszeit.  |
| Ablenkkoeffizienten   | 5 mV/DIV ... 2 V/DIV  | In neun kalibrierten Stufen in 1-2-5 Folge. Nichtkalibriert, kontinuierlich einstellbar 1 : ≥ 2,5   |
| Fehlergrenze  | ± 3 %   |   |
| Eingangsspannung  | ± 400 V maximal   | Gleichspannung + Spitzenwert einer Wechselfspannung. In den 5 mV/DIV ... 20 mV/DIV Stufen des Eingangsabschwächer, Minderung bei Frequenzen über 500 kHz. Siehe Abb. 1.2. |
| Maximale Ablenkung  | 24 DIV<br>≥ 6 DIV   | Für sinusförmige Signale bis 15 MHz<br>Für sinusförmige Signale von 15 MHz bis 50 MHz   |
| Maximale Gesamtsignalamplitude in Betriebsarten A-B und C-D | 24x Abschwächer Einstellung   | Abschwächer in CAL Stellungen   |
| Verschiebungsbereich  | 16 DIV  |   |
| Gleichtaktunterdrückung                                     | ≥ 100:1 bei 1 MHz   | Nach Abgleich   |
| Übersprechen zwischen Kanälen                               | 35 dB maximal   | Für alle Abschwächerkombinationen Bezogen auf 6 DIV. Signalamplitude (0 ... 50 MHz) Chopper-Betrieb   |
| Bild-Instabilität DC Drift                                  | ≤ 0,3 DIV/Stunde bei 20 °C  | Nach 15 Minuten Anwärzeit   |
| Temperaturdrift   | ≤ 60 µV/°C typisch  |   |
| Abschwächungsgleichgewicht                                  | ≤ 0,3 DIV   | Beim Umschalten zwischen beliebigen Abschwächer-Einstellungen.  |
| Eingangsimpedanz  | 1 Mohm//15 pF   |   |
| Kopplung  | AC-0-DC   |   |
| RC-Zeit des Eingangs  | 22 ms   |   |
| Sichtbare Signalverzögerung                                 | 20 ns   | Kopplung-Schalter auf AC  |
| <b>1.2.3. Horizontalablenkung (X)</b>                       |   |   |
| Darstellungsarten   | <ul style="list-style-type: none"> <li>- Hauptzeitbasis</li> <li>- Hauptzeitbasis aufgehehlt durch verzögerte Zeitbasis</li> <li>- verzögerte Zeitbasis</li> <li>- X/Y Betrieb</li> </ul> | Bis zu vier X/Y Darstellungen. Betrieb mit X-Ablenkung durch einen der vier Kanäle, ein externes Signal oder das Netzsignal   |
| Frequenzbereich des Horizontalablenkungs-Verstärkers        | DC ... 1 MHz  | über 6 DIV<br>-3 dB obere Bandbreitegrenze  |
| Ablenkkoeffizient   | 450 mV/DIV<br>Vertikalabschwächkoeffizienten  | Bei Anwendung von Eingang EXT Zutreffend wenn einer der vertikalen Kanäle für Horizontalablenkung angewandt wird.   |
| Fehlergrenze  | ± 10 %  | Bei Anwendung eines der vertikalen Kanäle für Horizontalablenkung   |

| <i>Benennung</i>   | <i>Beschreibung</i> | <i>Nähere Angaben</i>   |
|--|---------------------|---|
| Eingangsimpedanz   | 1 Mohm//15 pF       |   |
| Phasendifferenz zwischen Vertikal- und Horizontalabf. Verstärker | weniger als 3°      | bei 100 kHz   |
| Ablenkung durch Netzspannung                                     | 8 DIV               | Die Ablenkung ist abhängig von der Netzspannung und ist ab Fabrik eingestellt auf 8 DIV bei 220 V Netzspannung. |

#### 1.2.4. Hauptzeitablenkung

|               |                                       |   |
|---------------|---------------------------------------|---|
| Betrieb       | Automatisch<br>Getriggert<br>Einmalig | Bei Betriebsart AUTO ist die Zeitbasis etwa 100 ms nach Verschwinden des Triggersignals freilaufend.    |
| Zeitmaststäbe | 0,5 s/DIV ... 50 ms/DIV               | 22 kalibrierte Stufen in 1-2-5 Folge.<br>Nichtkalibriert: kontinuierliche<br>Einstellung 1 : $\geq 2,5$ |
| Fehlergrenze  | $\pm 3\%$                             | $\pm 5\%$ für 0,5 s/DIV und 0,2 s/DIV<br>$\pm 5\%$ für 100 ns/DIV und 50 ms/DIV                         |

#### 1.2.5. Verzögerte Zeitablenkung

|  |  |  |
|--|--|--|
|  | Sofort nach Verzögerungszeit<br>laufend oder triggerbar nach<br>Verzögerungszeit |  |
| Zeitmaststäbe                                | 1 ms/DIV ... 50 ns/DIV   | 14 kalibrierte Stufen in 1-2-5 Folge<br>Nichtkalibriert, kontinuierliche<br>Einstellung 1 : $\geq 2,5$ |
| Fehlergrenze                                 | $\pm 3\%$  | $\pm 5\%$ für 100 ns/DIV und 50 ns/DIV   |
| Dehnung der Zeitbasis                        | $\times 5$   |  |
| Maximale effektive<br>Schreibgeschwindigkeit | 10 ns/DIV  |  |
| Zuzügliche Toleranz                          | $\pm 2\%$  |  |

#### 1.2.6. Triggerung der Hauptzeitablenkung

|                              |   |   |
|------------------------------|---|---|
| Triggerquelle                | Intern<br>Zusammengesetzt<br>Netz<br>Extern   | von Kanal A, B, C oder D                              |
| Trigger-Bandbreite           | DC ... 50 MHz                                 | Obere Bandbreitegrenze -15 dB                         |
| Trigger-Empfindlichkeit      | Intern $\leq 0,5$ DIV<br>Extern $\leq 250$ mV | 0,3 DIV typisch<br>150 mV typisch                     |
| Flankenwahl                  | + oder -                                      |   |
| Ext. Triggereingangsimpedanz | 1 Mohm//15 pF                                 | Gleich dem Eingang einer beliebigen Vertikalablenkung |
| Eingangsspannung             | $\pm 400$ V max.                              | DC + AC Spitze  |

#### 1.2.7. Triggerung der verzögerten Zeitablenkung

Gleich der Hauptzeitablenkungstriggerung ausser:

|               |                           |                          |
|---------------|---------------------------|--------------------------|
| Triggerquelle | Intern<br>Zusammengesetzt | Von Kanal A, B, C oder D |
|---------------|---------------------------|--------------------------|

#### Verzögerte Ablenkung

|                  |   |
|------------------|---|
| Verzögerungszeit | Stufenlos regelbar zwischen<br>0,3x und 10x der Zeitmasstab<br>der Hauptzeitablenkung mit<br>Heipotentiometer |
|------------------|---|

| <i>Benennung</i>   | <i>Beschreibung</i>  | <i>Nähere Angaben</i>   |
|--|--|---|
| Zusätzlicher Verzögerungszeitfehler  | 0,5 %  |   |
| Verzögerungszeitjitter   | ≤ 1 : 20 000   |   |
| <b>1.2.8. Kalibriereinheit</b>   |  |   |
| Spannung   | 3 V <sub>s-s</sub>   | Rechtecksignal, Grundlinie ist Nullspannung                                 |
| Strom  | 6 mA   | Durch Stromkreis  |
| Fehlergrenze   | ± 1 %  | Für Spannung und Strom  |
| Frequenz   | 2 kHz  | ± 2 %   |
| Sicherung  | Der Ausgang ist kurzschlussfest  |   |
| <b>1.2.9. Speisung</b>   |  |   |
| Netzspannungen   | 90 ... 270 V Wechselfspannung (AC) oder<br>100 ... 350 V Gleichspannung (DC)                               | In einem Bereich  |
| Netzfrequenz   | 46 ... 440 Hz oder DC  |   |
| Eingebaute Sicherung   | 1,6 A, träge   | Für alle Netzspannungen   |
| Leistungsaufnahme  | 29 W   |   |
| <b>1.2.10. Einflussgrößen</b>  |  |   |
| Die angegebenen Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden. |  |   |
| Umgebungstemperaturen  | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C   | Betrieb innerhalb Spezifikation<br>Arbeitsbereich<br>Lagerung und Transport |
| Höhe   | 5000 m<br>15000 m  | Betriebsfähig<br>Nicht Betriebsfähig  |
| Feuchtigkeit   | Das Gerät entspricht den Anforderungen gemäss IEC 68 Db Standard   |   |
| Stoßfestigkeit   | 1000 Stöße von 10 g, ½ Sinus, Dauer 8 ms, in allen 3 Richtungen  |   |
| Vibration  | 30 Minuten in jeder der drei Richtungen, 10-150 Hz; 0,7 mm (Spitze-Spitze) und 5 g maximale Beschleunigung |   |
| Akklimationszeit   | 30 Minuten für Normalbetrieb   | Kommend von -10 °C nach +20 °C bei 60 % relativer Feuchtigkeit              |
| Störgrad   | Das Gerät entspricht den Anforderungen gemäss VDE Störgrad K   |   |
| <b>1.2.11. Mechanische Daten</b>   |  |   |
| Abmessungen  | Länge 410 mm<br>Breite 316 mm<br>Höhe 154 mm   | Ohne Bedienungsorgane, Deckel und Füsse                                     |
| Gewicht  | 9,7 kg   |   |



Benennung

Beschreibung

Nähere Angaben

## 1.2.12. Standardzubehör

Kontrastfilterscheibe  
 Abdeckhaube mit Aufbewahrungsraum  
 Faltbarer Lichtschutztubus PM 9366  
 BNC Übergangstecker PM 9051  
 CAL Anschlussklemme - BNC Adapter  
 Anleitung  
 4 x 10:1 Messkopf PM 9350/PM 8927

## 1.2.13. Wahlzubehör

|          |   |         |   |
|----------|---|---------|---|
| PM 9335  | 1:1 Messkopf<br>1,5 m Kabel                           | PM 9355 | 12 Hz ... 70 MHz Strom-Messkopf                   |
| PM 9335L | 1:1 Messkopf<br>2,5 m Kabel                           | PM 9346 | Stromversorgung für aktive<br>Messköpfe           |
| PM 9350  | 10:1 Messkopf<br>1,5 m Kabel                          | PM 8960 | 19" Gestelleinbausatz                             |
| PM 9350L | 10:1 Messkopf<br>2,5 m Kabel                          | PM 8992 | Zubehörtasche                                     |
| PM 8927  | 10:1 Messkopf<br>1,5 m Kabel                          | PM 9380 | Oszillografenkamera                               |
| PM 8927L | 10:1 Messkopf<br>2,5 m Kabel                          | PM 8971 | Kamera Adapter für PM 9380                        |
| PM 9358  | 100:1 Messkopf,<br>5600 V maks., 2 pF,<br>1,5 m Kabel | PM 8910 | Polaroid Anti-Reflex Filter                       |
| PM 9347  | Aktiver T.V. Messkopf                                 | PM 8980 | Langer Einblicktubus                              |
| PM 9352  | Aktiver 10:1 Miniaturmesskopf<br>100 kohm//6 pF       | PM 8901 | Batteriespeisung 24 V und<br>140 V Gleichspannung |
| PM 9353  | Aktiver 2:1 FET-Messkopf<br>1 Mohm//3,5 pF            | PM 8991 | Rollwagen   |

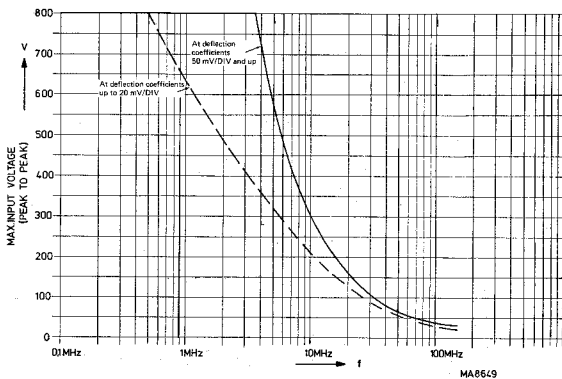


Abb. 1.2. Minderung der höchstzulässigen Eingangsspannung als Funktion der Frequenz



Abb. 2.1. Abnehmen der Abdeckhaube

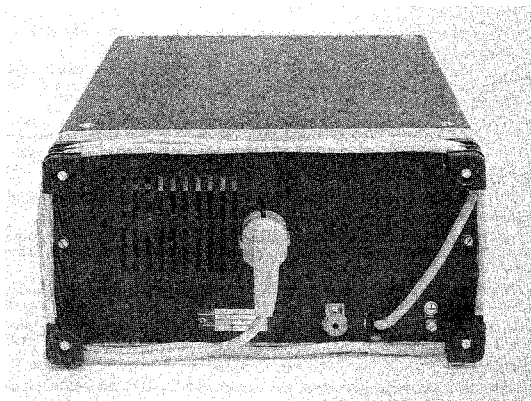


Abb. 2.2. Rückansicht des Gerätes

## 2. Gebrauchsanleitung

### 2.1. INBETRIEBNAHME

#### 2.1.1. Abnehmen und Aufsetzen der Abdeckhaube

Abnehmen:

- Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen (Stellung UNLOCKED).
- Deckel abnehmen.

Aufsetzen:

- Den Verriegelungsknopf in Stellung UNLOCKED drehen.
- Deckel an der Vorderseite des Oszillografen befestigen.
- Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

*Bemerkung: Der Handgriff lässt sich drehen wenn die Druckknöpfe auf ihren Lagern eingedrückt werden.*

**WARNUNG:** In diesem Gerät werden hohe Spannungen erzeugt, deshalb darf es niemals in geöffnetem Zustand eingeschaltet werden.

Vor Wartungsarbeiten ist der Netzstecker zu ziehen und ist darauf zu achten dass alle Hochspannung führenden Teile entladen sind.

Bevor irgend eine Verbindung ausgeführt wird muss die Erdanschlussklemme an einen Schutzleiter angeschlossen werden (siehe Abschnitt "Erdung").

#### 2.1.2. Netzspannungseinstellungen und Sicherung


Da das Gerät bei jeder Netzspannung zwischen 90 und 270 V Wechselspannung und zwischen 100 und 350 V Gleichspannung betriebsfähig ist, erübrigt sich das Umschalten auf die örtliche Netzspannung.

Der Sicherungshalter ist an der Rückwand angebracht. Die Sicherung 1,6 A, trägt wird bei allen Netzspannungen angewandt.

Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalter sind nicht zulässig. Das Gerät muss von allen Spannungsquellen getrennt sein wenn eine Sicherung ersetzt wird.

#### 2.1.3. Erdung

Vor dem Einschalten muss das Gerät auf eine der folgenden Weisen mit einem Erdschutzleiter verbunden werden:

- über den Erdanschluss (gekennzeichnet ).
- über das dreidrädrige Netzkabel. Der Netzstecker darf nur in eine Schutzkontaktdose eingeführt werden. Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch Verwendung einer Verlängerungsleitung ohne Schutzleiter.

**WARNUNG:** Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Geräts ist unzulässig.

Wenn ein Gerät von kalter in warme Umgebung gebracht wird, kann dies zu einem sicherheitstechnisch gefährlichen Zustand führen. Deshalb sind alle Erdungsvorschriften sorgfältig zu beachten.

#### 2.1.4. Öffnen des Geräts

Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein. Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundenen Gefahren kennt.

Ersetzen des Netzsteckers geschieht auf eigene Gefahr. Nach dem Ersetzen des Netzsteckers ist es ratsam einen Hochspannungstest IEC 348 vorzunehmen.

Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde.

#### 2.1.5. Einschalten

Der Netzschalter POWER ist gekoppelt mit der Rasterbeleuchtungseinsteller ILLUM und befindet sich an der Vorderseite des Gerätes unter dem Bildröhrenrahmen.

Der Oszillograf darf niemals eingeschaltet werden, wenn eine Leiterplatte oder Baustein entfernt wurde.

Eine Leiterplatte oder Baustein darf nicht früher als eine Minute nach Ausschaltung des Gerätes entfernt werden.

## 2.2. BEDIENUNGSORGANE UND BUCHSEN

### 2.2.1. Vertikalablenkung (Y)

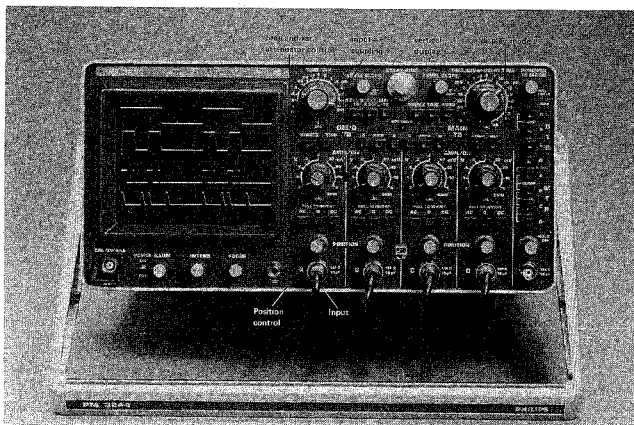


Abb. 2.3. Vertikalablenkung

#### 1. Vertikalablenkungsart-Schalter

|            |                                    |
|------------|------------------------------------|
| Taste A    | Kanal A                            |
| Tasten A+B | Kanäle A und B algebraisch addiert |
| Taste B    | Kanal B                            |
| Taste C    | Kanal C                            |
| Tasten C+D | Kanäle C und D algebraisch addiert |
| Taste D    | Kanal D                            |

Jede Kombination obiger Darstellungsarten ist möglich.  
Wenn keine Taste gedrückt ist, ist Kanal A eingeschaltet.

#### 2. Darstellungsart-Schalter CHOP/ALT

Die in Punkt 1 erwähnten Kanäle können *gechopped* oder *alternierend* dargestellt werden. Wenn keine Taste gedrückt ist und zwei oder mehr Kanäle eingeschaltet sind, dann ist die Darstellung *gechopped*.

#### 3. Abschwächer-Einsteller

|                           |   |
|---------------------------|---|
| AMPL/DIV                  | Stufenweise Einstellung der Ablenkoeffizienten, kombiniert mit:   |
| AMPL/CAL                  | Stufenlose Einstellung der Ablenkoeffizienten.<br>Wenn dieser Knopf gezogen ist, wird die Polarität des Kanals invertiert.  |
| Eingangskopplung-Schalter | AC Signalkopplung über einen Sperrkondensator<br>O Kanaleingang geerdet, Signalleerlauf<br>DC Direkte Kopplung<br>(Wenn keine Taste eingedrückt ist, ist Einstellung AC wirksam.) |
| POSITION                  | Stufenlose Einstellung bewirkt vertikale Verschiebung des betreffenden Kanals.  |

#### VOREINSTELL-BEDIENUNGSORGANE

|      |  |
|------|--|
| BAL  | Ausgleich des Stufenabschwächergleichgewichtes |
| GAIN | Verstärkereinstellung des Stufenabschwächers   |

## 2.2.2. Horizontalablenkung (X)

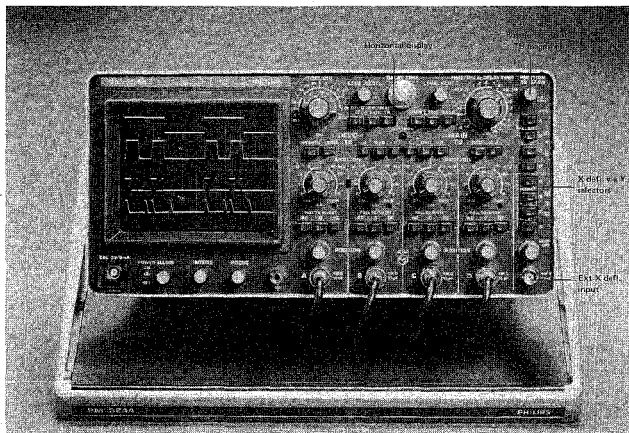


Abb. 2.4. Horizontalablenkung

## 1. Horizontalablenkungsart-Schalter

MAIN TB

Die Horizontalablenkung wird vom Hauptzeitablenkgenerator bewirkt. Ein Teil der Darstellung wird aufgehellt wenn die verzögerte Zeitablenkung eingeschaltet ist.

EXT X DEFL

Horizontalablenkung wird bewirkt durch ein Signal kommend von:

- der Eingangsbuchse des Horizontalverstärkers
- einem der vertikalen Kanäle
- dem Netz

DEL'D TB

Die Horizontalablenkung wird vom verzögerten Zeitablenkgenerator bewirkt. Wenn keine Taste eingedrückt ist, dann gilt MAIN TB.

## 2. Position und Dehnung der Zeitablenkung

POSITION

Stufenlose Einstellung der horizontalen Verschiebung der Darstellung.

TB MAGN

Zug-Druck Schalter für 5-fache Steigerung der Zeitablenkoeffizienten.

## 2.2.3. Hauptzeitablenkung

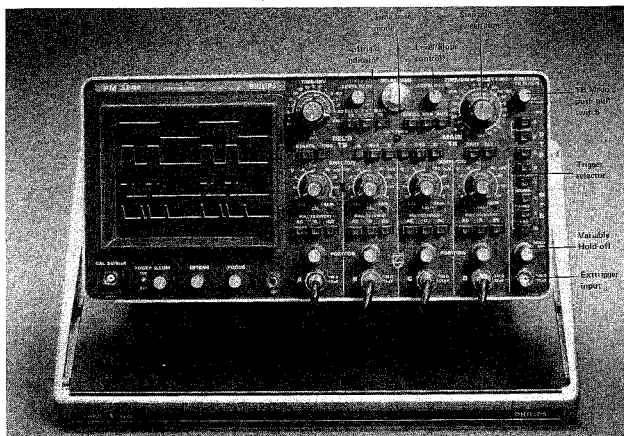


Abb. 2.5. Hauptzeitablenkung

## 1. Hauptzeitablenkung-Wahlschalter

AUTO

Wenn keine Triggerimpulse vorhanden sind, ist der Hauptzeitablenk-generator freilaufend.

TRIG

Die Hauptzeitablenkung wird auf normale Weise getriggert.

SINGLE

Single sweep Zeitablenkung. Nach Betätigung der Taste Single läuft der Hauptzeitablenkgenerator nur einmal ab. Wenn keine Taste eingedrückt ist, arbeitet die Zeitablenkung in Betriebsart Single Sweep.

## 2. Schalter TIME/DIV or DELAY

Stufenweise Einstellung der Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 22 Stellungen. Wenn die verzögerte Zeitablenkung wirksam ist, dann ist die Verzögerungszeit nach der die verzögerte Zeitablenkung startet gegeben durch die Einstellung der Helipotentiometer "DELAY TIME" mal TIME/DIV Koeffizient dieses Schalters.

TIME/DIV CAL

Stufenlose Einstellung des Zeitkoeffizienten.

## 3. LEVEL/SLOPE

Stufenlose Einstellung zur Wahl der Triggerpegels bei welchem der Zeitablenkgenerator startet. Der Zug-Druckschalter gestattet Wahl der Triggerrichtung auf der positiv oder negativ gerichteten Flanke des Signals.

## 4. Anzeige NOT TRIG'D

Leuchtet auf wenn keine Triggerrichtung des Hauptzeitablenkgenerators erfolgt ist.

5. Hauptzeitablenkung  
Triggerquelle-Wahlschalter

Dieser Schalter besteht aus vier Tasten (A, B, C, D) für die Wahl des Triggersignals von einem der Vertikalablenkungskanäle. Wenn die beiden Tasten A und B eingedrückt sind, wird das zusammengesetzte Triggersignal gewählt. Wenn die beiden Tasten B und C eingedrückt sind, wird ein Teil der Netzspannung als Triggersignal verwendet.

Wenn die beiden Tasten C und D eingedrückt sind, wird das Signal welches an Buchse EXT liegt als Triggersignal verwendet. Falls keine Taste eingedrückt ist, ist Signal A eingeschaltet.

## 2.2.4. Verzögerte Zeitablenkung

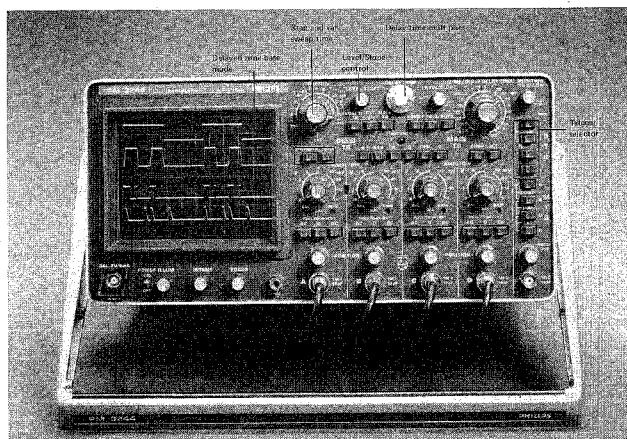


Abb. 2.6. Verzögerte Zeitablenkung

## 1. Schalter TIME/DIV

Stufenweise Einstellung der Zeitkoeffizienten der verzögerten Zeitablenkung: Drehschalter mit 14 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.

TIME/DIV CAL

Stufenlose Einstellung der Zeitkoeffizienten der Zeitablenkung.

## 2. DELAY TIME

Kalibrierter Helipotentiometer zur Einstellung der Verzögerungszeit, nach welcher der verzögerte Zeitablenkungsgenerator wirksam wird. Diese Verzögerungszeit ist gegeben durch die Einstellung DELAY TIME mal TIME/DIV Koeffizient der Hauptzeitablenkung.

## 3. STARTS/TRIG

Wenn Taste STARTS eingedrückt ist, startet sofort nach der Verzögerungszeit die verzögerte Zeitablenkung (die verzögerte Zeitablenkung erfordert in diesem Falle kein Triggersignal). Wenn Taste TRIG eingedrückt ist startet die verzögerte Zeitablenkung nach der Verzögerungszeit nach Empfang eines Triggerimpulses. Keine Taste gedrückt hat die gleiche Wirkung wie Taste STARTS gedrückt.

## 4. LEVEL/SLOPE

Stufenlose Einstellung zur Wahl des Triggerpegels bei welchem der verzögerte Zeitablenkungsgenerator getriggert wird. Der Zug-Druck Schalter gestattet Wahl der Triggerrichtung auf der positiv oder negativ gerichteten Flanke des Signals.

5. Verzögerte Zeitablenkung  
Triggerquelle-Wahlschalter

Dieser Schalter besteht aus vier Tasten (A, B, C und D) für die Wahl des Triggersignals von einem der Vertikalablenkungskanäle. Wenn die beiden Tasten A und B eingedrückt sind, wird das zusammengesetzte Triggersignal gewählt.

Falls keine Taste eingedrückt ist, ist Signal A eingeschaltet.

## 2.2.5. Bildteil

- |                |   |
|----------------|---|
| 1. POWER/ILLUM | Stufenlose Einstellung der Rasterbeleuchtung, kombiniert mit Ein/Aus-Netzschalter. Signallampe zeigt Betriebszustand (ON) an. |
| 2. INTENS      | Stufenlose Einstellung der Bildhelligkeit   |
| 3. FOCUS       | Stufenlose Einstellung der Fokussierung des Elektronenstrahls.  |

### Verschiedenes

- |        |  |
|--------|--|
| 1. CAL | Ausgangsbuchse für die Kalibrierung:<br>– der Verstärkung des Vertikalablenkverstärkers<br>– der Frequenzkompensation von Abschwächer-Messköpfen.<br>Geignet für Spannungs-Messköpfe und Strommessköpfe. |
|--------|--|

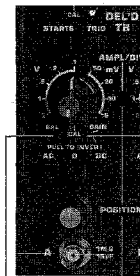
## 2.3. GRUNDEINSTELLUNGEN

Bevor mit dem Oszillografen Messungen ausgeführt werden, muss man sich überzeugen dass der Stufenabschwächer-Ausgleich und die Verstärkungskalibrierung für alle Kanäle einwandfrei eingestellt sind. Falls erforderlich, wie folgt handeln:

1. Einstellen des Stufenabschwächer-Gleichspannungsgleichgewichts
  - Taste MAIN TB des Horizontalablenkungsschalters eindrücken.
  - Taste AUTO des Hauptzeitablenkungsschalters eindrücken.
  - Mit Einstellern INTENSITY und FOCUS die Bildschärfe adjustieren.
  - Die entsprechende Kanaltaste des Vertikalablenkungsschalters eindrücken.
  - Taste 0 des Eingangskopplungsschalters eindrücken.
  - Mit Knopf POSITION das Bild derart einstellen, dass es sich ungefähr in der Mitte des Schirms befindet.
  - Den stufenlosen Einsteller AMPL auf CAL stellen.
  - Es ist darauf zu achten dass beim Drehen des Stufenschalters AMPL das Bild nicht springt.  
Wenn nötig, Regler BAL einstellen.
  - Den Vorgang für jeden Kanal wiederholen.
2. Verstärkungskalibrierung
 

Wenn nicht anders erwähnt befinden sich die Einstellelemente in den gleichen Stellungen wie beim vorgehenden Verfahren.

  - Schalter AC-0-DC auf AC stellen.
  - Schalter AMPL auf 0,5 V und den stufenlosen Einsteller auf CAL stellen.
  - Kanaleingang mit Ausgang CAL verbinden.
  - Kontrollieren ob die Vertikalablenkung genau 6 Div. beträgt. Nötigenfall Regler GAIN adjustieren.
  - In diese Kalibrierung kann ein Abschwächer-Messkopf einbezogen werden. Der Abschwächfaktor des Messkopfs muss in Bezug auf die Stellung des Schalters AMPL in Betracht gezogen werden.
  - Den Vorgang für jeden Kanal wiederholen.



Att. step balance

Gain calibration

## 2.4. BEDIENUNGSANLEITUNGEN

### 2.4.1. Allgemeines

Vor dem Einschalten überzeuge man sich ob der Oszillograf einwandfrei den INBETRIEBNAHME Vorschriften gemäss (Abschnitt 2.1.) installiert ist und dass die erwähnten Sicherheitsmassnahmen eingehalten wurden.

### 2.4.2. Vertikalablenkung

Zur Darstellung der gewünschten Kanäle die entsprechenden Tasten des Vertikalablenkungsschalters eindrücken. Wenn zwei oder mehr Bildsignale dargestellt werden, kann die Darstellung in alternierender oder gechoppeter Betriebsart erfolgen. In der alternierenden Betriebsart werden die Kanäle hintereinander dargestellt; beim Rücklauf der Hauptzeitablenkung wird die Darstellung von einem Kanal auf den anderen umgeschaltet.



In der gepochten Betriebsart werden die Kanäle während der Zeitablenkung von einem auf den anderen umgeschaltet. In der gepochten Betriebsart ist die Darstellungszeit ca. 500 ns pro Kanal. Ab /03 Version; 0,5 und 2  $\mu$ s, schaltbar, siehe Abb. 3.18.

Für eine gute Darstellung ist es üblich bei höheren Ablenkgeschwindigkeiten die alternierende Betriebsart anzuwenden und bei niedrigeren Ablenkgeschwindigkeiten die gepochte.

Es ist zu beachten dass bei zusammengesetzter Triggerungsart die alternierende Darstellung gewählt wird, weil sonst die Chopperimpulse die Triggerschaltung beeinflussen.

Die zu beobachtenden Signale sind an die Buchse (n) A ... D zu legen und der AC/0/DC Schalter ist abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.

Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein. Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechsellspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz-Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen. Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

Mit Hilfe der Einsteller POSITION lässt sich die Darstellung in vertikaler Richtung verschieben. Es ist zu beachten, dass bei zusammengesetzter Triggerungsart der Trigger-Startpunkt von der vertikalen Verschiebung beeinflusst wird.

#### 2.4.3. Horizontalablenkung

Abhängig von der Stellung des Horizontalablenkungsschalters ist folgende Horizontalablenkung möglich:

- Hauptzeitablenkung
- Ext. X-Ablenkung
- Verzögerte Zeitablenkung

Mit Einsteller POSITION kombiniert mit der Dehnung der Zeitablenkung kann die Darstellung in horizontaler Richtung verschoben werden.

Wenn Taste MAIN TB oder DEL'D TB eingedrückt ist, wird die Horizontalablenkung von der Hauptzeitablenkung bzw. der verzögerten Zeitablenkung bewirkt. Wenn Taste EXT X DEFL eingedrückt ist, wird Horizontalablenkung bewirkt durch:

- Einen der Vertikalablenkungskanäle A, B, C oder D
- Netzspannung
- Extern über Buchse EXT

#### 2.4.4. Hauptzeitablenkung

Lineare Horizontalablenkung ist verfügbar wenn Taste MAIN TB der Horizontalablenkungsschalter eingedrückt ist.

Die Betriebsart der Zeitablenkung ist mit den folgenden Schaltern wählbar:

- |        |  |
|--------|--|
| AUTO   | – Zeitablenkung freilaufend, auch wenn keine Triggerimpulse anliegen. Folglich ist das Bild immer sichtbar. Betriebsart AUTO kann in allen Fällen verwendet werden, in welchen auch Betriebsart TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit einer "AUS" Zeit über 100 ms. Sobald Triggerimpulse vorhanden sind, wird der Freilauf der Zeitablenkung automatisch beendet und wird der Zeitablenkgenerator normal getriggert. |
| TRIG   | – Die Zeitablenkung wird sichtbar sobald Triggerimpulse vorhanden sind und die Triggerpegelinstellung korrekt ist.   |
| SINGLE | – Die Zeitablenkung läuft nach Empfang eines Triggerimpulses nur einmal ab. Nach diesem "Sweep" muss die Zeitablenkung durch Eindrücken der Taste SINGLE erneut eingestellt werden. Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden.                         |

#### 2.4.5. Triggerung

Wenn ein oder mehrere Signale dargestellt werden sollen, muss um ein stillstehendes Bild zu erhalten, die Zeitablenkung immer an einem festen Punkt des Signals gestartet werden.

Der Zeitablenkungs-generator wird deshalb von Triggerimpulsen gestartet, die abhängig von der Stellung des Hauptzeitbasis-Triggerquelle-Wahlschalter, folgenden Signalquellen entstammen:

- Einer der Vertikalablenkungs Kanäle A, B, C oder D
- Zusammengesetztes Signal
- Netzspannung
- Externe Spannung

Die Amplitude der Triggersignale von einem der Vertikalablenkungs Kanäle, oder vom zusammengesetzten Signal ist proportional zur Vertikalablenkung des Bildes und daher von der Einstellung des Eingangsabschwächer abhängig.

Für zusammengesetzte Triggerung müssen die Taste A und B eingedrückt werden. Bei dieser Betriebsart wird das Triggersignal dem gemeinsamen Vertikalablenkungsverstärker entnommen.

Zusammengesetzte Triggerung ermöglicht:

- a. Triggerung durch Differenzsignale, mit beispielsweise dem Gerät in Betriebsart A+B und mit einer der Eingangsspannungen invertiert.
- b. Darstellung von zwei bis vier Signalen mit verschiedenen Frequenzen ohne Beziehung zueinander. In diesem Fall müssen die Triggerpunkte der verschiedenen Signale im gleichen Triggerpegelbereich liegen.

*Bemerkung:* - Bei Triggerung in der zusammengesetzten Betriebsart, muss die Darstellung immer in Betriebsart ALT erfolgen.

*In Betriebsart CHOP wirken die Chopper-Impulse als Triggerimpulse und verursachen dadurch ein unstabiles Bild.*

*- Bei zusammengesetzter Triggerung wird der Triggerpunkt des Signals auch vom Vertikal-einsteller POSITION bestimmt. Eine kleine Modifikation für "AC" zusammengesetzte Triggerung löst dieses Problem. Beschreibung (nur in Englisch) im Abschnitt 3.2.2.*

Netztriggerung wird durch Eindrücken der beiden Tasten B und C bewirkt.

Die Hauptzeitablenkung wird von einem Teil der Netzspannung getriggert. Die Kopplung mit der Netzspannung wird mit Hilfe einer optischen Trennschaltung erlangt, dadurch bleibt das Gerät von der Netzspannung isoliert.

Externe Triggerung wird durch Eindrücken der beiden Tasten C und D bewirkt.

Die Hauptzeitablenkung wird nun von einem an BUCHSE EXT angelegten externen Signal getriggert.

Mit Einsteller LEVEL ist der Triggerpunkt auf der Flanke des Signals wählbar.

Der Zug-Druck Schalter SLOPE erlaubt die Wahl der positiv oder negativ gerichteten Flanke.

Wenn der Hauptzeitbasisgenerator keine Triggerimpulse erhält, dann leuchtet Anzeige NOT TRIG'D auf.

Im SINGLE SWEEP-Betrieb leuchtet diese Anzeige wenn der Zeitablenkungs-generator erneut eingestellt wurde und das Erscheinen des nächsten Triggerimpulses erwartet.

Die Ablenkzeit der Hauptzeitablenkung wird mit Knopf TIME/DIV or DELAY TIME eingestellt. Wenn die verzögerte Zeitablenkung eingeschaltet ist, dann ist die Zeit zwischen dem Start der Hauptzeitablenkung und der verzögerten Zeitablenkung vom Produkt der Einstellung des 10-Drehungsknopfes DELAY TIME mal der Einstellung des Ablenkzeitschalters MAIN TB gegeben.

Mit dem inneren Knopf lassen sich Zeitablenkzeiten zwischen den Stufen einstellen. Für Zeitmessungen muss dieser Knopf immer auf CAL stehen.

Der Koeffizient TIME/DIV der Zeitablenkung lässt sich durch Ziehen des Zug-Druck Schalters TB MAGN 5-fach dehnen.

Mit Einsteller HOLD OFF lässt sich die Sperrzeit des Hauptzeitablenkengenerators variieren. Dies ist die Zeit die der Zeitablenkungs-generator benötigt bis er zum Empfang des nächsten Triggerimpulses bereit ist. Einsteller HOLD OFF ermöglicht eine stabile Darstellung von komplizierteren Signalen, z.B. periodische Doppelimpulse. Der normale Stand des Einstellers HOLD OFF ist Rechtsanschlag. Linksdrehung erweitert die Sperrzeit.

#### 2.4.6. Verzögerte Zeitablenkung

Wenn Taste MAIN TB des Schalters für die horizontale Darstellung eingedrückt ist und der Knopf TIME/DIV der verzögerten Zeitablenkung nicht in Stellung OFF ist, wird ein Teil der Hauptzeitablenkungslinie zusätzlich aufgehellt.

Der Zeitpunkt des Starts der verzögerten Zeitablenkung wird von den Einstellungen des Knopfs TIME/DIV der Hauptzeitablenkung und des 10-Drehungsknopfes DELAY TIME bestimmt. Wenn Taste STARTS des Schalters

der verzögerten Zeitablenkungsart eingedrückt ist, dann startet die verzögerte Zeitablenkung sofort nach der Verzögerungszeit.

Wenn Taste TRIG eingedrückt ist startet die verzögerte Zeitablenkung nach der Verzögerungszeit und nach Erhalt eines Triggerimpulses.

Der Triggerwähler der verzögerten Zeitablenkung besitzt die gleichen Möglichkeiten wie der Triggerwähler der Hauptzeitablenkung mit Ausnahme von LINE und EXT Triggerart.

Die Funktion des Einstellers LEVEL/SLOPE ist die gleiche wie für die Hauptzeitablenkung beschrieben.

Die Zeitdauer des zusätzlich aufgehellten Teils der Hauptzeitablenkung wird von der Einstellung des Knopfs TIME/DIV der verzögerten Zeitablenkung bestimmt.

Mit dem inneren Knopf lassen sich die Ablenkzeiten zwischen den Stufen einstellen. Für Zeitmessungen muss dieser Knopf immer auf CAL gestellt werden.

Wenn Taste DEL'D TB der horizontalen Darstellung eingedrückt ist wird der zusätzlich aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht.

## Notice d'emploi et d'entretien



# 1.Generalites

## 1.1. INTRODUCTION

L'oscilloscope portatif haute fréquence PM 3244 présente quatre voies identiques de déviation verticale à haute sensibilité (5 mV/div) et sur une largeur de bande étendue de 50 MHz.

Il y a un large choix de déviations verticales possibles: une, deux, trois ou quatre voies (alternées ou découpées). De plus, les deux premières voies peuvent être additionnées et aussi les deux dernières voies. La polarité de chaque voie peut être inversée.

Pour ce qui est des déviations horizontales possibles, on distingue: la déviation de base de temps principale (avec ou sans base de temps retardée intensifiée), la déviation de base de temps retardée ou la déviation externe.

Si l'on excepte la source de déclenchement normal, le PM 3244 offre un déclenchement composite.

Cet oscilloscope se caractérise par une alimentation à faible dissipation fonctionnant pour une tension alternative entre 90 et 270 V ou pour une tension continue entre 100 et 350 V.

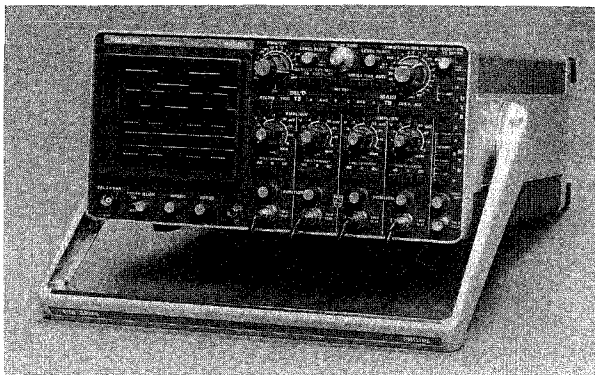


Fig. 1.1. Oscilloscope portatif à quatre voies PM 3244

## 1.2. CARACTERISTIQUES TECHNIQUES

Les spécifications sont valables après que l'appareil a été préchauffé pendant 15 minutes.

Les valeurs indiquées avec tolérance sont garanties. Les chiffres sans tolérance ne servent qu'à titre d'information et correspondent aux caractéristiques d'un appareil moyen.

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe I. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

| <i>Désignation</i>                         | <i>Spécification</i>  | <i>Information supplémentaire</i>   |
|--|---|---|
| <b>1.2.1. Tube à rayons cathodiques</b>    |   |   |
| Type                                       | PHILIPS D14-125 GH/08   | Tube à face rectangulaire, type domed mesh, post-accélérateur, couche phosphore doublée de métal  |
| Aire de mesure                             | 80 mm x 100 mm  |   |
| Type d'écran                               | Phosphore P31 (GH)  | en option, couche phosphore P11 (BE) ou P7 (GM)   |
| Vitesse d'écriture photographique          | ≥ 750 cm/μs   | Mesuré avec un appareil photographique Steinheil Oscillophot M5<br>Ouverture: 1:1,2<br>Rapport objet/image: 1:0,5<br>Film: Polaroid 410 (10000 ASA)<br>pas de pré-voilage<br>Phosphore du type P31 (GH) |
| Tension d'accélération totale              | 10 kV   |   |
| Graticule                                  | Divisions 8 x 10 cm avec subdivisions de 2 mm sur les axes centraux.  | Les lignes interrompues indiquent les points 10 % et 90 % pour la mesure du temps de montée.  |
| Illumination de graticule                  | Continuellement variable  | Luminosité maximale nettement visible dans les conditions d'éclairage normales de laboratoire.  |
| <b>1.2.2. Déviation verticale (Y)</b>      |   |   |
| Nombre de voies                            | 4   | Quatre voies identiques, A, B, C et D   |
| Modes d'affichage                          | Voie A seulement<br>Voie B seulement<br>Voie C seulement<br>Voie D seulement<br>Voies A+B additionnées<br>Voies C+D additionnées<br>Ces modes peuvent tous être découpés ou alternés.<br>Toutes les voies peuvent être inversées. |   |
| Temps d'affichage par voie en mode découpé | Environ 500 ns  | A partir de la version /03: 0,5 ou 2 μs, commutable. Voir fig. 3.18.  |
| Gamme de fréquence                         | Continu à 50 MHz<br><br>10 Hz à 50 MHz  | Couplage continu<br>Largeur de bande supérieure -3 dB<br>Couplage capacitif<br>Largeur de bande supérieure -3 dB  |
| Temps de montée                            | 7 ns  |   |
| Dépassement                                | ± 2 % max.  | Impulsion d'essai avec temps de montée 1 ns, déviation de 6 divisions et temps de répétition de 1 μs  |

| <i>Désignation</i>                        | <i>Spécification</i>                         | <i>Information supplémentaire</i>  |
|---|--|--|
| Coefficients de déviation                 | 5 mV/DIV à 2 V/DIV                           | En 9 positions étalonnées (progression 1-2-5), avec commande non-calibrée continue 1: $\geq 2,5$ par potentiomètre   |
| Précision                                 | $\pm 3 \%$                                   |  |
| Tension d'entrée                          | $\pm 400$ V max.                             | Tension continue + crête de tension alternative. En positions 5 mV/DIV à 20 mV/DIV de l'atténuateur d'entrée réduction de la tension d'entrée maximale admise à fréquences $> 500$ kHz. Voir Fig. 1.2. |
| Déviati on maximale                       | 24 divisions<br>$\geq 6$ divisions           | Pour tensions sinusoïdales jusqu'à 15 MHz<br>Pour tensions sinusoïdales de 15 MHz à 50 MHz   |
| Amplitude totale maxi en modes A-B et C-D | 24x réglage d'atténuateur                    | Atténuateurs en position CAL   |
| Gamme de décadrage                        | 16 divisions                                 |  |
| Réjection en mode commun                  | $\geq 100:1$ à 1 MHz                         | Après de réglage   |
| Diaphonie entre voies                     | 35 dB max.                                   | Pour toutes combinaisons d'atténuateurs. La référence est 6 div. d'amplitude (0 à 50 MHz), mode découpé.   |
| Instabilité, dérive de trace              | $\leq 0,3$ div/h à 20 °C                     | Après 15 min. de pré-chauffage   |
| Dérive de température                     | $\leq 60 \mu\text{V}/^\circ\text{C}$ typique |  |
| Balance d'atténuateur                     | $\leq 0,3$ div                               | En commutant entre positions d'atténuateur   |
| Entrée                                    |  |  |
| Impédance                                 | 1 Mohm//15 pF                                |  |
| Couplage                                  | AC-0-DC                                      |  |
| Temps RC                                  | 22 msec                                      | Commutateur de couplage sur "AC"   |
| Retard de signal visible                  | 20 nsec                                      |  |

### 1.2.3. Déviation horizontale (X)

|                   |  |   |
|-------------------|--|---|
| Modes d'affichage | <ul style="list-style-type: none"> <li>— Base de temps principale</li> <li>— Base de temps principale intensifiée par base de temps de retardée</li> <li>— Base de temps retardée</li> <li>— Fonctionnement X/Y</li> </ul> | Fonctionnement X/Y quatre traces avec déviation X par une des 4 voies verticales, un signal externe ou le signal d'alimentation |
|-------------------|--|---|

#### Amplificateur de déviation horizontale

|                          |   |  |
|--------------------------|---|--|
| Largeur de bande         | Continue à 1 MHz                                  | Sur 6 divisions<br>Limite supérieure $-3$ dB   |
| Coefficient de déviation | 450 mV/div<br>Coefficients d'atténuateur vertical | A l'aide de l'entrée EXT<br>S'appliquent lorsqu'une des voies verticales est utilisée à la déviation horizontale |
| Précision                | $\pm 10 \%$                                       | Utilisant un canal vertical pour déviation horizontal  |
| Impédance d'entrée       | 1 Mohm//15 pF                                     |  |



| <i>Désignation</i>   | <i>Spécification</i>  | <i>Information supplémentaire</i>   |
|--|---|---|
| Différence de phase entre ampl. de déviation vert. et ampl. de déviation horizontale | inférieure à 3°   | à 100 kHz   |
| Déviations par tension secteur   | 8 divisions   | La déviation dépend de la tension secteur et est réglée sur 8 DIV pour tension secteur 220 V à l'usine                          |
| <b>1.2.4. Base de temps principale</b>   |   |   |
| Fonctionnement   | Automatique<br>Déclenché<br>Balayage unique   | En mode automatique, la base de temps est en fonctionnement libre env. 100 ms. après la disparition du signal de déclenchement. |
| Coefficients de temps  | 0,5 s./DIV ... 50 ms./DIV   | En 22 positions étalonnées (progression 1-2-5)<br>Commande continue non-étalonnée<br>1 : $\geq$ 2,5                             |
| Précision  | $\pm$ 3 %   | $\pm$ 5 % pour 0,5 s./DIV et 0,2 s./DIV<br>$\pm$ 5 % pour 100 ns./DIV et 50 ms./DIV   |
| <b>1.2.5. Base de temps retardée</b>   |   |   |
|  | Démarré immédiatement après le temps de retard ou est déclenchable après le temps de retard |   |
| Coefficients de temps  | 1 ms./DIV ... 50 ns./DIV  | En 14 positions étalonnées (progression 1-2-5)<br>Commande continue non-étalonnée<br>1 : $\geq$ 2,5                             |
| Précision  | $\pm$ 3 %   | $\pm$ 5 % pour 100 ns./DIV et 50 ns./DIV  |
| <b>Agrandisseur de base de temps</b>   |   |   |
| Agrandissement   | x5  |   |
| Vitesse de balayage efficace maximale  | 10 nsec/DIV   |   |
| Tolérance supplémentaire   | $\pm$ 2 %   |   |
| <b>1.2.6. Déclenchement de la base de temps principale</b>                           |   |   |
| Source   | Interne<br>Composite<br>Secteur<br>Externe  | A partir de la voie A, B, C ou D  |
| Largeur de bande de déclenchement  | Continu à 50 MHz  | Limite supérieure -15 dB  |
| Sensibilité de déclenchement   | Interne $\leq$ 0,5 DIV<br>Externe $\leq$ 250 mV   | 0,3 DIV typique<br>150 mV typique   |
| Sélection de pente   | + ou -  |   |
| Impédance d'entrée pour déclenchement externe  | 1 Mohm//15 pF   | Identique pour chaque entrée de déviation verticale   |
| Tension d'entrée   | $\pm$ 400 V max.  | Tension continue + crête de tension alternative   |

**1.2.7. Déclenchement de la base de temps retardée**

Identique au déclenchement de la base principale sauf:

|   |   |  |
|---|---|--|
| Source                                      | Interne<br>Composite  | A partir de la voie A, B, C ou D                 |
| <b>Retard de balayage</b>                   |   |  |
| Temps de retard                             | Continuellement variable entre<br>0,3x et $\geq 10x$ le coefficient de<br>temps de la base de temps<br>principale | Réglable à l'aide d'un potentiomètre<br>10-tours |
| Erreur supplémentaire du<br>temps de retard | 0,5 %   |  |
| Jitter du temps de retard                   | $\leq 1 : 20.000$   |  |

**1.2.8. Unité d'étalonnage**

|            |  |                                |
|------------|--|--------------------------------|
| Tension    | 3 V <sub>CC</sub>                            | Onde carrée, ligne de base 0 V |
| Courant    | 6 mA   | Par le boucle de courant       |
| Précision  | $\pm 1 \%$                                   | Pour la tension et le courant  |
| Fréquence  | 2 kHz $\pm 2 \%$                             |                                |
| Protection | La sortie est exempte de<br>courts-circuits. |                                |

**1.2.9. Alimentation**

|                           |   |                              |
|---------------------------|---|------------------------------|
| Tensions secteur          | 90 ... 270 V en alternatif<br>ou 100 ... 350 V en continu | En une gamme                 |
| Fréquence secteur         | 46 ... 440 Hz ou continu                                  |                              |
| Fusible secteur incorporé | 1,6 A action différée                                     | Pour toutes tensions secteur |
| Consommation              | 29 W  |                              |

**1.2.10. Données d'environnement**

Les données d'environnement ne s'appliquent que lorsque l'appareil est contrôlé conformément aux processus officiels. Pour plus de détails sur ces processus et les critères de panne, s'adresser à l'organisation Philips locale ou à N.V. Philips' Gloeilampenfabrieken, Test and Measuring Department, Eindhoven, Holland.

|                                |  |  |
|--------------------------------|--|--|
| Température ambiante           | +5 °C ... +40 °C<br>-10 °C ... +55 °C<br>-40 °C ... +70 °C   | Gamme nominale d'utilisation<br>Gamme limite de fonctionnement<br>Gamme d'emmagasinage et de transport |
| Altitude                       | 5 000 m<br>15 000 m  | Fonctionnement<br>A l'arrêt  |
| Humidité                       | L'appareil répond aux normes<br>IEC 68 Db  |  |
| Choc                           | 1000 chocs de 10 g, ½ sinusoïde,<br>durée 6 ms, dans chacune des<br>trois directions                             |  |
| Vibration                      | 30 min. dans chacune des trois<br>directions, 10-150 Hz; 0,7 mm<br>crête-à-crête et 5 g accélération<br>maximale |  |
| Temps de rétablissement        | 30 minutes (en fonctionnement<br>normal)   | quand l'appareil passe de -10 °C à<br>+20 °C à 60 % d'humidité relative                                |
| Perturbation électromagnétique | L'appareil répond aux normes<br>VDE, Stögrad K   |  |

## 1.2.11. Caractéristiques mécaniques

|            |          |        |   |
|------------|----------|--------|---|
| Dimensions | Longueur | 410 mm | Non compris commandes, couvercle et pieds |
|            | Largeur  | 316 mm |   |
|            | Hauteur  | 154 mm |   |
| Poids      | 9,7 kg   |        |   |

## 1.2.12. Accessoires livrés avec l'appareil

Filtre de contraste  
Couvercle frontale avec remplacements pour accessoires  
Visière pliante PM 9366  
Adaptateur BNC banane PM 9051  
Borne CAL - Adaptateur BNC  
Notice d'emploi et d'entretien  
4x Sonde 10:1 PM 9350/PM 8927

## 1.2.13. Accessoires en option

|          |   |         |  |
|----------|---|---------|--|
| PM 9335  | Sonde 1:1, câble 1,5 m                        | PM 9353 | Sonde FET active 2:1<br>1 Mohm//3,5 pF       |
| PM 9335L | Sonde 1:1, câble 2,5 m                        | PM 9355 | Sonde de courant 12 Hz ... 70 MHz            |
| PM 9350  | Sonde 10:1, câble 1,5 m                       | PM 9346 | Alimentation de sonde                        |
| PM 9350L | Sonde 10:1, câble 2,5 m                       | PM 8960 | Jeu pour montage en rack 19"                 |
| PM 8927  | Sonde 10:1, câble 1,5 m                       | PM 8992 | Sacoche pour accessoires                     |
| PM 8927L | Sonde 10:1, câble 2,5 m                       | PM 9380 | Appareil de photographie<br>d'oscillogrammes |
| PM 9358  | Sonde 100:1, 5,6 kV max.<br>200 Mohm//2 pF    | PM 8971 | Adaptateur de caméra pour PM 9380            |
| PM 9347  | Sonde T.V. active, 10:1, 11 pF                | PM 8910 | Filtre Polaroid                              |
| PM 9352  | Sonde miniature active 10:1<br>100 kohm//6 pF | PM 8980 | Visière longue                               |
|          |   | PM 8901 | Jeu de batteries                             |
|          |   | PM 8991 | Chariot                                      |

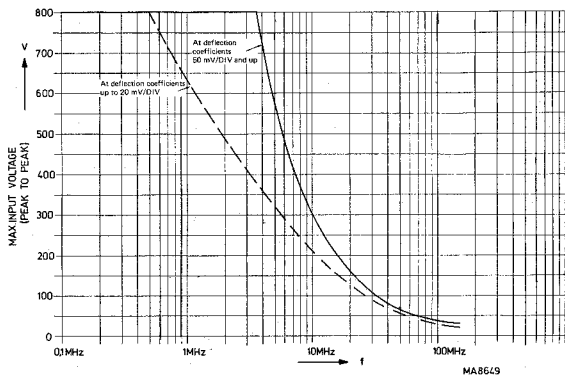
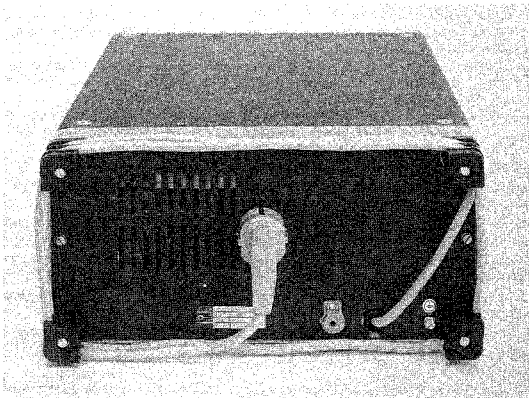


Fig. 1.2. Réduction de la tension d'entrée maximale en fonction de la fréquence



*Fig. 2.1. Dépose du couvercle frontal*



*Fig. 2.2. Vue arrière de l'appareil*

## 2. Mode d'emploi

### 2.1. INSTALLATION

#### 2.1.1. Démontage et montage du couvercle frontal

Démontage:

- Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED).
- Enlever le couvercle.

Montage:

- Tourner le bouton de verrouillage vers position UNLOCKED
- Fixer le couvercle sur la partie avant de l'oscilloscope.
- Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

*Remarque: Pour faire pivoter la poignée, il faut enfoncer les boutons-poussoirs aux étriers.*

**ATTENTION:** Le présent appareil produit des tensions élevées et ne peut donc pas être utilisé avec les plaques du châssis déposées. La fiche secteur doit être enlevée et tous les points haute tension déchargés avant de procéder à n'importe quel travail d'entretien.

Avant de procéder à toute autre connexion, la borne de terre de l'appareil doit être reliée à la ligne de terre du réseau (voir mise à la terre).

#### 2.1.2. Adaption à la tension secteur et fusible


La capacité d'utilisation à toute tension secteur comprise entre 90 et 270 V alternatif ou entre 100 et 350 V continu supprime la nécessité d'adapter le PM 3244 à la tension secteur locale.

La porte-fusible monté sur le panneau arrière porte un fusible à action retardée de 1,6 A (pour toute tension réseau).

S'assurer que des fusibles correctement calibrés et du modèle convenable sont utilisés en cas de remplacement. Il faut éviter d'utiliser des fusibles réparés et de court-circuiter des porte-fusibles. En cas de remplacement d'un fusible l'appareil doit être débranché de toutes sources de tension.

#### 2.1.3. Mise à la terre

Avant toute mise sous tension, l'appareil doit être connecté à la terre de l'une des manières suivantes:

- Par la borne de terre de l'appareil (symbole ).
- Par le cordon secteur à trois conducteurs. La fiche secteur ne doit être introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre.

**ATTENTION:** Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.

Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

#### 2.1.4. Démontage

L'ouverture des capots ou la dépose d'organes, à l'exception de ceux directement accessibles à la main sont susceptibles de mettre à jour des composants et des connecteurs sous tension.

L'appareil doit être débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d'entretien ou une réparation demandant l'ouverture de l'appareil.

Au cas où le réglage, l'entretien ou la réparation de l'appareil ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.

Le remplacement d'une fiche secteur se fait aux risques et périls de l'utilisateur. Après le remplacement d'une fiche secteur, un test haute tension conforme à la norme CEI 348 est fortement recommandé.

Ne pas oublier que les condensateurs à l'intérieur de l'appareil peuvent être chargés, même si l'appareil est déconnecté de toute source de tension.

#### 2.1.5. Enclenchement

Le commutateur POWER est incorporé dans la commande d'illumination de graticule ILLUM (panneau avant), juste sous le bord de l'écran.

L'oscilloscope ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé. Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'oscilloscope.

## 2.2. BOUTONS, DOUILLES ET LEURS FONCTIONS

### 2.2.1. Déviation verticale

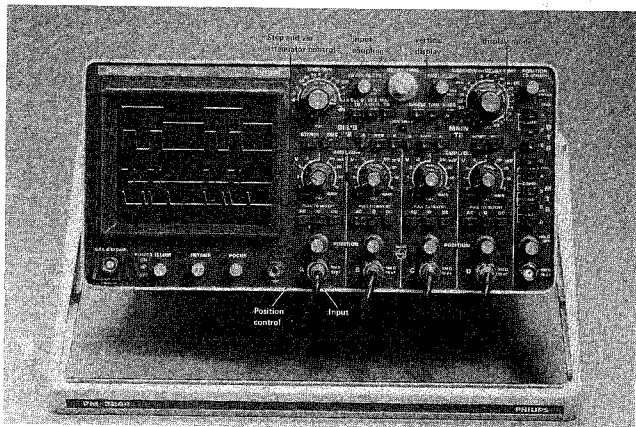


Fig. 2.3. Déviation verticale

#### 1. Sélecteur de déviation verticale

|             |   |
|-------------|---|
| Bouton A    | voie A                                  |
| Boutons A+B | voies A et B additionnés algébriquement |
| Bouton B    | voie B                                  |
| Bouton C    | voie C                                  |
| Boutons C+D | voies C et D additionnés algébriquement |
| Bouton D    | voie D                                  |

Toute combinaison des affichages précités est possible. Si aucun bouton n'est enfoncé, la voie A est enclenchée.

#### 2. CHOP-ALT commutateur

Les affichages mentionnés en peuvent être utilisés en mode découpé ou alterné, en fonction de la position du commutateur CHOP-ALT. Si aucun bouton n'est enfoncé et que deux voies ou plus sont enclenchées, l'affichage est en mode découpé.

#### 3. Commandes d'atténuateur

|                                  |  |
|----------------------------------|--|
| AMPL/DIV                         | Commande échelonnée des coefficients de déviation combinée avec:   |
| AMPL/CAL                         | Commande continûment variable des coefficients de déviation. Si ce bouton est tiré, la polarité de voie est inversée.  |
| Commutateur de couplage d'entrée | AC Couplage de signal par l'intermédiaire d'un condensateur de blocage<br>0 Entrée de voie connectée à la terre; charge interrompue<br>DC Couplage direct<br>Si aucun bouton n'est enfoncé, AC est obtenu. |
| POSITION                         | Commande continûment variable indiquant le décalage vertical de la voie en question.   |

#### COMMANDES DE PRE-REGLAGE

|      |  |
|------|--|
| BAL  | Equilibrage de l'atténuateur par échelons            |
| GAIN | Etalonnage d'amplitude de l'atténuateur par échelons |

## 2.2.2. Déviation horizontale

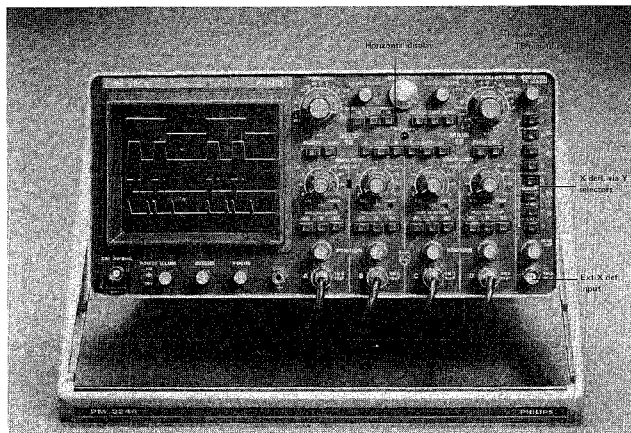


Fig. 2.4. Déviation horizontale

## 1. Sélecteur de déviation horizontale

MAIN TB

La déviation horizontale est fournie par le générateur de base de temps principale. Une partie de l'affichage est intensifié lorsque la base de temps retardée est mise en service.

EXT X DEFL

La déviation horizontale est obtenue à partir d'un signal externe provenant :

- de la borne d'entrée de l'amplificateur horizontal
- d'une des voies de déviation verticale
- du réseau

DEL'D TB

La déviation horizontale est fournie par le générateur de base de temps retardée. Si aucun bouton n'est enfoncé, la base de temps principale est enclenchée.

## 2. Positionnement et agrandisseur de base de temps

POSITION

Commande continûment variable pour décadrage horizontal de l'affichage

TB MAGN

Commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 5. Cet effet est nul en mode EXT X DEFL.

## 2.2.3. Base de temps principale

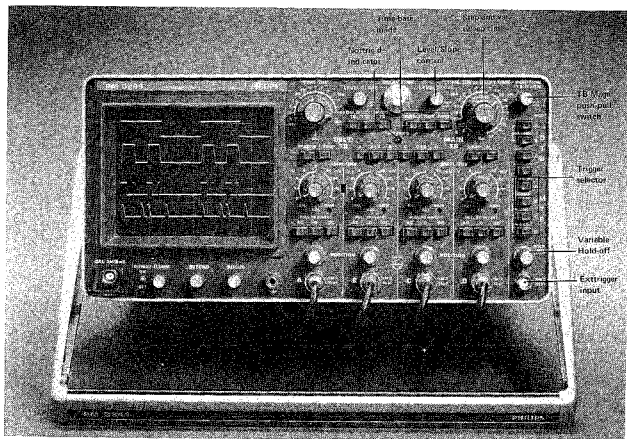


Fig. 2.5. Base de temps principale

1. Sélecteur de base de temps principale
 

|                                       |   |
|---------------------------------------|---|
| <p>AUTO</p> <p>TRIG</p> <p>SINGLE</p> | <p>Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.</p> <p>Le générateur de base de temps est déclenché normalement.</p> <p>Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulsion de déclenchement.</p> <p>Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.</p> |
|---------------------------------------|---|
2. Commutateur TIME/DIV or DELAY
 

|                     |  |
|---------------------|--|
| <p>TIME/DIV CAL</p> | <p>Commande par échelons des coefficients de temps pour la base de temps principale; commutateur rotatif à 22 positions.</p> <p>Si la base de temps retardée est en service, le temps de retard, à l'issue duquel la base de temps démarre, est égal au réglage étalonné DELAY TIME x le coefficient TIME/DIV de ce commutateur.</p> <p>Commande continûment variable des coefficients de temps.</p> |
|---------------------|--|
3. LEVEL/SLOPE
 

|  |   |
|--|---|
|  | <p>Commande continûment variable pour sélectionner le niveau de déclenchement auquel le générateur de base de temps démarre.</p> <p>Le commutateur "push-pull" permet de choisir le déclenchement soit sur la pente positive, soit sur la pente négative du signal.</p> |
|--|---|
4. Indicateur NOT TRIG'D
 

|  |  |
|--|--|
|  | <p>S'allume lorsque le générateur de base de temps principale n'est pas déclenché.</p> |
|--|--|
5. Sélecteur de source de déclenchement de la base de temps principale
 

|  |   |
|--|---|
|  | <p>Ce commutateur comporte quatre boutons (A, B, C et D) servant à sélectionner le signal de déclenchement en provenance d'une des voies de déviation verticale. Lorsque les boutons A et B sont enfoncés, le signal de déclenchement composite est sélectionné. Lorsque les boutons B et C sont enfoncés, une partie de la tension réseau sert de signal de déclenchement. Lorsque les boutons C et D sont enfoncés, le signal appliqué au connecteur EXT sert de signal de déclenchement. Si aucun bouton n'est enfoncé, le signal de déclenchement A est disponible.</p> |
|--|---|



## 2.2.4. Base de temps retardée

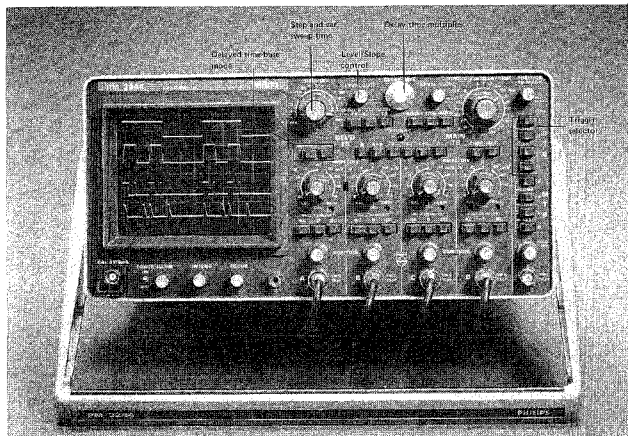


Fig. 2.6. Base de temps retardée

1. Commutateur TIME/DIV  
 Commande par échelons des coefficients de temps pour la base de temps retardée; commutateur rotatif à 14 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclenchée.  
 TIME/DIV CAL  
 Commande continûment variable des coefficients de la base de temps.
2. DELAY TIME  
 Potentiomètre étaonné à 10 tours pour ajuster le temps de retard, après quoi la base de temps retardée est mis hors service. Ce temps de retard est égal au réglage DELAY TIME x le coefficient TIME/DIV de la base de temps principale.
3. STARTS/TRIG  
 Lorsque le bouton STARTS est enfoncé, la base de temps retardée démarre immédiatement après le temps de retard, car elle ne requiert aucun signal de déclenchement.  
 Lorsque le bouton TRIG est enfoncé, la base de temps retardée démarre à la réception d'une impulsion de déclenchement après le temps de retard. Si aucun bouton n'est enfoncé, on obtient le même effet que STARTS enfoncé.
4. LEVEL/SLOPE  
 Commande continûment variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement.
5. Sélecteur de source de déclenchement de la base de temps retardée  
 Ce commutateur comporte quatre boutons (A, B, C et D) servant à sélectionner le signal de déclenchement en provenance d'une des voies de déviation verticale. Lorsque les boutons A et B sont enfoncés, le signal de déclenchement composite est sélectionné.  
 Si aucun bouton n'est enfoncé, le signal de déclenchement A est disponible.

## 2.2.5. Tube à rayons cathodiques

### 1. POWER/ILLUM

Commande continûment variable de l'illumination de graticule; comprend le commutateur secteur. La lampe témoin indique la position ON.

### 2. INTENS

Commande continûment variable pour la brillance de la trace.

### 3. FOCUS

Commande continûment variable pour la focalisation du faisceau.

#### Divers

### 1. CAL

Douille de sortie pour étalonnage:

- du gain de l'amplificateur de déviation verticale
  - de la compensation de fréquence des sondes atténuatrices
- Appropriée pour sondes de tension et de courant.

## 2.3. REGLAGES PRELIMINAIRES

Avant de procéder à des mesures à l'aide du présent oscilloscope, vérifier si l'équilibrage et l'étalonnage de gain de l'atténuateur par échelons sont adéquatement ajustés pour toutes les voies.

Au besoin, procéder comme suit:

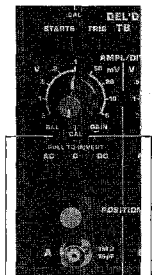
### 1. Equilibrage continu de l'atténuateur par échelons

- Enfoncer le bouton MAIN TB du sélecteur de déviation horizontale.
  - Enfoncer le bouton AUTO du sélecteur de base de temps principale.
  - Régler les commandes INTENSITY et FOCUS afin d'obtenir une trace nette et fine.
  - Enfoncer le bouton de voie appropriée du sélecteur de déviation verticale.
  - Enfoncer le bouton 0 du commutateur de couplage d'entrée.
  - Régler le bouton POSITION de telle sorte que la trace se trouve quelque part au centre de l'écran.
  - Mettre la commande continue AMPL sur CAL.
  - Vérifier si la trace ne saute pas lorsque le commutateur AMPL est tourné.
- Au besoin, ajuster la commande BAL.
- Répéter ce processus pour chaque voie.

### 2. Etalonnages du gain

A moins qu'indiqué différemment, les commandes occupent les mêmes positions que pendant le processus décrit ci-avant.

- Mettre le commutateur AC-0-DC en position AC.
  - Régler la commande AMPL sur .5 V et la commande continue sur CAL.
  - Connecter l'entrée de voie à la sortie CAL.
  - Vérifier si la déviation verticale est de 6 divisions exactement.
- Au besoin, régler la commande GAIN.
- Une sonde atténuatrice peut également être incluse à cet étalonnage.
- Dans ce cas, il faut tenir compte du facteur d'atténuation de la sonde en fonction de la position du commutateur AMPL.
- Répéter ce processus pour chaque voie.



Att. step balance

Gain calibration

## 2.4. INSTRUCTIONS DE COMMANDE

### 2.4.1. Généralités

Avant d'enclencher l'appareil, s'assurer que l'oscilloscope est réglé conformément aux recommandations d'installation (section 2.1.) et que les précautions décrites ont été observées.

### 2.4.2. Déviation verticale

Pour représenter les voies requises, il faut enfoncer les boutons correspondants du sélecteur de déviation verticale. Si deux traces ou plus sont affichées, l'affichage peut se faire soit en mode découpé, soit en mode alterné.

En mode alterné, les voies sont affichées successivement; pendant le retour du spot de la base de temps principale, l'affichage est commuté d'une voie à l'autre. En mode découpé, les voies sont commutées de l'une à l'autre pendant le balayage de la base de temps.

Le temps d'affichage en mode découpé est d'environ 500 ns. A partir de la version /03: 0,5 ou 2  $\mu$ s, commutable, voir fig. 3.18.

Pour obtenir un affichage constant on utilise généralement le mode alterné à grandes vitesses de balayage et le mode découpé à petites vitesses de balayage.

A remarquer qu'en mode de déclenchement composite, il faut choisir le mode alterné, si non les impulsions de découpage exerceraient une certaine influence sur le circuit de déclenchement.

Les signaux observés sont appliqués aux prises d'entrées A ... D et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.

Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

Les commandes de positionnement permettent de décadrer l'affichage en sens vertical. A remarquer qu'en mode de déclenchement composite le point de démarrage du déclenchement est également influencé par la commande de position verticale.

#### 2.4.3. Déviation horizontale

Selon la position du sélecteur de déviation horizontale, la déviation peut être fournie par:

- la base de temps principale
- une source de signal externe
- la base de temps retardée

La commande de positionnement avec agrandisseur de base de temps permet de décadrer l'affichage en sens horizontal.

Si le bouton MAIN TB or DEL'D TB est enfoncé, la déviation horizontale est déterminée par la base de temps principale ou par la base de temps retardée. Au cas où le bouton EXT X DEFL est enfoncé, la déviation horizontale peut être obtenue à partir:

- d'une des voies de déviation verticale A, B, C ou D
- de la tension réseau (secteur)
- d'une source externe par l'intermédiaire du connecteur EXT.

#### 2.4.4. Base de temps principale

La déviation horizontale linéaire est obtenue lorsque le bouton MAIN TB de l'affichage horizontal commuté est enfoncé.

Le mode de base de temps est choisi à l'aide du sélecteur de base de temps principale.

##### AUTO

- La base de temps fonctionne librement, même si aucune impulsion de déclenchement n'est disponible.

La trace reste visible.

Le mode AUTO peut être choisi dans tous les cas où le mode TRIG est applicable, sauf pour des fréquences inférieures à 10 Hz ou des trains d'impulsions ayant un temps supérieur à 100 ms.

Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre de la base de temps est automatiquement achevé et le générateur est déclenché normalement.

##### TRIG

- La base de temps est visible lorsque des impulsions de déclenchement sont disponibles et que le niveau de déclenchement est exact.

##### SINGLE

- La base de temps n'effectue qu'un balayage à la réception d'une impulsion de déclenchement. Ensuite, la base de temps doit être remise à zéro en enfonçant à nouveau le bouton SINGLE. Lorsque des effets uniques sont observés (par exemple par photographie), il faut s'assurer qu'un seul balayage est engendré, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question.

#### 2.4.5. Déclenchement

Si un ou plusieurs signaux doivent être affichés, le balayage de la base de temps doit toujours être démarré en un point fixe du signal afin d'obtenir un affichage stationnaire.

A cet effet, le générateur de base de temps est démarré par des impulsions de déclenchement dérivées des sources suivantes, en fonction de la position du sélecteur de source de déclenchement pour base de temps principale:

- une des voies de déviation verticale A, B, C ou D
- un signal composite
- la tension réseau
- une source de tension externe.

Les amplitudes des signaux de déclenchement provenant d'une des voies de déviation verticale ou du signal composite sont proportionnelles à la déviation verticale de l'affichage, car dépendant des réglages de l'atténuateur d'entrée.

Pour le déclenchement composite, les boutons A et B doivent être enfoncés. Dans ce mode, le signal de déclenchement est pris de l'amplificateur de déviation verticale commune. Le déclenchement de signal composite se caractérise par:

- a. Le déclenchement par signaux différentiels, par ex. si l'appareil est en mode A+B, l'une des tensions d'entrée étant inversées.
- b. Deux à quatre signaux de fréquences différentes et sans rapport, qui peuvent être affichés.

Dans ce cas, les points de déclenchement des différents signaux doivent se trouver dans la même gamme de niveau de déclenchement.

- Remarque:*
- Lorsque le déclenchement est en mode composite, l'affichage doit toujours se faire en mode alterné. En mode découpé, les impulsions de découpage fonctionnent comme impulsions de déclenchement et l'affichage est instable.
  - En mode de déclenchement composite, le point de déclenchement du signal dépend également de la commande POSITION verticale. Pour déclenchement composite en alternatif (AC) une petite modification décrite à la section 3.2.2. (seulement en Anglais) résout ce problème.

Le déclenchement réseau s'effectue en enfonçant les boutons B et C.

La base de temps principale est déclenchée par une partie de la tension réseau (secteur). Le couplage avec la tension réseau est obtenue par un circuit opto-isolateur incorporé, de sorte que l'appareil reste isolé de la tension réseau.

Le déclenchement externe s'effectue en enfonçant les boutons C et D.

La base de temps principale est alors déclenchée par un signal externe appliqué par l'intermédiaire du connecteur EXT.

La commande LEVEL permet de sélectionner le point de déclenchement sur la pente du signal.

Le commutateur "push-pull" SLOPE permet de sélectionner la pente positive ou négative.

Si le générateur de base de temps principale ne reçoit aucune impulsion de déclenchement, le témoin NOT TRIG'D s'allume. En mode de balayage SINGLE, ce témoin s'allume lorsque le générateur de base de temps a été remis à zéro et est en position d'attente (impulsion de déclenchement suivante).

Le temps de balayage de la base de temps principale est réglé à l'aide du bouton TIME/DIV or DELAY TIME. Si la base de temps retardée est enclenchée, le temps entre le démarrage du balayage de base de temps principale et celui de la base de temps retardée est déterminé par le bouton à 10 tours DELAY TIME (1) et le commutateur du temps de balayage pour la base de temps principale (2): temps = réglage (1) x réglage (2). Le bouton central permet d'ajuster les temps de balayage de la base de temps entre les échelons. Pour les mesures de temps, ce bouton doit toujours être en position CAL.

Le coefficient TIME/DIV de la base de temps peut être accru d'un facteur 5 en tirant le bouton "push-pull" TB MAGN.

La commande HOLD OFF permet de faire varier le temps de blocage du générateur de base de temps principale. Il s'agit du temps dont le générateur a besoin pour être prêt à la réception de l'impulsion de déclenchement suivante. La commande HOLD OFF permet l'affichage constant de signaux plus complexes, comme par exemple les impulsions périodiques doubles.

La position extrême droite est considérée comme la position normale de la commande HOLD OFF. En position extrême gauche, le temps de blocage est étendu.

#### 2.4.6. Base de temps retardée

Si le bouton MAIN TB pour affichage horizontal est enfoncé et que le bouton TIME/DIV de la base de temps retardée n'est pas en position OFF, une partie de la ligne de balayage pour base de temps principale est affichée à intensité accrue.

Le moment de démarrage de la base de temps retardée est déterminé par les réglages du bouton TIME/DIV de la base de temps principale et du bouton à 10 tours DELAY TIME. Si le bouton STARTS du sélecteur de base de temps retardée est enfoncé, la base de temps retardée démarre immédiatement après ce temps de retard.

Si le bouton TRIG est enfoncé, la base de temps retardée est démarrée après ce temps de retard et à la réception d'une impulsion de déclenchement.

Le sélecteur de déclenchement de la base de temps retardée présente les mêmes possibilités que le sélecteur de la base de temps principale sauf pour le déclenchement secteur et externe.

La commande LEVEL/SLOPE a la même fonction que décrite pour la base de temps principale.

Le temps de balayage de la partie intensifiée du balayage de base de temps principale dépend de la position du bouton TIME/DIV de la base de temps retardée.

Le bouton central permet d'ajuster le temps de balayage entre les échelons. Pour les mesures de temps, ce bouton doit toujours être en position CAL.

Si le bouton DEL'D TB du sélecteur de déviation horizontale est enfoncé, la partie intensifiée du balayage de base de temps principale est représentée sur l'écran tout entier.

## Service data



The heart of the channel selection logic is formed by six D-type flip-flops, which are connected in cascade. They are housed in three integrated circuits, type SN74LS74N, indicated IC206, 209 and 214 on the schematic diagram (Fig. 3.11). A brief explanation of their operation is as follows:

Every flip-flop has two outputs: Q (pin 5 or 9) and the inverse of Q (pin 6 or 8). The information applied to the D (= data) input (pin 2 or 12) is transferred to output Q on the positive transition of the clock input (pin 3 or 11). The flip-flop is set in the case where Q is high, and therefore contains a "1". The flip-flop is reset in the case where Q is low, and contains a "0". The clear input (pin 1 or 13) is active when low and makes Q low independently of the clock or D input signal. The preset input is not used and is connected to +5 V.

The row of the six flip-flops represents the six modes: channel A, channel A and B added, channel B, channel C, channel C and D added, channel D. For identification, these flip-flops are marked in the block diagram FFa, FFa+b, FFb, FFc, FFc+d, FFd. All flip-flops receive the same clock-pulses. The flip-flops can be selected with the corresponding display mode switches SK12B ... SK17B. As these switches function independently, any display combination is possible. When one channel is selected, the corresponding flip-flop is continuously set. When more channels are selected, the "1" jumps on every positive clock transition of the clock inputs, to the next selected flip-flop in the row. From the last selected flip-flop the "1" jumps to the first selected flip-flop in the row. The channel selection logic has provisions to eliminate errors such as an unwanted set or reset of a flip-flop due to interference.

### 3.2.4. Block Diagram Description – Channel Selection Logic

The flip-flops can be selected with SK12B ... SK17B. Except for SK12B, these switches produce directly in their OFF position a "clear" command to the associated flip-flops so that their inverse output is high. The clear for FFa is given by the block CLEAR CIRCUIT FFa. The six inputs of this block are connected with the display mode switches SK12B ... SK17B.

This block only produces a clear signal for FFa if SK12B is in the OFF position and at least one of the other switches SK13B ... SK17B is in the ON position. This provision activates channel A if none of the display mode switches is depressed.

The six flip-flops are connected in cascade. The D inputs of FF (a+b) ... FFd are connected to the inverse outputs of the preceding flip-flops via five identical blocks SET/PRESET FF (a+b) ... SET/RESET FFd. The function of such a block is explained for the block SET/RESET FFc for the two possible situations:

- The preceding FFb is not selected (SK 14B closed): the signal on the D input of FFb is routed to the D input of FFc.
- The preceding FFb is selected (SK14B open): the signal on the D input of FFb is not routed to the D input of FFc. The signal on the D input of FFc now depends on the condition of FFb. If FFb is set, the D input of FFc is high and if FFb is reset the D input of FFc is low.

Because of this provision the "1" jumps on every positive clock transition, to the next selected flip-flop in the row.

From the last selected flip-flop the "1" jumps to the first selected flip-flop in the row by means of the block SET/RESET FFa. As this block incorporates the elimination of errors facility it is rather complex.

It has twelve inputs that are connected to:

- The output of FFa
- The inverse outputs of FF (a+b), FFb, FFc, FF (c+d).
- SK 13B ... SK 17B and the inverse of SK13B ... SK16B.

The block generates a high output signal in order to set FFa under the following conditions:

- At the end of a cycle when the last selected flip-flop in the row will be reset at the next positive clock transition to appear.
- In the case where a flip-flop is reset by unwanted interference signals: i.e. if a "1" is lost.
- In the case where more than one flip-flop in the selected row has been set due to interference and the "1" will leave the last selected at the next clock-pulse.

Because of the above-mentioned provisions a potential error has been eliminated when the first selected flip-flop is set at the start of a new cycle.

The inverse outputs of the six flip-flops control the channels via four 2-input Nand gates. These Nand gates are designated CH. A, CH. B, CH. C and CH. D after the channels they control.

When FFa, FFb, FFc or FFd is set, one input of the relevant Nand gate becomes low; so its output becomes high and respectively switches channel A, B, C or D on.

When FF(a+b) or FF(c+d) is set, two Nand gate outputs become high together to achieve the addition of two channels.



The clock inputs of the six flip-flops are connected to the output of the CLOCK PULSE SELECTOR. Depending on the position of the chopped/alternate switch SK18A, this block selects either the output signal of the CHOPPER OSCILLATOR or the output signal of the block ALTERNATE PULSE ON/OFF. Moreover, in the chopped mode, the selector sends the inverted clock-pulses to the input of the BLANKING PULSE SHAPER. This block now generates a positive blanking pulse during the low-to-high transition of the clock inputs of the flip-flops, so that during the switching from one channel to another the display is blanked. The CHOPPER OSCILLATOR produces a square-wave of about 2 MHz if SK201 is open and 0,5 MHz if SK201 is closed. The oscillator is switched off by means of SK18A in the alternate mode. Present from /03 version: older versions have a fixed 2 MHz frequency.

Both the blocks CHOPPER OSCILLATOR and ALTERNATE PULSE ON/OFF can be switched off by the block CLOCK PULSE ON/OFF. The output depends on the inputs as follows:

- a. Six inputs are connected to SK12A ... SK17A. As indicated in the block diagram these contacts are operated by the same front-panel push-buttons as SK12B ... SK17B. If more than one channel is selected, more than one input is connected to earth and the output becomes high, so that the clock-pulses are switched on.
- b. Four inputs are connected to the outputs of the Nand gates that drive the channel switches in the vertical intermediate amplifiers. If none of the flip-flops is set, no channel is selected and the four inputs are low. If in this situation only 1 channel has been selected, the situation remains unless clock-pulses are applied to the flip-flops in order to set the selected flip-flop. So if all four inputs are low the clock-pulses are switched on. They are switched off if one input becomes high because the selected flip-flop has been set.

As discussed, the chopper oscillator and alternate pulses are switched off if they are not needed. This is done to limit transmission of interference caused by these signals.

### 3.2.5. Circuit Description – Channel Selection Logic (Fig. 3.11)

This circuit description explains how the various blocks work and outlines their contents in relation to the schematic diagram.

#### *Test hint*

When troubleshooting it may be easy in some cases to observe the change of voltage levels on certain gates and flip-flops after each clock-pulse. This can be done by using the instrument in alternate and single-shot mode. Every time the single-shot control is operated a clock-pulse is generated at the end of the MTB sweep (MTB triggered by mains unit).

#### *Clear Circuit FFa*

The "clear" signal for FFa is made by TS203, Nor gate IC217/8,9,10 and inverter IC203/3,4. Transistor TS203 has a high collector voltage if the display mode switches SK13B ... SK17B are in the off position so that this transistor does not receive any base current.

SET/RESET FF(a+b) ... SET/RESET FFd: every block contains two Nand gates; as there are five identical blocks, ten Nand gates are needed. These Nand gates are located in the circuit diagram just above the row of six flip-flops. The block SET/RESET FFc, which is built up with the Nand gates IC207/9,10,8 and IC211/4,5,6 operates as follows:

- a. With SK14B in the off position (closed) both Nand gates function as an inverter and the voltage level on the D input of FFb is fed through to the D input of FFc.
- b. With SK14B in the on position (open) output 8 of IC207 is high. Now IC211/4,5,6 inverts the inverse output of FFb. Consequently, if FFb is set, output 6 of IC211 is high and if FFb is reset, output 6 of IC211 is low.

#### *SET/RESET FFa*

The heart of this circuit is formed by five Nand gates of the open collector type with one common collector load resistor R203. These Nand gates form a so-called wire Or, which makes the D input signal for FFa. The Nand gates, which are marked RN (= resistor not), are IC208/1,2,3, IC208/4,5,6, IC208/9,10,8, IC208/12,13,11 and IC213/9,10,8.

The output of this wired-Or is only high if the output of all separate Nand gates are high. One input of each Nand gate is directly controlled by one of the switches SK13B ... SK17B.

The remaining input of IC208/1,2,3 is controlled by the output of FFa. The remaining other four inputs are controlled by two Nand gates each. They are located on the schematic diagram just below the five open collector Nand gates.

The conditions under which the output of the block SET/RESET FFa becomes high, have already been detailed in the block diagram description.

#### *Chopper oscillator*

The Nand gates IC202/1,2,3 and IC202/4,5,6 form the chopper oscillator because of the RC feedback circuit with R201, R202, C201, C202 and C200. Capacitor C200 can be connected in parallel with C202 by means of SK201. The oscillator frequency is 2 MHz (SK201 open) or 0,5 MHz (SK201 closed). Described as present from /03 version. Older versions: C200 and SK201 not present.

The oscillator can be switched off by applying a low level to input 2 of IC202 (in alternate mode) or to input 5 of IC202 (in single channel mode).

#### *Alternate pulse ON/OFF*

This block is formed by Nand gate IC201/4,5,6. The alternate pulse which is low during the MTB hold-off period is applied to input 4 of IC201. The pulse can be blocked by applying a low level to input 2 of IC201 (in single channel mode).

#### *Clock pulse selector*

This block contains three Nand gates IC202/12,13,11, IC201/1,2,3 and IC201/12,13,11.

In the chopped mode, a low level is applied to input 1 of IC201 so that alternate pulses are blocked. Output 11 of IC201 sends chopper pulses to the clock inputs of the flip-flops. In the alternate mode a low level is applied to input 13 of IC202 so that chopper pulses are blocked. Output 11 of IC201 sends alternate pulses to the clock inputs of the flip-flops.

#### *Blanking pulse shaper*

Transistor TS202 and matched components form this block.

The transistor normally conducts and its collector voltage is therefore low. Via R204 and C204, TS202 receives a negative pulse on its base during the low-to-high transition of the clock pulse. Now this transistor is non-conductive for a period determined by R204 and C204 and its collector voltage is high. Present from /03 version. Older versions: pulse shaper contains 2 capacitor coupled amplifier stages. The input of this pulse shaper is connected to output 6 of IC202.

#### *Clock pulse ON/OFF*

This circuit is located in the lower left hand corner of the schematic diagram. When two or more channels (SK12A ... SK17A) are selected (switches closed) the base of transistor TS204 is so low that it is blocked. Its collector then becomes high. This collector signal is inverted by means of IC217/11,12,13. Resistors R233 ... R239 are located on the switch unit SK12A ... SK17A (see Fig. 3.20).

The output of this Nand gate is low if two or more channels are switched on, and causes output 8 of Nand gate IC201 to be high. If this output is high clock-pulses are applied to the flip-flops.

Independent of the number of chosen display modes, there is another command which switches the clock-pulses on. This command is made by the Nor gates IC217/5,6,4 and IC217/2,3,1 and the Nand gate IC213/12,13,11. It becomes active if all outputs of the channel selection logic are low (if all flip-flops are reset). In this case output 11 of IC213 is low, and the clock-pulses are switched on.

The logic circuit draws more current in the chopped mode than in the alternate mode. This difference could cause unwanted drift in other parts of the instrument. The trimming potentiometer R220 and R215 between +5 V and contact 3 of SK18A (chopped/alternate switch) compensate for this difference.

R220 must be adjusted to maximum chopped/alternate balance. Present from /03 version: older versions do not have this compensation.

### **3.2.6. Trigger Source Selector (Fig. 3.12)**

This unit switches the triggering signal from the desired source through to the MTB and DTB trigger amplifiers. These sources are the trigger pick-off amplifiers of the channels A, B, C, D and composite in the intermediate amplifier, the external input amplifier and the mains trigger amplifier. These are selected by SK21 for the MTB and SK10 for the DTB. The signals from the four channels and the composite signal are fed to five identical input circuits. The circuit explanation is given for channel A only.

The current from the pick-off amplifier in channel A is equally divided between the emitters of TS751 and TS752. Resistors R751 and R754 make the current division more independent of the emitter base voltages of TS751 and TS752.

Transistor TS751 is able to pass its collector signal to the base of TS704 if the diodes GR751 and GR753 conduct. These diodes conduct if their cathodes are connected via R753 and SK21 to  $-12$  V. Diode GR752 does not conduct in this situation. The base of TS704 is held at  $-6$  V by means of GR709 and R727. The collector signal of TS704 is applied to the MTB trigger amplifier by means of emitter-follower TS706. The output voltage of this emitter-follower is adjusted to earth potential by means of the adjustable current sources in the pick-off amplifiers.

If the cathodes of GR751 and GR753 are floating because SK21 does not apply R753 to any potential, the collector current flows through GR752 and the triggering signal of channel A does not reach the MTB trigger amplifier.

The circuit comprising TS752 is able to pass its collector signal to the base of TS707 in order to trigger the DTB. This happens if GR754 and GR757 are made conductive by applying their cathodes to  $-12$  V via R757 and SK10. The signal on the collector of TS707 is applied to the DTB trigger amplifier by means of emitter-follower TS708. The output voltage of this transistor is not separately adjustable to earth potential as described for TS706.

The signal on the external input (BU4) is applied to the base of emitter-follower TS701 via a voltage dividing network. This transistor is followed by TS702, which gives base current to TS704 if GR703 and GR704 conduct. These diodes conduct if their cathodes are applied to  $-12$  V by means of R714, R705 and SK21. Resistor R705 permits adjustment of the output voltage of TS706. Diode GR702 conducts if GR703 and GR704 are non-conductive.

The signal from the mains trigger unit on the power supply reaches the base of TS703. The collector signal of this transistor is applied to the base of TS704 if GR707 and GR708 are conducting. These diodes conduct if their cathodes are connected to  $-12$  V via TS705 and R720.

This occurs if TS705 receives base current via R719 and R715, which is connected to earth via SK21. Because of a limitation of SK21, only an earth potential command for mains triggering is available and it is converted by means of TS705 into a  $-12$  V command. Switch SK21 gives  $-12$  V to R773 in the mains trigger mode (SK21B and SK21C both depressed). Diode GR771 becomes conductive in this situation and channel C is not switched on.

The DTB trigger pulses are blocked in the STARTS mode, when they are not needed. This is done by applying  $-12$  V to R735, which is otherwise floating. Moreover, contact 10 A/2 is now floating; this contact is otherwise connected to  $-12$  V.

The  $+6$  V supply for the trigger source selector is stabilised by means of TS709, GR712 and GR713. The changes in voltage due to variations of ambient temperature of these semiconductors compensate each other. This stabilisation prevents crosstalk of unselected trigger signals via the internal resistance of the power supply.

### 3.3. DISMANTLING THE INSTRUMENT

In addition to the procedures described in the PM 3240 manual, the removal of the trigger source selector p.c.b. and some pushbutton switch units is explained.

#### 3.3.1. Removal of Trigger Source Selector

1. Remove the bottom cover plate.
2. Remove shaft and knob from hold-off potentiometer by removing coupling piece.
3. Unsolder six leads and one coaxial cable from underside of p.c.b.
4. Loosen screw in front plate and screws in hold-off potentiometer support. When re-assembling this support remember to connect solder tag of hold-off potentiometer cable screening to earth.
5. Remove the top cover plate.
6. Remove shaft and knob from POSITION potentiometer by removing coupling piece.
7. Remove support of POSITION potentiometer by means of two screws.
8. Unsolder six leads and five coaxial cables from top-side of p.c.b.
9. Loosen hexagonal front-panel screw and clamping piece.

#### 3.3.2. Removal of the Pushbutton Units: SK8, SK9 and SK11 ... SK18

First remove the top cover plate for access to these switch units. As these switch units and the DELAY TIME multiplier are interconnected by means of several wires, care should be taken when removing these controls to ensure that these interconnections are not damaged.

1. Unscrew, with the tool indicated in Fig. 3.8 of the PM 3240 manual, two screws in the front plate in order to release the mounting piece of the LEVEL potentiometers.
2. Remove the DELAY TIME multiplier.
3. Remove the SK8, SK9 unit by unscrewing two hexagonal screws and removing two clamping pieces. In this situation it is also possible to remove the NOT TRIG'D LED indicator GR1.
4. Remove knobs from MTB and DTB switches.
5. Remove MTB and DTB switch units (unplug attached Stocko plugs on time base p.c.b).
6. Remove the SK11 ... SK18 unit by unscrewing four hexagonal screws and removing four clamping pieces.

### 3.4. ADJUSTING PROCEDURE

In addition to the adjusting procedure in the basic PM 3240 manual, the following adjustments can be carried out. For adjustment points see Fig. 3.17 and 3.18.

#### 3.4.1. Normal/Invert Balance

- Depress buttons A, B, C, D of the vertical display switch.
- Adjust the following potentiometers so that the corresponding trace does not jump when the 'PULL TO INVERT' switch is operated.
  - ch. A : R448
  - ch. B : R2648
  - ch. C : R2848
  - ch. D : R2448

These potentiometers are located on the intermediate amplifier unit.

#### 3.4.2. A+B Balance

- Depress buttons A, A+B and B of the vertical display switch.
- Shift the three traces so that they are superimposed on each other, using the ch. A and ch. B POSITION controls on the front panel.
- Adjust potentiometer R548 (located on the intermediate amplifier unit) so that the trace is on the horizontal centre-line of the graticule.

The C+D balance is now also correct.

#### 3.4.3. Chopped/Alternate Balance (present from /03 version)

Adjust R220 on the channel selection unit so that the voltage on R212 does not change when switching between chopped and alternate mode. Measure the voltage on R212 with a sensitive instrument: e.g. an oscilloscope.

#### 3.4.4. Chopper Frequency Adjustment (present from /03 version)

A display of 0,5  $\mu$ s or 2  $\mu$ s can be selected with the miniature slider switch SK201 on the channel selection unit. The 0,5  $\mu$ s position gives high resolution at fast single-shot displays. The 2  $\mu$ s position gives increased brightness at high sweep speeds.

#### 3.4.5. Trigger Balance

- Depress pushbutton A of the vertical display switch.
- Depress pushbutton MAIN TB of the horizontal display switch.
- Set TB MAGN. to x1 position.
- Depress pushbutton AUTO of the main timebase mode switch.
- Set main timebase sweep to 0,5 ms/DIV.
- Depress pushbutton A of the main timebase trigger source switch.
- Set input coupling switches of all vertical deflection channels in position D.
- Adjust horizontal POSITION control on the front panel so that the trace starts at the extreme left-hand graticule line.
- Adjust channel A POSITION so that the trace is on the horizontal centre graticule line.
- Depress button EXT X DEFL of the horizontal display switch.
- Adjust potentiometer R379 (intermediate amplifier unit) so that the spot is in the centre of the graticule.
- Depress pushbutton B of the main timebase trigger source switch.
- Adjust potentiometer R2579 (intermediate amplifier unit) so that the spot is in the centre.
- Depress pushbutton C of the main timebase trigger source switch.

- Adjust potentiometer R2779 (intermediate amplifier unit) so that the spot is in the centre.
- Depress pushbutton D of the main timebase trigger source switch.
- Adjust potentiometer R2379 (intermediate amplifier unit) so that the spot is in the centre.
- Depress both pushbuttons A and B (for comp.) of the main timebase trigger source switch.
- Adjust potentiometer R531 (trigger source selector unit) so that the spot is in the centre.
- Depress both C and D pushbuttons (for EXT) of the main timebase trigger source switch.
- Adjust potentiometer R705 (trigger source selector unit) so that the spot is in the centre.
- Depress both B and C pushbuttons (for LINE) of the main timebase trigger source switch.
- Select the value for R715 (7,15 ... 9,53 kohms) so that mains deflection is symmetrical around the centre of the graticule.

### 3.4.6. Delay-Time Calibration

(Start- and stop-potentiometers R987 and R979 are located on the small p.c. board underneath the c.r.t.)

- Set the delayed timebase sweep to .1 ms/DIV.
- Set the main timebase sweep to 1 ms/DIV.
- Depress pushbutton MAIN TB of the horizontal display switch.
- Depress pushbutton STARTS of the delayed timebase mode switch.
- Depress pushbutton A of the vertical display switch.
- Depress pushbutton A of the main timebase trigger source switch.
- Apply a 1 ms squarewave signal to the channel A input.
- Set the DELAY TIME multiplier dial knob to 1,00.
- Adjust 'start' potentiometer R987 (front-panel side) so that the beginning of the intensified part of the trace coincides with the beginning of the 2nd period.
- Set the DELAY TIME multiplier dial knob to 9,00.
- Adjust 'stop' potentiometer R979 so that the beginning of the intensified part of the trace coincides with the beginning of the 9th period.
- Repeat both adjustments for optimum results.

### 3.4.7. Attenuator adjustment

The /02 and /03 versions have been equipped with different attenuators, that are however mechanically interchangeable. The input capacitance and 10 kHz square wave compensation are equivalent for both types of attenuators.

Adjustment points that are different for both types are discussed briefly. These points are located on the bottom side of the unit.

#### /02 version

##### Variable Gain Balance (R128)

- Centre the timebase line, using the POSITION control.
- Adjust R128 (output DC offset compensation) to minimal timebase line jump when operating the CONT Gain Control.

#### /03 version (see Fig. 3.18)

##### LF Gain Adjustment (R132)

Besides the adjustment points in the intermediate amplifier the attenuators have a LF GAIN adjustment point R132. To be sure that the attenuator unit is well adjusted connect an oscilloscope to its output.

Apply a 100 Hz square wave signal to the input of the unit and adjust R132 if necessary. The attenuator has in the 5 mV/div. position an attenuation of 1,25x.

The attenuator output must have its normal load of approx. 50 ohms; for instance the intermediate amplifier.

##### DC/0 Balance (R129)

- Put R141 (output DC offset compensation) in its mid position.
- Set the AMPL/DIV switch to 5 mV/div.
- Depress alternately the DC and 0 coupling switches and adjust R129 to minimal time base line jump.

***Variable Gain Balance (R141)***

Identical to adjustment procedure of R128 in /02 version.

***100 kHz Square-wave Response Adjustment (C122)***

Besides the 100 kHz adjustment points in the intermediate amplifier the attenuators have a 100 kHz adjustment trimmer C122. This trimmer works on all attenuator positions. To be sure that the attenuator unit is well adjusted connect an oscilloscope with a bandwidth of 50 MHz or more to the output of the attenuator and set C122 to maximum square wave response. The attenuator output must have its normal load of approx. 50 ohms (for instance the intermediate amplifier). The attenuator has in the 5 mV/div position an attenuation of 1,25x.

## 3.5. PARTS LISTS

## 3.5.1. Mechanical parts list (addition to PM 3240 list)

| <i>Item</i> | <i>Ordering code</i> | <i>Description</i>             |
|-------------|----------------------|--------------------------------|
| —           | 5322 459 84021       | Inner plate of front cover box |
| —           | 5322 455 84064       | Text plate PM 3244             |
| —           | 5322 459 24071       | Cast aluminium front profile   |

## 3.5.2. Various parts

| <i>Ordering code</i> | <i>Description</i>             |
|----------------------|--------------------------------|
| 5322 320 44033       | Delay line                     |
| 5322 277 24053       | Slider switch SK201 logic unit |
| 5322 216 64258       | Time base unit                 |
| 5322 216 64259       | Delay time calibration unit    |
| 5322 414 34147       | Ten turn dial                  |
| 5322 216 54116       | Power supply unit              |
| 5322 218 64045       | Mains filter                   |
| 5322 216 64257       | Transistor unit TS1804 (BD232) |
| 5322 462 54138       | C.R.T. shield                  |

## 3.5.3. Unit list (addition to PM 3240 list)

| <i>Item</i> | <i>Ordering code</i> | <i>Description</i>           |
|-------------|----------------------|------------------------------|
| Unit 2      | 5322 105 44001       | Attenuator                   |
| Unit 12     | 5322 216 64261       | Intermediate amplifier unit  |
| Unit 14     | 5322 216 64263       | Channel selection logic unit |
| Unit 16     | 5322 216 64262       | Trigger source selector unit |

## 3.5.4. Electrical parts lists (Complete)

*Transistors*

| <i>Type</i> | <i>Ordering code</i> | <i>Remark</i> | <i>Encapsulation</i> | <i>Quantity in one set</i> |
|-------------|----------------------|---------------|----------------------|----------------------------|
| BC327       | 4822 130 40854       |               | T0-92                | 1                          |
| BC547       | 5322 130 44257       |               | T0-92                | 1                          |
| BC549       | 4822 130 40964       |               | T0-92                | 76                         |
| BC549C      | 5322 130 44246       |               | T0-92                | 8                          |
| BC557       | 5322 130 44256       |               | T0-92                | 1                          |
| BC559       | 4822 130 40963       |               | T0-92                | 19                         |
| BC559B      | 5322 130 44358       |               | T0-92                | 1                          |
| BCY71       | 5322 130 40373       |               | T0-18                | 2                          |
| BD136       | 5322 130 40712       |               | T0-126               | 3                          |
| BD137       | 5322 130 40664       |               | T0-126               | 1                          |
| BD262       | 5322 130 44357       |               | T0-126               | 1                          |
| BDY93/01    | 5322 130 44105       |               | T0-3                 | 1                          |
| BF199       | 5322 130 44154       |               | T0-96                | 14                         |
| BF324       | 5322 130 44396       |               | T0-96                | 27                         |
| BF336       | 4822 130 40908       |               | T0-39                | 2                          |
| BFS17       | 5322 130 40781       | Mark: E1      | SOT-23               | 7                          |
| BFS17R      | 5322 130 44338       | Mark: E4      | SOT-23               | 5                          |
| BFW44       | 5322 130 40672       |               | T0-39                | 2                          |
| BFY90       | 5322 130 40493       |               | T0-72                | 9                          |
| BRY39       | 5322 130 40482       | Thyristor     | T0-72                | 1                          |

| Type    | Ordering code  | Remark       | Encapsulation | Quantity in one set |
|---------|----------------|--------------|---------------|---------------------|
| BSW68   | 5322 130 40714 |              | T0-39         | 1                   |
| BSX20   | 5322 130 40417 |              | T0-18         | 5                   |
| BSX21   | 5322 130 40321 |              | T0-18         | 4                   |
| BSX60   | 5322 130 44019 |              | T0-39         | 1                   |
| CNY43   | 5322 130 44395 | Photocoupler | SOT-91B       | 1                   |
| FW5324  | 5322 130 40142 |              | T0-18         | 2                   |
| FW5497  | 5322 130 40673 |              | T0-18         | 2                   |
| 2N2894  | 5322 130 40018 |              | T0-18         | 3                   |
| 2N2894A | 5322 130 44127 |              | T0-18         | 1                   |
| 537-BSY | 5322 130 44359 | Mark: B3     | SOT-23        | 1                   |
| BFT25R  | 5322 130 44459 | Mark: V4     | SOT-23        | 4                   |
| BFR92R  | 5322 130 44606 | Mark: P4     | SOT-23        | 4                   |
| ON471   | 5322 130 44605 | Mark: M3     | SOT-23        | 4                   |

*Integrated circuits*

| Type           | Ordering code  | Remark                    | Encapsulation | Quantity in one set |
|----------------|----------------|---------------------------|---------------|---------------------|
| SN74LS00N      | 5322 209 84983 | Quad 2 input<br>nand gate | 14 PIN DIL    | 7                   |
| SN74LS02N      | 5322 209 84993 | Quad 2 input<br>nor gate  | 14 PIN DIL    | 1                   |
| SN74LS03N      | 5322 209 85265 | Quad 2 input<br>nand gate | 14 PIN DIL    | 2                   |
| SN74LS04N      | 5322 209 84984 | Hex inverter              | 14 PIN DIL    | 1                   |
| SN74LS74N      | 5322 209 84986 | Dual D flip-flop          | 14 PIN DIL    | 3                   |
| 4022 105 25160 | 5322 209 84424 | Impedance converter       |               | 4                   |
| QO002          | 5322 209 84355 | Transistor-diode array    | SOT-43        | 11                  |
| TAA521/709HC   | 5322 209 84452 | Operational amplifier     | T0-99         | 1                   |
| TBA281/LM723CH | 5322 209 84899 | Voltage regulator         | T0-100        | 1                   |
| LM208T         | 5322 209 85475 | Precision Op Amp          | T0-99         | 4                   |
| 4022 105 25430 | 5322 111 94032 | TF circuit                | -             | 4                   |

*Diodes*

| Type      | Ordering code  | Remark           | Encapsulation | Quantity in one set |
|-----------|----------------|------------------|---------------|---------------------|
| BA182     | 5322 130 30644 |                  | SOD-23        | 2                   |
| BAV45     | 5322 130 34037 |                  | T0-18         | 4                   |
| BAW62     | 5322 130 30613 |                  | D0-35         | 90                  |
| BAX12     | 5322 130 30424 |                  | SOD-17        | 14                  |
| BAX17     | 5322 130 30605 |                  | SOD-17        | 6                   |
| BY206     | 4822 130 30839 |                  | D0-14         | 9                   |
| BYX10     | 5322 130 30195 |                  | D0-14         | 1                   |
| BYX55/600 | 4822 130 30817 |                  | SOD-18        | 1                   |
| CQY24A    | 5322 130 34595 | LED              | -             | 2                   |
| BY179     | 5322 130 30521 | Bridge rectifier | SOD-28        | 1                   |
| BY409     | 5322 130 34594 |                  | SOD-34        | 6                   |
| AAZ15     | 5322 130 30229 | Germanium diode  | D0-7          | 2                   |
| BR100     | 4822 130 20039 | Trigger device   | D0-14         | 1                   |



*Voltage reference diodes*

| <i>Type</i> | <i>Ordering code</i> | <i>Remark</i> | <i>Encapsulation</i> | <i>Quantity in<br/>one set</i> |
|-------------|----------------------|---------------|----------------------|--------------------------------|
| BZX61C13    | 5322 130 30771       |               | SOD-22               | 1                              |
| BZX61C47    | 5322 130 30585       |               | SOD-22               | 1                              |
| BZX61C75    | 5322 130 34034       |               | SOD-22               | 1                              |
| BZX75C1V4   | 5322 130 34047       |               | D0-7                 | 1                              |
| BZX75C2V8   | 5322 130 34048       |               | D0-7                 | 2                              |
| BZX75C3V6   | 5322 130 30765       |               | D0-7                 | 1                              |
| BZX79C4V7   | 5322 130 30773       |               | D0-35                | 1                              |
| BZX79C5V6   | 5322 130 34173       |               | D0-35                | 5                              |
| BZX79C6V8   | 5322 130 30768       |               | D0-35                | 1                              |
| BZX79B7V6   | 4822 130 30861       |               | D0-35                | 2                              |
| BZX79B8V2   | 5322 130 34382       |               | D0-35                | 2                              |
| BZX79B9V1   | 5322 130 30667       |               | D0-35                | 1                              |
| BZX79C9V1   | 5322 130 30667       |               | D0-35                | 1                              |
| BZX79C10    | 5322 130 34297       |               | D0-35                | 2                              |
| BZX79C47    | 5322 130 34383       |               | D0-35                | 1                              |
| BZX79B62    | 5322 130 34384       |               | D0-35                | 2                              |
| BZY88C3V3   | 5322 130 30392       |               | D0-7                 | 1                              |

| ITEM              | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS        |
|-------------------|-----------------|-------|---------|-------|----------------|
| <u>CAPACITORS</u> |                 |       |         |       |                |
| C 101             | 5322 125 64009  | 3PF   |         | 500   | TRIMMER        |
| C 102             | 5322 125 64015  | 4.5PF |         | 500   | TRIMMER        |
| C 103             | 5322 123 34001  | 30PF  | 10      | 300   | MICA           |
| C 104             | 4872 121 40278  | 22NF  | 10      | 400   | POLYESTER FOIL |
| C 105             | 4872 122 31041  | 3.3PF | 0+25PF  | 100   | CERAMIC PLATE  |
| C 106             | 4872 122 31203  | 39PF  | 2       | 500   | CERAMIC PLATE  |
| C 107             | 5322 125 64012  | 1.5PF |         | 500   | TRIMMER        |
| C 108             | 5322 125 64014  | 3PF   |         | 500   | TRIMMER        |
| C 109             | 5322 125 64009  | 3PF   |         | 500   | TRIMMER        |
| C 111             | 5322 125 64015  | 4.5PF |         | 500   | TRIMMER        |
| C 112             | 5322 123 10188  | 300PF | 10      | 300   | MICA           |
| C 113             | 4872 122 30103  | 22NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 114             | 4872 122 30103  | 22NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 115             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 116             | 4872 122 30103  | 22NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 117             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 118             | 4872 122 31081  | 100PF | 2       | 100   | CERAMIC PLATE  |
| C 119             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 121             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 201             | 4872 122 30027  | 1NF   | 10      | 100   | CERAMIC PLATE  |
| C 202             | 4872 122 30135  | 820PF | 10      | 100   | CERAMIC PLATE  |
| C 203             | 4872 122 30053  | 680PF | 10      | 100   | CERAMIC PLATE  |
| C 204             | 4872 122 31085  | 150PF | 2       | 100   | CERAMIC PLATE  |
| C 205             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 206             | 4872 124 20467  | 1.5UF | -10+50  | 16    | ELECTROLYTIC   |
| C 208             | 4872 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 209             | 4872 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 211             | 4872 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 212             | 4872 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 213             | 4872 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 214             | 4872 122 31222  | 220PF | 2       | 100   | CERAMIC PLATE  |
| C 216             | 4872 122 31222  | 220PF | 2       | 100   | CERAMIC PLATE  |
| C 217             | 4872 122 31222  | 220PF | 2       | 100   | CERAMIC PLATE  |
| C 218             | 4872 122 31222  | 220PF | 2       | 100   | CERAMIC PLATE  |
| C 376             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 377             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 379             | 4872 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE  |
| C 381             | 4872 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE  |
| C 382             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 401             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 402             | 4872 125 50045  | 22PF  |         | 100   | TRIMMER        |
| C 403             | 4872 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 404             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 405             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 406             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 407             | 4872 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 408             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 409             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 410             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 411             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 412             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 413             | 4872 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 414             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 415             | 4872 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE  |
| C 416             | 4872 125 50045  | 22PF  |         | 100   | TRIMMER        |
| C 417             | 4872 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE  |
| C 420             | 4872 122 31058  | 1.5PF | 2       | 100   | CERAMIC PLATE  |
| C 423             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 424             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 425             | 4872 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE  |
| C 426             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 427             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 428             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 429             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 432             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 501             | 4872 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE  |
| C 504             | 4872 124 20467  | 1.5UF | -10+50  | 16    | ELECTROLYTIC   |
| C 506             | 4872 124 20467  | 1.5UF | -10+50  | 16    | ELECTROLYTIC   |

| ITEM  | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS        |
|-------|-----------------|-------|---------|-------|----------------|
| C 507 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 508 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 509 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 511 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 514 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 516 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 517 | 4822 122 30045  | 27PF  | 2       | 100   | CERAMIC PLATE  |
| C 518 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 521 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 522 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 523 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 524 | 4822 122 31063  | 22PF  | 2       | 100   | CERAMIC PLATE  |
| C 526 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 527 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 531 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 532 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 533 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 534 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 536 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 537 | 4822 124 20467  | 15UF  | -10-50  | 16    | ELECTROLYTIC   |
| C 601 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 602 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 603 | 4822 125 50045  | 22pF  |         | 100   | TRIMMER        |
| C 604 | 4822 122 31074  | 56PF  | 2       | 100   | CERAMIC PLATE  |
| C 605 | 4822 122 30045  | 27PF  | 2       | 100   | CERAMIC PLATE  |
| C 606 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER        |
| C 607 | 4822 122 30103  | 22NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 608 | 4822 122 30027  | 1NF   | 10      | 100   | CERAMIC PLATE  |
| C 609 | 4822 122 31116  | 2+2NF | 10      | 100   | CERAMIC PLATE  |
| C 614 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 616 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 618 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 619 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 621 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 622 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 623 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 624 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 626 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 627 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 628 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 629 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 631 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 632 | 4822 121 41161  | 100NF | 10      | 250   | POLYESTER FOIL |
| C 633 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE  |
| C 634 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 651 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 652 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 653 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 701 | 4822 122 31202  | 33PF  | 2       | 500   | CERAMIC PLATE  |
| C 703 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 704 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 705 | 4822 122 31195  | 10PF  | 2       | 500   | CERAMIC PLATE  |
| C 706 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 707 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 708 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 709 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 711 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 712 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 713 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 714 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 715 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 716 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 717 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 751 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 752 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 761 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 762 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 771 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 772 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |
| C 781 | 4822 122 30043  | 10NF  | -20-80  | 40    | CERAMIC PLATE  |

| ITEM   | ORDERING NUMBER | FARAD  | TOL (%) | VOLTS | REMARKS          |
|--------|-----------------|--------|---------|-------|------------------|
| C 782  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 791  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 792  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 801  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 802  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 803  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 804  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 805  | 4822 122 31036  | 2.2PF  | 0+25PF  | 100   | CERAMIC PLATE    |
| C 806  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 807  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 808  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 809  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 850  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 851  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 852  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 853  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 854  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 855  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 856  | 4822 122 31061  | 18PF   | 2       | 100   | CERAMIC PLATE    |
| C 857  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 858  | 4822 124 20483  | 6.8UF  | -10+50  | 40    | ELECTROLYTIC     |
| C 859  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 860  | 4822 122 31047  | 5.6PF  | 0+25PF  | 100   | CERAMIC PLATE    |
| C 861  | 4822 122 31061  | 18PF   | 2       | 100   | CERAMIC PLATE    |
| C 862  | 4822 122 30114  | 2.2NF  | 10      | 100   | CERAMIC PLATE    |
| C 863  | 4822 124 20459  | 22UF   | -10+50  | 10    | ELECTROLYTIC     |
| C 864  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 865  | 5322 121 54076  | 453PF  | 1       | 250   | POLYSTYRENE FOIL |
| C 867  | 5322 121 40224  | 4.7UF  | 10      | 100   | POLYESTER FOIL   |
| C 868  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 869  | 5322 121 54108  | 47NF   | 1       | 63    | POLYSTYRENE FOIL |
| C 871  | 5322 121 14072  | 330NF  |         | 35    | ROX              |
| C 872  | 4822 122 30034  | 470PF  | 10      | 100   | CERAMIC PLATE    |
| C 873  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 874  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 876  | 4822 122 30103  | 22NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 878  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 879  | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 881  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 882  | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1001 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1002 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1003 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1004 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1005 | 4822 122 31036  | 2.2PF  | 0+25PF  | 100   | CERAMIC PLATE    |
| C 1006 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1007 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1008 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1009 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1051 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1052 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1053 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1054 | 4822 124 20467  | 15UF   | -10+50  | 16    | ELECTROLYTIC     |
| C 1055 | 4822 122 31061  | 18PF   | 2       | 100   | CERAMIC PLATE    |
| C 1057 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1058 | 4822 122 31061  | 18PF   | 2       | 100   | CERAMIC PLATE    |
| C 1059 | 5322 121 54076  | 453PF  | 1       | 250   | POLYSTYRENE FOIL |
| C 1060 | 4822 122 31047  | 5.6PF  | 0+25PF  | 100   | CERAMIC PLATE    |
| C 1061 | 5322 121 54108  | 47NF   | 1       | 63    | POLYSTYRENE FOIL |
| C 1062 | 4822 122 30034  | 470PF  | 10      | 100   | CERAMIC PLATE    |
| C 1063 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1064 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1066 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1067 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1068 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1069 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1201 | 4822 122 30043  | 10NF   | -20+80  | 40    | CERAMIC PLATE    |
| C 1202 | 4822 122 31215  | 0.68PF | 0+25PF  | 100   | CERAMIC PLATE    |
| C 1203 | 4822 125 50077  | 5.5PF  |         | 100   | TRIMMER          |
| C 1204 | 4822 122 31116  | 2.2NF  | 10      | 500   | CERAMIC PLATE    |

| ITEM   | ORDERING NUMBER | FARAD    | TOL (%) | VOLTS | REMARKS          |
|--------|-----------------|----------|---------|-------|------------------|
| C 1205 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1206 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1207 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1208 | 4822 125 50077  | 5.5 PF   |         | 100   | TRIMMER          |
| C 1209 | 4822 122 31215  | 0.68PF   | 0+25PF  | 100   | CERAMIC PLATE    |
| C 1211 | 4822 122 31116  | 2+2NF    | 10      | 500   | CERAMIC PLATE    |
| C 1212 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1213 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1214 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1216 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1301 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1302 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1303 | 4822 122 30104  | 1PF      | 0+25PF  | 100   | CERAMIC PLATE    |
| C 1304 | 4822 122 30043  | 10NF     | -20+80  | 40    | CERAMIC PLATE    |
| C 1306 | 4822 122 30054  | 1+2NF    | 10      | 100   | CERAMIC PLATE    |
| C 1307 | 4822 122 30098  | 3+9NF    | 10      | 100   | CERAMIC PLATE    |
| C 1308 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1309 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1310 | 4822 121 40406  | 15NF     | 10      | 250   | POLYESTER FOIL   |
| C 1311 | 4822 122 31081  | 100PF    | 2       | 100   | CERAMIC PLATE    |
| C 1312 | 5322 122 54006  | 3+3NF    | -20+50  | 3K    | CERAMIC DISK     |
| C 1313 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1314 | 5322 122 54006  | 3+3NF    | -20+50  | 3K    | CERAMIC DISK     |
| C 1316 | 4822 124 20468  | 33UF     | -10+50  | 16    | ELECTROLYTIC     |
| C 1317 | 5322 121 40233  | 680NF    | 10      | 100   | POLYESTER FOIL   |
| C 1318 | 4822 121 50611  | 20NF     | 1       | 63    | POLYSTYRENE FOIL |
| C 1319 | 4822 124 20468  | 33UF     | -10+50  | 16    | ELECTROLYTIC     |
| C 1401 | 4822 124 20497  | 15UF     | -10+50  | 63    | ELECTROLYTIC     |
| C 1402 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1403 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1404 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1406 | 5322 122 54006  | 3+3NF    | -20+50  | 3K    | CERAMIC DISK     |
| C 1407 | 4822 121 40363  | 10NF     | 10      | 1600  | POLYESTER FOIL   |
| C 1416 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1417 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1418 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1419 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1421 | 5322 122 54004  | 470PF    | 20      | 4K    | CERAMIC DISK     |
| C 1801 | 5322 121 44142  | 220NF    | 10      | 250   | POLYESTER FOIL   |
| C 1802 | 5322 122 44009  | 2+2NF    | 20      | 250   | CERAMIC DISK     |
| C 1803 | 5322 122 44009  | 2+2NF    | 20      | 250   | CERAMIC DISK     |
| C 1804 | 5322 121 44142  | 220NF    | 10      | 250   | POLYESTER FOIL   |
| C 1806 | 4822 124 40066  | 50+50 UF |         | 400   | ELECTROLYTIC     |
| C 1807 | 4822 124 20324  | 4UF      | -10+30  | 400   | ELECTROLYTIC     |
| C 1808 | 4822 124 20324  | 4UF      | -10+30  | 400   | ELECTROLYTIC     |
| C 1809 | 4822 124 20306  | 50UF     | -10+30  | 100   | ELECTROLYTIC     |
| C 1810 | 4822 124 20581  | 220UF    | -10+50  | 4     | ELECTROLYTIC     |
| C 1811 | 4822 121 40427  | 220NF    | 10      | 100   | POLYESTER FOIL   |
| C 1812 | 4822 124 20583  | 1UF      | -10+50  | 63    | ELECTROLYTIC     |
| C 1814 | 4822 124 20467  | 15UF     | -10+50  | 16    | ELECTROLYTIC     |
| C 1816 | 4822 124 20461  | 47UF     | -10+50  | 10    | ELECTROLYTIC     |
| C 1817 | 4822 121 40443  | 680NF    | 10      | 250   | POLYESTER FOIL   |
| C 1818 | 4822 121 41161  | 100NF    | 10      | 100   | POLYESTER FOIL   |
| C 1819 | 4822 122 30094  | 220PF    | 10      | 100   | CERAMIC PLATE    |
| C 1821 | 4822 124 20459  | 27UF     | -10+50  | 10    | ELECTROLYTIC     |
| C 1822 | 4822 121 41161  | 100NF    | 10      | 100   | POLYESTER FOIL   |
| C 1823 | 4822 124 20587  | 100UF    | -10+50  | 25    | ELECTROLYTIC     |
| C 1824 | 4822 121 41169  | 220NF    | 10      | 250   | POLYESTER FOIL   |
| C 1826 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1827 | 4822 124 20457  | 470UF    | -10+50  | 6+3   | ELECTROLYTIC     |
| C 1828 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1829 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1830 | 4822 121 40298  | 47NF     | 10      | 1600  | POLYESTER FOIL   |
| C 1831 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1832 | 4822 121 41161  | 100NF    | 10      | 250   | POLYESTER FOIL   |
| C 1833 | 4822 124 20497  | 15UF     | -10+50  | 63    | ELECTROLYTIC     |
| C 1834 | 4822 124 20497  | 15UF     | -10+50  | 63    | ELECTROLYTIC     |
| C 1836 | 4822 124 20469  | 68UF     | -10+50  | 16    | ELECTROLYTIC     |
| C 1837 | 4822 124 20469  | 68UF     | -10+50  | 16    | ELECTROLYTIC     |
| C 1838 | 4822 124 20469  | 68UF     | -10+50  | 16    | ELECTROLYTIC     |

| ITEM   | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| C 1839 | 4822 124 20469  | 6RUF  | -10+50  | 16    | ELECTROLYTIC  |
| C 1841 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1842 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1843 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1844 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1846 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1847 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1848 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 1849 | 4822 124 20454  | 150UF | -10+50  | 6.3   | ELECTROLYTIC  |
| C 2376 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2377 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2379 | 4822 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE |
| C 2381 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2382 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2401 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2402 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2403 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2404 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2405 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2406 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2407 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2408 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2409 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2410 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2411 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2412 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2413 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2414 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2415 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2416 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2417 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2420 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2423 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2424 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2425 | 4822 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE |
| C 2426 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2427 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2428 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2429 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2432 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2576 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2577 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2579 | 4822 122 30048  | 1.8NF | 10      | 100   | CERAMIC PLATE |
| C 2580 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2581 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2582 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2601 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2602 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2603 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2604 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2605 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2606 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2607 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2608 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2609 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2610 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2611 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2612 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2613 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2614 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2615 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2616 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2617 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2620 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2623 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2624 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2625 | 4822 122 30099  | 3.3NF | 10      | 100   | CERAMIC PLATE |
| C 2626 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2627 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2628 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |

| ITEM   | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| C 2629 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2632 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2776 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2777 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2779 | 4822 122 30048  | 1+RNF | 10      | 100   | CERAMIC PLATE |
| C 2781 | 4822 122 31072  | 47PF  | 2       | 100   | CERAMIC PLATE |
| C 2782 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2801 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2802 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2803 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2804 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2805 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2806 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2807 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2808 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2809 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2810 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2811 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2812 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2813 | 4822 122 31054  | 10PF  | 2       | 100   | CERAMIC PLATE |
| C 2814 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2815 | 4822 122 30091  | 390PF | 2       | 100   | CERAMIC PLATE |
| C 2816 | 4822 125 50045  | 22PF  |         | 100   | TRIMMER       |
| C 2817 | 4822 122 31061  | 18PF  | 2       | 100   | CERAMIC PLATE |
| C 2820 | 4822 122 31058  | 15PF  | 2       | 100   | CERAMIC PLATE |
| C 2823 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2824 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2825 | 4822 122 30099  | 3+3NF | 10      | 100   | CERAMIC PLATE |
| C 2826 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2827 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2828 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2829 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |
| C 2832 | 4822 122 30043  | 10NF  | -20+80  | 40    | CERAMIC PLATE |

| ITEM      | ORDERING NUMBER | OHM   | TOL (%) | TYPE  | REMARKS                  |
|-----------|-----------------|-------|---------|-------|--------------------------|
| RESISTORS |                 |       |         |       |                          |
| R 1       | 5322 101 44014  | 100K  | 20      |       | CARBON POTM LIN + SWITCH |
| R 2       | 5322 103 64016  | 5K    | 5       | 2W    | WIRE-WOUND POTENTIOMETER |
| R 3       | 5322 101 44014  | 100K  | 20      |       | CARBON POTM LIN + SWITCH |
| R 4       | 5322 101 44015  | 50K   | 20      |       | CARBON POTM LIN + SWITCH |
| R 5       | 5322 101 40041  | 4+7K  | 20      | 0.25W | CARBON POTM LIN + SWITCH |
| R 6       | 5322 101 40041  | 4+7K  | 20      | 0.25W | CARBON POTM LIN + SWITCH |
| R 7       | 5322 101 74005  | 10K   | 20      | 0.1W  | CARBON POTM LOG + SWITCH |
| R 8       | 5322 101 24046  | 100   | 20      | 0.1W  | CARBON POTM LIN          |
| R 9       | 5322 101 34016  | 47K   | 20      | 0.1W  | CARBON POTM LOG          |
| R 10      | 5322 101 24108  | 500R  | 1       |       | CARBON POTM LIN          |
| R 11      | 5322 101 24091  | 47K   | 20      | 0.1W  | CARBON POTM LIN          |
| R 12      | 5322 101 24055  | 25K   | 20      |       | CARBON POTM LIN          |
| R 13      | 5322 101 34018  | 4+7K  | 20      | 0.1W  | CARBON POTM LOG          |
| R 14      | 5322 101 24062  | 2+2M  | 20      | 0.1W  | CARBON POTM LIN          |
| R 101     | 4822 111 30067  | 33    | 5       | CR16  | CARBON                   |
| R 102     | 5322 116 55021  | 920K  | 0.25    |       | METAL FILM               |
| R 103     | 5322 111 30383  | 68    | 5       | CR16  | CARBON                   |
| R 104     | 5322 116 55067  | 88+9K | 0.25    | MR24C | METAL FILM               |
| R 106     | 4822 111 30245  | 47    | 5       | CR16  | CARBON                   |
| R 107     | 5322 116 54892  | 200K  | 0.25    |       | METAL FILM               |
| R 108     | 5322 116 55023  | 800K  | 0.25    |       | METAL FILM               |
| R 109     | 4822 111 30309  | 560   | 5       | CR16  | CARBON                   |
| R 111     | 4822 111 30309  | 560   | 5       | CR16  | CARBON                   |
| R 112     | 4822 111 30069  | 39    | 5       | CR16  | CARBON                   |
| R 113     | 5322 116 55022  | 92K   | 0.25    |       | METAL FILM               |
| R 114     | 5322 116 55066  | 8+08K | 0.25    | MR24C | METAL FILM               |
| R 116     | 5322 111 30383  | 68    | 5       | CR16  | CARBON                   |
| R 118     | 5322 116 50592  | 442   | 1       | MR25  | METAL FILM               |
| R 119     | 5322 116 50592  | 442   | 1       | MR25  | METAL FILM               |
| R 121     | 4822 111 30347  | 10    | 5       | CR16  | CARBON                   |
| R 122     | 4822 111 30304  | 150K  | 5       | CR16  | CARBON                   |
| R 123     | 5322 116 54499  | 249   | 1       | MR25  | METAL FILM               |
| R 124     | 4822 110 63038  | 2+7   | 5       | CR25  | CARBON                   |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE  | REMARKS      |
|-------|-----------------|-------|---------|-------|--------------|
| R 126 | 4822 110 63043  | 3r9   | 5       | CR25  | CARBON       |
| R 128 | 5322 100 10141  | 10K   | 20      | 0.75W | TRIMMING POT |
| R 129 | 5322 116 50672  | 51.1K | 1       | MR25  | METAL FILM   |
| R 201 | 5322 116 54466  | 90r9  | 1       | MR25  | METAL FILM   |
| R 202 | 5322 116 54466  | 90r9  | 1       | MR25  | METAL FILM   |
| R 203 | 5322 116 54571  | 1.96K | 1       | MR25  | METAL FILM   |
| R 204 | 5322 116 50417  | 162   | 1       | MR25  | METAL FILM   |
| R 206 | 5322 116 50581  | 2.49K | 1       | MR25  | METAL FILM   |
| R 207 | 5322 116 54513  | 332   | 1       | MR25  | METAL FILM   |
| P 208 | 5322 116 50675  | 2.26K | 1       | MR25  | METAL FILM   |
| P 209 | 5322 116 50586  | 1.54K | 1       | MR25  | METAL FILM   |
| P 211 | 5322 116 50675  | 2.26K | 1       | MR25  | METAL FILM   |
| R 212 | 5322 116 50568  | 4.99  | 1       | MR25  | METAL FILM   |
| R 213 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 214 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 216 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 217 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 218 | 5322 116 50481  | 22.6K | 1       | MR25  | METAL FILM   |
| R 219 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| R 221 | 5322 116 50481  | 22.6K | 1       | MR25  | METAL FILM   |
| R 222 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| R 223 | 5322 116 50481  | 22.6K | 1       | MR25  | METAL FILM   |
| R 224 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| R 226 | 5322 116 50481  | 22.6K | 1       | MR25  | METAL FILM   |
| R 227 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| R 228 | 5322 116 50481  | 22.6K | 1       | MR25  | METAL FILM   |
| R 229 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| R 231 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 232 | 5322 116 54619  | 10K   | 1       | MR25  | METAL FILM   |
| P 233 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| P 234 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| R 236 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| R 237 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| R 238 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| R 239 | 5322 116 50664  | 2.05K | 1       | MR25  | METAL FILM   |
| P 241 | 5322 116 50556  | 4.42K | 1       | MR25  | METAL FILM   |
| P 242 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| P 376 | 5322 116 54012  | 6.81K | 1       | MR25  | METAL FILM   |
| R 377 | 5322 116 54595  | 5.11K | 1       | MR25  | METAL FILM   |
| R 379 | 5322 116 50558  | 18.7K | 1       | MR25  | METAL FILM   |
| R 379 | 5322 101 14048  | 47K   | 20      | 0.5W  | TRIMMING POT |
| R 381 | 5322 116 50527  | 33.2  | 1       | MR25  | METAL FILM   |
| R 382 | 4822 111 30067  | 33    | 5       | CR16  | CARBON       |
| R 383 | 5322 116 54557  | 1.21K | 1       | MR25  | METAL FILM   |
| R 387 | 5322 116 50452  | 10    | 1       | MR25  | METAL FILM   |
| P 388 | 5322 116 54519  | 402   | 1       | MR25  | METAL FILM   |
| P 389 | 5322 116 54469  | 100   | 1       | MR25  | METAL FILM   |
| R 390 | 5322 116 54541  | 825   | 1       | MR25  | METAL FILM   |
| R 391 | 5322 116 50568  | 4.99  | 1       | MR25  | METAL FILM   |
| R 392 | 5322 116 50527  | 33.2  | 1       | MR25  | METAL FILM   |
| R 393 | 4822 111 30324  | 100   | 5       | CR16  | CARBON       |
| R 394 | 5322 116 54439  | 35.7  | 1       | MR25  | METAL FILM   |
| R 396 | 5322 116 54548  | 976   | 1       | MR25  | METAL FILM   |
| R 397 | 5322 116 54439  | 35.7  | 1       | MR25  | METAL FILM   |
| R 398 | 4822 111 30324  | 100   | 5       | CR16  | CARBON       |
| P 401 | 5322 116 50524  | 3.01K | 1       | MR25  | METAL FILM   |
| P 402 | 5322 116 54508  | 301   | 1       | MR25  | METAL FILM   |
| P 403 | 4822 111 30067  | 33    | 5       | CR16  | CARBON       |
| P 404 | 5322 116 50524  | 3.01K | 1       | MR25  | METAL FILM   |
| P 405 | 5322 116 54464  | 86.6  | 1       | MR25  | METAL FILM   |
| P 406 | 4822 111 30347  | 10    | 5       | CR16  | CARBON       |
| P 407 | 5322 116 50492  | 46.4  | 1       | MR25  | METAL FILM   |
| P 408 | 5322 116 50568  | 4.99  | 1       | MR25  | METAL FILM   |
| R 409 | 5322 116 50492  | 46.4  | 1       | MR25  | METAL FILM   |
| R 410 | 5322 116 34036  | 47    | 5       | 0.5W  | NTC          |
| P 411 | 4822 111 30347  | 10    | 5       | CR16  | CARBON       |
| P 412 | 4822 111 30067  | 33    | 5       | CR16  | CARBON       |
| P 413 | 5322 116 50515  | 1.78K | 1       | MR25  | METAL FILM   |
| P 414 | 5322 116 54005  | 3.42K | 1       | MR25  | METAL FILM   |
| P 416 | 5322 116 50452  | 10    | 1       | MR25  | METAL FILM   |



| ITEM  | ORDERING NUMBER | DHM   | TOL (%) | TYPE | REMARKS            |
|-------|-----------------|-------|---------|------|--------------------|
| R 417 | 5322 116        | 50571 | 715     | 1    | MK25 METAL FILM    |
| R 418 | 4872 111        | 30245 | 47      | 5    | CK16 CARBON        |
| R 419 | 4872 111        | 30347 | 10      | 5    | CK16 CARBON        |
| R 420 | 5372 116        | 54464 | 86+6    | 1    | MK25 METAL FILM    |
| R 421 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 422 | 5372 116        | 54492 | 178     | 1    | MK25 METAL FILM    |
| P 423 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 424 | 5372 116        | 54576 | 2,37K   | 1    | MK25 METAL FILM    |
| R 426 | 5372 116        | 54587 | 3,65K   | 1    | MK25 METAL FILM    |
| R 427 | 5372 116        | 50527 | 33+2    | 1    | MK25 METAL FILM    |
| R 428 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 429 | 5372 116        | 54492 | 178     | 1    | MK25 METAL FILM    |
| R 431 | 4872 111        | 30347 | 10      | 5    | CK16 CARBON        |
| R 432 | 5372 116        | 50571 | 715     | 1    | MK25 METAL FILM    |
| R 433 | 4872 111        | 30245 | 47      | 5    | CK16 CARBON        |
| R 434 | 5372 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| P 436 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 437 | 5372 116        | 54613 | 8,66K   | 1    | MK25 METAL FILM    |
| R 438 | 5372 116        | 54005 | 3,32K   | 1    | MK25 METAL FILM    |
| R 439 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 440 | 5372 116        | 50484 | 4,64K   | 1    | MK25 METAL FILM    |
| R 441 | 5372 116        | 50926 | 40+2    | 1    | MK25 METAL FILM    |
| P 442 | 5322 100        | 10112 | 1K      | 20   | 0,5W TRIMMING POTM |
| R 443 | 5372 116        | 54515 | 348     | 1    | MK25 METAL FILM    |
| R 444 | 5372 116        | 50926 | 40+2    | 1    | MK25 METAL FILM    |
| R 445 | 5322 116        | 54595 | 5,11K   | 1    | MK25 METAL FILM    |
| R 446 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| P 447 | 5372 116        | 50442 | 48,7K   | 1    | MK25 METAL FILM    |
| P 448 | 5372 100        | 10113 | 10K     | 20   | 0,5W TRIMMING POTM |
| R 461 | 5372 116        | 54005 | 3,32K   | 1    | MK25 METAL FILM    |
| P 463 | 5372 116        | 54576 | 2,37K   | 1    | MK25 METAL FILM    |
| R 464 | 5372 116        | 54005 | 3,32K   | 1    | MK25 METAL FILM    |
| R 465 | 5372 116        | 54012 | 6,81K   | 1    | MK25 METAL FILM    |
| R 466 | 5372 116        | 54585 | 3,48K   | 1    | MK25 METAL FILM    |
| P 467 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 468 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 469 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 471 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 472 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 473 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 474 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 476 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 477 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 478 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 479 | 5372 116        | 50621 | 536     | 1    | MK25 METAL FILM    |
| P 481 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| P 482 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 483 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 484 | 5372 116        | 54613 | 8,66K   | 1    | MK25 METAL FILM    |
| R 486 | 5372 116        | 50524 | 3,01K   | 1    | MK25 METAL FILM    |
| R 487 | 5372 116        | 50527 | 33+2    | 1    | MK25 METAL FILM    |
| R 488 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 500 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 501 | 5372 116        | 54525 | 511     | 1    | MK25 METAL FILM    |
| R 502 | 5372 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 503 | 5372 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| R 504 | 5372 116        | 50511 | 48,7    | 1    | MK25 METAL FILM    |
| R 505 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 506 | 5372 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 507 | 5372 116        | 54525 | 511     | 1    | MK25 METAL FILM    |
| P 511 | 5372 116        | 54258 | 9,53    | 1    | MK25 METAL FILM    |
| R 512 | 5372 116        | 50568 | 4,99    | 1    | MK25 METAL FILM    |
| R 513 | 5372 116        | 54258 | 9,53    | 1    | MK25 METAL FILM    |
| R 514 | 5372 116        | 50568 | 4,99    | 1    | MK25 METAL FILM    |
| R 516 | 5372 116        | 54258 | 9,53    | 1    | MK25 METAL FILM    |
| R 517 | 5372 116        | 54258 | 9,53    | 1    | MK25 METAL FILM    |
| R 520 | 5372 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 521 | 5372 116        | 54525 | 511     | 1    | MK25 METAL FILM    |
| R 522 | 5372 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 523 | 5372 116        | 50452 | 10      | 1    | MK25 METAL FILM    |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|-------|-----------------|-------|---------|------|---------------|
| R 524 | 5322 116 50511  | 48.7  | 1       | MR25 | METAL FILM    |
| R 525 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 526 | 5322 116 54549  | 1K    | 1       | MR25 | METAL FILM    |
| R 527 | 5322 116 54525  | 511   | 1       | MR25 | METAL FILM    |
| R 528 | 5322 116 50524  | 3.01K | 1       | MR25 | METAL FILM    |
| R 529 | 5322 116 54621  | 10.2K | 1       | MR25 | METAL FILM    |
| R 531 | 5322 101 14048  | 47K   | 20      | 0.5W | TRIMMING PUTH |
| R 532 | 5322 116 50527  | 33.2  | 1       | MR25 | METAL FILM    |
| R 533 | 5322 116 54643  | 20.5K | 1       | MR25 | METAL FILM    |
| R 534 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 536 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 537 | 5322 116 50676  | 196   | 1       | MR25 | METAL FILM    |
| R 538 | 5322 116 50555  | 1.27K | 1       | MR25 | METAL FILM    |
| R 539 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 541 | 5322 116 50676  | 196   | 1       | MR25 | METAL FILM    |
| R 542 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 543 | 5322 116 50593  | 15.2K | 1       | MR25 | METAL FILM    |
| R 544 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 546 | 5322 116 54469  | 100   | 1       | MR25 | METAL FILM    |
| R 547 | 5322 116 54541  | 825   | 1       | MR25 | METAL FILM    |
| R 548 | 5322 101 14069  | 22K   | 20      | 0.5W | TRIMMING PUTH |
| R 549 | 5322 116 54595  | 5.11K | 1       | MR25 | METAL FILM    |
| R 550 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 552 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 553 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 554 | 5322 116 50506  | 154   | 1       | MR25 | METAL FILM    |
| R 556 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 557 | 5322 116 50511  | 48.7  | 1       | MR25 | METAL FILM    |
| R 558 | 5322 116 54561  | 1.33K | 1       | MR25 | METAL FILM    |
| R 559 | 5322 116 50569  | 95.3  | 1       | MR25 | METAL FILM    |
| R 560 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |
| R 561 | 5322 116 50506  | 154   | 1       | MR25 | METAL FILM    |
| R 562 | 5322 116 50511  | 48.7  | 1       | MR25 | METAL FILM    |
| R 563 | 5322 116 54561  | 1.73K | 1       | MR25 | METAL FILM    |
| R 564 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 566 | 5322 116 50452  | 10    | 1       | MR25 | METAL FILM    |
| R 567 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 568 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 569 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 571 | 5322 116 54005  | 3.72K | 1       | MR25 | METAL FILM    |
| R 572 | 5322 116 50569  | 95.3  | 1       | MR25 | METAL FILM    |
| R 573 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 574 | 5322 116 54258  | 9.53  | 1       | MR25 | METAL FILM    |
| R 576 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 577 | 5322 116 54258  | 9.53  | 1       | MR25 | METAL FILM    |
| R 578 | 5322 116 54258  | 9.53  | 1       | MR25 | METAL FILM    |
| R 579 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 581 | 5322 116 50568  | 4.99  | 1       | MR25 | METAL FILM    |
| R 601 | 5322 116 50926  | 40.2  | 1       | MR25 | METAL FILM    |
| R 602 | 5322 116 54506  | 287   | 1       | MR25 | METAL FILM    |
| R 603 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 604 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 606 | 5322 116 50676  | 196   | 1       | MR25 | METAL FILM    |
| R 607 | 5322 116 54519  | 402   | 1       | MR25 | METAL FILM    |
| R 608 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 609 | 5322 116 54492  | 178   | 1       | MR25 | METAL FILM    |
| R 610 | 5322 116 50524  | 3.01K | 1       | MR25 | METAL FILM    |
| R 611 | 5322 116 50926  | 40.2  | 1       | MR25 | METAL FILM    |
| R 612 | 5322 116 54506  | 287   | 1       | MR25 | METAL FILM    |
| R 613 | 5322 116 50506  | 154   | 1       | MR25 | METAL FILM    |
| R 614 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 615 | 5322 116 50524  | 3.01K | 1       | MR25 | METAL FILM    |
| R 616 | 5322 116 54444  | 53.6  | 1       | MR25 | METAL FILM    |
| R 617 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 618 | 5322 116 54444  | 53.6  | 1       | MR25 | METAL FILM    |
| R 619 | 5322 101 14011  | 100   | 20      | 0.5W | TRIMMING PUTH |
| R 621 | 5322 100 10114  | 4.7K  | 20      | 0.5W | TRIMMING PUTH |
| R 622 | 5322 100 10113  | 10K   | 20      | 0.5W | TRIMMING PUTH |
| R 623 | 5322 116 54613  | 8.66K | 1       | MR25 | METAL FILM    |
| R 624 | 5322 116 54619  | 10K   | 1       | MR25 | METAL FILM    |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS         |
|-------|-----------------|-------|---------|------|-----------------|
| R 627 | 4822 111 30245  | 47    | 5       | CK16 | CARBON          |
| R 628 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 629 | 5322 116 54608  | 7.5K  | 1       | MK25 | METAL FILM      |
| R 630 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 631 | 5322 116 50556  | 4.42K | 1       | MK25 | METAL FILM      |
| R 632 | 4822 111 30245  | 47    | 5       | CK16 | CARBON          |
| R 633 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 634 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 636 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 637 | 5322 116 50457  | 215   | 1       | MK25 | METAL FILM      |
| R 638 | 5322 116 50669  | 205   | 1       | MK25 | METAL FILM      |
| R 639 | 5322 116 54451  | 61.9  | 1       | MK25 | METAL FILM      |
| R 641 | 5322 101 14047  | 470   | 20      | 0.5W | TRIMMING POTM   |
| R 642 | 5322 116 50457  | 215   | 1       | MK25 | METAL FILM      |
| R 644 | 5322 116 50669  | 205   | 1       | MK25 | METAL FILM      |
| R 646 | 5322 116 54451  | 61.9  | 1       | MK25 | METAL FILM      |
| R 647 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 648 | 4822 111 30245  | 47    | 5       | CK16 | CARBON          |
| R 649 | 5322 116 50515  | 1.78K | 1       | MK25 | METAL FILM      |
| R 650 | 5322 116 54615  | 9.09K | 1       | MK25 | METAL FILM      |
| R 651 | 5322 116 54585  | 3.48K | 1       | MK25 | METAL FILM      |
| R 652 | 5322 116 50474  | 42.2K | 1       | MK25 | METAL FILM      |
| R 653 | 5322 116 50417  | 162   | 1       | MK25 | METAL FILM      |
| R 654 | 5322 116 54011  | 5.62K | 1       | MK25 | METAL FILM      |
| R 655 | 5322 116 50904  | 30.1  | 1       | MK25 | METAL FILM      |
| R 656 | 5322 116 54557  | 1.21K | 1       | MK25 | METAL FILM      |
| R 657 | 5322 116 50579  | 3.16K | 1       | MK25 | METAL FILM      |
| R 658 | 5322 116 54516  | 365   | 1       | MK25 | METAL FILM      |
| R 659 | 4822 111 30067  | 33    | 5       | CK16 | CARBON          |
| R 660 | 5322 116 54516  | 365   | 1       | MK25 | METAL FILM      |
| R 661 | 5322 116 50509  | 4.87K | 1       | MK25 | METAL FILM      |
| R 662 | 5322 116 50579  | 3.16K | 1       | MK25 | METAL FILM      |
| R 663 | 5322 116 54012  | 6.81K | 1       | MK25 | METAL FILM      |
| R 664 | 5322 116 54557  | 1.21K | 1       | MK25 | METAL FILM      |
| R 665 | 5322 116 54615  | 9.09K | 1       | MK25 | METAL FILM      |
| R 666 | 5322 116 54011  | 5.62K | 1       | MK25 | METAL FILM      |
| R 667 | 4822 111 30245  | 47    | 5       | CK16 | CARBON          |
| R 668 | 5322 116 50515  | 1.78K | 1       | MK25 | METAL FILM      |
| R 669 | 5322 116 54585  | 3.48K | 1       | MK25 | METAL FILM      |
| R 671 | 5322 116 50474  | 42.2K | 1       | MK25 | METAL FILM      |
| R 672 | 5322 116 50417  | 162   | 1       | MK25 | METAL FILM      |
| R 681 | 5322 116 50568  | 4.99  | 1       | MK25 | METAL FILM      |
| R 682 | 5322 116 50568  | 4.99  | 1       | MK25 | METAL FILM      |
| R 683 | 5322 116 50568  | 4.99  | 1       | MK25 | METAL FILM      |
| R 684 | 5322 101 20408  | 100K  | 20      | 0.1W | CARBON POTM LIN |
| R 700 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM      |
| R 701 | 5322 116 54743  | 301K  | 1       | MK25 | METAL FILM      |
| R 702 | 5322 116 54038  | 221K  | 1       | MK25 | METAL FILM      |
| R 703 | 5322 116 54595  | 5.11K | 1       | MK25 | METAL FILM      |
| R 704 | 5322 116 54263  | 681K  | 1       | MK30 | METAL FILM      |
| R 705 | 5322 101 14051  | 220   | 20      | 0.5W | TRIMMING POTM   |
| R 706 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM      |
| R 707 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM      |
| R 708 | 5322 116 54005  | 3.32K | 1       | MK25 | METAL FILM      |
| R 709 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM      |
| R 711 | 5322 116 54676  | 56.2K | 1       | MK25 | METAL FILM      |
| R 712 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM      |
| R 713 | 5322 116 54585  | 3.48K | 1       | MK25 | METAL FILM      |
| R 714 | 5322 116 54549  | 1K    | 1       | MK25 | METAL FILM      |
| R 716 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM      |
| R 717 | 5322 116 54587  | 3.65K | 1       | MK25 | METAL FILM      |
| R 718 | 5322 116 50515  | 1.78K | 1       | MK25 | METAL FILM      |
| R 719 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM      |
| R 720 | 5322 116 54525  | 511   | 1       | MK25 | METAL FILM      |
| R 721 | 5322 116 50664  | 2.05K | 1       | MK25 | METAL FILM      |
| R 722 | 5322 116 54536  | 750   | 1       | MK25 | METAL FILM      |
| R 723 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM      |
| R 724 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM      |
| R 725 | 5322 116 50954  | 38.3  | 1       | MK25 | METAL FILM      |
| R 726 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM      |

| ITEM  | ORDERING NUMBER | DHM   | TOL (%) | TYPE | REMARKS    |
|-------|-----------------|-------|---------|------|------------|
| P 727 | 5322 116 50571  | 715   | 1       | HK25 | METAL FILM |
| R 728 | 5322 116 50636  | 2.74K | 1       | HK25 | METAL FILM |
| R 729 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| R 731 | 5322 116 54525  | 511   | 1       | HK25 | METAL FILM |
| R 732 | 5322 116 50664  | 2.05K | 1       | HK25 | METAL FILM |
| D 733 | 5322 116 54536  | 750   | 1       | HK25 | METAL FILM |
| R 734 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| P 735 | 5322 116 50635  | 1.47K | 1       | HK25 | METAL FILM |
| R 736 | 5322 116 50527  | 33+2  | 1       | HK25 | METAL FILM |
| D 737 | 5322 116 50527  | 33+2  | 1       | HK25 | METAL FILM |
| R 738 | 5322 116 50571  | 715   | 1       | HK25 | METAL FILM |
| D 739 | 5322 116 50636  | 2.74K | 1       | HK25 | METAL FILM |
| R 740 | 5322 116 50954  | 38+3  | 1       | HK25 | METAL FILM |
| P 741 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| R 742 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 743 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| R 751 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| R 752 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| R 753 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| R 754 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| R 756 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 757 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| P 761 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 762 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| R 763 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| D 764 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 766 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 767 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| R 771 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 772 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| P 773 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| D 774 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| P 776 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 777 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| R 781 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 782 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 783 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| D 784 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 786 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 787 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| P 791 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 792 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 793 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| D 794 | 5322 116 54469  | 100   | 1       | HK25 | METAL FILM |
| D 796 | 5322 116 50452  | 10    | 1       | HK25 | METAL FILM |
| D 797 | 5322 116 54554  | 1.1K  | 1       | HK25 | METAL FILM |
| R 801 | 4872 111 30324  | 100   | 5       | CK16 | CARBON     |
| D 802 | 5322 111 30396  | 22    | 5       | CK16 | CARBON     |
| D 803 | 5322 116 54012  | 6.81K | 1       | HK25 | METAL FILM |
| D 804 | 4872 111 30263  | 3.33K | 5       | CK16 | CARBON     |
| D 806 | 5322 116 50586  | 1.54K | 1       | HK25 | METAL FILM |
| D 807 | 5322 116 50895  | 18.7  | 1       | HK25 | METAL FILM |
| D 808 | 5322 116 50895  | 18.7  | 1       | HK25 | METAL FILM |
| D 809 | 5322 111 30396  | 22    | 5       | CK16 | CARBON     |
| D 811 | 5322 116 54012  | 6.81K | 1       | HK25 | METAL FILM |
| D 812 | 5322 116 54525  | 511   | 1       | HK25 | METAL FILM |
| D 813 | 5322 111 30396  | 22    | 5       | CK16 | CARBON     |
| D 814 | 5322 116 54592  | 4.02K | 1       | HK25 | METAL FILM |
| D 816 | 5322 111 30396  | 22    | 5       | CK16 | CARBON     |
| D 817 | 5322 116 50415  | 1.15K | 1       | HK25 | METAL FILM |
| D 819 | 5322 116 50415  | 1.15K | 1       | HK25 | METAL FILM |
| D 819 | 5322 111 30396  | 22    | 5       | CK16 | CARBON     |
| D 821 | 4872 110 61054  | 10    | 5       | CK25 | CARBON     |
| D 822 | 5322 116 54683  | 68.1K | 1       | HK25 | METAL FILM |
| R 823 | 5322 116 50636  | 2.74K | 1       | HK25 | METAL FILM |
| D 824 | 5322 116 54683  | 68.1K | 1       | HK25 | METAL FILM |
| D 826 | 5322 116 54552  | 1.05K | 1       | HK25 | METAL FILM |
| D 827 | 5322 116 50635  | 1.47K | 1       | HK25 | METAL FILM |
| R 828 | 5322 116 50635  | 1.47K | 1       | HK25 | METAL FILM |
| D 829 | 5322 116 54552  | 1.05K | 1       | HK25 | METAL FILM |

| ITEM  | ORDERING NUMBER | OHM   | TOL (%) | TYPE  | REMARKS       |
|-------|-----------------|-------|---------|-------|---------------|
| R 831 | 5322 111 30396  | 22    | 5       | CM16  | CARBON        |
| R 832 | 5322 111 30396  | 22    | 5       | CM16  | CARBON        |
| R 833 | 5322 116 50527  | 33±2  | 1       | MM25  | METAL FILM    |
| R 834 | 5322 116 50506  | 154   | 1       | MM25  | METAL FILM    |
| R 836 | 5322 116 54508  | 301   | 1       | MM25  | METAL FILM    |
| R 837 | 5322 116 54552  | 1,05K | 1       | MM25  | METAL FILM    |
| R 838 | 5322 111 30396  | 22    | 5       | CM16  | CARBON        |
| R 839 | 5322 116 54552  | 1,05K | 1       | MM25  | METAL FILM    |
| R 840 | 5322 111 30396  | 22    | 5       | CM16  | CARBON        |
| R 841 | 5322 116 54576  | 2,37K | 1       | MM25  | METAL FILM    |
| R 842 | 5322 116 54519  | 402   | 1       | MM25  | METAL FILM    |
| R 843 | 4822 110 63054  | 10    | 5       | CM25  | CARBON        |
| R 844 | 4822 110 63054  | 10    | 5       | CM25  | CARBON        |
| R 851 | 4822 110 63036  | 2±2   | 5       | CM25  | CARBON        |
| R 852 | 4822 110 63036  | 2±2   | 5       | CM25  | CARBON        |
| R 853 | 4822 110 63036  | 2±2   | 5       | CM25  | CARBON        |
| R 854 | 4822 110 63036  | 2±2   | 5       | CM25  | CARBON        |
| R 856 | 5322 116 54564  | 1,5K  | 1       | MM25  | METAL FILM    |
| R 857 | 5322 111 44156  | 510   | 5       | CM16  | CARBON        |
| R 858 | 5322 116 54549  | 1K    | 1       | MM25  | METAL FILM    |
| R 859 | 5322 116 54619  | 10K   | 1       | MM25  | METAL FILM    |
| R 861 | 5322 116 54629  | 14K   | 1       | MM25  | METAL FILM    |
| R 862 | 5322 111 34094  | 620   | 5       | CM16  | CARBON        |
| R 863 | 4822 111 30303  | 8±2K  | 5       | CM16  | CARBON        |
| R 864 | 4822 111 30267  | 1,5K  | 5       | CM16  | CARBON        |
| R 866 | 4822 111 30119  | 3K    | 5       | CM16  | CARBON        |
| R 867 | 5322 116 50561  | 590   | 1       | MM25  | METAL FILM    |
| R 868 | 5322 116 54011  | 5,62K | 1       | MM25  | METAL FILM    |
| R 869 | 5322 116 54585  | 3,48K | 1       | MM25  | METAL FILM    |
| R 871 | 5322 111 44153  | 15    | 5       | CM16  | CARBON        |
| R 872 | 5322 116 54474  | 110   | 1       | MM25  | METAL FILM    |
| R 873 | 5322 101 14069  | 22K   | 20      | CM4H  | TRIMMING PUTM |
| R 874 | 5322 116 54661  | 34,8K | 1       | MM25  | METAL FILM    |
| R 876 | 5322 116 54619  | 10K   | 1       | MM25  | METAL FILM    |
| R 877 | 5322 116 54547  | 5,76K | 1       | MM25  | METAL FILM    |
| R 878 | 5322 116 50415  | 1,15K | 1       | MM25  | METAL FILM    |
| R 879 | 5322 116 54481  | 130   | 1       | MM25  | METAL FILM    |
| R 880 | 5322 116 54585  | 3,48K | 1       | MM25  | METAL FILM    |
| R 881 | 5322 116 50676  | 196   | 1       | MM25  | METAL FILM    |
| R 882 | 5322 116 54686  | 100K  | 1       | MM25  | METAL FILM    |
| R 883 | 5322 116 54632  | 14,7K | 1       | MM25  | METAL FILM    |
| R 884 | 5322 116 54632  | 14,7K | 1       | MM25  | METAL FILM    |
| R 885 | 5322 116 50583  | 5,9K  | 1       | MM25  | METAL FILM    |
| R 886 | 5322 116 50481  | 22,6K | 1       | MM25  | METAL FILM    |
| R 887 | 5322 116 50459  | 422   | 1       | MM25  | METAL FILM    |
| R 888 | 5322 116 54005  | 3,32K | 1       | MM25  | METAL FILM    |
| R 889 | 5322 116 54012  | 6,81K | 1       | MM25  | METAL FILM    |
| R 891 | 5322 116 50527  | 33±2  | 1       | MM25  | METAL FILM    |
| R 892 | 5322 116 50675  | 2,26K | 1       | MM25  | METAL FILM    |
| R 893 | 5322 116 54619  | 10K   | 1       | MM25  | METAL FILM    |
| R 893 | 4822 111 30067  | 33    | 5       | CM16  | CARBON        |
| R 894 | 5322 116 50509  | 4,87K | 1       | MM25  | METAL FILM    |
| R 895 | 5322 116 50586  | 1,54K | 1       | MM25  | METAL FILM    |
| R 896 | 5322 116 50636  | 2,74K | 1       | MM25  | METAL FILM    |
| R 897 | 5322 116 54519  | 402   | 1       | MM25  | METAL FILM    |
| R 898 | 5322 116 54534  | 681   | 1       | MM25  | METAL FILM    |
| R 899 | 5322 116 50452  | 10    | 1       | MM25  | METAL FILM    |
| R 900 | 4822 111 30067  | 33    | 5       | CM16  | CARBON        |
| R 901 | 5322 116 54549  | 1K    | 1       | MM25  | METAL FILM    |
| R 902 | 4822 111 30067  | 33    | 5       | CM16  | CARBON        |
| R 903 | 5322 116 50527  | 33±2  | 1       | MM25  | METAL FILM    |
| R 904 | 5322 116 50636  | 2,74K | 1       | MM25  | METAL FILM    |
| R 905 | 5322 116 54587  | 3,65K | 1       | MM25  | METAL FILM    |
| R 906 | 5322 111 30396  | 22    | 5       | CM16  | CARBON        |
| R 907 | 5322 116 50556  | 4,42K | 1       | MM25  | METAL FILM    |
| R 908 | 4822 111 30067  | 33    | 5       | CM16  | CARBON        |
| R 909 | 5322 116 50798  | 898   | 0,5     | MM24C | METAL FILM    |
| R 910 | 5322 116 54549  | 1K    | 1       | MM25  | METAL FILM    |
| R 911 | 5322 116 50579  | 3,16K | 1       | MM25  | METAL FILM    |
| R 912 | 5322 116 50556  | 4,42K | 1       | MM25  | METAL FILM    |

| ITEM   | ORDERING NUMBER | DHM   | TOL (%) | TYPE  | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| R 913  | 5322 116 50664  | 2+05K | 1       | MK25  | METAL FILM    |
| R 914  | 5322 100 10114  | 4+7K  | 20      | 0.5W  | TRIMMING POTM |
| R 915  | 5322 116 54624  | 11+5K | 1       | MK25  | METAL FILM    |
| R 916  | 5322 116 50481  | 22+6K | 1       | MK25  | METAL FILM    |
| R 917  | 5322 116 54549  | 1K    | 1       | MK25  | METAL FILM    |
| R 918  | 5322 116 54549  | 1K    | 1       | MK25  | METAL FILM    |
| R 919  | 5322 116 50559  | 27+4K | 1       | MK25  | METAL FILM    |
| R 921  | 5322 116 50559  | 27+4K | 1       | MK25  | METAL FILM    |
| R 922  | 5322 116 50556  | 4+42K | 1       | MK25  | METAL FILM    |
| R 923  | 5322 116 50556  | 4+42K | 1       | MK25  | METAL FILM    |
| R 925  | 5322 116 54619  | 10K   | 1       | MK25  | METAL FILM    |
| R 926  | 5322 116 54011  | 5+62K | 1       | MK25  | METAL FILM    |
| R 927  | 5322 116 54011  | 5+62K | 1       | MK25  | METAL FILM    |
| R 928  | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 929  | 5322 116 54627  | 13+3K | 1       | MK25  | METAL FILM    |
| R 931  | 4822 111 30352  | 82    | 5       | CK16  | CARBON        |
| R 932  | 4822 111 30245  | 47    | 5       | CK16  | CARBON        |
| R 933  | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 934  | 5322 111 30279  | 33K   | 5       | CK16  | CARBON        |
| R 936  | 5322 116 54565  | 1+62K | 1       | MK25  | METAL FILM    |
| R 937  | 5322 111 44156  | 510   | 5       | CK16  | CARBON        |
| R 939  | 5322 111 44156  | 510   | 5       | CK16  | CARBON        |
| R 941  | 4822 111 30327  | 220   | 5       | CK16  | CARBON        |
| R 942  | 5322 116 54632  | 14+7K | 1       | MK25  | METAL FILM    |
| R 944  | 5322 116 50664  | 2+05K | 1       | MK25  | METAL FILM    |
| R 946  | 5322 116 54608  | 7+5K  | 1       | MK25  | METAL FILM    |
| R 947  | 5322 116 50508  | 487   | 1       | MK25  | METAL FILM    |
| R 948  | 5322 116 54617  | 9+53K | 1       | MK25  | METAL FILM    |
| R 949  | 5322 116 54576  | 2+37K | 1       | MK25  | METAL FILM    |
| R 961  | 5322 116 54408  | 909K  | 1       | MK30  | METAL FILM    |
| R 962  | 5322 116 54762  | 365K  | 1       | MK30  | METAL FILM    |
| R 963  | 5322 116 54939  | 35+2K | 0,5     | MK24C | METAL FILM    |
| R 964  | 5322 116 55167  | 17+2K | 0,5     | MK24C | METAL FILM    |
| R 966  | 5322 116 55168  | 8+16K | 0,5     | MK24C | METAL FILM    |
| R 967  | 5322 116 54832  | 2+71K | 0,5     | MK24C | METAL FILM    |
| R 968  | 5322 116 50798  | 898   | 0,5     | MK24C | METAL FILM    |
| R 969  | 5322 116 54722  | 182K  | 1       | MK25  | METAL FILM    |
| R 971  | 5322 116 54977  | 89+8K | 0,5     | MK24C | METAL FILM    |
| R 976  | 5322 116 54549  | 1K    | 1       | MK25  | METAL FILM    |
| R 977  | 5322 116 50729  | 4+22K | 1       | MK25  | METAL FILM    |
| R 978  | 5322 116 50451  | 21+5K | 1       | MK25  | METAL FILM    |
| R 979  | 5322 101 14069  | 22K   | 20      | 0.5W  | TRIMMING POTM |
| R 981  | 5322 116 54005  | 3+32K | 1       | MK25  | METAL FILM    |
| R 982  | 5322 116 54549  | 1K    | 1       | MK25  | METAL FILM    |
| R 983  | 5322 116 50484  | 4+64K | 1       | MK25  | METAL FILM    |
| R 984  | 5322 116 50664  | 2+05K | 1       | MK25  | METAL FILM    |
| R 986  | 5322 116 50451  | 21+5K | 1       | MK25  | METAL FILM    |
| R 987  | 5322 101 14069  | 22K   | 20      | 0.5W  | TRIMMING POTM |
| R 1001 | 4822 111 30324  | 100   | 5       | CK16  | CARBON        |
| R 1002 | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 1003 | 5322 116 54012  | 6+81K | 1       | MK25  | METAL FILM    |
| R 1004 | 4822 111 30263  | 3+3K  | 5       | CK16  | CARBON        |
| R 1006 | 5322 116 50586  | 1+54K | 1       | MK25  | METAL FILM    |
| R 1007 | 5322 116 50895  | 18+7  | 1       | MK25  | METAL FILM    |
| R 1008 | 5322 116 50895  | 18+7  | 1       | MK25  | METAL FILM    |
| R 1009 | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 1011 | 5322 116 54012  | 6+81K | 1       | MK25  | METAL FILM    |
| R 1012 | 5322 116 54525  | 511   | 1       | MK25  | METAL FILM    |
| R 1013 | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 1014 | 5322 116 54592  | 4+02K | 1       | MK25  | METAL FILM    |
| R 1016 | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 1017 | 5322 116 50415  | 1+15K | 1       | MK25  | METAL FILM    |
| R 1018 | 5322 116 50415  | 1+15K | 1       | MK25  | METAL FILM    |
| R 1019 | 5322 111 30396  | 22    | 5       | CK16  | CARBON        |
| R 1021 | 4822 110 63054  | 10    | 5       | CK25  | CARBON        |
| R 1022 | 5322 116 54683  | 68+1K | 1       | MK25  | METAL FILM    |
| R 1023 | 5322 116 50636  | 2+74K | 1       | MK25  | METAL FILM    |
| R 1024 | 5322 116 54683  | 68+1K | 1       | MK25  | METAL FILM    |
| R 1026 | 5322 116 54552  | 1+05K | 1       | MK25  | METAL FILM    |
| R 1027 | 5322 116 50635  | 1+47K | 1       | MK25  | METAL FILM    |

| ITEM   | ORDERING NUMBER | QTY   | TOL (%) | TYPE  | REMARKS       |
|--------|-----------------|-------|---------|-------|---------------|
| R 1028 | 5322 116 50635  | 1,47K | 1       | MK25  | METAL FILM    |
| R 1029 | 5322 116 54552  | 1,05K | 1       | MK25  | METAL FILM    |
| P 1031 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| P 1032 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| R 1033 | 5322 116 50527  | 33,2  | 1       | MK25  | METAL FILM    |
| R 1034 | 5322 116 50506  | 1,54  | 1       | MK25  | METAL FILM    |
| R 1036 | 5322 116 54508  | 301   | 1       | MK25  | METAL FILM    |
| R 1037 | 5322 116 54552  | 1,05K | 1       | MK25  | METAL FILM    |
| R 1038 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| R 1039 | 5322 116 54552  | 1,05K | 1       | MK25  | METAL FILM    |
| R 1040 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| R 1041 | 5322 116 54576  | 2,37K | 1       | MK25  | METAL FILM    |
| P 1042 | 5322 116 54519  | 402   | 1       | MK25  | METAL FILM    |
| P 1043 | 4822 110 63054  | 10    | 5       | CR25  | CARBON        |
| R 1044 | 4822 110 63054  | 10    | 5       | CR25  | CARBON        |
| R 1051 | 4822 110 63036  | 2,2   | 5       | CR25  | CARBON        |
| P 1052 | 4822 110 63036  | 2,2   | 5       | CR25  | CARBON        |
| R 1053 | 4822 110 63063  | 22    | 5       | CR25  | CARBON        |
| P 1054 | 4822 110 63036  | 2,2   | 5       | CR25  | CARBON        |
| P 1056 | 5322 116 54576  | 2,37K | 1       | MK25  | METAL FILM    |
| P 1057 | 5322 116 54525  | 511   | 1       | MK25  | METAL FILM    |
| R 1058 | 5322 116 54474  | 110   | 1       | MK25  | METAL FILM    |
| P 1059 | 5322 111 44153  | 15    | 5       | CR16  | CARBON        |
| R 1061 | 5322 116 54532  | 649   | 1       | MK25  | METAL FILM    |
| P 1062 | 5322 116 50729  | 4,22K | 1       | MK25  | METAL FILM    |
| R 1063 | 5322 116 54011  | 5,62K | 1       | MK25  | METAL FILM    |
| P 1064 | 5322 101 14069  | 22K   | 20      | 0,5W  | TRIMMING POTM |
| P 1065 | 5322 116 50636  | 2,74K | 1       | MK25  | METAL FILM    |
| P 1066 | 5322 116 54629  | 14K   | 1       | MK25  | METAL FILM    |
| P 1067 | 5322 116 54597  | 5,36K | 1       | MK25  | METAL FILM    |
| R 1068 | 5322 116 54597  | 5,36K | 1       | MK25  | METAL FILM    |
| R 1069 | 5322 116 50415  | 1,15K | 1       | MK25  | METAL FILM    |
| P 1070 | 5322 116 54516  | 365   | 1       | MK25  | METAL FILM    |
| P 1071 | 5322 116 54648  | 24,9K | 1       | MK25  | METAL FILM    |
| P 1072 | 5322 116 54519  | 402   | 1       | MK25  | METAL FILM    |
| P 1073 | 5322 116 54545  | 909   | 1       | MK25  | METAL FILM    |
| P 1075 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| P 1076 | 5322 116 54597  | 5,36K | 1       | MK25  | METAL FILM    |
| R 1077 | 5322 116 54005  | 3,32K | 1       | MK25  | METAL FILM    |
| R 1078 | 5322 116 54603  | 6,49K | 1       | MK25  | METAL FILM    |
| P 1079 | 5322 116 50767  | 2,15K | 1       | MK25  | METAL FILM    |
| P 1081 | 4822 111 30067  | 33    | 5       | CR16  | CARBON        |
| R 1082 | 5322 116 54608  | 7,5K  | 1       | MK25  | METAL FILM    |
| P 1083 | 5322 116 54635  | 16,9K | 1       | MK25  | METAL FILM    |
| P 1084 | 4822 111 30067  | 33    | 5       | CR16  | CARBON        |
| P 1086 | 5322 116 50798  | 898   | 0,5     | MK24C | METAL FILM    |
| R 1087 | 4822 111 30067  | 33    | 5       | CR16  | CARBON        |
| P 1088 | 5322 116 50579  | 3,16K | 1       | MK25  | METAL FILM    |
| P 1089 | 5322 116 50527  | 33,2  | 1       | MK25  | METAL FILM    |
| P 1091 | 4822 111 30067  | 33    | 5       | CR16  | CARBON        |
| P 1092 | 5322 116 54587  | 3,65K | 1       | MK25  | METAL FILM    |
| P 1093 | 5322 116 50556  | 4,42K | 1       | MK25  | METAL FILM    |
| R 1094 | 5322 116 54595  | 5,11K | 1       | MK25  | METAL FILM    |
| P 1096 | 5322 116 50479  | 15,4K | 1       | MK25  | METAL FILM    |
| R 1097 | 5322 101 14069  | 22K   | 20      | 0,5W  | TRIMMING POTM |
| P 1098 | 5322 116 54549  | 1K    | 1       | MK25  | METAL FILM    |
| R 1099 | 5322 111 30278  | 27K   | 5       | CR16  | CARBON        |
| R 1101 | 4822 111 30362  | 82    | 5       | CR16  | CARBON        |
| P 1102 | 4822 111 30245  | 47    | 5       | CR16  | CARBON        |
| P 1103 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| R 1104 | 5322 111 30396  | 22    | 5       | CR16  | CARBON        |
| P 1106 | 5322 111 30279  | 33K   | 5       | CR16  | CARBON        |
| R 1107 | 5322 116 54565  | 1,62K | 1       | MK25  | METAL FILM    |
| P 1108 | 5322 116 54576  | 2,37K | 1       | MK25  | METAL FILM    |
| R 1109 | 5322 116 50514  | 64,9K | 1       | MK25  | METAL FILM    |
| P 1111 | 5322 116 54595  | 5,11K | 1       | MK25  | METAL FILM    |
| R 1112 | 5322 116 50586  | 1,54K | 1       | MK25  | METAL FILM    |
| P 1113 | 5322 116 54576  | 2,37K | 1       | MK25  | METAL FILM    |
| P 1114 | 5322 116 54557  | 1,21K | 1       | MK25  | METAL FILM    |
| P 1115 | 5322 100 10113  | 10K   | 20      | 0,5W  | TRIMMING POTM |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| R 1116 | 5322 116        | 54469 | 100     | 1    | MR25 METAL FILM    |
| R 1117 | 5322 116        | 54561 | 1.33K   | 1    | MR25 METAL FILM    |
| R 1118 | 5322 116        | 54576 | 2.47K   | 1    | MR25 METAL FILM    |
| R 1119 | 5322 116        | 54617 | 9.53K   | 1    | MR25 METAL FILM    |
| R 1121 | 5322 116        | 54561 | 1.33K   | 1    | MR25 METAL FILM    |
| R 1122 | 5322 116        | 50524 | 3.01K   | 1    | MR25 METAL FILM    |
| R 1123 | 5322 116        | 54561 | 1.33K   | 1    | MR25 METAL FILM    |
| R 1124 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1126 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1127 | 5322 116        | 54617 | 9.53K   | 1    | MR25 METAL FILM    |
| R 1128 | 5322 116        | 50583 | 5.9K    | 1    | MR25 METAL FILM    |
| R 1129 | 5322 116        | 54592 | 4.02K   | 1    | MR25 METAL FILM    |
| R 1163 | 5322 116        | 54939 | 35.2K   | 0.5  | MR24C METAL FILM   |
| R 1164 | 5322 116        | 55167 | 17.2K   | 0.5  | MR24C METAL FILM   |
| R 1166 | 5322 116        | 55168 | 8.16K   | 0.5  | MR24C METAL FILM   |
| R 1167 | 5322 116        | 54832 | 2.71K   | 0.5  | MR24C METAL FILM   |
| R 1168 | 5322 116        | 50798 | 898     | 0.5  | MR24C METAL FILM   |
| R 1169 | 5322 116        | 54722 | 182K    | 1    | MR25 METAL FILM    |
| R 1171 | 5322 116        | 54977 | 89.8K   | 0.5  | MR24C METAL FILM   |
| R 1201 | 5322 116        | 54558 | 8.25K   | 1    | MR25 METAL FILM    |
| R 1202 | 5322 116        | 50479 | 15.4K   | 1    | MR25 METAL FILM    |
| R 1203 | 5322 116        | 50484 | 4.64K   | 1    | MR25 METAL FILM    |
| R 1204 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1206 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1207 | 5322 116        | 50579 | 3.16K   | 1    | MR25 METAL FILM    |
| R 1208 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1209 | 5322 101        | 14009 | 2.2K    | 20   | 0.5W TRIMMING POTM |
| R 1211 | 5322 116        | 50621 | 536     | 1    | MR25 METAL FILM    |
| R 1212 | 5322 116        | 54524 | 499     | 1    | MR25 METAL FILM    |
| R 1213 | 5322 116        | 50621 | 536     | 1    | MR25 METAL FILM    |
| R 1214 | 5322 116        | 50511 | 48.7    | 1    | MR25 METAL FILM    |
| R 1216 | 5322 116        | 50457 | 215     | 1    | MR25 METAL FILM    |
| R 1217 | 4822 111        | 30333 | 1M      | 10   | CR16 CARBON        |
| R 1218 | 4822 111        | 30333 | 1M      | 10   | CR16 CARBON        |
| R 1219 | 5322 116        | 54619 | 10K     | 1    | MR25 METAL FILM    |
| R 1221 | 5322 116        | 50511 | 48.7    | 1    | MR25 METAL FILM    |
| R 1222 | 5322 116        | 50579 | 3.16K   | 1    | MR25 METAL FILM    |
| R 1223 | 5322 100        | 10113 | 10K     | 20   | 0.5W TRIMMING POTM |
| R 1224 | 5322 116        | 50579 | 3.16K   | 1    | MR25 METAL FILM    |
| R 1225 | 5322 116        | 50728 | 1.87K   | 1    | MR25 METAL FILM    |
| R 1226 | 5322 116        | 54615 | 9.09K   | 1    | MR25 METAL FILM    |
| R 1227 | 5322 116        | 54545 | 909     | 1    | MR25 METAL FILM    |
| R 1228 | 5322 116        | 54545 | 909     | 1    | MR25 METAL FILM    |
| R 1229 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1231 | 5322 116        | 50583 | 5.9K    | 1    | MR25 METAL FILM    |
| R 1232 | 5322 116        | 54012 | 6.81K   | 1    | MR25 METAL FILM    |
| R 1233 | 5322 116        | 50555 | 1.27K   | 1    | MR25 METAL FILM    |
| R 1234 | 5322 116        | 54716 | 162K    | 1    | MR25 METAL FILM    |
| R 1235 | 5322 116        | 50673 | 147K    | 1    | MR30 METAL FILM    |
| R 1236 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1237 | 5322 116        | 54661 | 34.8K   | 1    | MR25 METAL FILM    |
| R 1238 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1239 | 5322 116        | 54545 | 1K      | 1    | MR25 METAL FILM    |
| R 1241 | 5322 116        | 54337 | 332K    | 1    | MR30 METAL FILM    |
| R 1242 | 5322 116        | 54661 | 34.8K   | 1    | MR25 METAL FILM    |
| R 1243 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1244 | 5322 116        | 54615 | 9.09K   | 1    | MR25 METAL FILM    |
| R 1246 | 5322 116        | 54592 | 4.02K   | 1    | MR25 METAL FILM    |
| R 1247 | 5322 116        | 54587 | 3.65K   | 1    | MR25 METAL FILM    |
| R 1248 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1249 | 5322 116        | 54661 | 34.8K   | 1    | MR25 METAL FILM    |
| R 1251 | 5322 116        | 54661 | 34.8K   | 1    | MR25 METAL FILM    |
| R 1252 | 5322 116        | 54549 | 1K      | 1    | MR25 METAL FILM    |
| R 1253 | 5322 116        | 54188 | 1M      | 1    | MR30 METAL FILM    |
| R 1254 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1256 | 5322 116        | 54716 | 162K    | 1    | MR25 METAL FILM    |
| R 1257 | 4822 111        | 30067 | 33      | 5    | CR16 CARBON        |
| R 1258 | 5322 116        | 50555 | 1.27K   | 1    | MR25 METAL FILM    |
| R 1301 | 5322 116        | 54534 | 681     | 1    | MR25 METAL FILM    |
| R 1302 | 5322 116        | 50586 | 1.54K   | 1    | MR25 METAL FILM    |



| ITEM   | ORDERING NUMBER | DIM   | TOL (±) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| R 1303 | 5322 116        | 54532 | 649     | 1    | MK25 METAL FILM    |
| R 1304 | 5322 116        | 50492 | 46+4    | 1    | MK25 METAL FILM    |
| R 1306 | 5322 116        | 54571 | 1+96K   | 1    | MK25 METAL FILM    |
| R 1307 | 5322 116        | 50572 | 12+1K   | 1    | MK25 METAL FILM    |
| R 1308 | 5322 116        | 50767 | 2+15K   | 1    | MK25 METAL FILM    |
| R 1309 | 5322 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 1311 | 5322 116        | 50635 | 1+47K   | 1    | MK25 METAL FILM    |
| R 1312 | 5322 116        | 50492 | 46+4    | 1    | MK25 METAL FILM    |
| R 1313 | 5322 116        | 50492 | 46+4    | 1    | MK25 METAL FILM    |
| R 1314 | 5322 116        | 54592 | 4+02K   | 1    | MK25 METAL FILM    |
| R 1316 | 5322 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 1317 | 5322 116        | 54619 | 10K     | 1    | MK25 METAL FILM    |
| R 1318 | 5322 116        | 50492 | 46+4    | 1    | MK25 METAL FILM    |
| R 1319 | 5322 116        | 50524 | 3+01K   | 1    | MK25 METAL FILM    |
| R 1321 | 5322 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| R 1322 | 5322 116        | 54694 | 90+9K   | 1    | MK25 METAL FILM    |
| R 1323 | 5322 116        | 54624 | 11+5K   | 1    | MK25 METAL FILM    |
| R 1324 | 5322 116        | 50581 | 2+49K   | 1    | MK25 METAL FILM    |
| R 1325 | 5322 116        | 54627 | 13+3K   | 1    | MK25 METAL FILM    |
| R 1326 | 5322 116        | 50524 | 3+01K   | 1    | MK25 METAL FILM    |
| R 1327 | 5322 100        | 10113 | 10K     | 20   | 0.5W TRIMMING POTM |
| R 1328 | 5322 116        | 50536 | 464     | 1    | MK25 METAL FILM    |
| R 1329 | 5322 116        | 54619 | 10K     | 1    | MK25 METAL FILM    |
| R 1330 | 5322 116        | 50568 | 4+99    | 1    | MK25 METAL FILM    |
| R 1331 | 5322 116        | 50442 | 48+7K   | 1    | MK25 METAL FILM    |
| R 1332 | 5322 116        | 50442 | 48+7K   | 1    | MK25 METAL FILM    |
| R 1333 | 4822 110        | 63187 | 1M      | 5    | CK25 CARBON        |
| R 1334 | 4822 110        | 63187 | 1M      | 5    | CK25 CARBON        |
| R 1336 | 5322 116        | 54525 | 511     | 1    | MK25 METAL FILM    |
| R 1337 | 4822 110        | 63161 | 100K    | 5    | CK25 CARBON        |
| R 1338 | 4822 110        | 42189 | 1+2M    | 5    | VK37 CARBON        |
| R 1339 | 4822 110        | 42196 | 2+2M    | 5    | VK37 CARBON        |
| R 1340 | 5322 116        | 54071 | 10+5    | 1    | MK25 METAL FILM    |
| R 1341 | 4822 110        | 42207 | 5+6M    | 5    | VK37 CARBON        |
| R 1342 | 5322 116        | 54689 | 82+5K   | 1    | MK25 METAL FILM    |
| R 1343 | 5322 116        | 54721 | 178K    | 1    | MK25 METAL FILM    |
| R 1344 | 5322 101        | 14071 | 100K    | 20   | 0.5W TRIMMING POTM |
| R 1346 | 5322 101        | 14094 | 1M      | 20   | 0.5W TRIMMING POTM |
| R 1347 | 5322 116        | 54704 | 121K    | 1    | MK25 METAL FILM    |
| R 1348 | 5322 116        | 54743 | 301K    | 1    | MK25 METAL FILM    |
| R 1349 | 5322 116        | 54696 | 100K    | 1    | MK25 METAL FILM    |
| R 1350 | 5322 116        | 54696 | 100K    | 1    | MK25 METAL FILM    |
| R 1351 | 5322 116        | 54619 | 10K     | 1    | MK25 METAL FILM    |
| R 1352 | 5322 116        | 54502 | 261     | 1    | MK25 METAL FILM    |
| R 1353 | 5322 116        | 54502 | 261     | 1    | MK25 METAL FILM    |
| R 1354 | 5322 116        | 54516 | 365     | 1    | MK25 METAL FILM    |
| R 1356 | 5322 116        | 50583 | 5+9K    | 1    | MK25 METAL FILM    |
| R 1357 | 5322 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 1361 | 5322 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 1362 | 5322 100        | 10114 | 4+7K    | 20   | 0.5W TRIMMING POTM |
| R 1363 | 5322 116        | 54576 | 2+37K   | 1    | MK25 METAL FILM    |
| R 1364 | 5322 116        | 50608 | 6+19K   | 1    | MK25 METAL FILM    |
| R 1366 | 5322 116        | 54533 | 655     | 1    | MK25 METAL FILM    |
| R 1367 | 5322 116        | 55008 | 499     | 0.1  | MR24E METAL FILM   |
| R 1368 | 5322 116        | 54639 | 19+1K   | 1    | MK25 METAL FILM    |
| R 1369 | 5322 116        | 54502 | 261     | 1    | MK25 METAL FILM    |
| R 1371 | 5322 116        | 50608 | 6+19K   | 1    | MK25 METAL FILM    |
| R 1372 | 5322 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 1401 | 5322 116        | 54665 | 40+2K   | 1    | MK25 METAL FILM    |
| R 1402 | 5322 116        | 50442 | 48+7K   | 1    | MK25 METAL FILM    |
| R 1403 | 5322 116        | 54683 | 68+1K   | 1    | MK25 METAL FILM    |
| R 1404 | 5322 116        | 50474 | 42+2K   | 1    | MK25 METAL FILM    |
| R 1406 | 5322 116        | 54549 | 1K      | 1    | MK25 METAL FILM    |
| R 1407 | 5322 116        | 54696 | 100K    | 1    | MK25 METAL FILM    |
| R 1408 | 5322 116        | 54632 | 14+7K   | 1    | MK25 METAL FILM    |
| R 1409 | 5322 116        | 50672 | 51+1K   | 1    | MK25 METAL FILM    |
| R 1416 | 5322 111        | 50345 | 8+2M    | 5    | JW CARBON          |
| R 1800 | 4822 110        | 63041 | 3+3     | 5    | CK25 CARBON        |
| R 1801 | 5322 113        | 60064 | 2+7     | 10   | 2W WIRE-WOUND      |
| R 1802 | 5322 116        | 54643 | 20+5K   | 1    | MK25 METAL FILM    |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 1803 | 5372 116 54696  | 100K  | 1       | MK25 | METAL FILM    |
| R 1804 | 5372 116 54696  | 100K  | 1       | MK25 | METAL FILM    |
| R 1805 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 1806 | 4822 110 63198  | 2.7M  | 10      | CK25 | CARBON        |
| R 1807 | 5372 116 50442  | 48.7K | 1       | MK25 | METAL FILM    |
| R 1808 | 5372 116 54661  | 34.8K | 1       | MK25 | METAL FILM    |
| R 1811 | 4822 110 63041  | 3.3   | 5       | CK25 | CARBON        |
| R 1814 | 5372 116 50766  | 147   | 1       | MK25 | METAL FILM    |
| R 1815 | 5372 116 50557  | 46.4K | 1       | MK25 | METAL FILM    |
| R 1816 | 5372 116 54005  | 3.32K | 1       | MK25 | METAL FILM    |
| R 1818 | 5372 116 50417  | 162   | 1       | MK25 | METAL FILM    |
| P 1819 | 5372 110 50035  | 2     | 5       | CK37 | CARBON        |
| R 1820 | 5372 116 34028  | 150K  | 5       | 0.5W | NTC           |
| P 1821 | 5372 116 55149  | 24.9K | 1       | MK30 | METAL FILM    |
| R 1822 | 5372 116 54549  | 1K    | 1       | MK25 | METAL FILM    |
| P 1824 | 5372 116 50731  | 10.5K | 1       | MK25 | METAL FILM    |
| R 1826 | 5372 116 54549  | 1K    | 1       | MK25 | METAL FILM    |
| P 1827 | 5372 116 54564  | 1.5K  | 1       | MK25 | METAL FILM    |
| R 1828 | 5372 116 50636  | 2.74K | 1       | MK25 | METAL FILM    |
| R 1829 | 5372 116 50767  | 2.15K | 1       | MK25 | METAL FILM    |
| R 1830 | 5372 116 54619  | 10K   | 1       | MK25 | METAL FILM    |
| R 1831 | 5372 116 54549  | 1K    | 1       | MK25 | METAL FILM    |
| R 1832 | 5372 116 54558  | 8.25K | 1       | MK25 | METAL FILM    |
| R 1833 | 5372 116 50515  | 1.78K | 1       | MK25 | METAL FILM    |
| R 1834 | 5372 100 10112  | 1K    | 20      | 0.5W | TRIMMING POTM |
| R 1835 | 5372 116 54192  | 5.11  | 1       | MK25 | METAL FILM    |
| P 1836 | 5372 116 54558  | 8.25K | 1       | MK25 | METAL FILM    |
| Q 1837 | 4822 110 63178  | 470K  | 5       | CK25 | CARBON        |
| R 1838 | 5372 116 54651  | 26.1K | 1       | MK25 | METAL FILM    |
| R 1839 | 5372 116 54592  | 4.02K | 1       | MK25 | METAL FILM    |
| R 1840 | 5372 116 54676  | 56.2K | 1       | MK25 | METAL FILM    |
| R 1841 | 5372 101 14102  | 500K  | 20      |      | TRIMMING POTM |
| R 1842 | 5372 116 54655  | 30.1K | 1       | MK25 | METAL FILM    |
| R 1843 | 5372 116 54643  | 20.5K | 1       | MK25 | METAL FILM    |
| R 1844 | 5372 116 54643  | 20.5K | 1       | MK25 | METAL FILM    |
| P 1845 | 5372 116 54525  | 511   | 1       | MK25 | METAL FILM    |
| R 1846 | 5372 116 54696  | 100K  | 1       | MK25 | METAL FILM    |
| Q 1847 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 1848 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| Q 1849 | 5372 116 54619  | 10K   | 1       | MK25 | METAL FILM    |
| R 1851 | 5372 116 54648  | 24.9K | 1       | MK25 | METAL FILM    |
| R 2376 | 5372 116 54012  | 6.81K | 1       | MK25 | METAL FILM    |
| R 2377 | 5372 116 54595  | 5.11K | 1       | MK25 | METAL FILM    |
| Q 2378 | 5372 116 50558  | 18.7K | 1       | MK25 | METAL FILM    |
| R 2379 | 5372 101 14048  | 47K   | 20      | 0.5W | TRIMMING POTM |
| Q 2381 | 5372 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| R 2382 | 4822 111 30067  | 33    | 5       | CK16 | CARBON        |
| R 2383 | 5372 116 54557  | 1.21K | 1       | MK25 | METAL FILM    |
| R 2387 | 5372 116 50452  | 10    | 1       | MK25 | METAL FILM    |
| P 2388 | 5372 116 54519  | 402   | 1       | MK25 | METAL FILM    |
| R 2389 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 2390 | 5372 116 54541  | 875   | 1       | MK25 | METAL FILM    |
| R 2391 | 5372 116 50568  | 4.99  | 1       | MK25 | METAL FILM    |
| P 2392 | 5372 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| Q 2393 | 4822 111 30374  | 100   | 5       | CK16 | CARBON        |
| Q 2394 | 5372 116 54439  | 35.7  | 1       | MK25 | METAL FILM    |
| R 2396 | 5372 116 54548  | 976   | 1       | MK25 | METAL FILM    |
| P 2397 | 5372 116 54439  | 35.7  | 1       | MK25 | METAL FILM    |
| R 2398 | 4822 111 30374  | 100   | 5       | CK16 | CARBON        |
| R 2401 | 5372 116 50524  | 3.01K | 1       | MK25 | METAL FILM    |
| R 2402 | 5372 116 54508  | 301   | 1       | MK25 | METAL FILM    |
| R 2403 | 4822 111 30067  | 33    | 5       | CK16 | CARBON        |
| R 2404 | 5372 116 50524  | 3.01K | 1       | MK25 | METAL FILM    |
| R 2405 | 5372 116 54464  | 86.6  | 1       | MK25 | METAL FILM    |
| R 2406 | 4822 111 30347  | 10    | 5       | CK16 | CARBON        |
| R 2407 | 5372 116 50492  | 46.4  | 1       | MK25 | METAL FILM    |
| R 2408 | 5372 116 50568  | 4.99  | 1       | MK25 | METAL FILM    |
| R 2409 | 5372 116 50492  | 46.4  | 1       | MK25 | METAL FILM    |
| R 2410 | 5372 116 34036  | 47    | 5       | 0.5W | NTC           |
| R 2411 | 4822 111 30347  | 10    | 5       | CK16 | CARBON        |

| ITEM   | ORDERING NUMBER | DHM   | TOL (±) | TYPE | REMARKS       |
|--------|-----------------|-------|---------|------|---------------|
| R 2412 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2413 | 5322 116 50515  | 1.78K | 1       | MK25 | METAL FILM    |
| R 2414 | 5322 116 54005  | 3.32K | 1       | MK25 | METAL FILM    |
| R 2416 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM    |
| R 2417 | 5322 116 50571  | 715   | 1       | MK25 | METAL FILM    |
| R 2418 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2419 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2420 | 5322 116 54464  | 86.6  | 1       | MK25 | METAL FILM    |
| R 2421 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2422 | 5322 116 54492  | 178   | 1       | MK25 | METAL FILM    |
| R 2423 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2424 | 5322 116 54576  | 2.37K | 1       | MK25 | METAL FILM    |
| R 2426 | 5322 116 54587  | 3.65K | 1       | MK25 | METAL FILM    |
| R 2427 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| R 2428 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2429 | 5322 116 54492  | 178   | 1       | MK25 | METAL FILM    |
| R 2431 | 4822 111 30347  | 10    | 5       | CR16 | CARBON        |
| R 2432 | 5322 116 50571  | 715   | 1       | MK25 | METAL FILM    |
| R 2433 | 4822 111 30245  | 47    | 5       | CR16 | CARBON        |
| R 2434 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM    |
| R 2436 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2437 | 5322 116 54613  | 8.66K | 1       | MK25 | METAL FILM    |
| R 2438 | 5322 116 54005  | 3.32K | 1       | MK25 | METAL FILM    |
| R 2439 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2440 | 5322 116 50484  | 4.66K | 1       | MK25 | METAL FILM    |
| R 2441 | 5322 116 50926  | 40.2  | 1       | MK25 | METAL FILM    |
| R 2442 | 5322 100 10112  | 1K    | 20      | 0.5W | TRIMMING POTM |
| R 2443 | 5322 116 54515  | 348   | 1       | MK25 | METAL FILM    |
| R 2444 | 5322 116 50926  | 40.2  | 1       | MK25 | METAL FILM    |
| R 2445 | 5322 116 54595  | 5.11K | 1       | MK25 | METAL FILM    |
| R 2446 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2447 | 5322 116 50442  | 48.7K | 1       | MK25 | METAL FILM    |
| R 2448 | 5322 100 10113  | 10K   | 20      | 0.5W | TRIMMING POTM |
| R 2461 | 5322 116 54005  | 3.32K | 1       | MK25 | METAL FILM    |
| R 2463 | 5322 116 54576  | 2.37K | 1       | MK25 | METAL FILM    |
| R 2464 | 5322 116 54005  | 3.32K | 1       | MK25 | METAL FILM    |
| R 2465 | 5322 116 54012  | 6.81K | 1       | MK25 | METAL FILM    |
| R 2466 | 5322 116 54585  | 3.48K | 1       | MK25 | METAL FILM    |
| R 2467 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2468 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2469 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2471 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2472 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2473 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2474 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2476 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2477 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2478 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 2479 | 5322 116 50621  | 536   | 1       | MK25 | METAL FILM    |
| R 2481 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2482 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 2483 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2484 | 5322 116 54613  | 8.66K | 1       | MK25 | METAL FILM    |
| R 2486 | 5322 116 50524  | 3.01K | 1       | MK25 | METAL FILM    |
| R 2487 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| R 2488 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 2576 | 5322 116 54012  | 6.81K | 1       | MK25 | METAL FILM    |
| R 2577 | 5322 116 54595  | 5.11K | 1       | MK25 | METAL FILM    |
| R 2578 | 5322 116 50558  | 18.7K | 1       | MK25 | METAL FILM    |
| R 2579 | 5322 101 14048  | 47K   | 20      | 0.5W | TRIMMING POTM |
| R 2581 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| R 2582 | 4822 111 30067  | 33    | 5       | CR16 | CARBON        |
| R 2583 | 5322 116 54557  | 1.21K | 1       | MK25 | METAL FILM    |
| R 2587 | 5322 116 50452  | 10    | 1       | MK25 | METAL FILM    |
| R 2588 | 5322 116 54519  | 402   | 1       | MK25 | METAL FILM    |
| R 2589 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM    |
| R 2590 | 5322 116 54541  | 825   | 1       | MK25 | METAL FILM    |
| R 2591 | 5322 116 50568  | 4.99  | 1       | MK25 | METAL FILM    |
| R 2592 | 5322 116 50527  | 33.2  | 1       | MK25 | METAL FILM    |
| R 2593 | 4822 111 30324  | 100   | 5       | CR16 | CARBON        |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS      |
|--------|-----------------|-------|---------|------|--------------|
| R 2594 | 5372 116 54439  | 35.7  | 1       | MK25 | METAL FILM   |
| R 2596 | 5372 116 54548  | 976   | 1       | MK25 | METAL FILM   |
| R 2597 | 5372 116 54439  | 35.7  | 1       | MK25 | METAL FILM   |
| R 2598 | 4872 111 30324  | 100   | 5       | CK16 | CARBON       |
| R 2601 | 5372 116 50524  | 3.01K | 1       | MK25 | METAL FILM   |
| R 2602 | 5372 116 54508  | 301   | 1       | MK25 | METAL FILM   |
| R 2603 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2604 | 5372 116 50524  | 3.01K | 1       | MK25 | METAL FILM   |
| R 2605 | 5372 116 54464  | 86.6  | 1       | MK25 | METAL FILM   |
| R 2606 | 4872 111 30347  | 10    | 5       | CK16 | CARBON       |
| R 2607 | 5372 116 50492  | 46.4  | 1       | MK25 | METAL FILM   |
| R 2608 | 5372 116 50588  | 4.99  | 1       | MK25 | METAL FILM   |
| R 2609 | 5372 116 50492  | 46.4  | 1       | MK25 | METAL FILM   |
| R 2610 | 5372 116 34036  | 47    | 5       | 0.5W | NTC          |
| R 2611 | 4872 111 30347  | 10    | 5       | CK16 | CARBON       |
| R 2612 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2613 | 5372 116 50515  | 1.78K | 1       | MK25 | METAL FILM   |
| R 2614 | 5372 116 54005  | 3.32K | 1       | MK25 | METAL FILM   |
| R 2616 | 5372 116 50452  | 10    | 1       | MK25 | METAL FILM   |
| R 2617 | 5372 116 50571  | 715   | 1       | MK25 | METAL FILM   |
| R 2618 | 4872 111 30245  | 47    | 5       | CK16 | CARBON       |
| R 2619 | 4872 111 30347  | 10    | 5       | CK16 | CARBON       |
| R 2620 | 5372 116 54464  | 86.6  | 1       | MK25 | METAL FILM   |
| R 2621 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2622 | 5372 116 54492  | 178   | 1       | MK25 | METAL FILM   |
| R 2623 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2624 | 5372 116 54576  | 2.37K | 1       | MK25 | METAL FILM   |
| R 2626 | 5372 116 54587  | 3.65K | 1       | MK25 | METAL FILM   |
| R 2627 | 5372 116 50527  | 33.2  | 1       | MK25 | METAL FILM   |
| R 2628 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2629 | 5372 116 54492  | 178   | 1       | MK25 | METAL FILM   |
| R 2631 | 4872 111 30347  | 10    | 5       | CK16 | CARBON       |
| R 2632 | 5372 116 50571  | 715   | 1       | MK25 | METAL FILM   |
| R 2633 | 4872 111 30245  | 47    | 5       | CK16 | CARBON       |
| R 2634 | 5372 116 50452  | 10    | 1       | MK25 | METAL FILM   |
| R 2636 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2637 | 5372 116 54613  | 8.66K | 1       | MK25 | METAL FILM   |
| R 2638 | 5372 116 54005  | 3.32K | 1       | MK25 | METAL FILM   |
| R 2639 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2640 | 5372 116 50484  | 4.64K | 1       | MK25 | METAL FILM   |
| R 2641 | 5372 116 50926  | 40.2  | 1       | MK25 | METAL FILM   |
| R 2642 | 5372 100 10112  | 1K    | 20      | 0.5W | TRIMMING POT |
| R 2643 | 5372 116 54515  | 348   | 1       | MK25 | METAL FILM   |
| R 2644 | 5372 116 50926  | 40.2  | 1       | MK25 | METAL FILM   |
| R 2645 | 5372 116 54595  | 5.11K | 1       | MK25 | METAL FILM   |
| R 2646 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2647 | 5372 116 50442  | 48.7K | 1       | MK25 | METAL FILM   |
| R 2648 | 5372 100 10113  | 10K   | 20      | 0.5W | TRIMMING POT |
| R 2661 | 5372 116 54005  | 3.32K | 1       | MK25 | METAL FILM   |
| R 2663 | 5372 116 54576  | 2.37K | 1       | MK25 | METAL FILM   |
| R 2664 | 5372 116 54005  | 3.32K | 1       | MK25 | METAL FILM   |
| R 2665 | 5372 116 54012  | 6.81K | 1       | MK25 | METAL FILM   |
| R 2666 | 5372 116 54585  | 3.48K | 1       | MK25 | METAL FILM   |
| R 2667 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2668 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2669 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2671 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2672 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2673 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2674 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2676 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2677 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2678 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM   |
| R 2679 | 5372 116 50621  | 536   | 1       | MK25 | METAL FILM   |
| R 2681 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2682 | 5372 116 54469  | 100   | 1       | MK25 | METAL FILM   |
| R 2683 | 4872 111 30067  | 33    | 5       | CK16 | CARBON       |
| R 2684 | 5372 116 54613  | 8.66K | 1       | MK25 | METAL FILM   |
| R 2686 | 5372 116 50524  | 3.01K | 1       | MK25 | METAL FILM   |
| R 2687 | 5372 116 50527  | 33.2  | 1       | MK25 | METAL FILM   |

| ITEM   | ORDERING NUMBER | OHM   | TOL (%) | TYPE | REMARKS            |
|--------|-----------------|-------|---------|------|--------------------|
| P 2688 | 5322 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 2776 | 5322 116        | 54012 | 6.81K   | 1    | MK25 METAL FILM    |
| R 2777 | 5322 116        | 54595 | 5.11K   | 1    | MK25 METAL FILM    |
| R 2778 | 5322 116        | 50558 | 18.7K   | 1    | MK25 METAL FILM    |
| R 2779 | 5322 101        | 14048 | 4.7K    | 20   | 0.5W TRIMMING POTH |
| R 2781 | 5322 116        | 50527 | 33.2    | 1    | MK25 METAL FILM    |
| R 2782 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2783 | 5322 116        | 54557 | 1.21K   | 1    | MK25 METAL FILM    |
| R 2787 | 5322 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| R 2788 | 5322 116        | 54519 | 402     | 1    | MK25 METAL FILM    |
| R 2789 | 5322 116        | 54469 | 100     | 1    | MK25 METAL FILM    |
| R 2790 | 5322 116        | 54541 | 825     | 1    | MK25 METAL FILM    |
| R 2791 | 5322 116        | 50568 | 4.99    | 1    | MK25 METAL FILM    |
| R 2792 | 5322 116        | 50527 | 33.2    | 1    | MK25 METAL FILM    |
| R 2793 | 4872 111        | 30324 | 100     | 5    | CK16 CARBON        |
| R 2794 | 5322 116        | 54439 | 35.7    | 1    | MK25 METAL FILM    |
| R 2796 | 5322 116        | 54548 | 976     | 1    | MK25 METAL FILM    |
| R 2797 | 5322 116        | 54439 | 35.7    | 1    | MK25 METAL FILM    |
| R 2798 | 4872 111        | 30324 | 100     | 5    | CK16 CARBON        |
| P 2801 | 5322 116        | 50524 | 3.01K   | 1    | MK25 METAL FILM    |
| R 2802 | 5322 116        | 54508 | 30.1    | 1    | MK25 METAL FILM    |
| P 2803 | 4822 111        | 30067 | 33      | 5    | CK16 CARBON        |
| P 2804 | 5322 116        | 50524 | 3.01K   | 1    | MK25 METAL FILM    |
| P 2805 | 5322 116        | 54464 | 86.6    | 1    | MK25 METAL FILM    |
| R 2806 | 4872 111        | 30347 | 10      | 5    | CK16 CARBON        |
| R 2807 | 5322 116        | 50492 | 46.4    | 1    | MK25 METAL FILM    |
| R 2808 | 5322 116        | 50568 | 4.99    | 1    | MK25 METAL FILM    |
| R 2809 | 5322 116        | 50492 | 46.4    | 1    | MK25 METAL FILM    |
| R 2810 | 5322 116        | 34036 | 47      | 5    | 0.5W NTC           |
| R 2811 | 4872 111        | 30347 | 10      | 5    | CK16 CARBON        |
| R 2812 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2813 | 5322 116        | 50515 | 1.78K   | 1    | MK25 METAL FILM    |
| R 2814 | 5322 116        | 54005 | 3.32K   | 1    | MK25 METAL FILM    |
| R 2816 | 5322 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| R 2817 | 5322 116        | 50571 | 715     | 1    | MK25 METAL FILM    |
| R 2818 | 4872 111        | 30245 | 47      | 5    | CK16 CARBON        |
| R 2819 | 4872 111        | 30347 | 10      | 5    | CK16 CARBON        |
| P 2820 | 5322 116        | 54464 | 86.6    | 1    | MK25 METAL FILM    |
| R 2821 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2822 | 5322 116        | 54492 | 178     | 1    | MK25 METAL FILM    |
| R 2823 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| P 2824 | 5322 116        | 54576 | 2.37K   | 1    | MK25 METAL FILM    |
| R 2826 | 5322 116        | 54587 | 3.65K   | 1    | MK25 METAL FILM    |
| R 2827 | 5322 116        | 50527 | 33.2    | 1    | MK25 METAL FILM    |
| P 2828 | 4822 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2829 | 5322 116        | 54492 | 178     | 1    | MK25 METAL FILM    |
| R 2831 | 4822 111        | 30347 | 10      | 5    | CK16 CARBON        |
| R 2832 | 5322 116        | 50571 | 715     | 1    | MK25 METAL FILM    |
| R 2833 | 4872 111        | 30245 | 47      | 5    | CK16 CARBON        |
| P 2834 | 5322 116        | 50452 | 10      | 1    | MK25 METAL FILM    |
| R 2836 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| P 2837 | 5322 116        | 54613 | 8.66K   | 1    | MK25 METAL FILM    |
| R 2838 | 5322 116        | 54005 | 3.32K   | 1    | MK25 METAL FILM    |
| R 2839 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2840 | 5322 116        | 50484 | 4.64K   | 1    | MK25 METAL FILM    |
| R 2841 | 5322 116        | 50926 | 40.2    | 1    | MK25 METAL FILM    |
| R 2842 | 5322 100        | 10112 | 1K      | 20   | 0.5W TRIMMING POTH |
| R 2843 | 5322 116        | 54515 | 348     | 1    | MK25 METAL FILM    |
| R 2844 | 5322 116        | 50926 | 40.2    | 1    | MK25 METAL FILM    |
| R 2845 | 5322 116        | 54595 | 5.11K   | 1    | MK25 METAL FILM    |
| R 2846 | 4822 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2847 | 5322 116        | 50442 | 48.7K   | 1    | MK25 METAL FILM    |
| R 2848 | 5322 100        | 10113 | 10K     | 20   | 0.5W TRIMMING POTH |
| R 2861 | 5322 116        | 54005 | 3.32K   | 1    | MK25 METAL FILM    |
| R 2863 | 5322 116        | 54576 | 2.37K   | 1    | MK25 METAL FILM    |
| P 2864 | 5322 116        | 54005 | 3.32K   | 1    | MK25 METAL FILM    |
| R 2865 | 5322 116        | 54012 | 6.81K   | 1    | MK25 METAL FILM    |
| R 2866 | 5322 116        | 54585 | 3.48K   | 1    | MK25 METAL FILM    |
| R 2867 | 4872 111        | 30067 | 33      | 5    | CK16 CARBON        |
| R 2868 | 4822 111        | 30067 | 33      | 5    | CK16 CARBON        |

| ITEM   | ORDERING NUMBER | QHM   | TOL (%) | TYPE | REMARKS    |
|--------|-----------------|-------|---------|------|------------|
| R 2869 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2871 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2872 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2873 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| P 2874 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| P 2876 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2877 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2878 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM |
| R 2879 | 5322 116 50621  | 536   | 1       | MK25 | METAL FILM |
| R 2881 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2882 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM |
| R 2883 | 4822 111 30067  | 33    | 5       | CK16 | CARBON     |
| R 2884 | 5322 116 54613  | 8466K | 1       | MK25 | METAL FILM |
| R 2886 | 5322 116 50524  | 3401K | 1       | MK25 | METAL FILM |
| R 2887 | 5322 116 50527  | 3342  | 1       | MK25 | METAL FILM |
| R 2888 | 5322 116 54469  | 100   | 1       | MK25 | METAL FILM |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| DIODES |                 |                  |
| GR1    | 5322 130 34595  | CQY24A-I         |
| GR2    | 5322 130 34595  | CQY24A-I         |
| GR101  | 5322 130 34037  | BAV45            |
| GR401  | 5322 130 30613  | BAW62            |
| GR501  | 5322 130 30613  | BAW62            |
| GR507  | 5322 130 34278  | RZX79-C6V8       |
| GR601  | 5322 130 30644  | BA187            |
| GR602  | 5322 130 30644  | BA187            |
| GR603  | 4822 130 30862  | RZX79-C9V1       |
| GR604  | 4822 130 30861  | RZX79/R7V5       |
| GR606  | 5322 130 34382  | RZX79/R8V2       |
| GR607  | 5322 130 34382  | RZX79/R8V2       |
| GR608  | 4822 130 30861  | RZX79/R7V5       |
| GR609  | 4822 130 30862  | RZX79-C9V1       |
| GR701  | 5322 130 30613  | BAW62            |
| GR702  | 5322 130 30613  | BAW62            |
| GR703  | 5322 130 30613  | BAW62            |
| GR704  | 5322 130 30613  | BAW62            |
| GR705  | 5322 130 30613  | BAW62            |
| GR706  | 5322 130 30613  | BAW62            |
| GR707  | 5322 130 30613  | BAW62            |
| GR708  | 5322 130 30613  | BAW62            |
| GR709  | 5322 130 30613  | BAW62            |
| GR710  | 5322 130 30613  | BAW62            |
| GR711  | 5322 130 30613  | BAW62            |
| GR712  | 5322 130 30613  | BAW62            |
| GR713  | 5322 130 34173  | RZX79-B5V6       |
| GR751  | 5322 130 30613  | BAW62            |
| GR752  | 5322 130 30613  | BAW62            |
| GR753  | 5322 130 30613  | BAW62            |
| GR754  | 5322 130 30613  | BAW62            |
| GR756  | 5322 130 30613  | BAW62            |
| GR757  | 5322 130 30613  | BAW62            |
| GR761  | 5322 130 30613  | BAW62            |
| GR762  | 5322 130 30613  | BAW62            |
| GR763  | 5322 130 30613  | BAW62            |
| GR764  | 5322 130 30613  | BAW62            |
| GR766  | 5322 130 30613  | BAW62            |
| GR767  | 5322 130 30613  | BAW62            |
| GR771  | 5322 130 30613  | BAW62            |
| GR772  | 5322 130 30613  | BAW62            |
| GR773  | 5322 130 30613  | BAW62            |
| GR774  | 5322 130 30613  | BAW62            |
| GR776  | 5322 130 30613  | BAW62            |
| GR777  | 5322 130 30613  | BAW62            |
| GR781  | 5322 130 30613  | BAW62            |
| GR782  | 5322 130 30613  | BAW62            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| GR783  | 5322 130 30613  | RAW62            |
| GR784  | 5322 130 30613  | RAW62            |
| GR786  | 5322 130 30613  | RAW62            |
| GR787  | 5322 130 30613  | RAW62            |
| GR791  | 5322 130 30613  | RAW62            |
| GR792  | 5322 130 30613  | RAW62            |
| GR793  | 5322 130 30613  | RAW62            |
| GR794  | 5322 130 30613  | RAW62            |
| GR796  | 5322 130 30613  | RAW62            |
| GR797  | 5322 130 30613  | RAW62            |
| GR801  | 5322 130 34048  | RZX75-C2V8       |
| GR802  | 5322 130 30613  | RAW62            |
| GR803  | 5322 130 30613  | RAW62            |
| GR804  | 5322 130 30613  | RAW62            |
| GR806  | 5322 130 30613  | RAW62            |
| GR851  | 5322 130 30613  | RAW62            |
| GR853  | 5322 130 30613  | RAW62            |
| GR854  | 5322 130 30613  | RAW62            |
| GR855  | 5322 130 30229  | AAZ15            |
| GR856  | 5322 130 30613  | RAW62            |
| GR857  | 5322 130 30613  | RAW62            |
| GR858  | 5322 130 34174  | RZX79-C4V7       |
| GR861  | 5322 130 30613  | RAW62            |
| GR862  | 5322 130 30613  | RAW62            |
| GR863  | 5322 130 30613  | RAW62            |
| GR1001 | 5322 130 34048  | RZX75-C2V8       |
| GR1002 | 5322 130 30613  | RAW62            |
| GR1003 | 5322 130 30613  | RAW62            |
| GR1004 | 5322 130 30613  | RAW62            |
| GR1006 | 5322 130 30613  | RAW62            |
| GR1051 | 5322 130 30613  | RAW62            |
| GR1052 | 5322 130 30613  | RAW62            |
| GR1053 | 5322 130 30613  | RAW62            |
| GR1054 | 5322 130 30613  | RAW62            |
| GR1056 | 5322 130 30613  | RAW62            |
| GR1057 | 5322 130 30613  | RAW62            |
| GR1058 | 5322 130 30613  | RAW62            |
| GR1059 | 5322 130 30613  | RAW62            |
| GR1061 | 5322 130 30613  | RAW62            |
| GR1062 | 5322 130 30613  | RAW62            |
| GR1063 | 5322 130 30613  | RAW62            |
| GR1064 | 5322 130 30613  | RAW62            |
| GR1065 | 5322 130 30613  | RAW62            |
| GR1066 | 5322 130 30613  | RAW62            |
| GR1067 | 5322 130 30613  | RAW62            |
| GR1201 | 5322 130 30613  | RAW62            |
| GR1202 | 5322 130 30613  | RAW62            |
| GR1203 | 5322 130 30613  | RAW62            |
| GR1204 | 5322 130 30613  | RAW62            |
| GR1207 | 5322 130 34173  | RZX79-C5V6       |
| GR1208 | 5322 130 34384  | RZX79-862        |
| GR1209 | 5322 130 34383  | RZX79-847        |
| GR1211 | 5322 130 34384  | RZX79-862        |
| GR1212 | 5322 130 34173  | RZX79-C5V6       |
| GR1301 | 5322 130 30613  | RAW62            |
| GR1302 | 5322 130 30613  | RAW62            |
| GR1303 | 5322 130 30392  | HZY88-C3V3       |
| GR1304 | 5322 130 30613  | RAW62            |
| GR1306 | 4822 130 30842  | BAV21            |
| GR1307 | 4822 130 30842  | BAV21            |
| GR1308 | 4822 130 30842  | BAV21            |
| GR1309 | 4822 130 30842  | BAV21            |
| GR1311 | 5322 130 30613  | RAW62            |
| GR1312 | 5322 130 30613  | RAW62            |
| GR1316 | 5322 130 34173  | RZX79-C5V6       |
| GR1317 | 5322 130 34173  | RZX79-C5V6       |
| GR1401 | 4822 130 30842  | BAV21            |
| GF1402 | 4822 130 30842  | BAV21            |
| GR1403 | 5322 130 34594  | BY409            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| GR1416 | 5322 130 34594  | BY400            |
| GR1417 | 5322 130 34594  | BY409            |
| GR1418 | 5322 130 34594  | BY409            |
| GR1419 | 5322 130 34594  | BY409            |
| GR1421 | 5322 130 34594  | BY409            |
| GR1801 | 5322 130 30521  | BY179            |
| GR1802 | 5322 130 34107  | BZX61-C13        |
| GR1803 | 5322 130 34297  | BZX79-C10        |
| GR1804 | 4822 130 30817  | BYX55/600        |
| GR1805 | 5322 130 34605  | BAX12            |
| GR1806 | 5322 130 34034  | BZX61-C75        |
| GR1807 | 5322 130 30565  | BZX61-C47        |
| GR1808 | 5322 130 30613  | RAW62            |
| GR1809 | 4822 130 30839  | RY206            |
| GR1811 | 4822 130 30839  | RY206            |
| GR1812 | 4822 130 30839  | RY206            |
| GR1813 | 5322 130 30613  | RAW62            |
| GR1815 | 5322 130 30613  | RAW62            |
| GR1816 | 5322 130 34047  | BZX75-C1V4       |
| GR1817 | 5322 130 30613  | RAW62            |
| GR1818 | 5322 130 30613  | RAW62            |
| GR1819 | 5322 130 30195  | RYX10            |
| GR1820 | 5322 130 30613  | RAW62            |
| GR1821 | 5322 130 34297  | BZX79-C10        |
| GR1822 | 5322 130 34605  | BAX12            |
| GR1823 | 4822 130 30839  | RY206            |
| GR1824 | 4822 130 30839  | RY206            |
| GR1825 | 4822 130 20039  | RR 100           |
| GR1826 | 4822 130 30839  | RY206            |
| GR1827 | 4822 130 30839  | RY206            |
| GR1828 | 4822 130 30839  | RY206            |
| GR1829 | 4822 130 30839  | RY206            |
| GR1830 | 5322 130 30613  | RAW62            |
| GR1831 | 5322 130 34605  | BAX12            |
| GR1832 | 5322 130 34605  | BAX12            |
| GR1833 | 5322 130 34605  | BAX12            |
| GR1834 | 5322 130 34605  | BAX12            |
| GR1835 | 5322 130 30765  | BZX75-C3V6       |
| GR1836 | 5322 130 34605  | BAX12            |
| GR1837 | 5322 130 34605  | BAX12            |
| GR1838 | 5322 130 34605  | BAX12            |
| GR1839 | 5322 130 34605  | BAX12            |
| GR1841 | 5322 130 34605  | BAX12            |
| GR1842 | 5322 130 34605  | BAX12            |
| GR1843 | 5322 130 34605  | BAX12            |
| GR1844 | 5322 130 34605  | BAX12            |
| GR2401 | 5322 130 30613  | RAW62            |
| GR2601 | 5322 130 30613  | RAW62            |
| GR2801 | 5322 130 30613  | RAW62            |

TRANSISTORS

|       |                |       |
|-------|----------------|-------|
| TS201 | 5322 130 40417 | RSX20 |
| TS202 | 5322 130 40417 | RSX20 |
| TS203 | 4822 130 40964 | RC540 |
| TS204 | 4822 130 40964 | RC540 |
| TS376 | 5322 130 44154 | RF190 |
| TS377 | 4822 130 40964 | RC540 |
| TS378 | 5322 130 44396 | RF324 |
| TS379 | 5322 130 44154 | RF190 |
| TS401 | 4822 130 40964 | RC540 |
| TS402 | 5322 130 44396 | RF324 |
| TS403 | 5322 130 44396 | RF324 |
| TS404 | 4822 130 40964 | RC540 |
| TS409 | 4822 130 40964 | RC540 |
| TS411 | 4822 130 40964 | RC540 |
| TS412 | 4822 130 40964 | RC540 |
| TS413 | 4822 130 40964 | RC540 |
| TS414 | 4822 130 40964 | RC540 |
| TS416 | 4822 130 40964 | RC540 |



| ITEM  | JRDERING NUMBER | TYPE/DESCRIPTION |
|-------|-----------------|------------------|
| TS417 | 4822 130 40964  | RC549            |
| TS501 | 4822 130 40963  | RC559            |
| TS502 | 4822 130 40963  | RC559            |
| TS503 | 4822 130 40963  | RC559            |
| TS504 | 4822 130 40963  | RC559            |
| TS506 | 5322 130 44154  | RF199            |
| TS507 | 4822 130 40964  | RC549            |
| TS508 | 5322 130 44154  | RF199            |
| TS509 | 5322 130 44396  | RF324            |
| TS511 | 5322 130 40664  | BU137            |
| TS601 | 5322 130 44396  | RF324            |
| TS602 | 5322 130 44396  | RF324            |
| TS603 | 4822 130 40964  | RC549            |
| TS604 | 5322 130 40142  | FW5374           |
| TS606 | 5322 130 40673  | FW5497           |
| TS607 | 5322 130 40673  | FW5497           |
| TS608 | 5322 130 40142  | FW5374           |
| TS611 | 5322 130 44257  | RC547            |
| TS612 | 5322 130 44256  | RC557            |
| TS701 | 5322 130 44246  | BC549C           |
| TS702 | 4822 130 40963  | RC559            |
| TS703 | 4822 130 40963  | RC559            |
| TS704 | 5322 130 44154  | RF199            |
| TS705 | 4822 130 40964  | RC549            |
| TS706 | 5322 130 44154  | RF199            |
| TS707 | 5322 130 44154  | RF199            |
| TS708 | 5322 130 44154  | RF199            |
| TS709 | 4822 130 40854  | 9C327            |
| TS751 | 5322 130 44396  | RF324            |
| TS752 | 5322 130 44396  | RF324            |
| TS761 | 5322 130 44396  | RF324            |
| TS762 | 5322 130 44396  | RF324            |
| TS771 | 5322 130 44396  | RF324            |
| TS772 | 5322 130 44396  | RF324            |
| TS781 | 5322 130 44396  | RF324            |
| TS782 | 5322 130 44396  | RF324            |
| TS791 | 5322 130 44396  | RF324            |
| TS792 | 5322 130 44396  | RF324            |
| TS801 | 5322 130 44246  | RC549C           |
| TS802 | 5322 130 40493  | RFY90            |
| TS803 | 4822 130 40964  | RC549            |
| TS804 | 5322 130 40493  | RFY90            |
| TS806 | 4822 130 40964  | RC549            |
| TS807 | 5322 130 40493  | RFY90            |
| TS808 | 5322 130 40493  | RFY90            |
| TS809 | 4822 130 40964  | RC549            |
| TS811 | 5322 130 44338  | RFS17R           |
| TS817 | 5322 130 40781  | RFS17            |
| TS851 | 5322 130 44338  | RFS17R           |
| TS852 | 5322 130 44359  | 53785Y           |
| TS853 | 4822 130 40963  | RC559            |
| TS854 | 4822 130 40964  | RC549            |
| TS856 | 5322 130 40781  | RFS17            |
| TS857 | 5322 130 40781  | RFS17            |
| TS858 | 5322 130 44338  | RFS17R           |
| TS859 | 4822 130 40964  | RC549            |
| TS861 | 4822 130 40964  | RC549            |
| TS862 | 4822 130 40964  | RC549            |
| TS863 | 5322 130 40493  | RFY90            |
| TS864 | 4822 130 40963  | RC559            |
| TS865 | 4822 130 40964  | RC549            |
| TS866 | 4822 130 40963  | RC559            |
| TS867 | 4822 130 40963  | RC559            |
| TS868 | 5322 130 40417  | RSX20            |
| TS869 | 4822 130 40964  | RC549            |
| TS870 | 5322 130 40417  | RSX20            |
| TS871 | 4822 130 40963  | RC559            |
| TS872 | 4822 130 40964  | RC549            |
| TS873 | 4822 130 40964  | RC549            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| TSR74  | 5322 130 44246  | RC549C           |
| TSR76  | 5322 130 44246  | RC549C           |
| TSR77  | 4822 130 40964  | RC549            |
| TSR78  | 4822 130 40964  | RC549            |
| TSR79  | 4822 130 40964  | RC549            |
| TSR81  | 4822 130 40964  | RC549            |
| TSR82  | 4822 130 40964  | RC549            |
| TSR83  | 5322 130 44396  | RF324            |
| TSR84  | 5322 130 44396  | RF324            |
| TSR86  | 4822 130 40963  | BC559            |
| TSR87  | 5322 130 44246  | BC549C           |
| TSR88  | 5322 130 44246  | BC549C           |
| TS1001 | 4822 130 40964  | BC549            |
| TS1002 | 5322 130 40493  | RFY90            |
| TS1003 | 4822 130 40964  | RC549            |
| TS1004 | 5322 130 40493  | RFY90            |
| TS1006 | 4822 130 40964  | RC549            |
| TS1007 | 5322 130 40493  | RFY90            |
| TS1008 | 5322 130 40493  | RFY90            |
| TS1009 | 4822 130 40964  | RC549            |
| TS1011 | 5322 130 40781  | RF517            |
| TS1012 | 5322 130 44338  | RF517R           |
| TS1051 | 5322 130 40781  | RF517            |
| TS1052 | 5322 130 40781  | RF517            |
| TS1053 | 5322 130 44338  | RF517R           |
| TS1054 | 4822 130 40963  | RC559            |
| TS1056 | 5322 130 40781  | RF517            |
| TS1057 | 4822 130 40963  | RC559            |
| TS1058 | 4822 130 40963  | BC559            |
| TS1059 | 4822 130 40964  | RC549            |
| TS1061 | 5322 130 40417  | RSX20            |
| TS1062 | 4822 130 40963  | RC559            |
| TS1063 | 4822 130 40964  | BC549            |
| TS1064 | 4822 130 40964  | RC549            |
| TS1066 | 4822 130 40964  | RC549            |
| TS1067 | 4822 130 40964  | RC549            |
| TS1068 | 4822 130 40963  | RC559            |
| TS1069 | 4822 130 40963  | RC559            |
| TS1071 | 4822 130 40964  | RC549            |
| TS1072 | 4822 130 40963  | RC559            |
| TS1201 | 4822 130 40964  | RC549            |
| TS1202 | 4822 130 40964  | RC549            |
| TS1203 | 4822 130 40964  | RC549            |
| TS1204 | 4822 130 40964  | RC549            |
| TS1206 | 5322 130 40018  | 2N2894           |
| TS1207 | 5322 130 40018  | 2N2894           |
| TS1208 | 4822 130 40908  | RF336            |
| TS1209 | 5322 130 40672  | RFW44            |
| TS1211 | 5322 130 44127  | 2N2894A          |
| TS1212 | 5322 130 40417  | RSX20            |
| TS1213 | 4822 130 40908  | RF336            |
| TS1214 | 5322 130 40672  | RFW44            |
| TS1301 | 4822 130 40964  | RC549            |
| TS1302 | 5322 130 40018  | 2N2894           |
| TS1303 | 5322 130 40321  | RSX21            |
| TS1304 | 5322 130 40321  | RSX21            |
| TS1306 | 5322 130 40321  | RSX21            |
| TS1307 | 5322 130 40373  | RCV71            |
| TS1308 | 5322 130 40321  | RSX21            |
| TS1309 | 5322 130 40712  | RD136            |
| TS1311 | 5322 130 40712  | RD136            |
| TS1317 | 5322 130 40712  | RD136            |
| TS1401 | 5322 130 40373  | RCV71            |
| TS1402 | 5322 130 40714  | RSW68            |
| TS1801 | 5322 130 44357  | RD262            |
| TS1802 | 5322 130 44246  | BC549C           |
| TS1807 | 5322 130 44105  | RDV93            |
| TS1808 | 5322 130 44358  | RC559B           |
| TS1809 | 5322 130 44019  | RSX60            |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| TS1811 | 5322 130 40482  | RRV30            |
| TS1812 | 5322 130 44246  | RC549C           |
| TS1813 | 5322 130 44395  | CNY43            |
| TS2376 | 5322 130 44154  | BF199            |
| TS2377 | 4822 130 40964  | RC549            |
| TS2378 | 5322 130 44396  | RF324            |
| TS2379 | 5322 130 44154  | RF199            |
| TS2401 | 4822 130 40964  | RC549            |
| TS2402 | 5322 130 44396  | RF324            |
| TS2403 | 5322 130 44396  | RF324            |
| TS2404 | 4822 130 40964  | RC549            |
| TS2409 | 4822 130 40964  | RC549            |
| TS2411 | 4822 130 40964  | RC549            |
| TS2412 | 4822 130 40964  | RC549            |
| TS2413 | 4822 130 40964  | RC549            |
| TS2414 | 4822 130 40964  | RC549            |
| TS2416 | 4822 130 40964  | RC549            |
| TS2417 | 4822 130 40964  | RC549            |
| TS2576 | 5322 130 44154  | RF199            |
| TS2577 | 4822 130 40964  | RC549            |
| TS2578 | 5322 130 44396  | RF324            |
| TS2579 | 5322 130 44154  | RF199            |
| TS2601 | 4822 130 40964  | RC549            |
| TS2602 | 5322 130 44396  | RF324            |
| TS2603 | 5322 130 44396  | RF324            |
| TS2604 | 4822 130 40964  | RC549            |
| TS2609 | 4822 130 40964  | RC549            |
| TS2611 | 4822 130 40964  | RC549            |
| TS2612 | 4822 130 40964  | RC549            |
| TS2613 | 4822 130 40964  | RC549            |
| TS2614 | 4822 130 40964  | RC549            |
| TS2616 | 4822 130 40964  | RC549            |
| TS2617 | 4822 130 40964  | RC549            |
| TS2776 | 5322 130 44154  | RF199            |
| TS2777 | 4822 130 40964  | RC549            |
| TS2778 | 5322 130 44396  | RF324            |
| TS2779 | 5322 130 44154  | RF199            |
| TS2801 | 4822 130 40964  | RC549            |
| TS2802 | 5322 130 44396  | RF324            |
| TS2803 | 5322 130 44396  | RF324            |
| TS2804 | 4822 130 40964  | RC549            |
| TS2809 | 4822 130 40964  | RC549            |
| TS2811 | 4822 130 40964  | RC549            |
| TS2812 | 4822 130 40964  | RC549            |
| TS2813 | 4822 130 40964  | RC549            |
| TS2814 | 4822 130 40964  | RC549            |
| TS2816 | 4822 130 40964  | RC549            |
| TS2817 | 4822 130 40964  | RC549            |

INTEGRATED CIRCUITS

|       |                |              |
|-------|----------------|--------------|
| IC101 | 5322 209 84424 | TF CIRCUIT   |
| IC201 | 5322 209 84823 | SN74LS00N-00 |
| IC202 | 5322 209 84823 | SN74LS00N-00 |
| IC203 | 5322 209 85486 | SN74LS04N-00 |
| IC204 | 5322 209 84823 | SN74LS00N-00 |
| IC206 | 5322 209 84986 | SN74LS74N-00 |
| IC207 | 5322 209 84823 | SN74LS00N-00 |
| IC208 | 5322 209 85265 | SN74LS03N-00 |
| IC209 | 5322 209 84986 | SN74LS74N-00 |
| IC211 | 5322 209 84823 | SN74LS00N-00 |
| IC212 | 5322 209 84823 | SN74LS00N-00 |
| IC213 | 5322 209 85265 | SN74LS03N-00 |
| IC214 | 5322 209 84986 | SN74LS74N-00 |
| IC216 | 5322 209 84823 | SN74LS00N-00 |
| IC217 | 5322 209 85312 | SN74LS02N-00 |
| IC401 | 5322 209 84355 | OQ001        |
| IC402 | 5322 209 84355 | OQ001        |
| IC501 | 5322 209 84355 | OQ001        |
| IC601 | 5322 209 84355 | OQ001        |

| ITEM   | ORDERING NUMBER | TYPE/DESCRIPTION |
|--------|-----------------|------------------|
| IC602  | 5322 209 84355  | 00002            |
| IC1301 | 5322 209 84452  | 709HC            |
| IC1801 | 5322 209 84899  | LM723CH          |
| IC2401 | 5322 209 84355  | 00002            |
| IC2402 | 5322 209 84355  | 00002            |
| IC2601 | 5322 209 84355  | 00002            |
| IC2602 | 5322 209 84355  | 00002            |
| IC2801 | 5322 209 84355  | 00002            |
| IC2802 | 5322 209 84355  | 00002            |

#### MISCELLANEOUS

|        |                |             |
|--------|----------------|-------------|
| L 401  | 5322 281 64154 | COIL        |
| L 1301 | 5322 150 14015 | ROTARY COIL |
| L 1800 | 5322 281 64154 | COIL        |
| L 1803 | 5322 152 24027 | CHOKE       |
| L 1804 | 5322 158 10052 | COIL        |
| L 1806 | 5322 281 64154 | COIL        |
| L 1807 | 5322 158 10052 | COIL        |
| L 1808 | 5322 281 64154 | COIL        |
| L 1909 | 5322 158 10052 | COIL        |
| L 1811 | 5322 281 64154 | COIL        |
| L 1812 | 5322 158 10052 | COIL        |
| L 1813 | 5322 281 64154 | COIL        |
| L 1814 | 5322 158 10052 | COIL        |
| L 1815 | 5322 281 64154 | COIL        |
| L 1817 | 5322 158 10052 | COIL        |
| L 1818 | 5322 281 64154 | COIL        |
| L 1819 | 5322 158 10052 | COIL        |
| L 1871 | 5322 281 64154 | COIL        |
| LA7    | 5322 134 44123 | LAMP        |
| LA7    | 5322 134 44123 | LAMP        |
| PE101  | 5322 280 24076 | RELAY COIL  |
| PE102  | 5322 280 24076 | RELAY COIL  |
| PE103  | 5322 280 24076 | RELAY COIL  |
| PE104  | 5322 280 24076 | RELAY COIL  |
| PE106  | 5322 280 24076 | RELAY COIL  |
| PE107  | 5322 280 24076 | RELAY COIL  |
| PE108  | 5322 280 24076 | RELAY COIL  |
| PE109  | 5322 280 24076 | RELAY COIL  |
| PE111  | 5322 280 24076 | RELAY COIL  |
| PE112  | 5322 280 24076 | RELAY COIL  |
| T 1401 | 5322 148 84023 | TRANSFORMER |
| T 1801 | 5322 146 14069 | TRAPP FXC   |
| T 1802 | 5322 148 84026 | TRAPP       |
| VL1    | 4822 253 30024 | FUSE        |
| SK4    | 5322 105 34038 | SWITCH      |
| SK6    | 5322 105 34039 | SWITCH      |
| SKA    | 5322 276 14158 | PUSH-BUTTON |
| SK10   | 5322 276 14158 | PUSH-BUTTON |
| SK11   | 5322 276 14158 | PUSH-BUTTON |
| SK17   | 5322 273 44043 | SWITCH      |
| SK22   | 5322 276 14158 | PUSH-BUTTON |



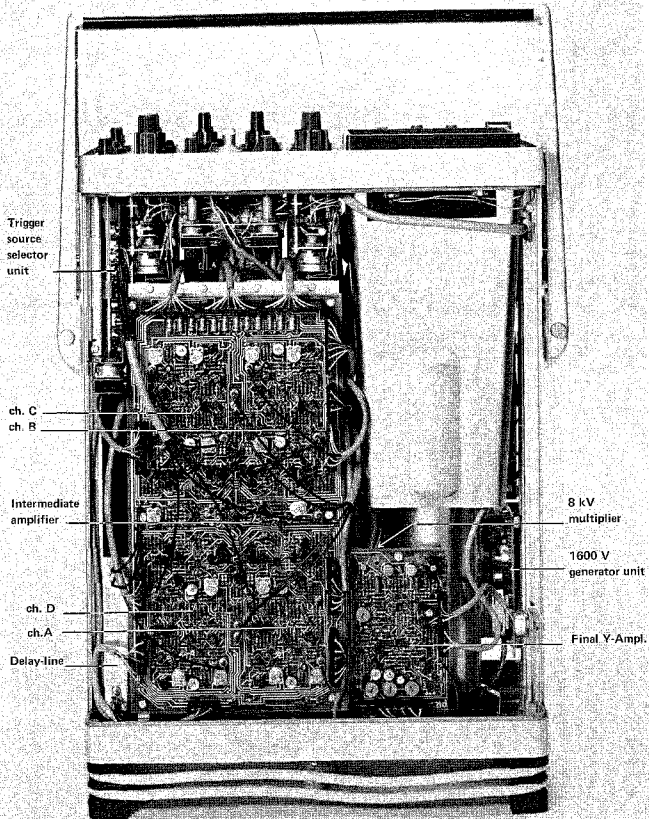


Fig. 3.1. Unit location, top view

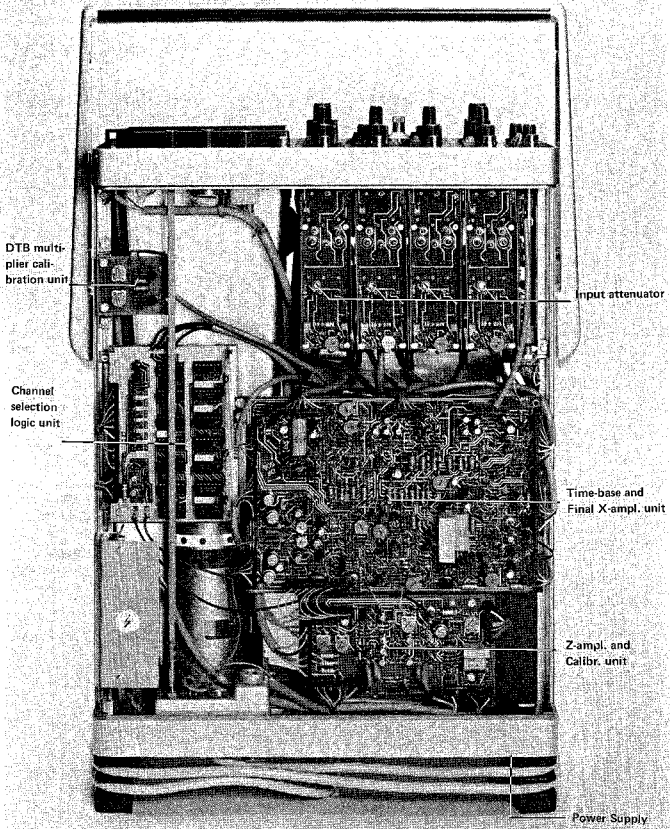


Fig. 3.2. Unit location, bottom view

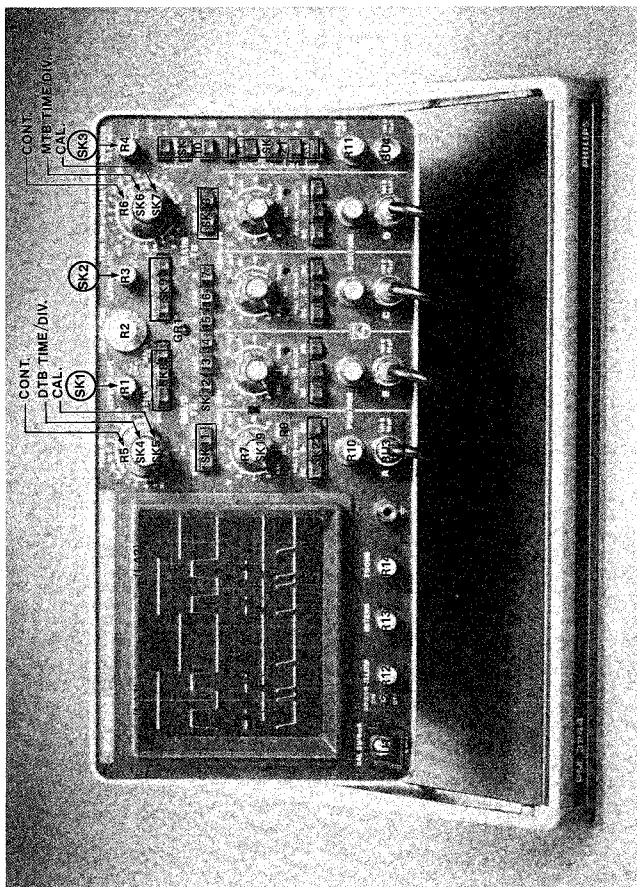


Fig. 3.3. Electrical item numbers, front panel





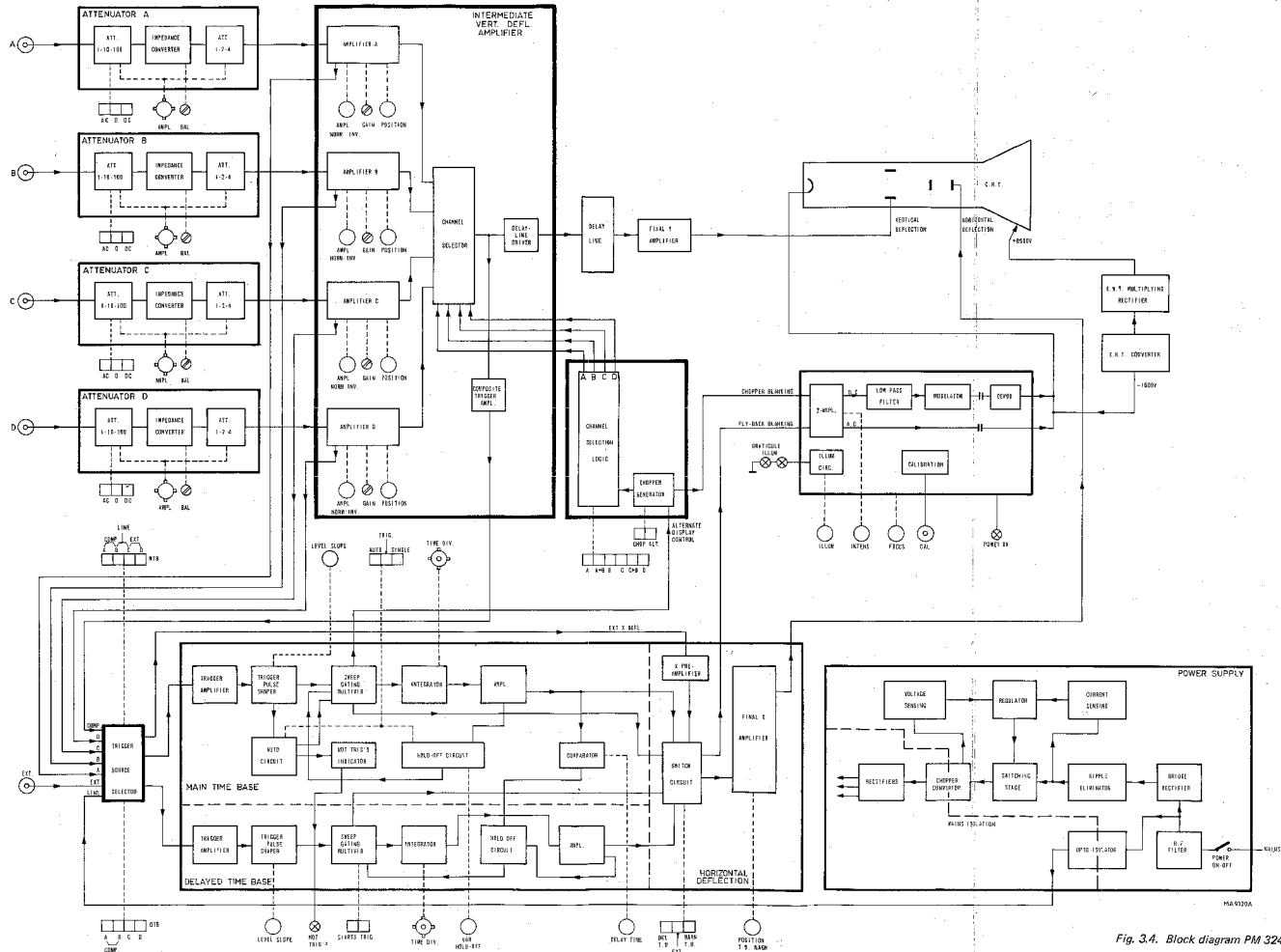
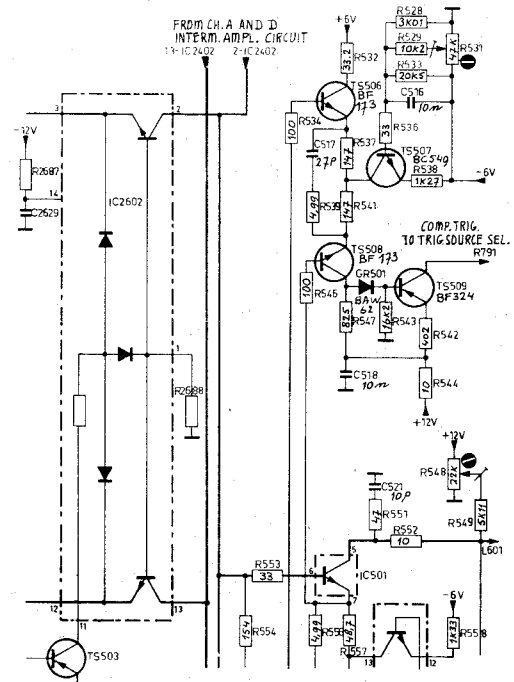


Fig. 3.4. Block diagram PM 3244







MA9379

Fig. 3.7. Basic circuit for composite triggering





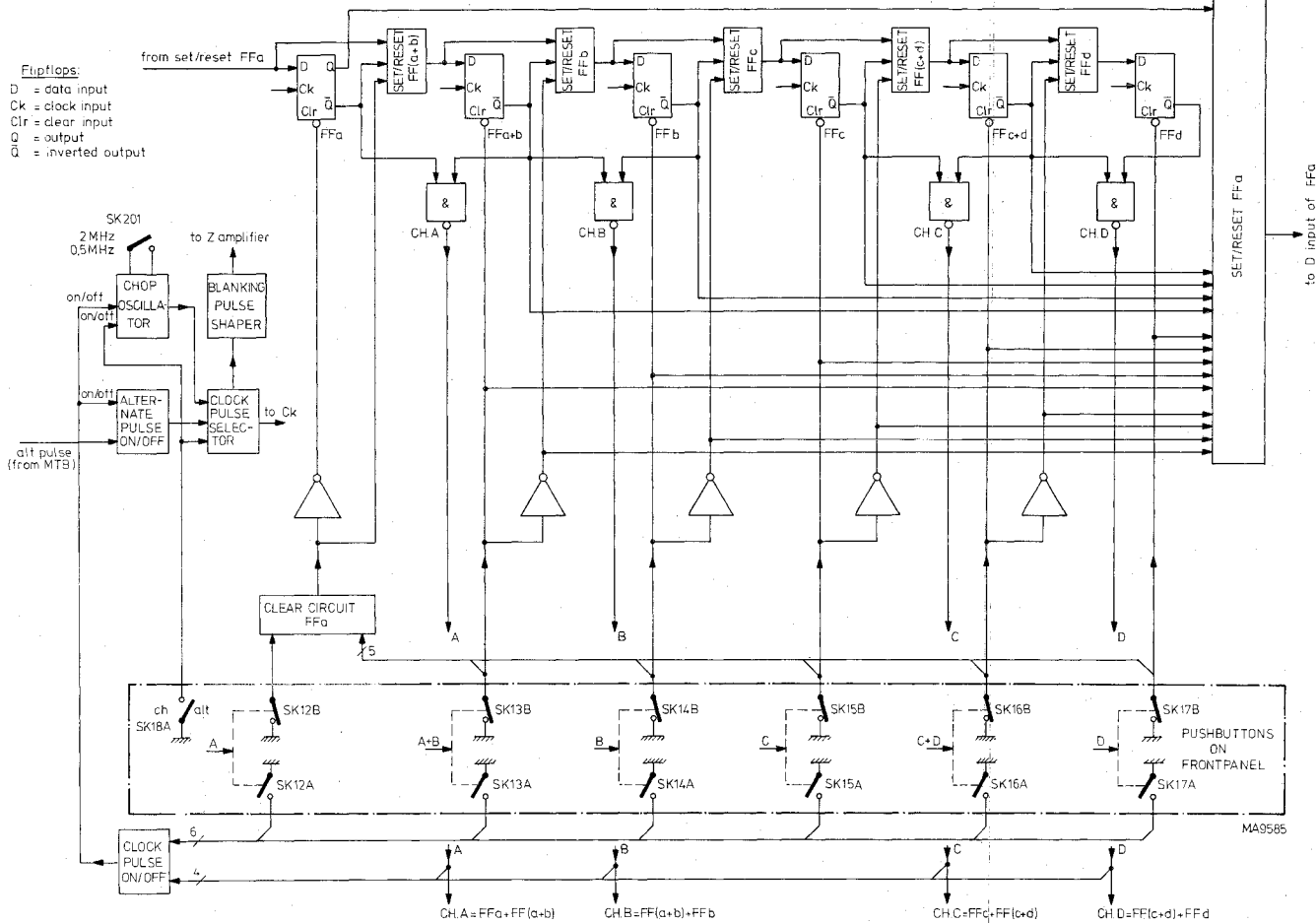
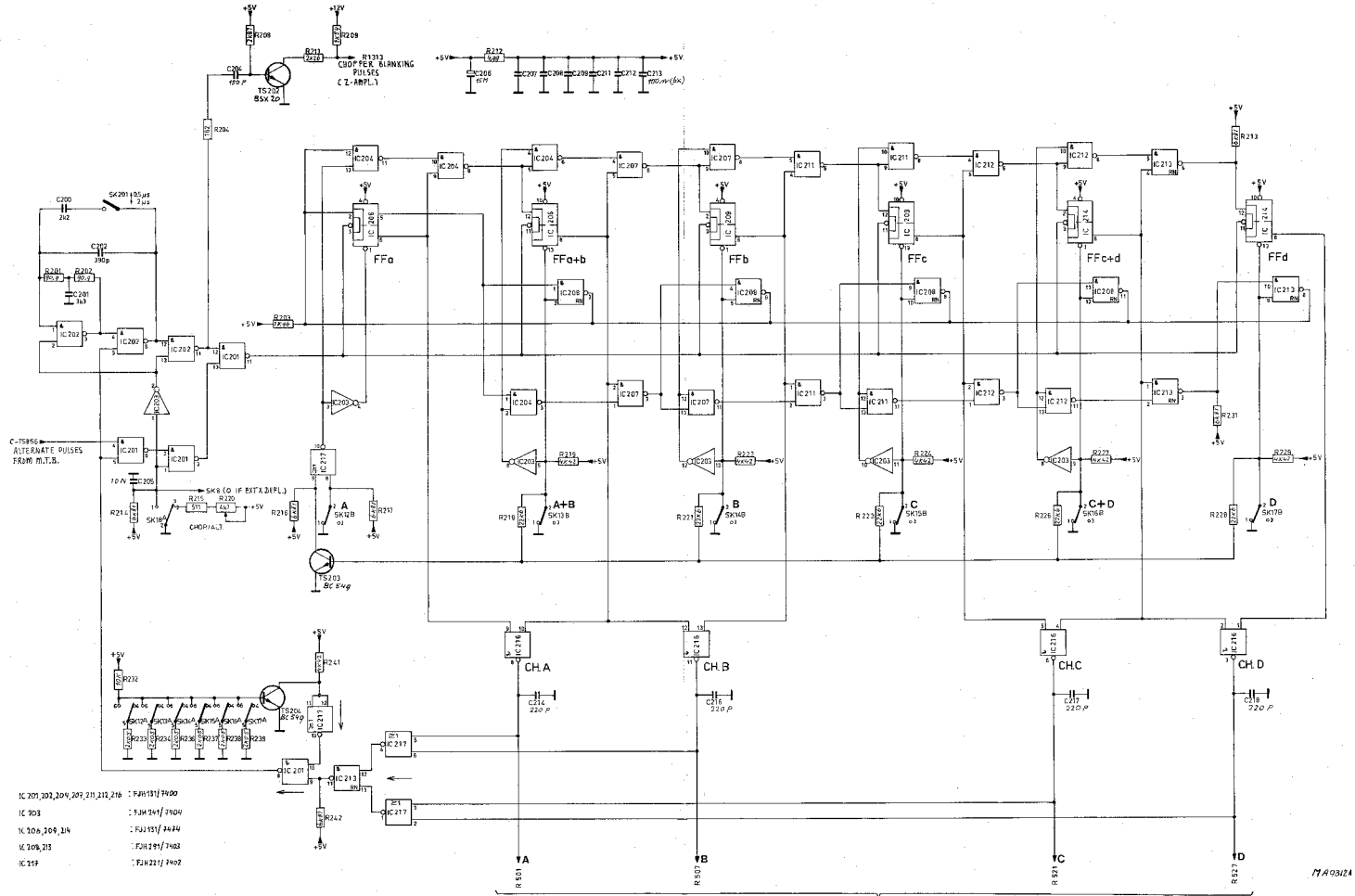


Fig. 3.10. Block diagram channel selection logic





- IC 201, 202, 204, 207, 211, 212, 216 : FAH151/3900
- IC 203 : FAH151/3904
- IC 204, 209, 214 : FAH151/3424
- IC 205, 213 : FAH151/7403
- IC 215 : FAH211/7402

MA9302A

Fig. 3.11. Circuit diagram, logic unit (from /03 version)

s60PE

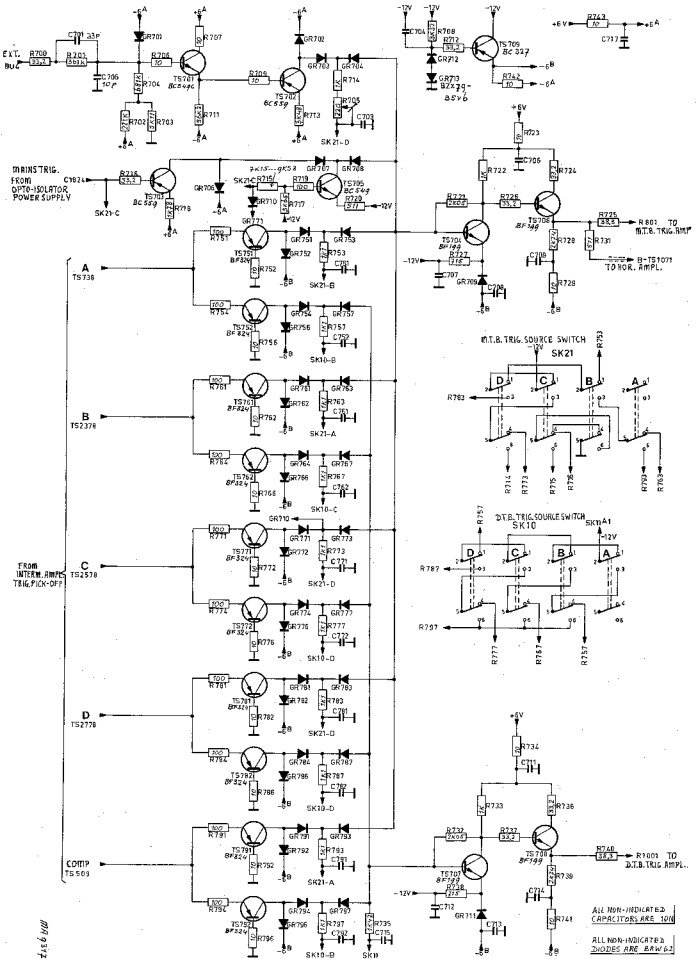
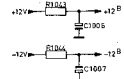
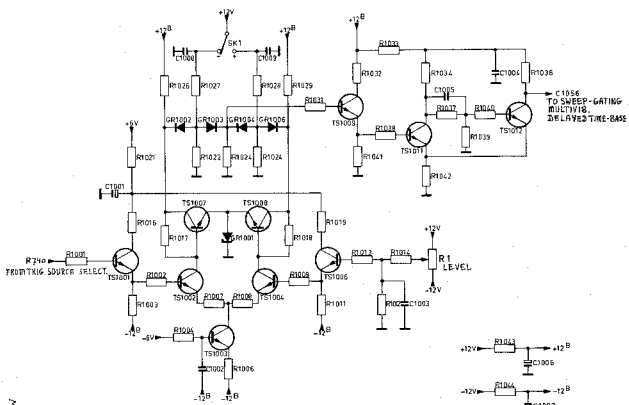
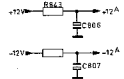
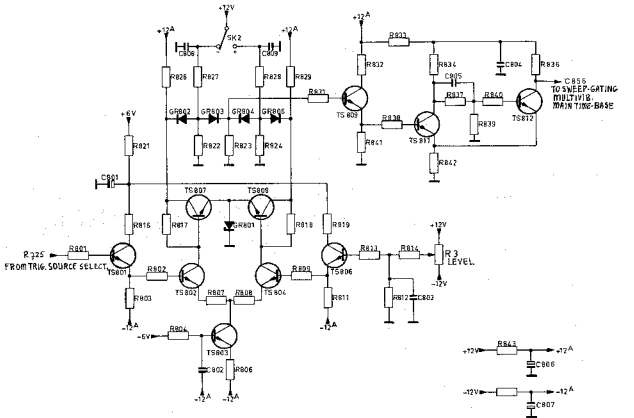


Fig. 3.12. Circuit diagram, trigger source selector



M/A 9318

Fig. 3.13. Circuit diagram, trigger amplifier

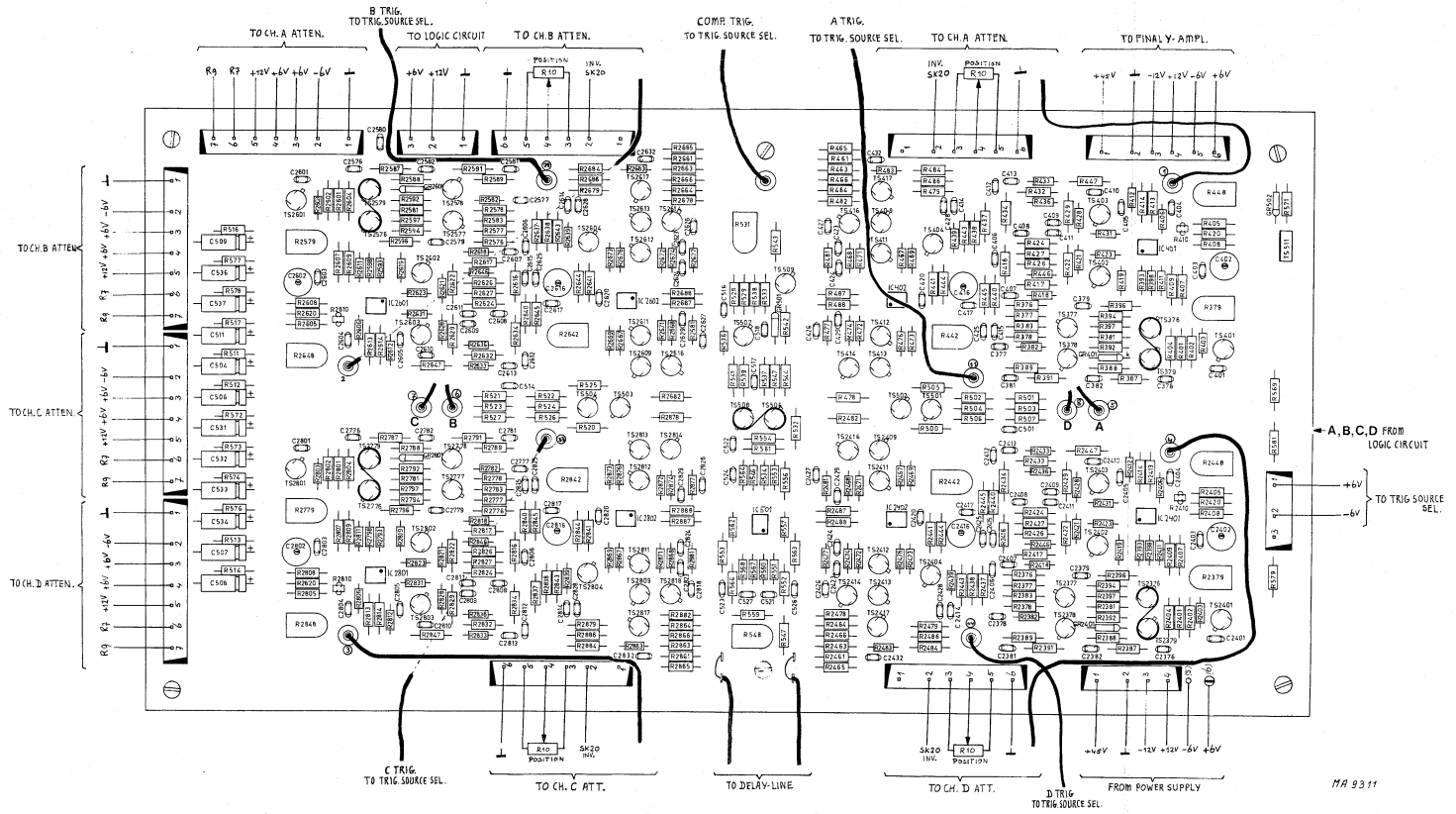


Fig. 3.14. Components lay-out, intermediate amplifier

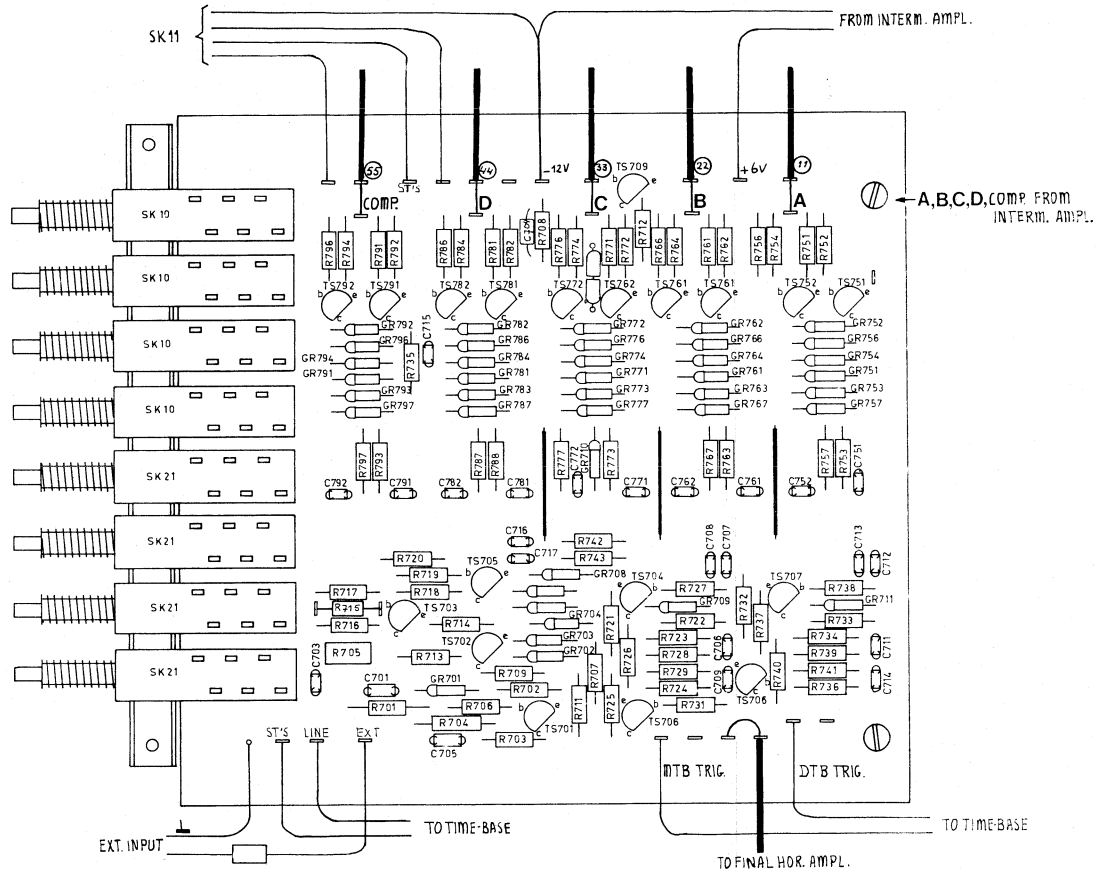


Fig. 3.15. Components lay-out, trigger source selector

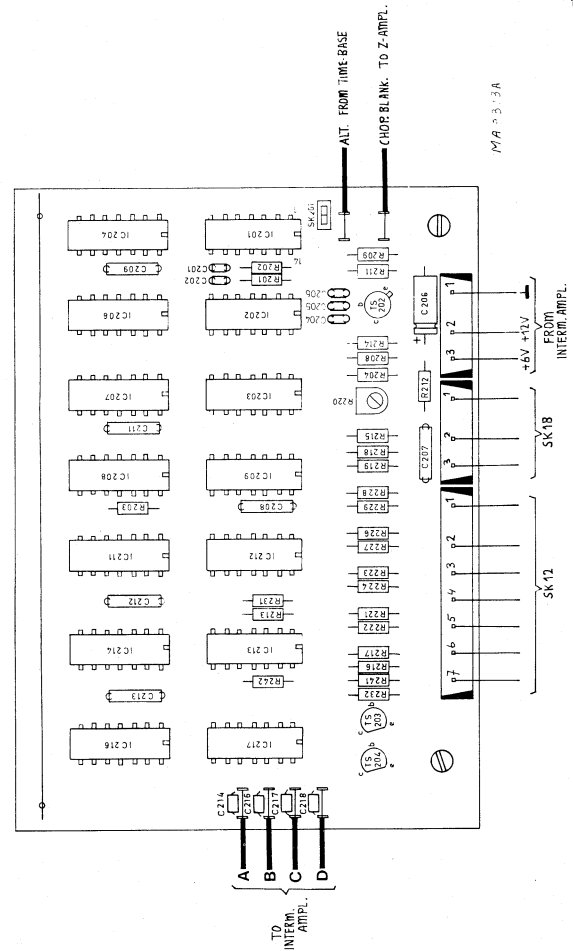


Fig. 3.16. Components lay-out, logic unit (from /03 version)



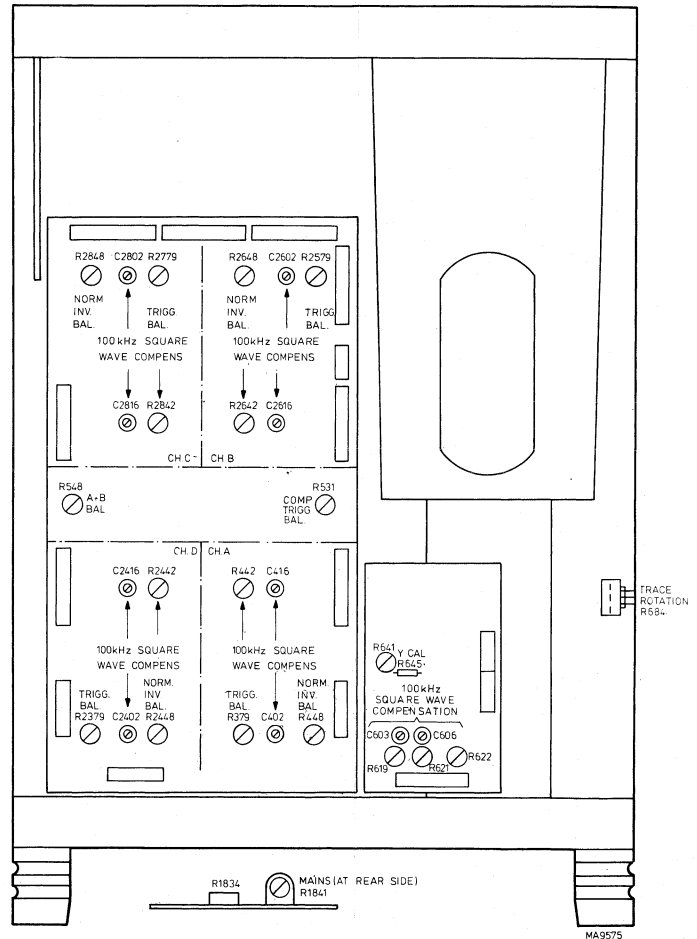


Fig. 3.17. Adjustment points, top view

MA9575

Fi





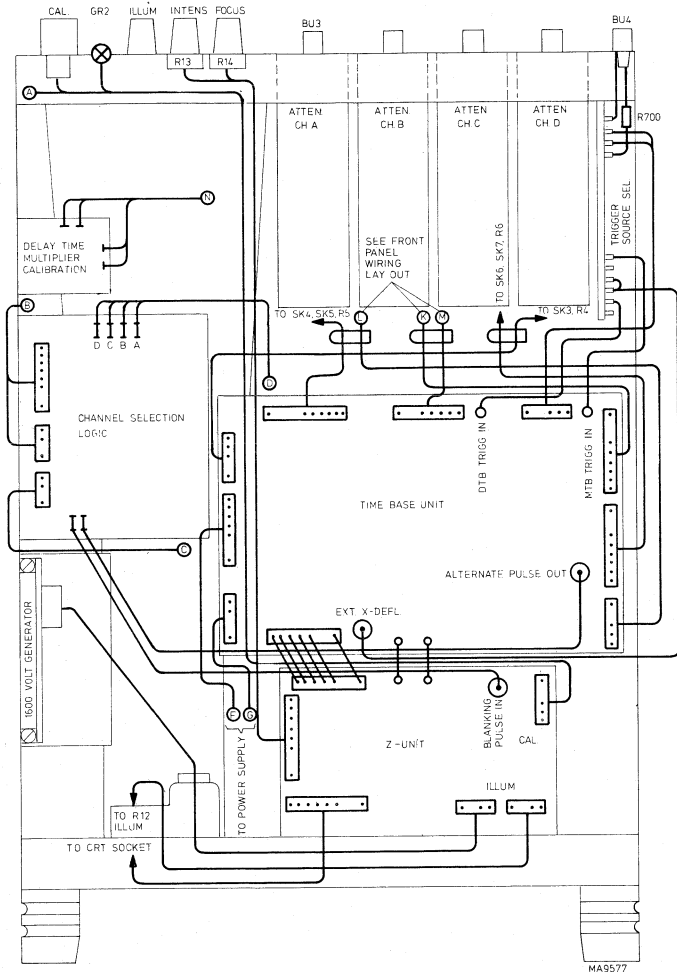


Fig. 3.19. Cable lay-out, bottom view

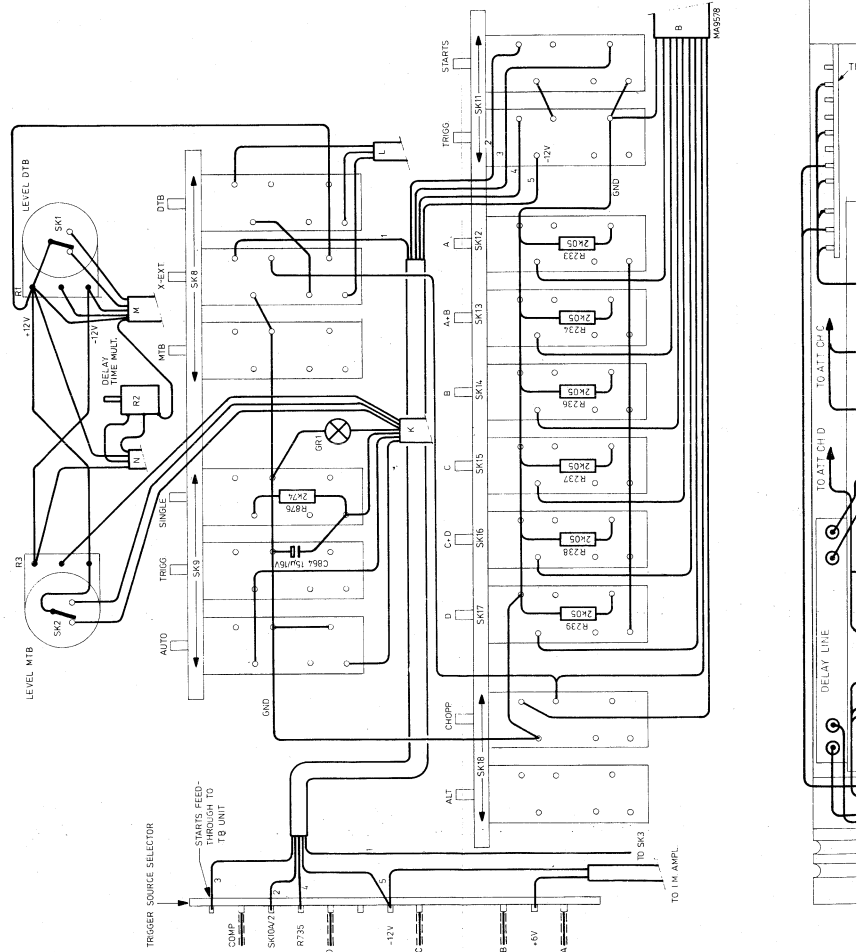


Fig. 3.20. Wiring lay-out, front panel





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