50 MHz Digital Storage Oscilloscope
PM3350
PM3352

Operation Manual

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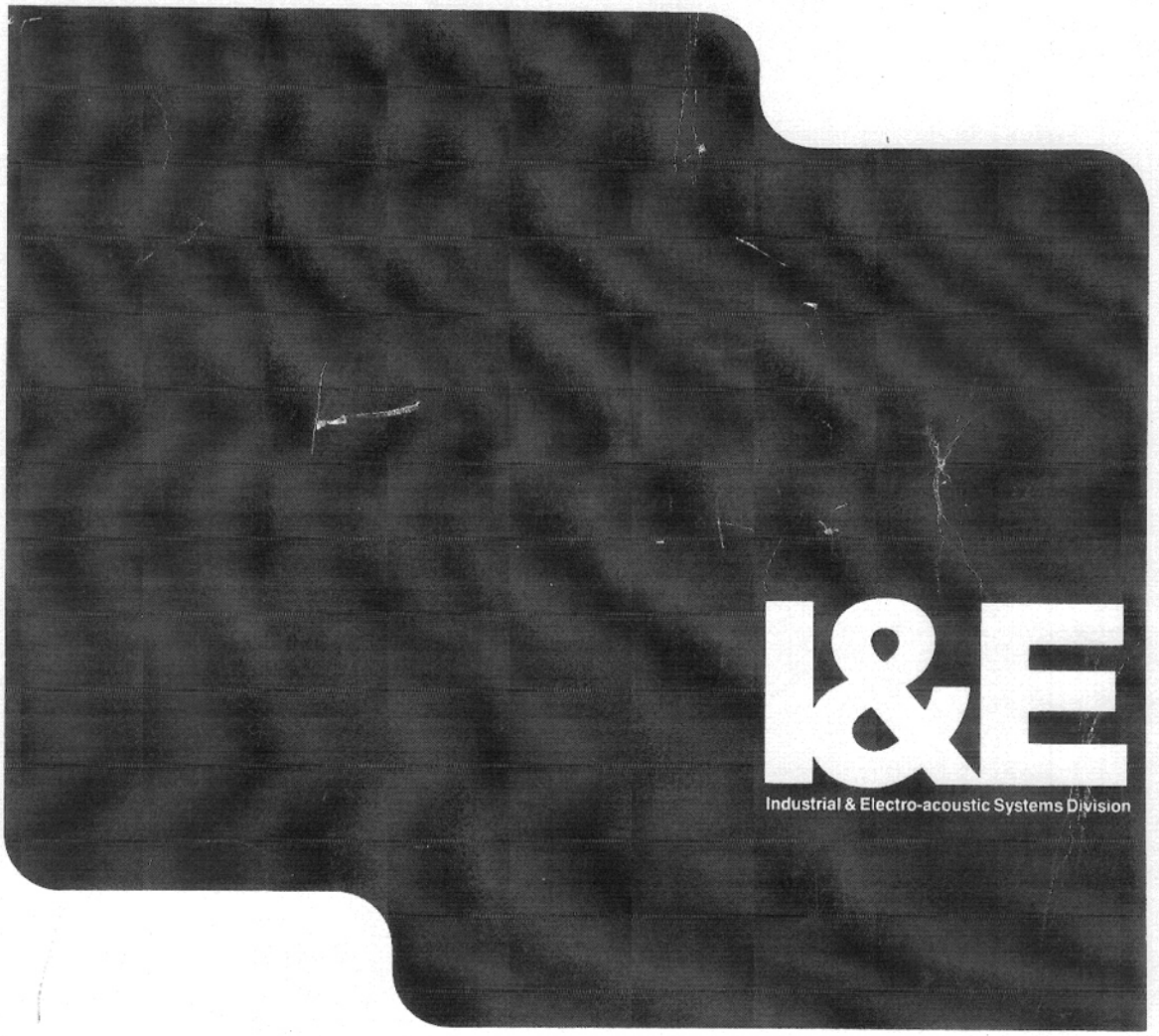
871111/1/01



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50 MHz Digital Storage Oscilloscope
PM3350
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MAT3046

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IMPORTANT

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

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

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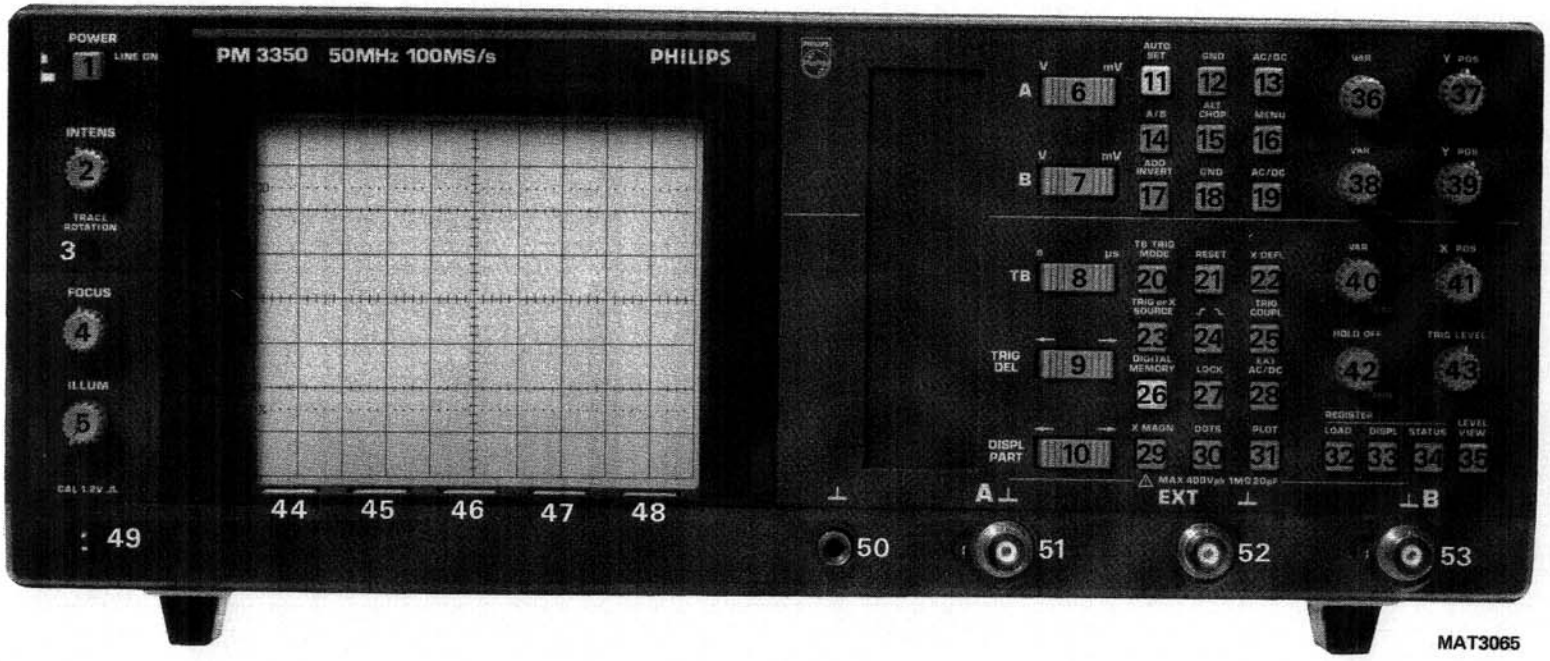

POWER
1
LINE ON
PM 3350 50MHz 100MS/s
PHILIPS
INTENS
2
TRACE ROTATION
3
FOCUS
4
ILLUM
5
CAL 1.2V
A
6
B
7
TB
8
TRIG DEL
9
DISPL PART
10
AUTO SET
11
GND
12
AC/DC
13
A/B
14
ALT CHOP
15
MENU
16
ADD INVERT
17
GND
18
AC/DC
19
TB TRIG MODE
20
RESET
21
X DEFL
22
TRIG or X SOURCE
23
TRIG COUPL
24
25
DIGITAL MEMORY
26
LOCK
27
AC/DC
28
X MAGN
29
DOTS
30
PLOT
31
REGISTER
LOAD
DISPL
STATUS
32
33
34
LEVEL VIEW
35
VAR
36
Y POS
37
VAR
38
Y POS
39
VAR
40
X POS
41
HOLD OFF
42
TRIG LEVEL
43
MAX 400Vpk 1MΩ 20pF
A
EXT
B
44
45
46
47
48
49
50
51
52
53

MAT3065

CONTENTS

1. OPERATORS SAFETY

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

1.1 INTRODUCTION

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 servicing personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.3 CAUTION AND WARNING STATEMENTS

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

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

1.4 SYMBOLS

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.

2. INSTALLATION INSTRUCTIONS

ATTENTION: You are strongly advised to read this chapter thoroughly before installing your oscilloscope.

2.1 INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred 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.

2.2 SAFETY INSTRUCTIONS

2.2.1 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.

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

2.2.2 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.

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

This oscilloscope has a tapless switched-mode power supply that covers most nominal voltage ranges in use: 100 V...240 V a.c. (r.m.s.) or 120 V...370 V d.c.. This obviates the need to adapt to the local mains voltage. The nominal frequency range is 50 Hz...400 Hz.

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

Mains fuse rating: 1,6 A delayed-action, 250 V.

The mains fuseholder is located on the rear panel (see Figure 2.1). If the mains fuse needs replacing, proceed as follows:

- remove the cover of the fuseholder by means of a screwdriver.
- fit a new fuse of the correct rating and refit the cover 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 the repaired fuses, and/or short-circuiting of the fuseholder, is prohibited.

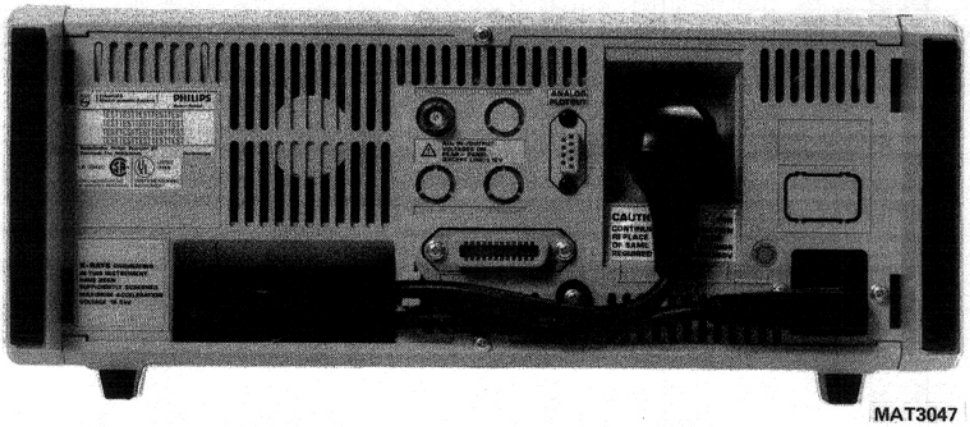


Figure 2.1 Rear view of the oscilloscope.

2.3 MEMORY BACK–UP

This instrument is provided with a built-in memory back-up circuit that forces the oscilloscope into its previous front-setting again after restoration of the power supply.
It can be used for the following conditions:

- after a power source interruption of more than 20 ms.
- when the oscilloscope is switched off.

The memory back-up batteries are fitted in the instrument; if replacement is necessary, it must be carried out only by a qualified technician.

2.4 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 two sloping positions (see Figure 2.2)
The available oscilloscope angles with respect to the working surface are 13^{o} and 20^{o} selected after pulling the carrying handle arms outwards and rotating.

The characteristics given in Chapter 5 are fully guaranteed for all the above-mentioned positions.

ATTENTION: – Do not position the oscilloscope on any surface which radiates heat, or in direct sunlight.
– Ensure that the ventilation holes at the rear and top are free from obstruction.

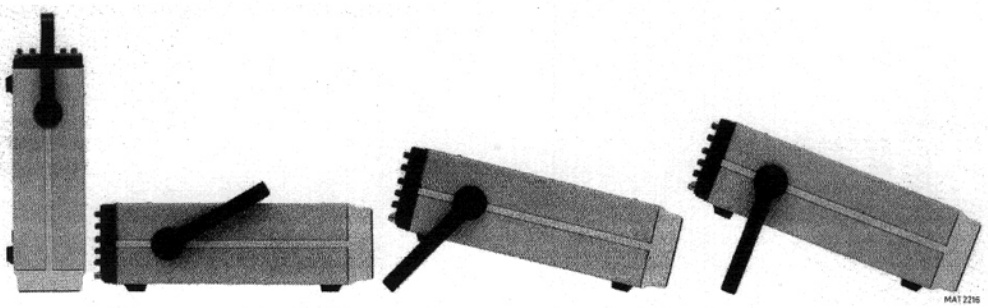
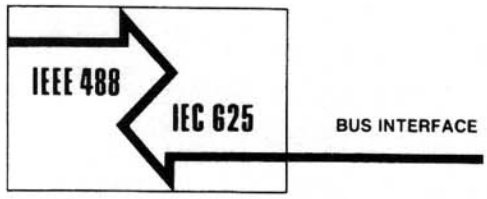


Figure 2.2 Handle in different positions.

2.5 IEE 488/IEC 625 BUS INTERFACE



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:

IEE 488/IEC 625 BUS INTERFACE

2.6 RACKMOUNT VERSION

The PM3352 is provided with a rackmount cabinet without carrying handle. This offers the possibility to build the instrument into a 19 inch rack, using the screws supplied.

3. 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.

3.1 SWITCHING–ON AND AUTO–SET

3.1.1 Switching-on

After the oscilloscope has been connected to the mains (line) voltage in accordance with Section 2.2.1 and 2.2.2 it can be switched on with the POWER ON pushbutton on the front panel.

Immediately the oscilloscope is switched on, all segments of the LCD light up for 1 sec. approx. and the oscilloscope is set in the SOFTSTART condition (see Figure 3.1) or, if the memory back-up is active, the instrument settings at the moment of switchting-off are restored again.
With normal installation, according to Chapter 2, and after a warming-up time of 30 minutes, the characteristics according to Chapter 5 are valid.

Attention: Take care that the time between switching-off and switching-on again is at least 5 s. A shorter time interval might activate a protection circuit in the power supply that prevents it from starting up. If this protection circuit becomes activated, (a high pitched noise is heard), it can be de-actived simply by switching off the instrument for 5 s.

3.1.2 Auto set

Attention: The AUTO SET is only effective when an input signal is applied to the channel A or B BNC input socket.

The AUTO SET allows you to set all softkeys and UP–DOWN controls with one single pushbutton for a clear display of any input signal. This can be used as a starting point for any refinements in the setting of the softkeys which may be needed for a thorough investigation of complex waveforms.
For this, proceed as follows:

- Apply the signal to input A and/or B.
- Set both Y POS and X POS controls to their mid-position.
- Press AUTO SET
- Notice that a clear display with at least two signal periods approx. and 2...5 DIV amplitude is visible on the screen.

Note: When no signal is applied to any BNC–input socket, the SOFTSTART procedure can be used to obtain a presetting of the softkeys and UP–DOWN controls. The instrument can be softstarted by pressing MENU and AUTO SET in sequence.

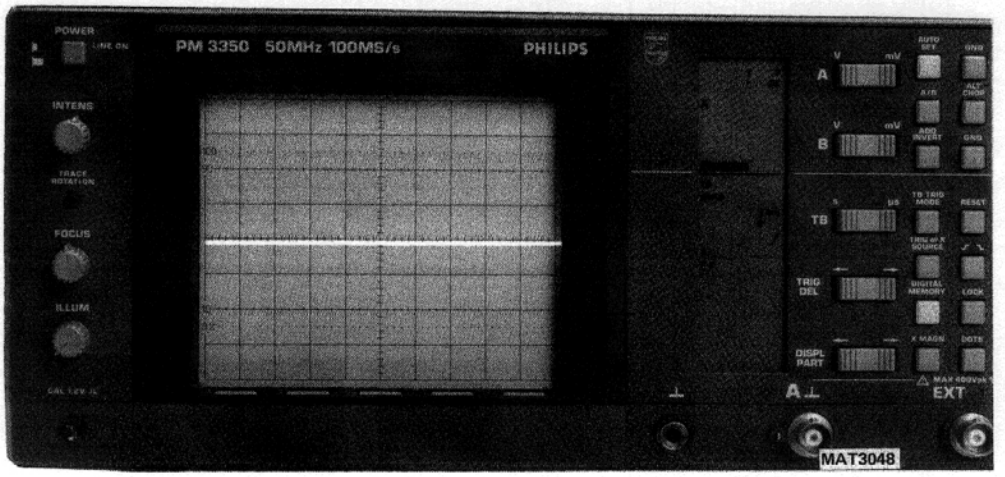


Figure 3.1 SOFTSTART condition.

3.2 EXPLANATION OF CONTROLS AND SOCKETS

3.2.1 Introduction

The front panel is designed with optimum ergonomic and logical- ordering of the controls: from left to right and from top to bottom, like reading a book.
For ease of access to the oscilloscope controls and sockets, the front panel is divided into six main areas (see Appendix A).

- CRT control area (see section 3.2.2)
- Up-down control area (see section 3.2.3)
- Function control area (see section 3.2.4)
- Potentiometer area (see section 3.2.5)
- CRT softkey control area (see section 3.2.6)
- Inputs and outputs (see section 3.2.7)

Liquid Crystal Display (LCD)
The LCD displays the different switch and control functions in one area on the front panel.
The LCD itself is divided into the areas shown below.

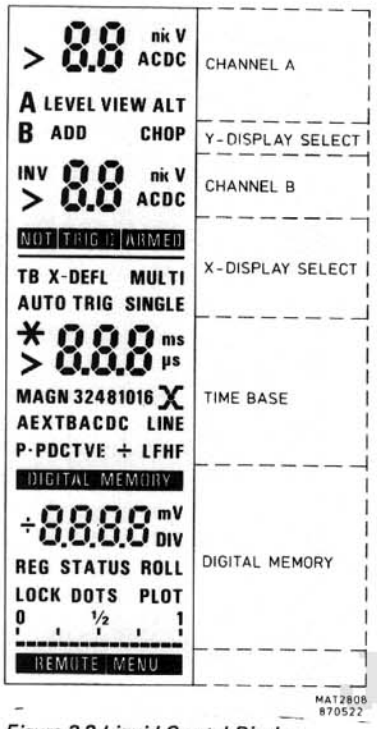


Figure 3.2 Liquid Crystal Display

Note: A flashing segment indicates that an incorrect combination of softkeys has been selected, that a VAR (variable) control is in UNCAL position (segment : >), that the end of the range of an UP–DOWN control has been reached, that a control has been operated during the PLOT action, or, that the DISPL. PART has been pressed in TB MAGN x1 mode.

Up-Down controls

These rocker switches permit selection of the vertical deflection coefficients or horizontal time base, delay and displayed memory part in an up-going or down-going sequence dependent on which part of the push-button is depressed.

MAT1804

Softkeys

This oscilloscope features the possibility to select several functions with a single pushbutton in sequential order under control of the microcomputer. To obtain the correct function it is necessary to press the particular pushbutton repeatedly until the correct indication is visible in the LCD.

The sequence of the softkeys with the related LC display is given in the following figure.
Note that, after the last function in line, the sequence starts again.
Example:

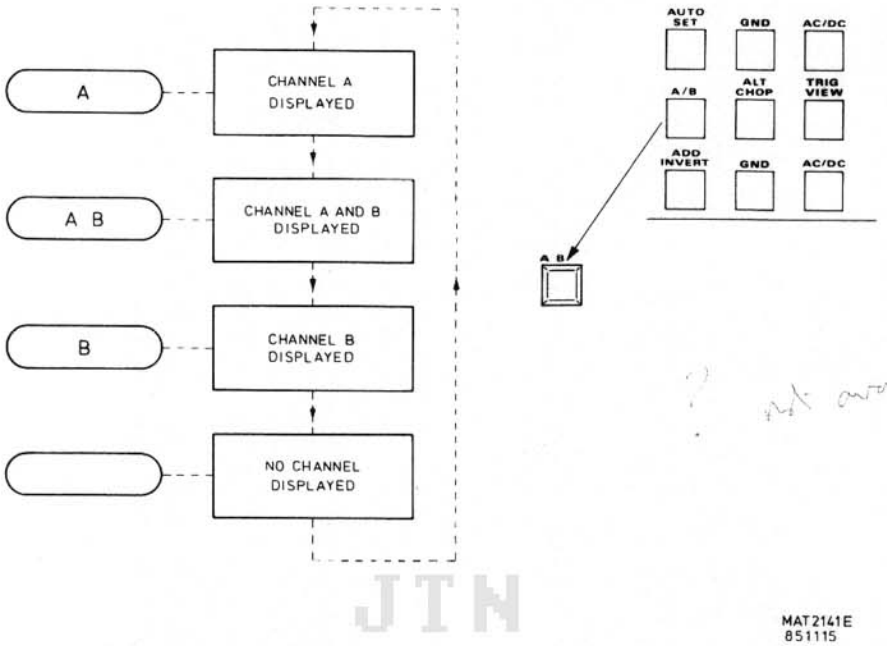


Figure 3.3 Sequence of the A/B softkey.

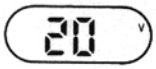
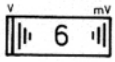
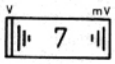
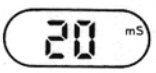
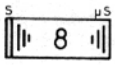
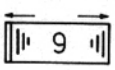
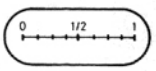
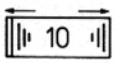
CRT softkey control

The five softkeys located below the CRT can be used for different functions in digital memory mode, e.g. cursor and calculation control. After selecting a menu, the CRT screen indicates the next level function of the softkeys.
RETURN means that the next higher function menu can again be selected. The function RETURN is always assigned to the furthest right softkey in the row of five.
The CRT screen contains two areas for CRT text. The text can be switched-off by means of the TEXT-OFF function softkey (see Section 3.2.6.4). The top text area shows all calculation information and channel settings, the bottom text area shows all functions assigned to the five softkeys.

3.2.2 CRT control area

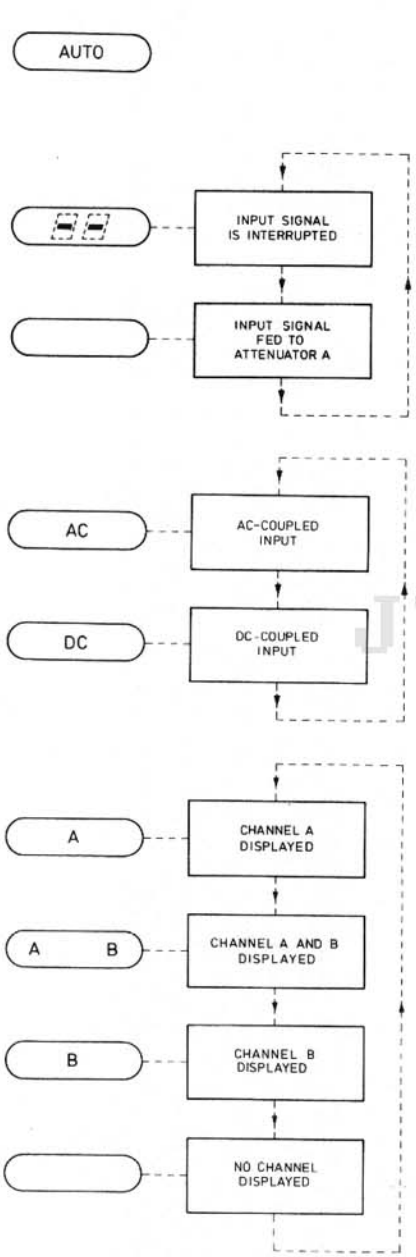
Knob/control	Description
POWER	Mains ON/OFF switch
INTENS	Continuously-variable control of the trace brilliance on the CRT screen.
TRACE ROTATION	Screwdriver control for aligning the trace in parallel with the horizontal graticule lines.
FOCUS	Continuously-variable control of the focussing of the C.R.T. electron beam.
ILLUM	Continuously-variable control of the graticule illumination.

3.2.3 Up-down control area

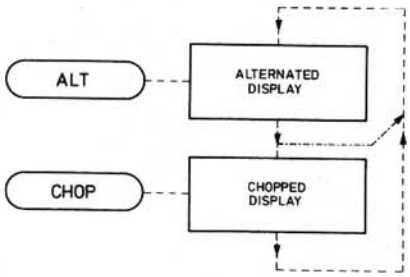
LCD	UP-DOWN switch	Description
		Selection of the ch.A deflection coefficients from 2 mV/DIV...10 V/DIV in a 1-2-5 sequence.
		Selection of the ch.B deflection coefficients from 2 mV/DIV...10 V/DIV in a 1-2-5 sequence.
		Selection of the time-base deflection coefficients in a 1-2-5 sequence. In real-time mode the time-base range is 50 ns/DIV...0,5 s/DIV. In digital memory mode the following ranges are possible: - ROLL mode: 50 s/DIV...1 s/DIV - Direct mode: 0,5 s/DIV...5 ms/DIV - P^2CCD mode: 2 ms/DIV...0,5 us/DIV
		Selection of the trigger delay from −10.00 DIV...+250.0 DIV in a 1 DIV step. Only active when DIGITAL MEMORY is selected. * When TB MAGN is selected the trigger delay and step value are precalculated.
		Selection of the displayed part of the magnified signal; only active when DIGITAL MEMORY is selected. The display memory locations are: 0 - 1/8 - 2/8 - 3/8 - 4/8 - 5/8 - 6/8 - 7/8 - 1 The following display is given in the LCD. The following display- and LCD steps are possible:

magn.	displ.step	LCD step
x 2	1/4	1/4
x 4	1/8	1/8
x 8	1/16	1/6
x16	1/32	1/6
x32	1/64	1/6

3.2.4 Function control area



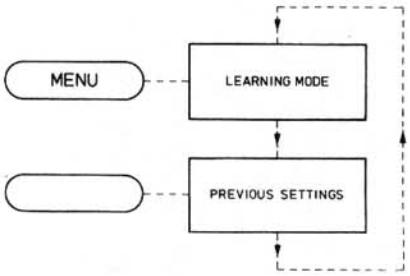
LCD	sequence	SOFTKEY	REMARKS



ALT CHOP 15

Selection for the ALTernate and the CHOPped display mode when more channels are selected.

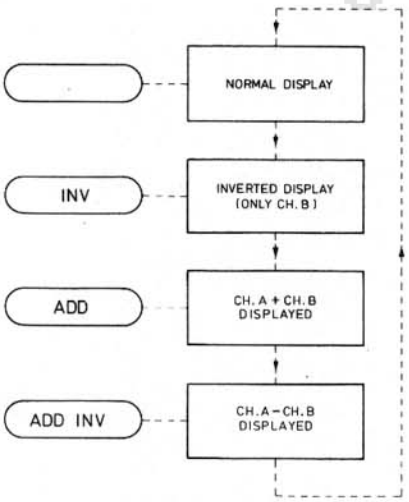
* 1. ALT not used in X DEFL.
CHOP not used in COMP.TRIG.
2. Not active when DIGITAL MEMORY is selected.



MENU 16

Selection for **learning mode**, activates only the LCD. Depressing MENU once blanks the LCD and activates the learning mode. Only "MENU" is visible on the LCD.

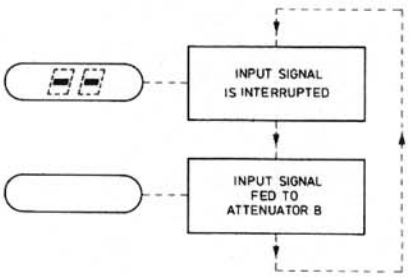
- After pressing a softkey (one at a time), any function behind that softkey will be displayed in the LCD in a half-second step sequence. All softkeys can selected at random.
- Depressing MENU a second time means that the previous settings before the learning mode are displayed again in the LCD.



ADD INVERT 17

Switch for inversion of the channel B polarity and for the addition or subtraction of channel A and B.

* ADD not active when DIGITAL MEMORY is selected.

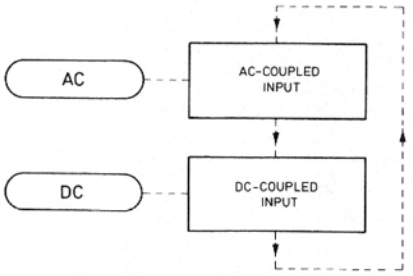


GND 18

Interruption of channel B input signal, while the attenuator is connected to earth (ground).

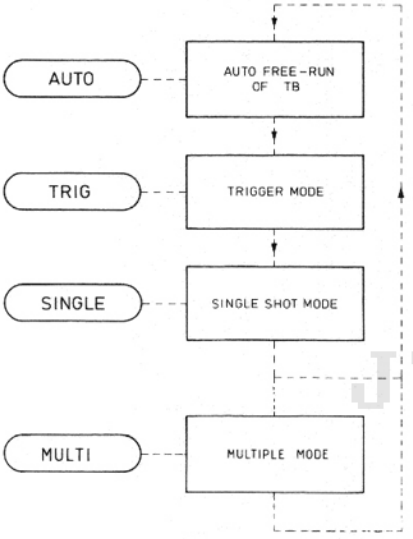
* 1. When grounded the trig.mode will automatically set to auto free-run
2. When grounded the composite trig. source will automatically set to ch. A trig.source, provided that a signal is applied to ch. A.

LCD	sequence	SOFTKEY	REMARKS



AC/DC 19

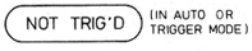
Channel B input coupling.



TB TRIG MODE 20

Selection for the time-base trigger mode.

* 1. When AUTO selected, the TB is free-running in the absence of trigger signals.
2. When SINGLE or MULTIPLE selected, ARMED is visible in the LCD. SINGLE or MULTIPLE is possible for ch. A or ch. B only or for ch. A and ch. B when chopped.
3. MULTIPLE only active when DIGITAL MEMORY is selected.



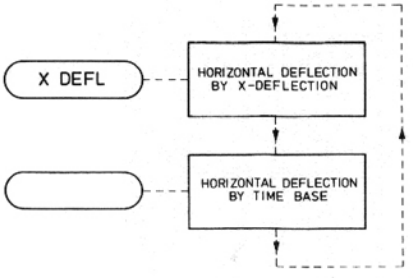
RESET 21

When SINGLE or MULTIPLE selected, enables the TB for receiving a trigger pulse.

* Only active in combination with the SINGLE or MULTIPLE mode.

Is in digital memory mode also a CLEAR function, related to the centre of the screen. This is valid for all trigger modes.

* When the key is depressed for longer than 2 seconds the line is cleared to −5 DIV and this is not visible.

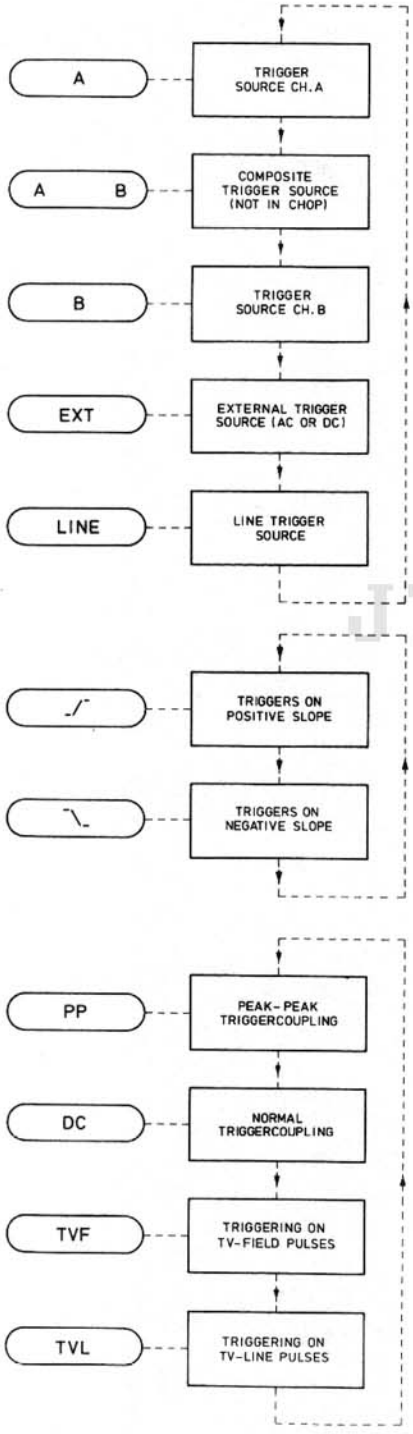


X DEFL 22

Selection for horizontal deflection mode. Horizontal deflection is achieved by X DEFL or by time-base.

* Not active when DIGITAL MEMORY is selected.

LCD	sequence	SOFTKEY	REMARKS



TRIG or X SOURCE 23

Selection for the time-base TRIGGER SOURCE or source for X Deflection.

* 1. EXT AC or EXT DC selectable by EXT AC/DC softkey (see key 28)
2. Composite not active when X DEFL or DIGITAL MEMORY is selected.

24

Trigger slope selection of the input signal via the time-base or selection for X DEFL polarity.

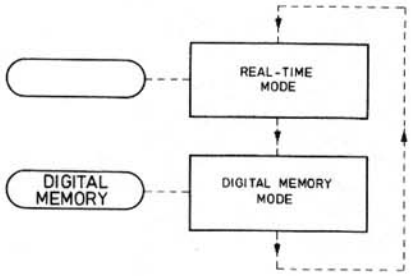
* When TVF, TVL or X DEFL selected, the LCD indication is +or− resp., for pos. or neg. video.

TRIG COUPL 25

Selection for the time-base TRIGGER COUPLING.

* TVL not active when DIGITAL MEMORY is selected.

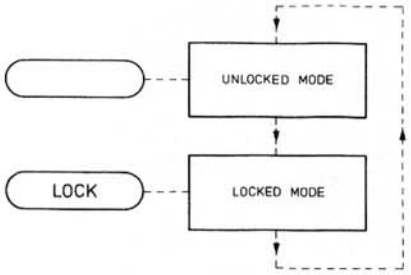
LCD	sequence	SOFTKEY	REMARKS



DIGITAL MEMORY 26

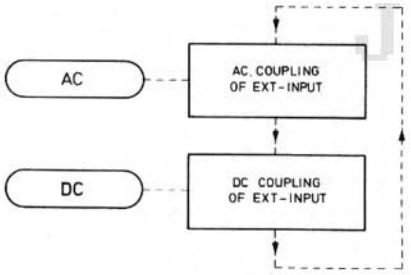
Selection for the digital memory mode.

* 1. When real-time mode is selected, the MULTIPLE mode is not active
2. When digital melory mode is selected, the ADD–ALT/CHOP–X DEFL and COMPOSITE modes are not active.



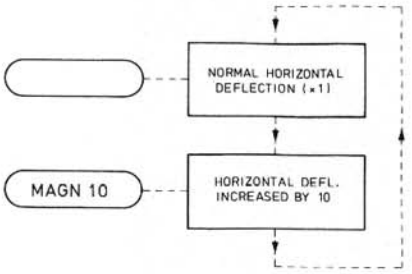
LOCK 27

When locked, the contents of the input memory and display memory cannot be changed. The settings of the last locked trace can always made visible on the LCD by means of the REGISTER STATUS softkey (see key 34) Only active when DIGITAL MEMORY is selected.



EXT AC/DC 28

Input coupling for EXT-input as a trigger source for the time-base.

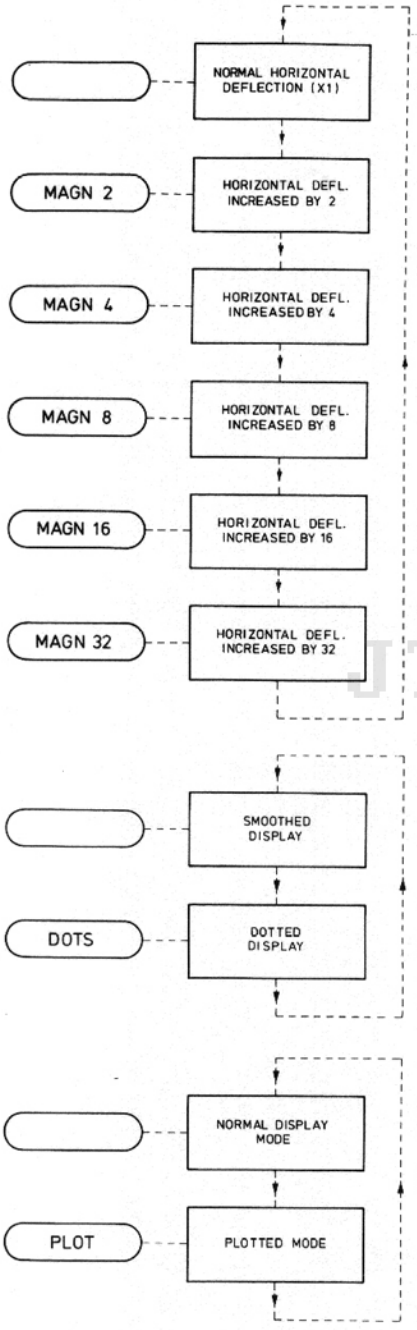


TB MAGN 29

Real-time mode:
Time-base magnification by factor of 10.

* 1. Horizontal deflection coefficient in LCD is precalculated
2. Not active when X DEFL is selected.

LCD sequence SOFTKEY REMARKS



Digital memory mode:
Selection for different time-base magnifications

* 1. Horizontal deflection coefficient in LCD is precalculated.
2. Selection of what part is displayed on the screen is obtained by DISPL PART control.

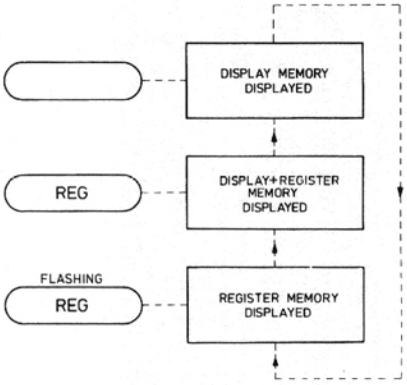
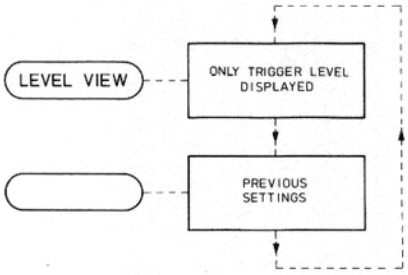
DOTS 30

Selection for smoothed display (dots-joined) or dotted display. Only active when DIGITAL MEMORY is selected.

PLOT 31

When depressed, the acquisition will stop and the output signals are available on the plotter output. The plot action stops after pressing the PLOT softkey once again or when the plot is ready. Only active when DIGITAL MEMORY is selected.

* 1. The plotter speed and penlift level can be selected by means of service menu (see Section 3.2.9.2).
2. During plot action all softkeys are inactive.

LCD	sequence	SOFTKEY	REMARKS
		LOAD 32	When depressed, the acquisition will stop and the contents of the input memory will be copied into the register memory. Only active when DIGITAL MEMORY is selected.
		DISPL 33	Selection to display the contents of the display memory and the register memory on the CRT screen. Only active when DIGITAL MEMORY is selected.
STATUS	STATUS IS DISPLAYED	STATUS 34	During the time that the STATUS softkey is depressed, the settings of the register contents are displayed in the LCD. Depressing the softkey another time within 1 s results in displaying the settings which belong to the trace on the CRT in the LCD. Only active when DIGITAL MEMORY is selected.
		VIEW 35	Displaying the trigger level on the CRT screen, provided that the normal trigger coupling mode (DC) has been selected. First the grounded line has to be set to the central vertical graticule line. Besides the indication "LEVEL VIEW", only the V/DIV setting of the selected channel and the trigger source status are visible on the LCD, while a zero-line is visible on the CRT screen. Depending on the LEVEL control this zero-line moves up or down to determine the trigger point of the signal. * Not active when COMPOSITE - or LINE trigger source is selected.

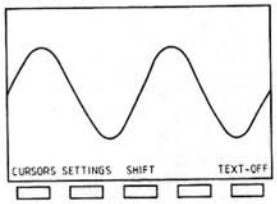
3.2.5 Potentiometer area

LCD	Control	Description
FLASHING (>) (WHEN NOT IN CAL POSITION)	VAR (36) \ CAL	VAR control ch. A Continuously-variable control of the channel A deflection coefficients. CAL position selected when fully clockwise.
	Y POS (37)	Y POS control ch. A Continuously-variable control for the channel A trace shift over the screen.
FLASHING (>) (WHEN NOT IN CAL POSITION)	VAR (38) \ CAL	VAR control ch. B Continuously-variable control of the channel B deflection coefficients. CAL position selected when fully clockwise.
	Y POS (39)	Y POS control ch. B Continuously-variable control for the channel B trace shift over the screen.
FLASHING (>) (WHEN NOT IN CAL POSITION)	VAR (40) \ CAL	VAR control time-base Continuously-variable control of the time coefficients. The time-base is in CAL position when fully clockwise. * Not active when digital memory mode has been selected.
	X POS (41)	X POS control Continuously-variable control for the horizontal shift over the screen.
	HOLD OFF (42) \ MIN	HOLD OFF control This control determines the HOLD OFF time between the main time-base sweeps. Normal operation: control is fully clockwise, i.e. minimum HOLD OFF.
	TRIG LEVEL (43)	LEVEL control Continuously-variable control to set the level of the trigger point at which the main time-base starts. * When TRIG VIEW is depressed, a zero-line indicates the trigger point of the selected channel.

3.2.6 CRT softkey menu (see Appendix B)

Note: The CRT softkeys are only active when digital memory has been selected.

MAIN MENU

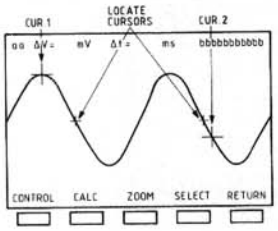


The MAIN menu has been divided into four menus:

CURSORS	(see Section 3.2.6.1)
SETTINGS	(see Section 3.2.6.2)
SHIFT	(see Section 3.2.6.3)
TEXT–OFF	(see Section 3.2.6.4)

Note: Only the channels and register which are selected are indicated in the bottom text area of the CRT screen.

3.2.6.1 Cursors menu



After pressing the CURSORS-function softkey two main cursors CUR1 and CUR2 are visible, that can be set to determine the measurement points on the selected waveform. Between these main cursors are the two LOCATE cursors that indicates the various automatic measurement positions.
The LOCATE cursors are only active for the FREQ, Vpp or t-rise calculation functions or if they have been selected in a previous measurement. At the same time, the top text area of the CRT screen shwos a row of calculation results that can be divided in:

a a = channel identification
A = cursors on signal of channel A
B = cursors on signal of channel B
R A = cursors on signal of register A
R B = cursors on signal of register B

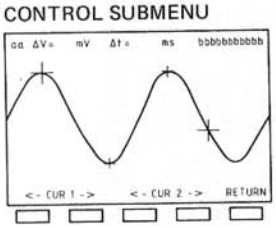
V=...mV = continuously calculated amplitude of signal between the cursors.
t=...ms = continuously calculated time of signal between the cursors.

bbbbbbbbbb = calculation which can give the following information :
1/ t=...Hz = frequency calculation when FREQ function has been selected
Vpp=...mV = calibrated p-p value of signal when Vpp function has been selected
Vpp=...DIV = uncalibrated p-p value of signal when Vpp function has been selected
tr=-...ms = rise- or fall-time calculation when t-rise function has been selected.

The calculation results are continuously recalculated when performing measurements

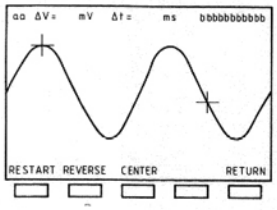
Subcursor menus are :
CONTROL
ZOOM
CALC
SELECT

CONTROL SUBMENU



Allows you to shift the main cursors CUR1 and CUR2 over the screen to determine the measurement area. When positioning these cursors, note that they cannot pass each other. CUR1 is always the left one and CUR2 is always the right one. The range for CUR1 and CUR2 is a screen-width.

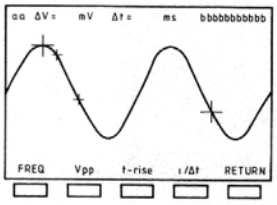
ZOOM SUBMENU



Gives the possibility to expand the signal between the main cursors while maintaining the same resolution. The time-base and the trigger delay will be adapted and a new acquisition made. Only for repetitive signals.

The CENTRE softkey puts the two main cursors to + and − 2 divisions from the central vertical graticule line. Then the signal is expanded by means of pressing the RESTART function. This procedure can be repeated until the time-base or trigger delay has reached its limit or after ten RESTART actions. The previous settings are stored into the CPU memory and can be shown again by pressing the REVERSE function.

CALC SUBMENU



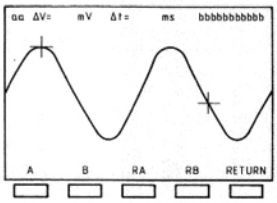
Gives the possibility to select the following calculation routines:

* FREQ
Frequency measurement of a selected signal. The LOCATE cursors mark the starts and end points of the signal period between the two main cursors as seen from CUR1.
The result is visible in the top text area by f =...Hz

*Vpp
Measures the peak-to-peak value of the lowest and highest point of the signal between the two main cursors. These two points are indicated by the LOCATE CURSORS.
The result is visible in the top test area by
Vpp=...mV when the selected signal is calibrated
Vpp=...DIV when the selected signal is uncalibrated

* t-rise
Measures the rise- or fall time of the first signal as seen from CUR1. The 10 % point and 90 % point of the edge are marked by the LOCATE CURSORS related to the 100 % as preselected by the MAIN CURSORS.
The result is visible in the top text area by
tr = ... ms when a rise-time is calculated
tr = − ... ms when a fall-time is calculated

SELECT SUBMENU

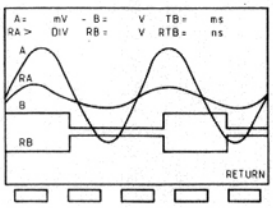


Allows you to select one of the following possible signals for CURSORS operation.

A = signal of channel A
B = signal of channel B
R A = signal of register A
R B = signal of register B

The top text area shows the selected signal, the amplitude calculation (V), the time calculation (t) and the continuously calculated information. Another signal can be selected by pressing a softkey once again.

3.2.6.2 Settings menu

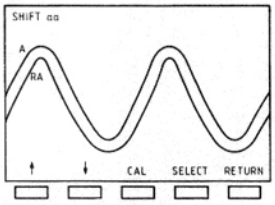


After pressing the SETTINGS function softkey, the top text area of the CRT screen shows the vertical and horizontal settings information of the active signals.
The following settings information can be displayed:

A = attenuator setting of channel A
B = attenuator setting of channel B
R A = attenuator setting of register A
R B = attenuator setting of register B
T B = time-base setting
RTB = register time-base setting

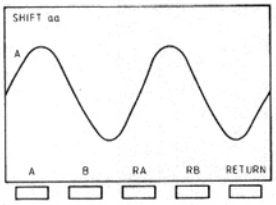
The "=" indicates that the attenuator is in calibrated position.
The ">" indicates that the attenuator is in uncalibrated position.
The "-" indicates that the channel B or register B is inverted.

3.2.6.3 Shift menu



After pressing the SHIFT function softkey, the active signals are indicated on the screen. The top text area shows the selected signal enabled to be shifted by means of the UP or DOWN function softkey, provided that the signal has been locked. The SELECT function softkey allows you to select the signals to be shifted (see SELECT sub-menu). Pressing the CAL function softkey means that the shifted signal is set in its original position again.

SELECT SUBMENU



Allows you to select one of the following possible signals for shift operation.

A = signal of channel A
B = signal of channel B
R A = signal of register A
R B = signal of register B

The top text area shows the selected signal. Another signal can be selected for shift operation by pressing a softkey once again.

3.2.6.4 Text-off menu

After pressing the TEXT–OFF function softkey, the CRT text is no longer displayed on the screen. Pressing any of the CRT softkeys in digital mode means that the text of the MAIN MENU will be displayed again.

3.2.7 Inputs and outputs

Socket	Description
CAL	Output socket providing a 1,2 Vp-p, 2 kHz approx. square-wave voltage (zero-line is at the top of the signal). To be used for probe compensation or to calibrate the vertical deflection AMPL. control.
⊥	Measuring earth socket.
⚠ A	BNC input socket for channel A with probe indication detector for precalculation in LCD of vertical deflection coefficients.

⚠ EXT

BNC input socket
- When EXT input is selected via the time-base the signal input is used for external triggering.
- When EXT input is selected via X DEFL, the horizontal deflection is determined by the signal applied to this socket.

⚠ B

BNC input socket for channel B with probe indication detector for precalculation in LCD of vertical deflection coefficients.

3.2.8 Rear panel

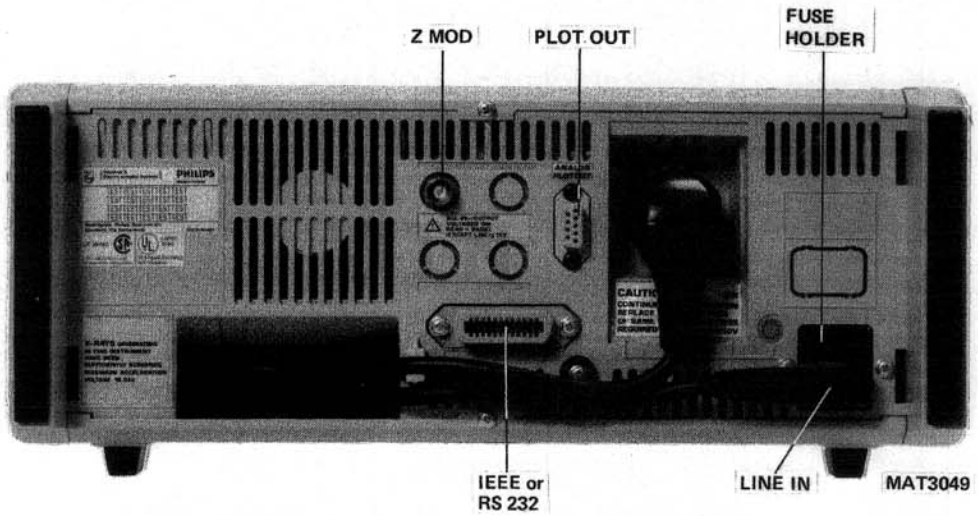


Figure 3.4 Rear view of the oscilloscope.

3.2.8.1 Standard

Z–MOD Input socket for Z-modulation of the CRT trace. The trace is blanked when this input is "high" (+2,5 V or more)
Maximum limit voltages: 0–12 V.

PLOT OUT Plot output socket, supplying the Y PLOT, X PLOT and PENLIFT signals.

LINE IN Mains input socket, 90 ...264 V a.c., 45 ...440 Hz or 150 ... 400 V d.c. For safety instructions, please read Section 2.2.

FUSE HOLDER Fuse rating 1,6 A delayed action. For safety instructions, please read Section 2.2.

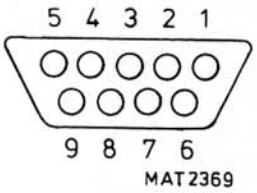
3.2.8.2 Optional

IEEE BUS Output socket to connect the oscilloscope to a IEEE 488/IEC 625 interface

RS232 BUS Output socket to connect the oscilloscope to a RS232C/V24 interface.

3.2.8.3 Plot out socket

Connector: D-sub-miniature connector with 9 female contacts.



Connector specification:

Connector	Name	Specification
1	PLOT X	100 mV/div.
2	PLOT Y	100 mV/div.
3	GROUND	
4	PENLIFT	TTL compatible
5	GROUND	
6	+5 V	
7	GROUND	
8	+5 V	
9	GROUND	

3.2.9 Application select menu

3.2.9.1 Introduction

The instrument offers the possibility to pre-select different applications by means of the APPLICATIONS SELECT menu. The applications are:

- plotter speed
- plotter penlift level
- single shot
- TV triggering after AUTO SET
- IEEE addressing (optional)
- IEEE mode (optional)

To enter this menu, proceed as follows:

- Press MENU and keep it pressed.
- Press also AUTO SET.
- Now the Service menu has been entered, the LCD should indicate "*".
- Press APPL, which is one of the CRT softkeys.
- The CRT should indicate "APPLICATION" on the upper side of the screen.

Having entered this menu, the lower level can be selected chosen by means of one of the four CRT softkeys.

3.2.9.2 Plot

After pressing the CRT softkey PLOT this submenu has been entered. Now the CRT screen should indicate the PLOT speed, the PENLIFT level and the GRID selection. The PLOT speed can be chosen between 20 ms ... 2000 ms in a 20 or 100 step sequence by means of the UP–DOWN SPEED softkeys. The default value for the speed is 200 ms.

The PENLIFT level can be set to active high or active low by means of the PENLIFT softkey. The default value for this level is active high.

Plotting or not plotting of the screen (grid) can be selected by means of the GRID softkey. The default value is GRID OFF.

3.2.9.3 Single shot

After pressing the CRT softkey SNGL–SHOT this submenu has been entered.
Selecting FIRST means that when using in alternated multi-channel mode and in single-shot mode only one channel (A) is displayed on the screen.
Selecting MULTI means that in the same situation all signals are displayed on the screen in sequence after the RESET softkey is depressed.
The default value for the single shot is FIRST.
Note: This application is only active for the real-time single-shot mode.

3.2.9.4 Auto set

After pressing the CRT softkey AUTO this submenu has been entered. Selecting TVF means that if TVF or TVL trigger coupling was selected, after an AUTO SET the trigger coupling is always forced to TVF. Selecting TVF/TVL means that for the same situation the already selected TV trigger coupling (being TVF or TVL) will be chosen again. The default value is TVF.

3.2.9.5 IEEE (optional)

After pressing CRT softkey this submenu is entered. Now the CRT screen indicates the IEEE addressing and the IEEE mode.
The IEEE address can be set between 0 ... 30 by means of the UP–DOWN address softkeys. The default value for the IEEE address is 8.

The IEEE interface can be set to the modes:
- talk only
- listen only
- talker/listener

The default mode for the IEEE interface is talker/listener.

3.3 PRINCIPLE OF OPERATION

This section describes the principle of operation and should be read in conjunction with the overall block diagram (see Appendix C).

The instrument can be used as an analogue real-time oscilloscope and as a digital storage oscilloscope. This selection can be made by means of the DIGITAL MEMORY softkey, which selects an analogue and a digital signal path. At the same time, selection is made between an analogue time-base circuit and a digital time-base circuit.

The oscilloscope circuit consists of six functional main sections:
- Control section (see section 3.3.1)
- Vertical deflection (see section 3.3.2)
- Horizontal deflection (see section 3.3.3)
- CRT display section (see section 3.3.4)
- Plotter section (see section 3.3.5)
- Power supply section (see section 3.3.6)

3.3.1 Control section

The knobs in the key-matrix on the front panel drive the various circuits via the software control lines. These lines are generated by the microprocessor, which also drives the LCD (Liquid Crystal Display) for the correct knob and control setting indication.

AUTO SET enables vertical and horizontal functions to be set depending on the value of the input signal.

MENU permits checking of all possible knob setting with their LC display.

The continuous controls and the knob LINE ON are directly connected to their control circuits.

3.3.2 Vertical deflection

As the vertical channels A and B are identical, only one is described. The input signals of channels A and B are fed via the ATTENUATORS to the DIGITAL MODE SWITCH.
The following ATTENUATOR functions are controlled by the front-panel softkeys via the microprocessor.

GND AC/DC	input signal coupling
V–mV	Vertical deflection coefficient
VAR	Continuously-variable attenuation control UNCAL indicated in LCD

The DIGITAL MODE SWITCH has the following functions:

DIGITAL MEMORY	Selection for real-time mode or digital memory mode.
INV (ch. B only)	Input signal and polarity inversion in digital memory mode.

Vertical shifting of the displayed signal is achieved by the Y POS control.

Real-time mode:

In real-time mode the signal is fed directly to the ANALOG VERTICAL CHANNEL SELECTION.

The ANALOG VERTICAL CHANNEL SELECTION selects the input signals A or B, depending on which function is activated via the softkeys.
The following vertical display modes can be selected:

A	channel A only
B	channel B only
A and B	channels A and B displayed together. ALT or CHOP mode is selected by its softkey.
INV (ch. B only)	Input signal inversion in real-time mode.

Digital memory mode:

In digital memory mode, the signal is first applied to the P^2CCD (Peristaltic Profiled Charge Coupling Device). This block serves as a delay-line (for Roll or Direct mode) or a time converter (for P^2CCD mode). This is controlled by the DIGITAL TIME–BASE GENERATOR.

The resulting signal is multiplexed and then digitized in a ANALOG–TO–DIGITAL CONVERTER (ADC). The timing of the ADC conversion is determined by one of the following sources:
– In Direct and Roll mode positions direct by the DIGITAL TIME–BASE GENERATOR
– In P^2CCD mode positions via the P^2CCD circuit.
After digitizing, the binary code is processed by the display processor containing the ACQUISITION MEMORY and the DISPLAY MEMORY. The TRIG DEL and DISPLAY PART UP–DOWN controls serve for manipulation of the digital signal in the ACQUISITION circuit. The INV softkey gives polarity inversion of the ch. B path with the result that only the input B signal is inverted (see also INV of DIGITAL MODE SWITCH).

The DISPLAY LOGIC allows selection of several digital vertical display modes of ch. A, ch. B, REG A and REG B by means of the A/B, REGISTER LOAD and REGISTER DISPL. softkeys. LOCK serves for locking the contents of the DISPLAY MEMORY.

The digital output information of the DISPLAY MEMORY is converted again to an analogue signal in the VERTICAL or HORIZONTAL DIGITAL–TO–ANALOG CONVERTER (Y–DAC and X–DAC). The DOTS softkey permits selection for a dot-joined display on the CRT screen.

The output of the Y–DAC is applied to the DIGITAL VERTICAL CHANNEL SELECTION.
The DIGITAL MEMORY softkey enables the digital memory to be displayed on the screen.
LEVEL VIEW permits displaying of the trigger level. This trigger level can be adjusted by means of the LEVEL control.

Another output of the Y–DAC is applied to the PLOT CIRCUIT.

The DELAY LINE permits the viewing of leading adges of fast input signals.

The selected signal derived from the analogue path or digital path is fed, via the DELAY LINE and the FINAL VERTICAL AMPLIFIER to the vertical deflection plates (Y) of the CRT.

3.3.3 Horizontal deflection

The analogue time-base is triggered on the signal selected in the TRIGGER SELECTOR stage.
Trigger selection can be made by the TRIG SOURCE or X softkey for:

A	signal derived from channel A
B	signal derived from channel B
COMP	composite triggering of both channels A and B
EXT	external input via BNC socket
LINE	signal derived from mains (line) voltage

Positive or negative triggering is selected by the SLOPE softkey.

After selection of the source, selection of the TB trigger mode or coupling can be made in the TRIGGER AMPLIFIER. The TB TRIG MODE softkey allows selection of:

AUTO	Automatic free-run in the absence of trigger signals
TRIG	Normal triggering
MULTIPLE	TB sweep runs twice for REGISTER and DISPLAY MEMORY
SINGLE	MTB sweep started once

The TRIG COUPL softkey allows selection of

P–P	Peak-to-peak triggering
DC	Normal triggering
TVF	Triggering on TV FIELD synchronisation pulses.
TVL	Triggering on TV LINE synchronisation pulses.

The level at which the MTB starts is determined by adjustment of the LEVEL control. In digital mode this level is displayed by means of the LEVEL VIEW softkey.

The ANALOG TIME–BASE GENERATOR determines the horizontal deflection coefficient in the real-time mode via the TB s-us UP–DOWN control and the VAR control.
The LCD displays the correct deflection simultaneously.

The DIGITAL TIME–BASE GENERATOR is under control of the MICROPROCESSOR CONTROL SYSTEM.

The DIGITAL TIME–BASE GENERATOR determines the horzontal deflection coefficient in the digital memory mode via the s-us UP–DOWN control. The output of this block controls the P^2CCD or ACQUISITION logic.

The X–DAC receives its digital information from the DISPLAY MEMORY and converts it into the analogue horizontal deflection signal. The output of the X–DAC is applied to the HORIZONTAL DEFLECTION.

The HORIZONTAL SELECTION stage selects the horizontal deflection source by the DIGITAL MEMORY softkey or the X DEFL softkey.
The following deflection sources are possible:

ANALOG TIME–BASE
DIGITAL TIME–BASE
X DEFLECTION

The X MAGN softkey enables the analogue 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 HORIZONTAL AMPLIFIER drives the horizontal deflection plates (X) of the CRT.

3.3.4 CRT Display

The trace intensity on the CRT is controlled by the Z AMPLIFIER.
The Z AMPLIFIER blanks the flyback on the trace and also the switching intervals between the traces. For the vertical switching modes in real-time mode, ALT and CHOP, the Z AMPLIFIER is driven by a Z-blanking signal from the ANALOG VERTICAL CHANNEL SELECTION (CHOP) or the HORIZONTAL SELECTION (ALT).
In the digital mode the blanking pulse is derived from the DISPLAY Logic. DOTS serves for a dot-joined display and PLOT serves for a more intensified dot on the CRT screen during the PLOT action.
External trace blanking is obtained via an applied signal to the Z MOD BNC-input.

The FOCUS control drives the focus electrodes of the CRT via the FOCUS control unit, to give trace sharpness.

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

The ILLUM control provides illumination of the graticule by means of two lamps.

3.3.5 Plotter section

The Y–DAC and X–DAC supply the plot signals to the PLOT circuit.
When the PLOT softkey is depressed this circuit generates the correct signal to the PLOT socket.

3.3.6 Power supply section

The oscilloscope may be powered by any a.c. voltage between 100 V and 240 V or any d.c. voltage between 150 V and 400 V.
When switched off, the LINE ON switch interrupts the primary cicruit. This switch is the only front-panel pushbutton that is **not** controlled by the microcomputer.

After rectification, the relevant d.c. supply voltages feed the various circuits in the instrument.

When the instrument is operating from an a.c. mains voltage, a related signal at mains frequency is fed to the TB TRIGGER SELECTION for LINE triggering.

The EHT CONVERTER produces 14,5 kV via the HT MULTIPLIER for the accelerator anode of the CRT and –2,1 kV for the FOCUS CONTROL.

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

3.4 BRIEF CHECKING PROCEDURE

3.4.1 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 2.**

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.*
It is not necessary to remove the instrument covers 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. Therefore, to ensure accuracy, allow the full indicated warm-up time.

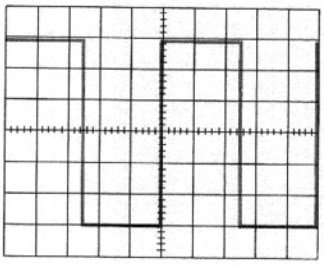
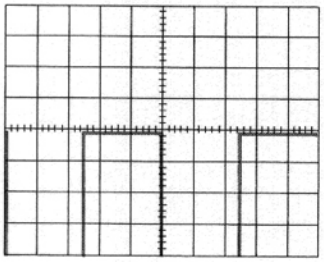
The following abbreviations are used: CW = Clockwise
CCW = Counter clockwise

The brief checking procedure is set up in such a way that in a fixed sequence of thirteen steps the most important functions, including front-panel controls, are shown and checked. At the end of each step, the continuously controls must be reset to the previous setting.
As stated, the procedure can be performed without removing the instrument covers.
For a complete check of every facet of the instruments calibration, refer to the section "Performance Check" in the Service Manual (for qualified personnel only).

3.4.2 Entering the brief checking procedure

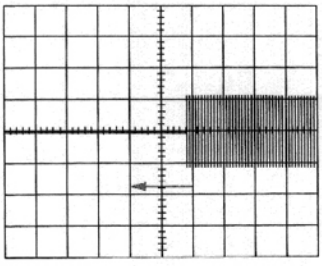
To enter the procedure, proceed as follows:
- Press MENU and keep it pressed.
- Press also AUTO SET.
- Now the Service menu has been entered, the LCD should indicate "*".
- Press "CHECK", which is one of the CRT softkeys.
- The CRT should indicate: "BRIEF CHECKING" on the upper side of the screen.
- Check that the trace lies parallel with the horizontal graticule lines; if necessary readjust the TRACE ROTATION control.
- Connect the CAL output to the channel A and B input sockets via 10:1 passive probes.
- Each step can now be selected by pressing the DOWN or UP softkey under the CRT screen.

- For leaving the brief checking procedure, press RETURN.

Measurements	Controls	Requirements
DC input coupling		
		– Square-wave of 6 DIV p-p (compensate both probes)
	– Y POS A or B: CCW	– Check that the signals shift downwards.
	– Y POS A or B: CW	– Check that the signals shift upwards.
	– LEVEL: CW or CCW	– Check that the trace triggers in the most extreme positions of the LEVEL control.
AC input coupling		
		– Check that the signals shift downwards since the attenuator input are AC-coupled – Check that the signals trigger on the falling edge.
	– VAR A or B: CCW	– Check that the amplitude decreases.
	– LEVEL: CW or CCW	– Check that the traces do not trigger in the most extreme positions of the LEVEL control.

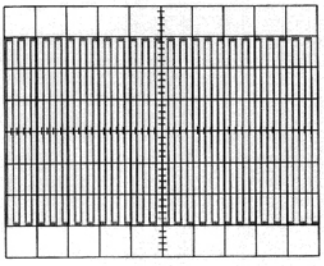
Measurements	Controls	Requirements

Roll Mode



– Check that the trace grows from right to left.

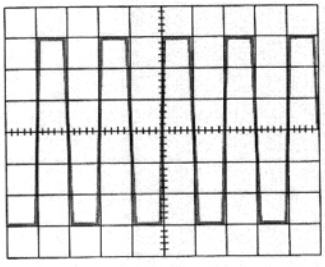
Display part x1



– X POS: CW or CCW

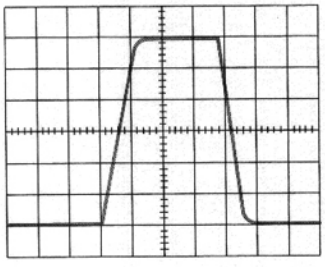
– Check that a 6 div square-wave with a high number of signal periods is visible.
– Check that the trace shifts horizontally over the screen.

Display part x8



– Check that the number of signal periods is decreased by eight.

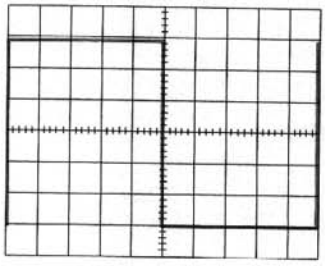
Display part x32



– Check that the number of signal periods is again decreased by four.

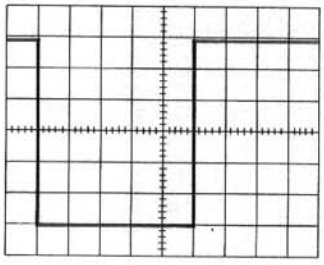
Measurements	Controls	Requirements

Trigger delay 0 div



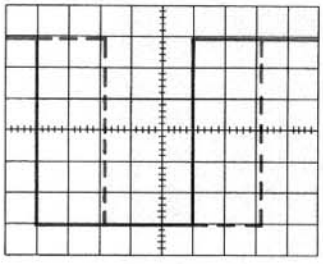
- Check that a 6 div square-wave is visible.
- Trigger moment is at 0 div.

Pre-trigger 6 div



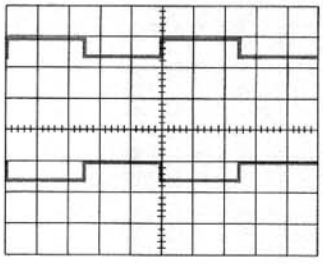
- Check that the rising edge is on the 6th vertical graticule line.

Delay trigger 94 div

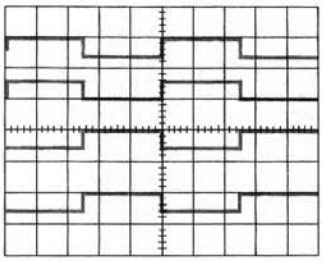
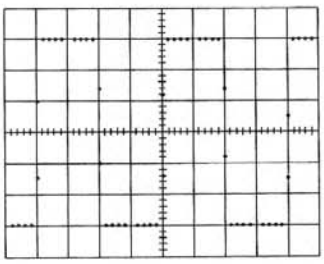
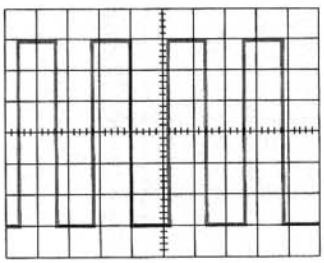


- Check that the rising edge is on the 6th vertical graticule line approx.

Multi display A+B



- Check that the signals are displayed simultaneously.

Measurements	Controls	Requirements
Register display 	– Y POS A or B: CW	– Check that four signals are displayed on the screen. – Note that first the Y POS A or B control must be turned before you can see the ch. A or ch. B signal.
Dotted display 		– Check that the signal is displayed in only dots.
Locked display 	– VAR A or B: CW or CCW – Y POS A or B: CW or CCW – X POS: CW or CCW	– Check that a 6 div square-wave is displayed. – Check that the VAR control is not active. – Check that the Y POS control is not active. – Check that the trace shifts horizontally over the screen.

Note: You can leave the service menu by pressing the AUTO SET softkey.

4. PREVENTIVE MAINTENANCE

4.1 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.

4.2 REMOVING THE BEZEL AND CONTRAST FILTER (to clean the contrast filter)

- Insert a screwdriver in the slot on the upperside of the bezel and gently loosen the bezel.
- Ease the bezel away from the front panel.
- Press the contrast filter from the bezel.
- To prevent scratches, when cleaning the filter, always use a clean soft cloth, free from dust and abrasive particles.

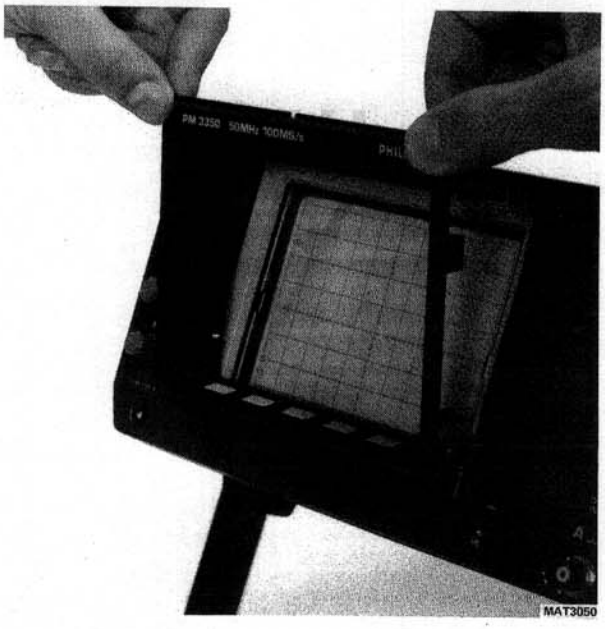


Figure 4.1 Removing the bezel and the contrast filter.

4.3 RECALIBRATION

To ensure accurate measurements, check the calibration of the instrument after specified recalibration intervals. Recalibration must be carried out by qualified personnel only.

5. 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. Safery Characteristics

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

C. Initial Characteristics

- Overall dimensions:
  - Width

Included handle	:	387 mm	
Excluded handle	:	350 mm	

  - Length

Included handle, excluded knobs	:	518,5 mm	530,5 mm included knobs.
Excluded handle, excluded knobs	:	443,5 mm	455,5 mm included knobs.

  - Height

Included feet	:	146,5 mm
Excluded feet	:	134,5 mm
Excluded under cabinet	:	132,5 mm

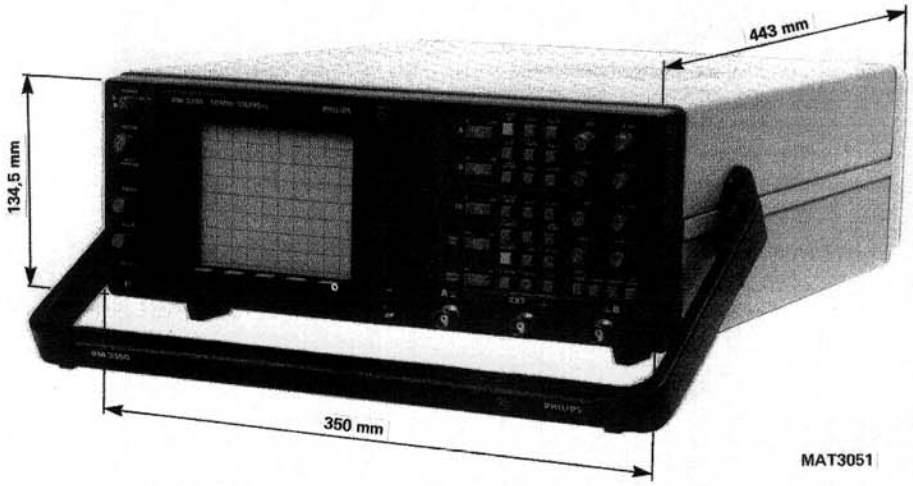


Figure 5.1 Dimensions

- Mass : 9,5 kg

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

D. Contents

5.1 DISPLAY

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• C.R.T.		
Typeno.	PHILIPS D 14-372	
Measuring area (h x w)	80 x 100 mm	8 x 10 div. 1 div. = 10 mm 1 subdiv. (sd) = 2 mm
• Screen type		
Standard	GH (P 31)	
Option	GM (P 7)	Long persistence
• Total acceleration voltage	16 kV	
• Illumination	Continuously variable	
• LCD liquid crystal display		All relevant settings are visible in display
Typeno.	LC 9438130	
Visible area	25,4 x 88,8 mm	
Back lighting	Permanently on	

5.2 VERTICAL DEFLECTION OR Y AXIS

• Deflection coeff.	2 mV/div. ... 10 V/div.	In 1, 2, 5 sequence.
• Variable gain control range	1 : > 2,5	If PM8936/09 is used, deflection coeff. is automatically calculated in display.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Error limit	< +/– 3 %	Only in calibrated position.
• Input impedance	1 MΩ +/– 2 %	Measured at f_o < 1 MHz.
Paralelled by	20 pF +/– 2 pF	Measured at f_o < 1 MHz.
Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltages (rms)	500 V	Max. duration 60 sec.
• Bandwidth for 20 mV up to 10 V @ 25°C	> 50 MHz	Input 6 div. sine-wave.
Bandwidth for 2 mV, 5 mV and 10 mV @ 25°C	> 35 MHz	Input 6 div. sine-wave.
• Rise time	7 ns or less	Calculated from 350/f-3 dB
• Pulse aberration		
Overshoot, ringing and rounding	< 1,5 sd peak to peak	Input pulse 5 div, +/– 2,5 div. from screen centre, positive as well as negative pulse.
Duration of ringing	20 ns	Ringing has ended when amplitude is 1/3 of starting amplitude
Hole or bump	< 0,7 sd (peak)	
Drop or tilt	< 0,7 sd (peak)	
• Noise 20 mV .... 10 V	< 0,5 sd	Measured visually. Pick-up on open BNC excluded.
• Lower – 3 dB point @ 25°C	< 10 Hz	In AC position, 6 div. sine-wave.
• Dynamic range		
@ 10 MHz	> +/– 24 div.	Vernier in cal. position.
@ 50 MHz	> 8 div.	Vernier in cal. position.
• Position range	> +/– 8 div.	Vernier in cal position.
• Decoupling factor between channels		Both channels same attenuater setting. Input max. 8 div. sine-wave.
@ 10 MHz	1 : > 100	2,5 and 10 V are excluded.
@ 50 MHz	1 : > 50	2,5 and 10 V are excluded.
• COMMON Mode Rejection Ratio @ 1 MHz	1 : > 100	Both channels same attenuater setting, vernier adjusted for best CMMR; measured with max. 8 div. (+/– 4 div.) each channel.
• Visible signal delay	> 15 ns	Max. intensity, measured from line start to trigger point.
• Base line jump		
Between attenuater steps		
20 mV ... 10 V	< 1 sd	
Addition jump between 10 mV ... 20 mV	< 1,5 sd	
Normal - Invert Jump	< 1 sd	Only channel B.
ADD Jump	< 0,6 div.	When A and B are positioned in screen centre (20 mV ... 10 V).
Variable jump	< 1 sd	Max. jump in any position of the vernier.

5.3 HORIZONTAL DEFLECTION OR X AXIS

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
5.3.1 Time-Base		
• Time coeff.	0,5 sec. ... 50 ns	1, 2, 5 sequence (magnifier off).
• Error limit	< 3 %	Measured at –4 ... +4 div. from screen centre
• Horizontal position range	Start of sweep and 10th div. must be shifted over screen centre	
• Variable control ratio	1 : > 2,5	
• Time-Base Magnifier	Expansion *10	Not valid in X-deflection.
• Error limit	< 4 %	Measured at +4 ... –4 div. from screen centre. Excluding first 50 ns and last 50 ns.
• Horizontal magnifier balance *10 *1	< 2,5 sd	Shift start of sweep in *10 in mid-screen position then switch to *1.
• Hold off Minimum to maximum hold-off time ratio	1 : > 10	Minimum hold-off time is related to time-base setting.
5.3.2 X-deflection		
• Deflection coeff. Via channel A or B Via EXT. input	2 mV ... 10 V/div. 100 mV/div.	1, 2, 5 sequence.
• Error limit Via channel A or B Via EXT. input	< +/– 5 % < +/– 5 %	
• Bandwidth Amplitude @ input signal 6 div. 2 MHz.	DC ..... > 2 MHz	DC coupled
• Phase shift between X and Y-defl.	$< 3^{o}$ @ 100 kHz	
• Dynamic range	> +/– 12 div. @ 100 kHz	
5.3.3 EXT input		
• Input impedance Paralelled by	1 MΩ +/– 2 % 20 pF +/– 2 pF	f_o < 1 MHz f_o < 1 MHz
• Max. input voltage	400 V (d.c. + a.c. peak)	
Max. test voltage (rms)	500 V	Max. duration 60 sec.
• Lower – 3 dB point	< 10 Hz	AC coupled.

5.4 TRIGGERING

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Trig- mode		
AUTO (auto free run)	Bright line in absent of trigger signal	Auto free-run start 100 ms (typ) after no trig-pulse.
Triggered		Switch automaticly to auto free-run if one of the display channels is grounded.
Single		In multi-channel mode (alternate) each channel is armed after reset; if sweep is already started, sweep is not finished.
• Trigger source		
A, B, Composite (AB), EXT, Line		Line trigger source always triggers on main frequency. Line trigger amplitude is depended on line input voltage. Approx. 6 div. @ 220 V a.c. input voltage.
• Trigger coupling		
Peak to peak (p-p), DC, TVL, TVF		
• Level range		
Peak to peak	Related to peak to peak value.	p-p coupling is DC rejected.
DC INTERNAL	> +/– 8 div.	
DC EXTERNAL	> +/– 800 mV	
TVL/TVF	Fixed level	
• Trigger slope	+/–	Slope sign in LCD and + or – if TVL/F is chosen.
• Trigger sensivity		
INTERNAL		
0 – 10 MHz	< 0.5 div.	Trig. coupling DC.
@ 50 MHz	< 1,0 div.	Trig. coupling DC.
@ 100 MHz	< 2,0 div.	Trig. coupling DC.
EXTERNAL		
0 – 10 MHz	< 50 mV	Trig. coupling DC.
@ 50 MHz	< 150 mV	Trig. coupling DC.
@ 100 MHz	< 500 mV	Trig. coupling DC.
TVL/TVF INTERNAL	< 0,7 div.	Sync. pulse.
EXTERNAL	< 70 mV	Sync. pulse.

5.5 SIGNAL ACQUISITION

• Sampling type @0,5 us/div ... 50 s/div	Real time	
• Max. Sample rate		Sampling rate depends on time/div setting.
Real time:	100 megasamples/s	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Vertical (voltage) Resolution	8 bits	0,4 % of full range
• Horizontal (time) Resolution		
In single-channel acquisition:		
@5 ms/div ... 50 ms/div	4096 samp./acquisition	1 Sample = 0,025 % of full record
@0,5 ms/div ... 2 ms/div	512 samp./acquisition	1 Sample = 0,2 % of full record
In dual-channel acquistion		
@5 ms/div ... 50 s/div	2048 samp./acquisition	1 Sample = 0,05 % of full record
@0,5 us/div ... 2 ms/div	512 samp./acquisition	1 Sample = 0,2 % of full record
• Record length	10,2 x time/div	Display in unmagnified position
• Acquisition time real-time	10,2 x time/div	
@0,5 s/div ... 5 ms/div	30 ms ... 50 ms	Exclusive delay time
@2 ms/div ... 0,5 us/div	50 ms ... 70 ms	Exclusive delay time
• Sources	Channel A	
	Channel B	Channel B can be inverted before acquisition
• Acquisition Modes	1 channel only	Full memory available for 1 channel
	2 channels	Simultaneously sampled; 2 channels share memory

5.6 CHANNELS A AND B

• Freq. Response		Z source = 25 Ohm
Lower transition point of BW:		
Input coupling in DC position	d.c.	
Input coupling in AC position	$\leqslant$ 10 Hz	
Upper transition point of BW: (Ambient: 15 ... 35°C)	$\geqslant$ 20 MHz (–3 dB)	Deviation max. 3 MHz for Ambient: 0 ... 40°C.
• Max. Base-Line Instability:		
Jump (Ambient: 15 ... 35°C)		Add 25 % for Ambient: 0 ... 40°C
when switching to memory mode	0,3 div	
When actuating INVertor switch	0,3 div	
between any time/div positions	0,5 div	
Drift	0,1 div/h	Measured in 20 mV/div position
Temperature coefficient	± 0,05 div/K	Measured in 20 mV/div position

5.7 TIME–BASE

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Modes		
	Single shot Recurrent	
	Multiple shot	Up to 2 shots
	Roll	Will be stopped by trigger
• Time Coefficients:		
In Recurrent	0,5 us/div ...	
	0,5 s/div	
In single shot	0,5 us/div ...	
and multiple shot	50 s/div ...	
Error Limit:		Ambient: 15 ... 35°C
In real-time mode	± 1 %	Add 0,5 % for Ambient: 0 ... 40°C

5.8 TRIGGER

• Trigger delay:		
Range	−10 ... 250 div	Adjustable in divisions
Accuracy	± 0,3 div.	
• Trigger level view:		Indication in LCD
In accuracy	⩽ 0,25 div.	

5.9 MEMORY

• Memory size:		
Inaccurcay	⩽ 0,75 div	
Registers	2	
Register Depth:		
acquisition	4096 words	
register	4096	
Wordlength	8 bits	
• Functions	Clear	
	Load	Contents of acquisition are saved in register
	Lock	Memory system is locked. If lock is not active The signal is written into the acquisition memory.

5.10 DISPLAY

• Sources	Channel A	
	Channel B	in any combination
	Register A	
	Register B	
• Display Expansion Horizontal	1x .. 32x	
• Display Manipulations	Dot join	Including digital interpolation at 0,5 µs/div ... 2 ms/div.
• Display-part range Horizontal	full memory	The displayed part of the magnified memory can be chosen

5.11 CALCULATION FACILITIES

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Functions	Peak-to-peak value Rise or Fall time Frequency	Between cursors indicated by markers,

5.12 AUTO SETTING

• Settling time	3 s	Auto set is effected in analogue mode.
• Cursors	off	
calculations	off	

5.13 CURSORS

• Horizontal resolution:		
in single-channel mode	1 : 4096	
in dual-channel mode	1 : 2048	
@ 2 ms/div ...	1 : 512	display in dots
0,5 us/div	1 : 1024	display in dot-join
• Vertical resolution	1 : 256	
• Read-out resolution	3 digits	
• Voltage cursors:		
Error Limit Ambient: 15 ... 35°C	± 3 %	Referred to input at BNC, error of probes, etc. excluded. Add 3 % for ambient 0 ... 40°C
Cursor Range	Displayed part of memory	Cursors cannot pass each other. (X-position is neglected)
• Time cursors		
Error Limit	± 0,2 %	

5.14 POWER SUPPLY

• Line input voltage a.c.		One range.
Nominal	100 – 240 V	
Limits of operation	90 – 264 V	
• Line frequency		
Nominal	50 – 400 Hz	
Limits of operation	43 – 445 Hz	
• Safety requirements within specification of : IEC 348 CLASS I UL 1244 VDE 0411 CSA 556 B		

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Power consumption (AC source)	70 W	At nominal source voltage

5.15 SUNDRIES

• Data and Settings retention		When instrument is switched off or during MAINS failure
Memory back-up voltage	2 ... 3,5 V	
Memory back-up current drain	typical 25 μA	@ 25^{o}C
Recommended batteries:		According to IEC 285, (Alkaline Manganese Penlight Battery), e.g. PHILIPS LR6 (9299 000 20734)
type	LR 6	
quantity	2 pcs	Delivered with the instrument
Temperature rise of batteries	20 K	After warming-up period of instrument
Retention Time	Typical 5 years	@ 25^{o}C, with recommended (fresh) batteries.
Temperature Range	0 ... +70^{o}C	@ −40 ... 0^{o}C Settings retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer period (24 h) below −30^{o}C or above 60^{o}C. N.B. Under no circumstances should batteries be left in the instrument @ temperatures beyond the rated range of the battery specification.
• Analogue Plot ouput		
Connector	Din plug 9 pin female	
Functions	Memory Dump	Register selectable
Sensitivity	1 V/Full memory ±3 %	Horizontal and vertical
Pen lift	TTL-compatible	Pen-up is software selectable (0 or 1). Open collector output; max 12 V
Plot time per dot	20 ms ... 2000 ms	Software selectable
Plot sequence	Channel A first	In dual-channel operation; With more registers starting with the lowest number.

5.16 AUXILIARY INPUTS OR OUTPUTS

• Z−MOD		TTL compatible.
ViH	> 2,0 V	Blanks display.
ViL	< 0,8 V	Max. intensity
		Analogue control between ViH and ViL is possible.
• CAL		To calibrate drop or tilt probes.
Output voltage	1,2 V +/− 1 %	Rectangular output pulse.
Frequency	2 kHz ± 5 %	The output may be short-circuited to ground.

5.17 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 SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Meets environmental requirements of	MIL–T–28800 C, type III, CLASS 5 Style D	
• Temperature		
Operating temp. range within specification	$10^{o} - 40^{o}C$	MIL–T–28800 C par. 3.9.2.3 tested c.f. par. 4.5.5.1.1.
Limits of operating temperature range	$0 - 50^{o}C$	Idem.
Non operating (Storage)	$-40^{o}C/+ 75^{o}C$	MIL–T–28800C par. 3.9.2.3 tested c.f. par. 4.5.5.1.1.
• Max. humidity operating non operating	95 % RH	
• Max. altitude		C.f. MIL–TL–28800 C par. 3.9.3. tested c.f. par. 4.5.5.2.
Operating	4,5 km (15000 feet)	Maximum (Operating temperature derated $3^{o}C$ for each km (for each 3000 feet) above see level.
Non operating (storage)	12 km (40.000 feet)	
• Vibration (operating)		C.f. MIL–T–28800 C par. 3.9.4.1 tested c.f. par. 4.5.5.3.1.
Freq. 5.....15 Hz Sweep Time	7 min.	
Excursion (p/p)	1,5 mm	
max. Acceleration	$7\ m/s^2$ (0,7 x g)	@ 15 Hz
Freq. 15.....25 Hz Sweep Time	3 min.	
Excursion (p/p)	1 mm	
max. Acceleration	$13\ m/s^2$ (1,3 x g)	@ 25 Hz
Freq. 25.....55 Hz Sweep Time	5 min.	
Excursion (p/p)	0,5 mm	
max. Acceleration	$30\ m/s^2$ (3 x g)	@ 55 Hz
Resonance Dwell	10 min.	@ each resonance freq. (or @ 33 Hz if no resonance was found). Excursion, 9.7.1 to 9.7.2.
• Shock (operating)		C.f. MIL–T–28800 C par. 3.9.5.1 tested c.f. par. 4.5.5.4.1.
Number of shocks total	18	
each axis	6	(3 in each direction).
Shock Wave Form	Half sinewave	
Duration	11 ms	11 ms
Peak Acceleration	$300\ m/s^2$ (30 x g)	

CHARACTERISTICS	SPECIFICATION	ADDITIONAL INFORMATION
• Bench handling Meets requirements of	MIL–STD–810 methode 516, proced.V	C.f. MIL–T–28800 C par. 3.9.5.3 tested c.f. par. 4.5.5.4.3.
• Salt Atmosphere Structural parts meet requirements of	MIL–STD–810 method 509, proced.I salt solution 20 %	C.f. MIL–T–28800 C par. 3.9.8.1 tested c.f. par. 4.5.6.2.1.
• EMI (Electronic Magnetic Interference) meets requirements of	MIL–STD–461 CLASS B VDE 0871 and VDE 0875, Grenzwertklasse B	Applicable requirements of part 7 : CE03 CS01, CS02, CS06, RE02, RS03
• Magnetic Radiated Maximum Susceptibility Deflection Factor	7 mm/mT (0,7 mm/gauss)	Tested conforming IEC 351-1 par. 5.1.3.1. Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a Flux intensity (p-p value) of 1,42 mT (14,2 gauss) and of symmetrical Sine wave form with a frequency of 45....66 Hz.

5.18 SAFETY

• Meets requirements of	IEC 348 CLASS I VDE 0411	Except for power cord, unless shipped with Universal European power plug.
	UL 1244 CSA 556 B	Except for power cord, unless shipped with North American power plug.
• Max. X-Radiation		Measured @ 5 cm from surface of instrument for a target area of 10 cm^2
• Recovery time	15 min. 30 min. 45 min. 60 min.	$-10^oC \longrightarrow +25^oC$ ambient temp. $-20^oC \longrightarrow +25^oC$ ambient temp. $-30^oC \longrightarrow +25^oC$ ambient temp. $-40^oC \longrightarrow +40^oC$ ambient temp.

5.19 ACCESSORIES

- Optional accessory — 10 : 1 passive probe set PM8936/09

5.19.1 Accessory information

- DELIVERIES

The PM8936/09 probe set consist of:

- 2x 10 : 1 probe PM8926/09, incl. * spring-loaded test clip
  * earth cable
- Instruction card

• INTRODUCTION

The PM8936/09 is a 10x attenuator modular probe with automatic range indication possibility, designed for oscilloscopes. The cable length is 1,5 m. At delivery the probe has been adjusted to an oscilloscope with an input capacitance of 20 pF.

• CHARACTERISTICS

– Attenuation (d.c.)	10x
– Bandwidth	d.c...200 MHz (–3 dB)
– Useful system bandwidth	d.c...100 MHz (–3 dB)
– Input resistance at d.c.	10 MΩ +or– 1,5 %
– Input capacitance at d.c.	13,5 pF
– Compensation range	5 pF....40 pF
– Max. non destructive input voltage (d.c. + a.c. peak) at d.c.	500 V

• DISMANTLING

* The probe body can be removed by sliding it from the cable assembly.
* The compensation box can be slid off the cable assy after the knurled nut has been unscrewed in a counter clockwise direction.
* To expose the h.f. adjustment controls slide the terminating box cover off the compensation box.

• ADJUSTMENTS

Matching the probe to the oscilloscope:
Connect the probe to the CAL socket of the oscilloscope.
A trimmer can be adjusted for the l.f. response through a hole in the compensation box to obtain optimum square-wave response.

6. GLOSSARY OF TERMS

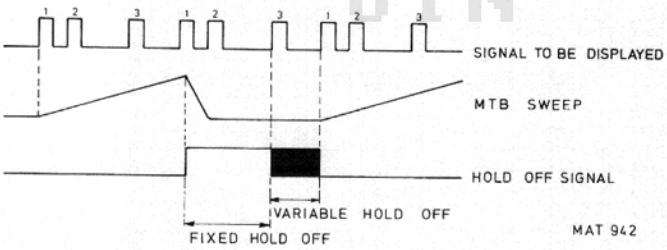
ALT: Alternate display. To display more than one vertical channel, the display switches over from one channel to another at the end of each time-base sweep. Is suitable for the higher sweep speeds (more than 0,1 ms/div).

AUTO: The MTB generator is free-running 100 ms after the last trigger pulse. This means that even in the absence of trigger pulses a line is written on the screen. As soon as triggers appear, the time-base circuit switches to the normal trigger mode (cannot be employed for signals with low repetition rates, 20 Hz or lower).

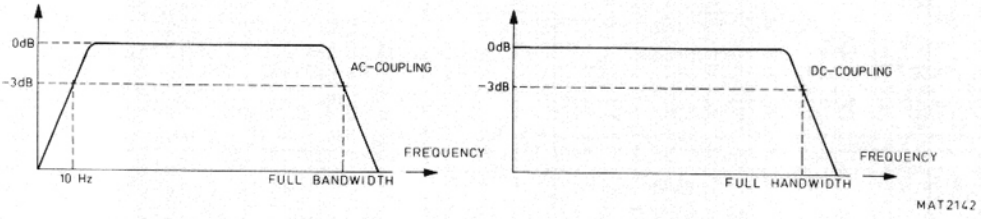
CHOP: Chopped display. To display more that one vertical channel, the display switches over from one channel to another at a fixed (chopper-) frequency. The channel that is displayed is also selected as a trigger source. Is suitable for the lower sweep speeds (less than 0,1 ms/div).

COMP: Composite triggering. Offers a stable display of two signals applied to channel A and B that are not time related. Works only in conjunction with the ALT-display mode.

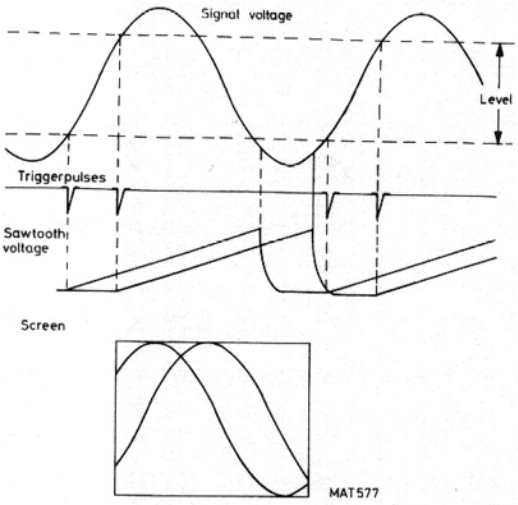
HOLD OFF: During the HOLD OFF time, the MTB cannot be started by a trigger pulse. When the HOLD OFF control is not in CAL-position, the HOLD OFF time can be increased in order to obtain a stable display in digital and computer applications, where complex pulse patterns need to be measured. When a complex pulse pattern is displayed and this pattern is also used for triggering, a multiple-picture display may occur. These effects can be corrected by adjusting the HOLD OFF control to increase the hold-off time, so that certain trigger pulses do not start the MTB.



INPUT COUPLING: Input coupling, can be a.c.– or d.c.–coupled.
AC-coupled: only the a.c.–component of the input signal is fed to the attenuator, via a blocking capacitor. This mode can be used when a signal with an a.c. component that is superimposed on a high d.c. voltage must be displayed.
DC–coupled: the complete input signal (both a.c. and d.c. components) is fed to the attenuator.



LEVEL: Determination of the starting point of the time-base can be varied by the LEVEL control. The time-base starts when the trigger signal reaches the voltage level of the LEVEL control.



LINE: Main time-base triggering on a signal derived from the mains voltage. Can be used when examining the mains ripple on the d.c. output voltage of a power supply. Line triggering is not available when the instrument is operated from a battery supply.

MULTIPLE: The time-base runs twice after receipt of a trigger pulse. The result of the first action is stored in the REGISTER, the second is stored in the DISPLAY MEMORY; both are displayed on the screen. The RESET softkey resets the time-base again so that it can start on a new trigger pulse, indicated by ARMED in the LCD.

PLOT: The signal information, present on the screen, can be plotted on an X–Y or an X(t) recorder. The plotter speed can be selected by means of service menu. When executing the PLOT-function, all softkeys and UP–DOWN keys are inactive. The plot action can be interrupted by pressing the PLOT softkey again.

The plot action starts and ends with a short delay to give sufficient time for manual pen positioning if no automatic pen lift function is available on the recorder.

P–P: Peak-to-peak triggering, gives automatic ranging of the LEVEL control. The LEVEL range is determined by the peak-to-peak value of the trigger signal.
Example: with a 4 division signal on the screen, the LEVEL control is adjustable from +1,8 div. (CW) to −1,8 div. (CCW) with a total range of 3,6 div.

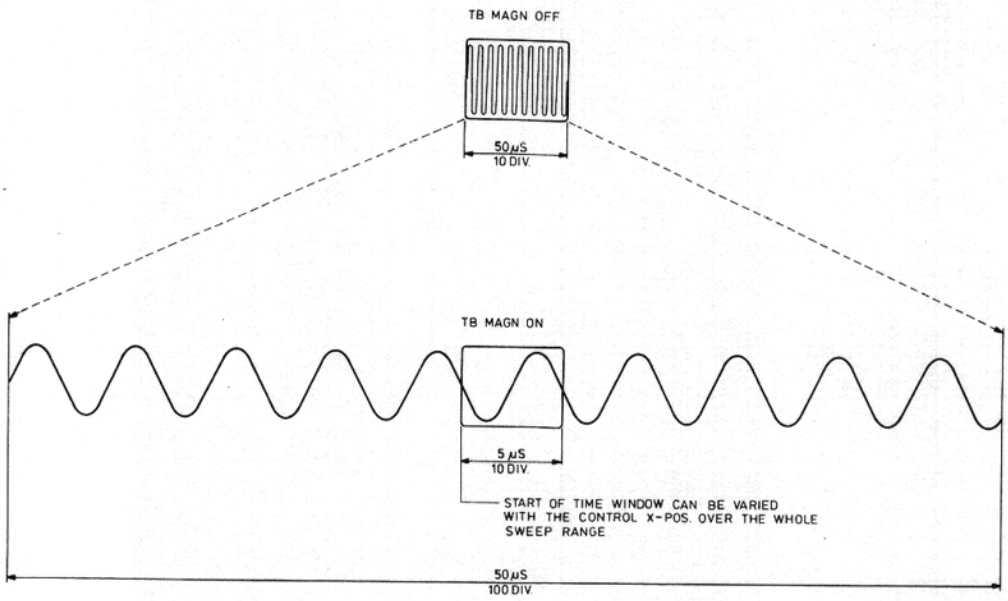
ROLL mode: The signal is built up point-by-point at the right-hand side of the screen and moves to the left. The ROLL segment on the LCD indicates that the ROLL mode is operative. When the memory has been filled the ROLL mode stops and the ROLL segment is extinguished again. This mode is used in the positions 1 s/div up to 50 s/div, so for very low frequency signals.

SINGLE real time: The time-base runs only once after receipt of a trigger pulse. When ARMED, the time-base is ready on receipt of a trigger pulse. The RESET softkey resets the time-base so that it can start again on a new trigger pulse. This can be used to display non-repetitive waveforms.

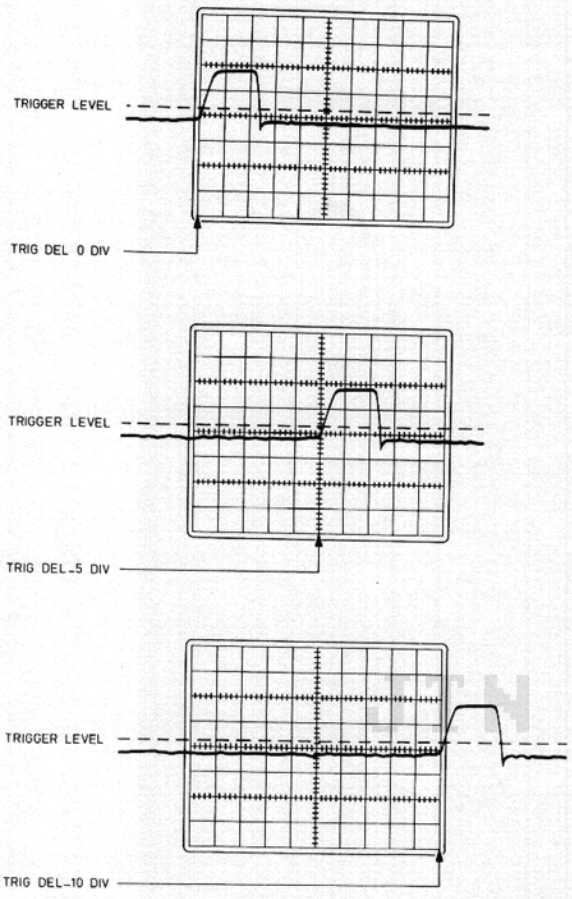
SINGLE (digital): The DISPLAY MEMORY is refreshed once after receipt of a trigger pulse, as also the CRT display. As long as the instrument is waiting for a trigger pulse, the LCD indication ARMED ligths.
When the SINGLE action is completed, the same mode can be chosen again by pressing the RESET softkey.

SLOPE: Determines on which slope the sweep is started. If positive, the time-base starts on the positive-going slope of the trigger signal. If negative, the time-base starts on the negative-going slope of the trigger signal.

TB MAGN: Fixed expansion of the TIME/DIV setting by a factor of 10. Now the portion of the signal formerly displayed over a width of one division occupies the full width of the screen (10 DIV.).

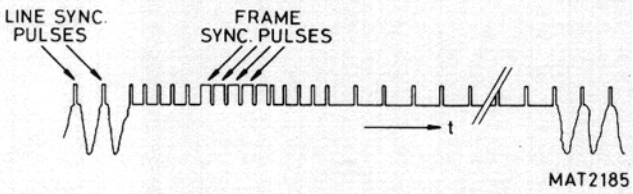


TRIGGER DELAY: The trigger delay enables the time (in division) between triggering and the start of the CRT display to be chosen from −10 DIV (pre-trigger) up to 250 DIV.
When pre-triggered, a certain portion of the signal preceding the trigger point is shown on the CRT. The selected trigger point in divisions is indicated on the LCD.
If the time-base is set to another sweep speed, the setting of the trigger delay is automatically recalculated (rounded off downwards to whole divisions-integers).



TRIG: Trigger mode. The time-base starts upon a signal derived from a selected trigger source (A, B, EXT, or LINE) and will not run without trigger pulses.

TVL, TVF: Triggering of the time-base on the TV line (TVL) synchronisation pulses or TV frame (TVF) synchronisation pulses (MTB only). In this mode a fixed level is set and the LEVEL control is inoperative.



X DEFL: Horizontal deflection (XY) is under control of the signal selected by the TRIG or X SOURCE softkey (A, B, EXT or LINE). The filters AC or DC remain active in the XY mode. Can be used for:
- Frequency response of circuits and filters, where amplitude must be displayed against frequency.
- Semiconductor measurements where output current must be displayed against input voltage.
- Frequency or phase shift comparisons by displaying Lissajous patterns.