200 MHz V.H.F. Dual Channel, Dual Time Base Oscilloscopes

PM3285A - PM3286A

Operating Manual/Gebrauchsanleitung/Notice d'emploi

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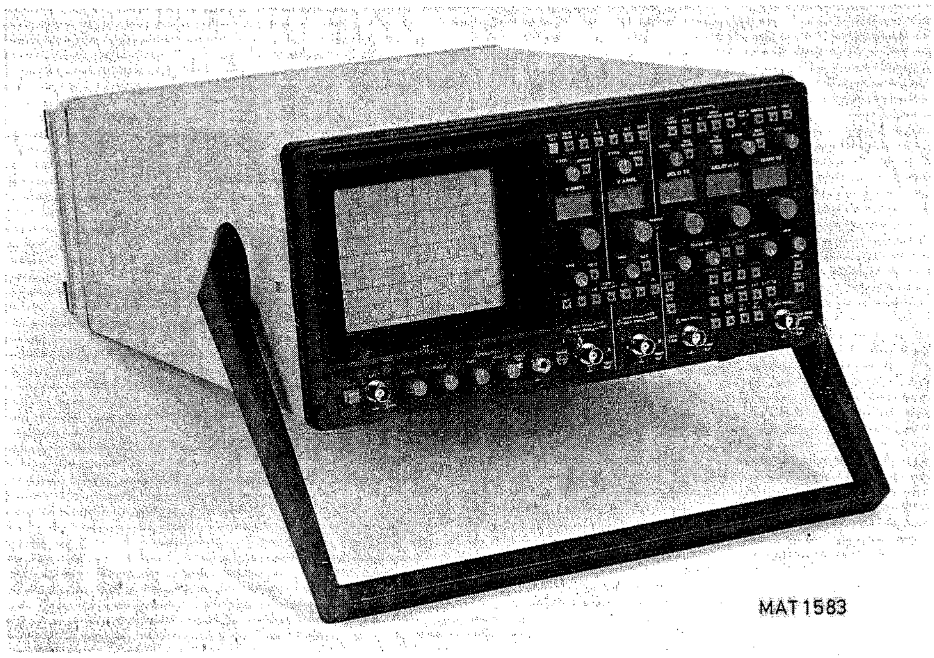

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Also published:
- Service Manual PM3285A-PM3286A
- IEEE-488/IEC625 interface PM8950
- Programming card PM8950

PHILIPS

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IMPORTANT

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

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

WICHTIG

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

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

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparation)
Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

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

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200 MHz V.H.F. Dual Channel, Dual Time Base Oscilloscopes

PM3285A - PM3286A

PHILIPS

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CONTENTS

1. OPERATOR SAFETY

Read this page carefully before installation and use of the instrument.

1.1. GENERAL INFORMATION

The instrument described in this manual is designed to be used by properly-trained personnel only. Adjustment, maintenance and repair of the exposed equipment shall be carried out only by qualified personnel.

1.2. SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.3. CAUTION AND WARNING STATEMENTS

CAUTION: is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: calls attention to a potential danger that requires correct procedures or practices in order to prevent personnel injury.

1.4. SYMBOLS

Read the operating instructions.

Protective earth (grounding) terminal (black)

1.5. IMPAIRED SAFETY PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians. Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

ARRANGEMENT OF MANUAL

This Operating Manual is arranged in such a way that the essential information on safety and operating procedures is immediately available in the first chapters.

You are strongly advised to read Section 3.2. SAFETY INSTRUCTIONS thoroughly before installing your oscilloscope.

In Chapter 4. QUICK-OPERATING PROCEDURE, the most important functions are indicated and clearly explained by means of illustrations. This procedure offers the possibility to operate the instrument immediately after installation.

More detailed operating information is given in the remainder of Chapter 4.

Complete information for preventive maintenance on the instrument can be found in Chapter 5. This is followed by details of the functional, mechanical and environmental data, listed in Chapter 6, Characteristics.

Finally, additional information regarding the various versions of the instrument and accessories is given in Chapter 7. and Chapter 8. respectively.

2. INTRODUCTION

2.1. ARRANGEMENT OF OSCILLOSCOPE

This compact V.H.F. oscilloscope features an extensive bandwidth of 200MHz and good ergonomic design for its numerous measurement capabilities. A unique feature is the AUTO SET pushbutton facility, which automatically sets various controls of the instrument to suit the input signal value. In this way, optimum ease of operation is obtained as the input signal immediately presents a correct, stable display on the bright c.r.t. screen.

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

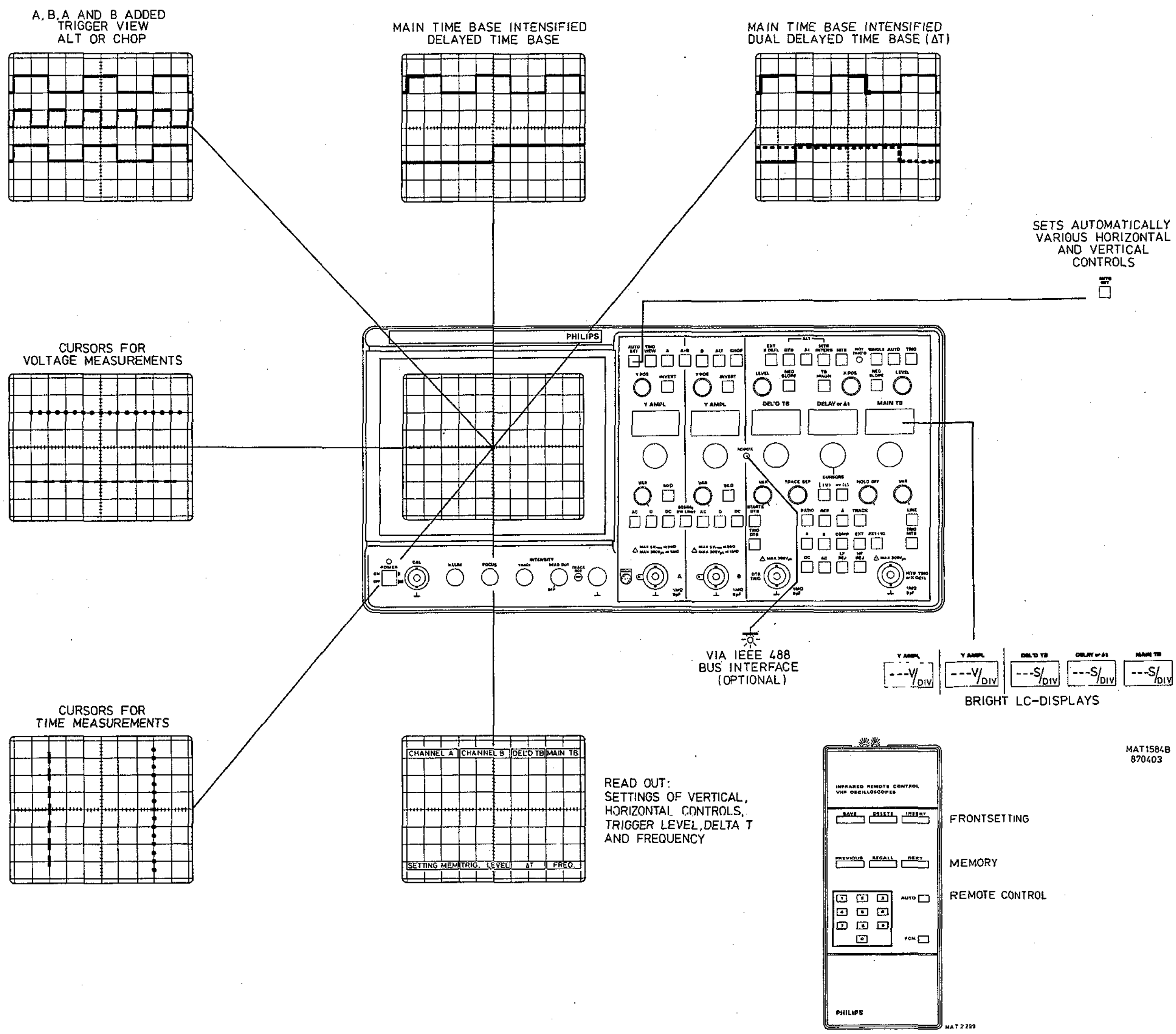


Fig. 2.1. 200MHz V.H.F. oscilloscope features

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

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

The PM3285A is the standard version of the two instrument types and has CRT text and cursors for easy time and voltage measurements.

Additional to this all, the PM3286A has a remote control that makes it possible to store and recall the settings of 75 different front panels. Moreover this type of instrument is always provided with a IEEE 488 interface bus.

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

3. INSTALLATION INSTRUCTIONS

3.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occured during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

3.2. SAFETY INSTRUCTIONS

3.2.1. Earthing

Before any connection to the input connectors is made, the instrument shall be connected to a protective earth conductor via the three-core mains cable; the mains plug shall be inserted only 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 is likely to make the instrument dangerous. Intentional interruption is prohibited.

''Before connecting the equipment to the mains of the building installation, the proper functioning of the protective earth lead of the building installation need to be verified''.

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.

3.2.2. Mains voltage cord and fuses

Different power cords are available for the various local mains voltage outlets.
The power cord version delivered is determined by the particular instrument version ordered (see also Chapter 7).

NOTE: If the mains plug has to be adapted to the local situation, such adaption should be done only by a qualified technician.

This oscilloscope has a tapless switched-mode power supply that covers most voltage ranges in use: 90V . . . 264V a.c. (r.m.s.). This obviates the needs to adapt to the local mains voltage. The mains frequency range is 45Hz . . . 440Hz.

WARNING: The instrument shall be disconnected from all voltage sources when renewing a fuse.

⚠ Mains fuse rating: 2.5 A delayed-action, 250V

The mains fuseholder is located on the rear panel (see Fig. 3.1.). If the mains fuse needs replacing, proceed as follows:
- remove the inner part of the fuseholder by means of a screwdriver or coin.
- fit a new fuse of the correct ratings and refit the inner part of the fuseholder.

WARNING: Make sure that only fuses of the required current and voltage rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or short-circuiting of the fuseholder, is prohibited.

3.3. MEMORY BACK-UP BATTERIES

3.3.1. General information

The memory back-up circuit has the following functions:

- after a power source interrruption of more than 20ms, or when the oscilloscope is switched off, the front-setting values are saved in a memory.
- after the power supply is restored, the oscilloscope starts up automatically.

3.3.2. Installation

The two 1.5V penlight batteries (e.g. Philips LR6) must be installed as follows:

- remove the cover of the battery compartment located on the rear panel, by pressing the two locking tongues towards each other and pulling (see Fig. 3.1.). The battery holders are now accessible.
- insert the two penlight batteries, paying attention to the polarity indication marked on the holder (also on Fig. 3.1.). CHECK POLARITY TO ENSURE CORRECT INSTALLATION!
- refit the push-on cover to the rear panel.

NOTE: It is advisable to remove the batteries when the oscilloscope is stored for longer periods than 24 hours at ambient temperatures below −30°C or above 60°C.

IMPORTANT: Under no circumstances should the batteries be left in the oscilloscope at ambient temperatures outside the rated range of the battery specifications!

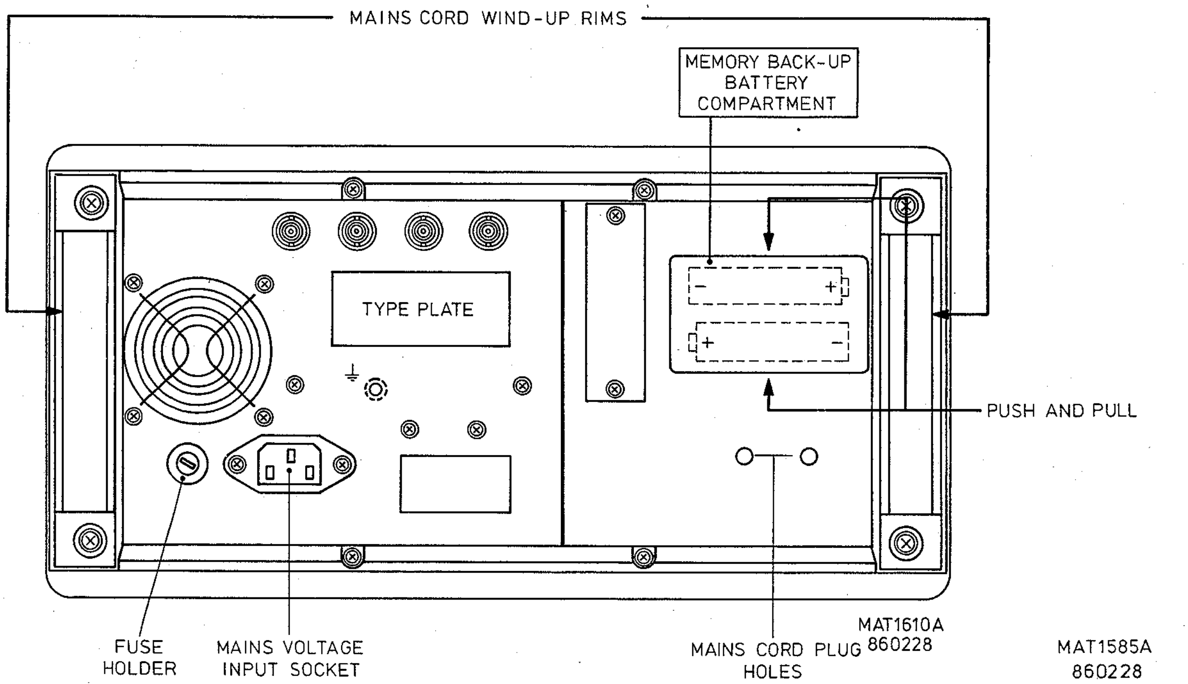


Fig. 3.1. Rear view of the oscilloscope

3.4. THE FRONT COVER (Fig 3.2)

3.4.1. Removing and fitting

For ease of removal and fitting, the front cover has been designed as a simple push-fit on the front of the instrument. The front can be removed as follows:
- pull both handle arms outwards (1);
- turn the carrying handle clear of the cover (2);
- pull both clamping lips of the front cover outwards (3);
- lift the cover off the instrument.

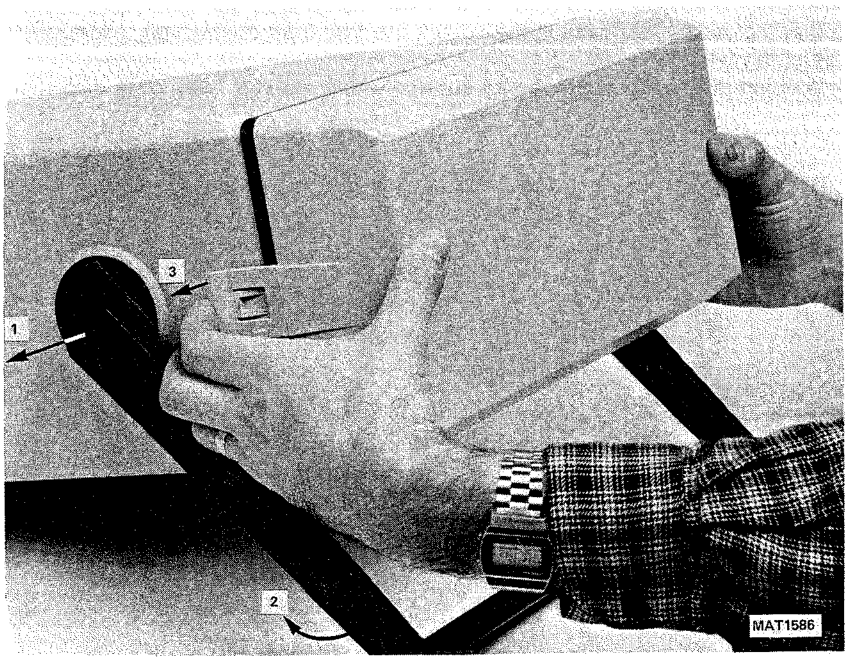


Fig. 3.2. Removing the front cover

The cover can be refitted by simply pushing it on the oscilloscope.

3.4.2. Acces to inner-cover storage space (fig. 3.3.)

Storage space for accessories such as probes, is available behind the inner front cover. This inner-cover can be lifted out by pressing the two locking tongues towards each other as indicated.

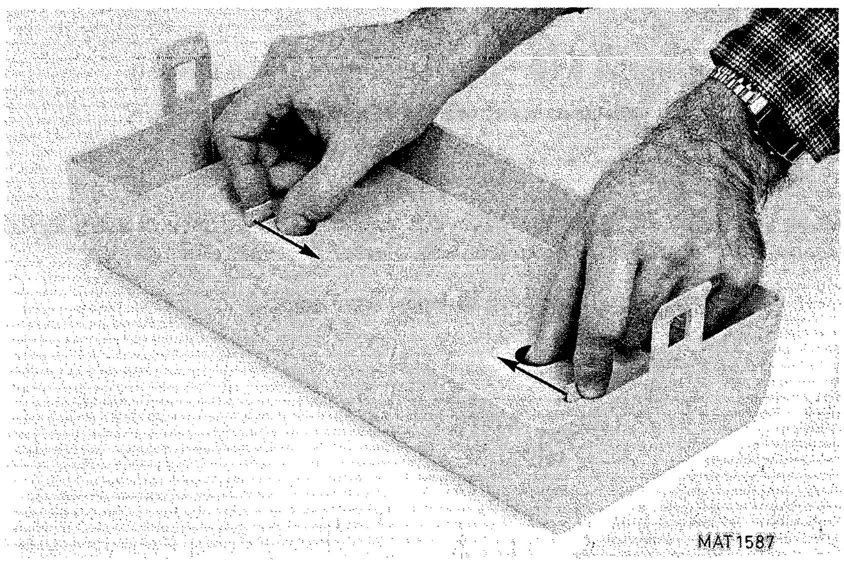


Fig. 3.3. Removing the inner front cover (storage space)

3.5 OPERATING POSITION OF THE INSTRUMENT

The oscilloscope may be used in the following positions:

- horizontally on its bottom feet;
- vertically on its rear feet;
- on the carrying handle in three sloping positions (see Fig.3.4.).
  The available oscilloscope angles with respect to the working surface are 12°, 20° and 25° selected after pulling the carrying handle arms outwards and rotating.

The characteristics given in Chapter 6 are fully guaranteed for all the above-mentioned positions.

ATTENTION: - Ensure that the ventilation holes in the covers are free from obstruction, especially at the rear because of the fan.
- Do not position the oscilloscope on any surface which radiates heat, or in direct sunlight.

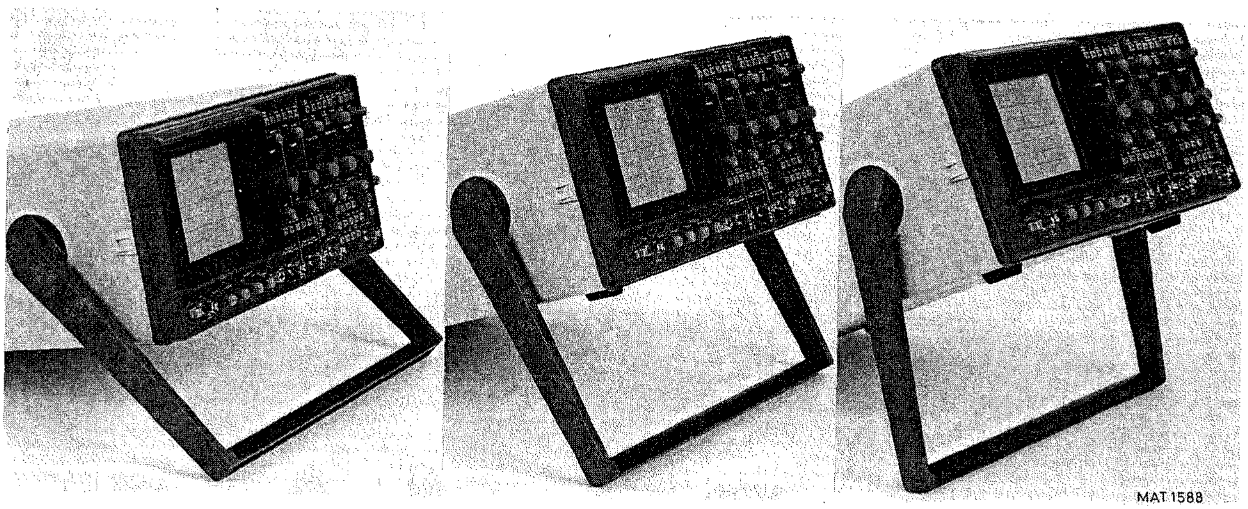
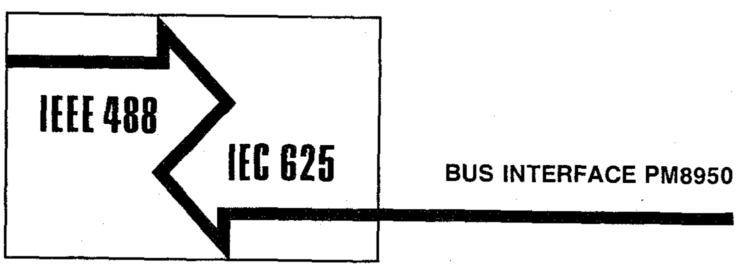


Fig. 3.4. Carrying handle rotation and sloping positions

3.6.



BUS INTERFACE PM8950

If your oscilloscope is equipped with an IEEE 488/IEC 625 bus option, it can be used in a bus system configuration. More detailed information regarding this option is given in a separate booklet:

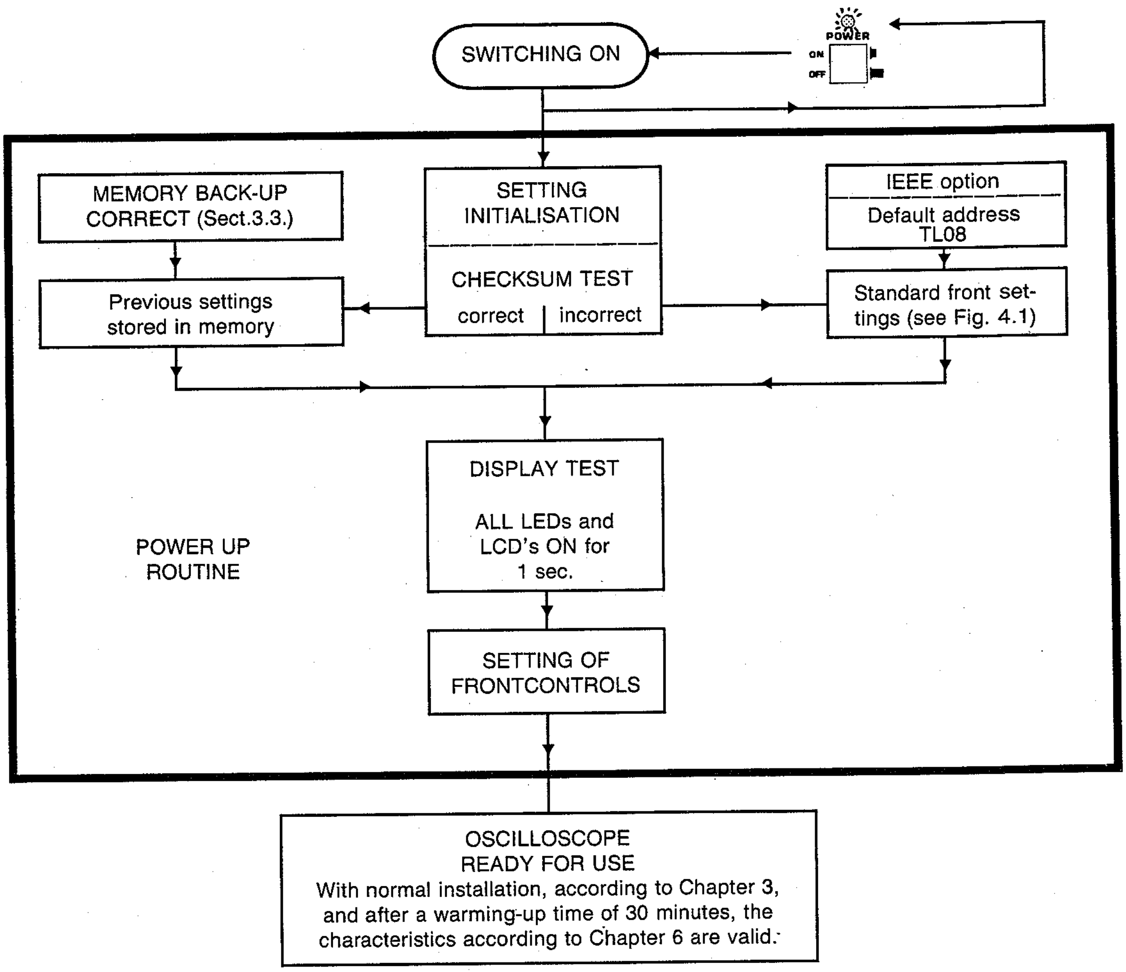
IEEE 488/IEC 625 BUS INTERFACE PM8950

4. OPERATING INSTRUCTIONS

This chapter outlines the procedures and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and indicators, and explains the practical aspects of operation to enable an operator to evaluate quickly the instrument's main functions.

4.1. SWITCHING-ON AND POWER-UP ROUTINE

After connecting the oscilloscope to the mains (line) voltage in accordance with Chapter 3, it can be switched on with the POWER ON/OFF switch.



***If during a test a circuit is found to be faulty,** the test stops and this will be indicated as follows:
- the instrument fails to operate normally;
- some, but not all, of the indicator lamps light.

If this occurs, it is recommended to switch off the instrument and switch on again after a few seconds.

IMPORTANT: IF THE FAULT CONDITION PERSISTS, CONTACT YOUR PHILIPS SERVICE DEPARTMENT.

***If an indicator lamp fails to light,** yet the instrument reverts to the operating mode after test, the lamp may be defective.

***If the system blocks during operation,** it may be due to extremely high static voltages. In this event, a switch-off, switch-on action should automatically reset the microprocessor-controlled system and restore operation.

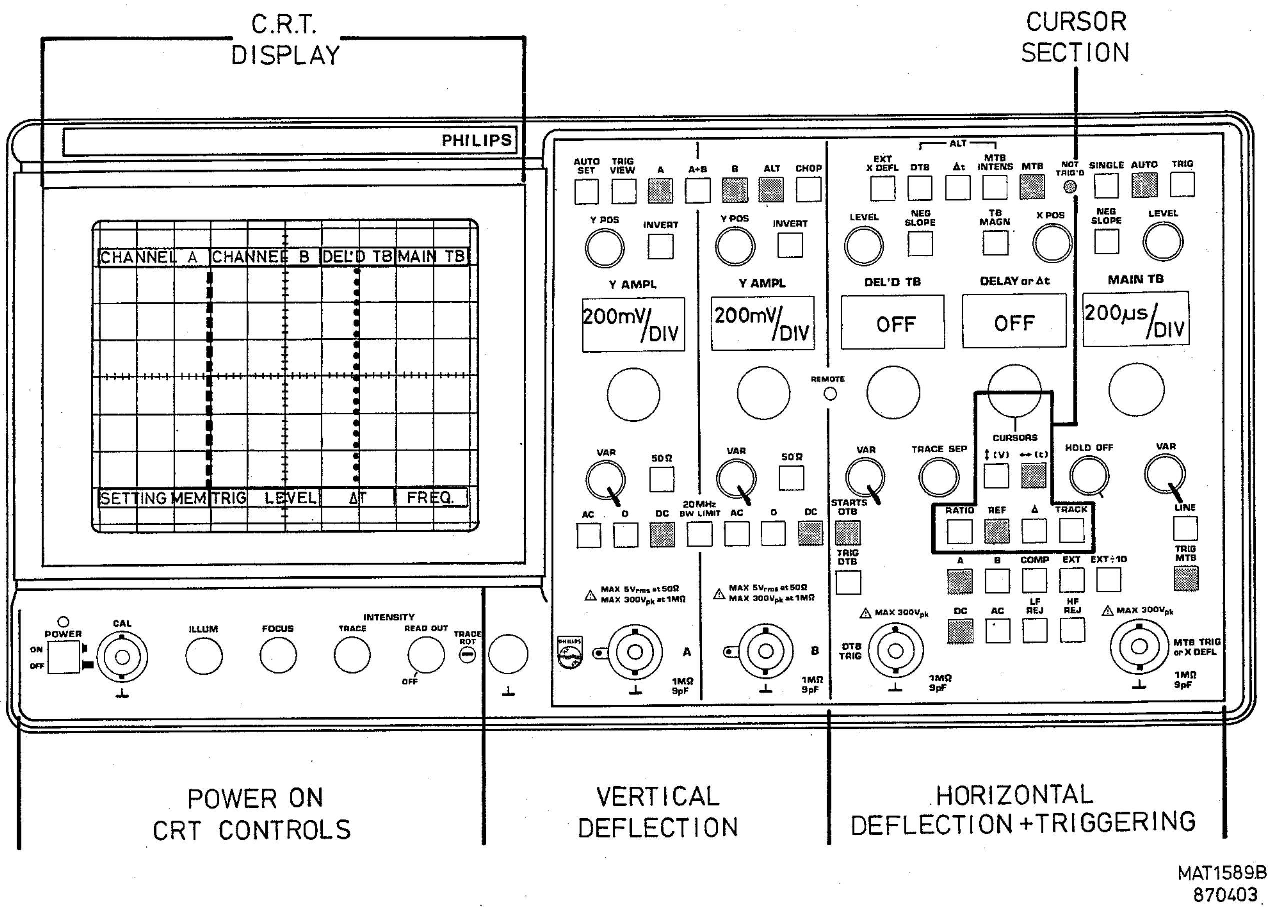


Fig. 4.1. Front panel functional layout

This front panel view shows the controls and sockets, the functional layout of the sections and the **standard settings.**

4.2. QUICK-OPERATING PROCEDURE

4.2.1. General information

This quick-operating procedure is designed to take you step-by-step through the most important operating facilities offered by your oscilloscope.
The various functions are explained by reference to diagrams. To simplify the procedure, it is arranged in such a way that the main functions are described in separate sections.

Note that every section is started by pressing the AUTO SET button and that each section can be performed separately. In the diagrams the action steps ① , etc. are numbered in sequence.
The result of an action step is indicated as [1] , etc. The functions that are active after switching-on and AUTO SET are indicated thus: ■

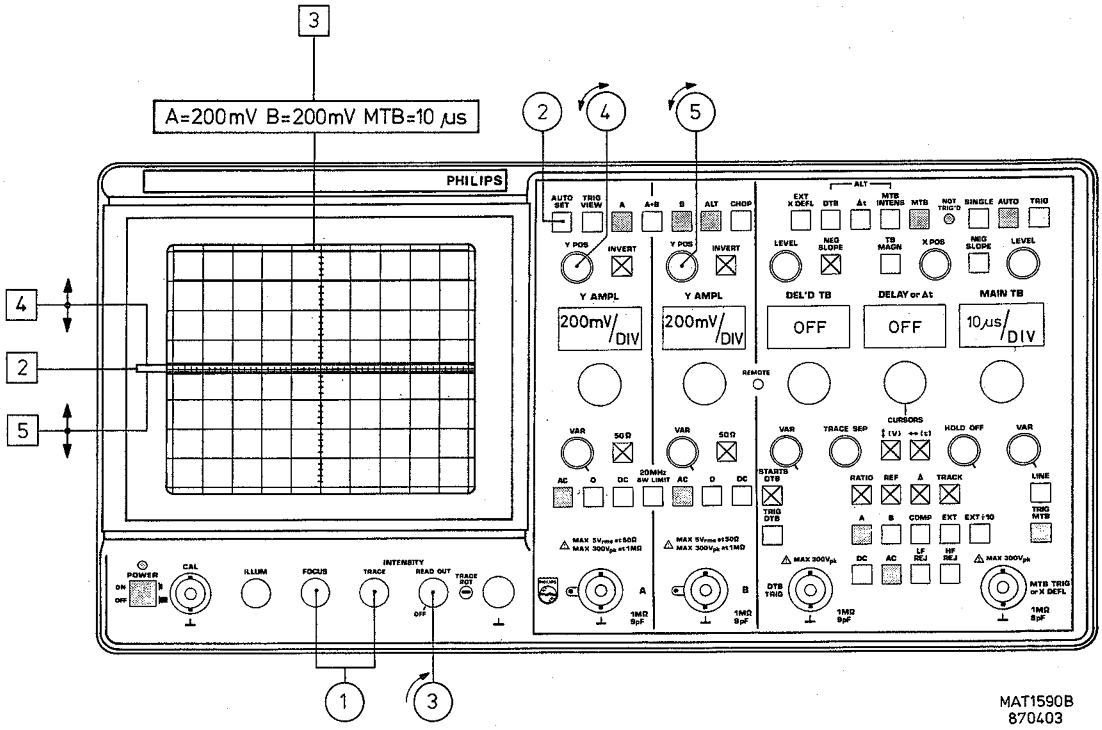
Below each diagram with its action steps, a number-related quick-operating procedure is briefly listed to speed-up the operation.
For ease of reference, the 'shorthand' symbols used in this chapter are listed below.

SYMBOL	MEANING
① , ② , ③ , etc.	action steps
[1] , [2] , [3] , etc.	result steps
■	active function
→	gives
⌒→	clockwise
←⌒	anticlockwise
←⌒→	either way
DTB	Delayed Time-Base
LCD	Liquid Crystal Display
MTB	Main Time-Base

No additional test equipment is necessary apart from the two 10:1 attenuator probes supplied and a BNC T-piece PM9067 together with two adaptors BNC female-probe tip.

The functional main sections covered in this procedure are indicated in Fig. 4.1.

4.2.2. Auto set, crt text



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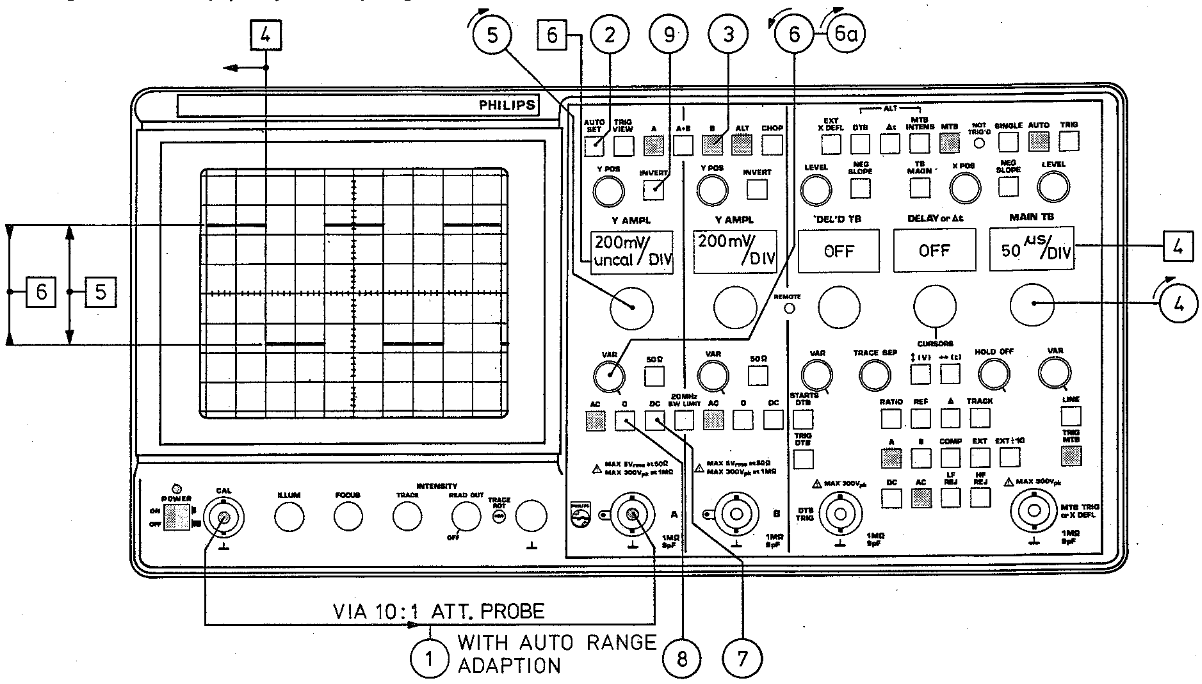
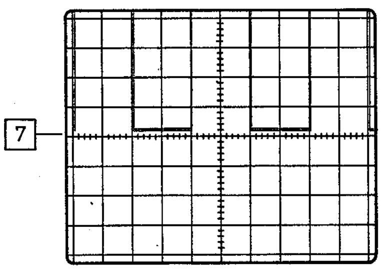
ACTION	RESULT
① Set FOCUS and INTENS controls for an optimum, well-defined trace.	
② Press AUTO SET	■ → [2]
③ Turn READ OUT ⌒	[3] CRT text visible, DTB and Δ values not indicated in this mode.
④ ⑤ } Turn Y pos. ⌒	After AUTO SET: Y POS controls are manually adjustable after turning them through their mid-positions. The traces can then be vertically shifted over the screen → [4] and [5].

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

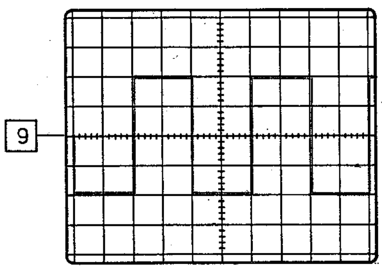
4.2.3. Single channel (A), input coupling, INVERT, MTB





DC INPUT COUPLING

ACTION	RESULT
① CAL signal via probe to input A.	
② Press AUTO SET	■
③ Press B	chan. B off, ALT off.
④ MAIN TB to 50µs/div	4
⑤ Y AMPL to 200mV/div	5
⑥ VAR ↶ ⑥a VAR ↷	UNCAL in LCD 6 UNCAL is off
⑦ Press DC	square-wave signal shifts up-wards 7 AC is off.
⑧ Press 0	straight line on display, DC is off.
Press AC	0 is off.
⑨ Press INVERT	inverted square-wave signal 9
Pres INVERT again	normal square-wave, INVERT off.



INVERTED INPUT SIGNAL

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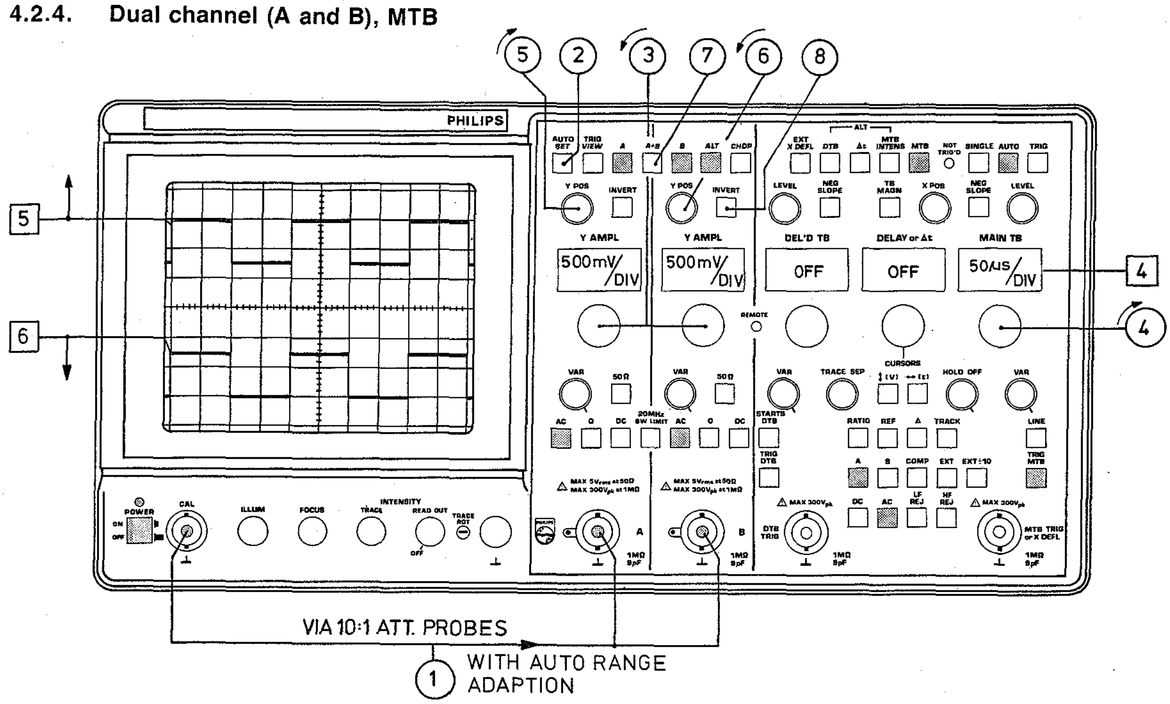
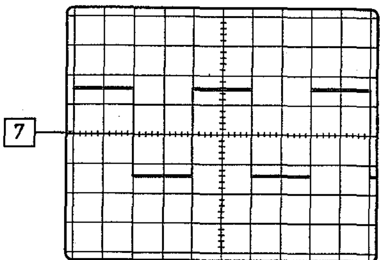
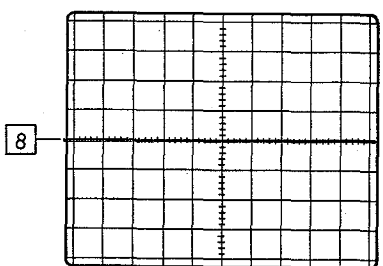
Channels A and B are identical; the above procedure can also be applied for channel B, but then read instead of A → B and B → A (action steps are only indicated for channel A).

4.2.4. Dual channel (A and B), MTB





A+B



A–B

ACTION	RESULT
① CAL signal via probes to inputs A and B.	
② Press AUTO SET	
③ Y AMPL 500mV/div.	in LCDs.
④ MAIN TB 50µs/div.	[4]
⑤ Turn Y POS ↷	[5] A trace upwards.
⑥ Turn Y POS ↶	[6] B trace downwards.
⑦ Press A + B	A and B signals are added.
Press A and B	A, B and ALT off. [7].
⑧ Press INVERT A or B	B input signal is subtracted from A input signal [8]
Press INVERT again	INVERT off

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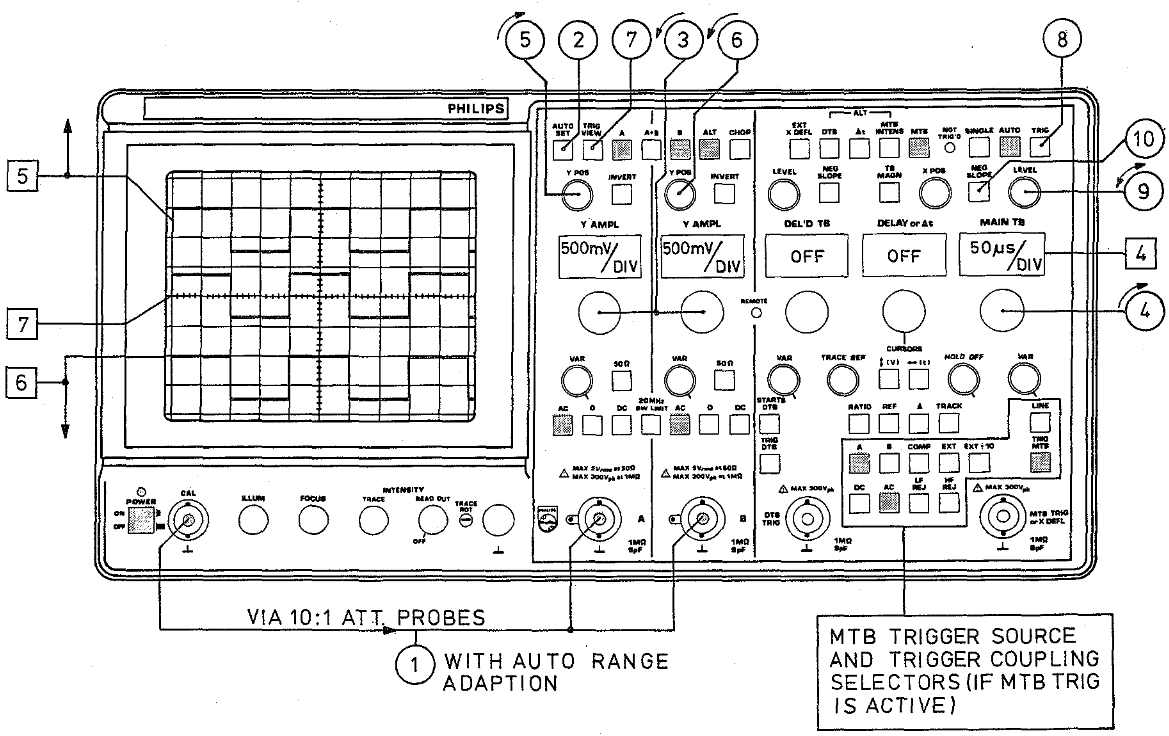
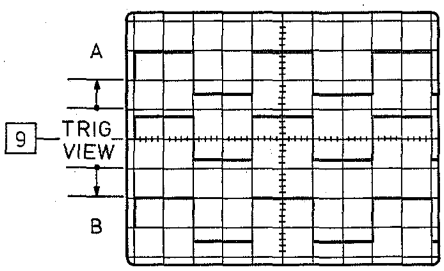
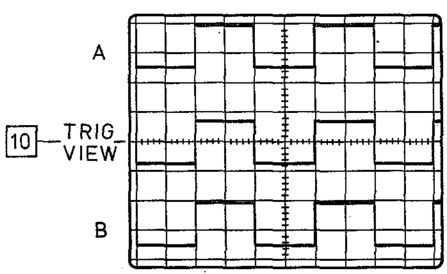
4.2.5. Dual channel (A and B), TRIG VIEW, MTB





MTB LEVEL RANGE



NEGATIVE TRIGGERING

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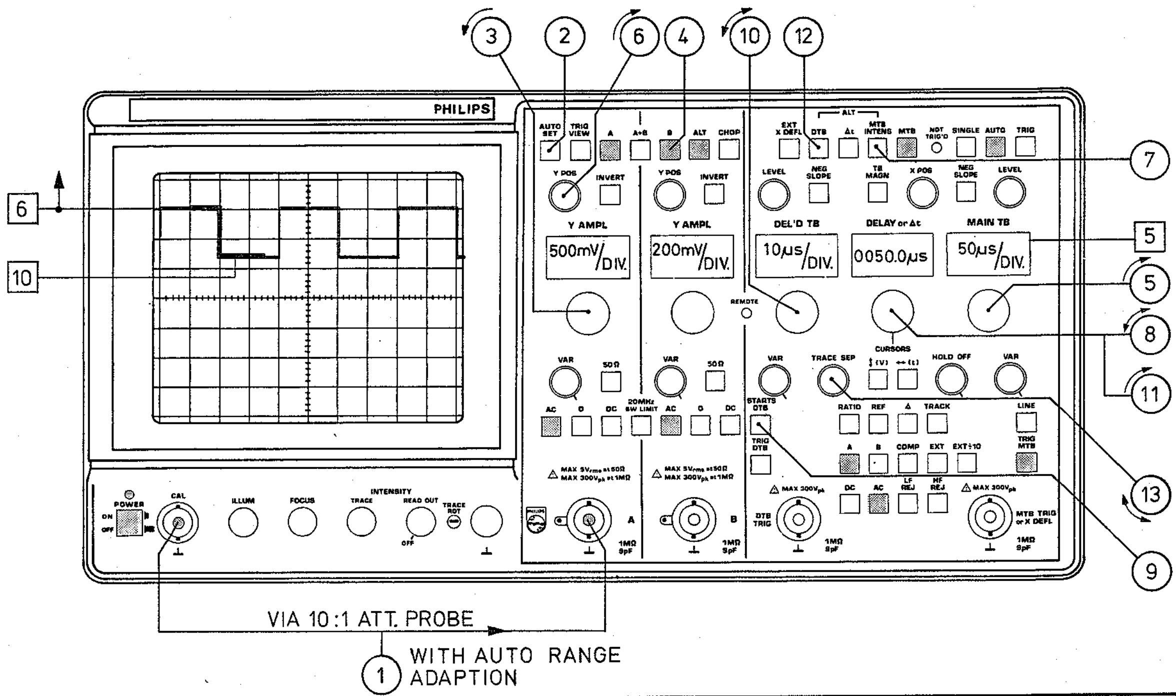
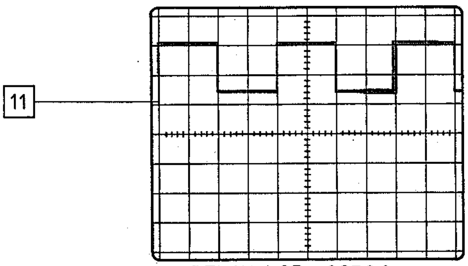
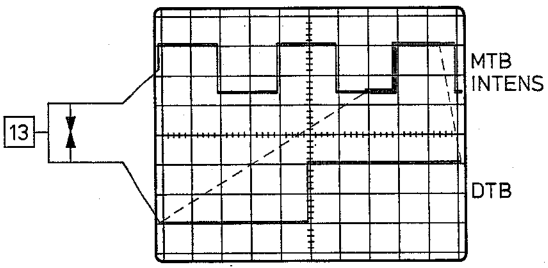
ACTION	RESULT
(1) CAL signal via probes to input A and B.	
(2) Press AUTO SET	■
(3) Y AMPL to 500mV/div	500mV/div LCD's
(4) MAIN TB to 50µs/div	[4]
(5) Turn Y POS ⌒→	[5], A trace upwards.
(6) Turn Y POS ←⌒	[6], B trace downwards.
(7) Press TRIG VIEW	3 traces: A, TRIG VIEW, B, [7].
(8) Press TRIG	AUTO off.
(9) Turn LEVEL ⌒→	TRIG VIEW signal 1 div. up/down [9], signals are triggered over a LEVEL range of 2 div.
Press AUTO Turn LEVEL	TRIG off. TRIG VIEW signal 1 div. up/down [9] signals are triggered over the complete LEVEL range (peak-peak triggering)
(10) Press NEG SLOPE Press NEG SLOPE	−ve triggering [10] +ve triggering [7]

4.2.6. Single channel (A) MTB INTENS, variable delay, DTB







ACTION	RESULT
(1) CAL signal via probe to input A.	
(2) Press AUTO SET	■
(3) Y AMPL to 500mV/div	500mV/div. in LCD.
(4) Press B	Chan. B off ALT off.
(5) MAIN TB 50μs/div	[5]
(6) Turn Y POS ⌒	[6]
(7) Press MTB INTENS	MTB is off.
(8) Turn DELAY ⌒	LCD 050.00μs
(9) Press STARTS DTB	UNCAL in LCD off
(10) DEL'D TB 10μs/div	LCD 10μs/div., [10] MTB INTENS.
(11) Turn DELAY ⌒	INTENSified part shifts horizontally LCD 350.00μs [11]
(12) Press DTB	MTB INTENS and DTB are active.
(13) Adjust TRACE SEP ⌒ Press TRIG DTB	[13] STARTS DTB off UNCAL in LCD DELAY

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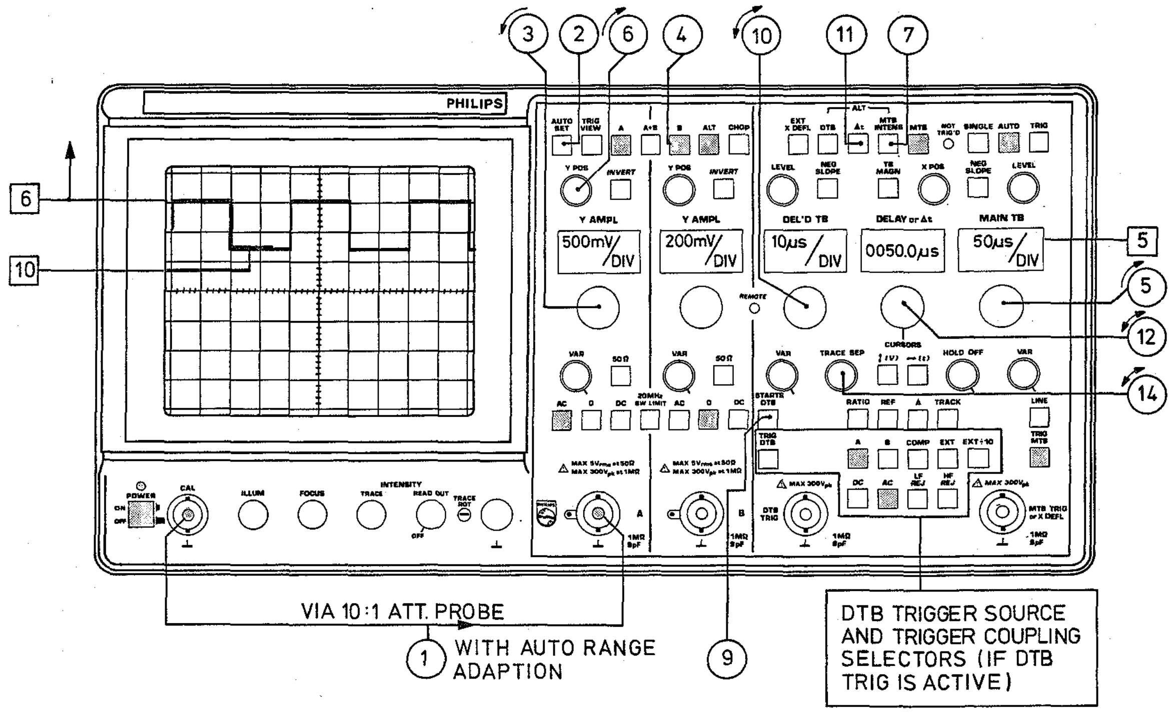
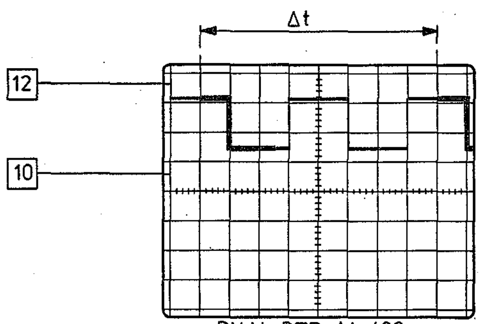
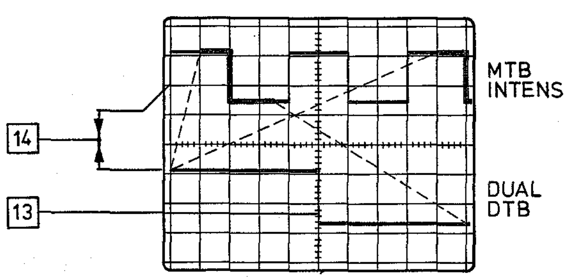
4.2.7. Single channel (A), MTB, dual DTB





DUAL DTB Δt:400µs



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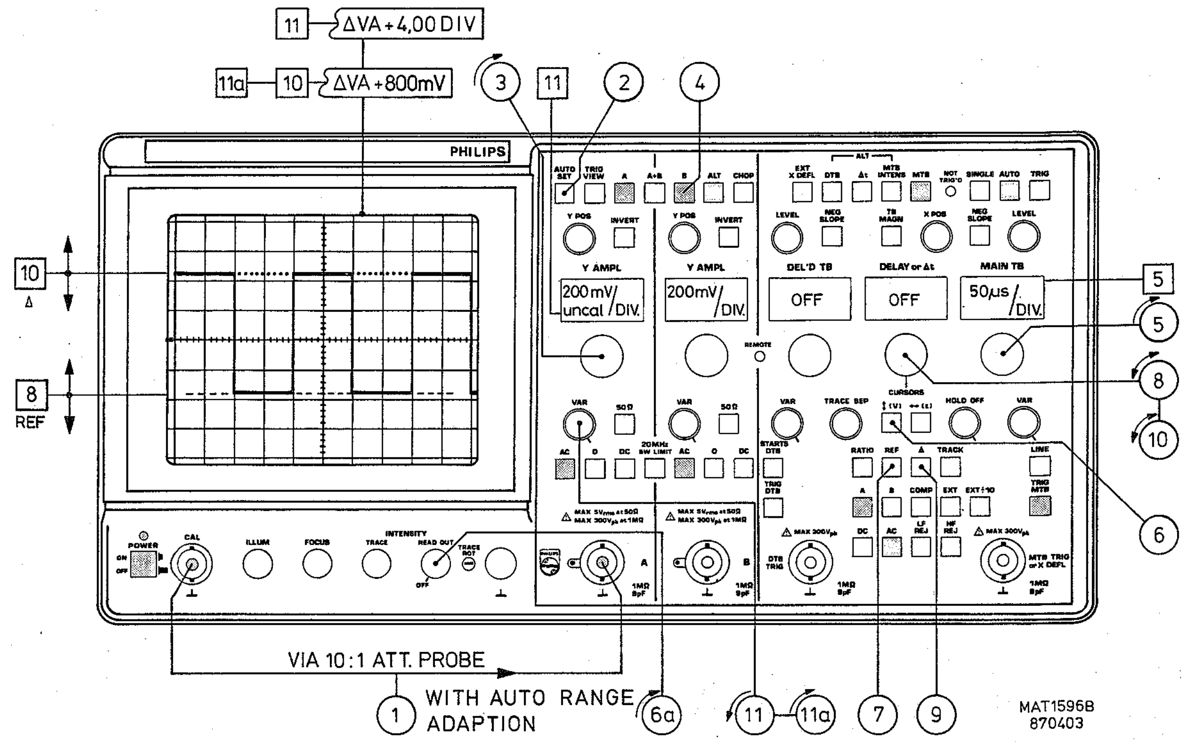
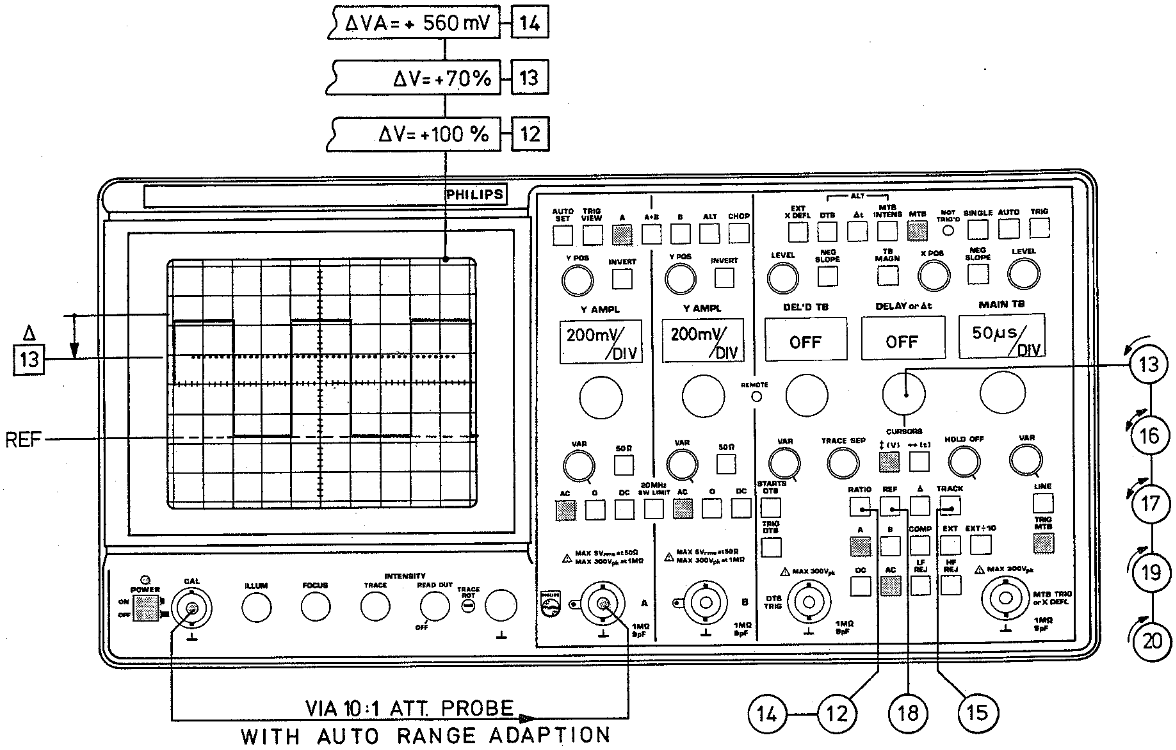
ACTION	RESULT
(1) CAL signal via probe to input A.	
(2) Press AUTO SET	■
(3) Y AMPL 500mV/div.	500mV in LCD
(4) Press B	channel B off ALT off.
(5) MAIN TB to 50µs/div	50µs/div in LCD. [5]
(6) Turn Y POS ↷	[6]
(7) Press MTB INTENS	MTB off.
(8) Turn DELAY ↶	LCD 050.00µs.
(9) Press STARTS DTB	UNCAL in LCD off
(10) DEL'D TB 10µs/div	LCD 10µs/div [10]
(11) Press Δt	MTB INTENS and Δt are active.
(12) Turn DELAY ↷	second INTENS part shifts horizontally Δt: LCD is 400.00 µs [12].
(13) Press DTB	MTB INTENS, Δt and DTB are active. 2 DTB traces cover each other. [13]
(14) TRACE SEP ↷ Press TRIG DTB	[14] STARTS DTB off UNCAL in LCD DELAY

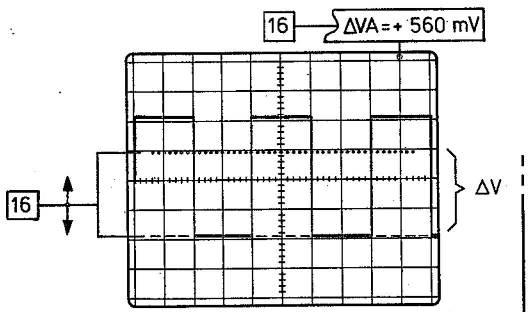
4.2.8. Cursors for voltage measurements (channel A)



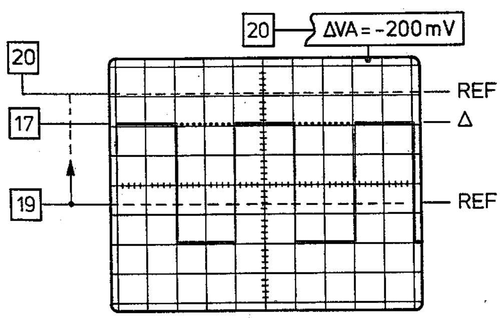
ACTION	RESULT
(1) CAL signal via probe to input A.	
(2) Press AUTO SET	■
(3) Y AMPL to 200mV/div	200mV in LCD
(4) Press B	chan. B off, ALT off.
(5) MAIN TB to 50μs/div	50 μs /DIV. in LCD → [5].
(6) Press ↕ (V)	RATIO, REF, Δ or TRACK is active;
(6a) READ OUT	cursors and values on c.r.t.
(7) Press REF	↕ (V) and REF active.
(8) Adjust CURSORS	REF cursor on bottom of square-wave signal [8]
(9) Press Δ	REF off (↕ (V) and Δ active).
(10) Adjust CURSORS	Δ cursor on top of squarewave signal [10] CRT text [10]
(11) Turn VAR	UNCAL in LCD [11] ΔV value in DIV.
(11a) Turn VAR	UNCAL is off Δ V value in V. [11a]

4.2.8. (cont'd) Cursors for voltage measurements (channel A)





ΔV TRACK

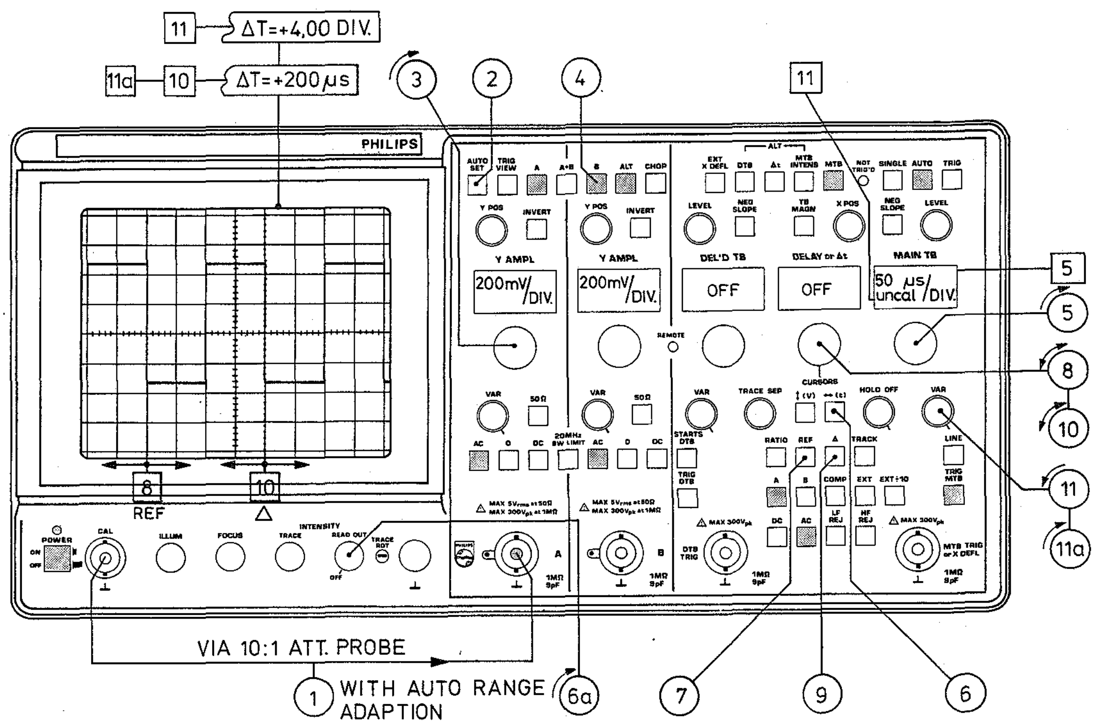


⑫ Press RATIO	↕ (V), Δ and RATIO active: CRT text 12
⑬ Turn CURSORS	Δ cursor on third div. from top of screen. CRT text 13
⑭ Press RATIO	RATIO off 14
⑮ Press TRACK	Δ V value is fixed.
⑯ Turn CURSORS	Δ V is shifted vertically over screen, 16
⑰ CURSORS	to set Δ cursor on top of square-wave signal 17
⑱ Press REF	TRACK, RATIO and Δ off.
⑲ Turn CURSORS	19
⑳ Turn CURSORS REF cursor above: Δ cursor Press ↕ (V)	20 (– ve Δ V value). ↕ (V) off

CURSOR VOLTage measurements are also possible on channel B input signal.

MAT 1597B
870403

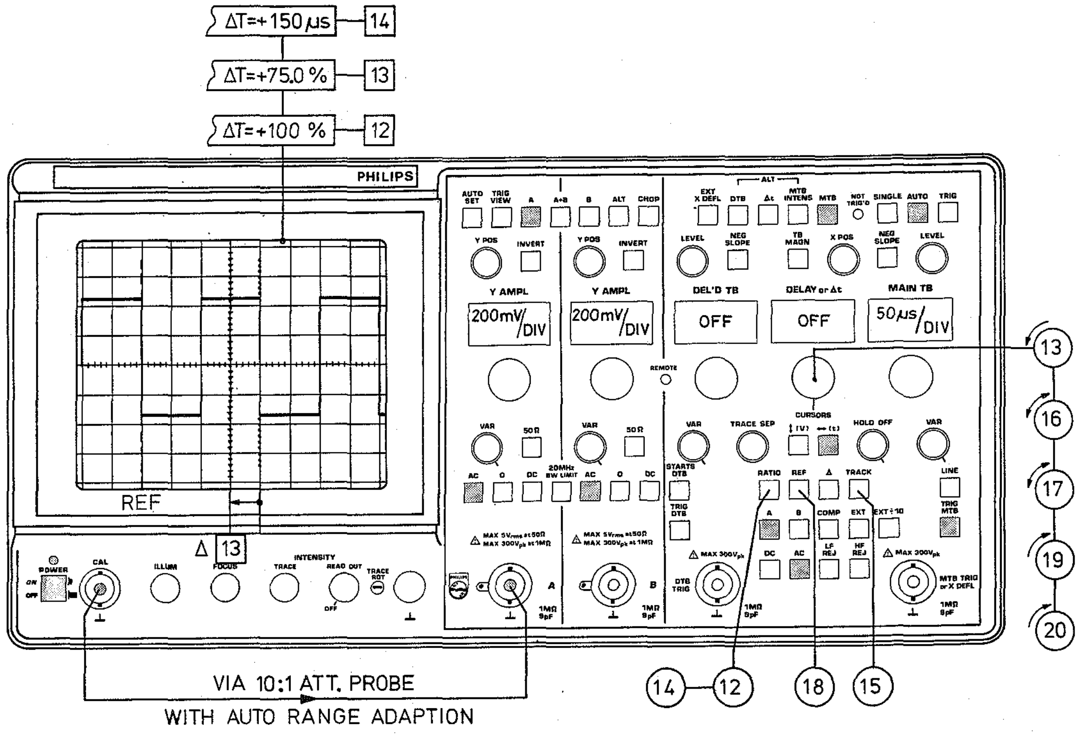
4.2.9. Cursors for time measurements on input signal (channel A) via MTB.

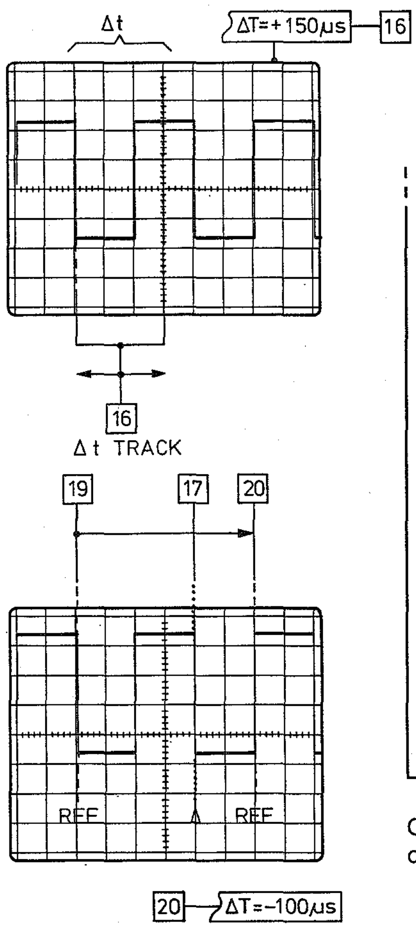


MAT1598B
870403

ACTION	RESULT
① CAL signal via probe to input A.	
② Press AUTO SET	■
③ Y AMPL to 200mV/div	200mV in LCD
④ Press B	channel B off, ALT off.
⑤ MAIN TB to 50μs/div	[5]
⑥ Press ↔ (t)	RATIO, REF or Δ is active;
⑥a READ OUT ↷	cursors and values on c.r.t.
⑦ Press REF	↔ (t) and REF active.
⑧ Adjust CURSORS ↷	REF cursor on first –ve slope [8]
⑨ Press Δ	REF off (↔(t) and Δ active)
⑩ Adjust CURSORS ↷	Δ cursor on second –ve slope [10] CRT text [10]
⑪ Turn VAR ↶	UNCAL in LCD [11] Δt value in DIV.
⑪a Turn VAR ↷	UNCAL is off. Δt value in μs [11a]

4.2.9. (cont'd) Cursors for time measurements on input signal (channel A) via MTB.





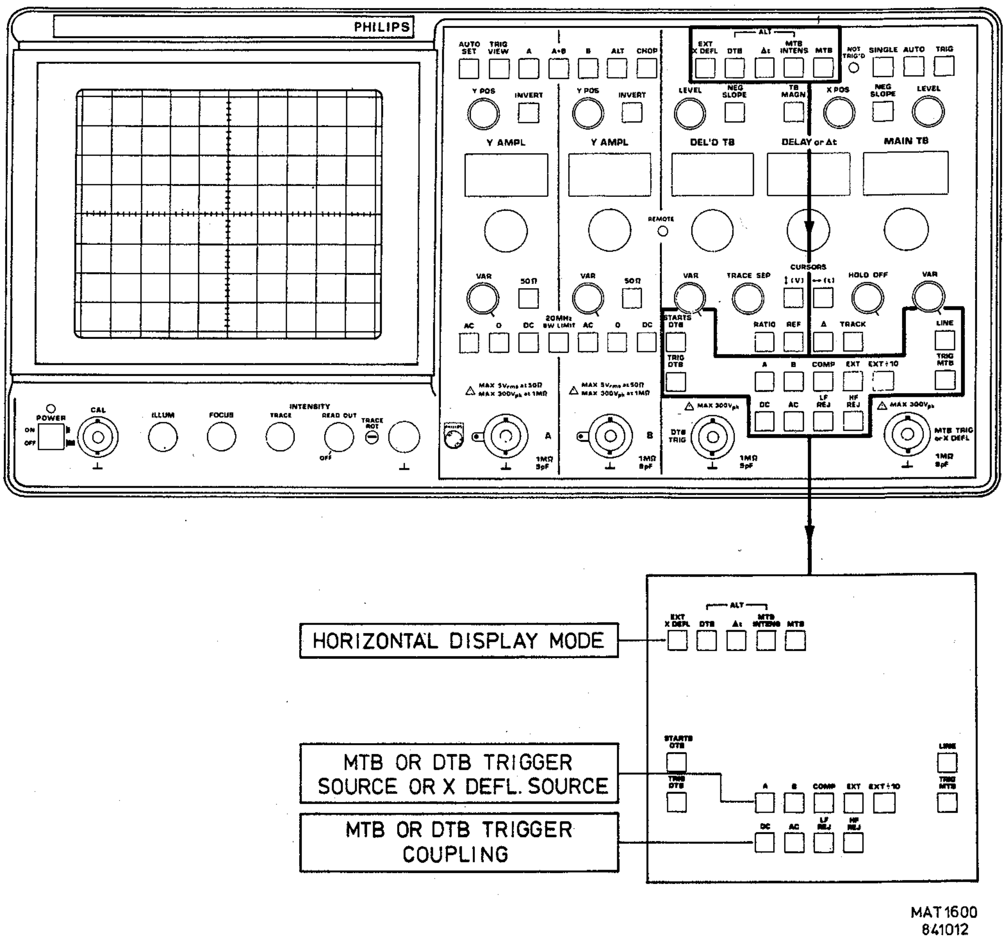
⑫ Press RATIO	↔ (t), Δ and RATIO active, CRT text 12
⑬ Turn CURSORS	Δ cursor on 6th vertical graticule line, CRT text 13
⑭ Press RATIO	RATIO off 14
⑮ Press TRACK	Δt value is fixed.
⑯ CURSORS	Δt is shifted horizontally over the screen 16
⑰ CURSORS	to set Δ cursor on second −ve slope 17
⑱ Press REF	TRACK, RATIO and Δ off.
⑲ Turn CURSORS	19
⑳ Turn CURSORS; REF cursor to other side of Δ cursor	20 (−ve Δt value)

CURSOR TIME measurements are also possible on channel B input signal via MTB.

MAT1599B
870515

4.2.10. Functional interactions and possible functional combinations.

ATTENTION: This section gives the functional interactions and combinations that are possible with the functions given in the figure below.
This section is specially designed for operators who want to practice the possible interactions.
It can also be useful and helpful when for the operator an unclear frontpanel reaction takes place.
Possible interactions of other functions then described in this chapter are given in "Explanation of controls and sockets" (section 4.3.).



If TRIG DTB is active:
* the DTB trigger sources A, B, COMP, EXT or EXT:10 can be selected.
* the DTB trigger coupling DC, AC, LF REJ or HF REJ can be selected.

If TRIG MTB is active:
* the MTB trigger sources A, B, COMP, EXT, EXT:10 or <u>LINE</u> can be selected.
* the MTB trigger coupling DC, AC, LF REJ or HF REJ can be selected.

If EXT-DEFL is active:
* the horizontal deflection sources A, B, EXT, EXT:10 or LINE can be selected.

EXT
X DEFL

* If EXT X DEFL is active and COMP is pressed, than A is selected as horizontal deflection source.
  COMP cannot be selected in EXT X DEFL mode.

* If EXT X DEFL is active, both TRIG DTB or STARTS DTB cannot be selected.
  DTB mode cannot be selected in EXT X DEFL mode.

* If vertical display modes A, B and ALT are active in MTB mode and EXT X DEFL is pressed, then on screen is displayed:
  NO ALT WHEN EXT X DEFL
  and ALT is switched off and CHOP becomes active.

DTB

* If DTB is selected then MTB INTENS becomes also active.
  If DTB is pressed once again, then only MTB INTENS is active.

ALT

DTB   MTB INTENS

* If DTB and MTB INTENS are active and MTB INTENS is pressed once again, then only DTB is active.

ΔT

* If Δt is selected, then MTB INTENS becomes also active.
  If Δt is pressed once again, then only MTB INTENS is active.

STARTS
DTB

* If STARTS DTB is active, then TRIG DTB off.

TRIG
DTB

* If TRIG DTB is active, then STARTS DTB and TRIG MTB are off.

* If TRIG DTB is active, then no LINE triggering possible.

* If LINE is selected in TRIG DTB mode, then on screen is displayed:
  ILLEGAL OPERATION.

* If MTB is selected in TRIG DTB mode, then TRIG DTB is switched off and TRIG MTB will become active.

COMP

* If COMP is active and EXT X DEFL is pressed, then A is selected as X DEFL source and on screen is displayed:
  NO ALT WHEN EXT-X-DEFL.

* If vertical display modes A, B and CHOP are active and COMP is pressed in MTB mode, then on screen is displayed:
  NO CHOP WHEN COMPOS MTB
  and CHOP is switched off and ALT becomes active.
  If CHOP is pressed once again then on screen is displayed:
  NO CHOP WHEN COMPOS MTB
  and CHOP is not selected.

* If vertical display modes A, B and CHOP are active and COMP is pressed in DTB mode, then on screen is displayed:
  NO CHOP WHEN COMPOS DTB
  and CHOP is switched off and ALT becomes active.
  If CHOP is pressed once again then on the screen is displayed:
  NO CHOP WHEN COMPOS DTB
  and CHOP is not selected.

TRIG MTB

* If TRIG MTB is active, then TRIG DTB is off.

LINE

* LINE can only be selected in TRIG MTB or EXT X DEFL mode.

* If LINE is active, only AC trigger coupling is possible.

DC

* If DC is active and HF REJ is pressed, then both DC and HF REJ are active.
  If DC is pressed once again, only DC is active.

AC

* If AC is active and HF REJ is pressed, then both AC and HF REJ are active.
  If AC is pressed once again, only AC is active.

LF REJ

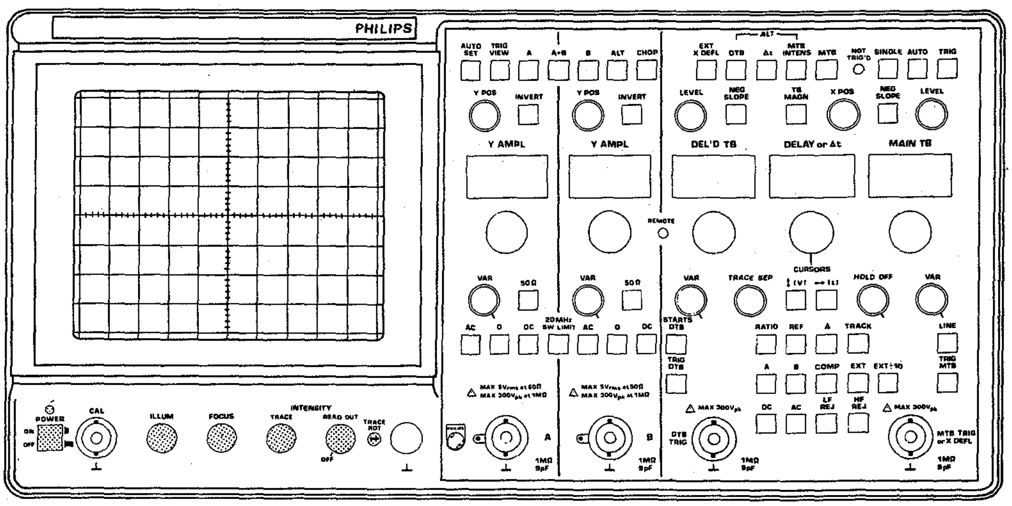
* If LF REJ is active and HF REJ is pressed, then HF REJ and <u>AC</u> will be active.

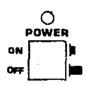
4.3. EXPLANATION OF CONTROLS AND SOCKETS

The controls and sockets are listed according to their functional sections and a brief description of each is given.

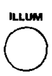
Note: switchable LCD-illumination.
The LCD illumination is switched on during 10 minutes after the last operation of a pushbutton, a rotary switch or between the CAL and UNCAL positions of a potentiometer.

4.3.1. CRT section

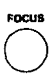




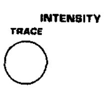
POWER ON/OFF switch
After switching-on the instrument, first an automatic power-up test is started (see also Section 4.1.).
The POWER ON LED indicates when the instrument is switched on.



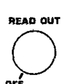
Continuously-variable control of the graticule illumination.



Continuously-variable control of the focussing of the c.r.t. electron beam (including the c.r.t. text).



Continuously-variable control of the trace brilliance on the c.r.t. screen.

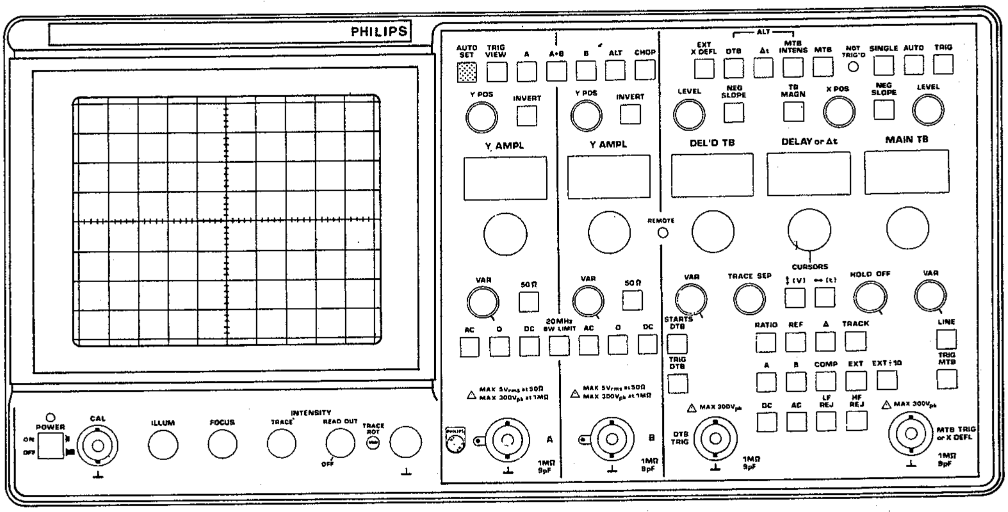


Continuously-variable control of the brilliance of the c.r.t. text (control settings and cursors).
The READ OUT of the control-settings and cursors on the c.r.t. screen can be switched off by turning this control fully anti-clockwise.

NOTE:
Some interference is visible on the trace in MAIN TB settings 200µs/div...5ms/div.
This is caused by displaying the c.r.t. text and cursors in between the time base sweeps.
This interference can be completely eleminated by turning the READ OUT control completely anti-clockwise.

Screwdriver control for aligning the trace in parallel with the horizontal graticule lines.

4.3.2. AUTO SET of vertical and horizontal functions



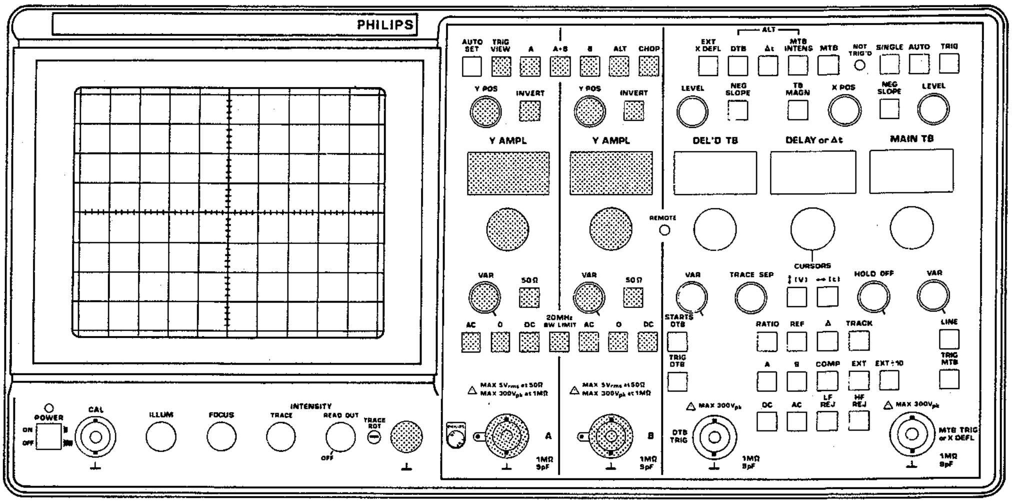
AUTO SET

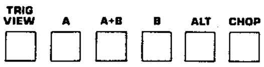
This pushbutton switch permits an AUTO pre-SET of the following controls, depending on the value(s) of the input signal(s):

Vertical functions	auto preset mode/value
- Channel **A** and **B**: LF signal HF signal - Probe **Read Out** detection	**CHOP** **ALT** only if probe is provided with a range indication BNC plug.
- **Input coupling** - **Vertical** deflection	**AC** - **6 div** or less if input voltage is 10mV ... 30V. - **200mV/div.** if input voltage is less than 10mV.
- **Base line** position: channel A and B	- A: +0,2 div. } from vertical - B: −0,2 div. } midposition
Horizontal functions:	auto preset mode/value
- **Bandwidth limiter** - **X deflection source** - MTB **trigger source** - MTB **trigger mode** - MTB **trigger coupling** - MTB trigger **LEVEL** - **X deflection**	**OFF** **MTB** **A or B or EXT (A** when no input signal) **AUTO** **AC** **1.2 div.** above vertical midposition of screen. **Max. 6 signal periods** when the frequency of input signal is 40Hz ... 60MHz. MTB at 20ns/div when signal input is >60MHz.

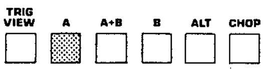
For AUTO SET presettings without input signal(s) see also chapter 4.2.2.

4.3.3. Vertical section

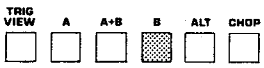




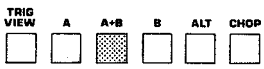
Vertical display mode switches; push on-push off functions. These pushbuttons permit 26 different vertical display modes to be selected.
One vertical function is always selected.



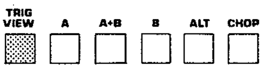
Vertical deflection is achieved by the signal connected to the channel A input.



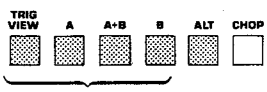
Vertical deflection is achieved by the signal connected to the channel B input.



The input signals of channels A and B are added and displayed on the c.r.t. screen.
In combination with the INVERT pushbutton(s), one channel can be subtracted from the other.



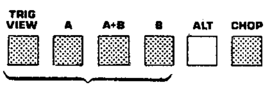
The MTB trigger signal is displayed on the c.r.t. screen.



11 display combinations

ALTernate vertical deflection is achieved by a minimum of two selected vertical functions. The display is switched over from one function to the other at the end of very time-base sweep.
Any combinations of the functions TRIG VIEW, A, A + B and B can be selected in ALT mode.

When one vertical function is selected, then the ALT function is switched off.

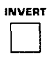


11 display combinations

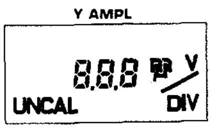
CHOPped vertical deflection is achieved by a minimum of two selected vertical functions.
The display is switched-over from one function to the other at a fixed frequency.
Any combination of the functions TRIG VIEW, A, A + B and B can be selected in CHOP mode.

When one vertical function is selected, then the CHOP function is switched off.

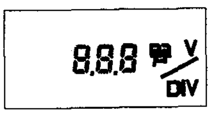
Continuously-variable control giving vertical shift of the trace over the screen. After AUTO SET, manually adjustable after turning through mid-position.



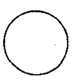
NORMAL-INVERT pushbutton switch (push on-push off). The displayed input signal of the relevant channel is inverted when this switch is active.
Pressing INVERT of channels A and B simultaneously the oscilloscope is set in the Service mode. For detailed information, see the Service Manual.



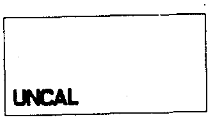
Liquid-Crystal Display, which indicates the following Y control settings:



- Indication of the setting of the vertical deflection coefficient of the relevant channel.
  The deflection coefficient of the relevant channel is adapted to the attenuator ratio of the probe in use, only if the probe is provided with a range indication BNC plug.



AMPL/DIV control.
This switch permits selection of the vertical deflection coefficients of the relevant channel. In 12 steps from 1mV/DIV ... 5V/DIV in a 1-2-5 sequence.



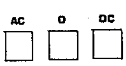
- vertical deflection coefficients of the relevant channel are not calibrated.
  VAR control of the relevant channel is not fully clockwise.
  Note that the indicated deflection coefficient is calibrated only if UNCAL is off.

Continuously-variable control of the vertical deflection coefficients of the relevant channel. The deflection coefficients of the relevant channel are only calibrated when this control is set fully clockwise (UNCAL in LCD is off) In UNCAL position, the vertical sensitivity decreases. The complete sensitivity range between two AMPL/DIV settings is adjustable.

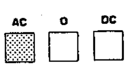
Pushbutton switch (push on-push off) which activates the 50 Ω terminator when depressed (lamp on). The 50 Ω terminator input is protected internally against excessive input signals; in this event the following is indicated on the screen:
UNSAFE CONDITION FOR 50 Ω

- if 50 Ω is pressed and input voltage is higher than 5 V dc and ac r.m.s. (50 Ω terminator is not switched on)
- if 50 Ω is active and the applied input voltage is higher than 25 V dc and ac r.m.s. (50 Ω terminator is not switched off)

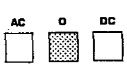
IMPORTANT:
In both situations described above:
REMOVE input voltage or DECREASE input voltage <5V dc and ac r.m.s.
The 50 Ω terminator will be switched off automatically at input voltages between 5V...25V dc and ac r.m.s.



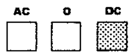
Input signal coupling switches.



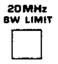
Only the a.c. component of the input signal is fed to the attenuator, via a capacitor, which blocks the d.c. component



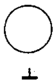
The input signal is interrupted, and the input of the attenuator is connected to earth potential, thus providing a zero reference for the relevant channel.



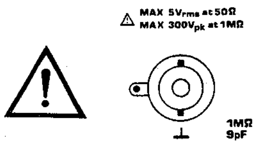
The complete input signal (both a.c. and d.c. components) is connected to the attenuator.



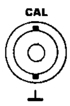
Pushbutton switch which activates the bandwidth limiter; upper bandwidth limit of instrument reduced to 20MHz.



Measuring earth socket.

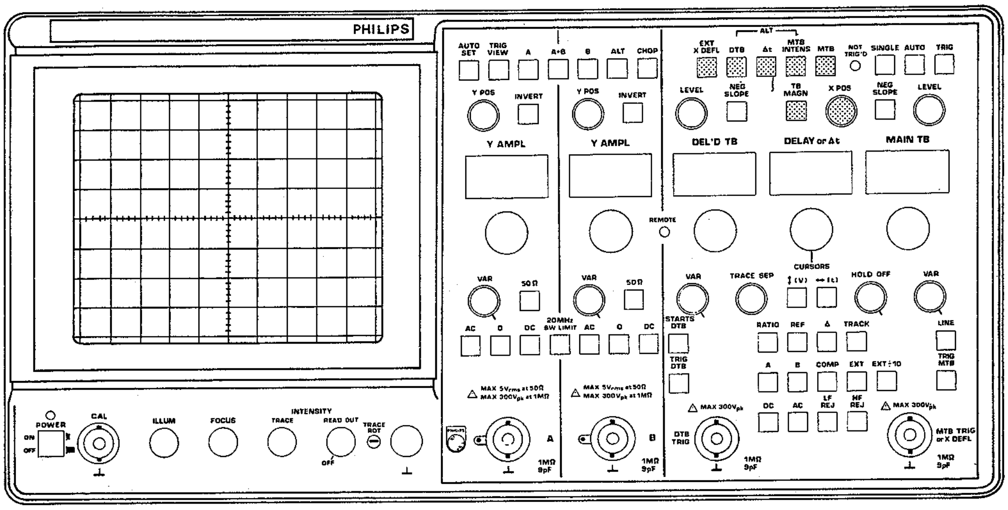


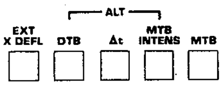
BNC input socket for the A and B channels with probe indication detectors. Maximum rated input voltage at 50 Ω position, 5V rms; in high-Z position, 300V peak.



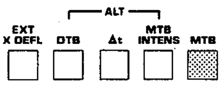
BNC output socket of a square-wave calibration signal with an amplitude of 0,8Vp-p and a frequency of 5kHz.
The output voltage is reduced by a half when the output is terminated in 50 Ω.
When the output is short-circuited, the output current is 16MAp-p (reduced by a half when terminated in 50 Ω).
Zero line of the square-wave signal is on the base-line level.

4.3.4. Horizontal section

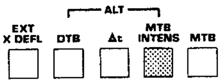




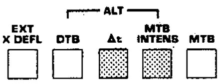
Horizontal display mode switches.
Eight different display modes can be selected.



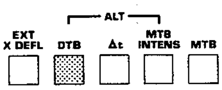
The horizontal deflection voltage is supplied by the MTB.



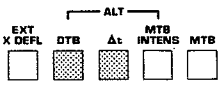
The horizontal deflection voltage is supplied by the MTB and the DTB. One part of the trace, representing the DTB, is intensified. The length of the intensified part depends on the settings of the DEL'D and the MAIN TB. The intensified part can be shifted over the time axis by the DELAY control.The time difference between the start of the MTB and the intensified part (DTB) is shown in the LCD DELAY or Δt.



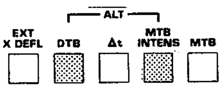
The horizontal deflection voltage is supplied by the MTB and two DTB intensified parts (dual DTB). The lengths of both intensified parts depend on the setting of the DEL'D TB and the MAIN TB.
The second intensified part can be shifted over the time axis by means of the Δt control. The time difference between the first and second intensified part is shown in LCD DELAY or Δ t.



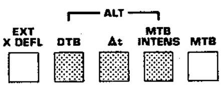
The horizontal deflection voltage is supplied by the DTB.
The time difference between the starting point of the MTB and the intensified part (DTB) is shown in the LCD DELAY or Δt.



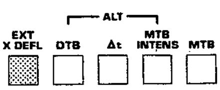
The horizontal deflection voltage is achieved by two DTB signals.
The time difference between these two DTB signals is shown in LCD DELAY or Δt.



The horizontal deflection is alternately supplied by the MTB with intensified part (DTB) and by the DTB (intensified part shown over the complete screen width).



The horizontal deflection is achieved by the following:
a) the MTB signal with two intensified parts (dual DTB);
b) the first intensified part over the complete screen width;
c) the second intensified part over the complete screen width.



The horizontal deflection is achieved by the signal selected with the trigger source selector switches A, B, EXT, EXT:10 or LINE and the signal is coupled via the switches DC, AC, LF REJ or HF REJ.

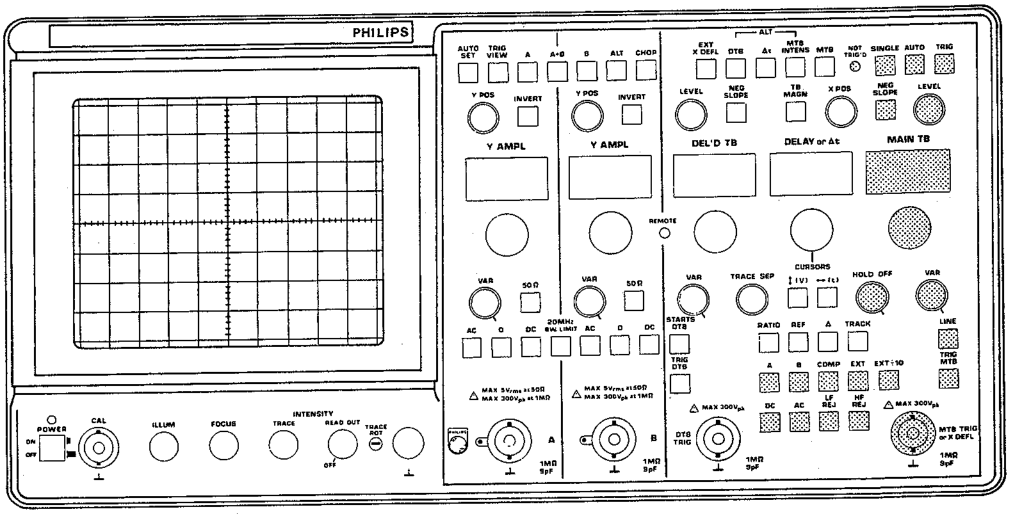
X POS

This continuously variable control gives horizontal shift of the trace over the screen.

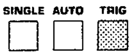
TB MAGN

When this switch (push on-push off) is active (lamp on), the horizontal deflection is increased by a factor of 10.
The values in the LCD and cursor values in the c.r.t. text are adapted.
When EXT X DEFL is selected then TB MAGN is switched off.

4.3.5. Main Time Base (MTB)



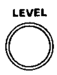
MTB trigger mode selection switches



In this mode the MTB will not run without trigger pulses (no base-line without trigger pulses) and must be normally triggered.

In the AUTO mode, the MTB will run automatically when no trigger pulses are available.
In this mode, AUTO peak-peak level is selected for triggering of the MTB signal. Consequently, the LEVEL control only influences the triggering within the level range of the peak-peak level.

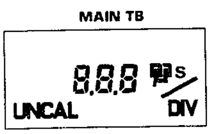
In SINGLE mode the MTB will only start once on receipt of a trigger pulse.
For photographing the display in SINGLE shot mode, first the text is displayed once for identification purposes for 0.1 s max., and afterwards, the signal.



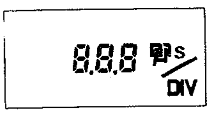
Continuously-variable control to determine the LEVEL of te trigger point on the trigger signal at which the MTB starts.
After AUTO SET: manually adjustable after turning through mid-position.

This LED lights up when the MTB is not triggered. or waits for a single-shot event (in SINGLE mode).

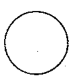
When this pushbutton is active (lamp on), the MTB is triggered on the negative-going slope of the signal.
Positive triggering is achieved when this pushbutton is depressed once again (lamp off).



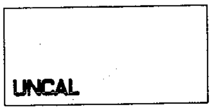
Liquid Crystal Display (LCD) which indicates the following MAIN TB settings:



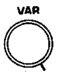
- indication of the setting of the time coefficient of the MTB.



MTB TIME/DIV control.
This switch permits selection of the time coefficients of the MTB in 24 steps from 20ns/div.... 1s/div. in a 1-2-5 sequence. When the DTB is on this switch is electrically coupled with the DTB TIME/DIV switch.

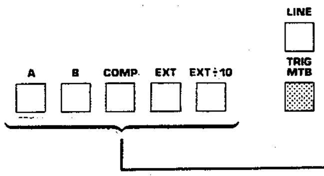


MTB time coefficients are not calibrated. VAR control for MTB is not fully-clockwise. Note that indicated time coefficient is calibrated only if UNCAL is off.



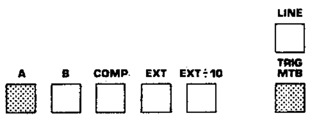
Continuously-variable control of MTB time coefficients, which are calibrated when this control is set fully clockwise (UNCAL is off in LCD). In UNCAL position the time coefficient increases. The complete sensitivity range between two TIME/DIV settings is adjustable.

4.3.5.1. MTB triggering

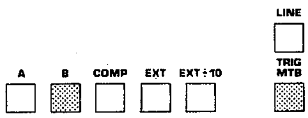


MTB trigger source selector switches, only when TRIG MTB is selected (lamp on).
Note: If EXT X DEFL is selected, the following functions can be selected for horizontal deflection: A, B, EXT, EXT:10 or LINE (not COMP).

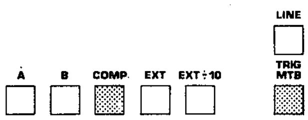
Controls also used as DTB trigger source selector (4.3.6.1.)



The MTB is internally triggered on a signal derived from channel A.



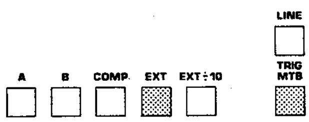
The MTB is internally triggered on a signal derived from channel B.



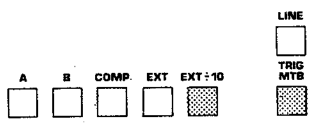
The MTB is internally triggered on signals derived from channels A and B in composite mode. This mode enables a stable display of two input signals that have no time relation. Composite triggering only functions correctly when vertical display mode ALT is selected. When COMP triggering is selected together with TRIG VIEW, the MTB trigger signal, derived from channel A, is displayed.
If vertical display modes A and B are active and MTB trigger source COMP also, and:

- A is switched off, then MTB trigger source → B; if A is switched on again, then MTB trigger source stays B.

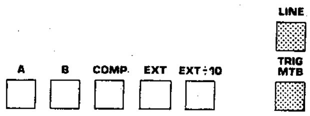
- B is switched off, then MTB trigger source → A; if B is switched on again, then MTB trigger source stays A.



The MTB is externally triggered on a signal connected to the MTB TRIG or X DEFL BNC socket.

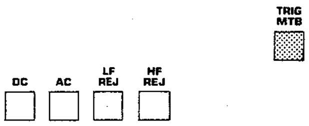


The MTB is externally triggered on an external signal as above, but attenuated by a factor of 10.

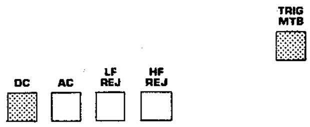


The MTB is internally triggered on a signal derived from the mains voltage.

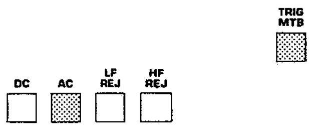
No LINE triggering is possible when the oscilloscope is connected to a d.c. supply voltage.



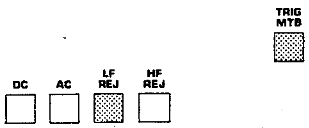
MTB trigger coupling switches, only when TRIG MTB is selected (lamp on).



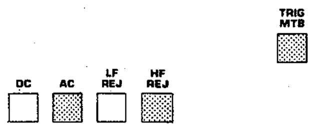
The MTB trigger signal is direct coupled. The full trigger bandwidth is available.



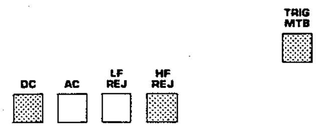
The MTB trigger signal is a.c.-coupled. The d.c. component of the trigger signal is blocked.



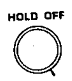
The MTB trigger signal is a.c.-coupled. The d.c. component of the trigger signal and low frequency trigger signals (up to 20kHz) are blocked.



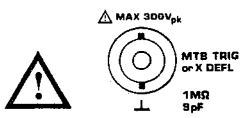
The MTB trigger signal is a.c.-coupled. The d.c. component of the trigger signal and high frequency trigger signals (>50kHz) are blocked.



The MTB trigger signal is direct-coupled. The d.c. and a.c. components (up to 50kHz) of the trigger signal are passed through to the MTB.

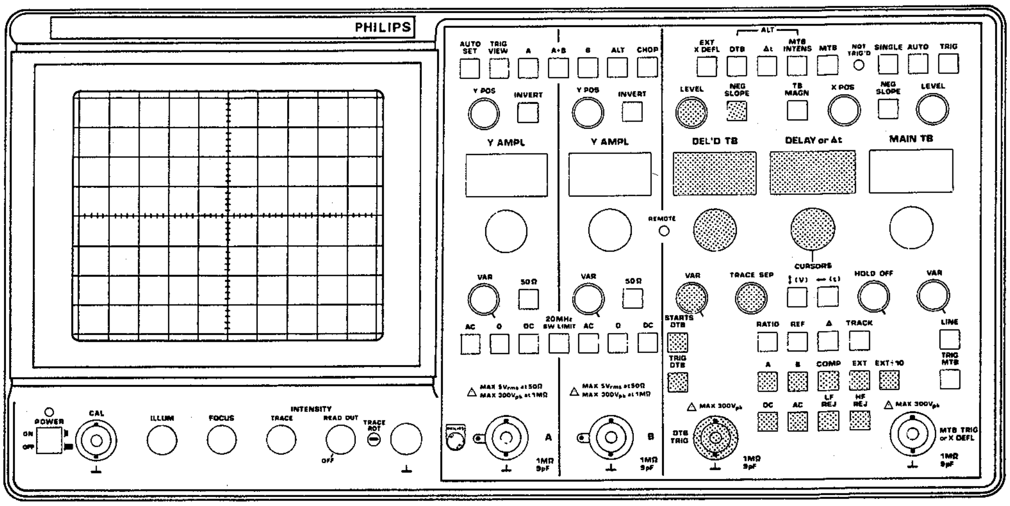


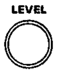
This control determines the HOLD OFF time between the MTB sweeps. During the HOLD OFF time the MTB does not respond to trigger pulses, which permits certain trigger pulses to be suppressed. For normal operation, this control must be set fully clockwise to give minimum HOLD OFF time.



External trigger input of the MTB to be used together with switches TRIG MTB and EXT, EXT:10. When EXT X DEFL is selected, the horizontal deflection is determined by the signal applied to this BNC socket when EXT or EXT:10 is selected. The maximum rated input voltage is 300V peak.

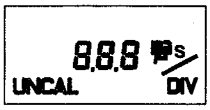
4.3.6. Delayed Time-Base (DTB)



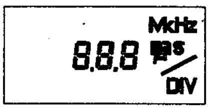


Continuously-variable control to determine the LEVEL of the trigger point on the trigger signal at which the DTB starts. After AUTO SET: manually adjustable after turning through mid-position.

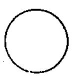
When this pushbutton is depressed (lamp on), the DTB is triggered on the the negative-going slope of the signal. Positive triggering is achieved when this pushbutton is depressed once again (lamp off).



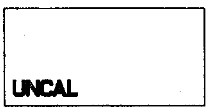
Liquid Crystal Display (LCD) which indicates the following DEL'D TB settings:



- indication of the setting of the DTB time coefficient.



DTB TIME/DIV. control.
This switch permits selection of the time coefficients of the DTB in 23 steps from 20ns...0.5sdiv. in a 1-2-5 sequence. The DTB TIME/DIV. switch is electrically coupled with the MTB TIME/DIV switch. The DTB time coefficient can never be slower than one step faster than the value of the MTB time coefficient.

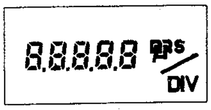


DTB coefficients are not calibrated. VAR control of the DTB is not in fully clockwise position. Note that the indicated time coefficient is calibrated only if UNCAL is off.

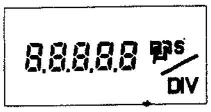
Continuously-variable control of the time coefficients of the DTB. The time coefficients of the DTB are calibrated when this control is set fully clockwise. (UNCALL in LCD is off). In UNCAL position the time coefficient increases. The complete sensitivity range between two DTB TIME/DIV settings is adjustable.

Continuously-variable control which determines the space between the MTB and DTB signals. This is only possible when Δt, MTB INTENS or both are selected together with DTB.

DELAY or Δt

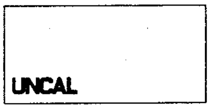


Liquid Crystal Display (LCD) which indicates the following DELAY time or Δt values:



- **in the case of mono DTB:** MTB INTENS and/or DTB selected. Indication of the time difference (DELAY TIME) between the starting point of the MTB and the intensified part (DTB). When VAR (MTB) is turned out of CAL position, the DELAY TIME is indicated in DIV.

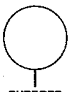
- **in case of dual DTB:** Δt selected. Indication of the time difference between the start of the first and the second DTB. When VAR (MTB) is turned out of CAL position, the DELAY TIME is indicated in DIV.



- **in TRIG DTB mode:** The indicated delay time is not the delay between the starting points of MTB and DTB because the starting point of DTB is determined by the receipt of a trigger pulse after the indicated delay time.

DELAY or Δt

DELAY TIME control/ Δt control or Cursor control



CURSORS

-DELAY TIME control.

Operative when MTB INTENS and/or DTB is selected.
The DELAY TIME can be adjusted from 20ns...10s in 24 steps/div. The switching speed of this control increases after turning continuously in one direction.
If turning is stopped, starting in reverse direction resumes with the slow switching speed. The adjusted DELAY TIME is indicated in the LCD DELAY or Δt.

- Δt control.

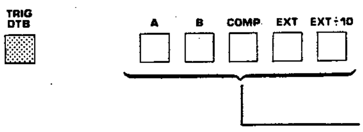
When Δt is selected: dual DTB. In this mode it is possible to adjust the start position of the second DTB part over the time axis from 20ns...10 x the MTB TIME/DIV setting (LCD MAIN TB) using this control. The time difference between the first and second DTB part is shown in LCD DELAY or Δ t. The switching speed of this control increases after turning continuously in one direction. If turning is stopped, starting in reverse direction resumes with slow switching speed.

-Cursor control: only in MTB mode!

With the cursor 'on' (↕(V) and/or ↔(t) active), it is possible to shift the cursor lines over the screen, in vertical (↕(V) or horizontal (↔(t)) order by this control. For further details, see Section 4.3.7.

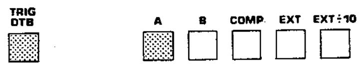
4.3.6.1 DTB triggering.

When the STARTS DTB mode is selected (lamp on) the DTB will start immediately after the selected DELAY TIME in MTB INTENS and/or DTB mode.

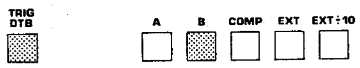


DTB trigger source selection switches, only when TRIG DTB is selected (lamp on.)

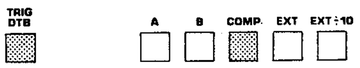
Also used as MTB trigger source selector (see 4.3.5.1.) and as EXT X DEFL source selector (4.3.4.).



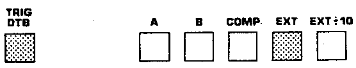
After the selected DELAY TIME the DTB is internally triggered on the trigger signal derived from channel A.



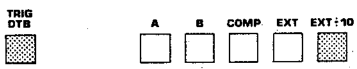
After the selected DELAY TIME the DTB is internally triggered on the trigger signal derived from channel B.



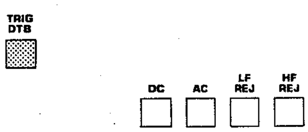
After the selected DELAY TIME the DTB is internally triggered on composite trigger signals derived from channels A and B. This composite mode enables a stable display of two input signals that have no time relation. Composite triggering only functions correctly when vertical display mode ALT is selected. When COMP triggering is selected together with TRIG VIEW, the MTB trigger signal derived from channel A is displayed.



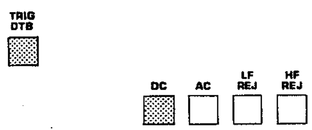
After the selected DELAY TIME the DTB is externally triggered on a signal connected to the DTB TRIG BNC socket.



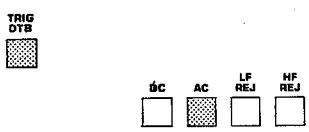
After the selected DELAY TIME the DTB is externally triggered on a signal, attenuated by a factor of 10, connected to the DTB TRIG BNC socket.



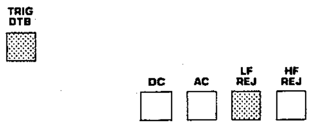
DTB trigger coupling switches are operative only when TRIG DTB is selected (lamp on).



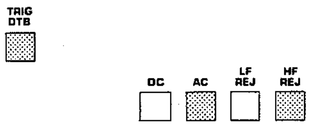
The DTB is direct-coupled. Full trigger bandwidth is available.



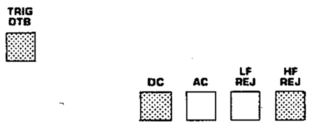
The DTB trigger signal is a.c.-coupled. The d.c. component of the trigger signal is blocked.



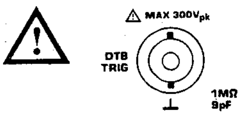
The DTB trigger signal is a.c.-coupled. The d.c. component of the trigger signal and low frequency trigger signals (up to 20kHz) are blocked.



The DTB trigger signal is a.c-coupled. The d.c. component of the trigger signal and high frequency signals (>50kHz) are blocked.



The DTB signal is direct-coupled. The d.c. and a.c components (up to 50kHz) of the trigger signal are passed through to the DTB.

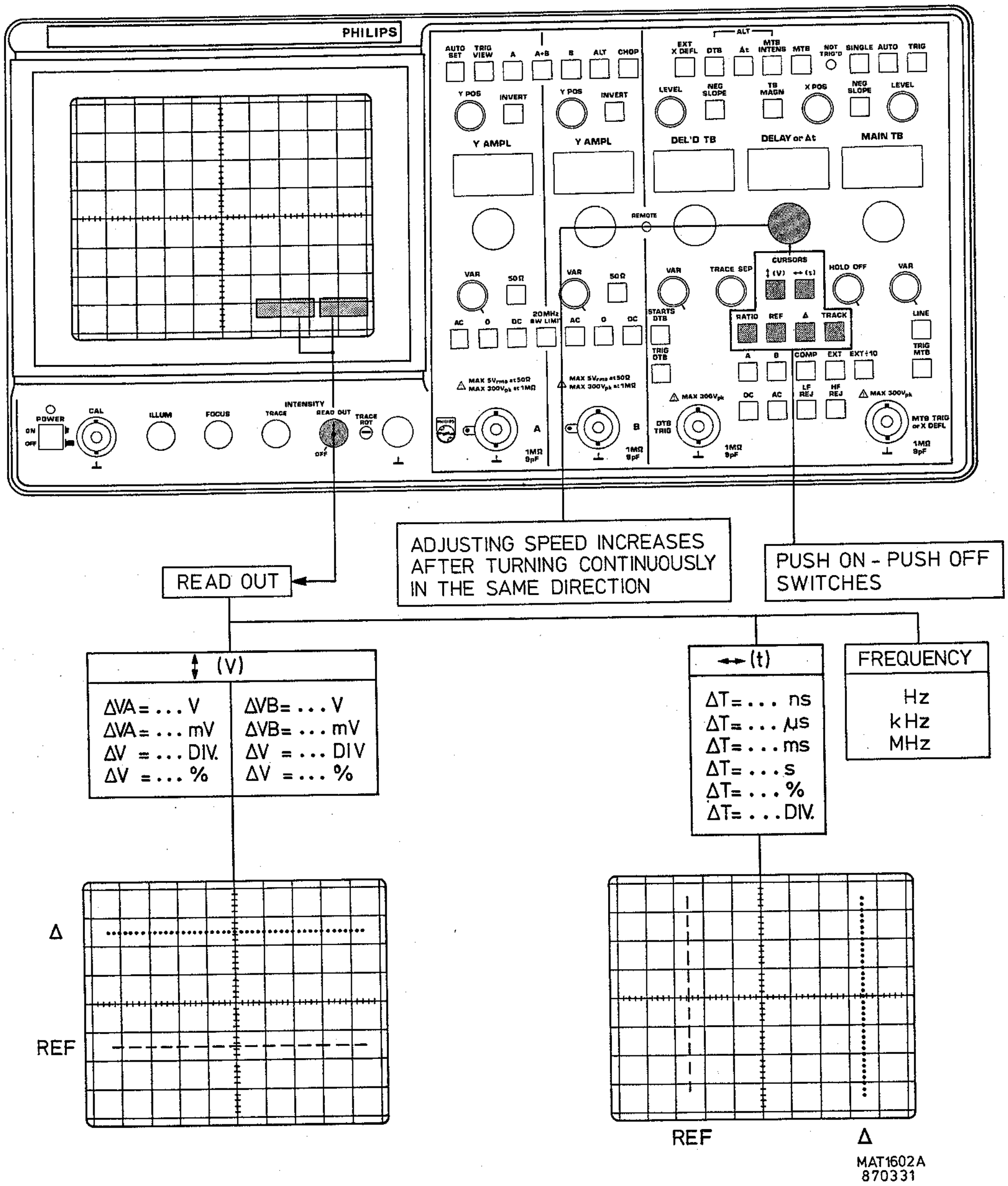


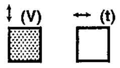
External trigger input of the DTB. To be used together with the switches: TRIG DTB and EXT, EXT: 10. Maximum rated input voltage: 300Vpeak.

4.3.7. Cursor section

CRT text indication:
If RATIO, REF, Δ or TRACK is selected when ↕ (V) or ↔ (t) is not active, then on screen is displayed:
FIRST SELECT ΔV OR Δt CURSORS

When the cursor mode is switched on the following c.r.t. text is displayed:
Full text display: settings Ch. A, settings Ch. B, settings DEL'D TB, settings MAIN TB, setting memory information (only in remote control version), trigger level (only if IEEE bus is installed), Δt or cursor value and frequency.

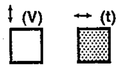




Push-on push-off switch for the voltage cursors. When this function is on, two horizontal cursor lines appear on the screen. The voltage between these two lines is displayed in the CRT text area on the screen.

Important notes for use of the voltage cursors:

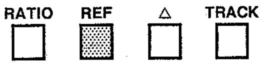
- Cursor Voltage measurements on **channel A** input signal when: A, ALT or CHOP (A and B) is selected and when signal of A is triggered via the MTB.
- Cursor Voltage measurements on **channel B** input signals when: B, ALT or CHOP (A and B) is selected and when signal of B is triggered via the MTB.
- If only vertical display mode TRIG VIEW is active together with ↕ (V) then the ΔV value is expressed in DIV.
- In EXT X DEFL mode the cursor value on screen is indicated as: ΔY = ...DIV.



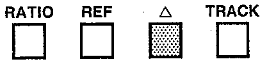
Push-on push-off switch for the time cursors. When this function is on, two vertical cursor lines appear on the screen. The time between these two lines is displayed in the CRT text area on the screen.

Important note for use of the time cursors:

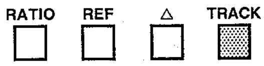
- In EXT X DEFL mode the cursor value on screen is indicated as: ΔX = ...DIV.



Reference cursor can be positioned across the screen with the "CURSORS" control.



Delta (Δ) cursor can be positioned across the screen with the "CURSORS" control.

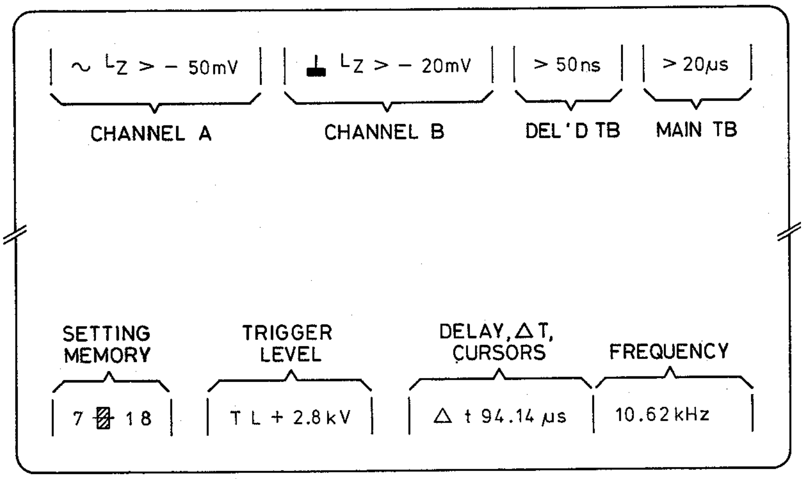


The reference cursor and the delta (Δ) cursor can be positioned together across the screen with the "CURSORS" control. When doing this, the distance between both cursors stays unchanged.

The cursor read-out on the screen is always reset to 100% after having depressed this pushbutton. In Ratio mode it is possible to select also REF, Δ or TRACK mode. Depending on the fact if you position the cursors towards or from each other, the 100% read out decreases on increases. For more details refer to chapter 4.2.8., 4.2.9. and 4.4.4.

4.3.8. Crt text

The brilliance of the c.r.t. text is adjustable with the READ OUT control. If this control is fully anti-clockwise the c.r.t. text is off.
The focussing of the c.r.t. text is adjustable with the FOCUS control (together with the signal focussing).
The following c.r.t. text can be displayed on the screen.



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The following information blocks can be displayed on the CRT:

- CHANNEL A and CHANNEL B settings. The lay-out of both blocks is identical. The following information is given:
  - Input coupling. In this example channel A is a.c.-coupled, B is "0" coupled and connected to ground. in case of d.c.-coupling the sign " = " is displayed.
  - If 50Ω input impedance is selected, the display shows "LZ" (low Z).
  - If the channel is in the UNCALibrated position, it is indicated with the sign ">".
  - If the channel is in the INVERTed mode, it is indicated with the sign "-".
  - The input sensitivity is given in V or mV.

- DEL'D TB and MAIN TB settings. The lay-out of both blocks is identical. The following information is given:
  - If the time base is in the UNCALibrated position, it is indicated with the sign ">
  - The sweep speed is given in s, ms, μs or ns.

- SETTING MEMORY information. This information is only displayed in the remotely controllable instrument type. The first figure (between ∅...9) indicates the IDentification number that has been given to the osilloscope. The second figure (between ∅...75) indicates the stored front panel that determines the actual settings of the instrument. Both figures are separated by a small horizontal line that changes into a square if the instrument receives a command from the remote control. For more information refer to chapter 4.7.

- TRIGGER LEVEL. This block of information is only displayed if the instrument is provided with an IEEE interface bus. The adjusted MAIN TB trigger level is displayed in divisions. The trigger level is displayed in volts if the MAIN TB is in TRIG or SINGLE mode, the selected trigger source is in CALibrated position and d.c. coupled if the MAIN TB triggering is d.c. coupled.

- DELAY and Δ T or CURSORS and FREQUENCY. Depending on the selected time base or cursor functions the following information is given.
  - If MTB INTENS is selected (Δt off) the selected DELAY time is given. The delay time figure is preceeded by the sign "t".
  - If MTB INTENS and Δt are both active the DELTA T time is displayed. The Δt figure is proceeded by the sign "Δt". The FREQUENCY block displays the 1/Δt value. If the horizontal distance between the start of the two intensified parts is exactly 1 period of the signal (see fig. 4.9.), the signal frequency is displayed in the block FREQUENCY.
  - If the time cursors are selected, the time between both cursors is displayed. This figure is preceeded by the sign "Δt". If the distance between both cursors is exactly 1 period of the signal, the signal frequency is displayed in the block FREQUENCY.
  - If the voltage cursors are selected the voltage between both cursors is displayed. This figure is preceeded by the sign ΔV and A (for channel A) or B (for channel B).

Operating information

UNSAFE CONDITION FOR 50 Ω INPUT

- if 50 Ω is pressed and input voltage is higher than 5 V dc and ac r.m.s (50 Ω terminator is not switched on)
- if 50 Ω is active and the applied input voltage is higher than 25 V dc and ac r.m.s (50 Ω terminator is not switched off).

IMPORTANT:
In both situations described above:
REMOVE input voltage or DECREASE input voltage : <5 V dc and ac r.m.s.
The 50 Ω terminator will be switched off automatically at input voltages between 5V...25V dc and ac r.m.s.

NO CURSORS IF DTB IS ACTIVE

- if cursor function ↕(V) or ↔(t) are selected while the DTB is on for X deflection.

FIRST SELECT T OR V CURSORS

- If cursor function RATIO, REF, Δ or TRACK is pressed while the functions ↕(V) or ↔(t) are **not** active.

ILLEGAL OPERATION

- if LINE is pressed while TRIG DTB is active.
- if the last active vertical channel is switched off.
- if EXT X DEFL is active and comp is pressed.

NO CHOP WHEN COMPOSITE MTB ACTIVE!

- if MTB trigger source COMP is pressed while CHOP is active. In this situation CHOP will be switched off and ALT is active.
- if CHOP is pressed while MTB trigger source COMP is active.

NO CHOP WHEN COMPOSITE DTB ACTIVE!

- if DTB trigger source COMP is pressed while CHOP is active. In this situation CHOP will be switched off and ALT is active.
- if CHOP is pressed while DTB trigger source COMP is active.

NO COMP WHEN EXT-X-DEFL!

- if EXT X DEFL is pressed while COMP (MTB or DTB triggersource) is active.
- if COMP (MTB or DTB triggersource) is selected while EXT X DEFL is active.

NO ALT WHEN EXT-X-DEFL!

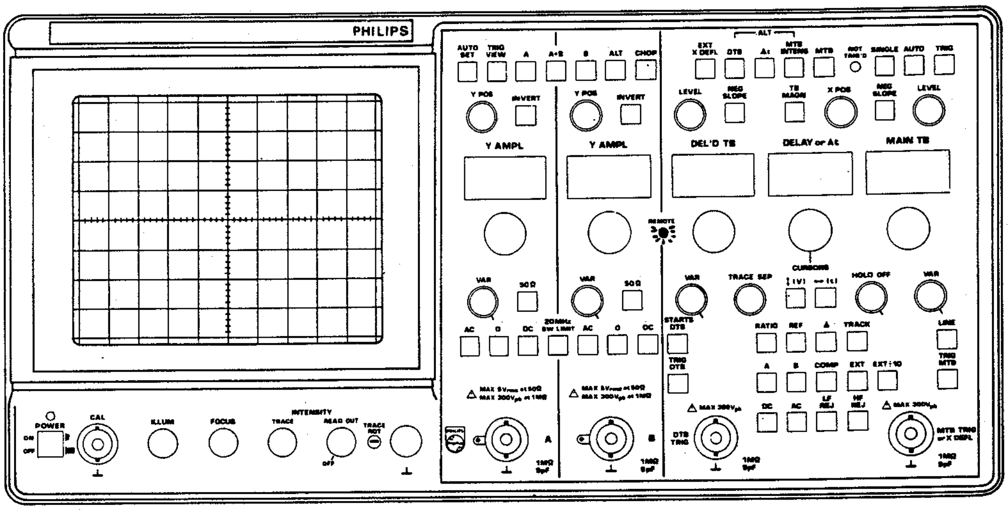
- if EXT X DEFL is pressed while ALT is active.
- if ALT is pressed while EXT X DEFL is active.

AUTO SETTING

- after function AUTO SET is pressed.

NOTE: For photographing the display, in SINGLE shot mode, first the text is displayed once for identification purposes for 0.1 s max., and afterwards, the signal.

4.3.9. Remote Mode-via IEEE 488 bus (option)



REMOTE

In the REMOTE mode, this LED is on and the oscilloscope can only be controlled via an IEEE488 bus system.
The controls on the front panel are blocked for local operation except for the following functions:

POWER ON
ILLUM*
FOCUS
INTENSITY — TRACE
READ OUT
TRACE ROT.

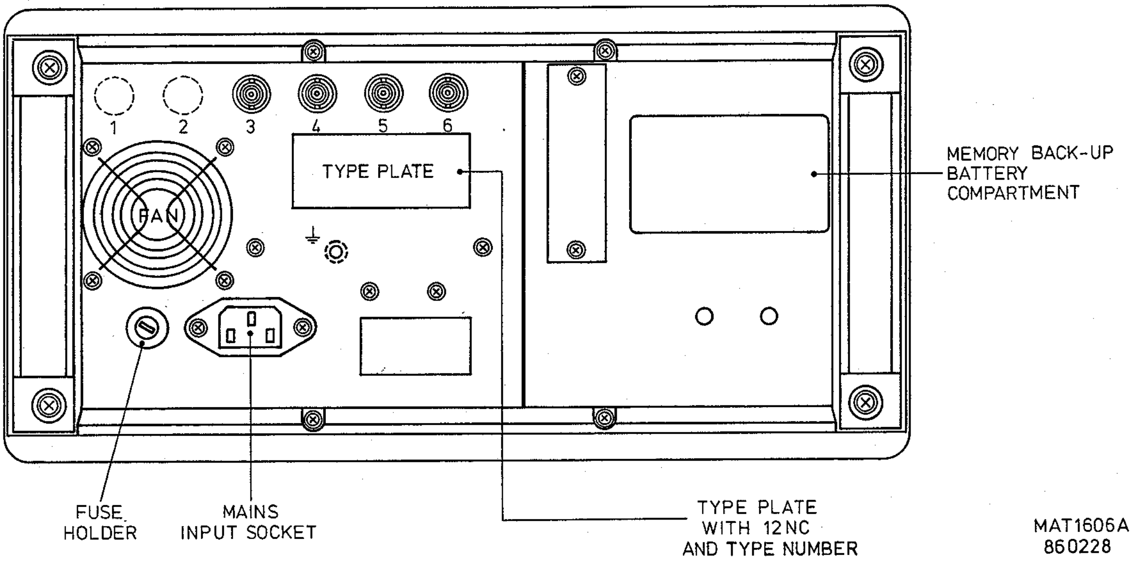
Presetting specific functions from REMOTE to local operation ('MASKING') can only be performed via the IEEE488 bus by the controller (see separate BUS INTERFACE booklet).

All REMOTE functions can be set to local via the system bus or by switching the oscilloscope OFF and ON.

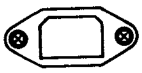
Via a special IEEE-bus command, the oscilliscope can be brought in such a mode that the instrument can be operated both via the IEEE-bus and the front panel controls. This mode is indicated by a blinking REMOTE LED.

For the IEEE protocol, refer to the separate publications belonging to the PM 8950 IEEE 488/IEC625 bus interface.

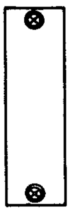
4.3.10. Rear panel



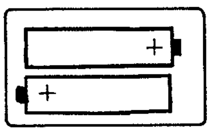
Fuseholder, fuse rating: 2.5A, delayed action.
For safety instructions, read Section 3.2.2.



Mains input socket, 90V ... 264Vac, 45 ... 440Hz.
For safety instructions, read Section 3.2.2.



Cut-out for an IEEE488/IEC 625 socket (optional).



Removable cover of memory back-up battery compartment.
For installation instructions, read Section 3.3.


1 2

Knockout holes for BNC sockets reserved for options.


3

MTB gate output.
Output socket of a TTL-compatible signal, which is 'high' during the MTB sweep and 'low' under other conditions.
The output is short-circuit protected


4

DTB gate output.
Output socket of a TTL-compatible signal, which is 'high' during the DTB sweep and 'low' under other conditions.
The output is short-circuit protected.

5 Z mod. input.
Input socket for Z modulation of the c.r.t. trace.
The trace is blanked when this input is 'high' (+ 2.5V or more).
Half-tones are also possible at input voltages between 0.4V and 2.5V.

Maximum input voltage: + or -10V.

6 Y output.
Output socket of the Y signal.
The source can be selected with the DTB trigger source pushbuttons:
A, B, COMP, EXT and EXT: 10.
Y output signal coupling is achieved via the DTB trigger coupling pushbuttons:
DC, AC, LF REJ and HF REJ.

4.4. DETAILED OPERATING INFORMATION

4.4.1. Introduction

Before switching on, ensure that the oscilloscope has been installed in accordance with the instructions given in Chapter 3 and that the various precautions outlined have been observed.

The following sections give more detailed information regarding the specific functions of the instrument, together with some application possibilities.
Before reading this chapter, it is recommended that Chapter 4.3.
Explanation of controls and sockets is first read.

This detailed information is especially useful for those operators who are not familiar with this type of oscilloscope.

The following subjects are described:

vertical deflection:

- use of probes
- input coupling AC-DC-0
- chopped (CHOP) or alternate (ALT) display
- added mode and common-mode measurement
- XY measurements
- use of trigger view (TRIG VIEW) channel

triggering and time-bases:

- MTB trigger sources and filters
- DTB trigger sources and filters
- using the MTB and DTB LEVEL and NEG SLOPE controls
- MTB modes and HOLD OFF
- DTB modes including dual DTB
- time-base magnifier (TB MAGN)

basic cursor applications:

- voltage cursor measurement examples
- time cursor measurement examples including rise-time measurement

measuring methods for high frequency signals:

- introduction
- measurements via the 50 Ω oscilloscope input.
- measurements via the 1 M Ω oscilloscope input including probe information.

4.4.2. Vertical deflection part

The oscilloscope has two identical vertical channels and a third channel called TRIGger VIEW.
The following details are important:

Use of probes

To obtain a suitable connection between the oscilloscope and the device under test a probe is often used. The most common probes are referred to in this chapter together with their ranges. More information regarding this subject can be found in Section 4.4.5. Measuring methods for high-frequency signals.

1:1 passive probes should only be used for d.c. and low-frequency signals. The capacitive loading of these probes attenuates high frequencies or increases the rise-time of signals to be measured (dependent on the source impedance).

10:1 and 100:1 passive probes have smaller capacitive loading and are therefore better suited to measurements at higher frequencies. Against this, it may be a disadvantage that they decrease the sensitivity respectively by a factor of 10 and a 100.

FET probes are superior, especially when measurements are to be taken from high impedance test points at the upper frequency limit of the oscilloscope bandwidth. Probes of this type have a very low capacitive loading, yet do not reduce the sensitivity.

10:1 and 100:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies. For correct adjustment of the 10:1 attenuator probes delivered with this oscilloscope, refer to Section 8.1.1.

Input coupling switches AC, 0, DC

The signals under observation are fed to input socket A and/or B and the AC, 0, DC switches are set to either AC or DC depending on the compensation of the signal. As the vertical amplifier is d.c.-coupled, the full bandwidth of the intrument is available, and d.c. components are displayed as trace shifts in the DC position of the AC, 0, DC switches. This may be inconvenient when small signals superimposed on high d.c. voltages need to be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. This is remedied by using the AC position of the input coupling switches, which employs a blocking capacitor to suppres the d.c. and l.f. signals. However, some pulse droop will occur when l.f. square-wave signals are dispayed.

The 0 position interrupts the input signal (not the 50 Ω terminator) and earths the amplifier input, thus providing a quick check of the 0V reference level.

Chopped or alternate display mode

To display more than one channel, use either the chopped mode (CHOP pushbutton active) or the alternate mode (ALT pushbutton active).

When the ALT mode is selected, the display switched over from one channel to the other during the flyback of the time-base signal (see fig. 4.2.).
Although the ALT mode can be used at all sweep speeds of the time-base generator, the CHOP mode gives a better display quality for long sweep times, because in the ALT mode these slow sweep alternations become clearly visible, thus marring the trace.
In the CHOP mode, the display is switched over from one channel to the other at a fixed frequency (see fig. 4.2.).

In general alternate display is very suitable for the higher sweep speeds. Chopped mode however is very suitable for the lower sweep speeds and also for single shot measurements at all sweep speeds.

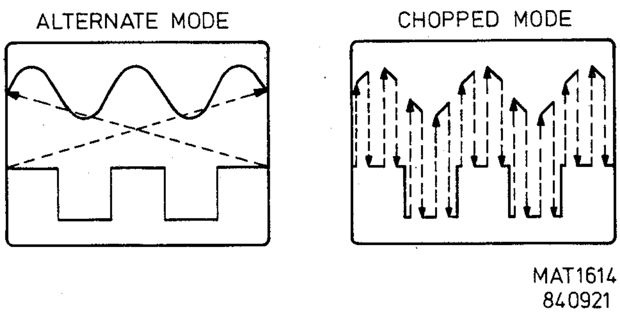


Fig. 4.2 Two channel display in alternate and chopped mode.

Added mode and common-mode measurements

If the A + B pushbutton of the vertical display mode switches is selected, the signal voltages of both vertical channels are added.
Depending on the position of the INVERT pushbutton of the A or B channel, either the sum or the difference of the input signal is displayed.
The A + B mode also enables differential measurements to be made. With these measurements, advantage is taken of the common-mode rejection in the A + B position. When the channel B INVERT switch is activated (channel A INVERT switch not activated), the common-mode portions of the signals on input sockets A and B will only be subjected to very slight amplification compared with the differential-mode portions (see Fig. 4.3. Suppression of common-mode signals).
In measurements where signal lines carry substantial common-mode signals, e.g. hum, the differential mode will largely cancel out these signals and leave the remainder of interest (A-B). The capability of the oscilloscope to suppress common-mode signals is given by the Common-Mode Rejection (CMRR) factor.
To obtain the degree of common-mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the CAL output connector, and adjusting one of the continuous VAR controls for minimum deflection on the screen.

When passive attenuator probes are used, a similar equalisation process is recommended by adjusting their compensating controls for minimum deflection.

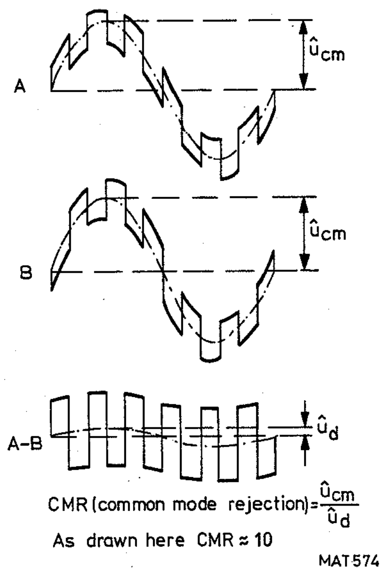


Fig. 4.3. Suppression of common-mode signals

XY measurements

If pushbutton EXT X DEFL of the horizontal display mode selection is activated, the time-base generators are switched off and the horizontal deflection is initiated by the MTB trigger source. This source can be vertical channel A or B, the external MTB trigger input EXT (or divided by ten if EXT:10 is activated) or LINE. The filter DC, AC, LF REJect, HF REJect remain active in the XY mode.

X-Y displays can be used for a wide range of applications, for example:
- frequency response of circuits and filters, where amplitude must be displayed against frequency.
- The oscillograms in Fig. 4.4. show the amplitude response of two different filters covering a certain frequency range.

The signal with this frequency range comes from a sweep generator. The voltage, responsable for the frequency sweep, is used for horizontal deflection of the oscilloscope: for instance via channel A. The sensitivity of channel A must be adjusted to 10 divisions horizontal deflection. The voltage at the filter output is applied to channel B that gives the vertical deflection.

- semiconductor measurements where output current must be displayed against input voltage

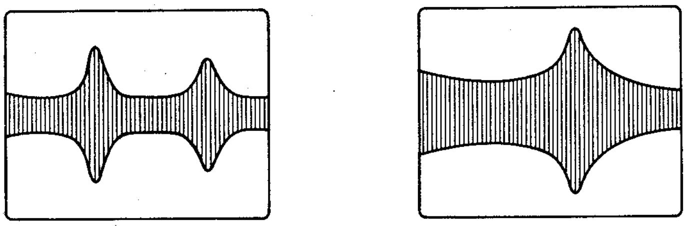


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Fig. 4.4 Two examples of filter frequency responses measured in XY-display mode.

Use of the trigger view channel

External and internal trigger view

If the TRIG VIEW pushbutton is activated the trigger view channel is switched on and the signal triggering the MTB is displayed. If the external input MTB TRIG or X DEFL is used for triggering an extra vertical channel becomes available. The sensitivity of the TRIG VIEW channel via the external trigger input is 100mV/div (EXT activated) or 1V/div (EXT:10 activated). When using a 10:1 attenuator probe the sensitivity is decreased by ten times.
Internal trigger sources can also be displayed via the TRIG VIEW channel. If the TRIG VIEW channel is selected together with composite triggering; trigger view only shows the channel A trigger signal unless channel B is displayed.
The TRIG VIEW mode shows the level at which the MTB sweep starts, which of course is adjustable with the LEVEL control.

Single shot measurements

The LEVEL and NEG SLOPE controls enable the trigger level to be set at a predetermined value without the need of an input signal. This is important when the signal to be measured is not available in advance as when single events are to be observed. When inputs which exceed a known trigger level have to be displayed, the trigger level can be set in advance and an input signal of sufficient amplitude will initiate the time-base sweep.

The procedure is as follows:
- activate the TRIG VIEW pushbutton
- position the trace of the TRIG VIEW channel relative to the mid-position horizontal graticule line to coincide with the required trigger level.

4.4.3. Triggering and time-bases

MTB trigger sources and filters

The MTB can be triggered on signals derived from the vertical channels A and B. If two time-related signals (e.g. digital) are displayed via channels A and B, a stable display is obtained if the trigger source is the signal with the lower frequency.

The COMPosite mode may also be selected. In this mode, which only works in conjunction with the ALTernate display mode, the trigger source (channel A or B) is switched together with its associated vertical channel that is in turn displayed. The COMPosite mode offers a stable display of two signals applied to channels A and B that are not time-related.

NOTE: Bear in mind that the apparent time relation displayed can give a false impression of the reality of the circuit under test.

The MTB can also be triggered on a signal applied to the external trigger input socket MTB TRIG or X DEFL. This input has two sensitivities, selectable with the pushbuttons EXT or EXT:10.

If triggering on the external input is combined with the vertical display mode TRIG VIEW, a third channel becomes available. This channel has two sensitivities (0.1V/div and 1V/div). The sensitivity ranges can be increased by using different probes (1:1, 10:1 or 100:1).

If the LINE pushbutton is active, the MTB triggers on a signal derived from the mains voltage. This mode is useful, for instance, when examining the mains voltage ripple on the d.c. output voltage of a power supply. LINE triggering is naturally not available if the instrument is operated from a d.c. supply.

Filters can be applied for the selected MTB trigger source. The filter mode can be selected by means of the DC, AC, LF REJect or HF REJect pushbuttons. The belonging filter responses are shown in fig. 4.5.

If the DC function is active, the full bandwidth of the trigger channel is available. If AC is active, the lower frequency range of the trigger channel is limited to 10Hz. This is achieved by introducing a d.c. blocking capacitor into the signal input. This mode is recommended when triggering on an a.c. signal that is superimposed on a high d.c. voltage. If the LF REJect function is active, the trigger signal path is a.c.-coupled and signals with a frequency lower than 20kHz are blocked by a high-pass filter. This mode is useful for triggering on an h.f. signal that is polluted with l.f. noise (e.g. hum). If the HF REJect function is active, the trigger signal path is a.c.-coupled and signals with a frequency higher than 50kHz are blocked by a low-pass filter. This mode is advisable for triggering on an l.f. signal that is distorted by high-frequency noise. If HF REJect and DC are both active the signal path is d.c.-coupled instead of a.c.- coupling.

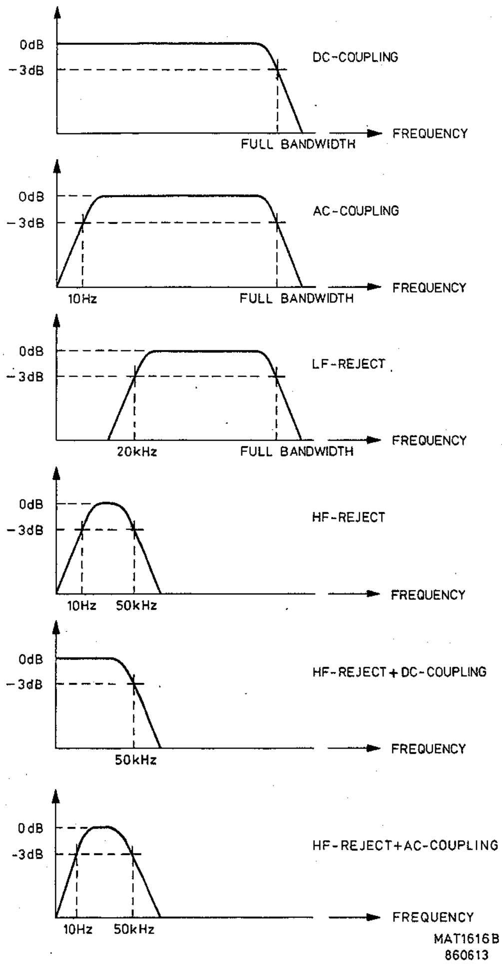


Fig. 4.5. MTB and DTB trigger filter responses

DTB triggering and filters

In most cases, the DTB must be started directly after the adjusted DELAY time. This situation occurs if the STARTS DTB pushbutton is active. In this mode it is not necessary to select a trigger source and a filter for DTB triggering. In this case, the source selector and filter pushbuttons are dedicated to the MTB triggering. However, if there is an extreme difference between MTB and DTB sweep times, the DTB display could show some instability (jitter). In order to stabilise this display, depress TRIG DTB and select a trigger source and a trigger filter. This must be done with the same pushbuttons that are used for MTB trigger source selection. These pushbuttons are now dedicated to DTB triggering.
The same sources and filters as those for MTB can be selected with the exception of LINE triggering. For trigger filter responses see fig. 4.5.

Using the MTB and DTB LEVEL and NEG SLOPE controls

The position of the particular LEVEL control determines the starting point of the time-base.
The circuit connected to the LEVEL controls functions as follows:
The trigger signal is fed to the input of a comparator. The voltage on the other input of this comparator is determined by the position of the LEVEL control. If the trigger signal reaches the voltage level of the LEVEL potentiometer, a trigger pulse is generated by the comparator and the time-base starts (see also Fig. 4.6.)

In this way, the time-base is started at a fixed point of the trigger signal, which means that by using the LEVEL control, it is possible to scan the shape of the waveform.

The NEG SLOPE pushbutton permits selection of the trigger slope. If the switch is not activated (LED off), the time-base starts on the positive-going slope. If the switch is activated (LED on), the time-base starts on the negative-going slope of the trigger signal.

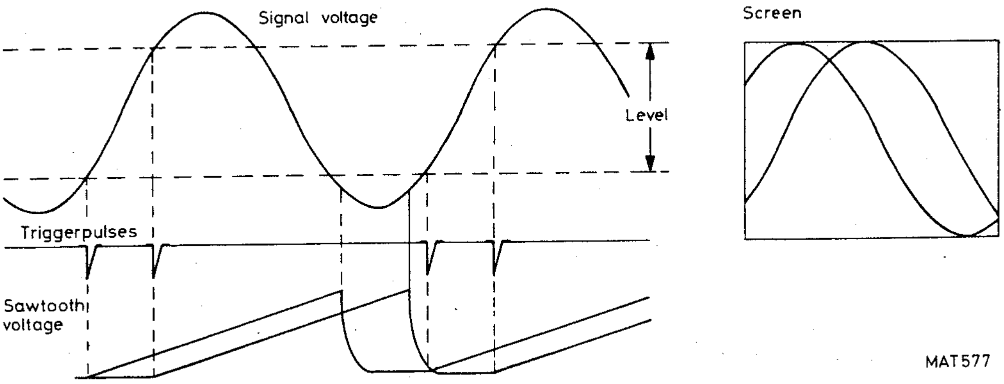


Fig. 4.6. Scanning the waveform by means of the LEVEL potentiometer

The adjustment range of the DTB LEVEL control is fixed, which means that in the extreme positions of the LEVEL control the signal is not triggered. The same is valid for the MTB LEVEL control if either the SINGLE or TRIG pushbutton is active. The NOT TRIG'D LED lights if the MTB is not triggered. However, if the AUTO pushbutton is active, the range of the MTB LEVEL control lies automatically within the peak-to-peak value of the displayed signal: as a result, the display is always triggered.

MTB modes and HOLD OFF

There are three MTB modes, listed with their applications, as follows:

AUTO mode: the MTB generator becomes free running 100ms after the last trigger pulse. This means that even in the absence of trigger pulses a line is written on the screen. If a trigger signal is again applied, then the time-base triggers normally. An extra feature of the AUTO mode is that the MTB LEVEL range lies within the peak-to-peak value of the signal amplitude. Due to the fact that the MTB becomes free-running 100ms after the last trigger pulse, the AUTO mode cannot be used for signals with a repetation rate of 100ms or more; for this the TRIGgered mode must be selected.

TRIG mode: The time-base generator is only running if a trigger signal is present. If no trigger signal is present the display remains dark.

SINGLE mode: The time-base generator runs only ones after receipt of a trigger pulse. This mode is often used when phenomenae that occur only ones must be photographed. After a single sweep the time-base is set ready for receipt of the next trigger pulse by pressing the SINGLE button again. If the instrument is waiting for a trigger pulse after the SINGLE pushbutton has been operated, the NOT TRIG'D LED is on.

HOLD OFF:

The oscilloscope also features a variable HOLD OFF control, which performs a useful function in digital and computer applications where complex pulse patterns need to be measured.

When a complex pulse pattern is displayed (see Fig. 4.7.) and this pattern is also used for triggering, a double or even multiple-picture display may occur. The more complex the pattern, the greater the possibility of multiple displays. These effects can be corrected by adjusting the HOLD OFF control to increase the hold-off time (see Fig. 4.7.).

Normally, the HOLD OFF control should be fully clockwise (minimum hold-off time) to maintain trace brightness at the faster sweep rates.

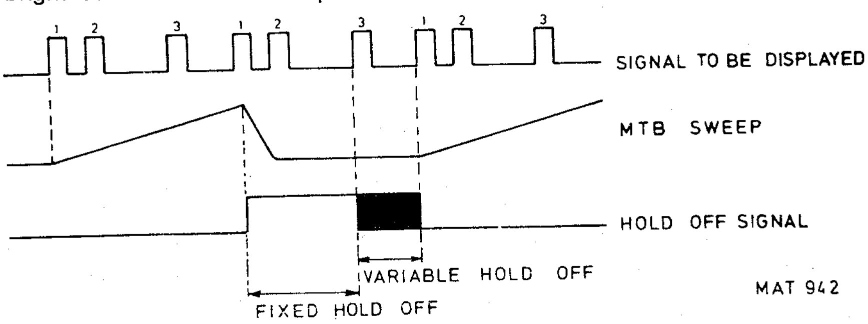


Fig. 4.7. Trigger pulse suppression with the variable HOLD OFF control

DTB modes including dual DTB

The DTB is in principle identical to the MTB, except that the DTB can only run while the MTB is running. The start of the DTB occurs later than the start of the MTB. This difference in starting time is referred to as the DELAY time and can be adjusted by means of the control knob below the LC-Display DELAY or Δt. The sweep speed of the DTB is usually adjusted to a faster sweep than the MTB. This is in accordance with the function of the DTB; i.e. to display a detail of the signal displayed via the MTB. If the MTB INTENS pushbutton is depressed, the time for which the DTB is running is displayed as an intensified part. This intensified part can be shifted horizontally by changing the DELAY time. If the DTB pushbutton is depressed, the intensified part can be displayed over the total horizontal screen width.
If both DTB and MTB INTENS pushbuttons are active, both the MTB and the DTB are displayed. If necessary, the two displays can be shifted apart with the TRACE SEParation control (Fig. 4.8. shows this for the modes STARTS DTB and TRIG DTB. Refer also to chapter 'DTB triggering and filters).

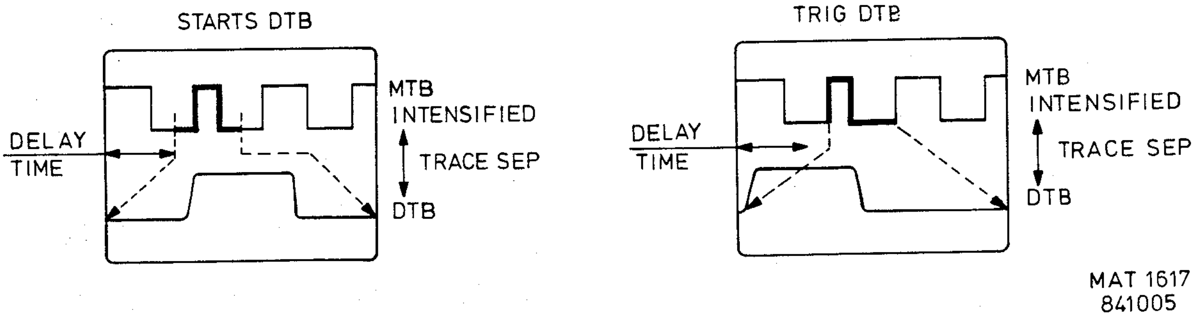


Fig. 4.8 Start of DTB

Dual DTB operation

Another important feature of the DTB in this oscilloscope is the dual DTB operation. In this mode, two intensified parts can be positioned upon the MTB display.
The LCD DELAY or Δt shows the time difference between the starting points of both intensified parts. This mode is explained by means of a measuring example shown in Fig. 4.9.

This example measures the period time and frequence of a square-wave signal.

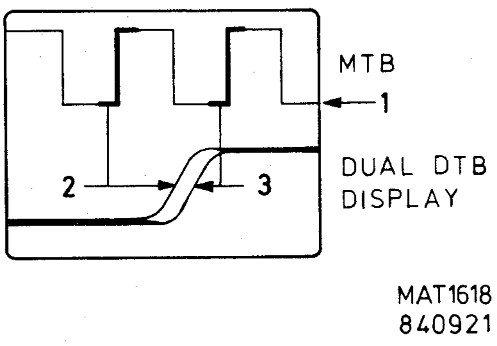


Fig. 4.9. DUAL DTB operation

The procedure is as follows:
- Apply the signal to vertical channel A with DC input coupling.
- Adjust the Channel A input sensitivity to obtain a display of reasonable amplitude.
- Check that the MTB INTENS pushbutton is active.
- Trigger the MTB on channel A and select the DC trigger coupling mode.
- Check TRIG MTB is active (LED on).
- Adjust the MTB sweep speed to display a number of pulses comparable with trace ① .
- Adjust the DTB sweep speed so that the length of the intensified part on the MTB is comparable with trace ① .
- Adjust the DELAY time so that the intensified part coincides with the rising slope of the square-wave ② .
- Press pushbutton Δt and note that a second intensified part can be shifted on the MTB display. This can be done with the control knob below the LCD DELAY or Δt. Shift the second intensified part on the rising slope following the rising slope with the first intensified part ③ .
- Press the DTB pushbutton.
- Now position the two signal slopes visible on the dual DTB display exactly upon each other. In this position, the time between the starting points of both intensified parts is exactly equal to the time period of the signal displayed on the screen. This time period can be read out on the LCD DELAY or Δt.
  The frequency of the signal can be found from a simple calculation, using the formula:
  f(Hz) = 1/t (seconds)

In the measuring example with dual DTB, the two intensified parts are both located on the same signal displayed via channel A. However, if channel A and B are selected in the ALT display mode the first intensified part is present on the channel A display and the second intensified part on the channel B display. This is a useful mode to measure the time difference between two different parts of the signals on channels A and B. For a satisfactory measurement, these two signals must be time-related (e.g. synchronised from the same clock signal).

Time base magnifier (see Fig. 4.10.)

When the TB MAGN pushbutton is activated, the sweep on the screen expands to 10x the TIME/DIV setting. In this position, the portion of the signal displayed over a width of one division in the mid-position of the screen in the x1 position (i.e. TB MAGN not activated) is magnified along the time axis by a fixed factor of 10 and now occupies the full width of the screen.
The reduced time window provides a more detailed display. Using the X POS control, any portion of the trace can be shifted into the display area.

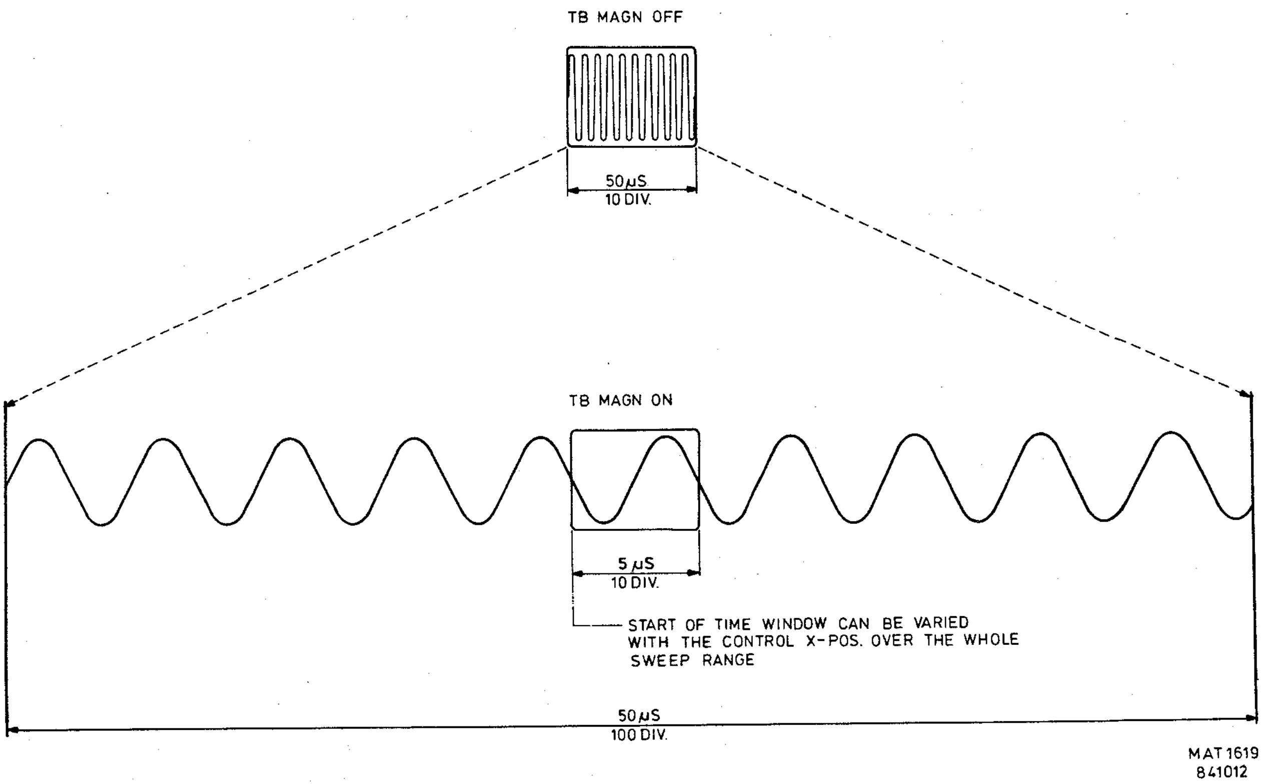


Fig. 4.10. TB MAGNification

4.4.4. Basic applications of cursors

Introduction

This oscilloscope offers the possibility to perform accurated and easy voltage and time measurements by means of the cursors. By a number of typical examples, this chapter explains how to use the cursors. From the experience gained, the operator should be able to produce efficient measuring techniques for his own specific measuring problem.
The cursors can be switched on with either the VOLT pushbutton: ↕(V) (voltage cursors) or the TIME push-button: ↔(t) (time cursors) , provided that the DTB is off.
The cursors are only visible if the READ OUT intensity is sufficient. If the cursors are switched on, two horizontal (VOLT depressed) or two vertical lines (TIME depressed) appear on the screen. Both lines can be shifted over the screen by means of the control knob CURSORS. One line is the reference line; this dashed line can be shifted after depressing the REF pushbutton. The other line is referred to as the delta line: this dotted line can be shifted after pressing the Δ pushbutton. Both lines can be shifted after depressing the TRACK pushbutton: during this action the distance between the two lines does not change.For ease of operation the CURSOR controls combines fine and coarse position adjustment in one knob.

Voltage cursor measurement ↕ (V),

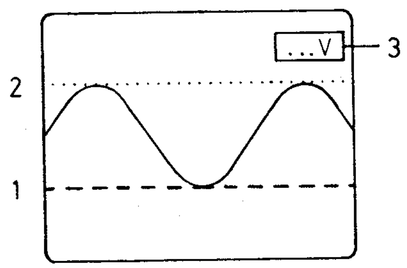
For this mode, it is necessary that the LED in the VOLT push on-push off button is on: check that two horizontal lines appear on the screen, and that information is given in the top right-hand corner regarding the vertical displacement between the lines. This information can be represented as follows:

- in V or mV: if the RATIO pushbutton is not active and if the vertical VAR control is in its CAL position. The voltage value on the screen is normally based on the Y AMPL setting of channel A. However, it is based on the Y AMPL setting of channel B if, at least, channel B is displayed and the MTB is triggered on channel B.
- in divisions if the vertical VAR control occupies the UNCAL position.
- in %: if the RATIO function is active (LED on). After RATIO is activated, the cursor read-out area on the screen shows 100%.

  If the distance is changed between the cursor lines the percentage will vary (increase for bigger distance, decrease for smaller distance). This feature can be used for the comparison of different voltage levels. The information in the top right-hand corner of the screen is positive if the Δ cursor is above the reference cursor. On the other hand, if the reference cursor is above the Δ cursor the information is negative.

Here are some examples of how to use the VOLT cursors. In all these examples channel A is used with DC input coupling. Triggering is also via channel A with DC-coupled filter. The vertical sensitivity Y AMPL and MTB sweep signal MAIN TB must be adjusted to a good read-out value. Select AUTO for MTB.

Example 1. Peak-to-peak voltage measurement



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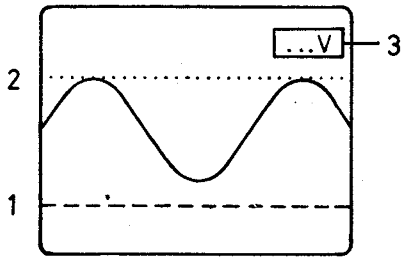
For this measuring example the sinewave signal is taken as shown in the figure. To find the peak-to-peak voltage value proceed as follows:

- Ensure that the VOLT cursor mode is active (LED on) and that RATIO mode is off (RATIO LED off).
- Press REF pushbutton and position the reference cursor on the bottom level of the signal ①.
- Press Δ pushbutton and position the delta cursor on the top level of the signal ②.
- The peak-to-peak voltage value of the signal can be read in the top right-hand corner of the screen ③.

Example 2. Peak voltage measurement

In this example the sinewave signal is superimposed on a positive d.c. voltage (see figure). To find the peak value of the signal proceed as follows:

- Ensure that the VOLT cursor is active (LED on) and that the RATIO mode is off (RATIO LED off).
- Press 0 pushbutton of channel A input coupling to establish a base-line at 0 VOLT level.
- Press REF pushbutton and position the reference cursor on the base-line ① .



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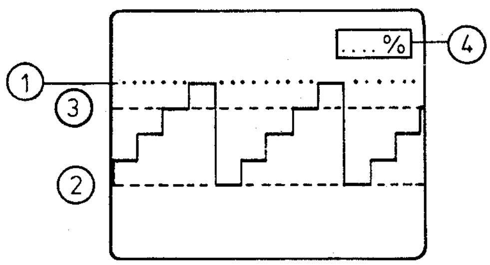
- Press the DC pushbutton of the channel A input coupling.
- Press Δ pushbutton and position the delta cursor line on the top level of the sinewave signal ②.
- The peak voltage level of the signal can be read in the top right-hand corner of the screen ③.

Example 3. Voltage ratio measurement including the use of the TRACK function

This measuring example is carried out with a staircase voltage consisting of 4 equal stairs. In this measuring example we first measure the amplitude of the top stair as a percentage of the peak-to-peak of the total signal. Afterwards we use the TRACK function in order to check if the stairs are equal. Now proceed as follows:

- Ensure that the Volt cursor mode is active (LED on).
- Press the Δ pushbutton and position the delta cursor line on the top level of the signal ①.
- Press the REF pushbutton and position the reference cursor on the bottom line of the signal ②.
- Press the RATIO pushbutton and check that the information in the top right-hand corner shows 100%.
- Reposition the reference cursor to the bottom level of the top stair ③.
- Read off the ratio of the synchronisation pulses compared with the total signal amplitude ④. This percentage should be close to 25%.



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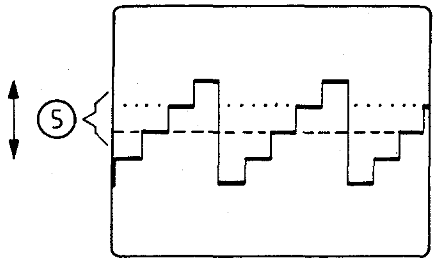
Now we are going to check the equality of the stairs:

- Press pushbutton TRACK: The reference and delta cursor can now be shifted together across the screen.
- Shift both cursors downwards and check if they can be positioned exactly on the top and bottom level of the next staircase ⑤ (see figure).
- If this is possible this staircase is equal to the proceeding one



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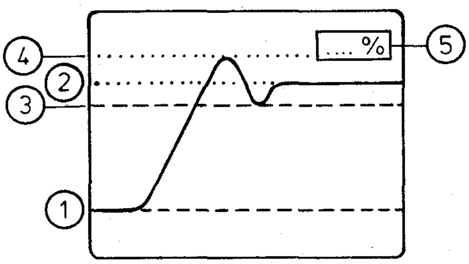
- In a similar way as described above the other stairs can be checked for equality.

Example 4. Pulse aberration measurements

When a fast-rising pulse is applied to the vertical input of an oscilloscope, for accurate measurements, it must be displayed with minimum pulse distortion. Because of the high harmonic content of steep-edged pulses, these aberrations can cause serious distortion. The figure shows a fast-rising signal edge with overshoot. The maximum aberration as a percentage of the signal amplitude is specified for every oscilloscope. To measure this accurately, proceed as follows:



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- Apply the fast-rising output signal from a calibrated square-wave generator to the channel A input socket. Switch the input impedance to 50 Ω if required by the generator.
- Ensure that the VOLT cursor mode is active (LED on).
- Press the REF pushbutton and position the reference cursor line on the bottom level of the pulse ①.
- Press the Δ pushbutton and position the delta cursor on the main top level of the pulse (excluding overshoot) ②.
- Press the RATIO pushbutton and check that the screen read-out shows 100%.
- Press the REF pushbutton again and position the reference cursor line on the bottom level of the aberrations (undershoot) ③.
- Press the Δ pushbutton again and position the delta cursor line on the top of the aberrations (overshoot) ④.
- The pulse aberrations as a percentage of the pulse amplitude now appear in the screen read-out ⑤.

Time cursor measurements --(t)

For this mode, the TIME push on-push off button must be on (LED on), to display two vertical lines on the screen. The read-out in the top right-hand corner of the screen gives information regarding the horizontal displacement between the two lines, represented as follows:

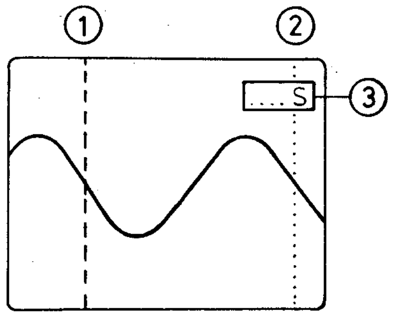
- in sec, msec or usec: if RATIO pushbutton is not active (LED off) and if the MAIN TB VAR control is at CAL position. The time between the cursor lines is based on the MTB setting.
- in division: if the MAIN TB VAR control is in the UNCAL position.
- in %: if the RATIO function is active (LED on). After activation of RATIO, the cursor read-out on the screen indicates 100%. Changing the distance between the cursor lines will either increase (larger distance) or decrease (reduced distance) the percentage. This feature is useful for comparing time differences.

The screen read-out information is positive (+) if the delta cursor (dotted line) is to the right-hand side of the reference cursor (dashed line). However, if the delta cursor is to the left-hand side of the reference cursor the information is negative (−):

Some examples are now given on how to use the TIME cursors. In all of these examples, channel A is used with DC input coupling. Triggering is via channel A and the DC filter.
The vertical sensitivity Y AMPL and MTB sweep speed MAIN TB must be adjusted to give a good read-out. Select AUTO as MTB mode.

Example 1. Measuring the period time and frequency of a signal

In this example, a sine-wave signal is taken (see figure) but this procedure also applies for other signal waveforms.



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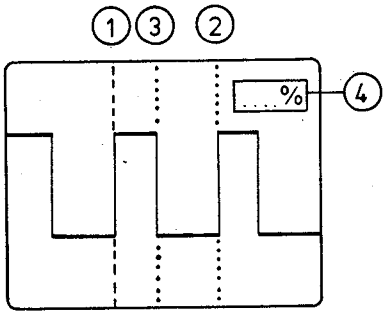
Note: In order to facilitate accurate positioning of the cursors, it is recommended that the MTB is adjusted to display only a limited number of signal periods.

- Ensure that the TIME cursor mode is active (LED on) and that the RATIO mode is not active (RATIO LED off).
- Press the REF pushbutton and position the reference cursor at the first zero crossing of the signal ①.
- Press the Δ pushbutton and position the delta cursor on the third zero crossing of the signal ②.
- The period time (T) of the signal appears in the read-out of the screen ③.

If the frequency is required, this can be found by a simple calculation from the formula:
f(Hz) = 1/T (sec)

Example 2. Measuring the duty cycle of a square-wave signal

It is often necessary to measure the duty cycle of a square-wave signal; i.e. the percentage of the total period time for which the signal is 'high'.
To measure this duty cycle (see figure). proceed as follows:



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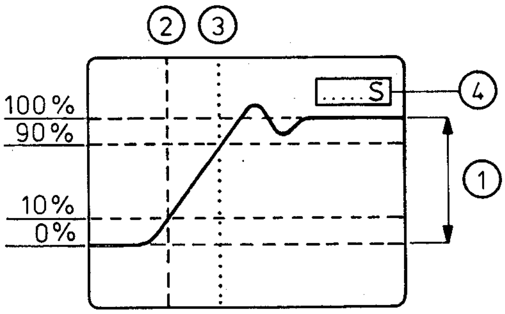
- Ensure that the TIME cursor mode is on (LED on).
- Press the REF pushbutton and position the reference cursor so that it coincides with the start of a period (positive signal edge) of the square-wave ①.
- Press the Δ pushbutton and position the delta cursor on the start of the second period of the square-wave ②.
- Press the RATIO mode pushbutton; check that the screen read-out indicates 100%.
- Position the delta cursor on the negative-going edge of the first period of the signal ③.
- Check the percentage of the duty cycle indicated in the screen read-out ④.

Example 3. Rise-time measurements

Measuring the rise-time of a fast leading-edge of a square-wave is an important procedure that can be simplified by using the TIME cursors.
The rise-time of a signal is the time required for the signal to rise from 10% to 90% of its base to peak value (see figure). For ease of measurement, the c.r.t. graticule is provided with horizontal lines at 0, 10, 90 and 100%.



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This measurement can either determine the rise-time of the signal to be examined or check the rise-time of the oscilloscope.

Measuring the signal rise-time

In general, the rise-time T_R measured on the oscilloscope screen depends on the rise-time of the signal and the rise-time of the oscilloscope according to the formula:

$$T_R \text{ (measured)} = \sqrt{T_R \text{ (signal)}^2 + t_R \text{ (oscilloscope)}^2}$$

This means that the rise-time measured on the screen is longer than the rise-time of the signal because of the measuring error. This error increases if the rise-time of the oscilloscope is longer. A simple rule is as follows:
- the measuring error does not exceed 3% if the rise-time to be measured is at least four times that of the oscilloscope.

Therefore, to examine a signal with an expected rise-time of 500 psec, use a measuring oscilloscope with a rise-time of at least 2 nsec.

Checking the oscilloscope rise-time

The oscilloscope rise-time measurement is important since the rise-time has a fixed relationship with the maximum bandwidth of the instrument, given in the formula:

$$\text{Rise-time of oscilloscope (s)} = \frac{0.35.}{\text{bandwidth (Hz) of oscilloscope}}$$

In the same way as previously explained, a measuring error can occur because the rise-times of generator and oscilloscope both influence the read-out of the rise-time on the screen.
As a simple rule, the measuring fault does not exceed 3% if the rise-time of the generator is at least four times shorter than the rise-time of the oscilloscope. Therefore, if it is necessary to check the rise-time of an oscilloscope with T_R = 2ns, a signal must be applied with a rise-time of $\leq$500 psec.

Rise-time measurement procedure (see figure)

- Adjust the amplitude of the signal (excluding any possible aberrations) so that it fits exactly between the 0 and 100% lines on the screen. The amplitude can be adjusted at the signal source and/or by varying the vertical input sensitivity of the oscilloscope ①.
- Ensure that the TIME cursor mode is active (LED on) and that the RATIO function is not active (RATIO LED off).
- Press the REF pushbutton and position the reference cursor on the crossing point of the 10% graticule line and the rising signal slope ②.
- Depress the Δ pushbutton and position the delta cursor on the crossing point of the 90% graticule line and the rising signal slope ③.
- Check the value of the rise-time in the screen read-out ④.

4.4.5. Measuring methods for high-frequency signals

4.4.5.1. Introduction

This chapter gives various methods of measuring high-frequency signals, each method with its own advantages and disadvantages. These are explained to enable the user to choose the best measuring solution for a particular problem. To this end, the accent of this chapter is more towards practical situations than pure theory.
A general scheme for a measuring set-up is given in Fig. 4.11. The configuration consists of three components:

- The signal source, or the device under test (DUT), from which a signal is derived. This signal must be displayed on the oscilloscope screen with the highest possible accuracy.

- The measuring oscilloscope.

- The interconnecting cable between the device under test and the oscilloscope. This cable must be of the required length and, of course, have suitable connectors.

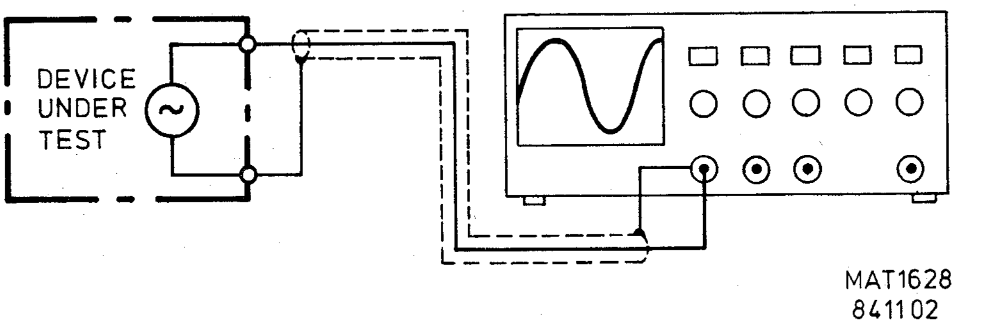


Fig. 4.11. General configuration of measuring set-up.

There are two measuring methods of using this measuring set-up:

1. In a 50 Ω system: this means that the impedance of the device under test, the cable impedance and the input impendance of the oscilloscope are all 50 Ω
2. Using the 1M Ω input of the oscilloscope: generally in combination with a 10:1 or 100:1 attenuator probe.

Before discussing the advantages and disadvantages of the various measuring methods, it is useful to give some background information dealing with the behaviour of high-frequency signals.

4.4.5.2. *Behaviour of high-frequency signals*

This section explains how a sine-wave is transferred from the signal source, via the cable, to the input of the oscilloscope, which functions as a load impedance.

The sine-wave 'travels' along the connecting cable to this load impedance; Fig. 4.12. shows the instantaneous values of the signal voltage along the cable for four different times T1, T2 T3 and T4 (in time-sequence).

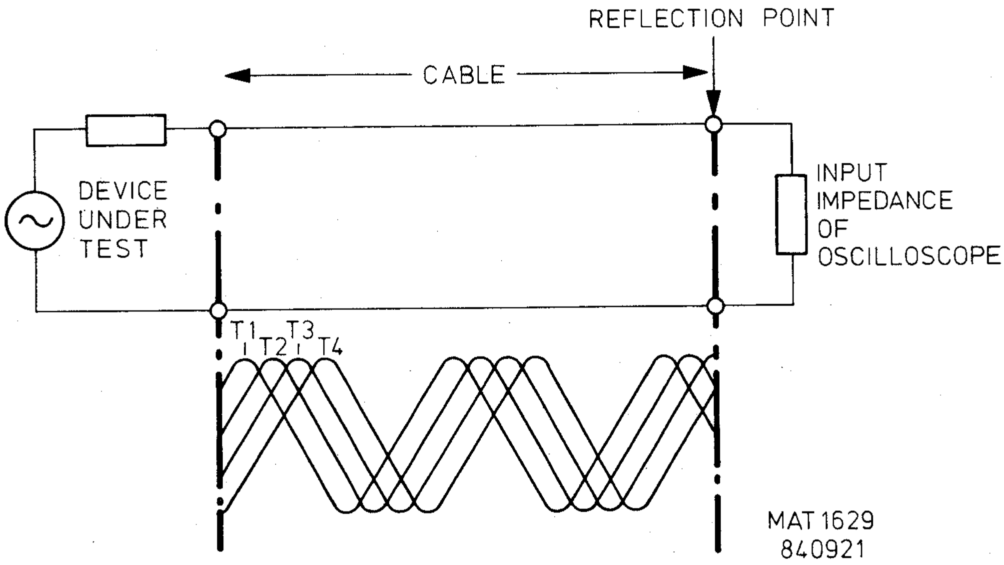


Fig. 4.12. Travelling wave, showing position of sine-wave along the cable for sequential times T1, T2, T3, T4.

If the oscilloscope impedance is equal to the impedance of the cable and device under test, half the voltage from the device under test will appear across the oscilloscope input. If the oscilloscope input impedance differs from the impedance of cable and device under test, a part of the sine-wave travelling from the device towards the oscilloscope input is reflected at the oscilloscope input. This reflected sine-wave travels in the opposite direction to that shown in Fig. 4.12. Thus two sine-waves travel in the cable in opposite directions, and will alternately add and subtract from each other.
This phenomenon is known as a standing wave. It is the envelope of the addition/subtraction of both travelling sine-waves. This envelope can be measured if an a.c. voltmeter is moved progressively along the cable: the maxima and minima of the standing wave do not move.

Such a standing wave is shown in Fig. 4.13. for three different situations, as follows:

- The end of the cable is short-circuited and total reflection takes place. The voltage at the end of the cable is of course zero. The maximum value is twice the generator voltage.
- The end of the cable is open. Total reflection again occurs, the standing wave at the end of the cable is maximum and is twice the generator voltage.
- The end of the cable is terminated with an impedance differing from the characteristic impedance. Now a part of the sine-wave is reflected and the maximum value of the standing wave is higher than the generator voltage.

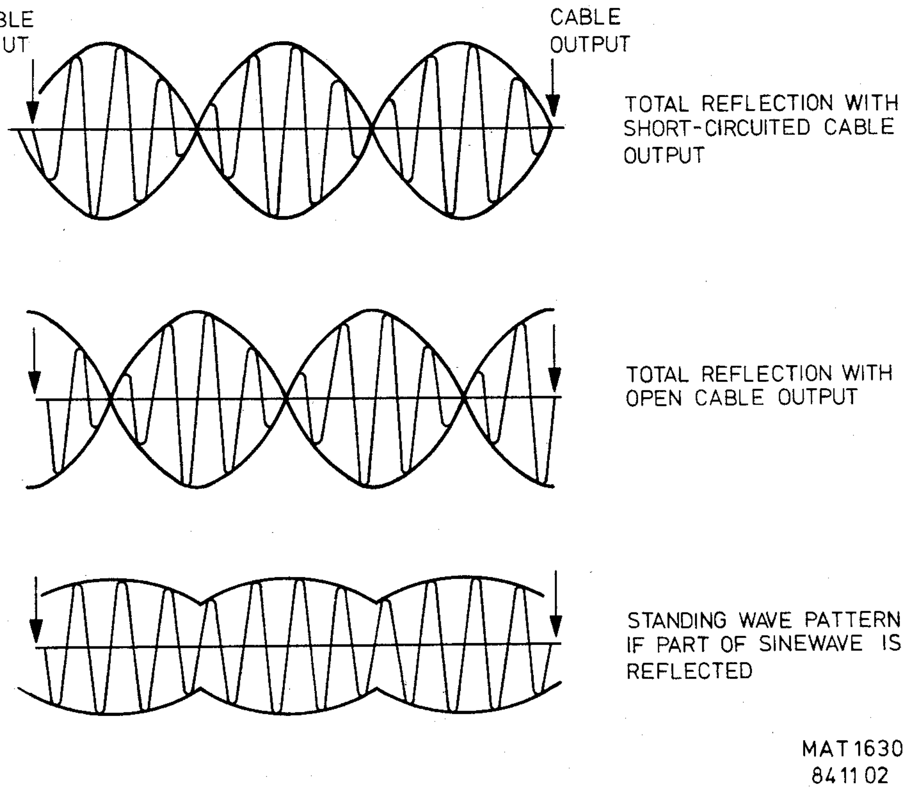


Fig. 4.13. Standing wave patterns in three different situations

After these considerations, it is easier to understand the two following important definitions for the reflection coefficient and the voltage standing wave ratio (VSWR):

- reflection coefficient $= \dfrac{\text{amplitude of reflected signal}}{\text{amplitude of generator voltage}} = \Gamma$

The reflection coefficient is represented by the Greek letter Γ (gamma) and depends on the impedance Z of the device under test and cable and the input impedance Z_0 of the oscilloscope according to the formula:

$$\Gamma = \frac{Z - Z_0}{Z + Z_0}$$

Γ represents a complex number consisting of an absolute value $/\Gamma/$ and an angle.

- Voltage standing wave ratio (VSWR) $= \dfrac{\text{max. amplitude of standing wave}}{\text{min. amplitude of standing wave}}$

The VSWR depends on the absolute value of $/\Gamma/$ in the formula:

$$\text{VSWR} = \frac{1 + /\Gamma/}{1 - /\Gamma/}$$

4.4.5.3. *Using the 50 Ω input of the oscilloscope*

To make UHF measurements, it is preferable to use the 50 Ω input facility of the oscilloscope. This should be done in conjunction with cables and a device under test/signal source of the same impedance. Such a system has the advantage that the cable length and parasitic capacitances/inductances do not affect the measurement. The system, together with its associated voltage levels is shown in Fig. 4.14.

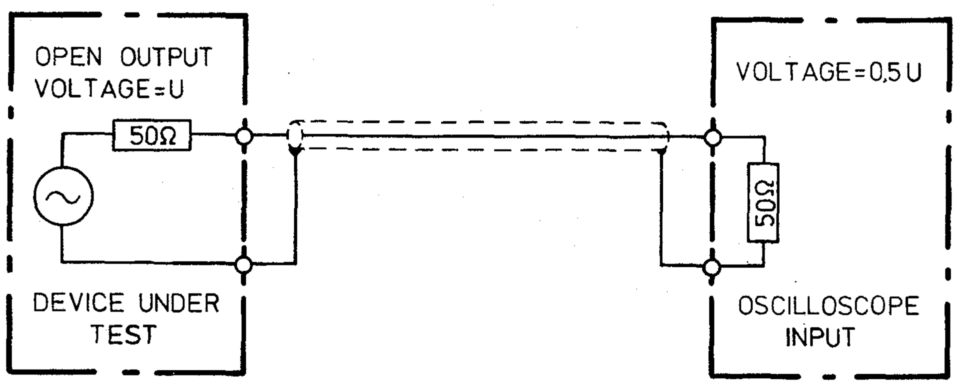


Fig. 4.14. Measuring set-up using 50 Ω impedances

For devices under test where 50 Ω measurements do not seem possible, a satisfactory solution can often be found. For instance, to measure the signal voltage across a 300 Ω load resistor it is possible to divide it up into a 50 Ω and 250 Ω resistor. The signal voltage can then be measured across the 50 Ω portion, remembering of course that the signal amplitude is now attenuated by a factor of six.

Hints for measurement

- The internal 50 Ω input facility of the oscilloscope gives fewer reflections and a superior VSWR figure than an oscilloscope with a 1M Ω input and external 50 Ω termination resistor.
- When using the internal 50 Ω resistor, always ensure that the maximum input voltage is not exceeded. This is especially important when measuring a.c. voltages that are superimposed on a d.c. voltage.
- An extra 50 Ω attenuator of good quality added between the cable end and the 50 Ω input of the oscilloscope will reduce reflections and improve the VSWR figure (at less sensitivity).
- if the energy from the device under test (e.g. a transmitter) is too high for the oscilloscope input, a power splitter may be a good solution. By using a power splitter, only part of the device under test energy is applied to the oscilloscope; the rest of the energy is applied to the normal load.

Fig. 4.15. gives a configuration where only a quarter of the energy (and half the voltage) from the device under test is applied to the oscilloscope input. Note that the 50 Ω impedance in this system is not disturbed by introducing the power splitter.
Other resistance values for the impedances of the power divider make different power division rates possible. The power splitter in this example is built up by a resistor network. In this case, half the energy is dissipated in the splitter.

Other types of splitters making use of transformers do not have these losses; however, they have a limited bandwidth.

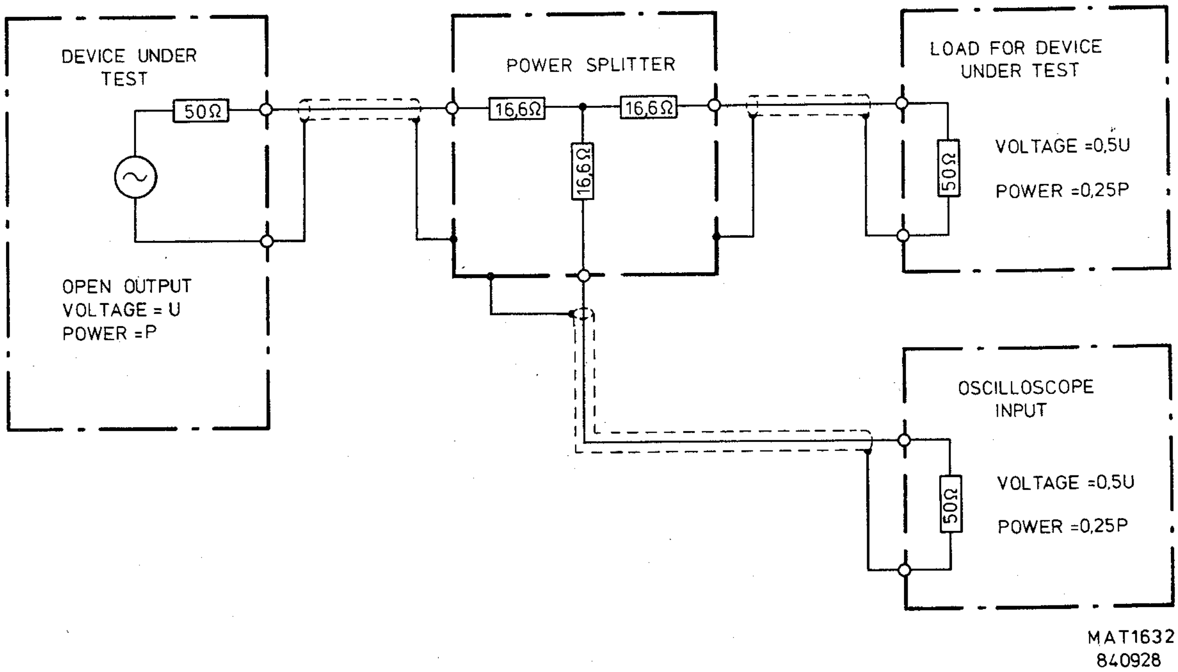


Fig. 4.15. Measuring configuration with power splitter

4.4.5.4. *Measurements in 75 Ω systems*

Previously, measuring configurations have been mentioned where the impedances of the device under test, cable and oscilloscope input are equal. The following example discusses measurements with the oscilloscope 50 Ω input in a system where the device under test and cable impedances are 75 Ω. The systems configuration is the same as in Fig. 4.14.
Important factors are:

- Due to the mismatch at the oscilloscope input, reflection takes place at this input. This results in a standing wave pattern in the cable. Therefore, the signal amplitude at the oscilloscope input depends on the signal frequency and cable length. This means that for certain cable lengths it is possible to perform satisfactory measurements, but only for certain frequencies.

A better solution for the above problem is to include a 75-50 Ω adaptor between the cable end and the oscilloscope input.

4.4.5.5. *Measurements with leading edges of square-wave signals*

Since a square-wave signal is composed of the odd harmonics of sine-wave signals of various frequencies and amplitudes, the reflection problems discussed for sine-wave signals also occur with square-waves this is demonstrated for five examples to show the effects of mismatch. The terminations that are discussed (see also table below) are:
- open-cable output
- short-circuited output
- resistive load at output
- capacitive load at output
- inductive load at output

The pulse from the generator travels through the cable (length = l metres) to the termination point. The travelling time = T.l where T is constant (for most coaxial cable types it is 5ns/metre).
At the termination point of the cable the signal (or part of it) is reflected and travels back to the output of the device under test (travelling time again = T.l). At the output of the device under test both signals are added.

The table belows (see Fig. 4.16) shows voltage waveforms at the device under test output and cable output as a function of the cable length and load.

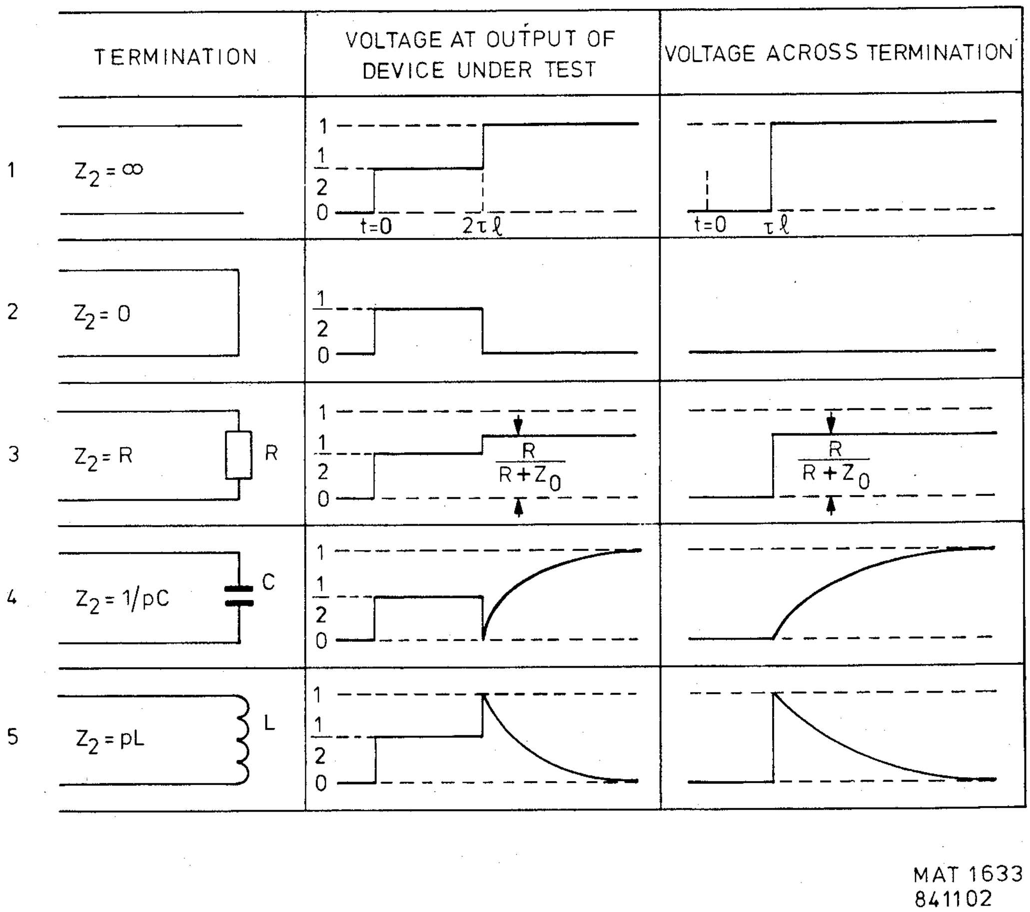


Fig. 4.16 Square wave signal behaviour as a function of termination.

4.4.5.6. *Use of probes*

Special 100:1 and 10:1 attenuator probes are available that must be used in combination with the 50 Ω input of the oscilloscope. At frequencies above 50MHz, probes such as these give a higher input impedance than a 10:1 type in combination with the 1M Ω input of the oscilloscope. This results in lower signal distortion.

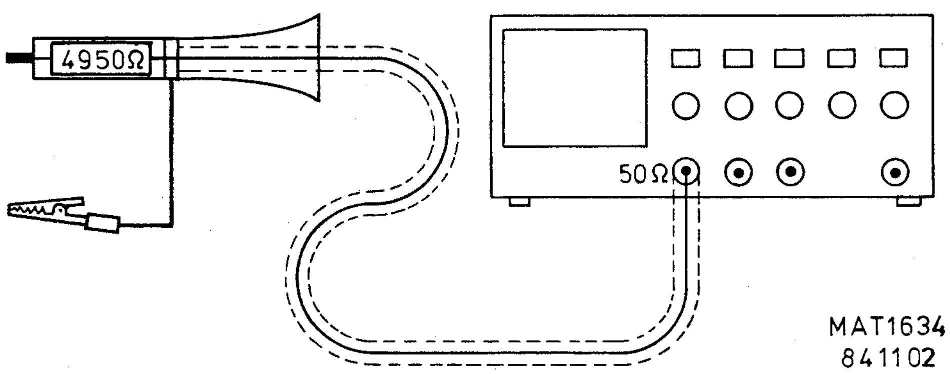


Fig. 4.17. 100:1 attenuator probe in combination with 50 Ω input of the oscilloscope

Generally, when using probes it is most important that the earth wire is as short as possible since this presents a certain self-inductance for high-frequency signals. The longer the wire, the higher the self-inductance, with a correspondingly higher signal distortion. Most probes designed for high frequency measurements are delivered with accessories for a short earth connection.

4.4.5.7. Using the 1M Ω input of the oscilloscope

The oscilloscope input impedance is very high (usually 1M Ω in parallel with 10...15pF) compared with the output impedance of the signal source. Apart from possible measuring faults, the oscilloscope receives an input signal with a very low energy level.
This signal needs amplification; a fact that has a negative influence on the signal-to-noise ratio.
The input impedance figure is however only valid for the d.c. and low-frequency signals. Already at signal frequenies above 1 MHz the input impedance can be lower than 1M Ω. This due to the influence of capacitances, inductances and resistances in the input circuit of the oscilloscope and possibly the connection cable or 1:1 probe. From this it will be realised that input impedance of 1K Ω at frequencies above 100MHz are quite normal. Obviously, this may load the device under test considerably.
Problems of this nature can be solved by using a special high frequency 10:1 probe. Accurate measurements up to 200MHz are then possible. This special high-frequency probe has a correction network that compensates for unwanted capacitances and inductances. The signal is of course attenuated by a factor of ten when using this probe.
A probe type that combines the high frequency behaviour of the 10:1 h.f. attenuator probe yet does not attenuate the signal (1:1 response) is the FET probe. This is specially recommended when measurements need to be made from signal sources with very low signal levels; e.g. signals in front-ends of radio and TV sets and signals from sensitive transducers.

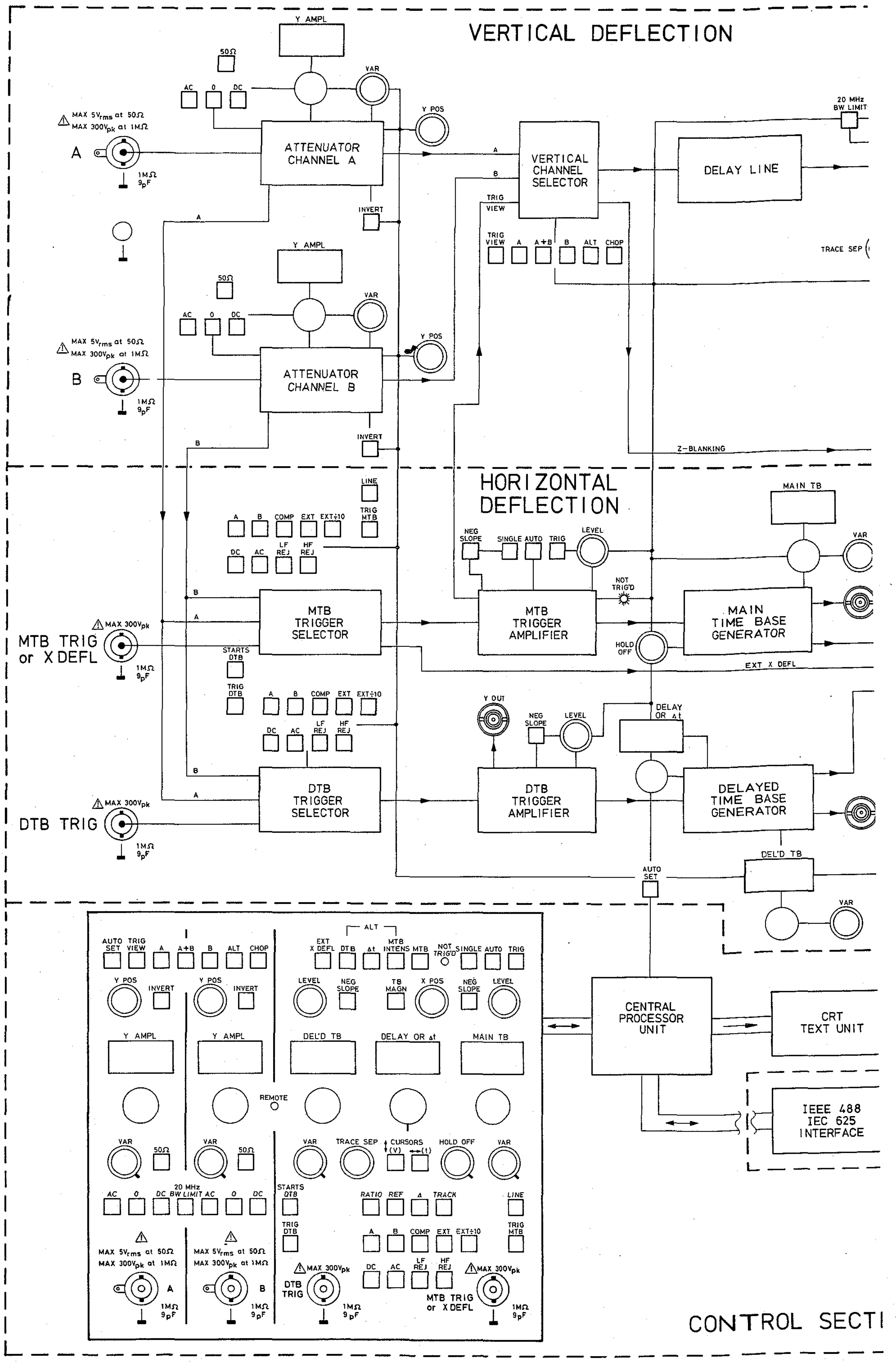


Fig. 4.18 Blockdiagram

4.5.3. Horizontal deflection

The oscilloscope has a MAIN and a DELAYED time-base.

MAIN TIME-BASE (MTB)
The MTB is triggered on the signal selected in the MTB TRIGGER SELECTOR.
The trigger selection switches are also used for the Delayed Time-Base (DTB).
When TRIG MTB is active, the trigger selection switches are active for the MTB, selection being made, via the CPU, by the switches:

A	Signal derived from channel A
B	Signal derived from channel B
COMP	Composite triggering of A and B, for input signals that are not time-related.
EXT	External input signal via BNC socket.
EXT:10	
LINE	Signal derived from the mains voltage.

The trigger signal coupling is also controlled via the CPU:

DC	Full bandwidth
AC	DC signal components are blocked.
LF REJ	LF input signals are blocked.
HF REJ	HF input signals are blocked.

The MTB trigger mode is selected with the following switches:

AUTO	Automatic peak-peak triggering. Always a trace, even in the absence of a trigger signal.
SINGLE	MTB sweep is started once.
TRIG	Normal triggering, no peak-peak triggering.

Positive or negative triggering is selected by the NEG SLOPE pushbutton switch.
The selected trigger signal is fed, via the MTB TRIGGER AMPLIFIER to the MAIN TIME-BASE GENERATOR.
The MTB GENERATOR determines the horizontal deflection coefficient, under the control of the CPU.
Indication of the selected horizontal deflection coefficient is given in the LCD MAIN TB.

DELAYED TIME BASE (DTB)

The DTB is triggered on the signal selected by the DTB TRIGGER SELECTOR.
The trigger selector switches are active for the DTB when TRIG DTB is active.
All DTB trigger sources are the same as for the MTB, except LINE; the DTB trigger coupling is also the same as for MTB.

When STARTS DTB is active, the DTB starts immediately after the selected DELAY TIME (i.e. it does not wait for a trigger signal).
Positive and negative triggering is selected by NEG SLOPE. The trigger signal is fed, via the DTB TRIGGER AMPLIFIER, to the DTB GENERATOR.
The DTB GENERATOR determines the horizontal deflection coefficient, which is shown in the LCD DEL'D TB.

Dual DTB is possible when Δt is selected.
The time difference between the two DTB signals is indicated in the LCD Δt.

The horizontal deflection source is selected in the HORIZONTAL CHANNEL SELECTOR, controlled by the horizontal channel selection switches via the CPU.
Horizontal deflection sources are as follows:

EXT X DEFL	the selected MTB trigger source
DTB	Delayed Time-Base generator
Δt	Dual DTB
MTB INTENS	Main Time-Base and Delayed Time-Base (intensified part)
MTB	Main Time-Base generator.

The selected horizontal deflection signal is fed to the FINAL X AMPLIFIER.
The TB MAGN switch enables the horizontal deflection coefficient to be magnified by a factor of 10.
Horizontal shift of the trace is achieved by the X POS control. The FINAL X AMPLIFIER drives the horizontal deflection plates of the c.r.t.

4.5.4. CRT display section

The trace intensity on the c.r.t. screen is controlled by the Z AMPLIFIER.
The Z AMPLIFIER blanks the flyback of the trace and also the switching intervals between the traces.
For the vertical switching modes, ALT and CHOP, the Z AMPLIFIER is driven by a Z-blanking signal from the VERTICAL CHANNEL SELECTOR.
For horizontal switching intervals, MTB and DTB and intensity differences in MTB INTENS mode, the Z AMPLIFIER is controlled by a signal derived from the HORIZONTAL CHANNEL SELECTOR.

The intensity of the trace is controlled by the INTENSITY-TRACE CONTROL and the intensity of the c.r.t. text by the READ OUT control.

The FOCUS control drives the focus electrodes of the c.r.t. via the FOCUS CONTROL CIRCUIT, to give trace sharpness.

Trace alignment is achieved by the TRACE ROT. control, which drives the trace rotation coil via the TRACE ROTATION CIRCUIT.

The ILLUM control, via the ILLUM CONTROL CIRCUIT, provides illumination of the graticule lines by means of two lamps.

4.5.5. Power supply

The oscilloscope may be powered by any a.c. voltage between 90V and 264V.
The POWER SUPPLY unit consists of two PRIMARY CONVERTERS, each with an output voltage of 24V d.c.
The PRIMARY CONVERTERS are switched in series to feed 48V d.c. to the SECONDARY CONVERTER, which converts it into the required d.c. supply voltages for the various circuits.
For LINE triggering, a mains voltage-related signal is fed to the MAIN TIME-BASE TRIGGER SELECTOR.

The HIGH VOLTAGE CONVERTER produces a positive high voltage (+14,3kV) via a high-voltage multiplier for the accelerator anode of the c.r.t. and a negative high voltage (−2,2kV) for the Z AMPLIFIER for FOCUS control.

The CALibration square-wave signal is generated in the CALIBRATION SIGNAL GENERATOR and fed to the CAL BNC socket.

4.6. BRIEF CHECKING PROCEDURE

4.6.1. General information

This procedure is intended to check the oscilloscope performance with a minimum of test steps and actions required.
It is assumed that the operator doing this test is familiar with oscilloscopes and their characteristics.

WARNING: Before switching-on, ensure that the oscilloscope has been installed in accordance with the instructions mentioned in Chapter 3.

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

If this test is started a few minutes after switching-on, bear in mind that test steps may be out of specification, due to insufficient warm- up time.
To be sure that this will happen, allow the full indicated warm-up time.
The check is set up in a logical sequence. The complete flow should be followed carefully to prevent repeating all control settings and input signals at the start of every single check. All checks in this procedure can be made without removing the instrument covers. For a complete check of every facet of the instrument's calibration, refer to the section 'Performance Check' in the service manual (for qualified persons only).

4.6.2. Preliminary settings of the controls

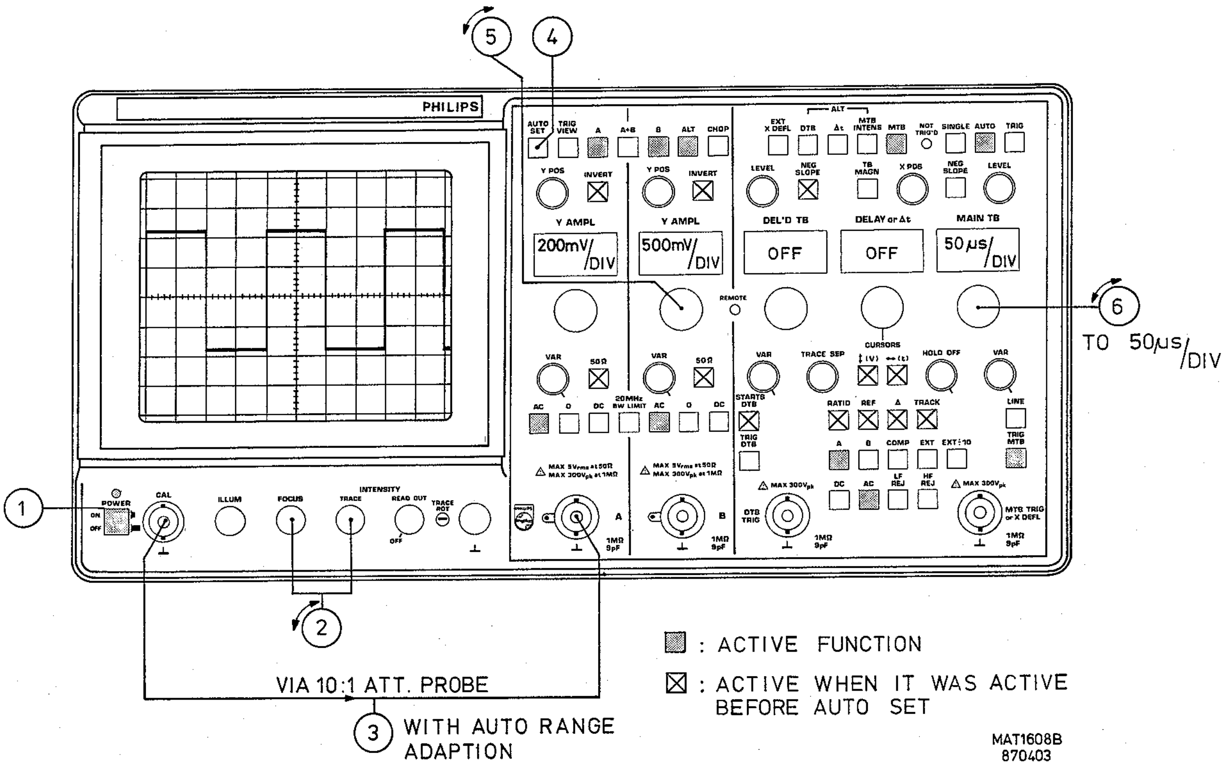


Fig. 4.19. Preliminary settings

①. Switch on the oscilloscope and check if the POWER-UP routine is executed in accordance with Section 4.1.

②. Set the INTENS and FOCUS controls for a well-defined sharp trace.

③. Connect the CAL signal to the A input via the 10:1 att. probe with automatic range adaption BNC plug.

④. Press pushbutton AUTO SET; the functions indicated in Fig. 4.19. Preliminary settings, should be active and the square-wave should be visible on the c.r.t. screen (2 div. trace height).

⑤. Set Y AMPL of channel A to 200mV/DIV, and channel B to 500mV/DIV.

⑥. Set MAIN TB to 50µs/DIV, indicated in LCD.
- Check if a square-wave signal (channel A) and a straight line (channel B) are displayed on the c.r.t. screen as indicated.

⑦. Set the functions indicated with ☒ off by pressing once (if necessary).

4.6.3. Trace rotation

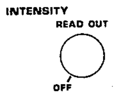
TRACE ROT

- Press 0 of channel B input coupling switches.
- Set the trace of channel B in the vertical mid-position of the screen by turning the Y POS control.
- Check that the trace lies in parallel with the horizontal graticule line; if necessary, re-adjust the TRACE ROT screwdriver control.

4.6.4. Use of probes

The 10:1 passive probes must be properly compensated before use to avoid pulse distortion or amplitude errors at high frequencies.
For correct adjustment, refer to Section 8.1.1.

4.6.5. Setting information on the screen

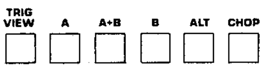


- Turn READ OUT control ⌒ ; check if vertical and and horizontal deflection coefficients are shown on the c.r.t. screen (see Section 4.3.8.).
- Turn READ OUT control ⌒ ; setting information is off.

4.6.6. Vertical channels

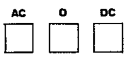
As channels A and B are identical, only the procedure for channel A is described.

4.6.6.1. Vertical display mode switches



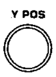
- Press B; check that only channel A (square-wave signal) is displayed; check that B and ALT is off.
- Press TRIG VIEW; check if the input signal of channel A and the signal used to trigger the MTB are displayed;
  check if A, TRIG VIEW and ALT are on.
- Press TRIG VIEW; check if TRIG VIEW is off; only A is on.
- Apply the CAL output to inputs A and B via 10:1 attenuator probes with auto range adaption BNC plug.
- Press AC of channel B input coupling switches
- Press A + B; check if A and A + B are displayed; check if displayed square-wave signal (A + B) is 7 divisions high.
- Press A + B; check that only A is selected.
- Remove input signal from channel B.

4.6.6.2. Input coupling

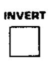


- Press 0 of channel A ; check that input signal is switched off, a straight line is visible on the screen and AC is off.
- Press DC; check that displayed square-wave is shifted upwards with zero line slightly above vertical mid-position and 0 is off.
- Press AC; check that DC is off.

4.6.6.3. Vertical positioning and inverted input signal



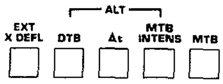
- Turn Y POS control of channel A; check if displayed square-wave signal can be shifted vertically.
  After AUTO SET, manually adjustable by turning through mid-position.
- Set trace in the vertical mid-position.



- Press INVERT of channel A; check that displayed square-wave signal is inverted.
- Press INVERT of channel A; check that display reverts to normal square-wave.

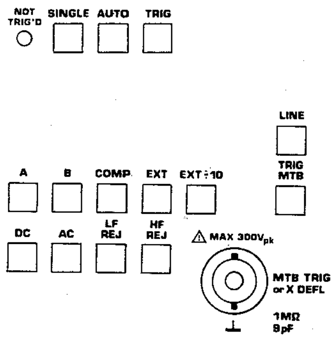
4.6.7 Horizontal channels and triggering

4.6.7.1 Horizontal display mode switches



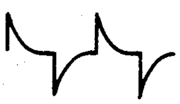
- Press MTB INTENS; check that MTB is off.
- Set DEL'D TB control to 5us/DIV. (in LCD).
- Press STARTS DTB
- Set start of MTB-signal exactly on the first vertical graticule line.
- Set DELAY control to 0100.0μs; check that intensified part (DTB) starts on the negative slope and has a width of one division.
- Turn DELAY control ; check intensified part shifts horizontally over the time axis.
- Set DELAY control to 0200.0μs; check that intensified part starts on the second positive slope of the input signal.
- Press DTB; check that DTB and MTB INTENS are active and that both signals are displayed (MTB with intensified part, and intensified part displayed over the full width of screen).
- Turn TRACE SEP ; check that both traces can be vertically shifted with respect to each other.
- Press DTB; check that only MTB INTENS is active.
- Turn DELAY control to 0100.0μs.
- Press Δt; check that Δt and MTB INTENS are active.
- Turn Δt to 0.200μs with Δt control; check that square-wave with two intensified parts is displayed and that the second intensified part starts on the second negative slope.
- Turn Δt control (DELAY control); check that the second intensified part is horizontally shifted over the time axis.
- Press DTB; check that DTB, Δt and MTB INTENS are active and three traces are displayed:
  - MTB with two intensified parts
  - two DTB traces that overlap each other.
- Press EXT X DEFL; check that only EXT X DEFL is active (MTB and DTB functions are off).
- Turn X POS ; check that two points are visible under an angle of 45° (X DEFL by input signal of channel A).
- Press MTB; check that EXT X DEFL is off.

4.6.7.2. MTB and DTB triggering

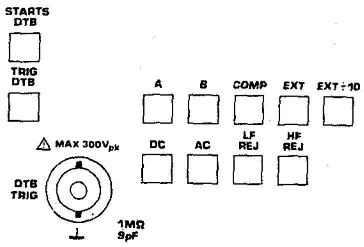


MTB triggering

- Press B; check that MTB is not triggered and A is off.
- Apply CAL signal to channel B input via 10:1 probe with auto range adaption; check that MTB is triggered via channel B.
- Press COMP; check that B is off and MTB is well triggered.
- Press EXT; check that MTB is not triggered and COMP is off.
- Remove input signal of B and apply CAL signal via 10:1 probe to MTB TRIG input ; check that MTB is well triggered .
- Press EXT:10; check that MTB is not triggered (input signal is too small).
- Press LINE; check that MTB is not triggered and EXT:10 is off.
- Press A; check that LINE is off and that MTB is well triggered.
- Remove input signal from MTB TRIG BNC.
- Turn Y-POS of channel A and set the square wave signal in the upper half of the c.r.t. screen.
- Press TRIG VIEW; check that input signal of A and signal on which the MTB starts are displayed. This TRIG VIEW signal must be a square-wave signal.
- Press AC; trigger view signal is a square-wave.



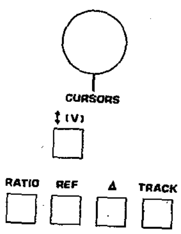
- Press LF REJ; check that AC is off and that the trigger view signal is a differentiated square-wave.
- Press HF REJ check that LF REJ is off and HF REJ and AC are on and that trigger view signal is a square- wave.
- Press DC; check that HF REJ and DC are active.
- Press DC; check that only DC is active.
- Press TRIG; check that AUTO is off.
- Turn LEVEL (MTB) ; check that LEVEL range over which MTB is well triggered is 5 divisions (equal to trace height).
- Set TRIG VIEW signal in the vertical mid-position of the screen by means of LEVEL (MTB) control.
- Press SINGLE; check that TRIG is off and SINGLE is on.
- Press SINGLE; check that the MTB is triggered once.
- Press AUTO; check that SINGLE is off.
- Press NEG SLOPE (MTB); check that the MTB is triggered on negative slope of input signal.
- Press NEG SLOPE (MTB); check that the positive triggering is activated.
- Press TRIG VIEW; check that TRIG VIEW is off and that only the input signal of channel A is displayed.



DTB triggering

- Press MTB INTENS
- Turn DELAY control to 0100.0us.
- Set DEL'D TB to 5us/DIV.
- Press STARTS DTB; check that DTB (intensified part) starts on the first negative slope of the square wave signal.
- Press TRIG DTB; check that TRIG MTB and STARTS DTB are off and that the DTB starts on the second positive slope of the input signal depending on the LEVEL DTB position.
- Press B; check that the DTB is not triggered.
- Apply CAL signal via 10:1 attenuator probe to input B; (input signal on A and B) check that DTB is well triggered depending on the LEVEL DTB position.
- Press COMP; check that DTB is well triggered.
- Press EXT; check that DTB is not triggered.
- Remove input signal of B and apply CAL signal via 10:1 atten. probe to DTB TRIG input BNC; check that DTB is well triggered (adjust LEVEL DTB).
- Press EXT:10; check that DTB is not well triggered (input signal too small).
- Press A; check that only A is active.
- In turn, select DC, AC, LF REJ, HF REJ and check that the DTB can be well triggered after adjusting the LEVEL DTB control.
- Press DC.
- Press NEG SLOPE (DTB); check that the DTB starts on the negative slope of the input signal.
- Press NEG SLOPE (DTB); check that the DTB starts on the positive slope of the input signal (adjust LEVEL DTB).
- Press MTB of horizontal display mode switches; check that DTB TRIG is off and that MTB TRIG is active.

4.6.8. Cursors

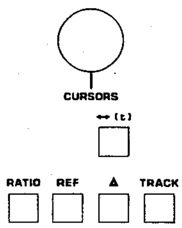


Voltage cursors

- Set READ OUT control ⌒ .
- Press ↕(V); check that one of the functions RATIO, REF, Δt or TRACK is active and that two horizontal lines (cursors) are visible on the screen.
- Press REF; check that ↕(V) and REF are active.
- Turn CURSOR control ⌒ ; check that lower cursor (dashed line) shifts vertically over the screen and that ΔV value in mV is indicated on the c.r.t. screen.
- Turn VAR control of channel A ⌒ (UNCAL); check that ΔV value is now indicated in DIV.

- Set VAR control (channel A) in CAL position ⌒
- Press RATIO; check that ↕(V), RATIO and REF are active and Δ value is indicated in %.
- Press Δ: check that ↕(V), RATIO and Δ are active.
- Turn CURSOR control ⌒ ; check that upper cursor (dotted line) shifts vertically over the screen and that ΔV value is indicated in %.
- Press RATIO; check that ↕(V) and Δ are active and that the ΔV value is indicated in mV.
- Turn CURSOR control to put Δ cursor (dotted line) below REF cursor; check that ΔV value is negative.
- Turn CURSOR control ⌒ ; check that Δ value goes positive.
- Press TRACK; check that ↕(V) and TRACK are active.
- Turn CURSOR control; check that ΔV value is fixed and that this ΔV window can be vertically shifted over the screen.

Time cursors



- Press ↔(t); check that two vertical lines are visible on the c.r.t. screen and that ↔ (t) and TRACK are active.
- Turn CURSOR control ⌒ ; check that Δt value is fixed and that the Δt window can be horizontally shifted across the screen.
- Press Δ; check that ↔(t) and Δ are active.
- Turn CURSOR control ⌒ ; check that the Δ cursor (dotted line) can be shifted across the screen and that the Δt value is indicated in μs.
- Turn the VAR control of the MTB ⌒ (UNCAL); check the Δt value is now indicated in DIV.
- Turn the VAR control to CAL position ⌒ .
- Press RATIO; check that ↔(t), Δ and RATIO are active and that Δt value is indicated in %.
- Press REF; check that ↔(t), REF and RATIO are active.
- Turn CURSOR control ⌒ ; check that the REF cursor (dashed line) can be shifted across the screen and Δt value is indicated in %.
- Press RATIO; check that ↔(t) and REF are active (RATIO is off), and that the Δt value is indicated in μs.
- Turn CURSOR control ⌒ and set the REF cursor to the right of the Δ cursor; check that the Δt value is now negative.
- Turn CURSOR control ⌒ ; check that Δt value is now positive.

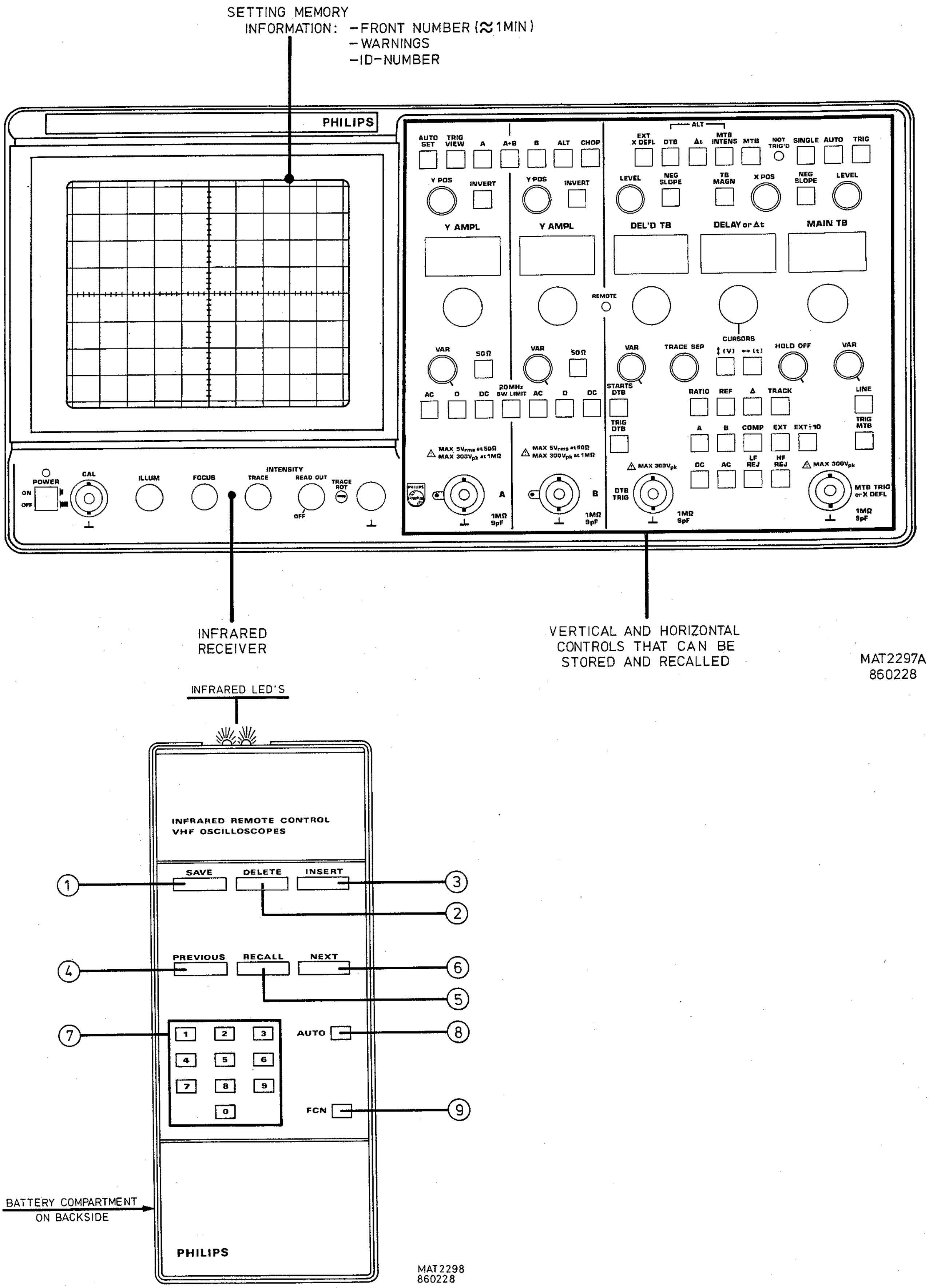


Fig. 4.20 Oscilloscope with FRONT SETTING MEMORY REMOTE CONTROL

4.7. FRONT SETTING MEMORY REMOTE CONTROL (ONLY VALID FOR PM3286A)

4.7.1. Introduction

With the separate FRONT SETTING MEMORY REMOTE CONTROL the front setting memory of the oscilloscope can be controlled via invisible infra-red light signals. In this front setting memory 75 different front settings can be stored.
All front control settings, except the settings of ILLUM, FOCUS, INTENSITY-TRACE-READ OUT can be stored (see fig. 4.20). Preselected front settings can be stored and recalled via the FRONT SETTING MEMORY REMOTE CONTROL.

4.7.2. Installation instructions

To control the memory of the oscilloscope the remote control must be held in such a way that the infra-red receiver, situated between the FOCUS and INTENSITY-TRACE control, can detect the infra-red light coming from the remote control.
If more oscilloscopes with the same remote function are present in the same room it may be necessary to give every oscilloscope a different Identification Number (ID number) to prevent that all present oscilloscopes react at the same time.
In this way only one oscilloscope will react on a cetain command (after ID number is given).
For more detailed information see section 4.7.3.2: FCN ⑨

4.7.2.1. Replacing the batteries of the remote control

To (re)place the batteries proceed as follows:
- Remove the cover of the battery compartment, situated on the back side of the remote control, by pushing with your thumb in the direction of the arrow on the cover.
- Install the 4 batteries (PHILIPS type R03S; 1,5V) in the correct way (see the indication in the battery compartment).
- Press the cover on the remote control housing so that appoximately 0,5 cm is still open.
- Shift the cover in the opposite direction of the arrow so that the locking tongues snap in the housing.
- The remote control is now ready for use.

NOTE: It is advisable to remove the batteries when the setting memory remote control is stored for longer periods than 24 hours at ambient temperatures below −25°C or above 60°C.

IMPORTANT: Under no circumstances should the batteries be left in the setting memory remote control at ambient temperatures outside the rated range of the battery specifications!

4.7.3. Operating instructions

4.7.3.1. General information

The front side of the remote control must be pointed towards the front side of the oscilloscope. Press one push-button firmly for each command and never give two commands at once.

If an incorret command is given a warning "ILLEGAL" is indicated on the c.r.t. screen.
If a remote signal is acknowledged a square part lights up on the c.r.t. screen (see fig. 4.20).
Before an "execute" button is pressed ① ... ⑥, a frontnumber must be selected with the numerical buttons ⑦. If only an "execute" button is pressed, on screen is indicated: ILLEGAL.

When a front setting is stored in the front setting memory and the oscilloscope is switched off, (back-up batteries present) the stored front settings are "WRITE PROTECTED" at switching on.
To change "WRITE PROTECTED" into "NOT WRITE PROTECTED" please read the information given at command FCN ⑨ (section 4.7.3.2.).
All programmed data, including the ID number, is saved in the setting memory of the oscilloscope at switching-off, only when the back-up batteries are installed (see section 3.3.).

If with the READ commands PREVIOUS, RECALL or NEXT a frontnumber is selected, the actual front setting of the oscilloscope is stored in the setting memory on frontnumber "0".
Front "0" is used as an "front setting back-up memory".
In this way it is possible to compare the recalled frontnumber with the latest actual frontsetting on frontnumber "0" by the command "0 RECALL".
Front "0 cannot be programmed by the WRITE commands (ILLEGAL).

4.7.3.2. Commands of the SETTING MEMORY REMOTE CONTROL

WRITE COMMANDS

To store front settings in the memory, the following functions can be selected:

① SAVE : to store a front setting in the memory.

② DELETE: to erase a front setting.

③ INSERT: to store a front setting in the memory in between two already stored frontnumbers.

A front setting can only be stored, deleted or inserted if the setting memory is **not write protected.**
If the setting memory is "WRITE PROTECTED" and a WRITE command is given, on the c.r.t. screen is indicated: PROTECTED.(for detailed information see command FNC ⑨).
To store front settings in the SETTING MEMORY proceed as follows:

① SAVE

- Select a frontnumber with the push buttons ⑦ (1...75).
- Press SAVE ① ; the actual front settings are stored in the memory under the selected frontnumber.

* When a frontnumber is selected (that was stored before SAVE is pressed) the previous front setting will be overwritten by the actual one.

② DELETE

- Select a frontnumber with the push-buttons ⑦ (1...75).
- Press DELETE ② ; the front settings stored on the selected frontnumber are erased.

③ INSERT

- Select a frontnumber with the push-buttons ⑦ (1...75).
- Press INSERT ③ ; the front settings are stored in the memory on the selected frontnumber inbetween two already stored frontnumbers.

* The front settings that were stored on the selected frontnumber are shifted to the next one, till the next empty frontnumber. The frontnumber that was empty will be filled with the front settings of the previous one.
If the front settings of all frontnumbers are shifted to the next one, the front settings of the last frontnumber (75) will be lost.

READ COMMANDS

To recall the stored front settings, the following commands can be selected:

④ PREVIOUS : to recall the front settings of the previous frontnumber.

⑤ RECALL : to recall a front setting.

⑥ NEXT : to recall the front settings of the next frontnumber.

To recall the stored front settings, proceed as follows:

④ PREVIOUS :

- Press PREVIOUS ④ ; the front settings stored in the previous frontnumber are recalled.

* When the previous frontnumber is deleted or erased, it will be skipped.
After the first stored frontnumber the final stored frontnumber will be selected.

* The selected frontnumber is indicated on screen for approx. 1 min.

* If PREVIOUS is pressed and all frontnumbers in the setting memory are deleted or erased, on screen is indicated: EMPTY.

⑤ RECALL : - Select a frontnumber with the push buttons ⑦ (0!...75).
- Press RECALL ⑤ ; the front settings stored in the selected frontnumber are recalled.

* If a frontnumber is selected that was deleted or erased, no action will be executed and on the c.r.t. is indicated:

"CANCELLED"

* The selected frontnumber is indicated on screen for approx. 1 min.

⑥ NEXT : - Press NEXT ⑥ ; the front settings of the next frontnumber are recalled.

* When the next frontnumber is deleted or erased, it will be skipped.
After the final stored frontnumber the fist stored frontnumber will be selected.

* The selected frontnumber is indicated on screen for approx. 1 min.

NUMERICAL PUSH BUTTONS

⑦ [1][2][3] [4][5][6] [7][8][9] [0]

Numerical push buttons to select the frontnumber and function numbers. (max. 2 digits).
The front- and function numbers must be selected before the next "execute" commands:
RECALL
DELETE
INSERT
SAVE
FCN

* If an incorrect number was selected just go on and press the correct number.
The last selected number(s) will be valid.
If after selection of the number no "execute" command is given, the selected number will be erased after a few seconds.

SPECIAL COMMANDS

⑧ AUTO : - When pressing AUTO ⑧ , the oscilloscope will execute "AUTO setting" as indicated in section 4.3.2.

⑨ FCN : - Pressing push-button FCN results in a warning on the screen of the oscilloscope: ILLEGAL.
Before FCN is pressed a functionnumber must be selected.
The following function commands are possible:

* **Cancel ID-number (Identification number, see also section 4.7.2.)**

[ID nr]–[1]–[FCN]

- Select the ID-number that must be cancelled (displayed on screen) with the numerical buttons ⑦ (0...9)
- Press "1" of the buttons ⑦
- Press FCN
- Now the selected ID number is cancelled (erased).

* **Programm ID number. (see also section 4.7.2)**

- If no ID number was programmed:

[ID nr]–[2]–[FCN]

- Select the new ID number (0...9) with the buttons ⑦
- Press "2" of the buttons ⑦
- Press FCN
- Now the new ID number is programmed and is continuously displayed on the c.r.t. screen.

If the oscilloscope is switched off and on, the ID nr is not indicated on screen, press any button of the Remote Control and it is indicated again.

- If an ID number must be changed:

[Old ID nr] - [New ID nr] - [2] - [FCN]

- Select the already programmed ID number (0. . .9)
- Select the new ID number with buttons ⑦
- Press "2" of the buttons ⑦
- Press FCN
- Now the new ID number is programmed and is continuously displayed on the the c.r.t. screen.

If the oscilloscope is switched off and on, the ID nr is not indicated on screen, press any button of the Remote Control and it is indicated again.

If an ID-number is programmed, then before every "execution" command the programmed ID number must be given, as follows:

[ID nr] - [AUTO]
[ID nr] - [NEXT]
[ID nr] - [PREVIOUS]
[ID nr] - [FRONT NUMBER 2 digits e.g. 00. . .75] - [RECALL]
[ID nr] - [FRONT NUMBER 2 digits e.g. 01. . .75] - [DELETE]
[ID nr] - [FRONT NUMBER 2 digits e.g. 01. . .75] - [INSERT]
[ID nr] - [FRONT NUMBER 2 digits e.g. 01. . .75] - [SAVE]
[ID nr] - [1] - [FCN]
[Old ID nr] - [New ID nr] - [2] - [FCN]
[ID nr] - [3] - [FCN]
[ID nr] - [4] - [FCN]

If an incorrect ID number is selected, only a square part indicates that information was sent, but no action will be done.
Only if the programmed ID number (indicated on screen) is selected two stars (**) indicated that the correct ID number was sent and the oscilloscope waits for the next information.

* Setting memory **not write protected**

[3] - [FNC]

- Select "3" of the buttons ⑦
- Press FNC
- Now the setting memory is **not write protected** and the WRITE COMMANDS can be executed.

* Setting memory **write protected**

[4] - [FNC]

- Select "4" of the buttons ⑦
- Press FNC
- Now the setting memory is **write protected.**
  Only the READ-commands and AUTO can be executed.
  After switching-off the oscilloscope (with back-up batteries) the setting memory is always **write protected** at switching-on.

4.7.3.3. *Messages displayed on the c.r.t. screen*

On the c.r.t. screen the following messages (information) can be indicated:

CANCELLED	* If a frontnumber is recalled that was deleted or erased.
EMPTY	* If a READ command is given and **all** frontnumbers are deleted or erased.
FRONT number	* If a READ command is given, the selected frontnumber is indicated for approx. 1 min.
ILLEGAL	* If an incorrect command is given. * If only an "execute" command is given without frontnumber. * If only FNC is pressed.
ID number	* If an ID number is programmed.
PROTECTED	* If a WRITE command is given and the setting memory is WRITE PROTECTED.
Square part □	* Message received indicator. Indicates that infra-red signals are detected by the Infra-red receiver. (Also when commands are not valid).

5. PREVENTIVE MAINTENANCE

5.1. GENERAL INFORMATION

This instrument normally requires no maintenance, since none of its components is subject to wear. However, to ensure reliable and trouble-free operation, the instrument should not be exposed to moisture, heat, corrosive elements or excessive dust.

5.2. REMOVING THE BEZEL AND CONTRAST FILTER (TO CLEAN THE CONTRAST FILTER)

The bezel is attached to the oscilloscope by four clamping lips. Slots on the left and right-hand side secure the viewing hood to the oscilloscope.

To clean or replace the contrast filter, proceed as follows (see also Fig. 5.1.):

- Grip the left and right-hand side of the bezel between each thumb and forefinger and pull it gently forward (if necessary, insert finger-nails in slots to ease it free).

- Press the contrast filter from the bezel.

- To prevent scratches, when cleaning the filter, ensure that a clean soft cloth, free from dust and abrasive particles, is used.

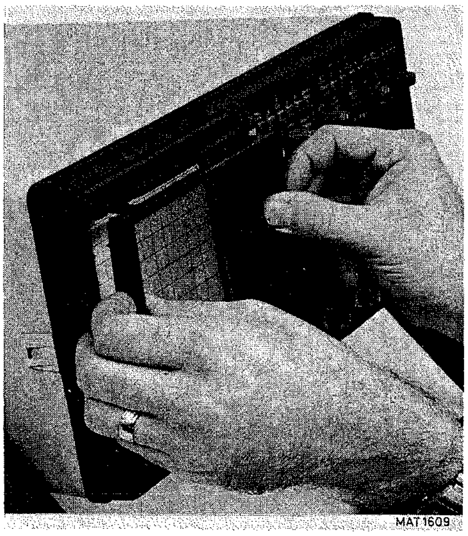


Fig. 5.1. Removing the bezel and contrast filter

5.3. REPLACING THE MEMORY BACK-UP BATTERIES

The two memory back-up batteries are installed in the battery compartment, situated on the rear panel. Fully-charged batteries have a typical lifetime of two years when the instrument is used according to the environmental specifications given in Chapter 6.

IMPORTANT NOTE:To save the front-panel setting values in the memory when replacing the batteries, it is recommended to switch-on the oscilloscope during the procedure.

Recommended batteries: two 1.5V alkaline manganese penlight batteries e.g. PHILIPS LR6 or DURACELL MN 1500.

When the batteries must be replaced, proceed as follows:

- Decide whether front-panel setting values need to be saved. If so, switch on oscilloscope (see note above).

- Remove the cover of the battery compartment on the rear panel by pressing the two locking tongues towards each other (see Fig. 3.1.).
- Remove the batteries.
- Note the indicated polarity to prevent incorrect installation.
- Install two fully-charged batteries.
- Refit the push-cover on to the rear panel.

5.4. RECALIBRATION

From experience, it is expected that the oscilloscope operates within its specifications for a period of at least 1200 hours, or for one year if used infrequently. Recalibration must be carried out by qualified personnel only.

6. CHARACTERISTICS

A. Performance Characteristics

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

B. Safety Characteristics

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

C. Initial Characteristics

- Overall dimensions:

- Height:		
Without feat and accessory pouch	:	170 mm (6,7 in)
Feet and accessory pouch included	:	240 mm (9,4 in)
Feet	:	10 mm (0,4 in)
- Width:		
Handle excluded	:	340 mm (13,4 in)
Handle included	:	386 mm (15,2 in)
- Depth:		
Handle excluded	:	473 mm (18,6 in)
Protective front cover included	:	508 mm (20 in)
With extended handle	:	575 mm (22,6 in)
• Mass	:	13,6kg (30lb)

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

D. Contents

6.1 DISPLAY

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Cathode Ray Tube		140mm Rectangular single beam tube with helical vertical deflection system.
• Measuring Area (h. x w.)	80mm x 100mm	8 divisions x 10 divisions
• Screen type:		
(basic version)	GH (P31)	
(optional)	GM (P7); BE (P11)	
• Total Acceleration Voltage:	16,5kV	
• Max. Writing Speed:		Measured in central 5 div x 5 div of screen; in absence of contrast filter.
(photographic)	typical 2cm/ns	Single Shot; Phosphor: GH; no prefogging; Lens aperture F:1,2; object to image ratio 1:0,5; Film: Polaroid type 612 (20 000 ASA).
• Graticule:	internal, fixed	
Illumination	continuously variable	
Engravings:		
division lines	At 1cm	Horizontal and vertical.
tick marks	At 2mm	On vert. and hor. central axes and on hor. lines at 2cm and 6cm from top.
dots	At 2mm	On dotted lines at 1,5cm and 6,5cm from top.
percentages	100, 90, 10, 0%	To facilitate rise and fall time measurements.

6.2 VERTICAL DEFLECTION OR Y-AXIS

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Deflection Sources	Ch.A; Ch.B; Ch.A and Ch.B added	Both channels can be inverted, (allowing for A-B and B-A in added position).
	Trigger View (MTB)	
• Deflection Modes:	1 Channel only; Alternate; Chopped	Any combination of sources.
Display Time Display Blanking	350ns 150ns	Each source (in chopped mode). After each display time (in chopped mode).
• Visual Signal Delay	20ns (typical)	At Maximum intensity and well focused display.
• Max. Delay Difference		
between Ch.A (B) and EXT.Trigg. View.	2ns (typical)	Trigger view delayed with respect to channel A or B
• Channel Isolation: of Deselected Channel	100:1	At 50MHz; input to deselected channel equivalent to 8 divisions or less.
between Selected Channels	50:1	At 200MHz; channels with equal V/div settings; input to either channel equivalent to 8 divisions or less
• Y-Signal Output:		Available at BNC on rear of instrument. Y Signal Output is not affected by BW limiter.
Source	= DTB Trigger Source	
Coupling	= DTB Trigger Coupling	Ch.A or Ch.B coupling eventually cascaded with DTB trigger coupling
Voltage into 1MΩ	20mV/div + or − 10%	Max. output + or − 80mV (160mV peak to peak).
into 50Ω	10mV/DIV + or − 10%	Max. output + or − 40mV (80mV peak to peak).
Freq.response	dc... 200MHz (−3dB)	Terminated with 50Ω. For influence of trigger coupling see 6.8.

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Rise Time (in 1mV and 2mV/div pos.)	5,4ns or less	When used for Y defl. Measured over central 6 div.
• Common Mode Rejection Ratio:		Both channels at same attenuator setting; vernier of V/div setting adjusted for best CMMR; measured with max. 8 div input at each channel, (+ or − 4div around zero).
at 1MHz	100:1	
at 50MHz	20:1	
Max. baseline instability: Jump between any V/div positions	0,2 div or 1mV	Whichever is greater
		* Calculated value according formula: $T_R = \frac{0,35}{\text{Bandwidth.}}$

6.4 TRIGGER VIEW

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Signal Source	= Trigger Source MTB	COMPosite = Channel A, unless only Channel B is displayed.
• Deflection Coefficient:		
Ch.A or Ch.B	see 6.3.	Except error limit.
EXT	100mV/div	
EXT:10	1V/div	
Error Limit	+ or − 5%	For all sources except LINE
• Dynamic Range:		Compression at limits of Dynamic Range: 7%
up to 100MHz	24 div	
up to 200MHz	8 div	
• Line deflection	6 div or more	Trigger Source: LINE; 49Hz<Line Freq.<61Hz
• Frequency Response	(−3dB)	Trigg. Coupling: DC; HF REJ: off; Band width: limiter: off;
Trigger source: Channel A or B (INT)	dc...150 MHz	channel A or B in 50Ω position. Z of signal source: 50Ω
Trigger source: EXT		
(ambient: 15°...35°C)	dc...200 MHz	Z of signal source: 25Ω
(ambient: 5...40°C)	dc...160 MHz	Deviation max. 10 MHz for ambient:
(ambient: 0...50°C)	dc...150 MHz	0°...50°C.
• Pulse Response:		Trigg. Coupling: DC; HF REJ: off; Band width limiter: off; Distortion due to peak to peak leveling may be visible, when in AUTO position of trigger selector and at trigger frequencies <100Hz.
• Rise Time:		
Trigger source: INT	2,33 ns	Z of signal source: 50Ω
Trigger source: EXT		Z of signal source: 25Ω
(ambient: 15...35°C)	1,75 ns	Calculated value according formula:
(ambient: 5...40°C)	2,19 ns	$T_R = \frac{0,35}{\text{Bandwidth.}}$
(ambient: 0...50°C)	2,33 ns	
• Trigger Point	center of screen	Measured at 50kHz.

6.5 HORIZONTAL DEFLECTION OR X-AXIS

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Deflection Sources	-MTB; -MTB intensified by DTB; -mono DTB; -dual DTB;	Can be displayed alternately in a quasi simultanuous way.
	-Ext. through Ch.A; -Ext. through Ch.B; -Ext. through EXT MTB trigger input; -Line	Selected by MTB trigger source selector
• Trace Separation:		Between MTB INTENSified and (mono or dual) DTB.
Max. Separation	at least 4 div	Symmetrical: (MTB shifting upward, DTB downward).
• Minimum Shift Range	+ or − 5 unexpand. div.	From screen center.
• Deflection Coefficient:		
Ch.A or Ch.B	see 6.3.	Except error limit
EXT	100mV/div	
EXT:10	1V/div	
Error Limit	+ or − 5%	For all sources except LINE.
• Dynamic Range	20 div	Measured at 50kHz; Compression at limits of dynamic range: 6%.
• Maximum Linearity Error	5%	Measured at 1KHz
• Line Deflection	7 div (+or-1,5 div:)	49Hz<line Frequency <61Hz.
• Frequency Response:		
Lower Transition Point of BW	see appropriate Channel	Input coupling of Ch.A or B and coupling of MTB trigger are cascaded.
Upper Transition Point of BW	2MHz (-3dB)	
• Max. Phase Diff. between Hor. and Vert.	3°	Up to 100kHz
• Max. Horizontal Display Instability: Drift	0,1 div/h	
Temp. Coëfficient	0.05div/K	

6.6 MAIN TIME BASE

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Modes	repetitive	Auto Bright Base Line occurs, when in AUTO Trigger Mode and if during $>0,1s$ no triggerable signal is available.
	single	
• Deflection Coefficient:		Measured over central 8 unmagn. div.
Steps (TB Magnifier: Off)	20ns...1s/div	In a 1-2-5 sequence of 24 steps.
Error limit (ambient: 5°...40°C)	+ or − (0,5% of full scale + 1% of reading)	Add 0,5% of full scale for 20ns....50ns/div. Add 0,5% of full scale for ambient: 0°...50°C
(TB Magnifier: x 10)	2ns...0,1s/div	In a 1-2-5 sequence of 24 steps
Error limit (ambient: 5°...40°C)	+ or − (1% of full scale + 1,5% of reading)	Add 0,5% of full scale for ambient: 0°...50°C
Vernier Ratio	2,5:1	Uncalibrated, contin. variable between steps.
• TB Magnification (Hor. Expansion):		
Max. Expansion	10x .	
Unbalance	+ or − 0,4 unexpand. div	When switching from X10 to X1, the center display will not shift more than stated value.
• Minimum Visual Display Length	10 unexpanded div	At Normal Intensity.
• Variable Hold Off:		
Minimum	1μs or 2 div of MTB setting	Whichever is greater
Maximum	6x minimum Hold Off	
• Gate Out:		Available at BNC on rear of instrument.
Time Base not running	$0V<output<0,4V$	Maximum Current Sink: 2mA
Time Base running	$2,4V<output<5V$	Maximum Current Supply: 400μA.
Output impedance	2,3kΩ	

6.8 MTB TRIGGERING

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Trigger sources	Channel A; Channel B; Composite (Ch. A & B); External; Line	
• Input Impedance (Ext. Trigg.): R par. C par.	1MΩ + or − 1% 9pF	Measured in DC position of Input Coupling; in AC position 18nF in series with R par. and C par.; for Frequency >1MHz: see Fig. 6.1.
Max. input cap difference	1,5p F	Difference between channel A, B, EXT MTB trigger and EXT DTB trigger inputs
• Coupling	d.c.; a.c.; LF rejected; HF rejected;	
⚠ • Maximum Input Voltage (Ext. Trigg.)	300V (d.c. + a.c. peak)	Apparatus should be properly grounded through the protective-ground conductor of the power cord. Up to 1MHz; for Frequency >1MHz: see Fig. 6.2.
• Minimum trigger Sensitivity:	up to 100MHz | up to 200/250MHz	In TRIG mode
Ch.A and Ch.B EXT EXT:10	0,5div | 1div 50mV | 300mV 500mV | 3V	up to 200 MHz Up to 250 MHz
• Slope Selection	positive going (+); negative going (−)	
• Level Control Range:		Not TRIG'D led lits unless triggered.
Ch. A and CH.B EXT EXT:10	+ or − 8 div + or − 0,8V + or − 8V	In TRIG and SINGLE positions of Mode Selector.
Any Source	related to peak value	In Auto position of Mode Selector.
• Frequency Response:		Trigger not affected by Bandwidth Limiter.
Lower Transition Point of BW		Channel A or Channel B coupling eventually cascaded with Trigger coupling.
	d.c. 10Hz(−3dB) or less	Trigger coupling in DC position Trigger Coupling in AC position
	20kHz(−3dB)	Trigger Coupling in LF REJected position.
Higher Transition Point of BW	50kHz(−3dB)	Trigger Coupling in HF REJected position.

6.9 DTB TRIGGERING

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Trigger sources	Channel A; Channel B; Composite (Ch.A & B); External; End of Delay (STARTS mode)	
• Input Impedance (Ext. Trigg.): R par. C par.	 1MΩ + or − 1% 9pF	Measured in DC position of Input Coupling; in AC position: 18nF in series with R and C par.; for Frequency >1MHz: see Fig. 6.1.
Max. input cap. difference	1.5p F	Difference between channel A, B, EXT MTB trigger and EXT DTB trigger inputs.
• Coupling	d.c.; a.c.; LF rejected; HF rejected;	
• Maximum Input Voltage (Ext. Trigg.)	300V (d.c. + a.c. peak)	Apparatus should be properly grounded through the protective-ground conductor of the power cord. Up to 1MHz; for Frequency >1MHz: see Fig. 6.2.
• Minimum trigger Sensitivity:	up to 100MHz | up to 200/250MHz	
Ch.A and Ch.B	0,5div | 1div	Up to 200 MHz
EXT EXT:10	50mV | 300mV 500mV | 3V	Up to 250 MHz
• Slope Selection	positive going (+) negative going (−)	
• Level Control Range: Ch.A and Ch.B EXT: EXT:10	 + or − 8 div + or − 0,8V + or − 8V	
• Frequency Response:		Trigger not affected by Bandwidth Limiter.
Lower Transition Point of BW		Channel A or Channel B coupling eventually cascaded with Trigger coupling.
	d.c.	Trigger Coupling in DC position.
	10Hz (−3dB) or less	Trigger Coupling in AC position.
	20kHz (−3dB)	Trigger Coupling in LF REJection position.
Higher Transition Point of BW	50kHz (−3dB)	Trigger coupling in HF REJected position.

6.10 BLANKING OR Z-AXIS

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Input Impedance	30kΩ	Input BNC on rear of instrument. When input is 0V...2,5V; otherwise>10 KΩ
• Input Coupling	d.c.	
• Maximum Input Voltage	+ or − 10V	
• Sensitivity: Unblanked Blanked	 0V + 2,5V or more	 Half tones are possible at input voltages between +0V and +2,5V.
• Response Time	20ns	From unblanked to fully blanked, when input is a transient of 0...+2,5V (rise time 2ns or less).

6.11. AUTO SETTING

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

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• MTB Trigger Source		
Triggerable Signal at Ch.A or Ch.B and no triggerable signal at EXT.	Channel A or Channel B	Channel with highest V/div setting is selected. (Channel A when settings are equal).
No signal at Ch.A or Ch.B, but Triggerable signal at input EXT	EXT	
No Trig. Sign. at Ch.A, Ch.B or EXT	Ch.A	
• MTB Trigger Mode	AUTO	
• MTB Trigger Coupling	AC	
• TB MAGNifier	OFF	
• TB deflection coefficient MTB 40Hz<Signal freq. <60 MHz	max. 6 signal periods on CRT screen	Vernier not affected by AUTO SET
Signal freq.<60 MHz	20 ns div.	
When no trigger found	10 μs div.	
		Due to trigger uncertainty at freq.>60MHz or at duty cycles <>50%, MTB setting can deviate from stated values, but the signal will remain on the screen
DTB	not afflected AUTO SET	
• Setting READ OUT on CRT	updated	Intensity of Setting READ OUT not affected by AUTO SET.
• Cursors	not affected by AUTO SET	

6.17. ENVIRONMENTAL CHARACTERISTICS

The environmental data mentioned in this manual are based on the results of the manufacturer's checking procedures.
Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEM DIVISION, EINDHOVEN, THE NETHERLANDS.

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Meets Environmental Requirements of	MIL-T-28800C Type III Class 5, Style D	
• Temperature		Memory back Up Batteries removed from instrument, unless batteries meet temperature specifications.
Operating:		
Min. Low Temperature	0°C	Cf. MIL-T-28800C par. 3.9.2.3. tested cf. par 4.5.5.1.1.
Max. High Temperature	+50°C	Cf. MIL-T-28800C par. 3.9.2.4. tested cf. par 4.5.5.1.1.
Non Operating: (Storage)		
Min. Low Temperature	−40°C	Cf. MIL-T-28800C par. 3.9.2.3. testes cf. par. 4.5.5.1.1.
Max. High Temperature	+75°C	Cf. MIL-T-28800C par. 3.9.2.4. tested cf. par 4.5.5.1.1.
• Maximum Humidity:		Cf. MIL-T-28800C par. 3.9.2.2. tested cf. par. 4.5.5.1.1.
Operating and Non Operating (Storage)	95% Relative Humidity	
• Maximum Altitude:		Cf. MIL-T-28800C par. 3.9.3. tested cf. par 4.5.5.2. Memory Back Up Batteries removed from instrument, unless batteries meet Maximum Altitude specs.
Operating	4,5km (15000 feet)	Maximum Operating Temperature derated 3°C for each km (for each 3000 feet) above sea level.
Non Operating (Storage)	12km (40000 feet)	

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Vibration (Operating)		Cf. MIL-T-28800C par 3.9.4.1. tested cf. par. 4.5.5.3.1.
Freq. 5...15Hz:		
Sweep Time	7 min	
Excursion (pk to pk)	1,5mm	
max. Acceleration	7m/s² (0,7g)	At 15Hz
Freq. 15...25Hz		
Sweep Time	3min	
Excursion (pk to pk)	1mm	
max. Acceleration	13m/s² (1,3g)	At 25Hz
Freq. 25...55Hz:		
Sweep Time	5min	
Excursion (pk to pk)	0,5mm	
max. Acceleration	30m/s² (3g)	At 55Hz
Resonance Dwell	10min	At each resonance freq. (or at 33Hz if no resonance was found).
• Shock (Operating):		Cf. MIL-T-28800C par. 3.9.5.1. tested cf. par. 4.5.5.4.1.
Amount of shocks		
total	18	
each axis	6	(3 in each direction)
Shock Wave Form	half sine wave	
Duration	11ms	
Peak Acceleration	300m/s² (30g)	
• Bench Handling (operating)		Cf. MIL-T-28800C par. 3.9.5.3. tested cf. par. 4.5.5.4.3.
Meets requirements of	MIL-STD-810 method 516, proced. V	
• Salt Atmosphere:		Cf. MIL-T-28800C par. 3.9.8.1. tested cf. par. 4.5.6.2.1.
Structural parts meet requirements of	MIL-STD-810 method 509, proced. I salt solution 20%	
• EMI (Electro Magnetic Interference) meets requirements of	MIL-STD-461 Class B VDE 0871 and VDE 0875 Grenzwertklasse B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS02, RS03.

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
	• Magnetic Radiated Susceptibility:		Tested conforming IEC 351-1 par. 5.1.3.1.
	Maximum Deflection Factor	7mm/mT (0,7mm/ gauss)	Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a Flux Intensity (peak to peak value) of 1,42mT (14,2 gauss) and of Symmetrical Sine wave Form with a Frequency of 45...66Hz.

6.18. SAFETY

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
	• Meets requirements of	IEC 348 Class I	
		VDE 0411	When shipped with Universal European power plug.
		UL 1244 CSA 556B	When shipped with North American power plug.

6.19. ACCESSORIES

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
	• Accessories furnished with instrument	2x10:1 passive probe PM8929/09	10MΩ, 10:1 Passive Probe with Read Out (1,5m).
		Collapsible Viewing Hood PM9310	
		Blue Contrast Filter	Factory installed
		Operating Manual	
		Front Cover	

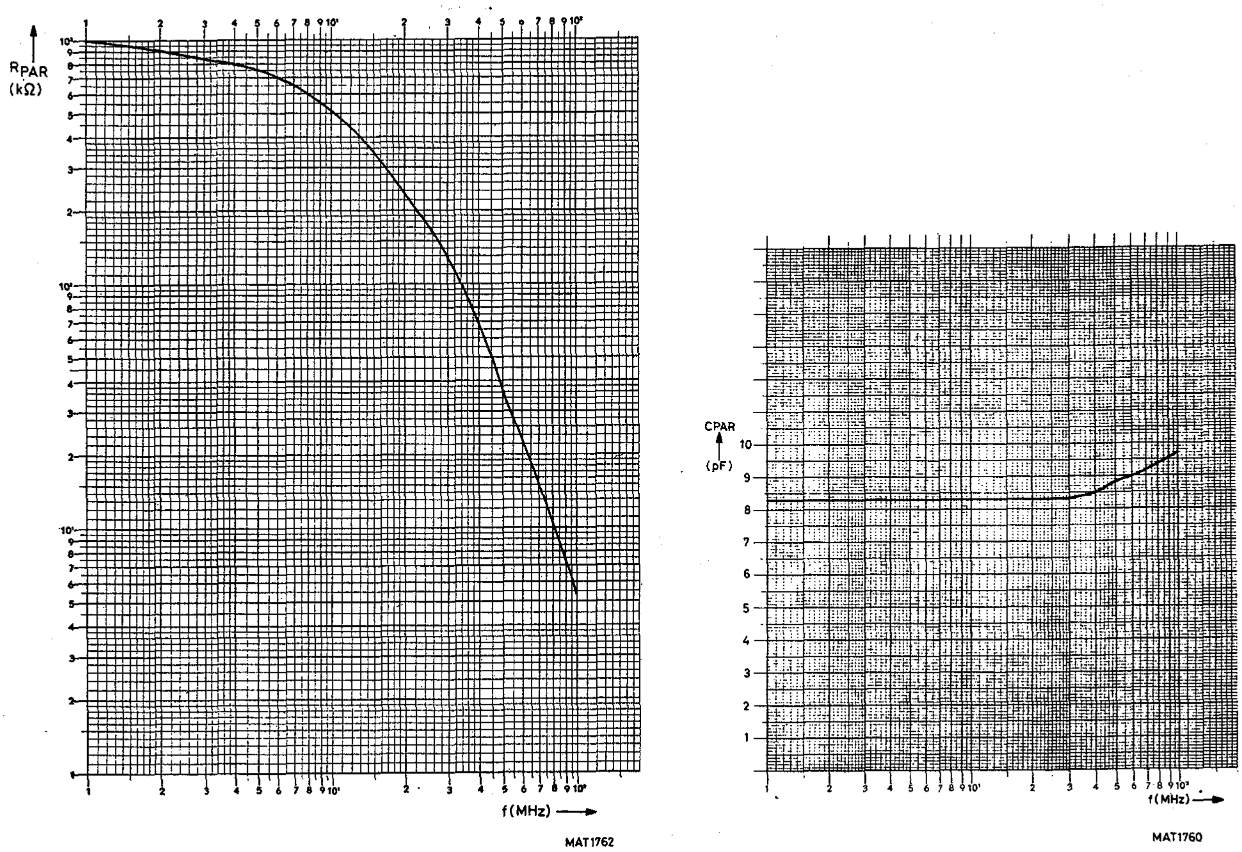


Fig.6.1 Input resistance R par. and capacitance C par. versus frequency.

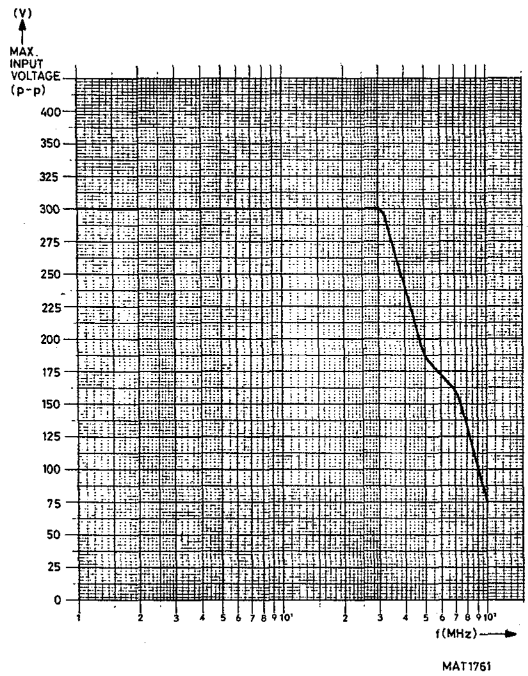


Fig.6.2 Maximum input voltage (peak to peak) derating versus frequency.

6.20. SETTING MEMORY (ONLY FOR PM3286A).

CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
• Memory size	max. 75 complete front panel settings	
• Functions		
Settings	Save	Actual settings are stored in memory, replacing contents of memory cell indicated on CRT
	Insert	Actual settings are stored in memory; insertion is after memory cell indicated on CRT
	Delete	Content of memory cell indicated on CRT is deleted
	Recall	Actual settings are replaced by contents of memory cell indicated on CRT. Actual settings are saved in "last setting" memory (= memory cell # 0)
	(Recall) Next	Actual settings are replaced by contents of memory cell indicated on CRT increased by 1 (empty cells are skipped). Actual settings are saved in "last setting" memory (= memory cell # 0)
	(Recall) Previous	Actual settings are replaced by content of memory cell indicated on CRT decreased by 1 (empty cells are skipped). Actual settings are saved in "last setting" memory (= memory cell # 0)
• Memory	protect	memory is write protected
	Unprotect	memory is not write protected
	Identify (#0. . .9)	Instrument is individualised, no respons to transmitter unless having some identifier #
• Remote control	AUTO setting	Pushing AUTO on transmitter has same result as pushing AUTO button on front panel of instrument, unless instrument is in remote control.

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

7. INSTRUMENT VERSIONS - ADDITIONAL INFORMATION

The version of your oscilloscope is indicated on the type plate situated on the rear panel (see fig. 7.1.).

The version is indicated as follows e.g. PM3286A

1 PM3286A/**XY** : in type number

2 12nc: 9444 **W**32 86**XYZ**: in code number

WXYZ are represented by numbers.
These numbers are given in this section and each version is briefly described.

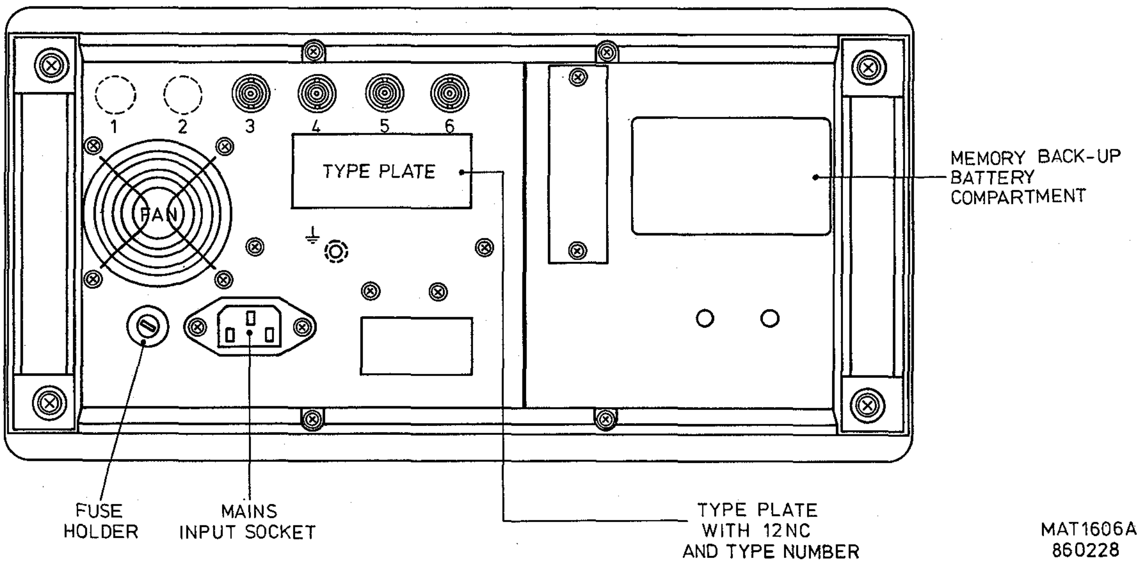


Fig. 7.1 Rear panel with indicated type plate position.

typenumber: PM3286A/**XY**

Codenumber: 9444 **W**32 86**XYZ**

W: Standard-project indication

W = 1 Standard version

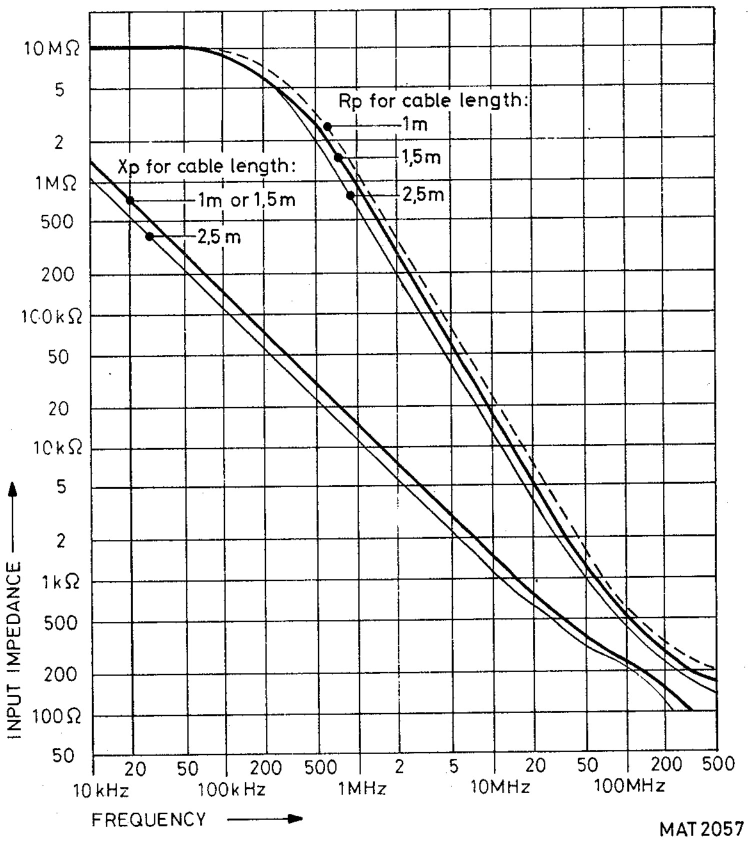
If **W** = 1 then **XY**: project-indication

XY = 00 Basic instrument without options

XY = 40, **XY** = 50 } Basic instrument with IEEE-488 bus option installed
For detailed information see separate booklet: IEEE-488 bus interface PM8950

XY = 30 Rackmount version

XY = 80 Rackmount version with IEEE interface bus option.



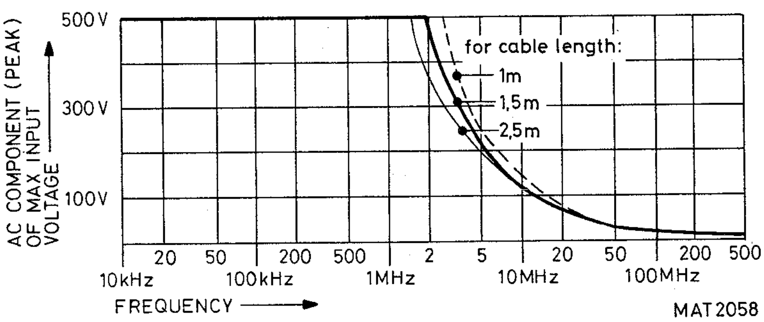


Fig. 8.3. Input impedance-reactance and voltage vs frequency

8.1.2. Collapsible viewing hood

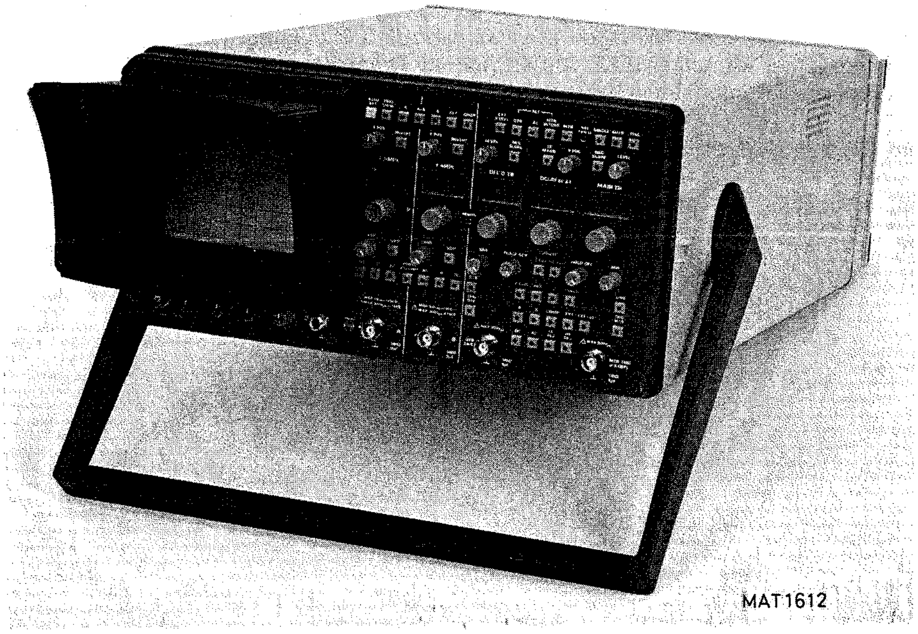


Fig.8.4 The instrument with viewing hood

8.1.3. Front cover

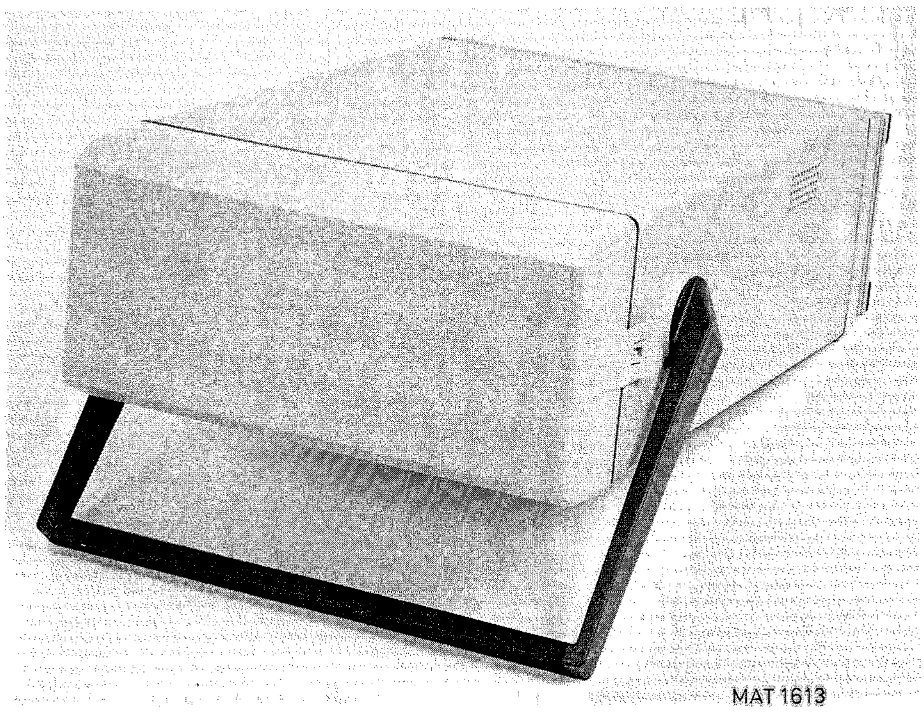


Fig. 8.5 The instrument with front cover

8.2. OPTIONAL ACCESSORIES

8.2.1. IEEE 488/IEC 625 bus interface PM8950

The IEEE 488/IEC 625 is a general-purpose bus interface designed according to the IEEE 488/IEC 625 standard. This option can be either retrofitted or factory installed. It enables the oscilloscope to be used in a measuring system together with other IEEE 488/IEC 625 bus compatible instruments.
For more detailed operating information concerning this facility, refer to the separate booklet:

IEEE 488/IEC 625 BUS INTERFACE PM8950

For installation instructions, see information delivered with the option.