2 GHz Digitizing Oscilloscope
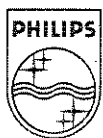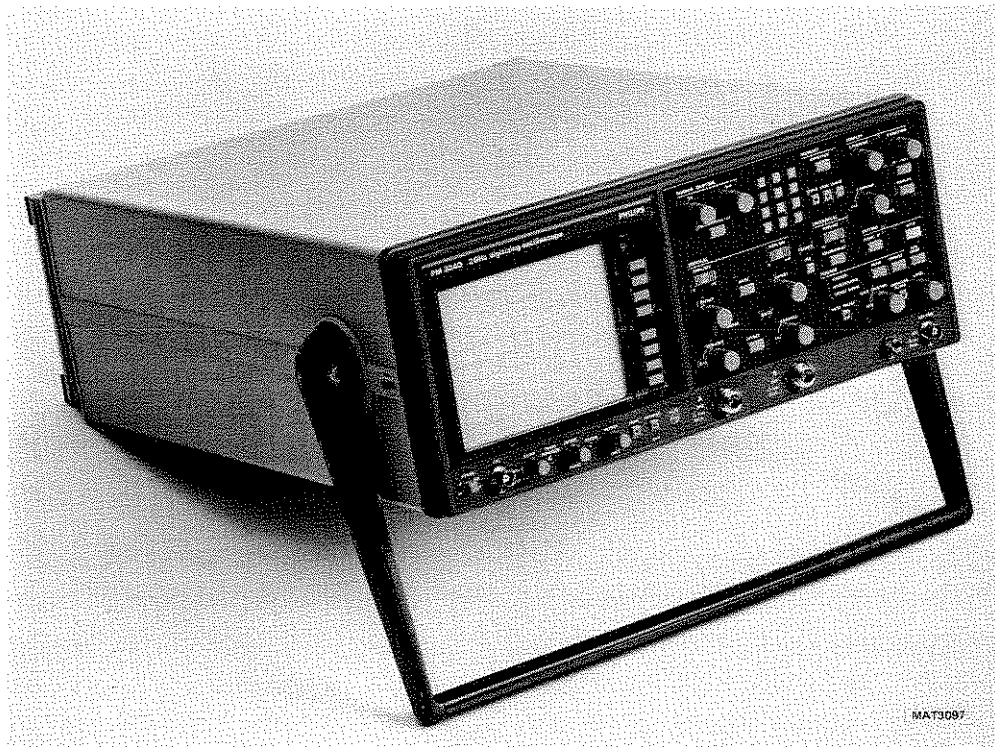
PM3340

Operating Manual

PHILIPS

PHILIPS

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.

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.

CONTENTS

IV

LIST OF FIGURES

1.0   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 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.

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.

2.0   INTRODUCTION

This compact dual channel digitizing storage oscilloscope features
sampling techniques that allow display of signals with a frequency up
to 2 GHz. The sampling system can work in normal and in high
resolution eye pattern mode. The instrument is extremely easy to use
because of the AUTO-SET pushbutton, that automatically adjusts the
controls to suit the input signal value.
The brightness is independent of the time base settings. The M68000
microprocessor gives a wide choise of measurement and display
possibilities, which can be selected via the ergonomic designed front
panel.
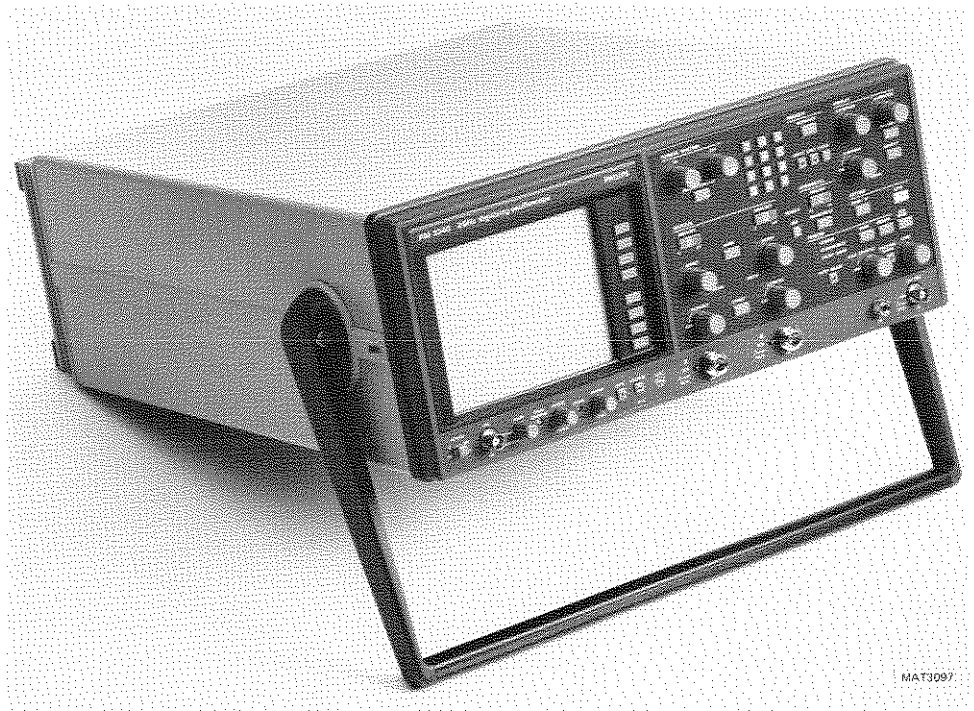
Figure 2.1 2 GHz digizing oscilloscope.

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

All these features make this oscilloscope suitable for a wide range of
high-frequency measuring applications such as in telecommunication,
component testing and development and in fast computers.

3.0   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 may 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.

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 power supply that covers most voltage ranges in use: 90 V...264 V a.c. (r.m.s.). This obviates the need to adapt to the local mains voltage by means of switch setting.
The mains frequency range is 45 Hz...440 Hz.

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

Mains fuse rating: 2.5 A delayed-action

The mains fuseholder is located on the rear panel (see Fig. 3.1.). If the mains fuse needs replacing, proceed as follows:
- switch the instrument off and disconnect it from the mains voltage.
- remove the inner part of the fuseholder by means of a screwdriver.
- fit a new fuse of the correct rating and refit the inner part of the fuseholder.

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

Figure 3.1 Rear view showing the fuse-holder.

3.3   MEMORY BACK-UP BATTERIES

3.3.1   General information

The memory back-up circuit has the following functions:

- after a power source interruption, or when the oscilloscope is switched off in the LOCK mode, the front-settings as well as the stored data values are saved in the internal memory.
- after the power supply is restored, the oscilloscope starts up automatically with the same front setting.

ATTENTION: If the power source is interrupted while the settings
              are changed by the user, it might happen that the front
              settings are disturbed and an automatic AUTO SET is
              performed after switching on the instrument again.

3.3.2   Installation of batteries

To install the batteries, the following procedure must be followed:
- 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. 3.2.). The battery holders are now accessible.
- insert the two penlight batteries, paying attention to the polarity
  indication marked on the holder (also on Fig. 3.2).
  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!
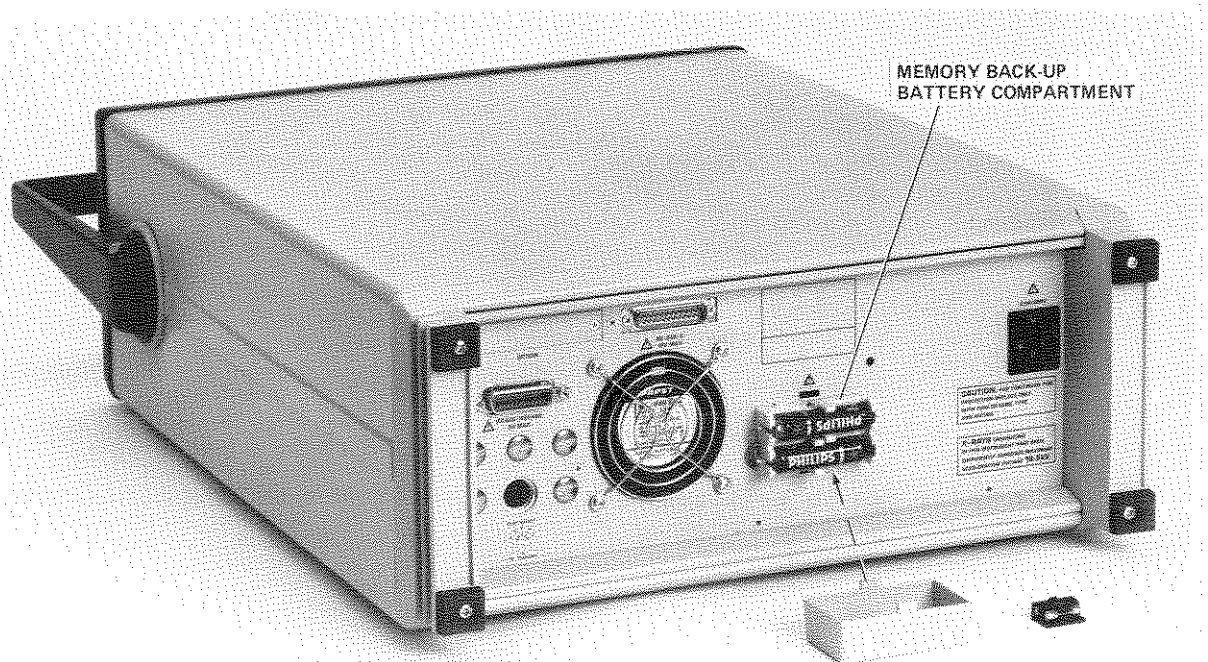
Figure 3.2 Rear view showing the battery compartment.

3.4 THE FRONT COVER

3.4.1 Removing and fitting of the front-cover

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:

- depress the pushbuttons in the brackets and turn the carrying handle as far as possible to the lower side of the oscilloscope.
- pull both clamping lips of the front cover outwards.
- lift the cover off the instrument.
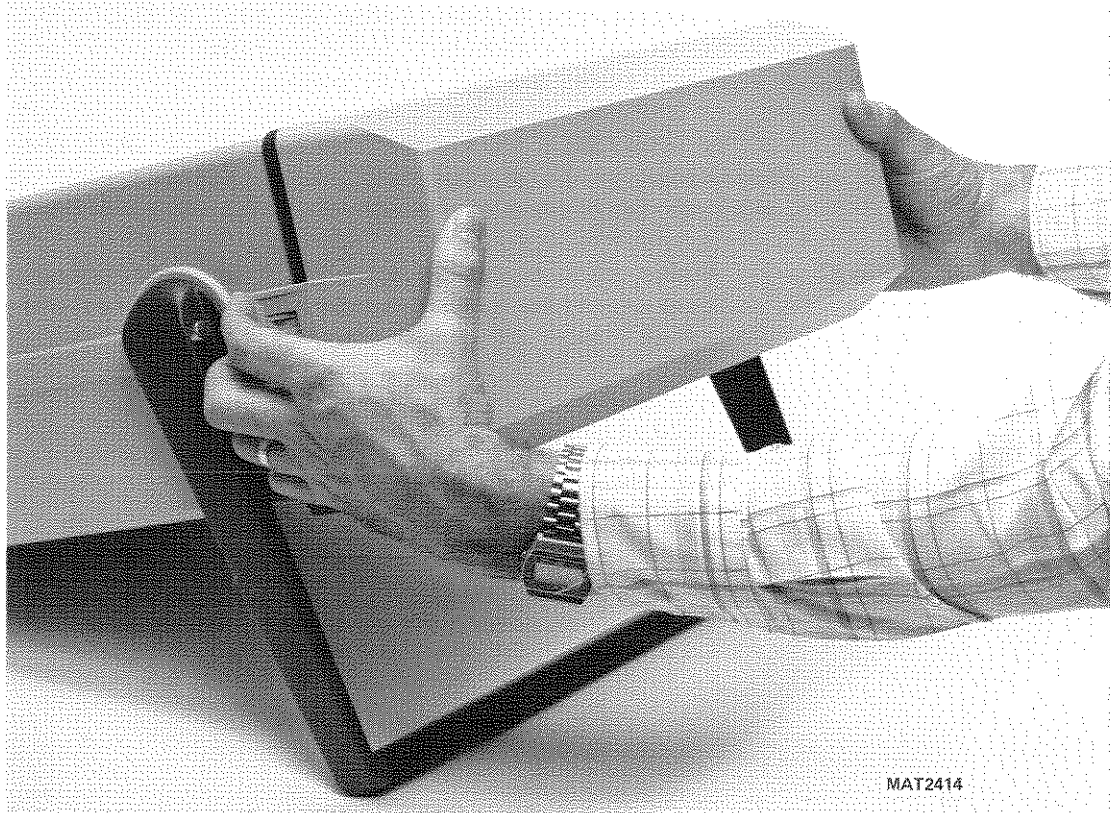
Figure 3.3 Removing the front cover.

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

3.4.2   Acces to inner-cover storage space

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.
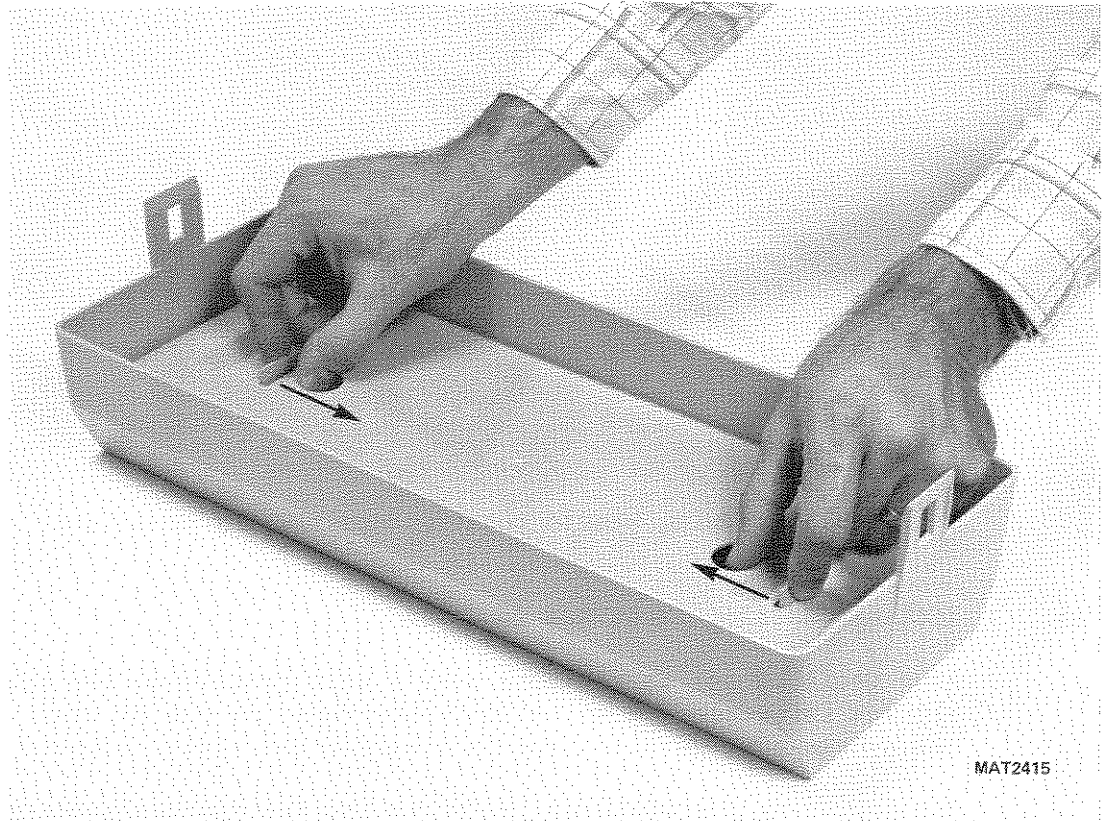
Figure 3.4 Removing the inner front cover. (storage space)

3.5   OPERATING POSITION OF THE INSTRUMENT

The oscilloscope may be used in the following positions:

-horizontally on its bottom feet;
-on the carrying handle in various sloping positions.

The available oscilloscope angles with respect to the working surface can be selected after depressing the push-buttons in the brackets of the carrying handle and turning.
The characteristics given in Chapter 6 are fully guaranteed for all the above-mentioned positions.

ATTENTION: Ensure that the fan hole in the rear cover and the
holes in the cover are free from obstruction, for
correct functioning of the fan.

Do not position the oscilloscope on any surface which
radiates heat, or in direct sunlight.
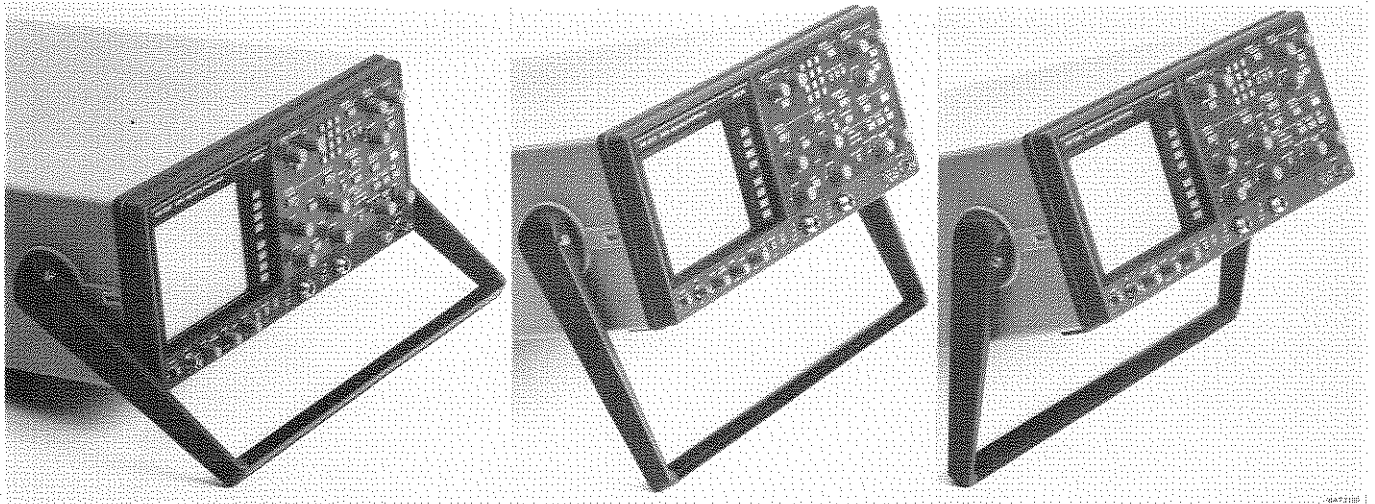
Figure 3.5 Carrying handle rotation and sloping positions.

3.6   IEEE-488/RS232-C INTERFACE PM 8956A

Your oscilloscope is equipped with a unit containing the IEEE
488 bus interface and an RS232-C interface. It can be used in an IEEE
bus system configuration and in a system for serial communication.

For operating instructions, refer to the instruction/programming
manual belonging to this interface.

4.0   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

4.1.1   Switching-on

After the oscilloscope has been connected to the mains (line) voltage in accordance with Section 3.2.1. and 3.2.2. it can be switched on with the POWER ON/OFF switch on the front panel.
The associated POWER indicator lamp is adjacent to the POWER ON/OFF switch.

Having switched on the oscilloscope, a power-up routine is performed after which the instrument is ready for use.

With normal installation, according to Chapter 3, and after a warming-up time of 30 minutes, the characteristics according to Chapter 6 are valid.

4.1.2   Power-up routine

When switching-on the instrument, note that the internal micro-processor automatically starts a test for a number of internal circuits.

If during this 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 local PHILIPS service department.

If the system blocks during operation, it may be due to extremely high static voltages. In this event, an automatical reset of the microprocessor system is performed and the operation of the instrument is restored.

4.1.3   Default settings after switching-on.

If no back up batteries are installed and the instrument is switched on, an automatic AUTO-SET action is performed.
With back up batteries installed, the instrument settings at the moment of switching off are restored and the instrument starts up with the same setting.

4.2 EXPLANATION OF CONTROLS AND SOCKETS

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

The next front panel view shows the controls and sockets, and the functional lay-out of the various sections.
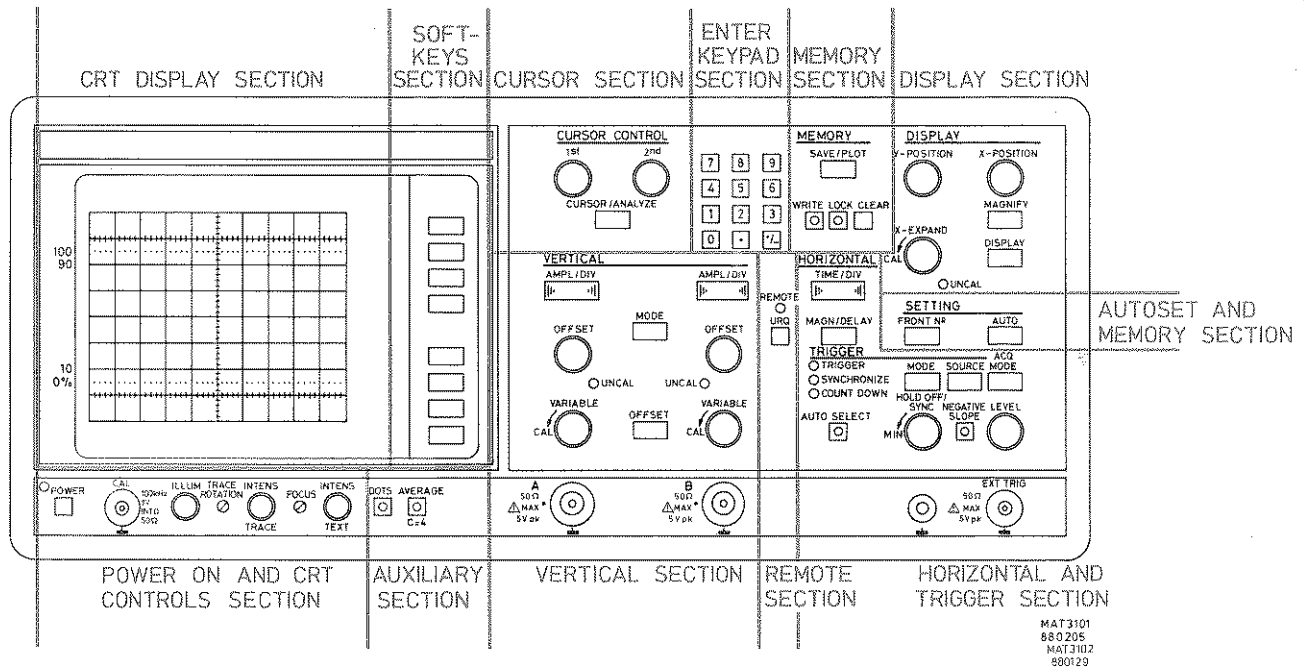
Figure 4.1 Front panel function lay-out.

Section:	See section:
SOFTKEYS SECTION	4.2.1
C.R.T. DISPLAY SECTION	4.2.2
AUTO SET SECTION	4.2.3
POWER ON & CRT CONTROLS SECTION	4.2.4
VERTICAL SECTION	4.2.5
HORIZONTAL SECTION	4.2.6
TRIGGER SECTION	4.2.7
CURSOR SECTION	4.2.8
MEMORY SECTION	4.2.9
DISPLAY SECTION	4.2.10
AUXILIARY SECTION	4.2.10
SETTING MEMORY SECTION	4.2.11
ENTER KEYPAD SECTION	4.2.12
REMOTE SECTION	4.2.12
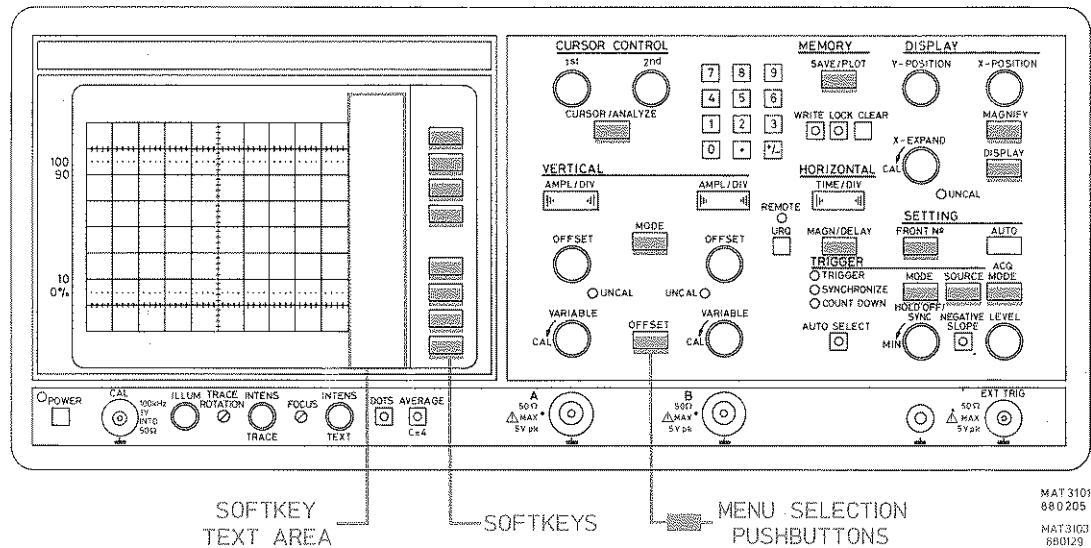
4.2.1   SOFTKEYS

Figure 4.2 Front panel view.

Eight softkeys are located directly at the right side of the C.R.T. screen.
Different functions for these softkeys can be selected with the following eleven menu selection pushbuttons:

Front panel section:	See section:	Menu selection pushbutton:	See section:
VERTICAL	4.2.5	MODE	4.2.5.1
		OFFSET	4.2.5.2
HORIZONTAL	4.2.6	AQU MODE	4.2.6.1
		MAGN/DELAY	4.2.6.2
TRIGGER	4.2.7	MODE	4.2.7.2
		SOURCE	4.2.7.3
CURSOR CONTROL	4.2.8	CURSOR/ANALYZE	4.2.8.1
MEMORY	4.2.9	SAVE/PLOT	4.2.9.1
DISPLAY	4.2.10	MAGNIFY	4.2.10.1
		DISPLAY	4.2.10.2
SETTING	4.2.11	FRONT No	4.2.11

After depressing one of the above mentioned pushbuttons, the selected softkey menu is displayed in the softkey text area on the C.R.T. screen, directly at the left side of the softkeys.
In general the selected functions are intensified displayed in this softkey text area.

When for example the frontpanel pushbutton VERTICAL MODE is depressed,
the following menu text will appear in the softkey text area.
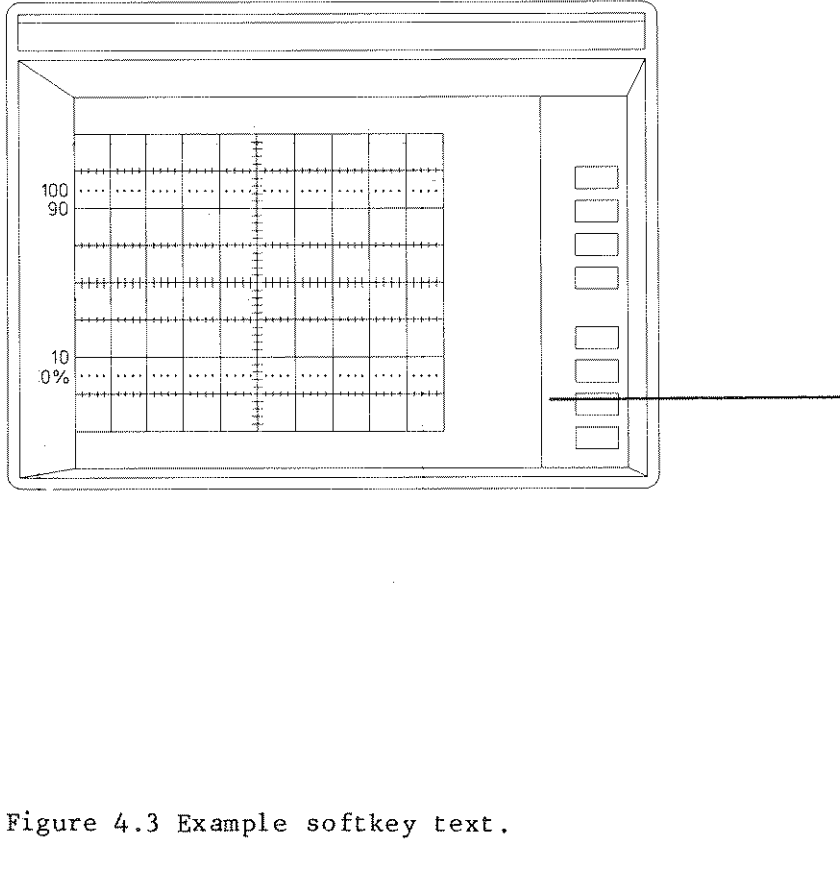
Figure 4.3 Example softkey text.

When the displayed softkey function is followed by a > , this
indicates that the relevant softkey can be used to select the next
lower function menu level.

RETURN: By depressing the softkey with the function RETURN (always
          the last softkey in the row of 8) a jump is made to the next
          higher function menu level.

STOP or
EXECUTE: For some menu's a function STOP or EXECUTE is selectable
          which gives an automatic RETURN to the next higher function
          menu level after the STOP or EXECUTE action.

For the detailed explanation of the various menu structures the
following explanation structure is used:
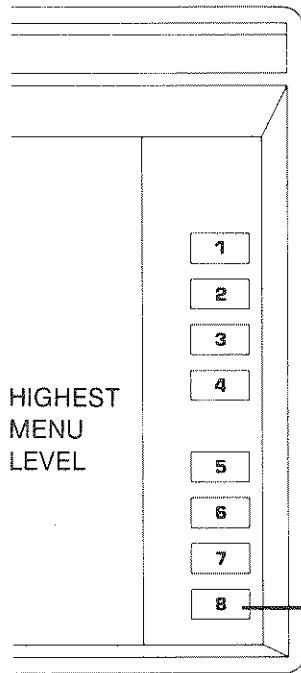
Explanation of the highest menu level which is selected
by pressing a MENU SELECTION pushbutton (see figure
4.2).
. . . .
. . . .

HIGHEST
MENU
LEVEL

1
2
3
4
5
6
7
8 ——————— (Softkey numbers)

1	Function	Explanation of the function behind softkey 1
2	Function	Explanation of the function behind softkey 2
3	Function	Explanation of the function behind softkey 3
4	Function>	(Jump to the next lower menu level)
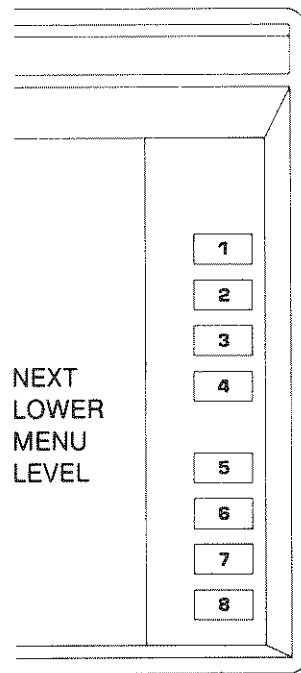
Explanation of the next lower menu level which in
this example is selected by pressing softkey
number four.
. . . .
. . . .

NEXT
LOWER
MENU
LEVEL

1
2
3
4
5
6
7
8

4	1	Function	Explanation of this function
4	2	Function	Explanation of this function
4	3	Function>	(Jump to the next lower menu level)
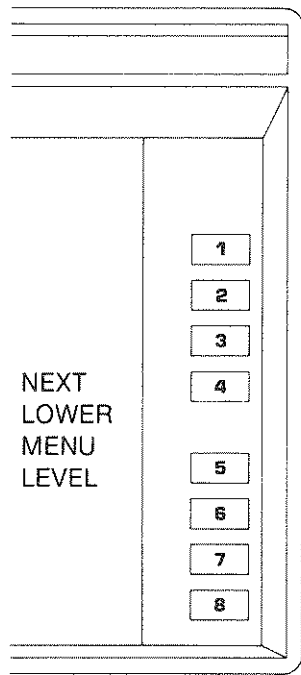
Explanation of the next lower menu level
which in this example is selected by pressing
softkey number three.
. . . .
. . . .

```
1
2
3
4

5
6
7
8
```

NEXT
LOWER
MENU
LEVEL

4	3	1	Function	Explanation
4	3	2	Function	Explanation
4	3	3	Function	Explanation
4	3	4	Function	Explanation
4	3	5	Function	Explanation
4	3	6	Function	Explanation
4	3	7	Function	Explanation
4	3	8	RETURN	Return to the next higher menu level

4	4	Function	Explanation
4	5	Function	Explanation
4	6	Function	Explanation
4	7	Function	Explanation
4	8	RETURN	Return to the highest menu level

5	Function
6	Function
7	Function
8	Function

Example:

If via the VERTICAL MODE menu the factor C=2 has to be selected for the AVERAGE mode, it can be done in the following way:

```
  ┌──────────────────────────── highest menu level
  │   ┌──────────────────────── next lower menu level
  │   │   ┌──────────────────── next lower menu level
  │   │   │
  7   4   2    C=2          (see section 4.2.5.1)
```
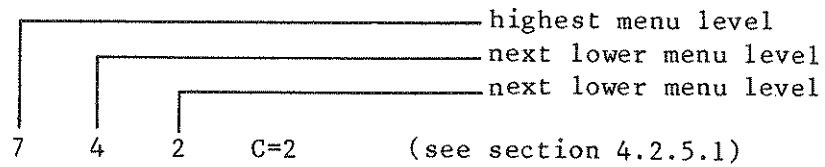
- Press frontpanel pushbutton VERTICAL MODE

- Press softkey 7 function PROCESSING>

- Press softkey 4 function AVERAGE>

- Press softkey 2 function C=2

4.2.2   Screen lay-out and text areas
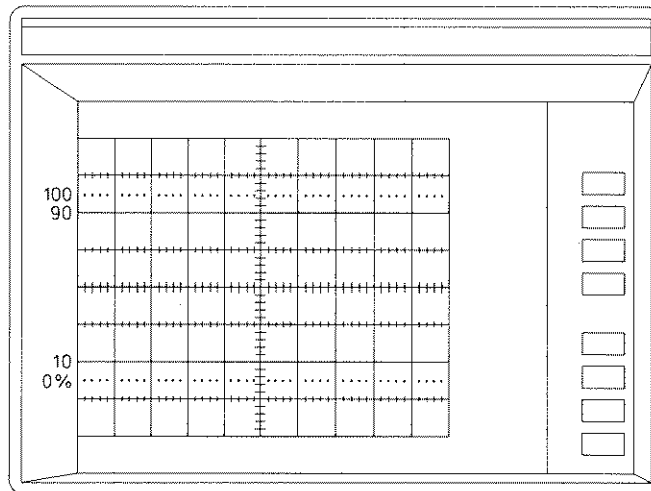
Figure 4.4 Screen lay-out.

Text areas:

ACTUAL FRONT SETTINGS AND CURSOR CALC. RESULTS IN THE TOP TEXT AREA

Channel A
input
sensitivi-
ty

Channel B
input
sensitivi-
ty

Time base
coeffi-
cient and
and mode

Trigger
delay
setting

Trigger
source
sensitivi-
ty and
h. off

Calculation
results
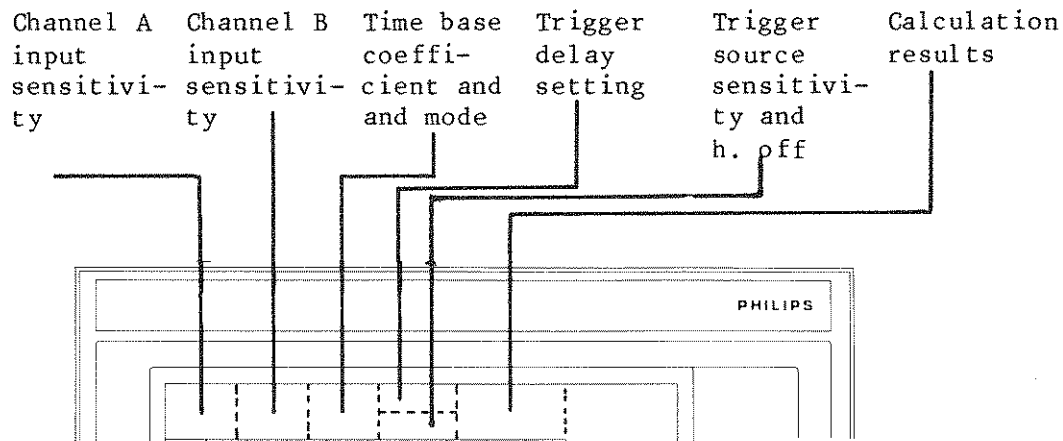
REDUCED TEXT IN THE TRACE AREA
(selectable via the DISPLAY menu if Y/5 is selected via the MAGNIFY
menu)
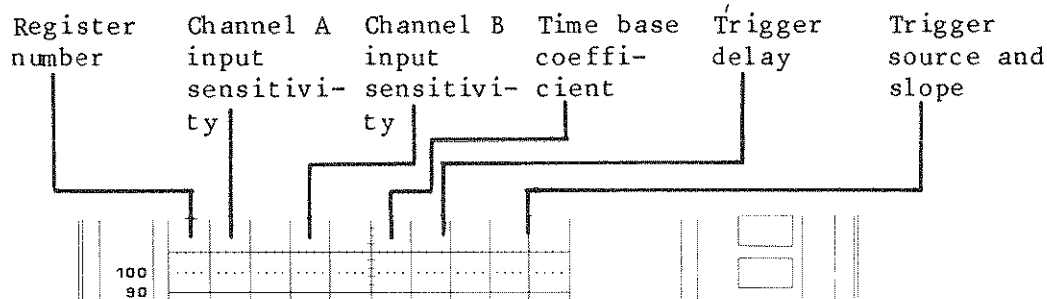
Register
number

Channel A
input
sensitivi-
ty

Channel B
input
sensitivi-
ty

Time base
coeffi-
cient

Trigger
delay

Trigger
source and
slope

FULL TEXT IN THE BOTTOM TEXT AREA
(selectable via the DISPLAY menu)

Register
number

Ch. A and
Ch. B input
sensitivi-
ty

Eye
pattern
and
offset
ch. A
and B

Time base
coeffi-
cient and
trigger,
delay

Horizontal
mode
Trigger
mode, slope
source and
sensitivity

FRONT TEXT IN THE BOTTOM TEXT AREA
(selectable via the DISPLAY menu)

Channel A
eye
pattern
and offset

Channel B
eye
pattern
and offset

Vertical
processing
mode

Trigger
mode
and slope

Trigger level
and
resolution
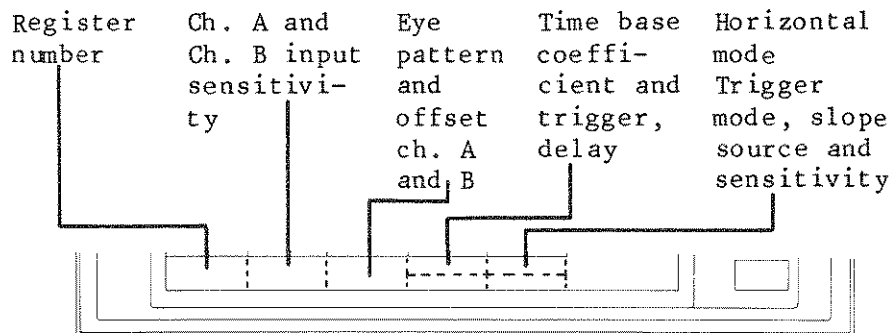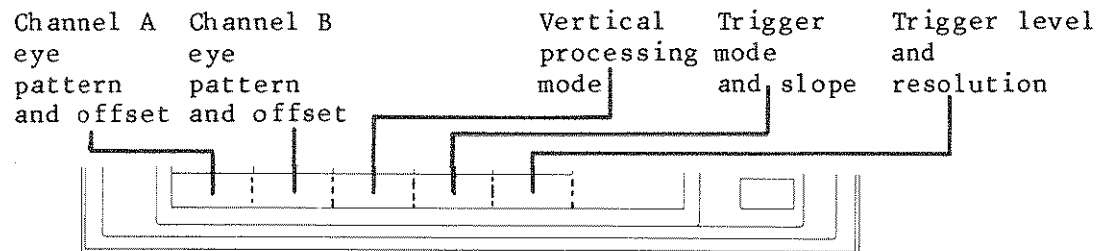
General information about screen lay out and texts:

- Activated functions are always intensified displayed.

- Only softkey functions that can be activated in the actual oscilloscope setting, are displayed.

- Only the registers that are selected for display, are visible in the softkey text area.

- A letter A and/or B can be displayed near the start of each trace on the screen for channel identification. (selectable via the DISPLAY menu).

- ~ indicates lower accuracy for this function; is also indicated by pilot lamps
  / indicates positive trigger slope selection
  \ indicates negative trigger slope selection

Example:
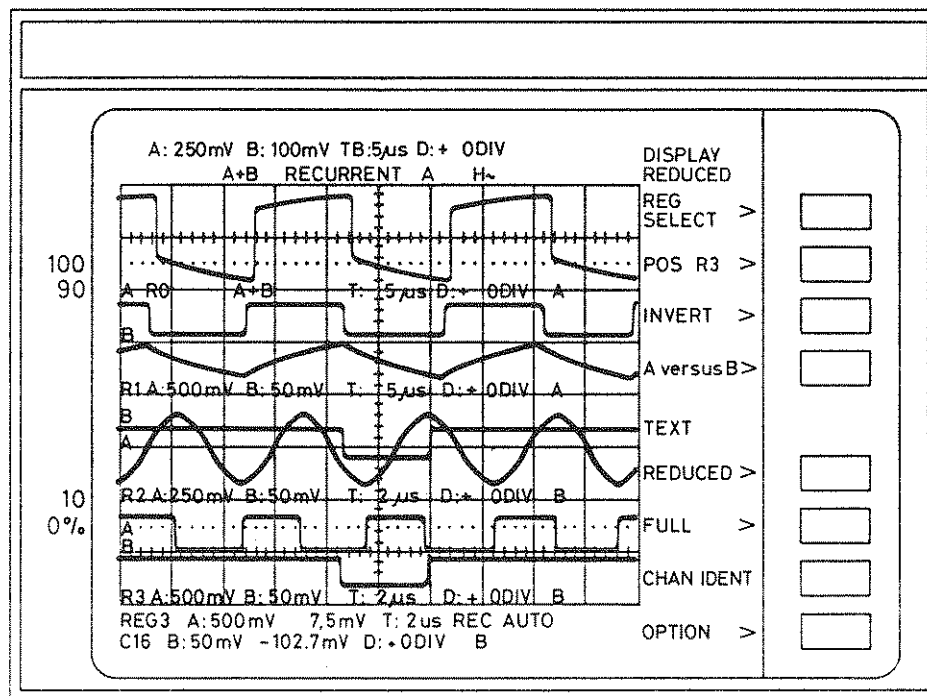
Figure 4.5 Example screen lay-out.

4.2.3   AUTO SET
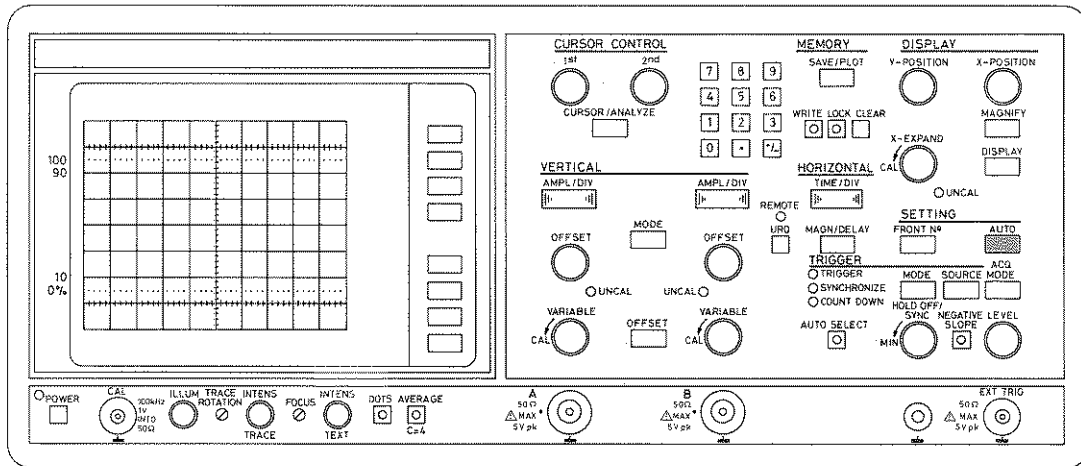
Figure 4.6 Front panel view.

AUTO   If AUTO is pushed, a number of functions are
                    preselected. Some of these functions are selected
                    in relation to the applied input signals.

                    During the AUTO SET action, a message

                    * * * * * AUTO SET BUSY * * * * * *
                     * * * * * * * * * * * * * * * * *

                    is displayed.

                    Settings are such, that the contents of register
                    R0 are displayed over the full C.R.T. screen.

                    The input signals will be displayed as triggered
                    signals of a few periods and with an amplitude of
                    a few divisions.

                    Details about AUTO SETTING are given in section
                    6.10 of the CHARACTERISTICS.

                    In LOCK mode a message

                    No AUTO SET possible in LOCK mode.

                    is displayed.

4.2.4. C.R.T. section
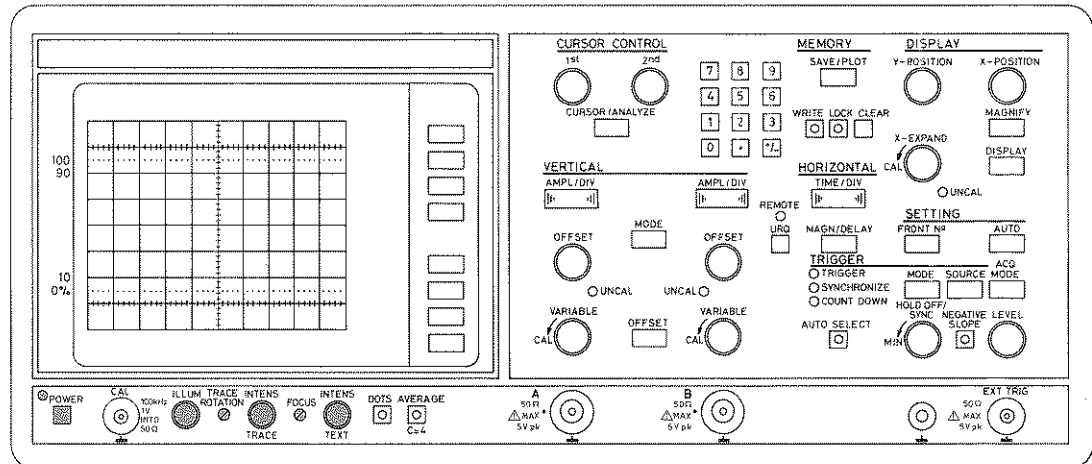

```
MAT310 MAT3106
880205  880129
```

Figure 4.7 Front panel view.

POWER ON	POWER ON/OFF switch
OFF	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.
ILLUM	Continuously-variable control of the graticule illumination.
TRACE ROTATION	Screwdriver control for aligning the trace in parallel with the horizontal graticule lines.
INTENS TRACE	Continuously-variable control of the trace brilliance on the C.R.T. screen.
FOCUS	Screwdriver control for the focussing of the C.R.T. electron beam (including the C.R.T. text).
INTENS TEXT	Continuously-variable control of the brilliance of the C.R.T. text (control settings, cursors, softkey functions and messages).

4.2.5.   VERTICAL SECTION AND MENU STRUCTURE
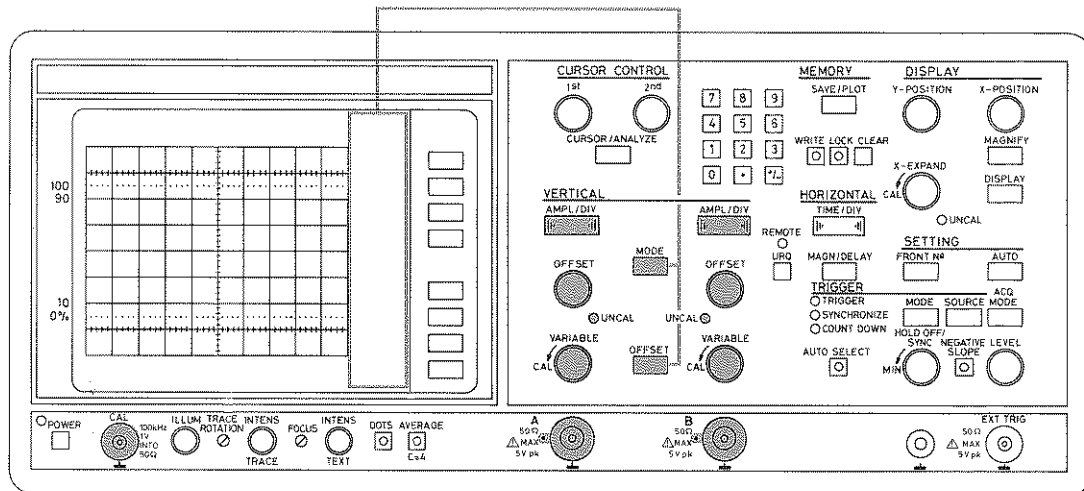
MAT3101MAT3107
880205 880129

Figure 4.8. Front panel view.

AMPL/DIV   This UP/DOWN control permits selection of the
                       vertical deflection coefficients of the relevant
                       channel in 8 steps from 1 mV/div...200 mV/div in a
                       1-2-5 sequence.
                       The selected vertical deflection coefficient for
                       the relevant channel is displayed in the top text
                       area of the C.R.T. screen.

                       If the left side of the UP/DOWN control (V) is
                       pushed, the amplitude of the signal on the screen
                       decreases. This means that the AMPL/DIV value
                       becomes bigger (e.g. the attenuator jumps from 2
                       mV/div to 5 mV/div).
                       If the right side of the UP/DOWN control (mV) is
                       pushed, the amplitude of the signal on the screen
                       increases. This means that the AMPL/DIV value
                       becomes smaller (e.g. the attenuator jumps for 5
                       mV/div to 2 mV/div)

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

                       The adjusting speed increases after turning
                       continuously in one direction. After stopping,
                       starting in the reverse direction resumes with a
                       slow adjusting speed.

UNCAL	Pilot lamp indicating lower accuracy for the relevant vertical deflection coefficients. If the VARIABLE control of the relevant channel is turned fully clockwise, the UNCAL pilot lamp is switched off.
OFFSET	Continuously variable control giving vertical input offset of the trace of the relevant channel.
	The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.
A(B)	N input socket for the channel with probe indication detector. Input impedance 50 ohm. Maximum safe input voltage: 5 V peak.
CAL	BNC output socket for a square-wave calibration signal with an amplitude of 1 Vp-p and a frequency of 100 kHz. The output voltage is 1 V if the output is terminated in 50 ohm. When the output is short-circuited, the output current is 20 mA p-p. The zero line of the square-wave signal is on the base-line level.
MODE	If pushbutton MODE is pushed, the VERTICAL MODE menu is displayed. See 4.2.5.1.
OFFSET	If pushbutton OFFSET is pushed, the VERTICAL OFFSET menu is displayed. See 4.2.5.2. This offset is introduced before the sampling gate, attenuation stages and memory. The offset can also be influenced via menu key OFFSET. If the offset-value is out of range, this is indicated with the warning: A-OFFSET OUT OF RANGE or B-OFFSET OUT OF RANGE

4.2.5.1. VERTICAL MODE MENU STRUCTURE

VERTICAL
MODE

VERTICAL
MODE

VERTICAL MODE	
A	1
A and B	2
ADD	3
B	4
A-INVERT	5
B-INVERT	6
PROCESSING>	7
---	8

VERTICAL PROCESSING	
EYE PATTRN	1
--	2
AVERG OFF.	3
AVERAGE >	4
C=.. M=..	
MULT SAMPL>	5
M SAMP OFF	6
ABS MINMAX>	7
RETURN	8

VERTICAL AVERAGE	
OFF	1
C = 2	2
C = 4	3
C = 8	4
C = 16	5
C = 32	6
C = 64	7
RETURN	8

VERTICAL ABS MIN/MAX	
--	1
R1	2
R2	3
R3	4
--	5
START STOP	6
AUTO ERASE	7
RETURN	8

VERTICAL MULT SAMPL	
OFF	1
M = 2	2
M = 4	3
M = 8	4
M = 16	5
M = 32	6
--	7
RETURN	8

Figure 4.9 Vertical mode menu structure.

VERTICAL MODE MENU
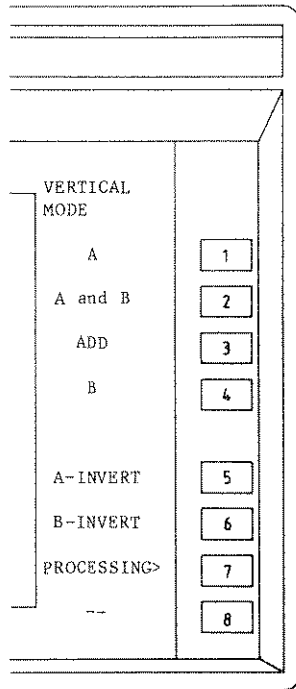
After selection of the VERTICAL MODE menu by depressing pushbutton VERTICAL MODE, various modes related to the signal acquisition can be selected.

```
VERTICAL
MODE

   A            [ 1 ]

 A and B        [ 2 ]

  ADD           [ 3 ]

   B            [ 4 ]


A-INVERT        [ 5 ]

B-INVERT        [ 6 ]

PROCESSING>     [ 7 ]

   --           [ 8 ]
```

1   A

Pushing softkey A gives signal input from channel A only, indicated by an intensified text A.
If softkey A is pushed and function A and B was operative, in A versus B - mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

and channel A will be selected.

2   A and B

Pushing softkey A and B gives signal input from both channels A and B, indicated by an intensified text A and B.

3   ADD

Pushing softkey ADD gives signal input from channel A and channel B and the algebraic sum of A and B is recorded in the memory, indicated by an intensified text ADD.
If softkey ADD is pushed and A and B was operative, in A versus B -mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

and ADD will be selected.

4   B

Pushing softkey B gives signal input from channel B only,
indicated by an intensified text B.
If softkey B is pushed and A and B was operative, in A versus B -
mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

and channel B will be selected.

5   A-INVERT

6   B-INVERT

After pushing the relevant INVERT softkey the signal of the
relevant channel is inverted before it is digitized and recorded
in the memory. The text A-INVERT or B-INVERT is then intensified
displayed.

7   PROCESSING>

VERTICAL PROCESSING	
EYE PATTRN	1
--	2
AVERG OFF	3
AVERAGE >	4
C=.. M=..	
MULT SAMPL>	5
M SAMP OFF	6
ABS MINMAX>	7
RETURN	8

After selecting PROCESSING>, the VERTICAL
PROCESSING menu is displayed and input signal
processing can be selected.
The text AVERG OFF is only visible if average is
selected.
The text M SAMP OFF is only visible if the
multiple sampling mode is selected.

7   1   EYE PAT

In this mode, the feedback loop of the sampling system of
channel A and B (refer to chapter 4.4, principle of
operation) is switched off so that eye pattern signals can
be displayed with a minimum of distortion. In EYE PATTERN
mode, the acquisition works with a high resolution of 4096
measured points. This instead of 512 measured points, while
the remaining points are obtained by means of calculation.
A register containing a signal that is obtained in EYE
PATTERN mode cannot be expanded via the horizontal expansion
mode under pushbutton MAGNIFY. However expansion is still
possible with the continuous variable control X-EXPAND.
However under other circumstances this mode must be off in
order to obtain the highest stability and dynamic range. If
you select EYE PATTERN mode with AVERAGE or MULTIPLE
SAMPLING mode on, the following message is displayed:

Eye pattern selected:
Average and Multiple sampling switched off!!!!

7   2   --

7   3   AVERG OFF

After pushing softkey AVERG OFF, AVERAGE is switched off.
This function is only displayed when AVERAGE is selected.

7   4   AVERAGE>

```
┌────────────────────┐
│═══════════════════ │
│                    │
│═══════════════════ │
│                   /│
│                  / │
│  VERTICAL         │
│  AVERAGE          │
│                   │
│    OFF     ┌───┐  │
│            │ 1 │  │
│   C = 2    ┌───┐  │
│            │ 2 │  │
│   C = 4    ┌───┐  │
│            │ 3 │  │
│   C = 8    ┌───┐  │
│            │ 4 │  │
│                   │
│   C = 16   ┌───┐  │
│            │ 5 │  │
│   C = 32   ┌───┐  │
│            │ 6 │  │
│   C = 64   ┌───┐  │
│            │ 7 │  │
│  RETURN    ┌───┐  │
│            │ 8 │  │
└────────────────────┘
```

After selecting AVERAGE, the VERTICAL AVERAGE
menu is displayed and the average function
can be selected. (See also section 4.3.12).
As long as average is operative, this is
indicated by an intensified text C= .. in the
VERTICAL PROCESSING menu.
If AVERAGE is not operative, it is indicated
by an intensified text C=OF in the VERTICAL
PROCESSING menu.
AVERAGE is not possible in combination with
eye pattern mode and low resolution mode. If
you select AVERAGE while one of these two
modes is already functioning, the following
message is displayed.

AVERAGE is not possible with EYE PATTERN mode
and/or LOW RESOLUTION mode. If you select
AVERAGE while one of these two modes is
already functioning, the following message is
displayed:

Averaging selected:
Eye pattern and/or low resolution off.

7   4   1   OFF

Softkey OFF must be pushed to switch the AVERAGE
function off.

7   4   2   C=2

7   4   3   C=4

7   4   4   C=8

7   4   5   C=16

7   4   6   C=32

7   4   7   C=64

Different calculation constants between C=2 and C=64
can be selected.
The bigger the value of C is, the stronger the AVERAGE
effect is. A direct selection of C=4 is also possible
via the front panel pushbutton AVERAGE C=4.
For more detailed information see chapter 4.3.12.

7   4   8   RETURN

After pushing softkey RETURN, the VERTICAL PROCESSING
menu is displayed again and the average selection (the
value of C) remains as selected before.

7   5   MULT SAMPL >

```
VERTICAL
MULT SAMPL

   OFF        | 1 |

   M = 2      | 2 |

   M = 4      | 3 |

   M = 8      | 4 |


   M = 16     | 5 |

   M = 32     | 6 |

   --         | 7 |

   RETURN     | 8 |
```
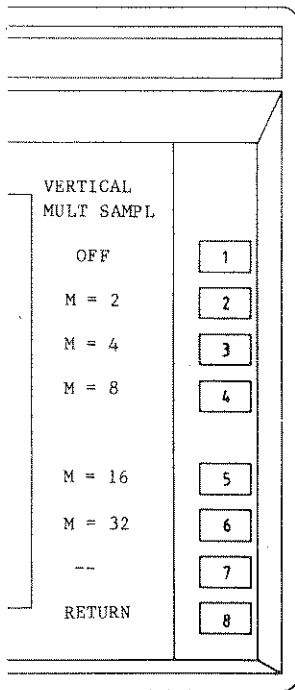
After having selected MULT SAMPL the vertical MULTIPLE
SAMPLING mode is active. In this mode you can select via
softkeys the figure M = 2, 4, 8, 16 or 32. This figure
represents the number of samples that is taken before one of
the 512 points is displayed on the screen. If you select M=4
four samples are taken of which the last one is displayed.
This mode reduces distortion of fast slopes; but the time to
capture a waveform increases with the M-value. The higher
the M-figure, the lower the distortion. As long as MULTIPLE
SAMPLING is operative, this is indicated by an intensified
text M= ... in the VERTICAL PROCESSING MENU.
If MULTIPLE SAMPLING is not operative, this is indicated by
an intensified text M=OF.
MULTIPLE SAMPLING is not possible in combination with EYE
PATTERN mode. If you select MULTIPLE SAMPLING while EYE
PATTERN mode is operative, the following message is
displayed:

Multiple sampling selected:
Eye pattern switched off!!!!

7   5   1   OFF

Softkey OFF must be pushed to switch the MULTIPLE
SAMPLING mode off.

7   5   2   M = 2

7   5   3   M = 4

7   5   4   M = 8

7   5   5   M = 16

7   5   6   M = 32

7   5   7   --

7   5   8   RETURN

After pushing RETURN, the VERTICAL PROCESSING menu is
displayed again and the selections previously made
remain active.

7   6   M SAMP OFF

After pushing softkey M SAMP OFF, the MULTIPLE SAMPLING MODE
is switched off.
This function is only displayed when MULTIPLE SAMPLING is
selected.

7   7   ABS MINMAX

VERTICAL
ABS MIN/MAX

--   [1]

R1   [2]

R2   [3]

R3   [4]

--   [5]

START STOP [6]

AUTO ERASE [7]

RETURN   [8]
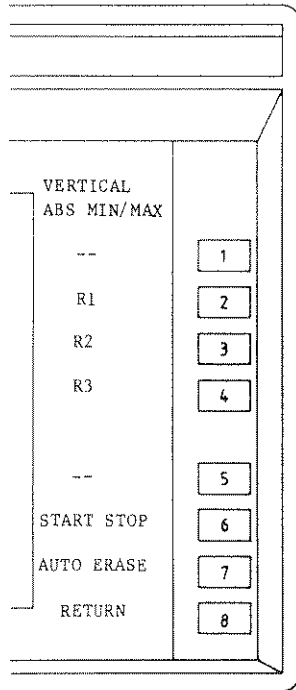
After selecting ABS MINMAX the ABSOLUTE
MINMAX menu is displayed and the ABS MINMAX
function can be selected.
The ABS MINMAX function stores in the even
addresses of a selected trace register the
maximum values over a number of sweeps.
In the odd addresses the minimum values over
a number of sweeps are stored.
So the register controls shows the limits in
a vertical sense between which the input
signal varies.

7	7	1	--
7	7	2	R1
7	7	3	R2
7	7	4	R3

With these softkeys the register can be selected in which the ABS MINMAX function is performed.

7	7	5	--
7	7	6	START STOP

The ABS MINMAX function can be activated or stopped with this softkey. The selected function is displayed intensified.

7	7	7	AUTO ERASE

The AUTO ERASE function clears the result of the ABS MINMAX function in the selected register after 10 seconds or after 100 sweeps, depending on whichever comes last.
If the function is active, the function is diplayed intensified. Pushing the softkey again switches the function off.

7	7	8	RETURN

After pushing softkey RETURN, the VERTICAL PROCESSING menu is displayed again.

7	8	RETURN

After pushing RETURN, the VERTICAL MODE menu is displayed again and the selections previously selected remain.

8	--

4.2.5.2. VERTICAL OFFSET MENU STRUCTURE
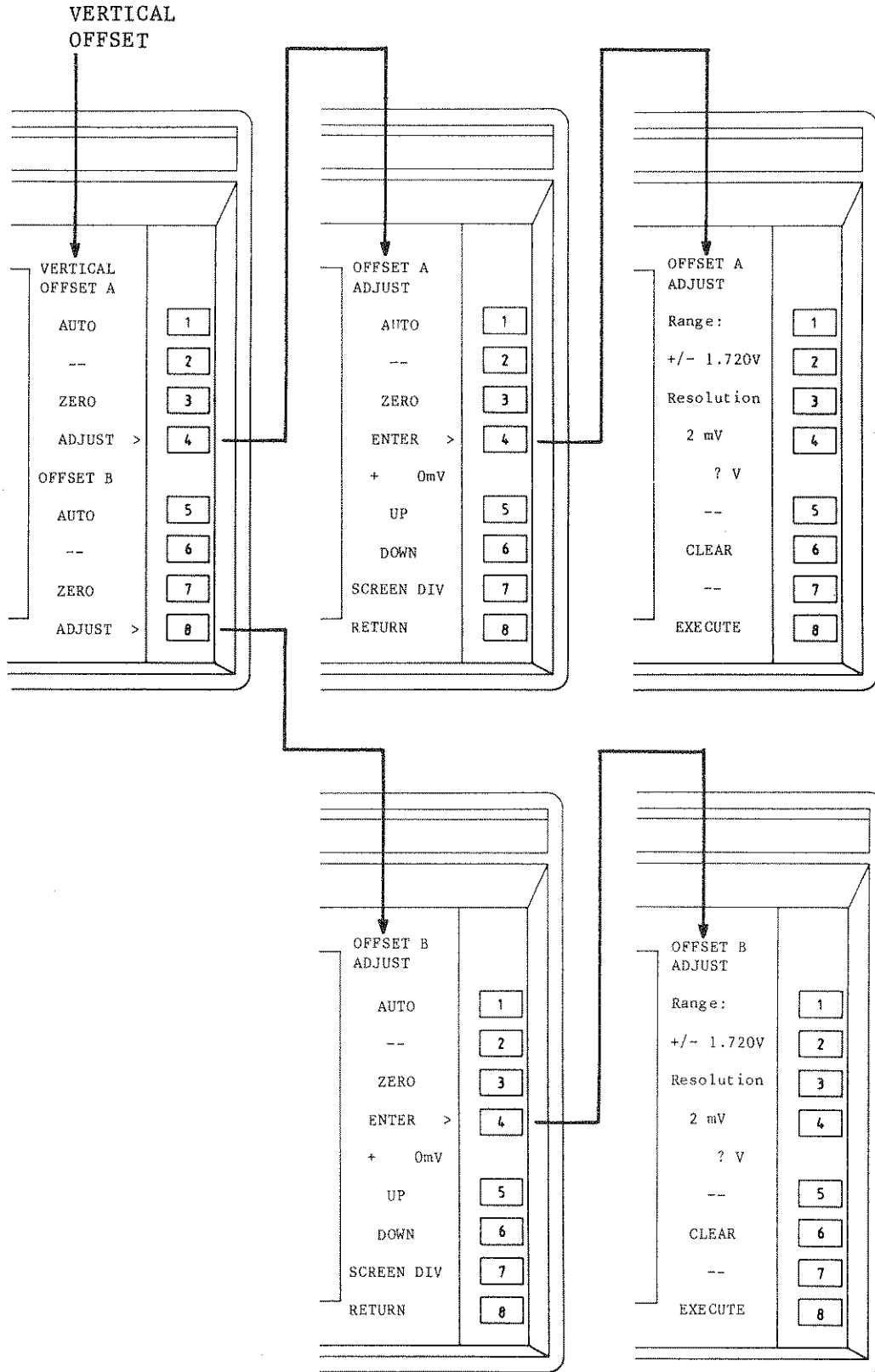
Figure 4.10 Vertical offset menu structure.

VERTICAL OFFSET MENU

```
VERTICAL
OFFSET A

AUTO        [ 1 ]

--          [ 2 ]

ZERO        [ 3 ]

ADJUST  >   [ 4 ]

OFFSET B

AUTO        [ 5 ]

--          [ 6 ]

ZERO        [ 7 ]

ADJUST  >   [ 8 ]
```
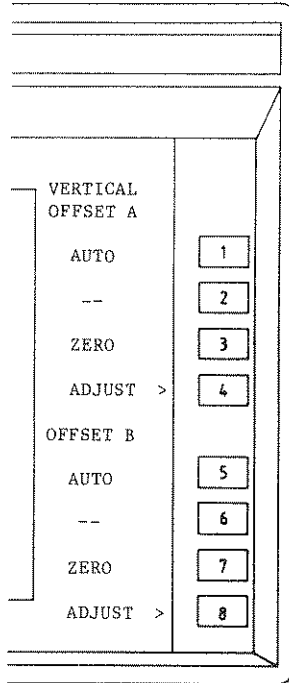
After pressing pushbutton VERTICAL OFFSET, the VERTICAL
OFFSET menu for channel A and channel B is displayed
and the input offset for these channels can be selected.
This offset via the softkeys has the same effect as the
rotary control OFFSET and is also introduced before the
sampling gate, attenuators and memory. The offset
adjustment via the softkeys is in steps while the
rotary gives a continuous adjustment possibility. If
the adjusted offset-value is out of range, this is
indicated with the warning:

A-OFFSET out of range   or
B-OFFSET out of range

1   AUTO

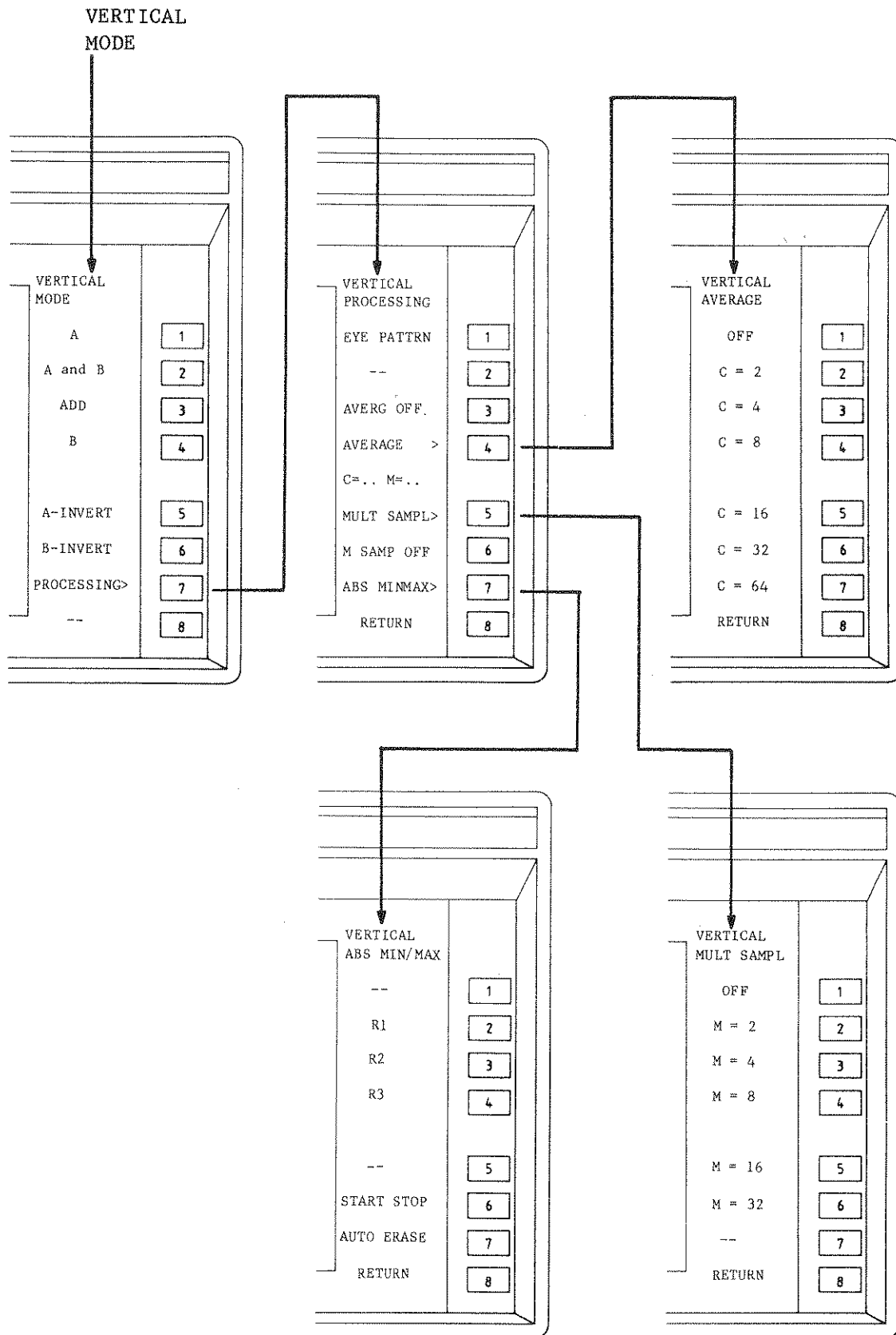With softkey AUTO, the offset value of channel A is set to such a
level, that the mid-value of the input signal is shifted as much
as possible to mid-memory.

A message

* * * AUTO OFFSET FOR CHANNEL A * * *
 * * * * * * * * * * * * * * * * * *

is displayed.

The new offset value is displayed in the softkey text area.
The VERTICAL SHIFT is set to zero.

A message

AUTO OFFSET error : signal offset out of range

is displayed if the input signal is exceeding the offset control
range. In this case the original offset value is restored.

2   --

3   ZERO

With softkey ZERO, the offset value of channel A is set to zero.

4   ADJUST> (channel A)

```
┌─────────────────────────┐
│                         │
│ ═══════════════════════ │
│                         │
│ ┌─────────────────────┐ │
│ │ OFFSET A            │ │
│ │ ADJUST              │ │
│ │                     │ │
│ │    AUTO      [ 1 ]  │ │
│ │                     │ │
│ │    --        [ 2 ]  │ │
│ │                     │ │
│ │    ZERO      [ 3 ]  │ │
│ │                     │ │
│ │   ENTER  >   [ 4 ]  │ │
│ │                     │ │
│ │    +   0mV          │ │
│ │                     │ │
│ │    UP        [ 5 ]  │ │
│ │                     │ │
│ │   DOWN       [ 6 ]  │ │
│ │                     │ │
│ │ SCREEN DIV   [ 7 ]  │ │
│ │                     │ │
│ │  RETURN      [ 8 ]  │ │
│ └─────────────────────┘ │
└─────────────────────────┘
```
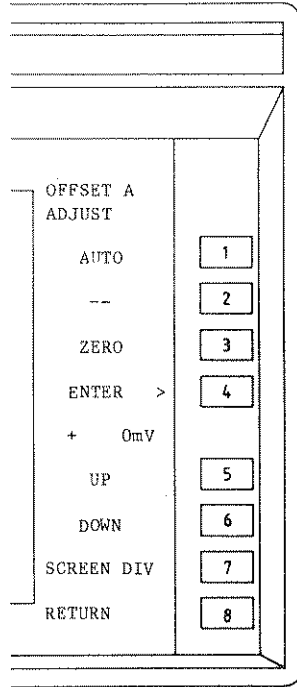
If ADJUST is selected the OFFSET A ADJUST menu
is displayed and an offset (vertical shift before
sampling gate) value can be selected.

The selected offset value is displayed in the
softkey menu.

4   1   AUTO

For description refer to AUTO softkey description given
under 1.

4   2   --

4   3   ZERO

With softkey ZERO, the offset value is set to zero.

4   4   ENTER>
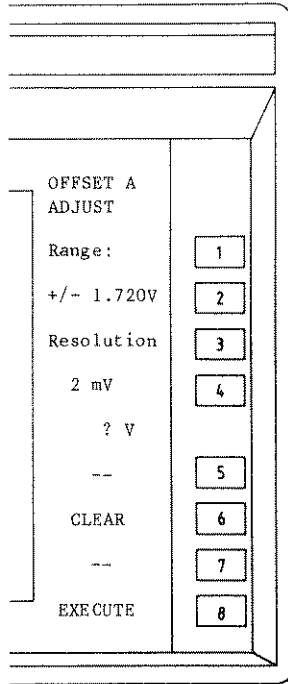
```
┌─────────────────────┐
│ ════════════════    │
│ ────────────────    │
│                  ┌──┐│
│ OFFSET A         │  ││
│ ADJUST           │  ││
│                ┌───┐ │
│ Range:         │ 1 │ │
│                └───┘ │
│ +/- 1.720V     ┌───┐ │
│                │ 2 │ │
│ Resolution     └───┘ │
│                ┌───┐ │
│ 2 mV           │ 3 │ │
│                └───┘ │
│    ? V         ┌───┐ │
│                │ 4 │ │
│                └───┘ │
│    --          ┌───┐ │
│                │ 5 │ │
│ CLEAR          └───┘ │
│                ┌───┐ │
│    --          │ 6 │ │
│                └───┘ │
│ EXECUTE        ┌───┐ │
│                │ 7 │ │
│                └───┘ │
│                ┌───┐ │
│                │ 8 │ │
│                └───┘ │
└─────────────────────┘
```

After selecting ENTER, the ENTER menu will be
displayed and the offset can be selected with the
numeric keypad.
The range in Volts is indicated and the selected
value is rounded off and made visisble in the
softkey text area.

A message

Too many digits: total entry is cleared

can be displayed if too many digits are entered on
the numeric keyboard.

4   4   1   --

4   4   2   --

4   4   3   --

4   4   4   --

4   4   5   --

4   4   6   CLEAR

If an error is made, the selected offset value can be
cleared after pushing softkey CLEAR.

4   4   7   --

4   4   8   EXECUTE

After pushing this softkey, the selected offset value
is entered and an AUTO RETURN is performed to menu
OFFSET A ADJUST.
If EXECUTE is pressed after CLEAR the previous value
remains (in the OFFSET A ADJUST menu).

A message

A- OFFSET out of range.

can be displayed if the entered value exceeds the given
range.

4   5   UP

Pushing softkey UP gives a more positive or less negative
offset to the signal. The amount depends on the attenuator
setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is added
to the existing offset after each push of the UP softkey.
If SCREEN is selected (SCREEN intensified) a full screen of
10 divisions is added to the existing offset after each push
of the UP softkey.
The result is displayed in volts, but the voltage is
recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 1.025 V,
then 1.045 V etc. if the attenuator has been set to 20
mV/div (200 mV for a full screen).

4   6   DOWN

Pushing softkey DOWN gives a less positive or more negative
offset to the signal. The amount depends on the attenuator
setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is
subtracted from the existing offset after each push of the
DOWN softkey.
If SCREEN is selected (SCREEN intensified) a full screen of
10 divisions is subtracted from the existing offset after
each push of the DOWN softkey.
The result is displayed in volts, but the voltage is
recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 985 mV,
then 965 mV etc. if the attenuator has been set to 20
mV/div. (200 mV for a full screen).

4   7   SCREEN DIV

With this softkey, a selection can be made between an offset
change in divisions or in screens (10 divisions) when the
softkeys UP or DOWN are operated.
Pushing this softkey changes the selection from SCREEN to
DIV or reverse. The active selection is displayed
intensified.

4   8   RETURN

> After pushing softkey RETURN, menu VERTICAL OFFSET A is
> displayed again.
> The selections as made before remain.

5   AUTO

With softkey AUTO, the offset value of channel B is set to such a
level, that the mid-value of the input signal is shifted as much
as possible to mid-memory.

A message

* * * AUTO OFFSET FOR CHANNEL B * * *
 * * * * * * * * * * * * * * * * *

is displayed.

The new offset value is displayed in the softkey text area.
The VERTICAL SHIFT is set to zero.

A message

AUTO OFFSET error : signal offset out of range

is displayed if the input signal is exceeding the offset control
range. In this case the original offset value is restored.

6   --

7   ZERO

With softkey ZERO, the offset value of channel A is set to zero.

8   ADJUST> (channel B)

```
┌─────────────────┐
│═════════════════│
│═════════════════│
│                 │
│ OFFSET B        │
│ ADJUST          │
│                 │
│   AUTO    ┌───┐ │
│           │ 1 │ │
│   --      ┌───┐ │
│           │ 2 │ │
│   ZERO    ┌───┐ │
│           │ 3 │ │
│  ENTER  > ┌───┐ │
│           │ 4 │ │
│   +   0mV       │
│   UP      ┌───┐ │
│           │ 5 │ │
│  DOWN     ┌───┐ │
│           │ 6 │ │
│ SCREEN DIV┌───┐ │
│           │ 7 │ │
│  RETURN   ┌───┐ │
│           │ 8 │ │
└─────────────────┘
```
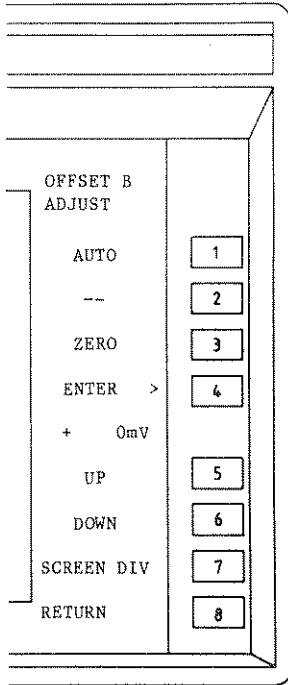
If ADJUST is selected, the OFFSET B ADJUST menu is displayed and an offset (vertical shift before sampling gate) value can be selected.

The selected offset value is displayed in the softkey menu.

8   1   AUTO

For description refer to AUTO softkey description given under 5.

8   2   --

8   3   ZERO

With softkey ZERO, the offset value is set to zero.

8   4   ENTER>
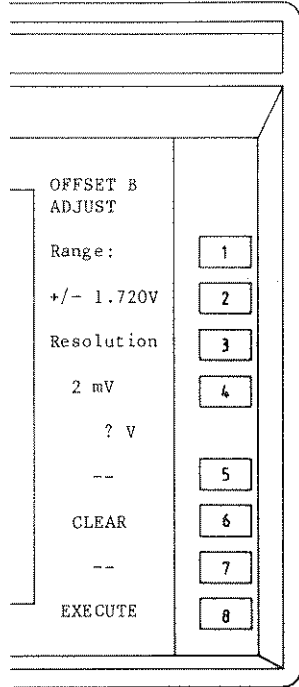
```
┌─────────────────────────┐
│ ═══════════════════════ │
│ ═══════════════════════ │
│ ─────────────────────── │
│                         │
│ OFFSET B                │
│ ADJUST                  │
│                         │
│ Range:          ┌───┐   │
│                 │ 1 │   │
│ +/- 1.720V      └───┘   │
│                 ┌───┐   │
│ Resolution      │ 2 │   │
│                 └───┘   │
│                 ┌───┐   │
│                 │ 3 │   │
│ 2 mV            └───┘   │
│                 ┌───┐   │
│     ? V         │ 4 │   │
│                 └───┘   │
│                         │
│                 ┌───┐   │
│     --          │ 5 │   │
│                 └───┘   │
│                 ┌───┐   │
│ CLEAR           │ 6 │   │
│                 └───┘   │
│                 ┌───┐   │
│     --          │ 7 │   │
│                 └───┘   │
│                 ┌───┐   │
│ EXECUTE         │ 8 │   │
│                 └───┘   │
└─────────────────────────┘
```

After selecting ENTER, the ENTER menu will be displayed and the offset can be selected with the numeric keypad.
The range in Volts is indicated and the selected value is rounded off and made visible in the softkey text area.

A message

Too many digits: total entry is cleared.

can be displayed if too many digits are entered on the numeric keyboard.

8   4   1   --

8   4   2   --

8   4   3   --

8   4   4   --

8   4   5   --

8   4   6   CLEAR

If an error is made, the selected offset value can be cleared after pushing softkey CLEAR.

8   4   7   --

8   4   8   EXECUTE

After pushing this softkey, the selected offset value is entered and an AUTO RETURN is performed to menu OFFSET B ADJUST.
If EXECUTE is pressed after CLEAR the previous value remains (in the OFFSET B ADJUST menu).

A message

B- OFFSET out of range.

can be displayed if the entered value exceeds the given range.

8   5   UP

Pushing softkey UP gives a more positive or less negative
offset to the signal. The amount depends on the attenuator
setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is added
to the existing offset after each push of the UP softkey.
If SCREEN is selected (SCREEN intensified) a full screen of
10 divisions is added to the existing offset after each push
of the UP softkey.
The result is displayed in volts, but the voltage is
recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 1.025 V,
then 1.045 V etc. if the attenuator has been set to 20
mV/div (200 mV for a full screen).

8   6   DOWN

Pushing softkey DOWN gives a less positive or more negative
offset to the signal. The amount depends on the attenuator
setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is
subtracted from the existing offset after each push of the
DOWN softkey.
If SCREEN is selected (SCREEN intensified) a full screen of
10 divisions is subtracted from the existing offset after
each push of the DOWN softkey.
The result is displayed in volts, but the voltage is
recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 985 mV,
then 965 mV etc. if the attenuator has been set to 20
mV/div. (200 mV for a full screen).

8   7   SCREEN DIV

With this softkey, a selection can be made between an offset
change in divisions or in screens (10 divisions) when the
softkeys UP or DOWN are operated.
Pushing this softkey changes the selection from SCREEN to
DIV or reverse. The active selection is displayed
intensified.

8   8   RETURN

After pushing softkey RETURN, menu VERTICAL OFFSET B is
displayed again.
The selections as made before remain.

4.2.6.HORIZONTAL SECTION AND MENU STRUCTURE
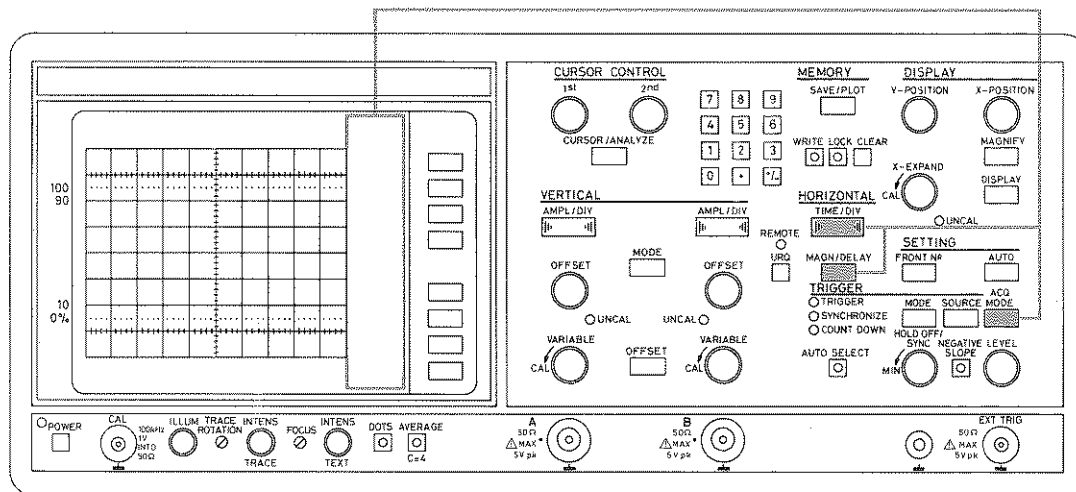
MAT3101 MAT3106
880205 880129

Figure 4.11 Front panel view.

TIME/DIV — This switch permits selection of the horizontal deflection coefficients of the time base in 14 steps from 1 ns/div ... 20 us/div. in a 1-2-5 sequence.

The selected horizontal deflection coefficient is displayed in the upper text area of the C.R.T. screen.

If the left side of the UP/DOWN control(s) is pushed, more signal periods will be displayed. This means that the TIME/DIV value becomes bigger (e.g. the time-base jumps from 2 ns/div to 5 ns/div).
If the right side of the UP/DOWN control (ns) is pushed fewer signal periods will be displayed. This means that the TIME/DIV value becomes smaller (e.g. the time-base jumps from 5 ns/div to 2 ns/div).

ACQ MODE — If pushbutton ACQuisition MODE is pushed, the HORIZONTAL MODE menu is displayed. See 4.2.6.1.

MAGN/DELAY — If pushbutton MAGN/DELAY is pushed the combined magnifier and delay menu is displayed. See 4.2.6.2.

4.2.6.1. HORIZONTAL MODE MENU STRUCTURE

HORIZONTAL
ACQ MODE

ACQ
MODE

RECURRENT	1
MULT. ARMD	2
SING. ARMD	3
MULT EYE	4
... SAMPL.	
UP	5
DOWN	6
DIFFERENCE>	7
FAST DISPL	8

DIFFERENCE
MODE

SAVE STOP	1
OFF	2
SAVE:Rn>	3
REFERENCE>	4
--	5
START STOP	6
--	7
RETURN	8

DIFFERENCE
SAVE TO:

--	1
R1	2
R2	3
R3	4
--	5
--	6
--	7
RETURN	8

DIFFERENCE
REFERENCE

RESTORE	1
R1	2
R2	3
R3	4
ADJUST GAP	
UP	5
DOWN	6
AMP TIME	7
RETURN	8
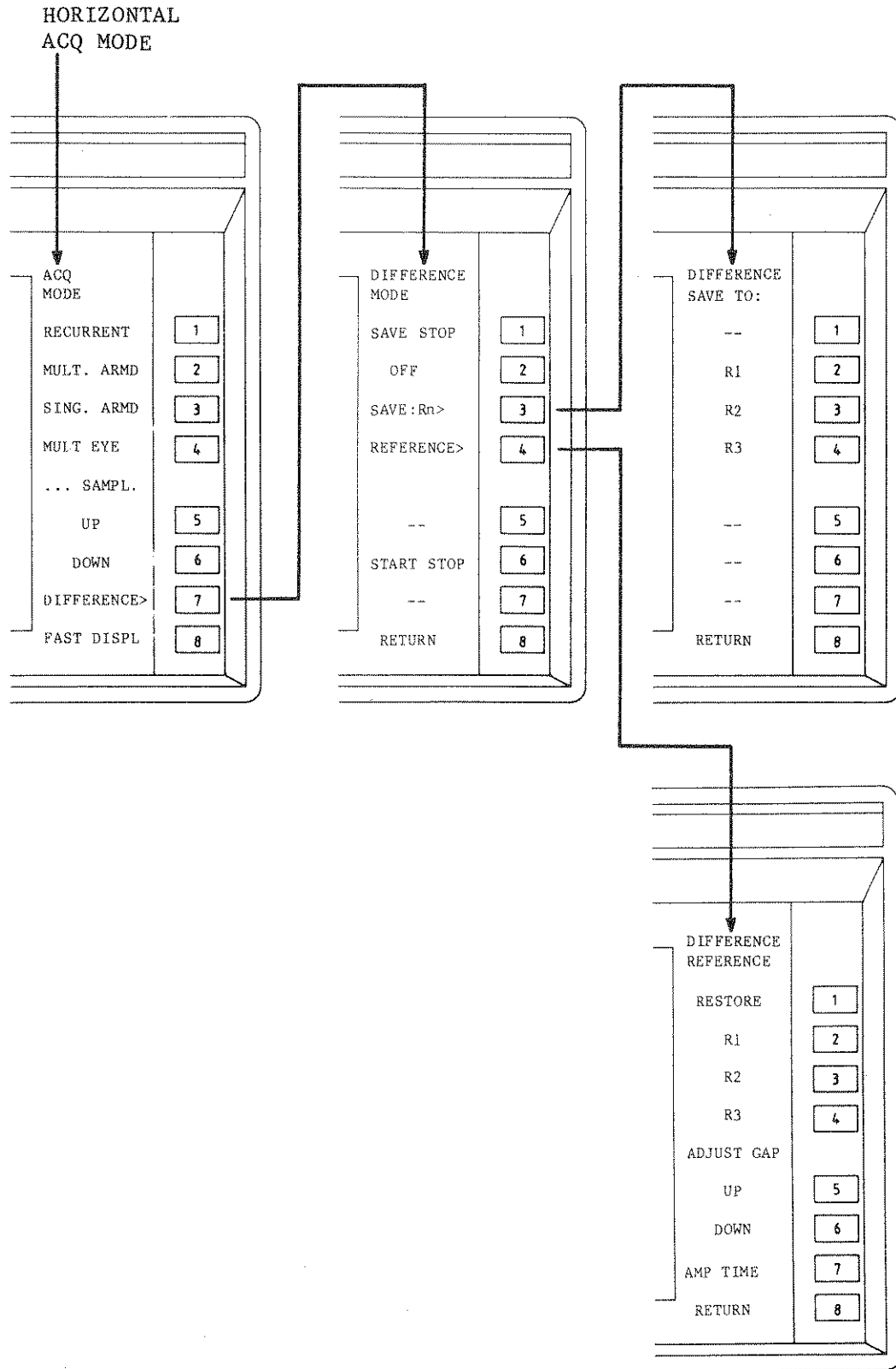
Figure 4.12 Horizontal acquisition mode menu structure.

HORIZONTAL ACQ MODE MENU
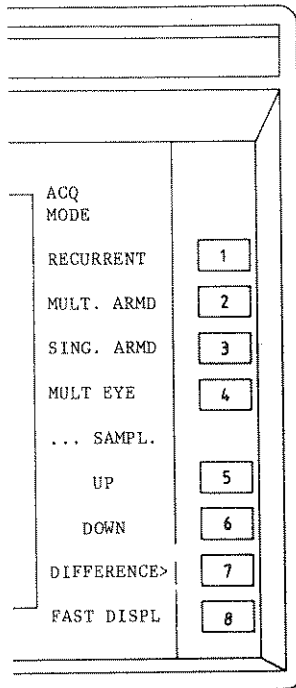
After selection of the HORIZONTAL ACQ MODE menu by
depressing pushbutton HORIZONTAL ACQ MODE, the required
time-base mode can be selected.

```
  ACQ
  MODE

  RECURRENT      [ 1 ]

  MULT. ARMD     [ 2 ]

  SING. ARMD     [ 3 ]

  MULT EYE       [ 4 ]

  ... SAMPL.

      UP         [ 5 ]

      DOWN       [ 6 ]

  DIFFERENCE>    [ 7 ]

  FAST DISPL     [ 8 ]
```

1   RECURRENT

If the RECURRENT-mode is selected, a new signal is recorded in
register R0 and afterwards after a hold off refreshed each time
that the trigger level is passed and that the selected delay has
been reached.

2   MULT. ARMD

In MULTIPLE-mode (text MULT. ARMD intensified), four single shot
signals can be captured sequentially. The signals are recorded in
R3, R2, R1 and the last one in R0. The end of the cycle is
indicated by a low intensified text ARMD.
A new cycle can be started by pushing softkey MULT. ARMD or
pushbutton CLEAR and the text ARMD is intensified until the last
single shot signal is recorded.

3   SING. ARMD

In SINGLE-mode (text SING. ARMD intensified) the contents of
register R0 will be overwritten by a new signal when the trigger
level is passed and the selected delay has been reached.
This is indicated by a low intensified text ARMD.
If afterwards a new single shot signal should be captured the
same SING. ARMD softkey or pushbutton CLEAR should be pushed and
the text ARMD is intensified until the single shot signal is
recorded.

4   MULT.EYE

This MULTIPLE EYE mode is a combination of the modes multiple
recurrent and eye pattern. Multiple recurrent means that data
captured in register R∅ is copied in register R3, the next data
captured in R∅ is copied in R2, the next data captured in R∅
is copied in R1, the next data captured in R∅ is copied again
in R3 and so on. this is a continuous process. For display R∅
is switched off while R1, R2 and R3 are on.
In this mode many functions are preset to a predifined value.
These values can be overruled afterwards if desired by the user.

5   UP

A complete picture consists of 4096 points of which normally 512
are obtained by sampling the input signal. The points inbetween
are obtained by means of calculation. By means of softkey
selection, the number of sampled points can be reduced to
respectively 256, 128 or 64. In this way a complete picture is
obtained faster; however this may be lead to distortion of the
displayed signal because the number of measured points decreases
while the number of calculated points increases. It may be that
we miss certain signal variations. Thus in general a resolution
of 512 points is advised. By means of softkey UP, the resolution
can be increased from 64 to 128, from 128 to 256 and from 256 to
512.

6   DOWN

This softkey has the opposite effect as softkey UP. So the
resolution can be decreased from 512 to 256, from 256 to 128 and
from 128 to 64. If you switch from 512 (normal resolution) to 256
samples and the vertical AVERAGE mode is on, the following
warning is displayed:

Low resolution selected:
Average switched off!!!

7   DIFFERENCE>
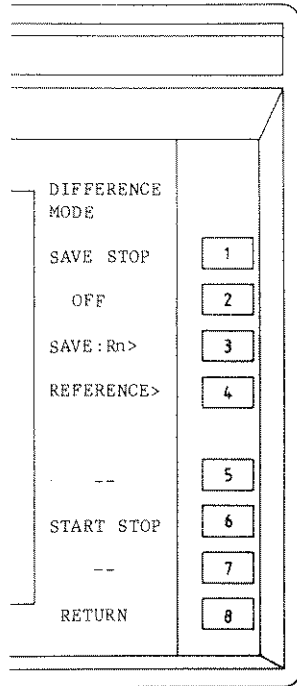
After selecting DIFFERENCE, the DIFFERENCE
MODE menu will be displayed and a DIFFERENCE
MODE function can be selected.

```
DIFFERENCE
MODE

SAVE  STOP      [ 1 ]

   OFF          [ 2 ]

SAVE : Rn>       [ 3 ]

REFERENCE>       [ 4 ]


   --           [ 5 ]

START  STOP      [ 6 ]

   --           [ 7 ]

RETURN          [ 8 ]
```

7   1   SAVE STOP

This softkey allows selection between SAVE ON DIFFERENCE and
STOP ON DIFFERENCE.
In both modes, the result of an acquisition stroke in $R\emptyset$
is compared with a reference signal in R1, R2 or R3.
If SAVE ON DIFFERENCE is selected, then the signal in $R\emptyset$
is saved in R1, R2 or R3 if one or more of the dots of $R\emptyset$
exceeds the limits of the reference signal.
If STOP ON DIFFERENCE is selected then the acquisition stops
if one or more of the dots of $R\emptyset$ exceeds the limits of the
reference signal.

7   2   OFF

Pushing this softkey turns the SAVE ON DIFFERENCE mode or
STOP ON DIFFERENCE mode off.

7   3   SAVE:Rn>

After selection of SAVE:Rn, the DIFFERENCE
SAVE TO: menu will be displayed.
This selection can only be made if the SAVE
ON DIFFERENCE mode was selected before.

```
DIFFERENCE
SAVE TO:

  --        [ 1 ]

  R1        [ 2 ]

  R2        [ 3 ]

  R3        [ 4 ]


  --        [ 5 ]

  --        [ 6 ]

  --        [ 7 ]

  RETURN    [ 8 ]
```

7   3   1   --

7   3   2   R1

7   3   3   R2

7   3   4   R3

With these softkeys, the register can be selected in
which the contents of $R\emptyset$ will be saved by the SAVE
ON DIFFERENCE function.

7   3   5   --

7   3   6   --

7   3   7   --

7   3   8   RETURN

After pushing softkey RETURN, the DIFFERENCE MODE menu
is displayed again.

7   4   REFERENCE>
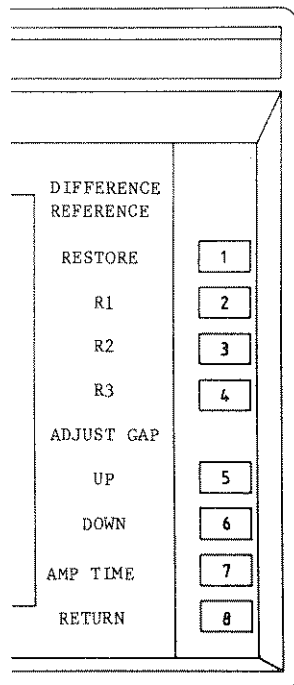
After selecting REFERENCE, the DIFFERENCE REFERENCE
menu will be displayed and a reference register can be
selected. Also the contents of a reference register can
be determined.

DIFFERENCE
REFERENCE

RESTORE | 1 |

R1 | 2 |

R2 | 3 |

R3 | 4 |

ADJUST GAP

UP | 5 |

DOWN | 6 |

AMP TIME | 7 |

RETURN | 8 |

7   4   1   RESTORE

This function saves the contents of R$\emptyset$ in the
selected reference register.

7   4   2   R1

7   4   3   R2

7   4   4   R3

With these softkeys the register can be selected, which
is used as the reference register for the SAVE ON
DIFFERENCE and the STOP ON DIFFERENCE functions.

7   4   5   UP

Pushing softkey UP increases the gap of the signal in
the selected reference register.
Depending on the AMP TIME setting, the gap increases in
a vertical direction (AMP) or in a horizontal direction
(TIME). The increment is 40 dots, which is 0.1 division
on the screen.

7   4   6   DOWN

Pushing softkey down decreases the gap of the signal in the selected reference register.
Depending on the AMP TIME setting, the gap decreases in a vertical direction (AMP) or in a horizontal direction (TIME). The decrement is 40 dots, which is 0.1 division on the screen.

7   4   7   AMP TIME

If AMP is intensified, the softkeys UP and DOWN operate in a vertical direction.
If TIME is intensified, the softkeys UP and DOWN operate in a horizontal direction.
Pushing the softkey, changes the selection from AMP to TIME or reverse.

7   4   8   RETURN

After pushing RETURN, the DIFFERENCE MODE menu is displayed again.

7   5   --

7   6   START STOP

Pushing this softkey starts or stops the SAVE ON DIFFERENCE or the STOP ON DIFFERENCE mode, depending on which mode was selected. The actual situation is displayed intensified.

7   7   --

7   8   RETURN

After pushing RETURN, the HORIZONTAL MODE menu is displayed again.

8   FAST DISPLAY

The resolution is directly switched to 64 samples for a complete screen. As explained under softkey UP, this mode is only advised to get a quick impression how a signal approximately looks like. For a good display quality a resolution of 512 samples is necessary.
If you switch from 512 samples to FAST DISPL, and the vertical AVERAGE mode is on, the following warning is displayed:

Low resolution selected:
Average switched off!!!

4.2.6.2 HORIZONTAL MAGNIFIER/DELAY MENU STRUCTURE

HORIZONTAL
MAGN/DELAY

TIME BASE MAGN: x..		TRIG.DELAY ENTER
EXPAND	1	Range :	1
x1	2	0...+10	2
COMPRESS	3	Resolution	3
DELAY ENTR>	4	1 DIV	4
DEL:...DIV		?	
UP	5	--	5
DOWN	6	CLEAR	6
SCREEN DIV	7	--	7
DELAY= XX	8	EXECUTE	8
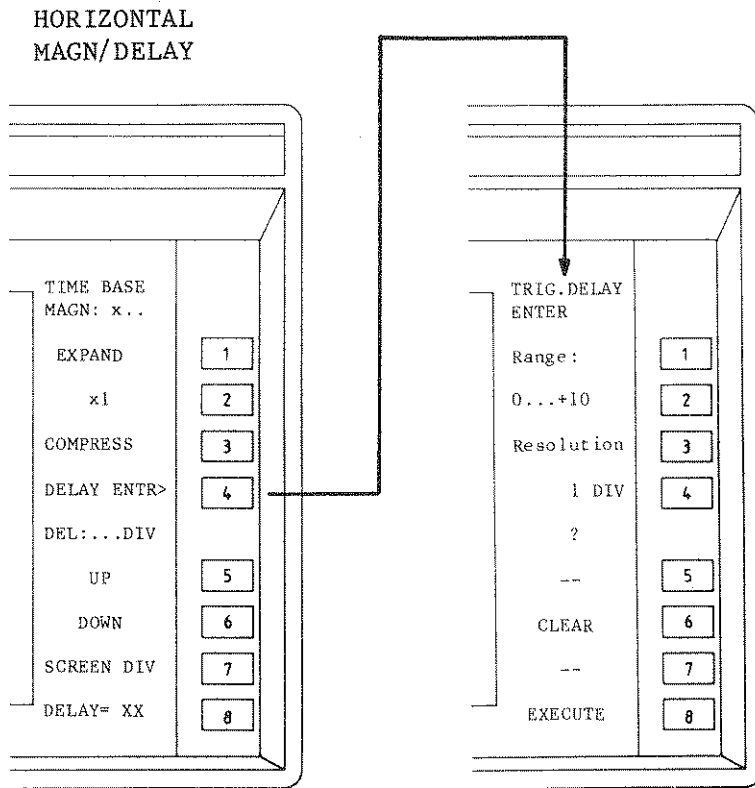
Figure 4.13 Horizontal magnifier/delay menu structure

HORIZONTAL MAGNIFIER/DELAY MENU STRUCTURE

```
┌─────────────────────────┐
│═════════════════════════│
│─────────────────────────│
│─────────────────────────│
│                         │
│ TIME BASE               │
│ MAGN: x..               │
│                         │
│   EXPAND      ┌───┐      │
│               │ 1 │      │
│     x1        ┌───┐      │
│               │ 2 │      │
│  COMPRESS     ┌───┐      │
│               │ 3 │      │
│ DELAY ENTR>   ┌───┐      │
│               │ 4 │      │
│ DEL:...DIV             │
│               ┌───┐      │
│     UP        │ 5 │      │
│               ┌───┐      │
│    DOWN       │ 6 │      │
│               ┌───┐      │
│ SCREEN DIV    │ 7 │      │
│               ┌───┐      │
│  DELAY= XX    │ 8 │      │
└─────────────────────────┘
```
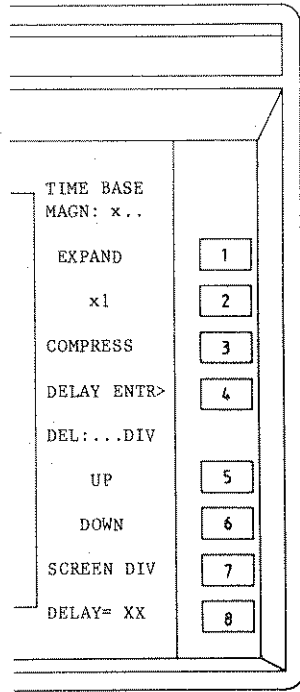
After selection of the MAGN/DELAY menu, the horizontal magnification and the trigger delay can be selected.
The MAGN menu allows adjustment of horizontal magnification factors of *1, *2, *5, *10, *20 and *50. Changing the horizontal magnification factor changes the time base sweep speed. However the horizontal display width is not changed and stays at 10 divisions. The DELAY menu allows adjustment of the number of divisions trigger delay.

1   EXPAND   With the this softkey, higher horizontal expand factors can be selected until *50 is reached. Then the text EXPAND is not displayed any longer. EXPAND is always with respect the midscreen.

2   *1   With softkey *1, the horizontal expand factor is set to X1 which means no expansion.

3   COMPRESS With this softkey, lower horizontal expand factors can be selected until *1 is reached. Then the text COMPRESS is not displayed any longer.

4   DELAY ENTR>

```
┌─────────────────┐
│═════════════════│
│─────────────────│
│    ┌────────────┤
│ TRIG.DELAY │    │
│ ENTER      │    │
│ Range:     │ ┌─┐│
│            │ │1││
│ 0...+10    │ ┌─┐│
│            │ │2││
│ Resolution │ ┌─┐│
│            │ │3││
│   1 DIV    │ ┌─┐│
│            │ │4││
│     ?      │    │
│            │ ┌─┐│
│    --      │ │5││
│            │ ┌─┐│
│  CLEAR     │ │6││
│            │ ┌─┐│
│    --      │ │7││
│            │ ┌─┐│
│  EXECUTE   │ │8││
│    ┌───────┴─┴─┘│
│════════════════ │
└─────────────────┘
```
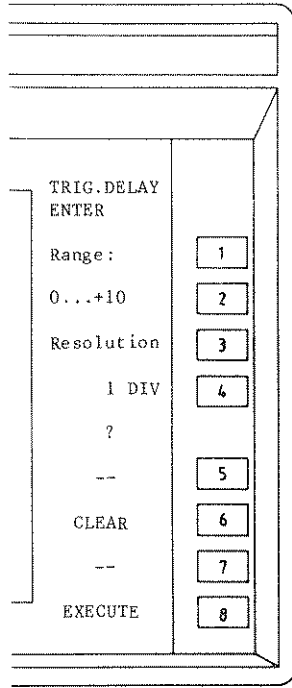
After selecting DELAY ENTR, the TRIGGER DELAY
menu will be displayed and the trigger delay
can be selected in divisions with the numeric
keyboard.
The actual range is indicated and the value
is visible in the softkey area.

A message

Too many digits; total entry is cleared.

can be displayed if too many digits are
entered via the numeric keyboard.

For DIV a message

No decimal point allowed in this enter menu.

can be displayed if a decimal point is
entered via the numeric keyboard.

The trigger delay ranges are always in
divisions. The actual range depends on the
TIME/DIV setting and the adjusted time base
MAGNifier position. The range is always
indicated in the softkey menu. In chapter
4.3.9 a table is given with all the possible
combinations.

4   1   --

4   2   --

4   3   --

4   4   --

4   5   --

4   6   CLEAR

If an error is made, the trigger delay value can be cleared
by pushing softkey CLEAR.

4   7   --

4   8   EXECUTE

After pushing this softkey, the selected trigger delay value
is entered and an AUTO RETURN is done to menu MAGN/DELAY.
If after CLEAR the softkey EXECUTE is pressed, the trigger
delay value keeps its previous value in the MAGN/DELAY menu.

A message

TRIGGER DELAY number out of range

can be displayed if the entered value exceeds the given
range.

4.2.7   TRIGGER SECTION AND MENU STRUCTURE
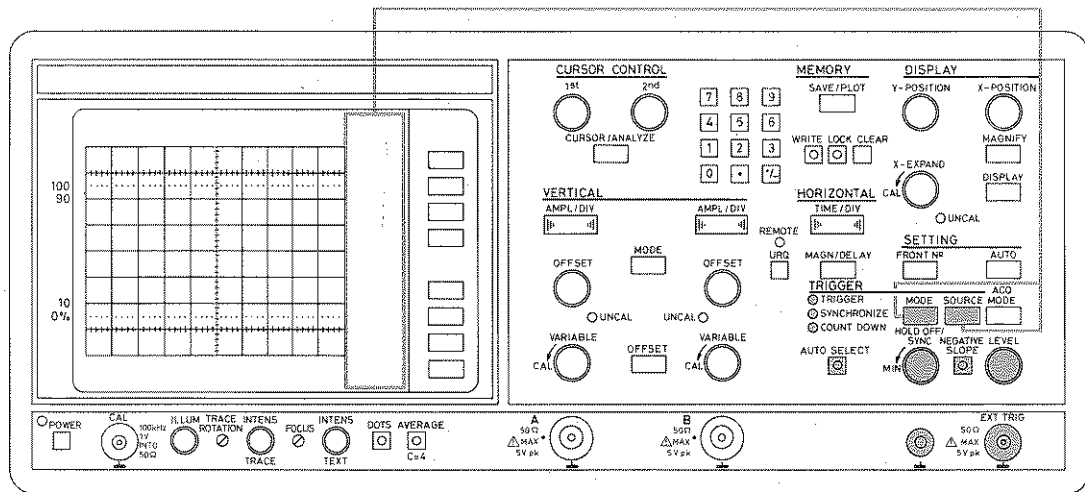
Figure 4.14 Front panel view.

TRIGGER   Pilot lamp indicating that the normal triggered
                    mode for the time base is operative.

SYNCHRONIZE   Pilot lamp indicating that the time base is in the
                    synchronized mode. In this mode a stable picture
                    can be obtained by means of synchronizing with the
                    rotary control HOLD OFF/SYNC

COUNT DOWN   Pilot lamp indicating that the triggering is in
                    the count down mode. In this mode, the frequency
                    of the trigger signal is divided by 128 by a
                    prescaler. This mode is only operative for signals
                    of 150 MHz and higher.

AUTO SELECT   After having depressed this pushbutton, the most
                    optimal of the 3 modes TRIGG'ED, SYNC'ED and
                    COUNTDOWN is activated. This is indicated by the
                    pilot lamps TRIG'D, SYNC'D and COUNTDOWN. If the
                    input signal is changed, the AUTOSELECT mode may
                    choose another mode if necessary. TRIGG'D is the
                    normal mode. SYNC'ED is the "free run" mode for
                    the time base. In this mode a stable picture can
                    be obtained in most cases by fine adjustment of
                    the HOLD OFF/SYNC control. The COUNTDOWN mode is
                    selected for signals with frequencies exceeding
                    160 MHz: the trigger signal is divided by 128 via
                    a prescaler.

⏚   Measuring earth socket.

EXT TRIG   BNC input socket for external triggering, to be
                         used in combination with the trigger source
                         selection facility.

NEGATIVE SLOPE   With NEGATIVE SLOPE off, the time base is
                         triggered on the positive-going edge of the
                         trigger signal. With NEGATIVE SLOPE activated
                         (on), the time base is triggered on the negative-
                         going edge of the trigger signal, which is
                         indicated by the built in pilot lamp. The pilot
                         lamp lights up if NEGATIVE SLOPE is selected. The
                         negative slope can only be selected if TRIGG'ED
                         mode is selected via the TRIGGER MODE pushbutton.
                         NEGATIVE SLOPE can not be selected if AUTO SELECT
                         mode is active.

LEVEL   Continuously-variable control to determine the
                         LEVEL of the trigger point on the trigger signal
                         at which the signal acquisition starts.

                         The adjusting speed increases after turning
                         continuously in one direction. After stopping,
                         starting in the reverse direction resumes with a
                         slow adjusting speed. The LEVEL control is only
                         operative if the pilot lamp TRIGG'D is on. The
                         trigger level is indicated in the CRT text with a
                         value between + 100 and − 100.

HOLD OFF/SYNC   Continuously-variable control to determine the
                         HOLD OFF time for the time base in TRIGG'D and
                         COUNTDOWN mode. During the HOLD OFF time, the time
                         base does not respond to trigger pulses. The HOLD
                         OFF time can be increased in order to suppress
                         unwanted trigger pulses. In the SYNC'ED mode of
                         the time base, this control can be used to
                         SYNChronize the time base for a stable display.

MODE   If pushbutton MODE is pushed, the TRIGGER MODE
                         menu is displayed. See 4.2.7.1.

SOURCE   If pushbutton SOURCE is pushed, the TRIGGER SOURCE
                         menu is displayed. See 4.2.7.2.

4.2.7.1 TRIGGER MODE MENU STRUCTURE
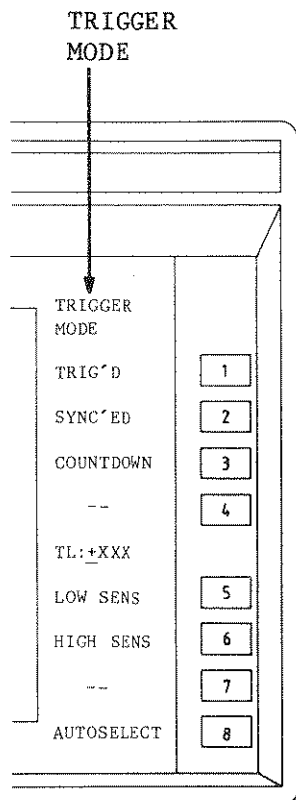
TRIGGER
MODE

After pushing the MODE pushbutton, the
TRIGGER MODE menu is displayed and different
trigger modes can be selected

```
 TRIGGER
 MODE

 TRIG'D         [ 1 ]

 SYNC'ED        [ 2 ]

 COUNTDOWN      [ 3 ]

 --            [ 4 ]

 TL:+XXX

 LOW SENS       [ 5 ]

 HIGH SENS      [ 6 ]

 -- --          [ 7 ]

 AUTOSELECT     [ 8 ]
```

Figure 4.15 Trigger mode menu structure.

TRIGGER MODE MENU

1   TRIGG'ED

      This is the normal trigger mode for the time base where it is
      possible to adjust the LEVEL control to a trigger level between
      0...100%. In this mode it is also possible to select NEGATIVE
      SLOPE for triggering.

2   SYNC'ED

      This is the free run mode for the time base. In this mode, a
      stable picture can be obtained in most cases by fine adjustment
      of the HOLD OFF/ SYNC control. In this mode using the LEVEL
      control and NEGATIVE SLOPE pushbutton is not possible. If you use
      these controls, the following messages are displayed:

      Leveling not possible when in SYNC-mode

      or

      Synchronized mode selected:
      Trigger slope not operable!!!

3   COUNTDOWN

In this mode the frequency of the trigger signal is divided by 128 by a prescaler. This mode only functions for signals with a frequency of 150 MHz and higher. In this mode the time base is normally triggered and the LEVEL control can be operated. The NEGATIVE SLOPE cannot be selected; if you do so a message is displayed:

Countdown mode selected:
Trigger slope not operable!!!

4   --

5   LOW SENS

In this position is the selected trigger source signal applied to the trigger circuits without extra amplification. Triggering is only possible on signals with a relatively high amplitude.

6   HIGH SENS

In this position is the selected trigger source signal applied to the trigger circuits via an amplifier that increases the trigger sensitivity ten times. Triggering is possible on signals with a low amplitude.

7   --

8   AUTOSELECT

Operating this softkey has the same result as pressing the AUTOSELECT pushbutton at the front panel. For explanation refer to the description belonging to this pushbutton in section 4.2.7.

4.2.7.2   TRIGGER SOURCE MENU STRUCTURE
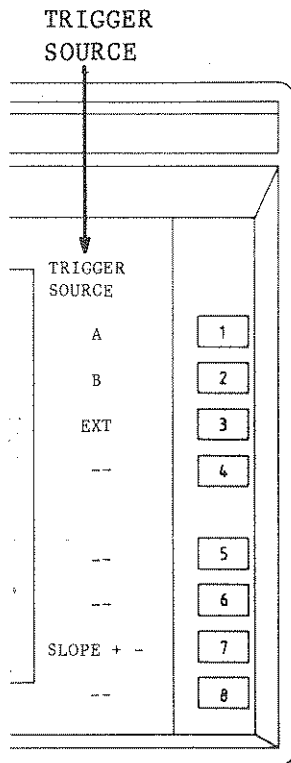
TRIGGER
SOURCE

After pushing the SOURCE pushbutton, the
TRIGGER SOURCE menu is displayed and
different trigger sources and slopes can be
selected.

Figure 4.16 Trigger source menu structure.

TRIGGER SOURCE MENU

1   A

With A selected, triggering is achieved on a signal that is
internally derived from channel A.

2   B

With B selected, triggering is achieved on a signal that is
internally derived from channel B.

3   EXT

With EXT selected, triggering is obtained from an external signal via the EXT TRIG input socket.

4   --

5   --

6   --

7   SLOPE + -

With this softkey, triggering on the positive or on the negative slope of the signal can be selected in the TRIGG'ED mode.This softkey has the same effect as the front panel pushbutton NEGATIVE SLOPE.

8   --

4.2.8   CURSOR SECTION AND MENU STRUCTURE
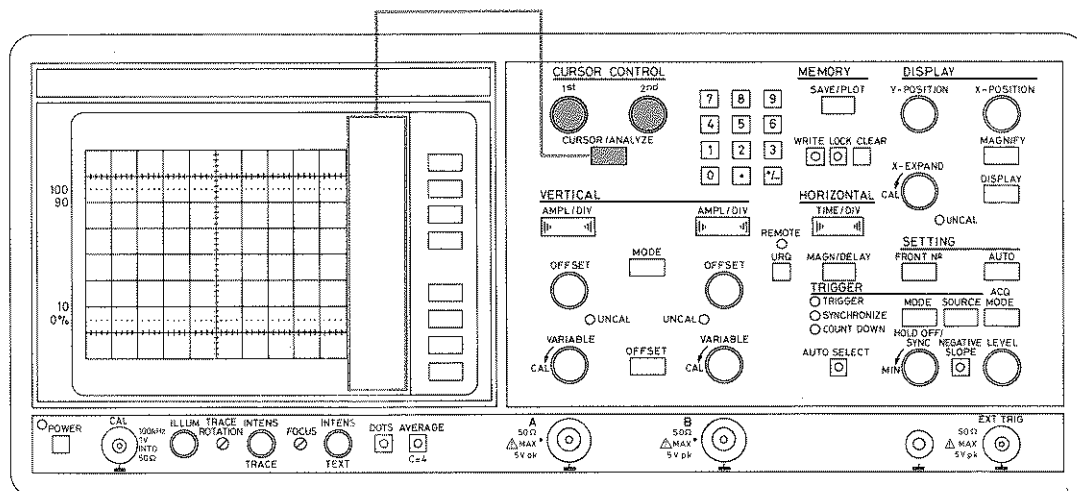
Figure 4.17 Front panel view.

1st   This control functions when cursor operation is switched on
           via the CURSORS SELECT menu.
           Continuously variable control to determine the position of
           the 1st cursor (most left cursor) on the screen.
           Range lies between the most left and most right side of the
           trace visible on the C.R.T. screen.
           The adjusting speed increases after turning continuously in
           one direction. After stopping, starting in the reverse
           direction resumes with a slow adjusting speed.
           The trace on which the cursor is positioned, can beselected
           via the CURSOR SELECT menu.

2nd   This control functions when cursor operation is switched on
           via the CURSORS SELECT menu.
           Continuously variable control to determine the position of
           the 2nd cursor (most right cursor) on the screen.
           Range lies between the most left and most right side of the
           trace visible on the C.R.T. screen.
           The adjusting speed increases after turning continuously in
           one direction. After stopping, starting in the reverse
           direction resumes with a slow adjusting speed.
           The trace on which the cursor is positioned can, be selected
           via the CURSOR SELECT menu.

CURSOR/ANALYZE   If pushbutton CURSOR/ANALIZE is pushed, the
                       CURSORS SELECT menu is displayed. See 4.2.8.1.

dt ....   Calculation results are displayed in the top of
                       the C.R.T. screen.
dV ....   dt ....   time between the cursors.
                       dV ....   voltage difference between the cursors.
1st .(dV1)/.(dt1)   1st ../.. results of left cursor measurements.
                       .(dt1)   time between first cursor and trigger.
                       .(dV1)   voltage between first cursor and zero.
2nd .(dV2)/.(dt2)   2nd ../.. results of right cursor measurements.
                       .(dt2)   time between second cursor and trigger.
                       .(dV2)   voltage between second cursor and zero.

4.2.8.1 Cursor/Analyze menu structure.
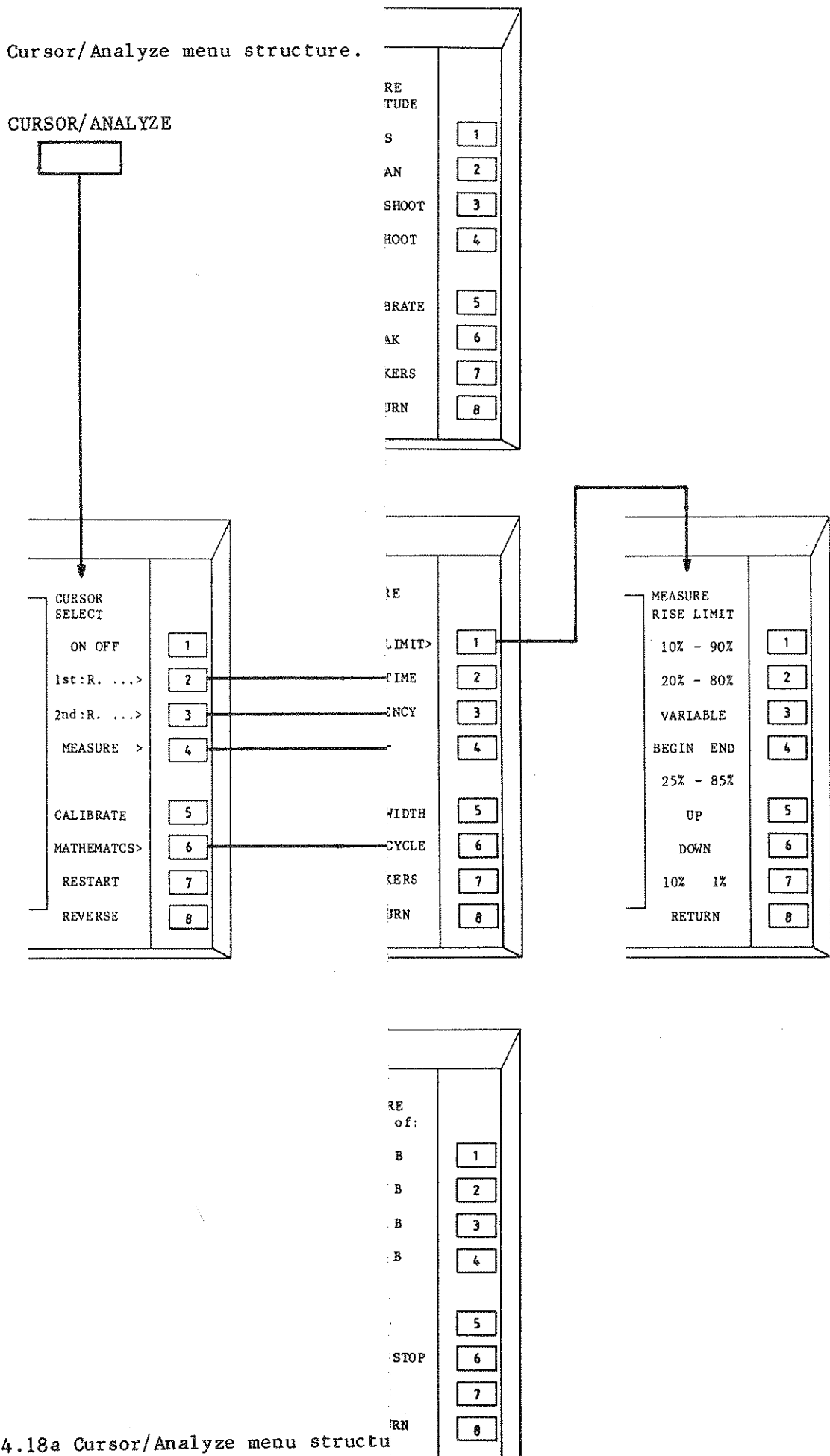
CURSOR/ANALYZE

Figure 4.18a Cursor/Analyze menu structu

CURSOR/ANALYZE

CH2:

RO ...   [1]

R1 ...   [2]

R2 ...   [3]

R3 ...   [4]

--   [5]

--   [6]

MORE (RES)   [7]

RETURN   [8]

CURSOR
SELECT

ON OFF   [1]

1st:R. ...>   [2] ➤ Fig. 4.18

2nd:R. ...>   [3] ➤ Fig. 4.18

MEASURE >   [4] ➤ Fig. 4.18

CALIBRATE   [5]

MATHEMATCS>   [6]

RESTART   [7]

REVERSE   [8]

SCALE
ENTER

Range: [1]

1-32256   [2]

Resolution   [3]

1   [4]

--   [5]

CLEAR   [6]

--   [7]

EXECUTE   [8]
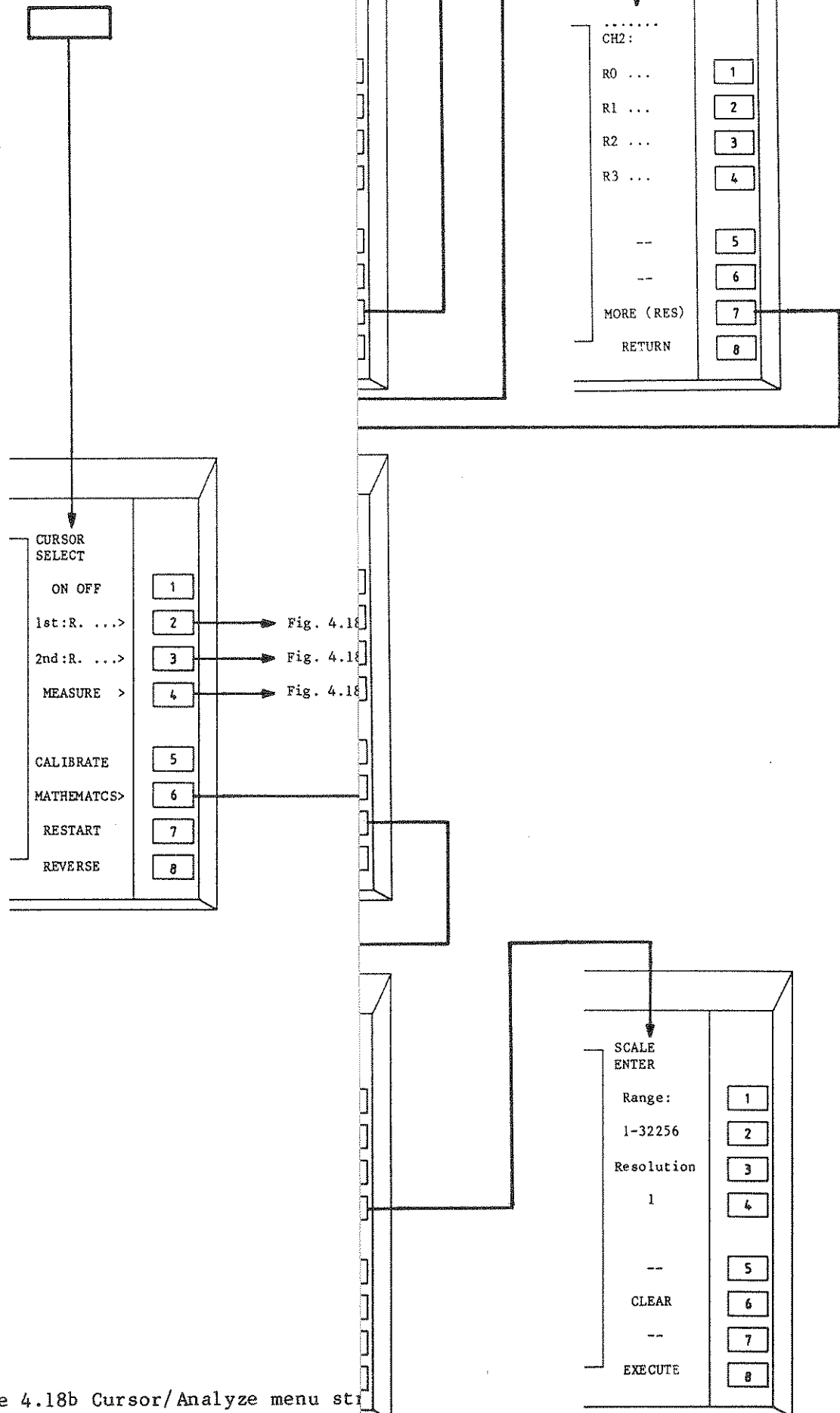
Figure 4.18b Cursor/Analyze menu st

Top-left panel:
```
MATCS
RATE
  ...>     [1]
          [2]
T:R. >    [3]
ALE  >    [4]
T(CH)
R LMT     [5]
  STOP    [6]
OFFST     [7]
JRN       [8]
```

Top-middle panel:
```
........
CH :
R0 ...    [1]
R1 ...    [2]
R2 ...    [3]
R3 ...    [4]
--        [5]
--        [6]
MORE (RES) [7]
RETURN    [8]
```

Middle-left panel:
```
MATCS
RENTL.
. ...>    [1]
ISTNC>    [2]
T:R. >    [3]
ALE  >    [4]
F(CH)
R LMT     [5]
  STOP    [6]
OFFST     [7]
URN       [8]
```

Middle-middle panel:
```
........
Result to:
   R0     [1]
   R1     [2]
   R2     [3]
   R3     [4]
   --     [5]
   --     [6]
MORE (SCA) [7]
RETURN    [8]
```

Middle-right panel:
```
DIFFERENTL
DISTANCE
  +/- 1   [1]
  +/- 2   [2]
  +/- 4   [3]
  +/- 8   [4]
  +/-16   [5]
  +/-32   [6]
  +/-64   [7]
RETURN    [8]
```

Bottom-left panel:
```
MATCS
GRAM
  ...>    [1]
          [2]
T:R. >    [3]
ALE  >    [4]
S(CH)
R LMT     [5]
  STOP    [6]
OFFST     [7]
URN       [8]
```

Bottom-middle panel:
```
........
SCALE
   --     [1]
   --     [2]
   --     [3]
ENTER >   [4]
R./12280
   UP     [5]
   DOWN   [6]
100 10  1 [7]
RETURN    [8]
```

Bottom-right panel:
```
SCALE
ENTER
Range:    [1]
1-32256   [2]
Resolution [3]
  1       [4]
  --      [5]
CLEAR     [6]
  --      [7]
EXECUTE   [8]
```

CURSOR/ANALYZE

CURSOR
SELECT

ON OFF   [1]

1st:R. ...>   [2] ➤ Fig. 4.1

2nd:R. ...>   [3] ➤ Fig. 4.1

MEASURE >   [4] ➤ Fig. 4.1

CALIBRATE   [5]

MATHEMATCS>   [6]

RESTART   [7]

REVERSE   [8]

DELAY CHAN
ENTER

Range: [1]

+/-2048   [2]

Resolution   [3]

1 dot   [4]

? Dot

--   [5]

CLEAR   [6]

--   [7]

EXECUTE   [8]

TCS

...>   [1]

AM.>   [2]

R. >   [3]

         [4]

CH)

LMT   [5]

TOP   [6]

         [7]

N   [8]

F.F.T.
CH :

RO ...   [1]

R1 ...   [2]

R2 ...   [3]

R3 ...   [4]

--   [5]

--   [6]

MORE (RES)   [7]

RETURN   [8]

F.F.T.
WINDOW

RECTANG.   [1]

HAMMING   [2]

HANNING   [3]

--   [4]

AMP SCALE:

LIN (V)   [5]

LOG (dB)   [6]

--   [7]

RETURN   [8]

F.F.T.
Result to:

RO   [1]

R1   [2]

R2   [3]

R3   [4]

--   [5]

--   [6]

MORE (CH)   [7]

RETURN   [8]

TCS

...>   [1]

DER>   [2]

R. >   [3]

         [4]

CH)

LMT   [5]

TOP   [6]

         [7]

N   [8]

FILTER
ORDER

3   [1]

5   [2]

9   [3]

17   [4]

33   [5]

65   [6]

129   [7]

RETURN   [8]
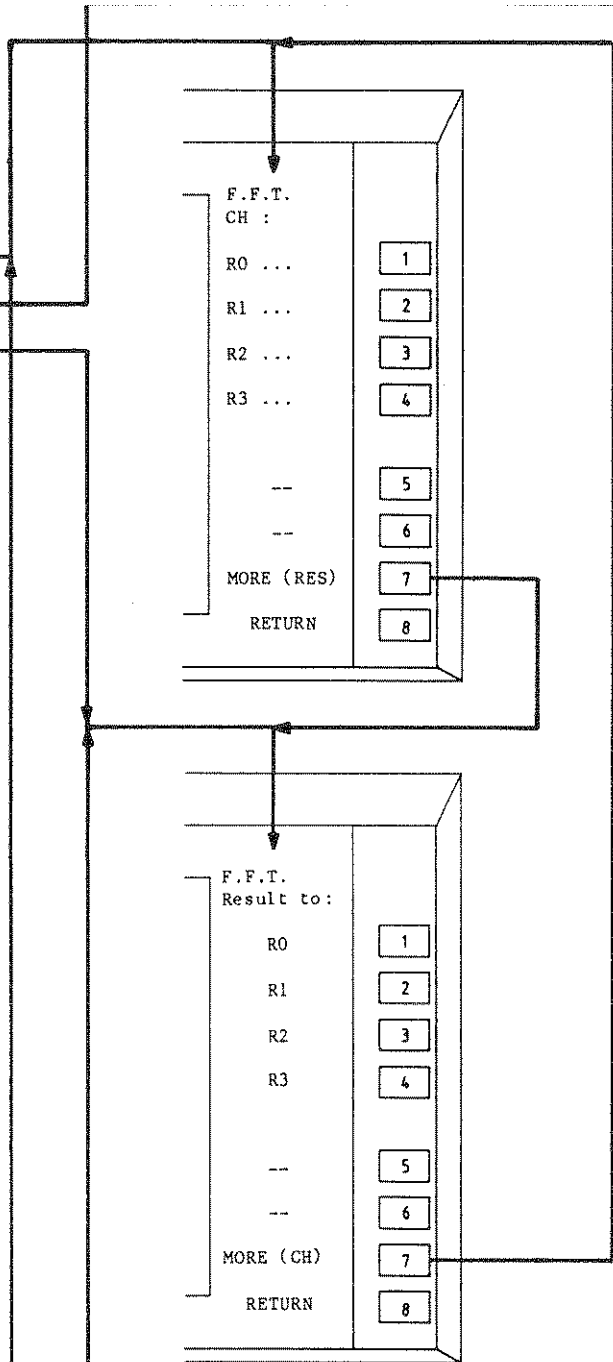
CURSOR MENU

CURSOR
SELECT

ON OFF | 1 |

1st:R. ...> | 2 |

2nd:R. ...> | 3 |

MEASURE > | 4 |

CALIBRATE | 5 |

MATHEMATCS> | 6 |

RESTART | 7 |

REVERSE | 8 |

After pushing pushbutton CURSOR, the CURSOR SELECT menu is displayed and the cursors 1st and 2nd can be set at choice for various measurements using the controls 1st and 2nd.
The cursors are displayed on the previous selected positions.
As soon as the cursors (crossed lines with a length of 2 divisions) are visible, the horizontal distance between the cursors and between cursor and trigger is measured and displayed . The vertical distance between the cursors and between cursor and ground is measured and displayed. The cursors can be positioned on different registers or channels.
The vertical and horizontal distance between the cursors are dispayed in the top text area.

When positioning cursor 1st and cursor 2nd, they can not pass each other. Cursor 1st is always the left one and cursor 2nd is always the right one.

Cursors range lies between the left and the right side of the visible traces on the screen.

The displayed calculation results are continuously recalculated.

IMPORTANT NOTE:

In LOCK the TIME/DIV and AMPL/DIV settings can be changed, which is displayed in the top text area of the screen.
The displayed cursor values are valid for the picture on the screen, so they don't correspond with the TIME/DIV and AMPL/DIV settings in the top text area.
The correct settings can be found in the bottom text area, if FULL TEXT display is selected via the DISPLAY menu.

At power-down, the last selected cursor positions are saved in memory.
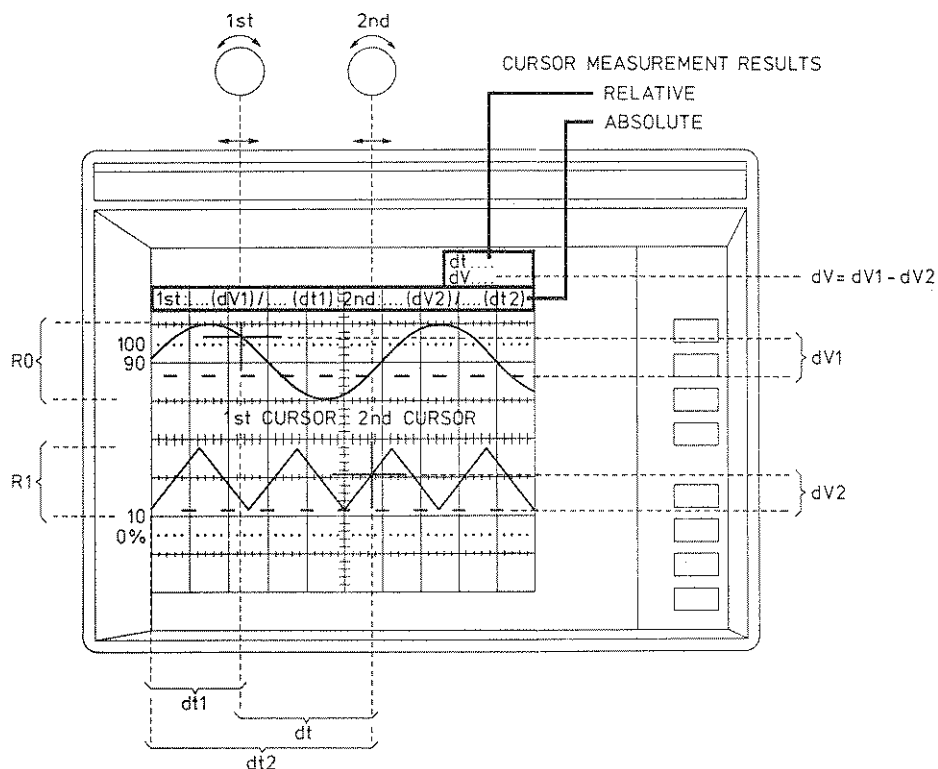
Figure 4.19 Cursor display and control.

1   ON OFF

Softkey 1 has a toggle function and switches ON and OFF the
cursors. The actual function is displayed.
When the cursors are switched ON, they will appear on the last
selected position.
If one of the registers or channels, in which a cursor was
positioned, is switched off (invisible), this cursor will be
positioned in the same register and trace as the other cursor.
If both cursors were positioned in a now invisible register or
channels, they will be positioned in the first visible trace that
is found. Searching starts at Register R0 and channel A.
The cursor result text line, in the top of the graticule, will
display the voltage and the time (from the trigger).

2   1st:R. ...>
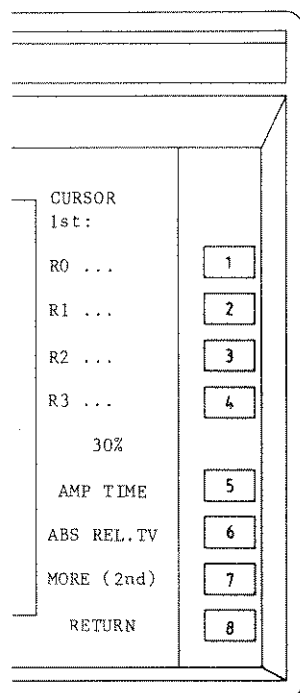
```
┌─────────────────────────┐
│ ═══════════════════════ │
│ ═══════════════════════ │
│ ─────────────────────── │
│                         │
│  ┌──────────────┐       │
│  │ CURSOR       │       │
│  │ 1st:         │       │
│  │              │       │
│  │ RO ...    ┌─┐│       │
│  │           │1││       │
│  │ R1 ...    ┌─┐│       │
│  │           │2││       │
│  │ R2 ...    ┌─┐│       │
│  │           │3││       │
│  │ R3 ...    ┌─┐│       │
│  │           │4││       │
│  │    30%       │       │
│  │              │       │
│  │ AMP TIME  ┌─┐│       │
│  │           │5││       │
│  │ ABS REL.TV┌─┐│       │
│  │           │6││       │
│  │ MORE (2nd)┌─┐│       │
│  │           │7││       │
│  │ RETURN    ┌─┐│       │
│  │           │8││       │
│  └──────────────┘       │
└─────────────────────────┘
```

This function is only displayed when cursors are switched ON.
It initiates a menu in which the (cursor) register is selected and the way the cursor is moved.
The cursor can be placed on any channel or register, provided it is displayed.
If a register contains two channels, the corresponding softkey will function as a toggle key between the channels after the register is selected.
The text area of this softkey indicates the register (and channel) in which this cursor is positioned.
The AMP TIME and ABS RELTV selection made here is also valid for the 2nd cursor.

2   1   RO ...

2   2   R1 ...

2   3   R2 ...

2   4   R3 ...

If a register is selected for cursor operation the cursor is visible on the screen for the selected (intensified) channel. The other channel can be selected by pushing the softkey once again.
Only displayed registers will appear in the menu.
The previous position of a cursor in a register is displayed when it is selected again.

Possible displays for the cursor positions are:
(R. A B), (R. A), (R. B), (R. ADD), (R. SUB),
(R. MUL), (R. DIV), (R. INT), (R. DIF), (R. DEL),
(R. FFT), (R. HYS) or (R. FIL).

If register RO and one channel is selected for both cursors, the Text RESTART is visible next to softkey 7 and an automatic selection of time base setting and/or delay is possible (see explanation for softkey 7).

If A versus B was selected for the selected register a message

REGISTER IN A VERSUS B: NO CURSORS POSSIBLE

is displayed and the cursors are switched off.

If a register is selected in which no traces and settings are stored, a message

REGISTER HAS NO LEGAL SETTINGS: NO CURSORS

is displayed.

2   5   AMP TIME

AMP TIME is a toggle function which indicates what way the cursor control knob is used. The selection AMP or TIME is valid for both cursors.

AMP function
The AMP function active means, the cursor control will position the cursor in a vertical way.
The text ABS RELTV becomes visible for softkey 6 when AMP is selected. The text line between softkey 4 and 5 indicates the position of the cursor.

TIME function
The TIME function active means, the cursor is moved horizontal.

2   6   ABS RELTV

Displayed when AMP is selected by softkey 5.
The selection is valid for both cursors.

ABS function
Indicates that the positioning of the cursor is in Volts.
If the voltage of the cursor is not found on the signal, an error message is displayed and the cursor is positioned on the nearest value. The voltage is indicated between softkeys 4 and 5.

RELTV function
This function will put the cursor on a relative vertical position on the signal. The 0% and 100% are the peak-peak values of the signal between the cursors. The percentage is indicated between softkeys 4 and 5.

2   7   MORE (2nd)

If MORE (2nd) is selected, the selection menu for the second cursor will appear. MORE (2nd) has the same result as pressing RETURN and then 2nd:R. ...

2   8   RETURN

After pushing softkey RETURN, the cursor SELECT menu becomes visible.

3   2nd:R. ...>
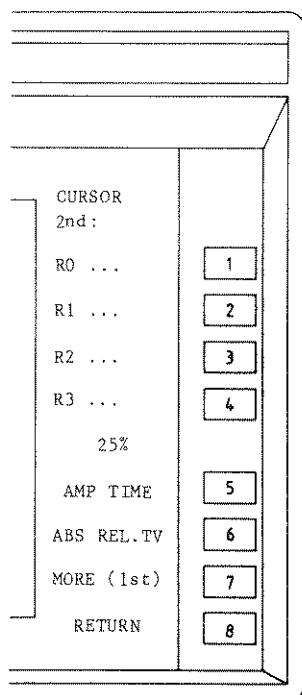
```
  ┌─────────────────────┐
  ├─────────────────────┤
  ├─────────────────────┤
  │                     │
  │                     │
  │  CURSOR             │
  │  2nd:               │
  │                 ┌───┐
  │  R0 ...         │ 1 │
  │                 └───┘
  │  R1 ...         ┌───┐
  │                 │ 2 │
  │                 └───┘
  │  R2 ...         ┌───┐
  │                 │ 3 │
  │                 └───┘
  │  R3 ...         ┌───┐
  │                 │ 4 │
  │      25%        └───┘
  │
  │  AMP TIME       ┌───┐
  │                 │ 5 │
  │                 └───┘
  │  ABS REL.TV     ┌───┐
  │                 │ 6 │
  │                 └───┘
  │  MORE (1st)     ┌───┐
  │                 │ 7 │
  │                 └───┘
  │   RETURN        ┌───┐
  │                 │ 8 │
  │                 └───┘
  └─────────────────────┘
```

This function is only displayed when cursors are switched ON.
It initiates a menu in which the (cursor) register is selected and the way the cursor is moved.
The cursor can be placed on any channel or register, provided it is displayed.
If a register contains two channels, the corresponding softkey will function as a toggle key between the channels after the register is selected.
The text area of this softkey indicates the register (and channel) in which this cursor is positioned.
The AMP TIME and ABS RELTV selection made here is also vallid for the 1st cursor.

3   1   R0 ...

3   2   R1 ...

3   3   R2 ...

3   4   R3 ...

If a register is selected for cursor operation the cursor is visible on the screen for the selected (intensified) channel. The other channel can be selected by pushing the softkey once again.
Only displayed registers will appear in the menu.
The previous position of a cursor in a register is displayed when it is selected again.

Possible displays for the cursor positions are:
(R. A B), (R. A), (R. B), (R. ADD), (R. SUB),
(R. MUT), (R. DIV), (R. INT), (R. DIF), (R. DEL),
(R. FFT), (R. HYS) or (R. FIL).

If register R0 and one channel is selected for both cursors, the Text RESTART is visible next to softkey 7 and an automatic selection of time base setting and/or delay is possible (see explanation for softkey 7).

If A versus B was selected for the selected register a message

REGISTER IN A VERSUS B: NO CURSORS POSSIBLE

is displayed and the cursors are switched off.

If a register is selected in which no traces and settings are stored, a message

REGISTER HAS NO LEGAL SETTINGS: NO CURSORS

is displayed.

3   5   AMP TIME

AMP TIME is a toggle function which indicates what way the cursor control knob is used. The selection AMP or TIME is valid for both cursors.

AMP function
The AMP function active means, the cursor control will position the cursor in a vertical way.
The text ABS RELTV become visible for softkey 6 when AMP is selected. The text line between softkey 4 and 5 indicates the position of the cursor.

TIME function
The TIME function active means, the cursor is moved horizontal.

3   6   ABS RELTV

Displayed when AMP is selected by softkey 5.
The selection is valid for both cursors.

ABS function
Indicates the positioning of the cursor is in Volts.
If the voltage of the cursor is not found on the signal, an error message is displayed and the cursor is positioned on the nearest value. The voltage is indicated between softkeys 4 and 5.

RELTV function
This function will put the cursor on a relative vertical position on the signal. The 0% and 100% are the peak-peak values of the signal between the cursors. The percentage is indicated between softkeys 4 and 5.

3   7   MORE (1st)

If MORE (1st) is selected the selection menu for the second cursor will appear. MORE (1st) will have the same result as pressing RETURN and then 1st:R. ...

3   8   RETURN

After pushing softkey RETURN, the cursor SELECT menu becomes visible.

4   MEASURE>

CURSOR
MEASURE

AMPLITUDE>   [1]

TIME   >   [2]

PHASE   >   [3]

dt 1/dt   [4]

CURSORS at

PERIOD   [5]

GROUND IND   [6]

INCL. OFFST   [7]

RETURN   [8]
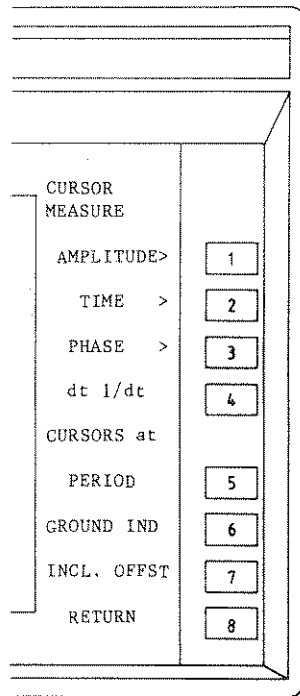
If MEASURE is selected, the CURSOR MEASURE menu is
displayed and a choise of cursor related
measurements can be selected.
The text MEASURE is only visible when the cursors
are switched ON.
To get the choise of amplitude and time
measurements, the cursor must be related to the
same trace.
A maximum of three measurements can be selected
and displayed in the measurement result text area
(see also section 4.2.2).

4   1   AMPLITUDE>

MEASURE
AMPLITUDE

RMS   [1]

MEAN   [2]

OVERSHOOT   [3]

PRESHOOT   [4]

CALIBRATE   [5]

PEAK   [6]

MARKERS   [7]

RETURN   [8]
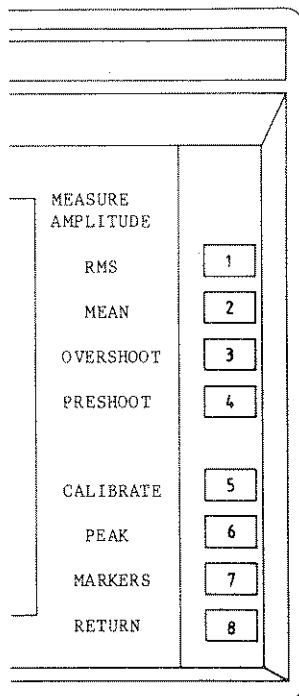
By pushing AMPLITUDE, the MEASURE AMPLITUDE
menu is displayed.
This function AMPLITUDE is only visible when
both cursors are related to one channel.
The CALIBRATE function is also in this menu
implemented because of the importance of a
correct ground-level in the RMS and MEAN
calculations.
MARKERS will only be visible when OVERSHOOT,
PRESHOOT or PEAK is selected and act on the
active measurement with the highest position
in the menu.
Results are displayed at the bottom of the
graticule.

4   1   1   RMS

After pushing RMS (Root Mean Square), the RMS value of
the signal detail between the cursors is calculated.
This RMS is related to the ground level.
Therefor it is recommended to calibrate the channel
before reading the RMS result.

4   1   2   MEAN

After pushing MEAN, the mean value of the signal detail
between the cursors is calculated.
This MEAN value is related to the ground level.
Therefor it is recommended to calibrate the channel
before reading the MEAN result.

4   1   3   OVERSHOOT

After pushing OVERSHOOT, the OVERSHOOT value of the
signal detail between the cursors is calculated. This
OVERSHOOT value is related to the cursor levels
according the formula:

When level 1st is lower than level 2nd:

$$OVERSHOOT = \frac{level\ peak - level\ 2nd}{level\ 2nd - level\ 1st} * 100\%$$

When level 2nd is lower than level 1st:

$$OVERSHOOT = \frac{level\ 2nd - level\ minimum}{level\ 1st - level\ 2nd} * 100\%$$

4   1   4   PRESHOOT

After pushing PRESHOOT, the PRESHOOT value of the
signal detail between the cursors is calculated.
This PRESHOOT value is related to the cursor levels
according the formula:

When level 1st is lower than level 2nd:

$$PRESHOOT = \frac{level\ 1st - level\ minimum}{level\ 2nd - level\ 1st} * 100\%$$

When level 2nd is lower than level 1st:

$$PRESHOOT = \frac{level\ peak - level\ 1st}{level\ 1st - level\ 2nd} * 100\%$$

4   1   5   CALIBRATE

After pushing CALIBRATE, the analog input circuits are
calibrated. The CALIBRATE procedure will calculate the
ground level correction and the offset correction,
which are used to get correct measurement values.
Same as CALIBRATE in the main (CURSOR SELECT) menu.

4   1   6   PEAK-PEAK

After pushing sofktey PEAK-PEAK, the voltage between
the lowest and the highest point of the signal between
two cursors, will be calculated and displayed in the
measurement result text are.
When PEAK-PEAK is selected, the text MARKERS becomes
visible for softkey 7.

4   1   7   MARKERS

After pushing softkey MARKERS, the MARKERS become
visible on the signal that is selected for both
cursors.
The MARKERS, two vertical lines, are placed on that
positions that are used for the selected measurement.
Just above the measurement results, the absolute
values, of the signal at the marker positions, are
displayed in relation to the ground level and the
trigger (see section 4.2.2).

4   1   8   RETURN

After pushing softkey RETURN, the CURSOR MEASURE menu
will be visible again.
The results of the selected measurements are still
displayed.

4   2   TIME>

MEASURE
TIME

RISE LIMIT>   [1]

RISE TIME   [2]

FREQUENCY   [3]

--   [4]

PULS WIDTH   [5]

DUTY CYCLE   [6]

MARKERS   [7]

RETURN   [8]
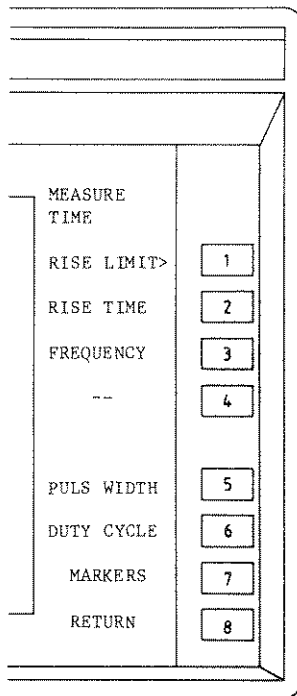
If TIME is selected, the MEASURE TIME menu is
displayed and a number of TIME measurements
can be selected.
The time measurement results are displayed
in the measurement result text area in the
the bottom of the graticule.
The text MARKERS becomes visible when a time
measurement is selected. The markers are
valid for the active measurement with the
highest position in the menu.

4   2   1   RISE LIMIT>

```
 _____
|_____|
|_____|
|_____|
|                        /
|  _____  /
| | MEASURE         | /
| | RISE LIMIT      |
| |                 |  ___
| |  10% - 90%      | | 1 |
| |                 |  ---
| |  20% - 80%      | | 2 |
| |                 |  ---
| |  VARIABLE       | | 3 |
| |                 |  ---
| |  BEGIN  END     | | 4 |
| |                 |  ---
| |  25% - 85%      |
| |                 |  ---
| |     UP          | | 5 |
| |                 |  ---
| |    DOWN         | | 6 |
| |                 |  ---
| |  10%   1%       | | 7 |
| |                 |  ---
| |   RETURN        | | 8 |
| |_____|  ---
|_____
|_____
```

If RISE LIMIT is selected, the MEASURE
RISE LIMIT menu is displayed and the
limits used for RISE TIME calculation
are selected.
Fixed limits are selected by the
softkeys 1 and 2, or variable limits by
softkey 3 and 4.
When VARIABLE is selected, softkey text
is displayed at softkeys 4, 5, 6 and 7,
to change the limits of the RISE TIME.
The RISE time function is switched ON
via the softkey RISE TIME.

4   2   1   1   10%-90%

After pushing softkey 10%-90%, the RISE TIME will
be measured from 10% till 90% of the amplitude
rise between the cursors.

4   2   1   2   20%-80%

After pushing softkey 20%-80%, the RISE TIME will
be measured from 20% till 80% of the amplitude
rise between the cursors.

4   2   1   3   VAR (Variable)

After pushing softkey VAR, variable RISE TIME
limits can be selected by softkeys 4...7 for which
the text is now displayed.
The selected limits are displayed between the
softkey text of the softkeys 4 and 5.
RISE TIME is measured from the BEGIN value to the
END values.

4   2   1   4   BEGIN END

This softkey text becomes visible after pushing
softkey VAR.
This softkey has a toggle function. With this
softkey, a selection is made between changing the
BEGIN or the END function.
The active state is displayed intensified.
The values of BEGIN and END are displayed directly
below the correspondending softkey text.

4   2   1   5   UP

        This softkey text becomes visible after pushing
        softkey VAR.
        Pushing this softkey, results in an increment of
        the BEGIN or END value, whichever is selected by
        softkey 4.
        The increment itself is selectable by softkey 7.

4   2   1   6   DOWN

        This softkey text becomes visible after pushing
        softkey VAR.
        Pushing this softkey, results in a decrement of
        the BEGIN or END value, whichever is selected by
        softkey 4.
        The decrement itself is selectable by softkey 7.

4   2   1   7   10% 1%

        This softkey text becomes visible after pushing
        softkey VAR.
        With this softkey, the increment or decrement is
        selected for the UP or DOWN softkeys 5 or 6.

4   2   1   8   RETURN

        After pushing softkey RETURN, the MEASURE TIME
        menu is displayed again. The selections as made
        before remain unchanged.

4   2   2   RISE TIME

        If RISE is selected, the RISE time is calculated for
        the limits set via the RISE LIMIT menu.
        The result is displayed in the bottom of the
        graticule.

4   2   3   FREQUENCY

        After pushing FREQUENCY, the FREQUENCY value is
        calculated as follows.
        The MEAN value of the signal detail between the cursors
        is calculated. From the time difference between the
        first and the third crossing with this MEAN value the
        FREQUENCY is calculated.

4   2   4   --

4   2   5   PULS WIDTH

        After pushing PULS WIDTH, the PULS WIDTH value is
        calculated as follows.
        The value in the middle between the PEAK-PEAK values is
        the level where PULS WIDTH is measured.
        PULS WIDTH is the time difference between the first and
        second crossing of the above level.

4   2   6   DUTY CYCLE

After pushing DUTY CYCLE, the DUTY CYCLE value is
calculated as followed.
The MEAN value of the signal detail between the cursors
is calculated. From the time difference between the
first and third crossing with this MEAN value the
period time is calculated.
The time difference between the first and second
crossing divided by the period time determines the DUTY
CYCLE.

4   2   7   MARKERS

If MARKERS is selected, The markers become visible on
the trace that is selected for the cursors.
The MARKERS will indicate the measurement positions of
the active TIME measurement that has the highest
position in the TIME menu.

4   2   8   RETURN

After pushing softkey RETURN, the CURSOR MEASURE menu
will be visible again.
The results of the selected measurements are still
displayed.

4   3   PHASE>

MEASURE
PHASE of:

RO A B | 1 |

R1 A B | 2 |

R2 A B | 3 |

R3 A B | 4 |

-- | 5 |

START STOP | 6 |

-- | 7 |

RETURN | 8 |
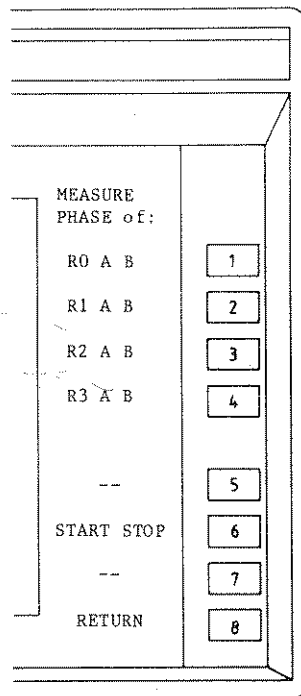
If PHASE is selected, the MEASURE PHASE menu
is displayed and a selection can be made
between all registers that contain two
channels.
If there are no two channel registers, PHASE
can not be selected and is not visible.
Each valid softkey has a toggle function
after it is selected. With this toggle
function, the channel can be selected that is
used as reference.
From this channel, the period time is
determined. From both channels, the MEAN
level is determined.
PHASE is the time difference between the
first crossings of the two channel signals
and their MEAN level, divided by the
reference period and expressed in degrees.
The result is displayed in the measurement
result text area (see section 4.2.2.2).
The PHASE measurement is started by toggling
softkey 6, START STOP.

4   3   1   R0 A B

4   3   2   R1 A B

4   3   3   R2 A B

4   3   4   R3 A B

After pushing one of these softkeys, the selected
register is used for measurement of the PHASE between
the channel present in this register.

4   3   5   --

4   3   6   START STOP

After pushing softkey START STOP, the PHASE measurement
is started and the result becomes visible.
This softkey has a toggle function so pushing it again
will stop the measurement.

4   3   7   --

4   3   8   RETURN

After pushing softkey RETURN, the CURSOR MEASURE menu
will visible again.
The result of the selected measurement are still
displayed.

4   4   dt 1/dt

By pushing this softkey, a selection is made for the
representation of the horizontal distance between the
cursors.
In dt mode, the value is expressed in seconds.
In 1/dt mode, the value is expressed in hertz.
The result is displayed in the top text area.
If both cursors are positioned on exactly the same position
the result will display 1/dt:1/ 0/d.

4   5   CURSORS at PERIOD

After pushing CURSORS at PERIOD, the cursors are placed at
the first and third zero crossing of the channel in which
the first cursor was situated and the period is measured.
If this period is not found, the cursors are placed on the
channel where the second cursor was.
If here also no period is found, an error message is given.

4   6   GROUND IND

By pushing GROUND IND the zero lines of the channels
selected for the cursors, is displayed.
The ground level is indicated by, ten (10) lines between the
vertical graticule lines, for the channel with the left
cursor and by nine (9) lines on the vertical graticule lines
for the channel with the right cursor.

4   7   INCL OFFST

> After pushing softkey INCL OFFST, the OFFST defined earlier
> is included in the measurement.

4   8   RETURN

> After pushing softkey RETURN, the CURSOR SELECT menu becomes
> visible.

5   CALIBRATE

After pushing softkey CALIBRATE, the main processor will build up
or correct an array of correction factors for ground and offset.
This array will contain:
- The real ground levels for channels A and B, in single channel
  mode with offset at zero, measured at time bases
  2 ms/div, 2 us/div and 100 ns/div.
- The real ground levels for channels A and B, in dual channel
  mode with offset at zero, measured at time bases
  2 ms/div, 2 us/div and 100 ns/div.
- Offset correction at four divisions for channels A and B.

These figures must be measured with the inputs open, in
recurrent and auto triggered. In order to ,obtain a proper
calibration, the message:

CALIBRATION of front end. Remove input signals before the end of
this message.

is generated during a couple of seconds, during which the user
has the opportunity to remove eventual input signals.
After the calibration procedure is completed, the oscilloscope
returns to the situation as before the calibration was started.

6   MATHEMATCS>

```
┌─────────────────────┐
│                     │
├─────────────────────┤
│                  ┌──┘
│  ┌─────────────┐ │
│  MATHEMATCS    │ │
│                │ │
│  ADD     >  ┌───┐
│             │ 1 │
│  SUBTRACT > ┌───┐
│             │ 2 │
│  MULTIPLY > ┌───┐
│             │ 3 │
│  DIVIDE  >  ┌───┐
│             │ 4 │
│             
│  INTEGRATE> ┌───┐
│             │ 5 │
│  DIFFERENTL>┌───┐
│             │ 6 │
│  MORE       ┌───┐
│             │ 7 │
│  RETURN     ┌───┐
│             │ 8 │
└─────────────────────┘
```

```
┌─────────────────────┐
│                     │
├─────────────────────┤
│                  ┌──┘
│  ┌─────────────┐ │
│  MATHEMATCS    │ │
│                │ │
│  DELAY CHAN>┌───┐
│             │ 1 │
│  F.F.T.  >  ┌───┐
│             │ 2 │
│  HISTOGRAM >┌───┐
│             │ 3 │
│  FILTER  >  ┌───┐
│             │ 4 │
│             
│  - -        ┌───┐
│             │ 5 │
│  - -        ┌───┐
│             │ 6 │
│  MORE       ┌───┐
│             │ 7 │
│  RETURN     ┌───┐
│             │ 8 │
└─────────────────────┘
```
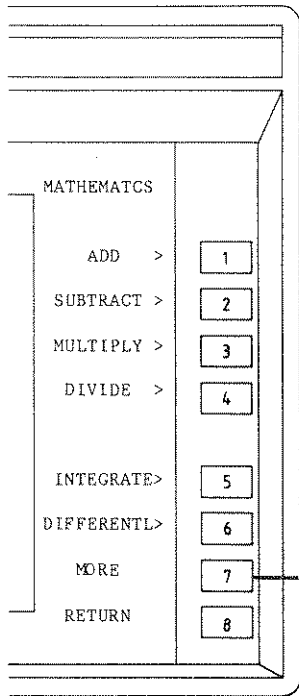
MATHEMATCS is selected, the MATHEMATCS menu
becomes visible and a number of mathematical
functions can be selected.
Because of the number of mathematical operations
exceeds the number of softkeys, a MORE function is
introduced to be able to select more functions on
this same menu level. A selection in this
MATHEMATICS 'MORE' menu is indicated with the
numbers 7,1 ... 7,8, where 7, indicates softkey 7
in the first MATHEMATCS menu.

ADD, SUBTRACT, MULTIPLY and DIVIDE are so called
type 1 operations that need two source channels
(CH1 and CH2). These traces can have different
length. Therefore they are expanded over 4096
points with linear interpolated points inbetween.
So the operation is always over 4096 points.

The type 2 operations INTEGRATE, DIFFERENTL, FFT
and HYSTOGRAM always operate on the real
resolution. The result is then expanded over 4096
points with linear interpolated points inbetween.

The result can be scaled with a selected value.
The amplitude and time indications are updated to
give the actual values.
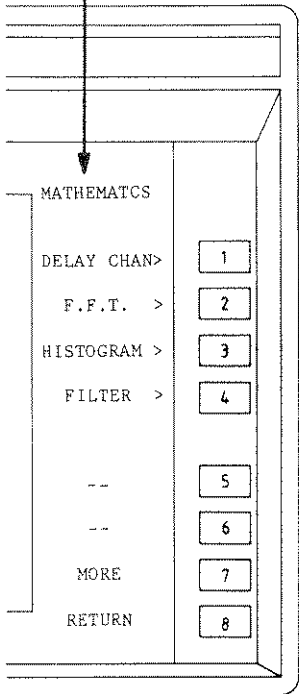
The function is started by pressing START STOP in
the selected function menu. It is stopped by
pressing START STOP again or by starting another
mathematical function.
The operations are restarted if the sources are
from the registers R1, R2 or R3, a save action
takes place and the operation still is active.
If the source is from R0, the operation is
continuously restarted.

If there are no registers active that contain two
channels the function DELAY CHAN will not be
visible

The selection of SOURCE, RESULT or SCALE for any
of the mathematic functions is valid for all other
mathematic functions.

6   1   ADD>

```
┌──────────────┐
│              │
│              │
├──────────────┤
│ ┌──────────┐ │
│ │ MATHEMATCS│ │
│ │ ADD       │ │
│ │ CH1:R. ...>│  ┌───┐
│ │           │  │ 1 │
│ │ CH2:R. ...>│  ┌───┐
│ │           │  │ 2 │
│ │ RESULT:R. >│  ┌───┐
│ │           │  │ 3 │
│ │    SCALE  >│  ┌───┐
│ │           │  │ 4 │
│ │ R.=CH1+CH2│
│ │           │  ┌───┐
│ │ CURSOR LMT│  │ 5 │
│ │           │  ┌───┐
│ │ START STOP│  │ 6 │
│ │           │  ┌───┐
│ │ INCL OFFST│  │ 7 │
│ │           │  ┌───┐
│ │   RETURN  │  │ 8 │
│ └──────────┘
```
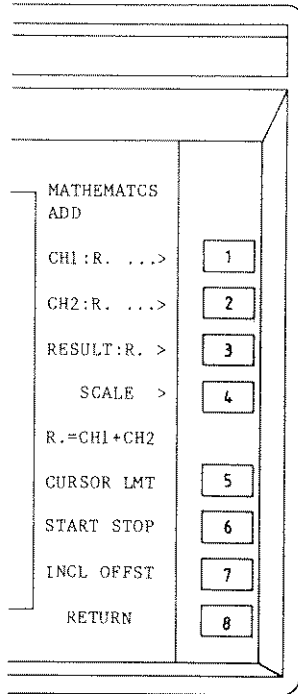
If ADD is selected, the MATHEMATCS ADD menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the ADD function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the ADD function.
CURSOR LMT results in the addition of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6   1   1   CH1:R. ...>
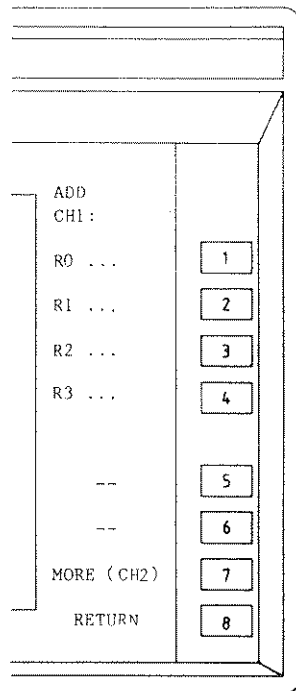
```
┌──────────────┐
│              │
│              │
├──────────────┤
│ ┌──────────┐ │
│ │ ADD      │ │
│ │ CH1:     │ │
│ │          │  ┌───┐
│ │ R0 ...   │  │ 1 │
│ │          │  ┌───┐
│ │ R1 ...   │  │ 2 │
│ │          │  ┌───┐
│ │ R2 ...   │  │ 3 │
│ │          │  ┌───┐
│ │ R3 ...   │  │ 4 │
│ │          │
│ │          │
│ │  --      │  ┌───┐
│ │          │  │ 5 │
│ │  --      │  ┌───┐
│ │          │  │ 6 │
│ │ MORE (CH2)│  ┌───┐
│ │          │  │ 7 │
│ │  RETURN  │  ┌───┐
│ │          │  │ 8 │
│ └──────────┘
```

If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6　　1　　1　　1　　R0 ...

6　　1　　1　　2　　R1 ...

6　　1　　1　　3　　R2 ...

6　　1　　1　　4　　R3 ...

> If softkey 1, 2, 3 or 4 is pressed, register R0,
> R1, R2 or R3 is selected as source CH1.
> If two channels are present in the selected
> register then pressing the softkey again will
> result in toggling between the two channels in the
> register.

6　　1　　1　　5　　--

6　　1　　1　　6　　--

6　　1　　1　　7　　MORE (CH2)

> If MORE (CH2) is pressed, the CURSOR CH2 menu will
> appear. MORE (CH2) has the same result as pressing
> RETURN and selecting CH2:R. ...

6　　1　　1　　8　　RETURN

> After pushing softkey RETURN, the MATHEMATCS ADD
> menu becomes visible.

6　　1　　2　　CH2:R. ...>
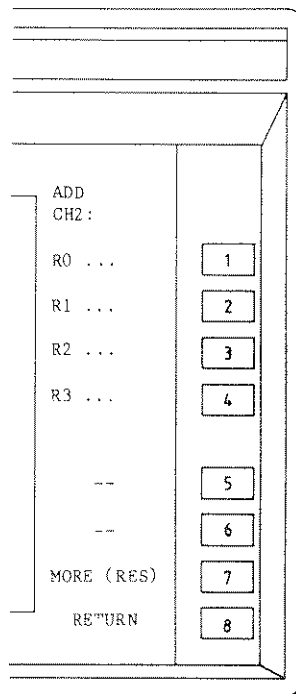
If CH2:R. ... is selected, the CH2 menu
becomes visible and channel 2 can be
selected from the registers. If there
are two channels in a register, the
selected channel is displayed
intensified.

```
ADD
CH2:

R0 ...        [ 1 ]

R1 ...        [ 2 ]

R2 ...        [ 3 ]

R3 ...        [ 4 ]


  --          [ 5 ]

  --          [ 6 ]

MORE (RES)    [ 7 ]

RETURN        [ 8 ]
```

6	1	2	1	R0 ...
6	1	2	2	R1 ...
6	1	2	3	R2 ...
6	1	2	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2. If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

6	1	2	5	--
6	1	2	6	--
6	1	2	7	MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

| 6 | 1 | 2 | 8 | RETURN |

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

| 6 | 1 | 3 | | RESULT: R.> |
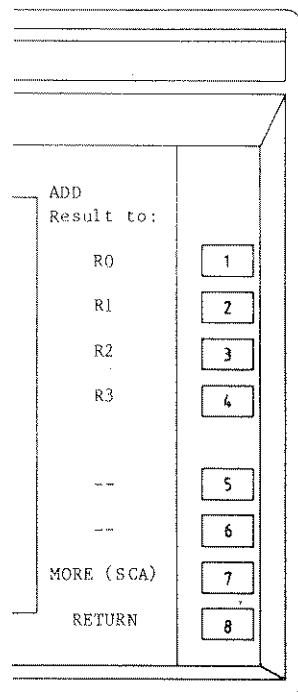
If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

ADD
Result to:

RO	1
R1	2
R2	3
R3	4
--	5
--	6
MORE (SCA)	7
RETURN	8

6	1	3	1	R0
6	1	3	2	R1
6	1	3	3	R2
6	1	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6	1	3	5	--
6	1	3	6	--
6	1	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6	1	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

6	1	4	SCALE>
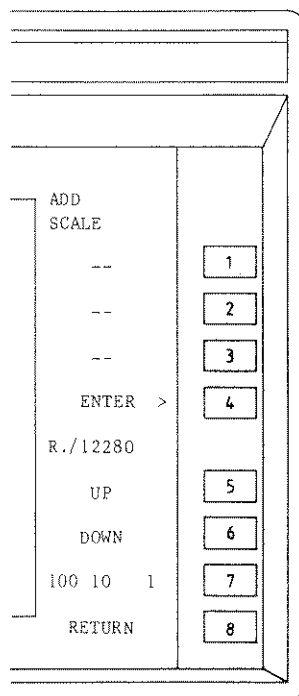
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS ADD operation inside the vertical register range.

```
ADD
SCALE
          --        [1]
          --        [2]
          --        [3]
      ENTER  >      [4]
  R./12280
        UP          [5]
      DOWN          [6]
  100 10   1        [7]
      RETURN        [8]
```

6	1	4	1	--
6	1	4	2	--
6	1	4	3	--

6   1   4   4   ENTER>

```
                       ┌─────────────┐
    SCALE
    ENTER
    Range:          ┌───┐
                    │ 1 │
    1-32256         ├───┤
                    │ 2 │
    Resolution      ├───┤
                    │ 3 │
    1               ├───┤
                    │ 4 │

                    ┌───┐
    --              │ 5 │
                    ├───┤
    CLEAR           │ 6 │
                    ├───┤
    --              │ 7 │
                    ├───┤
    EXECUTE         │ 8 │
                    └───┘
```
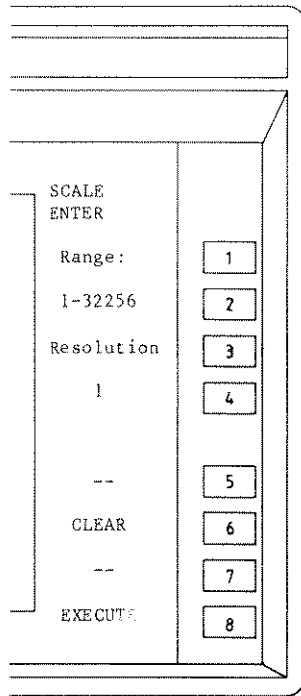
After selecting ENTER, the ADD
SCALE menu will be displayed and
the scale factor can be selected
with the numeric keyboard. The
actual range and the value is
visible in the softkey text area.

A message

Too many digits: total entry is
cleared.

is displayed if too many digits are
entered via the numeric keyboard.

Or a message

No decimal point allowed in this
enter menu.

is displayed if a decimal point is
entered via the numeric keyboard.

6   1   4   4   1   --

6   1   4   4   2   --

6   1   4   4   3   --

6   1   4   4   4   --

6   1   4   4   5   --

6   1   4   4   6   CLEAR

If an error is made, the scale value can be
cleared by pushing softkey CLEAR.

6   1   4   4   7   --

6   1   4   4   8   EXECUTE

After pushing this softkey, the selected
scale value is entered and an AUTO RETURN is
performed to the menu ADD SCALE.
If after a CLEAR the softkey EXECUTE is
pressed the scale value keeps its previous
value in the ADD SCALE menu.

A message

ADD SCALE number out of range

is displayed if the entered value exceeds the
given range.

6   1   4   5   UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6   1   4   6   DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6   1   4   7   100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6   1   4   8   RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

6   1   5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS ADD function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6   1   6   START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS ADD operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

6   1   7   INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS ADD operation. When the function is active, INCL OFFST is displayed intensified.

6   1   8   RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6   2   SUBTRACT>

```
┌─────────────────┐
│                 │
│─────────────────│
│─────────────────│
│              ╱  │
│─────────────│   │
│ MATHEMATCS  │   │
│ SUBTRACT    │   │
│             │   │
│ CH1:R. ...> │ 1 │
│             │   │
│ CH2:R. ...> │ 2 │
│             │   │
│ RESULT:R. > │ 3 │
│             │   │
│    SCALE  > │ 4 │
│             │   │
│ R.=CH1-CH2  │   │
│             │   │
│ CURSOR LMT  │ 5 │
│             │   │
│ START STOP  │ 6 │
│             │   │
│ INCL OFFST  │ 7 │
│             │   │
│   RETURN    │ 8 │
│             │   │
└─────────────────┘
```

If SUBTRACT is selected, the MATHEMATCS
SUBTRACT menu becomes visible and the sources
and destination can be selected.

Note: A change in the parameters of the
      SUBTRACT function will also change the
      parameters of all other functions,
      including any active one.

Selecting START (softkey 6) will
automatically switch OFF any active
MATHEMATCS function and start the SUBTRACT
function.
CURSOR LMT results in the subtraction of the
part between the cursors.
When one of the sources is updated, the
result register is also updated.

6   2   1   CH1:R. ...>

```
┌─────────────────┐
│                 │
│─────────────────│
│─────────────────│
│              ╱  │
│─────────────│   │
│ SUBTRACT    │   │
│ CH1:        │   │
│             │   │
│ R0 ...      │ 1 │
│             │   │
│ R1 ...      │ 2 │
│             │   │
│ R2 ...      │ 3 │
│             │   │
│ R3 ...      │ 4 │
│             │   │
│   --        │ 5 │
│             │   │
│   --        │ 6 │
│             │   │
│ MORE (CH2)  │ 7 │
│             │   │
│   RETURN    │ 8 │
└─────────────────┘
```

If CH1:R. ... is selected, the CH1 menu
becomes visible and channel 1 can be
selected from the registers. If there
are two channels in a register, the
selected channel is displayed
intensified.

6	2	1	1	R0 ...
6	2	1	2	R1 ...
6	2	1	3	R2 ...
6	2	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1. If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6	2	1	5	--
6	2	1	6	--
6	2	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6	2	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6	2	2	CH2:R. ...>
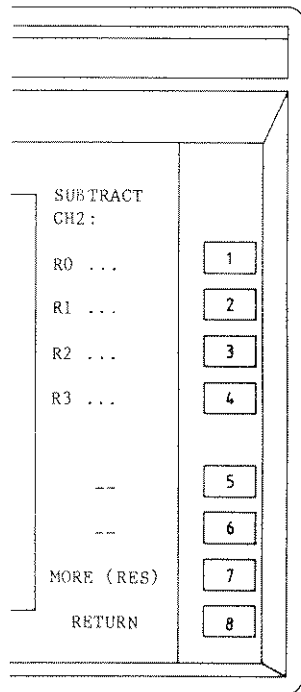
If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

4-84

6	2	2	1	R0 ...

6	2	2	2	R1 ...

6	2	2	3	R2 ...

6	2	2	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected
register, then pressing the softkey again will
result in toggling between the two channels in the
register.

6	2	2	5	--

6	2	2	6	--

6	2	2	7	MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will
appear. MORE (RES) has the same result as pressing
RETURN and selecting RESULT R..

6	2	2	8	RETURN

After pushing softkey RETURN, the MATHEMATCS
SUBTRACT menu becomes visible.

6	2	3	RESULT: R.>
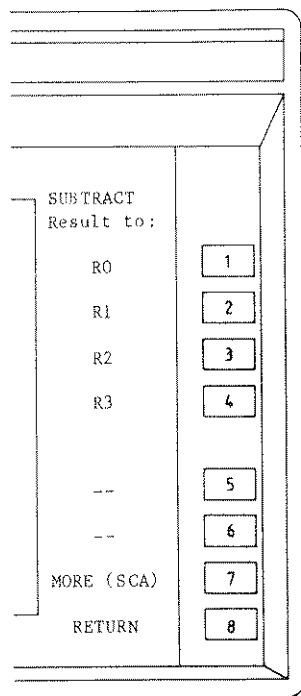
If RESULT: R. is selected, the RESULT
menu becomes visible and a register can
be selected in which the result is
stored.

SUBTRACT
Result to:

RO [1]

R1 [2]

R2 [3]

R3 [4]

-- [5]

-- [6]

MORE (SCA) [7]

RETURN [8]

6	2	3	1	R0

6	2	3	2	R1

6	2	3	3	R2

6	2	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as result register.

6	2	3	5	--

6	2	3	6	--

6	2	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will
appear. MORE (SCA) has the same result as pressing
RETURN and selecting SCALE.

6	2	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS
SUBTRACT menu becomes visible.

6	2	4		SCALE>
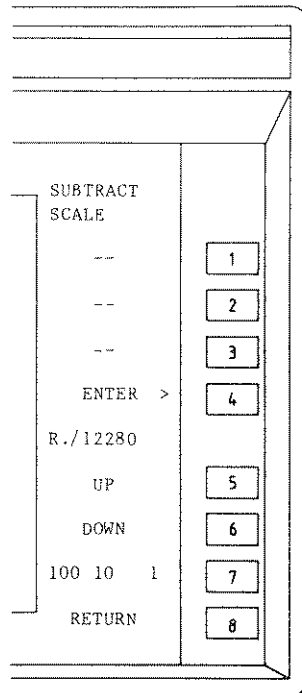
If SCALE is pressed, the SCALE menu
becomes visible and a scaling factor can
be selected to get the resulting trace
of the MATHEMATCS SUBTRACT operation
inside the vertical register range.

```
SUBTRACT
SCALE

  --          [ 1 ]

  --          [ 2 ]

  --          [ 3 ]

ENTER  >      [ 4 ]

R./12280

  UP          [ 5 ]

 DOWN         [ 6 ]

100 10  1     [ 7 ]

RETURN        [ 8 ]
```

6	2	4	1	--

6	2	4	2	--

6	2	4	3	--

6   2   4   4   ENTER>

```
            SCALE
            ENTER

            Range:        ┌───┐
                          │ 1 │
            1-32256       └───┘
                          ┌───┐
                          │ 2 │
            Resolution    └───┘
                          ┌───┐
                 1        │ 3 │
                          └───┘
                          ┌───┐
                          │ 4 │
                          └───┘

                          ┌───┐
                 --       │ 5 │
                          └───┘
                          ┌───┐
            CLEAR         │ 6 │
                          └───┘
                          ┌───┐
                 --       │ 7 │
                          └───┘
            EXECUTE       ┌───┐
                          │ 8 │
                          └───┘
```
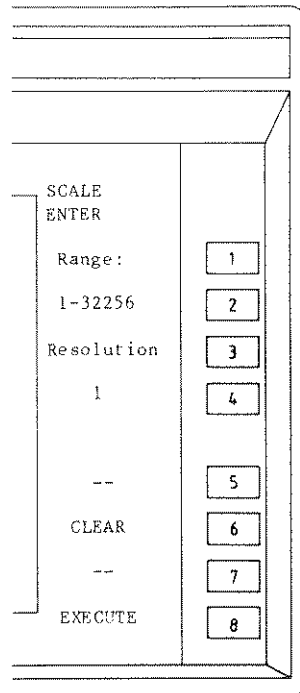
After selecting ENTER, the SUBTRACT SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6   2   4   4   1   --

6   2   4   4   2   --

6   2   4   4   3   --

6   2   4   4   4   --

6   2   4   4   5   --

6   2   4   4   6   CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6   2   4   4   7   --

6   2   4   4   8   EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu SUBTRACT SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the SUBTRACT SCALE menu.

A message

SUBTRACT SCALE number out of range

can be displayed if the entered value exceeds the given range.

6   2   4   5   UP

> Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6   2   4   6   DOWN

> Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6   2   4   7   100 10 1

> Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6   2   4   8   RETURN

> After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6   2   5   CURSOR LMT

> Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS SUBTRACT function is performed on the channels between the cursors only. Display points outside the cursors are put at −512 and are normally not displayed.
> The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
> When the function is active CURSOR LMT is displayed intensified.

6   2   6   START STOP

> Pushing softkey START STOP starts or stops the MATHEMATCS SUBTRACT operation. The actual state is displayed intensified.
> START will stop any other active MATHEMATCS function.

6   2   7   INCL OFFST

> Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS SUBTRACT operation. When the function is active, INCL OFFST is displayed intensified.

6   2   8   RETURN

> After pushing RETURN, the MATHEMATCS menu becomes visible.

6   3   MULTIPLY

```
  MATHEMATCS
  MULTIPLY

  CH1:R. ...>     [ 1 ]

  CH2:R. ...>     [ 2 ]

  RESULT:R. >     [ 3 ]

     SCALE  >     [ 4 ]

  R.=CH1*CH2

  CURSOR LMT      [ 5 ]

  START STOP      [ 6 ]

  INCL OFFST      [ 7 ]

     RETURN       [ 8 ]
```
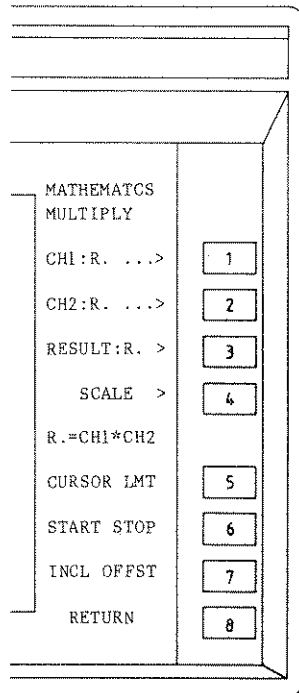
If MULTIPLY is selected, the MATHEMATCS
MULTIPLY menu becomes visible and the sources
and destination can be selected.

Note: A change in the parameters of the
      MULTIPLY function will also change the
      parameters of all other functions,
      including any active one.

Selecting START (softkey 6) will
automatically switch OFF any active
MATHEMATCS function and start the MULTIPLY
function.
CURSOR LMT results in the multiplication of
the part between the cursors.
When one of the sources is updated, the
result register is also updated.

6   3   1   CH1:R. ...>
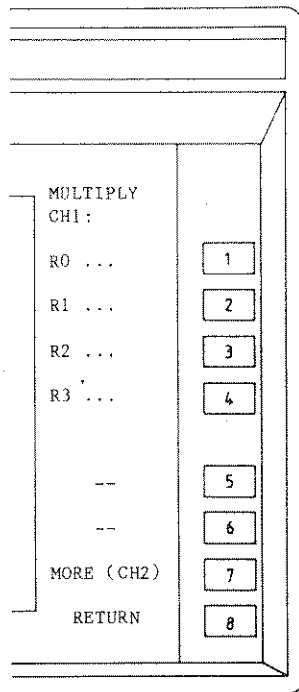
```
  MULTIPLY
  CH1:

  R0 ...      [ 1 ]

  R1 ...      [ 2 ]

  R2 ...      [ 3 ]

  R3 ...      [ 4 ]


    --        [ 5 ]

    --        [ 6 ]

  MORE (CH2)  [ 7 ]

  RETURN      [ 8 ]
```

If CH1:R. ... is selected, the CH1 menu
becomes visible and channel 1 can be
selected from the registers. If there
are two channels in a register, the
selected channel is displayed
intensified.

6	3	1	1	R0 ...
6	3	1	2	R1 ...
6	3	1	3	R2 ...
6	3	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1. If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6	3	1	5	--
6	3	1	6	--
6	3	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6	3	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6	3	2	CH2:R. ...>
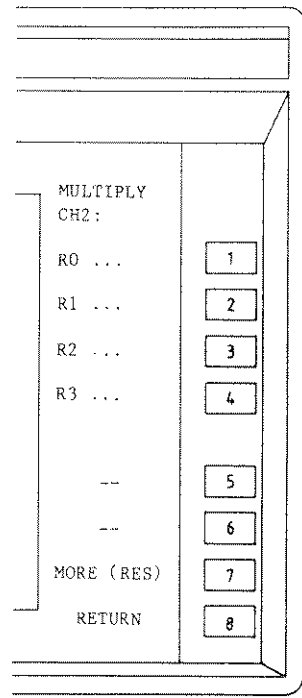
If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

MULTIPLY
CH2:

RO ...   1
R1 ...   2
R2 ...   3
R3 ...   4

--   5
--   6

MORE (RES)   7
RETURN   8

6	3	2	1	R0 ...
6	3	2	2	R1 ...
6	3	2	3	R2 ...
6	3	2	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

6	3	2	5	--
6	3	2	6	--
6	3	2	7	MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

6	3	2	8	RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6	3	3	RESULT: R.>
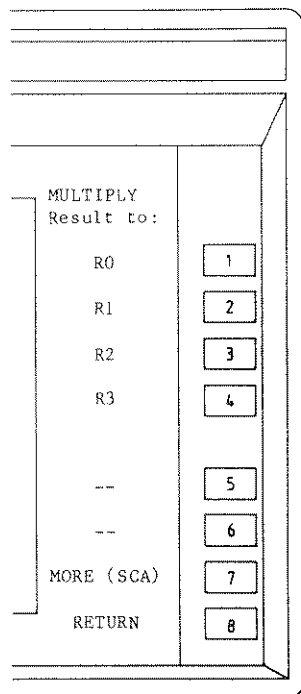
If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

```
MULTIPLY
Result to:

   R0      [ 1 ]

   R1      [ 2 ]

   R2      [ 3 ]

   R3      [ 4 ]


   --      [ 5 ]

   --      [ 6 ]

MORE (SCA)  [ 7 ]

 RETURN    [ 8 ]
```

6	3	3	1	R0
6	3	3	2	R1
6	3	3	3	R2
6	3	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6	3	3	5	--
6	3	3	6	--
6	3	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6	3	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6	3	4	SCALE>
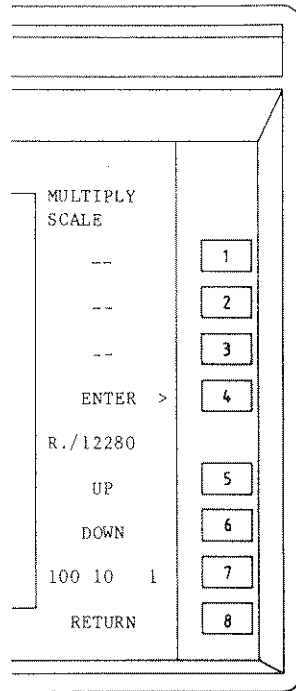
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS MULTIPLY operation inside the vertical register range.

```
MULTIPLY
SCALE
           --          [ 1 ]
           --          [ 2 ]
           --          [ 3 ]
        ENTER   >      [ 4 ]
   R./12280
          UP           [ 5 ]
        DOWN           [ 6 ]
   100 10    1         [ 7 ]
        RETURN         [ 8 ]
```

6	3	4	1	--
6	3	4	2	--
6	3	4	3	--

6   3   4   4   ENTER>

```
        SCALE
        ENTER

        Range:         [ 1 ]

        1-32256        [ 2 ]

        Resolution     [ 3 ]

        1              [ 4 ]


        --             [ 5 ]

        CLEAR          [ 6 ]

        --             [ 7 ]

        EXECUTE        [ 8 ]
```
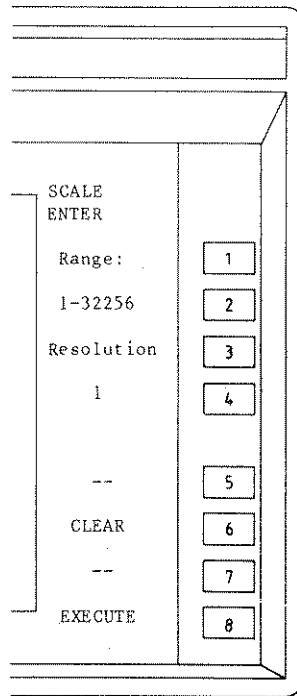
After selecting ENTER, the MULTIPLY SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6   3   4   4   1   ---

6   3   4   4   2   ---

6   3   4   4   3   ---

6   3   4   4   4   ---

6   3   4   4   5   ---

6   3   4   4   6   CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6   3   4   4   7   ---

6   3   4   4   8   EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu MULTIPLY SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the MULTIPLY SCALE menu.

A message

MULTIPLY SCALE number out of range

is displayed if the entered value exceeds the given range.

6   3   4   5   UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6   3   4   6   DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6   3   4   7   100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6   3   4   8   RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6   3   5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS MULTIPLY function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6   3   6   START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS MULTIPLY operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

6   3   7   INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS MULTIPLY operation. When the function is active, INCL OFFST is displayed intensified.

6   3   8   RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6   4   DIVIDE>

```
┌─────────────────────┐
│                     │
│                     │
├─────────────────┐   │
│ MATHEMATCS      │   │
│ DIVIDE          │   │
│                 │  ┌───┐
│ CH1:R. ...>     │  │ 1 │
│                 │  └───┘
│ CH2:R. ...>     │  ┌───┐
│                 │  │ 2 │
│                 │  └───┘
│ RESULT:R. >     │  ┌───┐
│                 │  │ 3 │
│                 │  └───┘
│      SCALE  >   │  ┌───┐
│                 │  │ 4 │
│ R.=CH1/CH2      │  └───┘
│                 │  ┌───┐
│ CURSOR LMT      │  │ 5 │
│                 │  └───┘
│ START STOP      │  ┌───┐
│                 │  │ 6 │
│ INCL OFFST      │  └───┘
│                 │  ┌───┐
│    RETURN       │  │ 7 │
│                 │  └───┘
│                 │  ┌───┐
│                 │  │ 8 │
│                 │  └───┘
└─────────────────┘
```

If DIVIDE is selected, the MATHEMATCS DIVIDE menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the DIVIDE function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the DIVIDE function.
CURSOR LMT results in the division of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6   4   1   CH1:R. ...>

```
┌─────────────────────┐
│                     │
│                     │
├─────────────────┐   │
│ DIVIDE          │   │
│ CH1:            │   │
│                 │  ┌───┐
│ R0 ...          │  │ 1 │
│                 │  └───┘
│ R1 ...          │  ┌───┐
│                 │  │ 2 │
│                 │  └───┘
│ R2 ...          │  ┌───┐
│                 │  │ 3 │
│                 │  └───┘
│ R3 ...          │  ┌───┐
│                 │  │ 4 │
│                 │  └───┘
│      --         │  ┌───┐
│                 │  │ 5 │
│                 │  └───┘
│      --         │  ┌───┐
│                 │  │ 6 │
│                 │  └───┘
│ MORE (CH2)      │  ┌───┐
│                 │  │ 7 │
│    RETURN       │  └───┘
│                 │  ┌───┐
│                 │  │ 8 │
│                 │  └───┘
└─────────────────┘
```

If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	4	1	1	RO ...
6	4	1	2	R1 ...
6	4	1	3	R2 ...
6	4	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register RO, R1, R2 or R3 is selected as source CH1. If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6	4	1	5	--
6	4	1	6	--
6	4	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6	4	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6	4	2	CH2:R. ...>
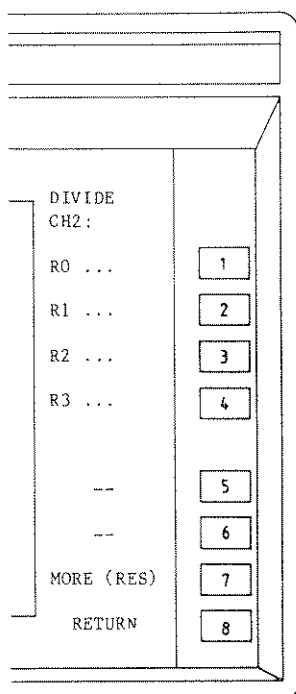
If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

```
DIVIDE
CH2:

RO ...       [ 1 ]
R1 ...       [ 2 ]
R2 ...       [ 3 ]
R3 ...       [ 4 ]

 --          [ 5 ]
 --          [ 6 ]
MORE (RES)   [ 7 ]
RETURN       [ 8 ]
```

| 6 | 4 | 2 | 1 | R0 ... |

| 6 | 4 | 2 | 2 | R1 ... |

| 6 | 4 | 2 | 3 | R2 ... |

| 6 | 4 | 2 | 4 | R3 ... |

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected
register, then pressing the softkey again will
result in toggling between the two channels in the
register.

| 6 | 4 | 2 | 5 | -- |

| 6 | 4 | 2 | 6 | -- |

| 6 | 4 | 2 | 7 | MORE (RES) |

If MORE (RES) is pressed, the RESULT R. menu will
appear. MORE (RES) has the same result as pressing
RETURN and selecting RESULT R..

| 6 | 4 | 2 | 8 | RETURN |

After pushing softkey RETURN, the MATHEMATCS
DIVIDE menu becomes visible.

| 6 | 4 | 3 | | RESULT: R.> |

If RESULT: R. is selected, the RESULT
menu becomes visible and a register can
be selected in which the result is
stored.
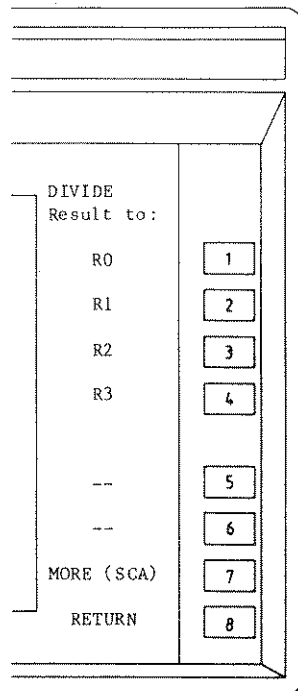
6	4	3	1	R0
6	4	3	2	R1
6	4	3	3	R2
6	4	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6	4	3	5	--
6	4	3	6	--
6	4	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6	4	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6	4	4	SCALE>
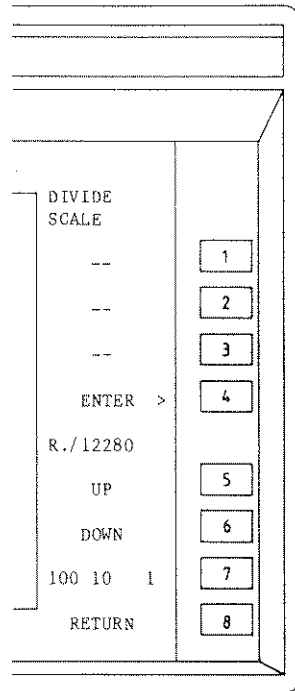
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS DIVIDE operation inside the vertical register range.

```
DIVIDE
SCALE

    --           | 1 |

    --           | 2 |

    --           | 3 |

  ENTER   >      | 4 |

R./12280

    UP           | 5 |

   DOWN          | 6 |

100 10   1       | 7 |

  RETURN         | 8 |
```

6	4	4	1	--
6	4	4	2	--
6	4	4	3	--

6   4   4   4   ENTER>

```
                          SCALE
                          ENTER

                          Range:         ┌───┐
                                         │ 1 │
                          1-32256        └───┘
                                         ┌───┐
                          Resolution     │ 2 │
                                         └───┘
                            1            ┌───┐
                                         │ 3 │
                                         └───┘
                                         ┌───┐
                                         │ 4 │
                                         └───┘

                           --            ┌───┐
                                         │ 5 │
                                         └───┘
                          CLEAR          ┌───┐
                                         │ 6 │
                           --            └───┘
                                         ┌───┐
                                         │ 7 │
                          EXECUTE        └───┘
                                         ┌───┐
                                         │ 8 │
                                         └───┘
```
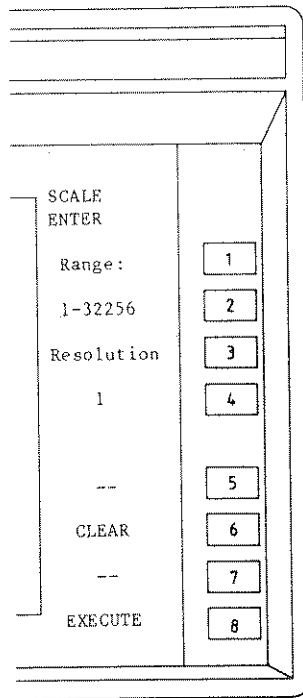
After selecting ENTER, the DIVIDE
SCALE menu will be displayed and
the scale factor can be selected
with the numeric keyboard. The
actual range and the value is
visible in the softkey text area.

A message

Too many digits: total entry is
cleared.

is displayed if too many digits are
entered via the numeric keyboard.

Or a message

No decimal point allowed in this
enter menu.

is displayed if a decimal point is
entered via the numeric keyboard.

6   4   4   4   1   --

6   4   4   4   2   --

6   4   4   4   3   --

6   4   4   4   4   --

6   4   4   4   5   --

6   4   4   4   6   CLEAR

If an error is made, the scale value can be
cleared by pushing softkey CLEAR.

6   4   4   4   7   --

6   4   4   4   8   EXECUTE

After pushing this softkey, the selected
scale value is entered and an AUTO RETURN is
performed to the menu DIVIDE SCALE.
If after a CLEAR the softkey EXECUTE is
pressed the scale value keeps its previous
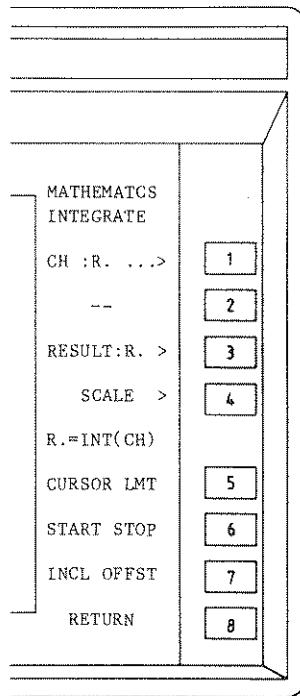value in the DIVIDE SCALE menu.

A message

DIVIDE SCALE number out of range

is displayed if the entered value exceeds the
given range.

6   4   4   5   UP

Pushing softkey UP increments the scale factor by
1, 10 or 100, selected by softkey 7.

6   4   4   6   DOWN

Pushing softkey DOWN decrements the scale factor
by 1, 10 or 100, selected by softkey 7.

6   4   4   7   100 10 1

Pushing this softkey toggles the size of the
increment or decrement step between 100, 10 and 1.
The actual value is displayed intensified.

6   4   4   8   RETURN

After pushing softkey RETURN, the MATHEMATCS
DIVIDE menu becomes visible.

6   4   5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or
OFF. When the function is switched ON, the MATHEMATCS
DIVIDE function is performed on the channels between
the cursors only. Display points outside the cursors
are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the
cursors are ON. The cursors are then automatically
positioned on CH1.
When the function is active CURSOR LMT is displayed
intensified.

6   4   6   START STOP

Pushing softkey START STOP starts or stops the
MATHEMATCS DIVIDE operation. The actual state is
displayed intensified.
START will stop any other active MATHEMATCS function.

6   4   7   INCL OFFST

Pushing softkey INCL OFFST will toggle this function.
INCL OFFST active will result in the offset of the
channels being included in the MATHEMATCS DIVIDE
operation. When the function is active, INCL OFFST is
displayed intensified.

6   4   8   RETURN

After pushing RETURN, the MATHEMATCS menu becomes
visible.

6   5   INTEGRATE>

```
┌─────────────────────┐
│                     │
│                     │
│                     │
├───────────────────┐ │
│ MATHEMATCS        ╲ │
│ INTEGRATE          │
│                    │
│ CH :R. ...>   [ 1 ]│
│                    │
│    --         [ 2 ]│
│                    │
│ RESULT:R. >   [ 3 ]│
│                    │
│    SCALE  >   [ 4 ]│
│                    │
│ R.=INT(CH)         │
│                    │
│ CURSOR LMT    [ 5 ]│
│                    │
│ START STOP    [ 6 ]│
│                    │
│ INCL OFFST    [ 7 ]│
│                    │
│    RETURN     [ 8 ]│
│                    │
└────────────────────┘
```

If INTEGRATE is selected, the MATHEMATCS
INTEGRATE menu becomes visible and the source
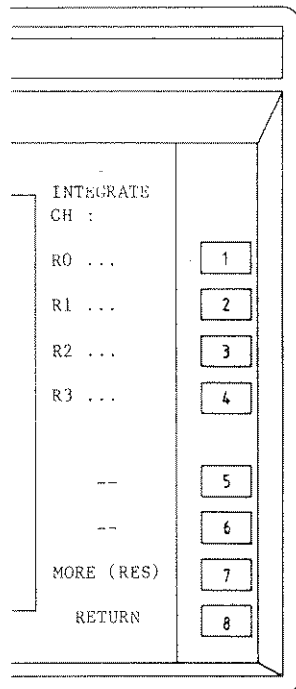and destination can be selected.

Note: A change in the parameters of the
      INTEGRATE function will also change
      the parameters of all other functions,
      including any active one.

Selecting START (softkey 6) will
automatically switch OFF any active
MATHEMATCS function and start the INTEGRATE
function.
CURSOR LMT results in the integratton of the
part between the cursors.
When the source is updated, the result
register is also updated.

6   5   1   CH :R. ...>

```
┌─────────────────────┐
│                     │
│                     │
│                   ╲ │
├───────────────┐    │
│ INTEGRATE     ╲    │
│ CH :               │
│                    │
│ RO ...      [ 1 ]  │
│                    │
│ R1 ...      [ 2 ]  │
│                    │
│ R2 ...      [ 3 ]  │
│                    │
│ R3 ...      [ 4 ]  │
│                    │
│                    │
│   --        [ 5 ]  │
│                    │
│   --        [ 6 ]  │
│                    │
│ MORE (RES)  [ 7 ]  │
│                    │
│   RETURN    [ 8 ]  │
│                    │
└────────────────────┘
```

If CH :R. ... is selected, the CH menu
becomes visible and the source channel
can be selected from the registers. If
there are two channels in a register,
the selected channel is displayed
intensified.

6	5	1	1	R0 ...
6	5	1	2	R1 ...
6	5	1	3	R2 ...
6	5	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6	5	1	5	--
6	5	1	6	--
6	5	1	7	MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6	5	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

6	5	2		--
6	5	3		RESULT: R.>

If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6	5	3	1	R0
6	5	3	2	R1
6	5	3	3	R2
6	5	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6	5	3	5	--
6	5	3	6	--
6	5	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6	5	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

6	5	4	SCALE>
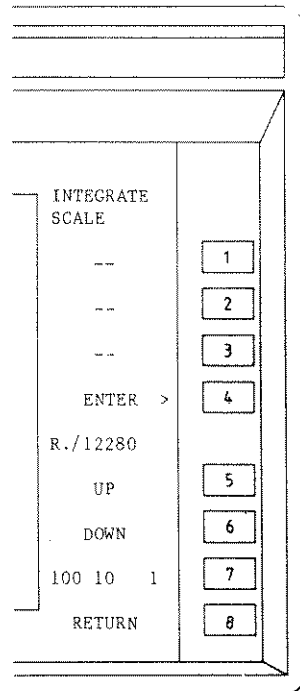
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS INTEGRATE operation inside the vertical register range.

6	5	4	1	--
6	5	4	2	--
6	5	4	3	--

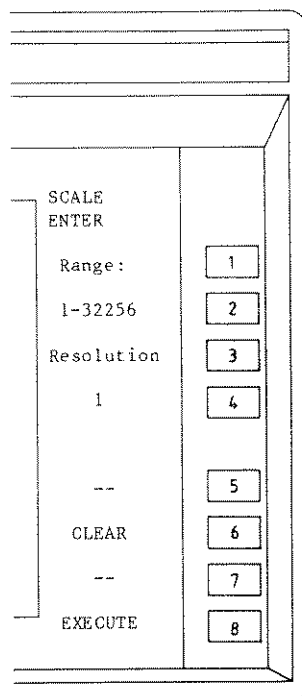6   5   4   4   ENTER>

```
                                           SCALE
                                           ENTER

                                           Range:    [ 1 ]

                                           1-32256   [ 2 ]

                                           Resolution[ 3 ]

                                           1         [ 4 ]


                                           --        [ 5 ]

                                           CLEAR     [ 6 ]

                                           --        [ 7 ]

                                           EXECUTE   [ 8 ]
```

After selecting ENTER, the INTEGRATE SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6   5   4   4   1   --

6   5   4   4   2   --

6   5   4   4   3   --

6   5   4   4   4   --

6   5   4   4   5   --

6   5   4   4   6   CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6   5   4   4   7   --

6   5   4   4   8   EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu INTEGRATE SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the INTEGRATE SCALE menu.

A message

INTEGRATE SCALE number out of range

is displayed if the entered value exceeds the given range.

6   5   4   5   UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6   5   4   6   DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6   5   4   7   100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6   5   4   8   RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

6   5   5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS INTEGRATE function is performed on the channel between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6   5   6   START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS INTEGRATE operation. The actual state is displayed intensified.
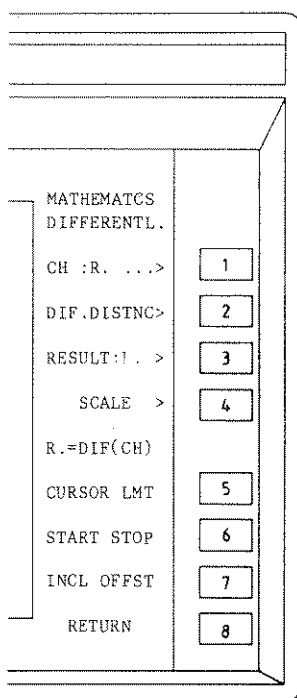
6   5   7   INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channel being included in the MATHEMATCS INTEGRATE operation. When the function is active, INCL OFFST is displayed intensified.

6   5   8   RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6   6   DIFFERENTL>

```
  ┌──────────────────────┐
  │                      │
  │   ┌──────────────┐   │
  │                      │
  │   MATHEMATCS         │
  │   DIFFERENTL.        │
  │                  ┌───┐
  │   CH :R.  ...>   │ 1 │
  │                  └───┘
  │   DIF.DISTNC>    ┌───┐
  │                  │ 2 │
  │                  └───┘
  │   RESULT:1 .  >  ┌───┐
  │                  │ 3 │
  │      SCALE   >   └───┘
  │                  ┌───┐
  │   R.=DIF(CH)     │ 4 │
  │                  └───┘
  │   CURSOR LMT     ┌───┐
  │                  │ 5 │
  │   START STOP     └───┘
  │                  ┌───┐
  │   INCL OFFST     │ 6 │
  │                  └───┘
  │      RETURN      ┌───┐
  │                  │ 7 │
  │                  └───┘
  │                  ┌───┐
  │                  │ 8 │
  │                  └───┘
  └──────────────────────┘
```
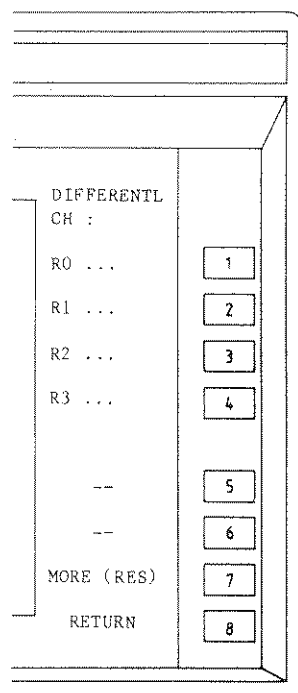
If DIFFERENTL is selected, the MATHEMATCS DIFFERENTL menu becomes visible and the source and destination can be selected. The differentiation formula is:

$$DIF(i) = point\ (i+n) - point\ (i-n)$$

Where i is the differentiated point and n is the differentiation distance.

At the begin and end of the channel 64 points are extra-polated by rotating the first 64 points 180 degrees around point 0 and the last 64 points 180 degrees around point 4095.

6   6   1   CH :R. ...>

```
  ┌──────────────────────┐
  │                      │
  │   ┌──────────────┐   │
  │                      │
  │   DIFFERENTL         │
  │   CH :               │
  │                  ┌───┐
  │   R0 ...         │ 1 │
  │                  └───┘
  │   R1 ...         ┌───┐
  │                  │ 2 │
  │                  └───┘
  │   R2 ...         ┌───┐
  │                  │ 3 │
  │                  └───┘
  │   R3 ...         ┌───┐
  │                  │ 4 │
  │                  └───┘
  │      --          ┌───┐
  │                  │ 5 │
  │      --          └───┘
  │                  ┌───┐
  │                  │ 6 │
  │   MORE (RES)     └───┘
  │                  ┌───┐
  │      RETURN      │ 7 │
  │                  └───┘
  │                  ┌───┐
  │                  │ 8 │
  │                  └───┘
  └──────────────────────┘
```

If CH :R. ... is selected, the CH menu becomes visible and the source CH can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	6	1	1	R0 ...
6	6	1	2	R1 ...
6	6	1	3	R2 ...
6	6	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as source CH.
If two channels are present in the selected
register then pressing the softkey again will
result in toggling between the two channels in the
register.

6	6	1	5	––
6	6	1	6	––
6	6	1	7	MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will
appear. MORE (RES) has the same result as pressing
RETURN and selecting RESULT:R.

6	6	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS
DIFFERENTL menu becomes visible.

6	6	2	DIF.DISTNC>

If DIF.DISTNC is selected, the
DIF.DISTNC menu becomes visible and the
differential distance is selected.
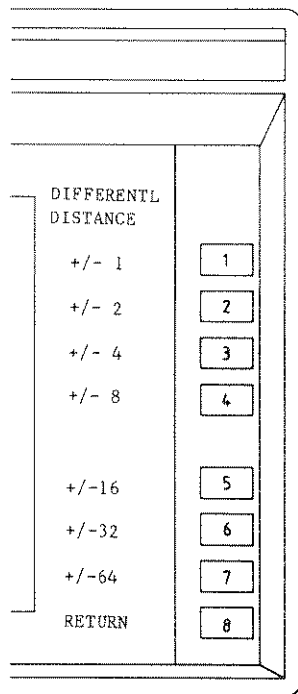
6	6	2	1	+/- 1
6	6	2	2	+/- 2
6	6	2	3	+/- 4
6	6	2	4	+/- 8
6	6	2	5	+/- 16
6	6	2	6	+/- 32
6	6	2	7	+/- 64

These softkeys select the differential distance used for the MATHEMATCS DIFFERENTL operation. The default value is +/- 1.

| 6 | 6 | 2 | 8 | RETURN |

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

| 6 | 6 | 3 | | RESULT: R.> |

If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

```
DIFFERENTL
Result to:

    RO        [ 1 ]
    R1        [ 2 ]
    R2        [ 3 ]
    R3        [ 4 ]

    --        [ 5 ]
    --        [ 6 ]
MORE (SCA)    [ 7 ]
    RETURN    [ 8 ]
```

6	6	3	1	RO
6	6	3	2	R1
6	6	3	3	R2
6	6	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register RO, R1, R2 or R3 is selected as result register.

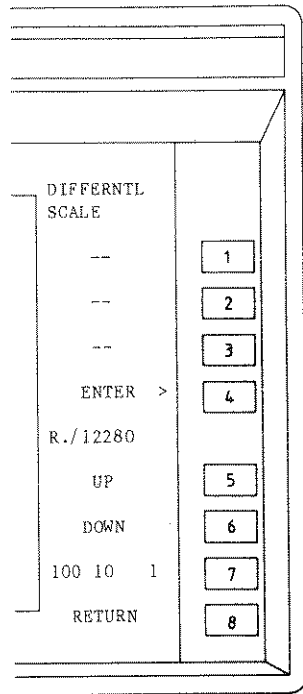6   6   3   5   --

6   6   3   6   --

6   6   3   7   MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will
appear. MORE (SCA) has the same result as pressing
RETURN and selecting SCALE.

6   6   3   8   RETURN

After pushing softkey RETURN, the MATHEMATCS
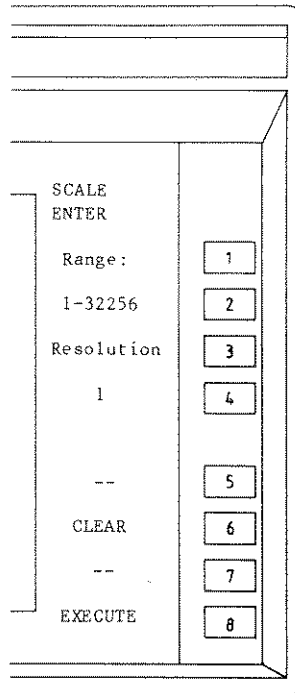DIFFERENTL menu becomes visible.

6   6   4   SCALE>

If SCALE is pressed, the SCALE menu
becomes visible and a scaling factor can
be selected to get the resulting trace
of the MATHEMATCS DIFFERENTL operation
inside the vertical register range.

```
DIFFERNTL
SCALE

  --          [ 1 ]

  --          [ 2 ]

  --          [ 3 ]

 ENTER  >     [ 4 ]

R./12280

  UP          [ 5 ]

 DOWN         [ 6 ]

100 10    1   [ 7 ]

 RETURN       [ 8 ]
```

6   6   4   1   --

6   6   4   2   --

6   6   4   3   --

6   6   4   4   ENTER>

```
 _____
|  _____  |
| |_____| |
|  _____  |
| /                          |
||  SCALE                     |
||  ENTER                     |
||                      ___   |
||  Range:             | 1 |  |
||                      ‾‾‾   |
||  1-32256            | 2 |  |
||                      ‾‾‾   |
||  Resolution         | 3 |  |
||                      ‾‾‾   |
||    1                | 4 |  |
||                      ‾‾‾   |
||                            |
||    --               | 5 |  |
||                      ‾‾‾   |
||  CLEAR              | 6 |  |
||                      ‾‾‾   |
||    --               | 7 |  |
||                      ‾‾‾   |
||  EXECUTE            | 8 |  |
| \                    ‾‾‾   |
|  _____  |
| /                          |
```

After selecting ENTER, the DIFFERENTL SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6   6   4   4   1   --

6   6   4   4   2   --

6   6   4   4   3   --

6   6   4   4   4   --

6   6   4   4   5   --

6   6   4   4   6   CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6   6   4   4   7   --

6   6   4   4   8   EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu DIFFERENTL SCALE. If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the DIFFERENTL SCALE menu.

A message

DIFFERENTL SCALE number out of range

is displayed if the entered value exceeds the given range.

6   6   4   5   UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6   6   4   6   DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6   6   4   7   100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6   6   4   8   RETURN

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

6   6   5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS DIFFERENTL function is performed on the channel between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6   6   6   START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS DIFFERENTL operation. The actual state is displayed intensified.

6   6   7   INCL OFFST
Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channel being included in the MATHEMATCS DIFFERENTL operation. When the function is active, INCL OFFST is displayed intensified.

6   6   8   RETURN

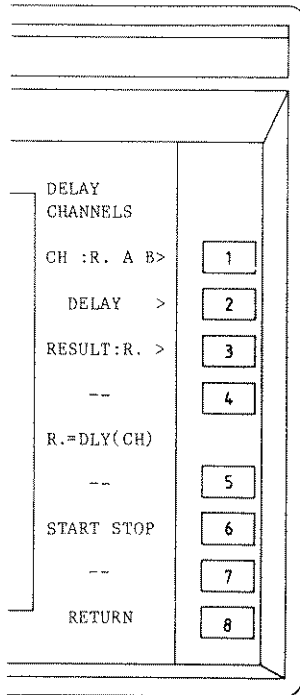After pushing RETURN, the MATHEMATCS menu becomes visible.

6 7 MORE
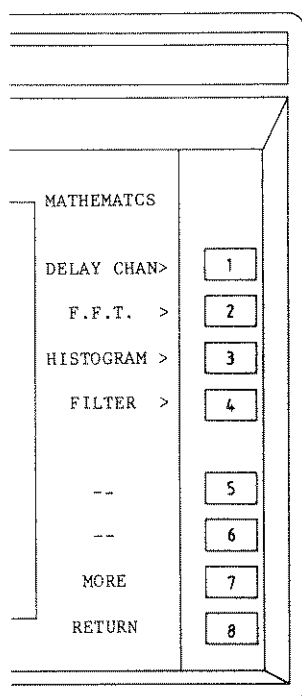
After pushing softkey MORE, the second
MATHEMATCS menu becomes visible.
This menu is an extension of the first
MATHEMATCS menu, so a selection in this menu
has the same level as a selection in the
first MATHEMATCS menu. This is indicated by
numbers 7,1 ... 7,8, where the first number
indicates the MORE selection and the second
number indicates the selection in the second
MATHEMATCS menu.

```
MATHEMATCS

DELAY CHAN>    [ 1 ]
  F.F.T.  >    [ 2 ]
HISTOGRAM >    [ 3 ]
  FILTER  >    [ 4 ]

    --         [ 5 ]
    --         [ 6 ]
  MORE         [ 7 ]
  RETURN       [ 8 ]
```

6 8 RETURN

After pushing RETURN, the CURSOR SELECT menu becomes
visible.

6   7,1   DELAY CHAN>

```
          ┌──────────────────────┐
          │                      │
          │   ┌──────────────────┴──┐
          │   │                     │
      ┌── │   │                     │
      │DELAY                        │
      │CHANNELS                     │
      │                ┌───┐        │
      │CH :R. A B>      │ 1 │       │
      │                └───┘        │
      │  DELAY    >     ┌───┐       │
      │                 │ 2 │       │
      │                 └───┘       │
      │RESULT:R.  >     ┌───┐       │
      │                 │ 3 │       │
      │     --          ┌───┐       │
      │                 │ 4 │       │
      │R.=DLY(CH)       └───┘       │
      │                 ┌───┐       │
      │     --          │ 5 │       │
      │                 └───┘       │
      │START STOP       ┌───┐       │
      │                 │ 6 │       │
      │     --          └───┐       │
      │                 │ 7 │       │
      │                 └───┘       │
      └─ RETURN         ┌───┐       │
                        │ 8 │       │
          │             └───┘       │
          └─────────────────────────┘
```

If DELAY CHAN is selected, the MATHEMATCS
DELAY CHAN menu becomes visible and the
sources and destination can be selected.
DELAY CHAN can only operate on registers that
contain two channels.
The DELAY CHAN operation will shift in time,
one of the two channels with the selected
delay. The channel to shift is selected in
the sub-menu DELAY.
The dots that are shifted out of a register
are lost and can not be recalled. The dots
that are shifted in on the other side are put
on the minimum level and are indicated as not
real samples.

6   7,1 1   CH :R. A B>

```
          ┌──────────────────────┐
          │                      │
          │   ┌──────────────────┴──┐
          │   │                     │
          │   │                     │
      ┌── │   │                     │
      │DELAY CHAN                   │
      │SOURCE:                      │
      │                ┌───┐        │
      │R0 A B          │ 1 │        │
      │                └───┘        │
      │R1 A B          ┌───┐        │
      │                │ 2 │        │
      │                └───┘        │
      │R2 A B          ┌───┐        │
      │                │ 3 │        │
      │                └───┘        │
      │R3 A B          ┌───┐        │
      │                │ 4 │        │
      │                └───┘        │
      │                ┌───┐        │
      │     --         │ 5 │        │
      │                └───┘        │
      │     --         ┌───┐        │
      │                │ 6 │        │
      │                └───┘        │
      │MORE (RES)      ┌───┐        │
      │                │ 7 │        │
      │                └───┘        │
      └─ RETURN        ┌───┐        │
                       │ 8 │        │
          │            └───┘        │
          └─────────────────────────┘
```
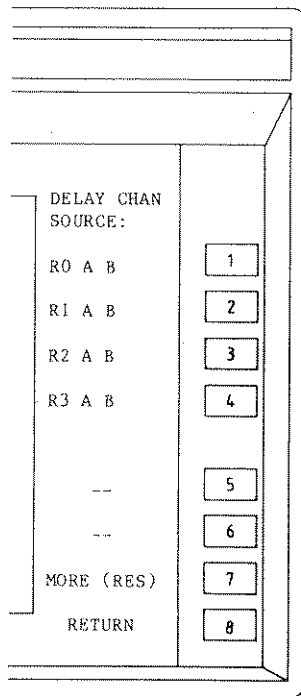
If CH :R. A B is selected, the CH menu
becomes visible and the source channel
can be selected from the registers. Only
registers in which two channels are
present can be selected.

6   7,1 1   1   R0 A B

6   7,1 1   2   R1 A B

6   7,1 1   3   R2 A B

6   7,1   1   4   R3 A B

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as source CH.
Only registers that contain two channels will be
displayed and can be selected.

6   7,1   1   5   --

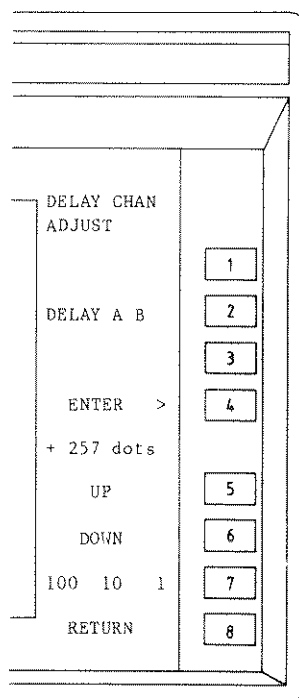6   7,1   1   6   --

6   7,1   1   7   MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will
appear. MORE (RES) has the same result as pressing
the RETURN and then selecting RESULT:R.

6   7,1   1   8   RETURN

After pushing softkey RETURN, the MATHEMATCS
DELAY CHAN menu becomes visible.

6   7,1   2   DELAY>

If DELAY is selected, the DELAY CHAN
ADJUST menu becomes visible. In this
menu the channel can be selected, that
has to be delayed and the delay can be
entered or changed.

DELAY CHAN
ADJUST

DELAY A B

ENTER   >
+ 257 dots

UP

DOWN

100 10   1

RETURN

6   7,1   2   1   --

6   7,1   2   2   DELAY A B

If DELAY A B is pressed, the
channel to delay is toggled between
A and B. The selected channel is
displayed intensified.

6   7,1   2   3   --

6   7,1 2   4   ENTER>

```
  _____
 |_____ |
 |_____ ||
 | _____  ||
 ||                         | ||
 ||  DELAY CHAN             |  ||
 ||  ENTER                  |   |
 ||                     ___  |  |
 ||  Range:            | 1 | |  |
 ||                     ---  |  |
 ||   +/-2048          | 2 | |  |
 ||                     ---  |  |
 ||  Resolution        | 3 | |  |
 ||                     ---  |  |
 ||   1 dot            | 4 | |  |
 ||                     ---  |  |
 ||    ? Dot                 |  |
 ||                     ___  |  |
 ||   --               | 5 | |  |
 ||                     ---  |  |
 ||  CLEAR             | 6 | |  |
 ||                     ---  |  |
 ||   --               | 7 | |  |
 ||                     ---  |  |
 ||  EXECUTE           | 8 | |  |
 ||_____---__| /
 |_____|
```
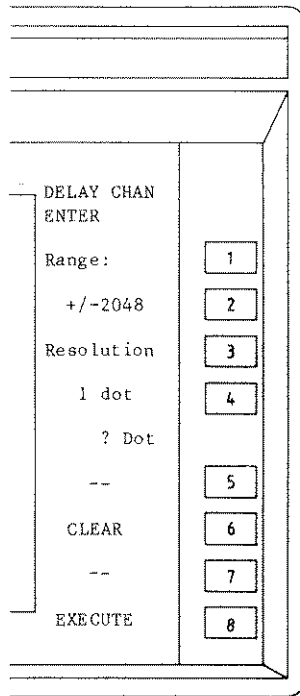
After selecting ENTER, the DELAY
ENTER menu will be displayed and
the delay can be selected with the
numeric keyboard. The actual range
and the value is visible in the
softkey text area.

A message

Too many digits: total entry is
cleared.

is displayed if too many digits are
entered via the numeric keyboard.

Or a message

No decimal point allowed in this
enter menu.

is displayed if a decimal point is
entered via the numeric keyboard.

6   7,1 2   4   1   --

6   7,1 2   4   2   --

6   7,1 2   4   3   --

6   7,1 2   4   4   --

6   7,1 2   4   5   --

6   7,1 2   4   6   CLEAR

If an error is made, the delay value can be
cleared by pushing softkey CLEAR.

6   7,1 2   4   7   --

6   7,1 2   4   8   EXECUTE

After pushing this softkey, the selected
scale value is entered and an AUTO RETURN is
performed to the menu DELAY CHAN ADJUST.
If after a CLEAR the softkey EXECUTE is
pressed the scale value keeps its previous
value in the DELAY CHANNEL ADJUST menu.

A message

DELAY CHANNEL ADJUST number out of range

is displayed if the entered value exceeds the
given range.

6   7,1   2   5   UP

Pushing softkey UP increments the scale factor by
1, 10 or 100, selected by softkey 7.

6   7,1   2   6   DOWN

Pushing softkey DOWN decrements the scale factor
by 1, 10 or 100, selected by softkey 7.

6   7,1   2   7   100 10 1

Pushing this softkey toggles the size of the
increment or decrement step between 100, 10 and 1.
The actual value is displayed intensified.

6   7,1   2   8   RETURN

After pushing softkey RETURN, the DELAY CHANNELS
menu becomes visible.

6   7,1   3   RESULT: R.>
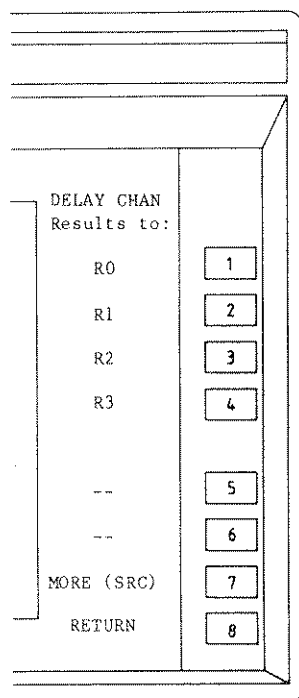
If RESULT: R. is selected, the RESULT
menu becomes visible and a register can
be selected in which the result is
stored.

DELAY CHAN
Results to:

RO   1

R1   2

R2   3

R3   4

--   5

--   6

MORE (SRC)   7

RETURN   8

6   7,1   3   1   RO

6   7,1   3   2   R1

6   7,1   3   3   R2

6   7,1   3   4   R3

If softkey 1, 2, 3 or 4 is pressed, register RO,
R1, R2 or R3 is selected as result register.

| 6 | 7,1 | 3 | 5 | -- |

| 6 | 7,1 | 3 | 6 | -- |

| 6 | 7,1 | 3 | 7 | MORE (SRC) |

If MORE (SRC) is pressed, the CH :R. A B menu will appear. MORE (SRC) has the same result as pressing RETURN and then selecting CH :R. A B

| 6 | 7,1 | 3 | 8 | RETURN |

After pushing softkey RETURN, the MATHEMATCS DELAY CHAN menu becomes visible.

| 6 | 7,1 | 4 | -- |

| 6 | 7,1 | 5 | -- |

| 6 | 7,1 | 6 | START STOP |

Pushing softkey START STOP starts or stops the DELAY CHAN operation. The actual state is displayed intensified.

| 6 | 7,1 | 7 | -- |

| 6 | 7,1 | 8 | RETURN |

After pushing RETURN, the second MATHEMATCS menu becomes visible.

6   7,2   F.F.T.>   OPTIONAL

```
  ┌──────────────────────────┐
  │ ════════════════════════ │
  │ ──────────────────────── │
  │                        ╱ │
  │ MATHEMATCS               │
  │ F.F.T.                   │
  │                     ┌───┐│
  │ CH :R. ...>         │ 1 ││
  │                     └───┘│
  │ FFT PARAM.>         ┌───┐│
  │                     │ 2 ││
  │ RESULT:R. >         └───┘│
  │                     ┌───┐│
  │     --              │ 3 ││
  │                     └───┘│
  │ R.=FFT(CH)          ┌───┐│
  │                     │ 4 ││
  │ CURSOR LMT          └───┘│
  │                     ┌───┐│
  │ START STOP          │ 5 ││
  │                     └───┘│
  │     --              ┌───┐│
  │                     │ 6 ││
  │ RETURN              └───┘│
  │                     ┌───┐│
  │                     │ 7 ││
  │                     └───┘│
  │                     ┌───┐│
  │                     │ 8 ││
  │                     └───┘│
  └──────────────────────────┘
```
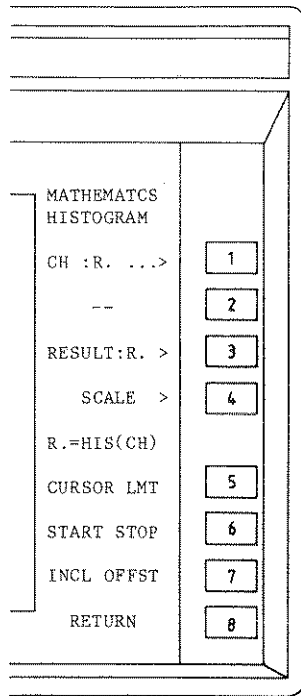
If F.F.T. is selected, the MATHEMATCS F.F.T.
menu becomes visible and the source and
destination can be selected.
The result register will contain the
frequency spectrum of the source CH.
When a window is selected, the source is
multiplied by the WINDOW function, before the
F.F.T. is performed. Windowing is used to
reduce the effect of leakage at the edges of
the source channel. (F.F.T. assumes the
register to be exactly one period of a
periodic signal, which normally is not the
case.)
The F.F.T. is started and stopped with the
START STOP softkey. Starting F.F.T. will stop
any other active MATHEMATCS function.

6   7,2   1   CH :R. ...>

```
  ┌──────────────────────────┐
  │ ════════════════════════ │
  │ ──────────────────────── │
  │                        ╱ │
  │ F.F.T.                   │
  │ CH :                     │
  │                     ┌───┐│
  │ R0 ...              │ 1 ││
  │                     └───┘│
  │ R1 ...              ┌───┐│
  │                     │ 2 ││
  │ R2 ...              └───┘│
  │                     ┌───┐│
  │ R3 ...              │ 3 ││
  │                     └───┘│
  │                     ┌───┐│
  │                     │ 4 ││
  │                     └───┘│
  │     --              ┌───┐│
  │                     │ 5 ││
  │     --              └───┘│
  │                     ┌───┐│
  │ MORE (RES)          │ 6 ││
  │                     └───┘│
  │ RETURN              ┌───┐│
  │                     │ 7 ││
  │                     └───┘│
  │                     ┌───┐│
  │                     │ 8 ││
  │                     └───┘│
  └──────────────────────────┘
```

If CH :R. ... is selected, the CH menu
becomes visible and the source channel
can be selected from the registers. If
there are two channels in a register,
the selected trace is displayed
intensified.

6   7,2 1   1   R0 ...

6   7,2 1   2   R1 ...

6   7,2 1   3   R2 ...

6   7,2 1   4   R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1, R2 or R3 is selected as source CH.
If there are two channels in the selected register
then pressing the softkey again will result in
switching between the two channels in the register.

6   7,2 1   5   --

6   7,2 1   6   --

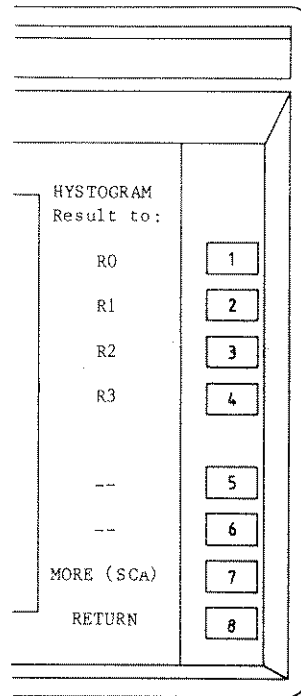6   7,2 1   7   MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will
appear. MORE (RES) has the same result as pressing
RETURN and selecting RESULT:R.

6   7,2 1   8   RETURN

After pushing softkey RETURN, the MATHEMATCS
F.F.T. menu becomes visible.

6   7,2 2   FFT PARAM.>

The FFT PARAM menu consists of 2 parts.
In the top half the WINDOW is selected.
The bottom part gives a selection for
the amplitude scaling. The time scaling
is always linear and depending on the
time-base of the source register.
The source CH is multiplied by the
WINDOW, which is used to reduce the
effect of leakage.

```
F.F.T.
WINDOW

RECTANG.    [ 1 ]

HAMMING     [ 2 ]

HANNING     [ 3 ]

   --       [ 4 ]

AMP SCALE:

LIN (V)     [ 5 ]

LOG (dB)    [ 6 ]

   --       [ 7 ]

RETURN      [ 8 ]
```

6   7,2 2   1   RECTANG.

If RECTANG. is selected, the source channel is
multiplied by a window with the value 1 over the
selected part of the channel. So the real channel
values are used for the FFT calculation.

6   7,2   2   2   HAMMING

If HAMMING is selected, the source CH is
multiplied by the function:

$$f(t) = 0.08 + 0.46(1-\cos2 \ t/T)$$

In which T is the length of the source channel or
the part limitted by the cursors.
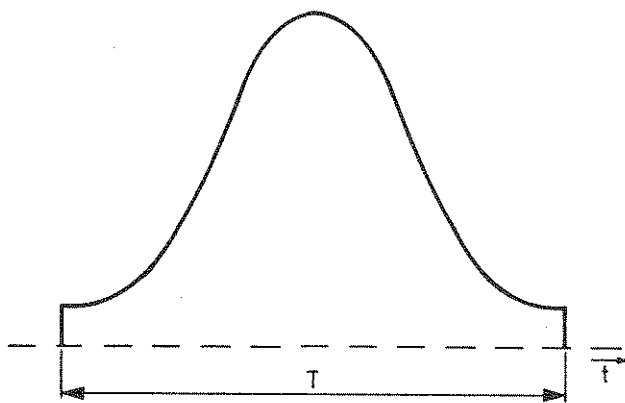
MAT3167

Figure 4.20 Hamming window.

6   7,2   2   3   HANNING

If HANNING is selected, the source CH is
multiplied by the function:

$$f(t) = \ 0.5 \ (1-\cos2 \ t/T)$$

In which T is the length of the source channel or
the part limitted by the cursors.
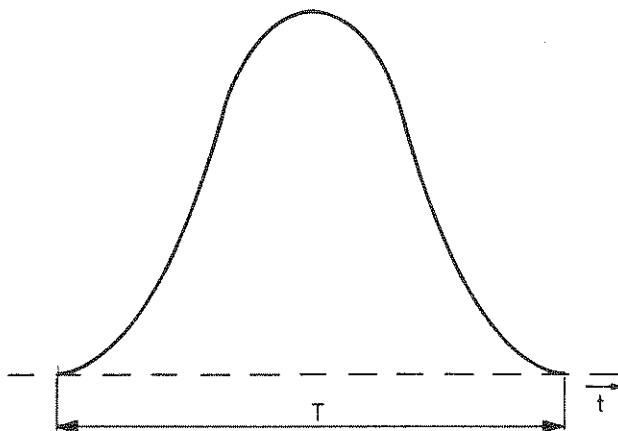
MAT3166

Figure 4.21 Hanning window.

| 6 | 7,2 | 2 | 4 | -- |

| 6 | 7,2 | 2 | 5 | LIN (V) |

The result of the FFT is vertically displayed on a linear (voltage) scale.

| 6 | 7,2 | 2 | 6 | LOG (dB) |

The result of the FFT is vertically displayed on a logarithm (dB) scale. The dynamic range is 49.8 dB and smaller results are all set to -49.8 dB.

| 6 | 7,2 | 2 | 7 | -- |

| 6 | 7,2 | 2 | 8 | RETURN |

After pushing softkey RETURN, the MATHEMATCS F.F.T. menu becomes visible.

| 6 | 7,2 | 3 | | RESULT: R.> |
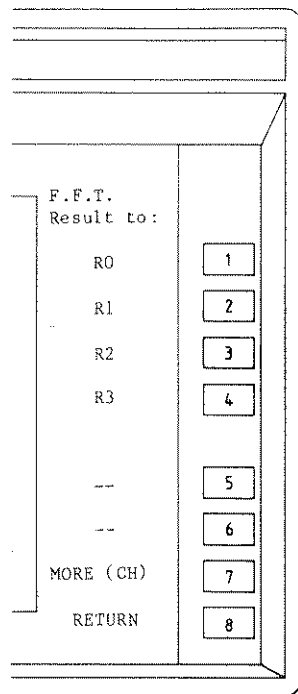
If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

F.F.T.
Result to:

R0	1
R1	2
R2	3
R3	4
---	5
---	6
MORE (CH)	7
RETURN	8

| 6 | 7,2 | 3 | 1 | R0 |

| 6 | 7,2 | 3 | 2 | R1 |

| 6 | 7,2 | 3 | 3 | R2 |

| 6 | 7,2 | 3 | 4 | R3 |

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 7,2 3 5 --

6 7,2 3 6 --

6 7,2 3 7 MORE (CH)

       If MORE (CH) is pressed, the CH :R... menu will
       appear. MORE (CH) has the same result as pressing
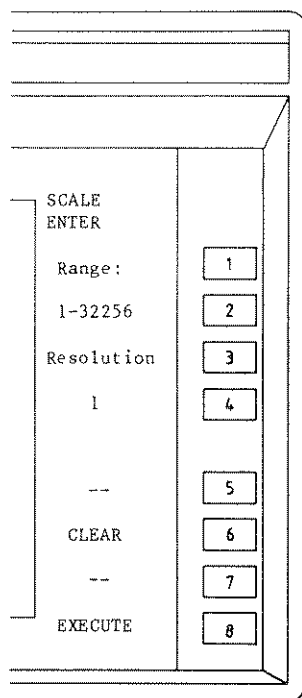   RETURN and than selecting CH :R...

6 7,2 3 8 RETURN

       After pushing softkey RETURN, the MATHEMATCS
       F.F.T. menu becomes visible.

6 7,2 4 --

6 7,2 5 CURSOR LMT

       Pushing softkey CURSOR LMT toggles the function on or
       off. When the function is switched on, the MATHEMATCS
       F.F.T. function is performed on the channel between the
       cursors only. Channel points outside the cursors are
       put at 0 (zero filling).
       The function CURSOR LMT can only be selected when the
       cursors are ON. The cursors are then automatically
       positioned on CH.
       When the function is active CURSOR LMT is displayed
       intensified.

6 7,2 6 START STOP

       Pushing softkey START STOP starts or stops the
       MATHEMATCS F.F.T. operation. The actual state is
       displayed intensified.

6 7,2 7 INCL OFFST
       Pushing softkey INCL OFFST will toggle this function.
       INCL OFFST active will result in the offset of the
       traces being included in the MATHEMATCS F.F.T.
       operation. When the function is active, INCL OFFST is
       displayed intensified.

6 7,2 8 RETURN

       After pushing RETURN, the second MATHEMATCS menu
       becomes visible.

6   7,3   HYSTOGRAM>

```
  MATHEMATCS
  HISTOGRAM

  CH :R. ...>        [ 1 ]

       --           [ 2 ]

  RESULT:R. >       [ 3 ]

     SCALE  >       [ 4 ]

  R.=HIS(CH)

  CURSOR LMT        [ 5 ]

  START  STOP       [ 6 ]

  INCL OFFST        [ 7 ]

     RETURN         [ 8 ]
```

If ADD is selected, the MATHEMATCS HYSTOGRAM menu becomes visible and the sources and destination can be selected.
Hystogram indicates the probability that a time varying signal will assume a value within a fixed amplitude range.

SINEWAVE

—— 5 V

—— 1V
—— 0V

HYSTOGRAM

-5   -4   -3   -2   -1   0   1   2   3   4   5   MAT3168
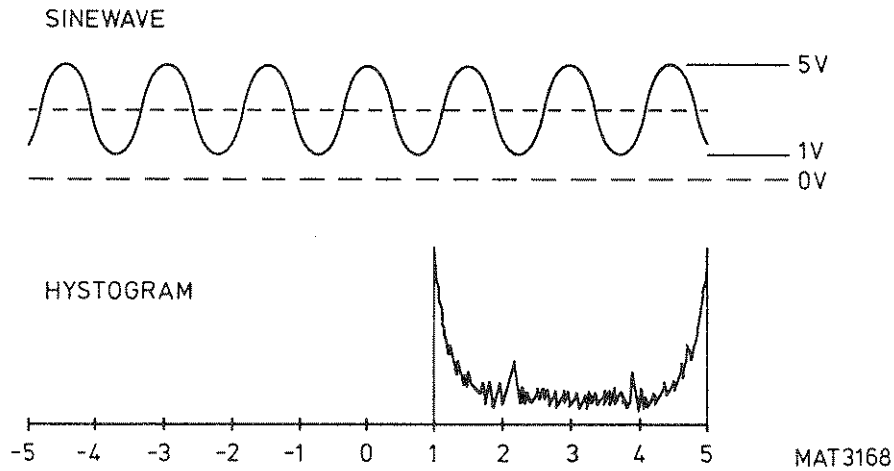
Figure 4.22 Hystogram display.

6   7,3   1   CH :R. ...>
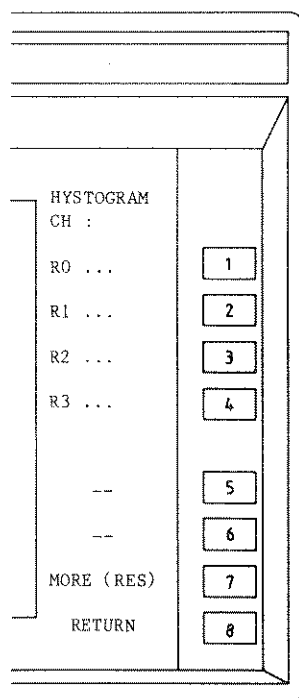
If CH :R. ... is selected, the CH menu
becomes visible and the source trace can
be selected from the registers. If there
are two traces in a register, the
selected trace is displayed intensified.

HYSTOGRAM
CH :

RO ... | 1 |

R1 ... | 2 |

R2 ... | 3 |

R3 ... | 4 |

-- | 5 |

-- | 6 |

MORE (RES) | 7 |

RETURN | 8 |

6   7,3   1   1   RO ...

6   7,3   1   2   R1 ...

6   7,3   1   3   R2 ...

6   7,3   1   4   R3 ...

If softkey 1, 2, 3 or 4 is pressed, register RO,
R1, R2 or R3 is selected as source CH.
If there are two channels in the selected register
then pressing the softkey again will result in
toggling between the two channels in the register.

6   7,3   1   5   --

6   7,3   1   6   --

6   7,3   1   7   MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will
appear. MORE (RES) has the same result as pressing
RETURN and selecting RESULT:R.

6   7,3   1   8   RETURN

After pushing softkey RETURN, the MATHEMATCS
HYSTOGRAM menu becomes visible.

6   7,3   2   --

6   7,3   3   RESULT: R.>

```
┌─────────────────┐
│  ═══════════════│
│  ═══════════════│
│  ═══════════════│
│                 │
│ ┌─ HYSTOGRAM    │
│ │  Result to:   │
│ │               │
│ │   R0    [ 1 ] │
│ │               │
│ │   R1    [ 2 ] │
│ │               │
│ │   R2    [ 3 ] │
│ │               │
│ │   R3    [ 4 ] │
│ │               │
│ │               │
│ │   --    [ 5 ] │
│ │               │
│ │   --    [ 6 ] │
│ │               │
│ │ MORE (SCA) [7]│
│ │               │
│ └─ RETURN  [ 8 ]│
│                 │
└─────────────────┘
```

If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6   7,3   3   1   R0

6   7,3   3   2   R1

6   7,3   3   3   R2

6   7,3   3   4   R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6   7,3   3   5   --

6   7,3   3   6   --

6   7,3   3   7   MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6   7,3   3   8   RETURN

After pushing softkey RETURN, the MATHEMATCS HYSTOGRAM menu becomes visible.

6   7,3 4   SCALE>
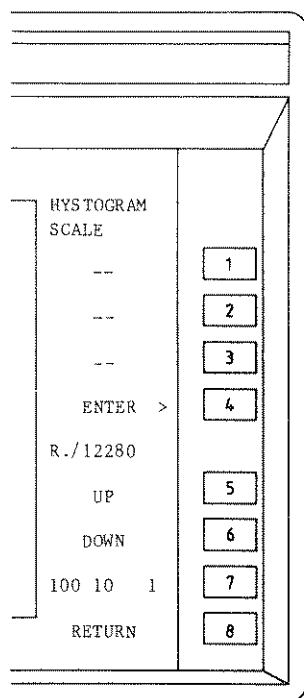
```
   HYSTOGRAM
   SCALE

      --            [ 1 ]

      --            [ 2 ]

      --            [ 3 ]

   ENTER  >         [ 4 ]

   R./12280

      UP            [ 5 ]

     DOWN           [ 6 ]

   100 10   1       [ 7 ]

    RETURN          [ 8 ]
```

If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS HYSTOGRAM operation inside the vertical register range.

6   7,3 4   1   --

6   7,3 4   2   --

6   7,3 4   3   --

6   7,3 4   4   ENTER>

```
   SCALE
   ENTER

   Range:           [ 1 ]

   1-32256          [ 2 ]

   Resolution       [ 3 ]

      1             [ 4 ]


      --            [ 5 ]

    CLEAR           [ 6 ]

      --            [ 7 ]

    EXECUTE         [ 8 ]
```

If ENTER is selected, the HYSTOGRAM SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value are visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6	7,3	4	4	1	--

6	7,3	4	4	2	--

6	7,3	4	4	3	--

6	7,3	4	4	4	--

6	7,3	4	4	5	--

6	7,3	4	4	6	CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6	7,3	4	4	7	--

6	7,3	4	4	8	EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu HYSTOGRAM SCALE. If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the HYSTOGRAM SCALE menu.

A message

HYSTOGRAM SCALE number out of range

is displayed if the entered value exceeds the given range.

6	7,3	4	5	UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6	7,3	4	6	DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6	7,3	4	7	100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6	7,3	4	8	RETURN

After pushing softkey RETURN, the MATHEMATCS HYSTOGRAM menu becomes visible.

6   7,3 5   CURSOR LMT

Pushing softkey CURSOR LMT toggles the function on or
off. When the function is switched on, the MATHEMATCS
HYSTOGRAM function is performed on the traces between
the cursors only. Display points outside the cursors
are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the
cursors are ON. The cursors are then automatically
positioned on CH.
When the function is active CURSOR LMT is displayed
intensified.

6   7,3 6   START STOP

Pushing softkey START STOP starts or stops the
MATHEMATCS HYSTOGRAM operation. The actual state is
displayed intensified.

6   7,3 7   INCL OFFST

Pushing softkey INCL OFFST will toggle this function.
INCL OFFST active will result in the offset of the
traces being included in the MATHEMATCS HYSTOGRAM
operation. When the function is active, INCL OFFST is
displayed intensified.

6   7,3 8   RETURN

After pushing RETURN, the second MATHEMATCS menu
becomes visible.

6   7,4 FILTER>   OPTIONAL

```
 _____
|   _____  |
|  |_____| |
|  |_____/ |
|  |  _____/  |
|  | |          /   |
|  | | MATHEMATCS   |
|  | | FILTER       |
|  | |              |   ___
|  | | CH :R. ...>  |  | 1 |
|  | |              |   ---
|  | | FILT ORDER>  |  | 2 |
|  | |              |   ---
|  | | RESULT:R. >  |  | 3 |
|  | |              |   ---
|  | |    --        |  | 4 |
|  | |              |   ---
|  | | R.=FIL(CH)   |
|  | |              |   ---
|  | | CURSOR LMT   |  | 5 |
|  | |              |   ---
|  | | START STOP   |  | 6 |
|  | |              |   ---
|  | |    --        |  | 7 |
|  | |              |   ---
|  |_| RETURN       |  | 8 |
|     |_____ |   ---
|_____|
```
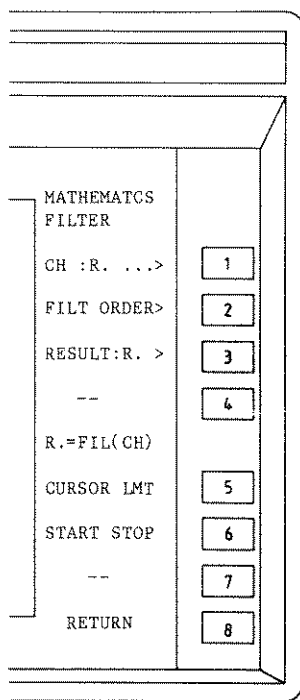
If FILTER is selected, the MATHEMATCS FILTER
menu becomes visible and the source and
destination can be selected.
The FILTER function is smoothing the source
register and storing the result in the result
register.
The FILTER ORDER is the number of points that
is used to calculate 1 resulting point. Each
resulting point is the addition of the
corresponding source point and its neighbours
each multiplied by a factor according the
filter formula.

$$Filter(n) = \frac{1 - \cos(2\pi\, n/(N+1))}{\displaystyle\sum_{k=1}^{N}(1 - \cos(2\pi\, k/(N+1)))} \quad \text{for } 1 <= n <= N$$

The sum of these filter factors is always 1.

e.g. When N=3 then   Filter(1) = 0.250
                     Filter(2) = 0.500
                     Filter(3) = 0.250

The formula for the resulting points is:

$$Result(n) = \sum_{k=n-(N-1)/2}^{n+(N-1)/2} (filter(n-k+(N+1)/2) * Source(k))$$

6   7,4 1   CH :R. ...>
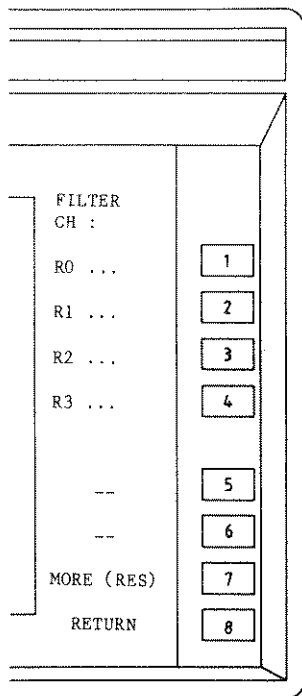
```
 _____
|   _____  |
|  |_____| |
|  |_____/ |
|  |  _____/  |
|  | |          /   |
|  | | FILTER       |
|  | | CH :         |
|  | |              |   ___
|  | | R0 ...       |  | 1 |
|  | |              |   ---
|  | | R1 ...       |  | 2 |
|  | |              |   ---
|  | | R2 ...       |  | 3 |
|  | |              |   ---
|  | | R3 ...       |  | 4 |
|  | |              |   ---
|  | |              |
|  | |    --        |  | 5 |
|  | |              |   ---
|  | |    --        |  | 6 |
|  | |              |   ---
|  | | MORE (RES)   |  | 7 |
|  | |              |   ---
|  |_| RETURN       |  | 8 |
|     |_____ |   ---
|_____|
```

If CH :R. ... is selected, the CH menu
becomes visible and the source channel
can be selected from the registers.
If there are two channels in a register,
the filter function will operate on both
channels

6   7,4 1   1   R0 ...

6   7,4 1   2   R1 ...

6   7,4 1   3   R2 ...

6   7,4 1   4   R3 ...

> If softkey 1, 2, 3 or 4 is pressed, register R0,
> R1, R2 or R3 is selected as source CH.
> If two channels are present in the selected
> register, the filter operation will be performed
> on both channels.

6   7,4 1   5   --

6   7,4 1   6   --

6   7,4 1   7   MORE (RES)

> If MORE (RES) is pressed, the RESULT:R. menu will
> appear. MORE (RES) has the same result as pressing
> RETURN and selecting RESULT:R.

6   7,4 1   8   RETURN

> After pushing softkey RETURN, the MATHEMATCS
> FILTER menu becomes visible.

6   7,4 2   FILT ORDER>
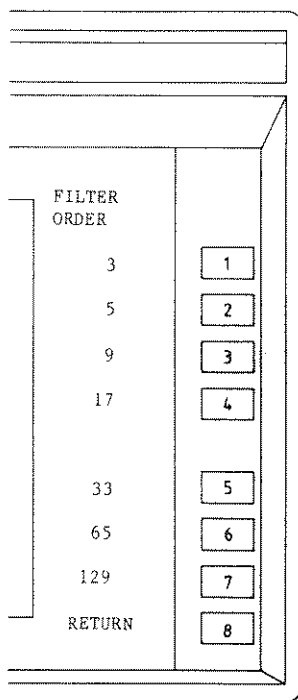
If FILT ORDER is selected, the FILTER
ORDER menu becomes visible and the order
can be selected.

```
        FILTER
        ORDER

          3        | 1 |

          5        | 2 |

          9        | 3 |

         17        | 4 |


         33        | 5 |

         65        | 6 |

        129        | 7 |

        RETURN     | 8 |
```

6	7,4	2	1	3
6	7,4	2	2	5
6	7,4	2	3	9
6	7,4	2	4	17
6	7,4	2	5	33
6	7,4	2	6	65
6	7,4	2	7	129

Pressing one of the softkeys 1 ... 7 will select
the filter order.
Filter order is the number of points that is used
to calculate 1 resulting point (see description at
FILTER menu above).

6	7,4	2	8	RETURN

After pushing softkey RETURN, the MATHEMATCS
FILTER menu becomes visible.

6	7,4	3		RESULT: R.>
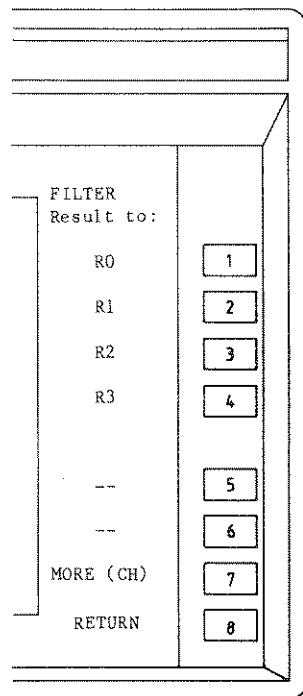
If RESULT: R. is selected, the RESULT
menu becomes visible and a register can
be selected in which the result is
stored.

```
FILTER
Result to:

    R0        [ 1 ]

    R1        [ 2 ]

    R2        [ 3 ]

    R3        [ 4 ]


    --        [ 5 ]

    --        [ 6 ]

 MORE (CH)    [ 7 ]

 RETURN       [ 8 ]
```

6	7,4	3	1	R0
6	7,4	3	2	R1
6	7,4	3	3	R2
6	7,4	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0,
R1. R2 or R3 is selected as result register.

6   7,4 3   5   --

6   7,4 3   6   --

6   7,4 3   7   MORE (CH)

> If MORE (CH) is pressed, the CH :R. ... menu will appear. MORE (CH) has the same result as pressing RETURN and selecting CH :R. ...

6   7,4 3   8   RETURN

> After pushing softkey RETURN, the MATHEMATCS FILTER menu becomes visible.

6   7,4 4   --

6   7,4 5   CURSOR LMT

> Pushing softkey CURSOR LMT toggles the function on or off. When the function is switched on, the MATHEMATCS FILTER function is performed on the traces between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
> The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
> When the function is active CURSOR LMT is displayed intensified.

6   7,4 6   START STOP

> Pushing softkey START STOP starts or stops the MATHEMATCS FILTER operation. The actual state is displayed intensified.

6   7,4 7   --

6   7,4 8   RETURN

> After pushing RETURN, the second MATHEMATCS menu becomes visible.

6   7,5 --

6   7,6 --

6   7,7 MORE

> If MORE is pressed, the first MATHEMATCS menu will appear. MORE has the same result as pressing RETURN and then selecting MATHEMATCS.

6   7,8 RETURN

> After pushing softkey RETURN, the CURSOR SELECT menu becomes visible.

7   RESTART

If the cursors are positioned on different traces or in the
registers R1, R2 or R3, the text RESTART is not visible.

If the cursors are in one of the traces of register R0 the text
RESTART is displayed.

After pushing softkey RESTART an automatic horizontal acquisition
expand is performed for the signal part between the two cursors.
A new trigger-delay setting (related to the first cursors) and a
new and faster time-base setting (related to the time between the
cursors) is automatically selected. After this selection a new
signal is recorded with this new settings on the first active
trigger.

The new settings are displayed in the top text area and the text
RESTART is visible in high intensity.
The new settings are choosen in such a way, that the original
signal part between the cursors, remains completely visible on
the screen and is recorded with the maximum possible resolution.

If further expansion is not possible, this is indicated by one of
the messages

No further expansion possible!!
RESTART not executed.

or

RESTART not fully executed because of
overflow in time base or trigger delay.

or

No more than 9 RESTART calculations possible.

Note: The first messages appears, if the distance between the
            cursors is so big, that even in one time-base setting
            faster, the original part between the cursors can't be
            displayed completely.
            It also appears in the fastest time-base setting or if
            further expansion requires exceeding of the maximum
            trigger delay.

8   REVERSE

Normally the text REVERSE is not visible.
After the first operation of the RESTART function, the text
REVERSE is visible.
If softkey REVERSE is pushed, then the settings as before
performing the RESTART action are recalled.
REVERSE can stay visible, after the conditions for RESTART
disappear or the cursors are switched OFF. This because the
number of RESTART's is larger than the number of REVERSE's
already given.

4.2.9   MEMORY SECTION AND MENU STRUCTURE
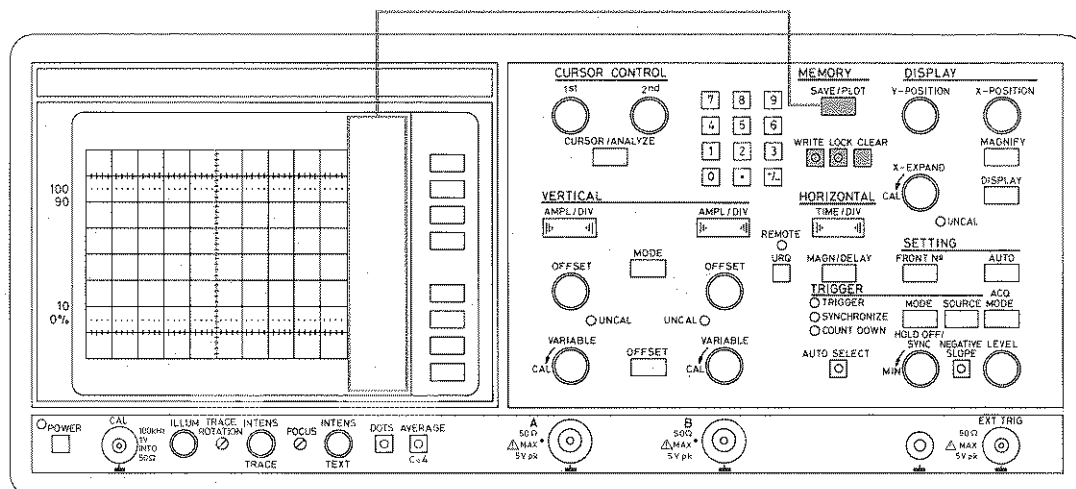
MAT3111MAT3101
880122880205

Figure 4.23 Front panel view.

WRITE   The acquisition functions only when pushbutton
                         WRITE is pushed.
                         The status is indicated by a pilot lamp in this
                         switch.

LOCK   If pushbutton LOCK is pushed, no signal
                         acquisition (new input) is possible.
                         The status is indicated by a pilot lamp in this
                         switch.

                         The following actions are still possible:

                         -Plot actions.
                         -Display actions.
                         -Cursor control actions.
                         -Setting of the acquisition system.
                          Not possible are all acquisition actions which
                          directly influence the contents of register R0.
                         -Data can be saved in a register after a message
                          has been given.
                         -Front number actions (also RECALLs).

                         If pushbutton AUTO-SET is pushed when the
                         instrument is in the LOCK-mode, the message

                         NO AUTO SET possible in LOCK mode.

                         is displayed in the bottom text area.

CLEAR   If pushbutton CLEAR is pushed and dots are
                               selected for display, a zero line is written into
                               the accumulator (R0) and no traces are displayed
                               on the screen.

                               If DOTS is off or SMOOTH is selected for display
                               and pushbutton CLEAR is pushed, a zero line is
                               written into the accumulator (R0) and displayed on
                               the C.R.T. screen.

                               The cleared contents of the accumulator can be
                               saved in one of the other registers R1...R3, to
                               clear the contents of these registers.

                               When pushbutton CLEAR is pushed during a SINGLE-
                               shot, a MULTIPLE-shot or a ROLL-mode operation,
                               the CLEAR pushbutton has a RESET function.
                               The function CLEAR is not possible in the LOCK
                               mode.

SAVE/PLOT   If pushbutton SAVE/PLOT is pushed, the SAVE/PLOT
                               menu is displayed. See 4.2.9.1.

4.2.9.1   SAVE/PLOT MENU STRUCTURE

SAVE/PLOT

AUTO.PLOT ANALOG (top right menu)

Label	Key
--	1
--	2
--	3
--	4
PLOT R0	
--	5
--	6
--	7
STOP	8

SAVE / PLOT

Label	Key
--	1
SAVE TO R1	2
SAVE TO R2	3
SAVE TO R3	4
PLOT Rn	
ANALOG >	5
DIGITAL >	6
AUTO PLOT >	7
SELECT >	8

PLOT AUTOMATIC

Label	Key
--	1
--	2
--	3
--	4
ANALOG >	5
--	6
--	7
RETURN	8

AUTO.PLOT ANALOG

Label	Key
--	1
--	2
--	3
--	4
PLOT R0	
--	5
--	6
--	7
STOP	8

PLOT SELECT

Label	Key
R0	1
R1	2
R2	3
R3	4
ANALOG >	5
DIGITAL >	6
--	7
RETURN	8

PLOT SELCT ANALOG

Label	Key
PEN UP "0"	1
PEN UP "1"	2
--	3
--	4
+ 20ms/DT	
UP	5
DOWN	6
--	7
RETURN	8

Figure 4.24 Save/plot menu structure.

SAVE/PLOT MENU

```
┌═══════════════════┐
│═══════════════════│
│═══════════════════│
│───────────────────│
│        ╱│
│      ╱  │
│ SAVE /  │
│ PLOT    │
│         │
│  --    [ 1 ]│
│         │
│ SAVE TO R1  [ 2 ]│
│         │
│ SAVE TO R2  [ 3 ]│
│         │
│ SAVE TO R3  [ 4 ]│
│         │
│ PLOT Rn │
│         │
│  ANALOG  >  [ 5 ]│
│         │
│  DIGITAL >  [ 6 ]│
│         │
│ AUTO PLOT > [ 7 ]│
│         │
│  SELECT  >  [ 8 ]│
│         │
│═══════════════════│
└═══════════════════┘
```
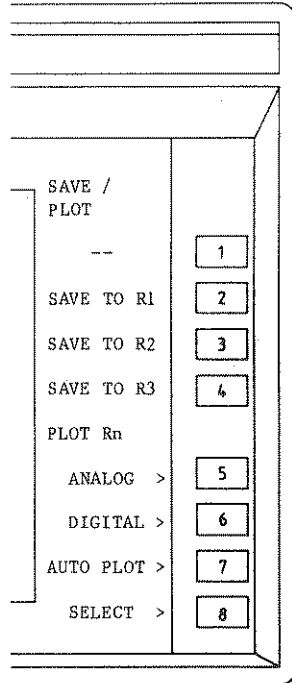
After selection of the SAVE/PLOT menu by
depressing pushbutton SAVE/PLOT, various SAVE
and PLOT selections can be done.
The register Rn which is selected for PLOT
actions via the PLOT SELECT menu, is
displayed on the screen.

Note: the softkey function DIGITAL that you
may find in certain menu's, has to be used in
case that a digital plotter is connected to
the instrument's interface PM8956A.
For operating details refer to the
instruction manual of the interface that also
gives the complete menu structure.

1   --

2   SAVE TO R1

3   SAVE TO R2

4   SAVE TO R3

If a SAVE function is selected, register R0 is copied in the
selected register. The SAVE action is performed as long as the
softkey is pressed, so that register R0 is copied again after
each acquisition.

A message

No direct SAVE in LOCK mode.
Press SAVE again during the display of this message.

becomes visible in the bottom text area for a short moment when
the instrument is in the LOCK-mode. A SAVE action is then only
possible as long as the message is displayed.

5   ANALOG>

```
  _____
 |_____|
 |_____|
 |_____    _/|
 |             |  /  |
 | AUTO.PLOT   | /   |
 | ANALOG      |     |
 |             |  ┌─┐
 |   --        |  │1│
 |             |  └─┘
 |   --        |  ┌─┐
 |             |  │2│
 |   --        |  └─┘
 |             |  ┌─┐
 |   --        |  │3│
 |             |  └─┘
 |             |  ┌─┐
 | PLOT R0     |  │4│
 |             |  └─┘
 |   --        |  ┌─┐
 |             |  │5│
 |   --        |  └─┘
 |             |  ┌─┐
 |   --        |  │6│
 |             |  └─┘
 |             |  ┌─┐
 | STOP        |  │7│
 |             |  └─┘
 |             |  ┌─┐
 |_____|  │8│
 |_____ └─┘|
 |_____|
```
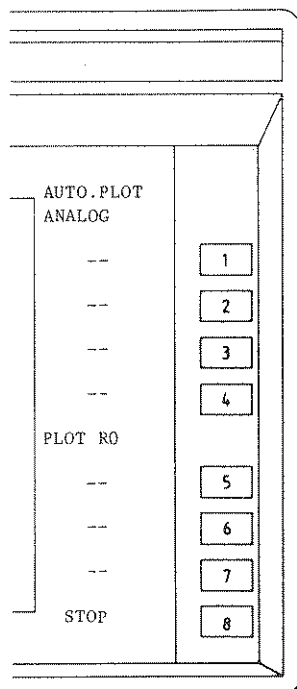
If ANALOG is selected, the contents of the
displayed register Rn is transferred to the analog
plot output. The default register is R0.
Other registers to plot as well as the plot speed
can be selected via the SELECT function of the
SAVE/PLOT menu (softkey 8). During the PLOT
action, the PLOT ANALOG menu is displayed and a
dot, which moves from the left to the right (over
10 divisions) is displayed in the bottom text area
of the screen to show the progress of the plot
action and a message

* * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has stopped

is displayed.

At the end of the PLOT action, the menu SAVE/PLOT
is displayed again.

5   1   --

5   2   --

5   3   --

5   4   --

5   5   --

5   6   --

5   7   --

5   8   STOP

       A PLOT action can be interrupted by pushing softkey STOP.
       The SAVE/PLOT menu is then displayed again. During a plot
       action, it is not possible to switch to another softkey
       menu.

6   --

7   AUTOPLOT>

```
┌─────────────────────┐
│─────────────────────│
│─────────────────────│
│─────────────────────│
└─────────────────────┘
    ┌──────────────┐
    │              │\
  ┌─┤ PLOT         │ \
  │ │ AUTOMATIC    │  \
  │ │              │   \
  │ │    --     ┌───┐ ┌─┐
  │ │           │ 1 │ │1│
  │ │    ---    └───┘ ┌─┐
  │ │                 │2│
  │ │    --           ┌─┐
  │ │                 │3│
  │ │    --           ┌─┐
  │ │                 │4│
  │ │                 ┌─┐
  │ │ ANALOG  >       │5│
  │ │    --           ┌─┐
  │ │                 │6│
  │ │    --           ┌─┐
  │ │                 │7│
  └─┤ RETURN          ┌─┐
    │                 │8│
    └──────────────┘
```
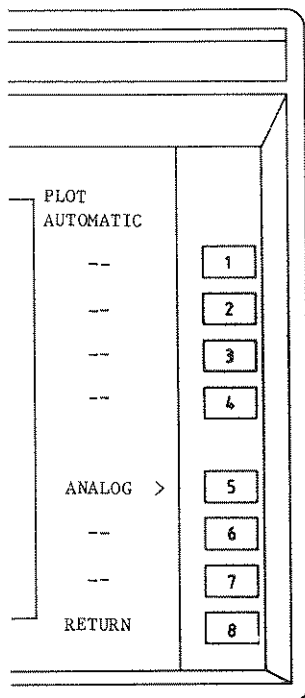
AUTOPLOT functions only in the SINGLE-shot mode.
If AUTOPLOT is selected, the contents of register
R0 is automatically transferred to an analog X-Y
recorder.
The text AUTOPLOT in not visible in an other
horizontal mode.
The contents of R0 is automatically plotted after
each refreshment of the memory when a valid
trigger is received.

7   1   --

7   2   ---

7   3   ---

7   4   --

7   5   ANALOG>

After selecting ANALOG, the AUTOPLOT ANALOG
menu is displayed and the function is active
for an analog X-Y recorder.
The PLOT speed can be selected via the
SELECT function of the SAVE/PLOT menu
(softkey 8). During the PLOT action, the
AUTO.PLOT ANALOG menu is displayed and a dot,
which moves from the left to the right is
displayed just above the bottom text area of
the screen and a message

* * * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has
stopped

is displayed.

At the end of the PLOT action, a new
acquisition takes place on receipt of a
trigger signal, after which a new plot is
initiated.

7   5   1   --

7   5   2   --

7   5   3   --

7   5   4   --

7   5   5   --

7   5   6   --

7   5   7   --

7   5   8   STOP

A PLOT action can be interrupted by pushing softkey
STOP. The PLOT AUTOMATIC menu is then displayed again.
During a plot action it is not possible to switch to an
other softkey menu.

7   6   --

7   7   --

7   8   RETURN

After pushing softkey RETURN, the SAVE/PLOT menu is
displayed again. The selections as made before remain
unchanged.

8   SELECT>

PLOT SELECT		
RO	1	
R1	2	
R2	3	
R3	4	
ANALOG >	5	
DIGITAL >	6	
--	7	
RETURN	8	
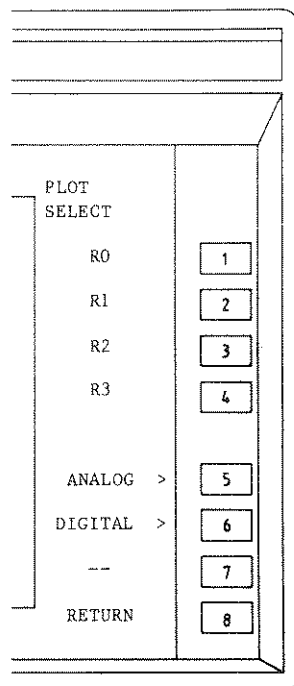
If SELECT is selected, a selection can be made
for a register, a plot output speed and the
penlift output polarity.

Only the registers which are selected for display,
can be selected for plot actions.

8   1   R0

8   2   R1

8   3   R2

8   4   R3

Hard copies are made from the selected register.

8   5   ANALOG>
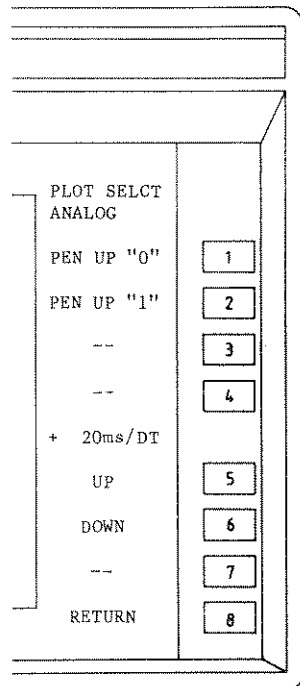
If ANALOG is selected, the PLOT SELECT ANALOG menu is displayed and the plot output speed as well as the penlift polarity can be selected.

```
PLOT SELCT
ANALOG

PEN UP "0"      [ 1 ]

PEN UP "1"      [ 2 ]

    --          [ 3 ]

    --          [ 4 ]

+   20ms/DT
    UP          [ 5 ]

    DOWN        [ 6 ]

    --          [ 7 ]

    RETURN      [ 8 ]
```

8   5   1   PEN UP "0"

If the text PEN UP "0" is intensified, the instrument will generate a low level TTL signal on its PENLIFT output.

8   5   2   PEN UP "1"

If the text PEN UP "1" is intensified, the instrument will generate a high level TTL signal on its PENLIFT output.

8   5   3   --

8   5   4   --

8   5   5   UP

The actual analog plot output speed is displayed on the screen. This speed is always a multiple of 20 ms/dot. Pushing softkey UP increases the value in steps of 20 ms, which means that the actual plot output speed decreases. Above 200 ms/dot the value increases in steps of 100 ms/dot. The fastest possible output speed is 20 ms/dot.
If 2000 ms/DT is displayed, and UP is depressed, a message

PLOT TIME out of range. Range is 20 .. 2000 ms.

is displayed.

The real plot time may be different than selected, due to automatic plot control speed adaption related to the signal shape.

NOTE: This plot speed must be adapted to the speed of a relative slow X-Y recorder.

8   5   6   DOWN

The actual analog plot output speed is displayed on the screen. This speed is always a multiple of 20 ms/dot. Pushing softkey DOWN decreases the value in steps of 20 ms, which means that the actual plot output speed decreases. Above 200 ms/dot the value decreases in steps of 100 ms/dot.
The slowest possible plot output speed is 2000 ms/dot. If 20 ms/DT is displayed and DOWN is depressed, a message

PLOT TIME out of range. Range is 20 .. 2000 ms.

is displayed.
The real plot time may be different than selected, due to automatic plot control speed adaption related to the signal shape.

8   5   7   --

8   5   8   RETURN

After pushing softkey RETURN, the PLOT SELECT menu is displayed again. The selections as made before remain unchanged.

8   6   --

8   7   --

8   8   RETURN

After pushing softkey RETURN, the SAVE/PLOT menu is displayed again.

4.2.10.   DISPLAY SECTION AND MENU STRUCTURE AND AUXILIARY SECTION
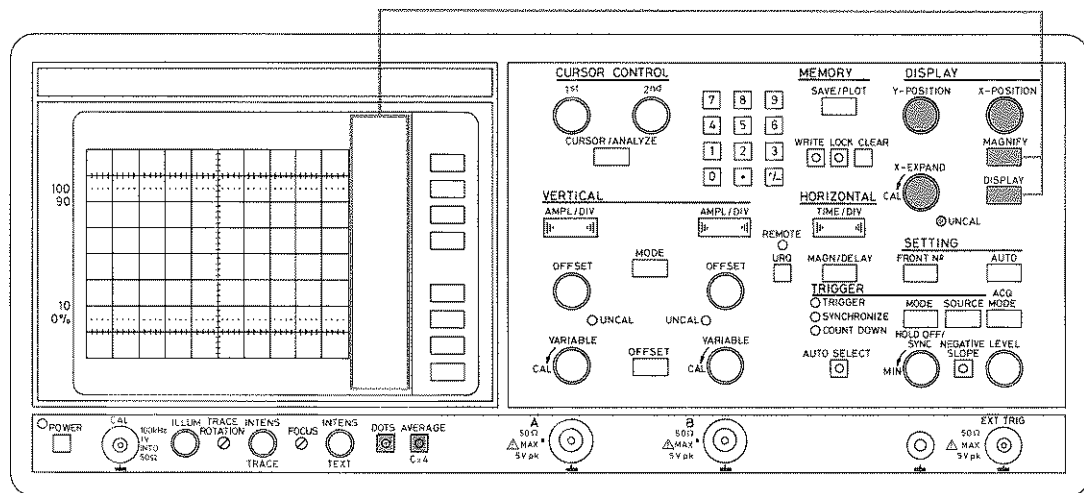
Figure 4.25 Front panel view.

Y POSITION   Continuously variable control giving vertical
                          shift of one of the four registers R0, R1, R2, R3
                          (including channels in the registers) can be
                          addressed via the DISPLAY menu.

                          The adjusting speed increases after turning
                          continuously in one direction. After stopping,
                          starting in the reverse direction resumes with a
                          slow adjusting speed.

X POSITION   Continuously variable control giving horizontal
                          shift of the total trace display.

                          Can also be addressed to one of the four registers
                          R0, R1, R2, R3 (including channels in the
                          registers) as long as menu DISPLAY Rn POSITION is
                          selected.

                          The adjusting speed increases after turning
                          continuously in one direction. After stopping,
                          starting in the reverse direction resumes with a
                          slow adjusting speed.

X EXPAND   Continuously variable control for horizontal
                          expand of the total trace display.

                          Can also be addressed to one of the four registers
                          R0, R1, R2, R3 (including channels in the
                          registers) as long as menu DISPLAY Rn POSITION is
                          selected.

                          The adjusting speed increases after turning
                          continuously in one direction. After stopping,
                          starting in the reverse direction resumes with a
                          slow adjusting speed.

UNCAL   Pilot lamp indicating that the X-EXPAND function
                 is active for one or more registers. If the X-
                 EXPAND control is fully turned anti clockwise, the
                 UNCAL pilot lamp is switched off.

DOTS   Selection between a display of discrete dots or a
                 display of joined dots for all registers. DOTS can
                 also be selected in A VERSUS B mode.

AVERAGE C=4   Direct selection of the AVERAGE mode with an
                 averaging factor C=4. This averaging factor and
                 a number of other factors can also be selected via
                 the menus VERTICAL MODE and PROCESSING. The
                 AVERAGE mode minimizes noise on the signal that
                 is displayed on the screen.

                 AVERAGE is not possible in combination with EYE
                         PATTERN mode and/or LOW RESOLUTION mode.
                         This combination gives a warning on CRT.

MAGNIFY   If pushbutton MAGNIFY is pushed, the MAGNIFY menu
                 is displayed. See 4.2.10.1.

DISPLAY   If pushbutton DISPLAY is pushed, the DISPLAY menu
                 is displayed. See 4.2.10.2.

4.2.10.1 MAGNIFY MENU STRUCTURE
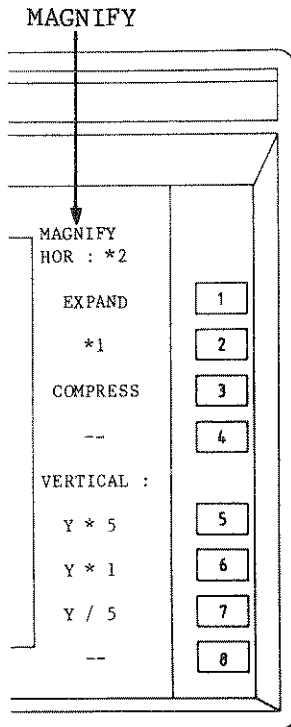
MAGNIFY

After selection of the MAGNIFY menu by
depressing pushbutton MAGNIFY, the signal(s)
can be expanded in horizontal or vertical
direction.
Expand factors *1, *2, *4, *8, *16, *32 or
*64 can be selected.
Each part of the complete register can be
displayed using the HORIZONTAL POSITION
control.

MAGNIFY
HOR : *2

EXPAND   [1]

*1   [2]

COMPRESS   [3]

--   [4]

VERTICAL :

Y * 5   [5]

Y * 1   [6]

Y / 5   [7]

--   [8]

Figure 4.26 Magnify menu structure.

MAGNIFY MENU

1   EXPAND

     With softkey EXPAND, higher horizontal expand factors can be
     selected until *64 is reached. Then the text expand is not
     displayed any longer. EXPAND is always with respect to mid-
     screen.
     The selected factor is displayed in the second line of the
     softkey menu header.
     With A VS B selected, the maximum expand factor is *8.

2   *1

     With softkey *1, the horizontal expand factor is set to *1 which
     means -no expand-.

3   COMPRESS

     With softkey COMPRESS, lower horizontal expand factors can be
     selected until *1 is reached. The selected factor is displayed in
     the second line of the softkey menu header.
     The text COMPRESS is not visible if the expand factor is *1.

4   --

5   Y*5

    After pushing softkey Y*5, the vertical expand factor is set to
    *5 and 1/5 of the contents of the selected registers is displayed
    over 10 vertical divisions of which 8 divisions are visible. Mid-
    memory is displayed on the center-line of the graticule.

6   Y*1

    After pushing softkey Y*1, the vertical expand factor is set to
    *1 and the contents of the selected registers is displayed
    over 10 vertical divisions of which 8 divisions are visible.
    Mid-memory is displayed on the center-line of the graticule.

7   Y/5

    After pushing softkey Y/5, the contents of each memory is
    displayed over 2 vertical divisions. If the Y-positions are in
    zero position, the registers are equally divided over the screen.
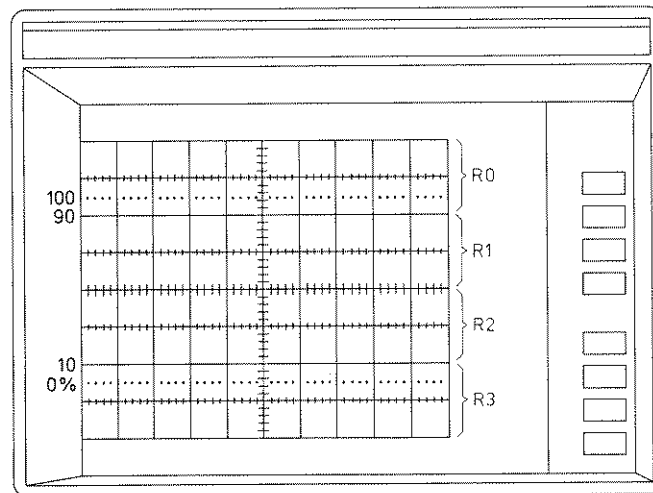
Figure 4.27 Y/5 display.

8   --

4.2.10.2 DISPLAY MENU STRUCTURE
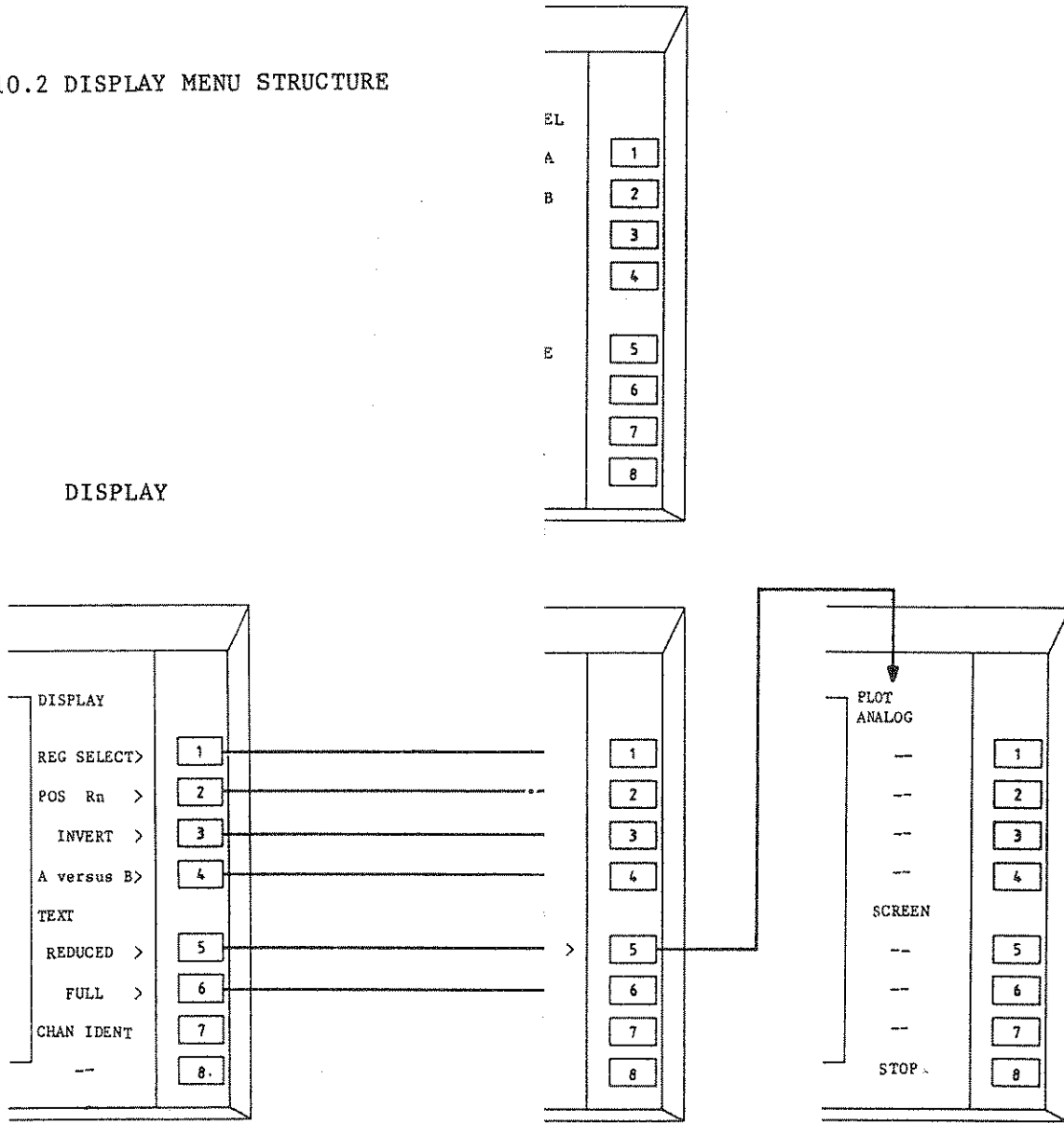
Figure 4.28 Display menu structur

DISPLAY MENU

DISPLAY

REG SELECT>	1
POS Rn >	2
INVERT >	3
A versus B>	4
TEXT	
REDUCED >	5
FULL >	6
CHAN IDENT	7
--	8
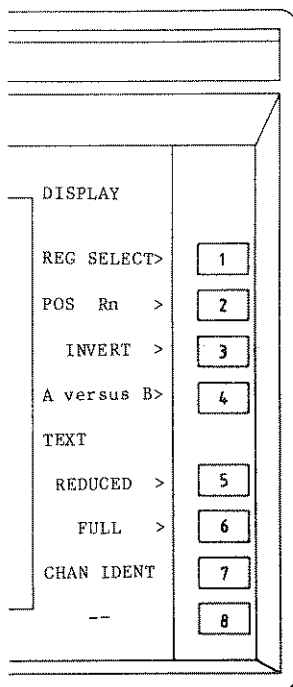
After selection of the DISPLAY menu by depressing pushbutton DISPLAY, various DISPLAY selections can be made.
Note: the softkey functions OPTION and DIGITAL have to be used in case of address setting of the instrument's interface bus and when using a digital plotter. For operating details refer to the instruction manual of the interface PM8956A. This instruction manual gives also the complete menu structure.

1   REG SELECT>

DISPLAY
R SELECT

R0 ON OFF	1
R1 ON OFF	2
R2 ON OFF	3
R3 ON OFF	4
--	5
--	6
--	7
RETURN	8
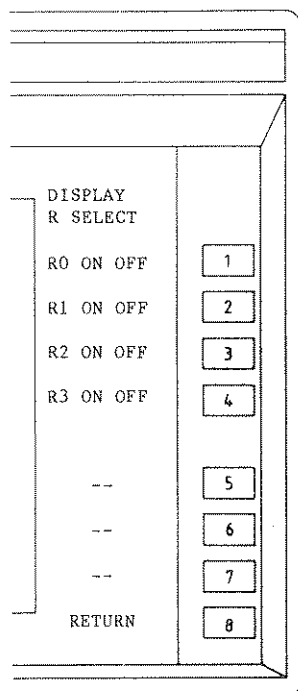
After selecting REG SELECT, the DISPLAY/R SELECT menu is displayed and a selection can be made of the registers which have to be displayed.

1   1   R0   ON   OFF

1   2   R1   ON   OFF

1   3   R2   ON   OFF

1   4   R3   ON   OFF

One or more registers can be selected for display.
Depending on the selection, the text ON or OFF is
intensified. Pushing the relevant softkey changes the
situation from ON to OFF or reverse.
If a register is switched OFF, the POSITION controls which
are eventually addressed to this register, are from that
moment on addressed to the next displayed register.
If a register which is not yet displayed, is selected for
display, the POSITION controls are addressed to this
register.
If cursors are selected, the cursors are on the selected
register now.

1   5   --

1   6   --

1   7   --

1   8   RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed
again. The selected registers remain displayed.

2   POS Rn>
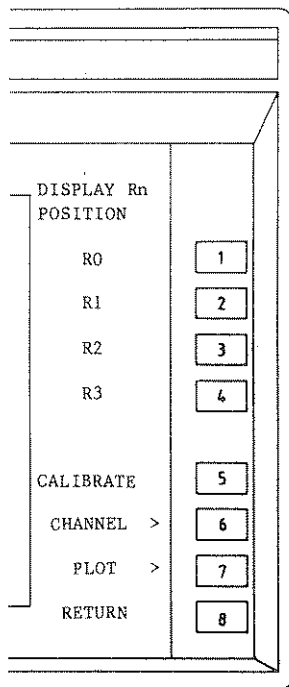
As long as softkey POS Rn is not pushed, the text
POS Rn is displayed and the position of the
selected register can be set with the VERTICAL
POSITION and HORIZONTAL POSITION control. The
HORIZONTAL POSITION control controls all other
registers as well at the same moment. The X-EXPAND
control functions also for the selected register.

After selecting POS Rn, the DISPLAY Rn POSITION
menu is displayed and the Y-POSITION control, the
X-POSITION control as well as the X-EXPAND control
can be assigned to one of the four registers. The
selected register number is intensified.

If a register is not selected for display, this
register can not be selected for positioning.
The text Rn for this register is then not
displayed.

2   1   R0

2   2   R1

2   3   R2

2   4   R3

The Y-POSITION, X-POSITION and X-EXPAND controls are
addressed to the selected register.

2   5   CALIBRATE

After pushing softkey CALIBRATE, the traces are set as
before pushing softkey CHANNEL (see next description).
The Y-POSITION is set so, that mid-memory is mid-screen in
Y*1 and Y*5 mode and on +3, +1, -1 and/or -3 divisions in
the Y/5 mode.
The X-POSITION is set so, that the beginning of the trace is
situated on the most left graticule line.
The X-EXPAND is set to its calibrated position.

2   6   CHANNEL>

```
        POSITION
        Rn CHANNEL

        CHANNEL A    [ 1 ]

        CHANNEL B    [ 2 ]

           --        [ 3 ]

           --        [ 4 ]


        CALIBRATE    [ 5 ]

           --        [ 6 ]

           --        [ 7 ]

        RETURN       [ 8 ]
```
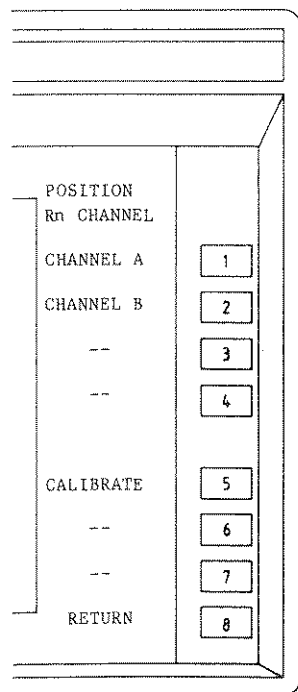
If CHANNEL is selected, the POSITION Rn
CHANNEL menu is displayed.
Traces within the same register can now be
positioned in relation to each other.
If only one channel is recorded in the
selected register, this menu can not be
reached and the text CHANNEL is not visible.

2   6   1   CHANNEL A

2   6   2   CHANNEL B

The position of the selected channel A or B in the
selected register Rn can be changed with the Y-
POSITION, the X-POSITION and the X-EXPAND controls.

2	6	3	--
2	6	4	--
2	6	5	CALIBRATE

After pushing softkey CALIBRATE, the display
modifications made under channel control are ignored
and the traces are adjusted as follows.
The Y-POSITION is set so, that mid-memory is mid-screen
in Y*1 and Y*5 mode and on +3, +1, -1, and/or -3
divisions in the Y/5 mode.
The X-POSITION is set so, that the beginning of the
trace is situated on the most left graticule line.
The X-EXPAND is set to its calibrated position.
The controls are not longer addressed to one of the
channels A or B but to the selected register.

2	6	6	--
2	6	7	--
2	6	8	RETURN

After pushing softkey RETURN, the DISPLAY Rn POSITION
menu is displayed again.
All settings done before remain unchanged.

2	7	PLOT>
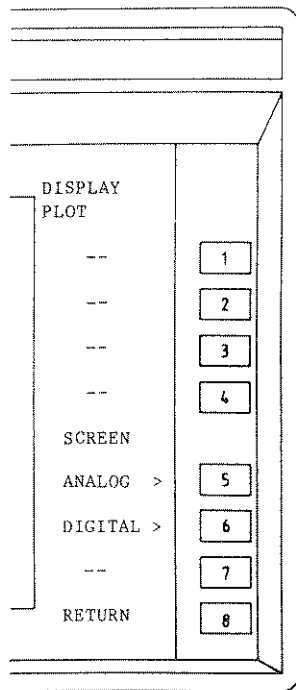
After selecting PLOT, the DISPLAY PLOT menu
is selected and a plot can be made from the
trace area of the screen.
In this way a copy of the trace area can be
made including the selected trace position
changes.

```
DISPLAY
PLOT

   --        [ 1 ]

   --        [ 2 ]

   --        [ 3 ]

   --        [ 4 ]

SCREEN

ANALOG  >    [ 5 ]

DIGITAL >    [ 6 ]

   --        [ 7 ]

RETURN       [ 8 ]
```

2	7	1	--

2   7   2   --

2   7   3   --

2   7   4   --

2   7   5   ANALOG>
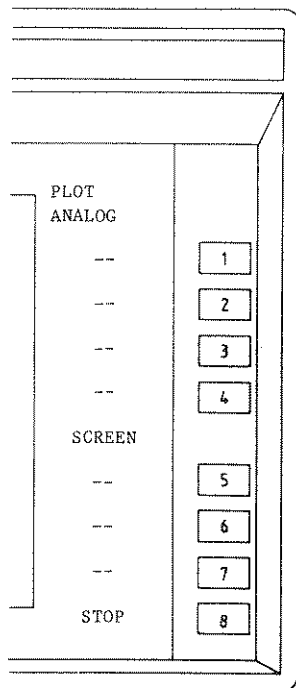
After selecting ANALOG, a copy of the screen is made on an analog X-Y recorder. During the PLOT action, the PLOT ANALOG menu is displayed and a dot which moves from the left to the right (over 10 divisions) is displayed just above the bottom text area of the screen to show the progress of the plot action and a message

* * * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has stopped.

is displayed.

The settings made with the Y-POSITION control, the X-POSITION control and the X-EXPAND control remain.
At the end of the plot action the menu DISPLAY PLOT is displayed again.

2   7   5   1   --

2   7   5   2   --

2   7   5   3   --

2   7   5   4   --

2   7   5   5   --

2   7   5   6   --

2   7   5   7   --

2   7   5   8   STOP

A PLOT action can be interrupted by pushing softkey STOP. The DISPLAY PLOT menu is then displayed again.

2   7   6   --

2   7   7   --

2   7   8   RETURN

                 After pushing softkey RETURN, the DISPLAY Rn POSITON menu is displayed again.

2   8   RETURN

            After pushing softkey RETURN, the DISPLAY menu is displayed again and the selected register (e.g. R2) can still be positioned. This is indicated by the text POS R2.
All modifications made between traces in X- as well as Y-direction (with the exception of Y changes, which are made via the CHANNEL menu), are eliminated.

3   INVERT>

If INVERT is selected, the DISPLAY/INVERT menu is displayed and a selection can be made of the registers of which the display has to be inverted. If a register is not selected for display, the inversion is not possible and the register number is not displayed.

3   1   R0   ON   OFF

3   2   R1   ON   OFF

3   3   R2   ON   OFF

3   4   R3   ON   OFF

            One or more registers can be selected for inverted display. Depending on the selection, the text ON or OFF is intensified.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.

3   5   --

3   6   ---

3   7   --

3   8   RETURN

>   After pushing softkey RETURN, the DISPLAY menu is displayed
>   again. The selections as made before remain unchanged.

4   A versus B>

DISPLAY A versus B	
RO ON OFF	1
R1 ON OFF	2
R2 ON OFF	3
R3 ON OFF	4
--	5
--	6
--	7
RETURN	8
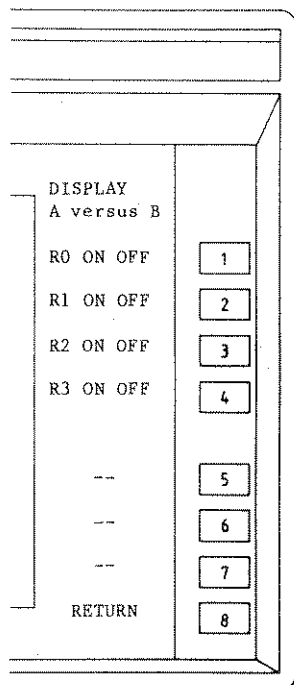
If A versus B is selected, the DISPLAY A versus B
menu is displayed.
One or more registers can be selected for A versus
B display.
If a register is not selected for display, or if
only one channel is recorded in a register, the
text Rn ON OFF is not displayed and A versus B
display is then not possible for this register.
If no register is displayed with two channels, A
versus B is not possible and the text A versus B
is not displayed and the function can not be
selected.

NOTE: If a register is deselected via the
           DISPLAY/R SELECT menu, then A versus B
           is switched off for that register.

4   1   RO   ON   OFF

4   2   R1   ON   OFF

4   3   R2   ON   OFF

4   4   R3   ON   OFF

>   One or more registers can be selected for A versus B display.
>   Depending on the selection the text ON or OFF is intensified.
>   Pushing the relevant softkey changes the situation from ON
>   to OFF or reverse.
>   If the CURSORS were selected for the selected register, a
>   message
>
>   Register in A versus B : no cursors possible.
>
>   is displayed and the cursors are switched off.

If a horizontal expand greater than *8 is selected via the MAGNIFY menu, a message

Max. horizontal expand in A versus B is *8

is displayed and horizontal expand is set to *8.

4   5   --

4   6   --

4   7   --

4   8   RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

5   REDUCED>
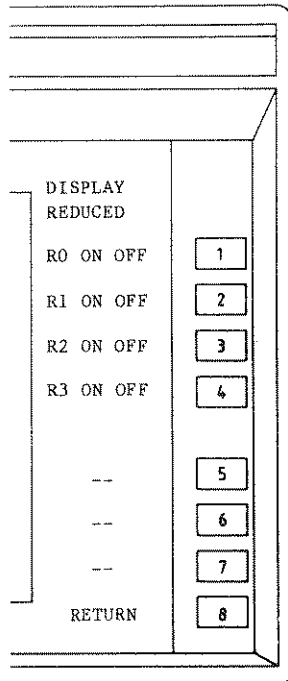
If REDUCED is selected, the DISPLAY REDUCED menu is displayed.
Only in Y/5 one or more registers can be selected for REDUCED text.

The text REDUCED is only visible if Y/5 is selected via the MAGNIFY menu.

If a register is not selected for display, the text Rn ON OFF is not displayed and the action is not possible.
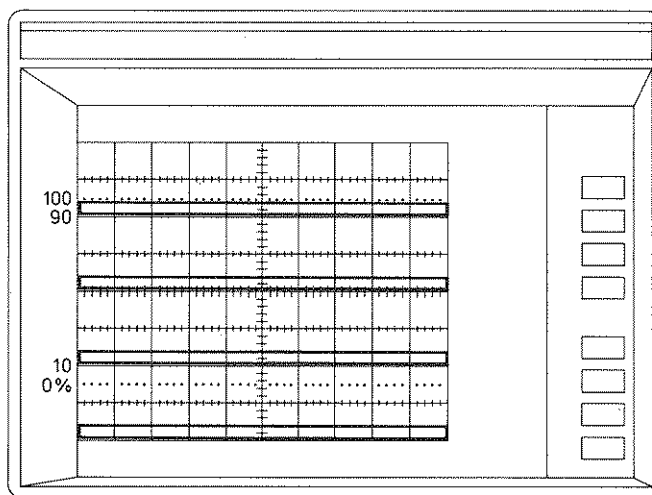
Figure 4.29 Reduced text display in Y/5.

5   1   R0   ON   OFF

5   2   R1   ON   OFF

5   3   R2   ON   OFF

5   4   R3   ON   OFF

One or more registers can be selected for REDUCED TEXT display. Reduced text means that the parameters of the signal(s) of the selected register are displayed in the trace area. See also 4.2.2.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.

5   5   ---

5   6   ---

5   7   ---

5   8   RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

6   FULL>

DISPLAY
FULL TEXT

RO   1

R1   2

R2   3

R3   4

FRONT   5

TEXT OFF 6

---   7

RETURN   8
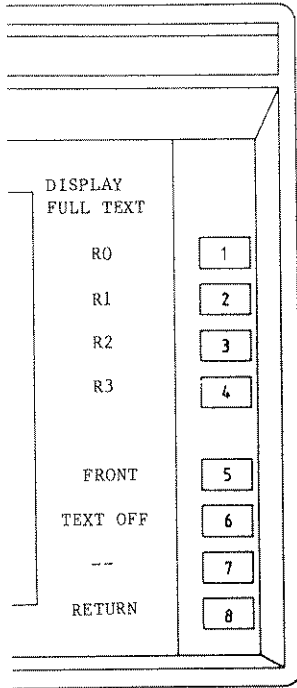
If FULL is selected, the DISPLAY/FULL TEXT menu is displayed.

The most important information of the front panel settings is always visible in the top text area but selection of the display of full information of a certain register or the additional information of the front panel setting, is possible.

If a register is not selected for display, the text Rn is not displayed and the action is not possible for this register.

If a register which is selected for full text is turned off via the REGISTER SELECT menu, full text is turned off.
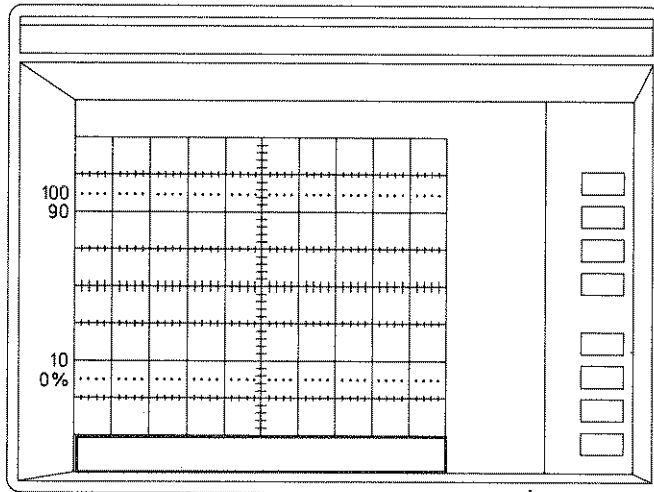
Figure 4.30 FULL text display.

6   1   RO

6   2   R1

6   3   R2

6   4   R3

The parameters of the selected register can be selected for
display in the bottom text area.
Front information in the bottom text area, selected by
softkey FRONT is not longer displayed then.
Pushing the relevant softkey changes the situation from ON
to OFF or reverse.

6   5   FRONT

With softkey FRONT, two extra lines with front panel
information are visible in the bottom text area.
Register information in the bottom text area, selected by
one of the softkeys R0, R1, R2 or R3 is not longer displayed
then.

6   6   --

6   7   TEXT OFF

This text is only visible if full text is selected.
The bottom text area is blanked when softkey TEXT OFF is
pushed.

6   8   RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed
again. The selections as made before remain unchanged.

7   CHAN IDENT

After pushing softkey CHAN IDENT, the channel identification (A
and/or B) on the C.R.T. screen can be switched on or off.
Pushing this softkey changes the situation from ON to OFF or
reverse, indicated by a high or a low intensity of the text CHAN
IDENT.

8   --

4.2.11.   FRONT No. SECTION AND MENU STRUCTURE
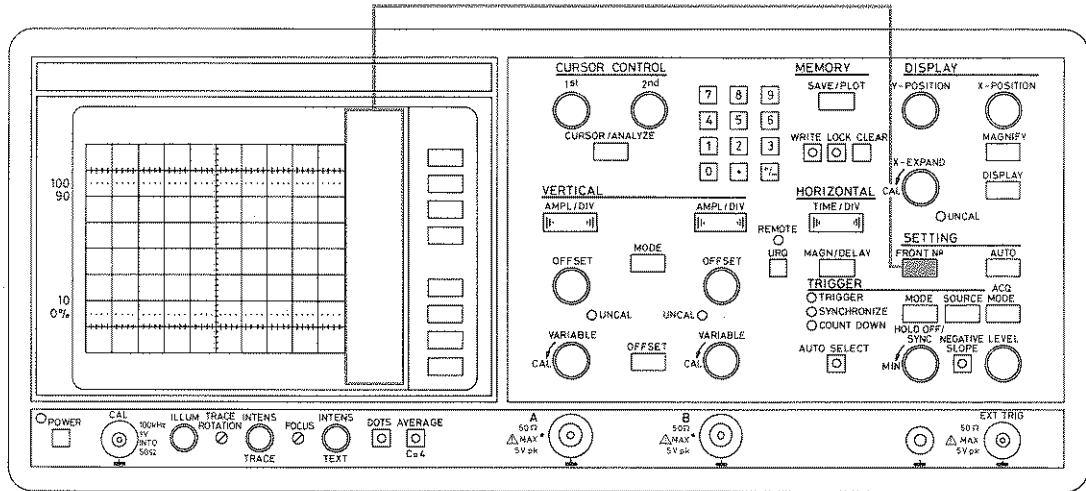
Figure 4.31 Front panel view.

FRONT No   If pushbutton FRONT No. is pushed, the FRONT
                           NUMBER menu is displayed. See 4.3.11.1.

4.2.11.1 FRONT NUMBER MENU STRUCTURE

FRONT No.
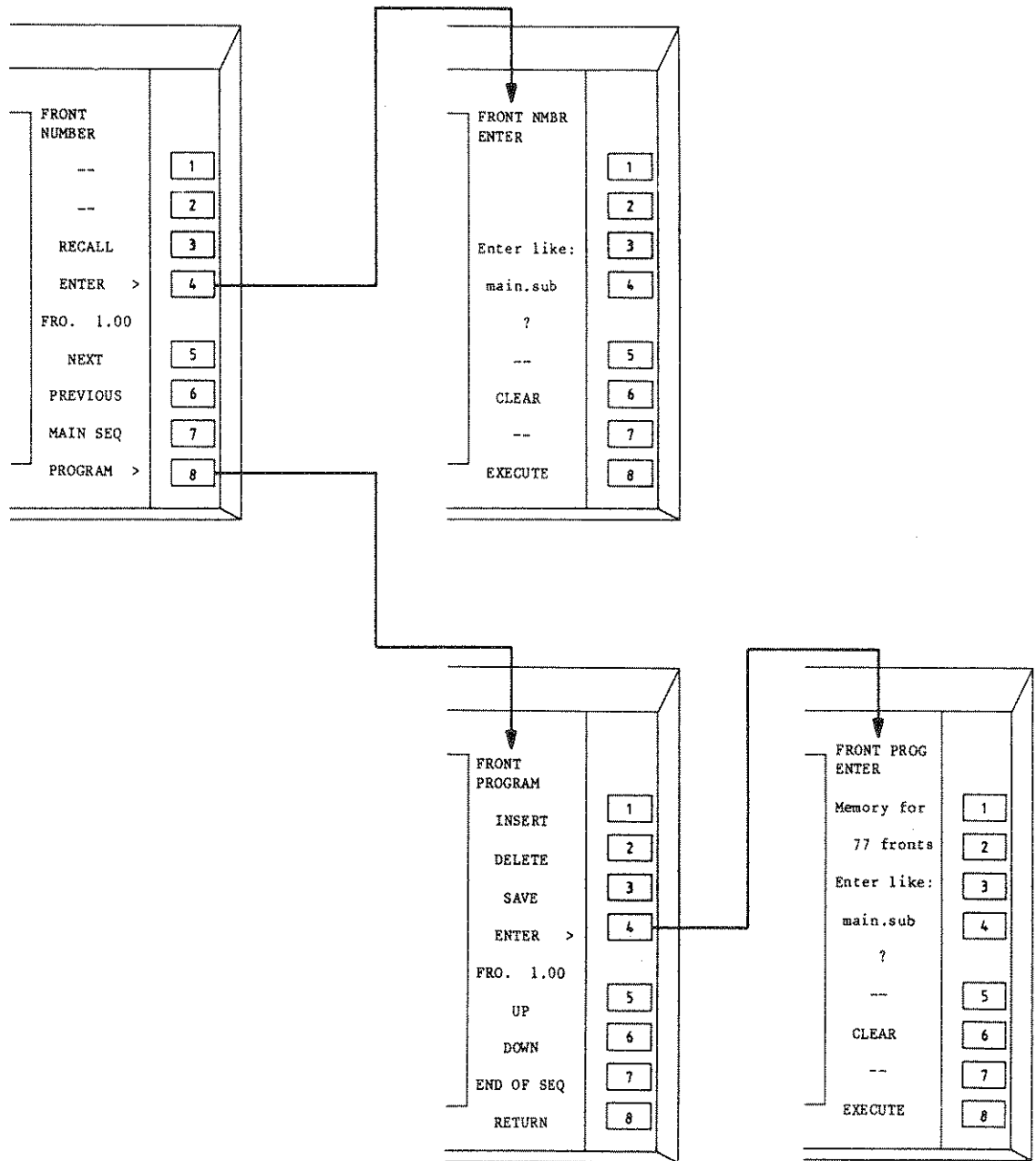
Figure 4.32 Front number menu structure.

FRONT NUMBER

FRONT
NUMBER

    --   `1`

    --   `2`

  RECALL   `3`

  ENTER   >   `4`

FRO. 1.00

  NEXT   `5`

 PREVIOUS   `6`

 MAIN SEQ   `7`

 PROGRAM > `8`
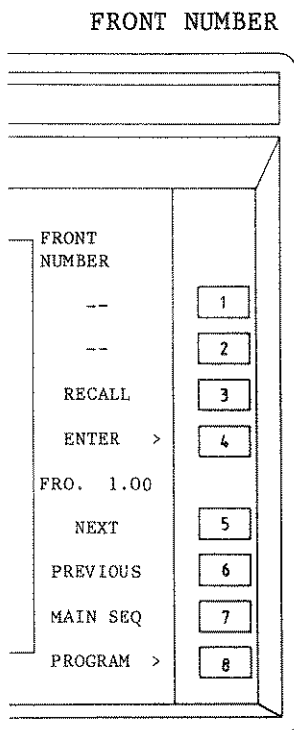
If pushbutton FRONT No. is depressed, the FRONT NUMBER menu will be visible on the screen and the front setting memory can be controlled.

The last used front number is visible in the softkey text area.

In this front setting memory, a number of sequences of different front settings can be saved and later on recalled.

When memory back-up batteries are installed, all saved front settings remain in memory after switching off the instrument.

A complete front setting, which will be called FRONT, is stored in the front setting memory with a front number.
The fronts are placed in a SEQUENCE.
The first front of a sequence is called MAIN FRONT.
The sequence is terminated with an EOS (END OF SEQUENCE).
In the front setting memory a number of different sequences can be programmed, as shown in figure 4.33.

SEQUENCE
NUMBER   SEQUENCE OF FRONTS

	00	01	02	03	04	05	06	
01	MAIN FRONT 01.00	FRONT 01.01	FRONT 01.02	FRONT 01.03	FRONT 01.04	FRONT 01.05	FRONT 01.06	E O S

	00	01	02	
02	MAIN FRONT 02.00	FRONT 02.01	FRONT 02.02	E O S

	00	01	02	03	04	
03	MAIN FRONT 03.00	FRONT 03.01	FRONT 03.02	FRONT 03.03	FRONT 03.04	E O S
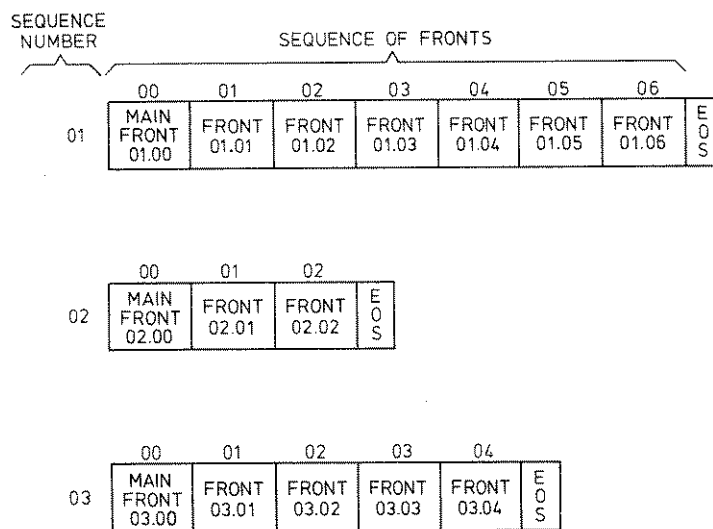
MAT2437A
871001

Figure 4.33 Contents of the front setting memory
(Example)

There are two fronts with a special meaning:

$\emptyset$ contains the actual front setting

9999 is a backup front, which can be used to restore a front that is deleted or overwritten by mistake.

1   --

2   --

3   RECALL

If softkey RECALL is pushed, the front number which is
displayed in the softkey text area is made actual.
This means that the oscilloscope is set according to the front
setting that is stored in the front setting memory.
The old front setting is saved in the backup front.
After selection of the FRONT NUMBER menu, the displayed front
number can be made actual by pressing softkey RECALL.

4   ENTER>
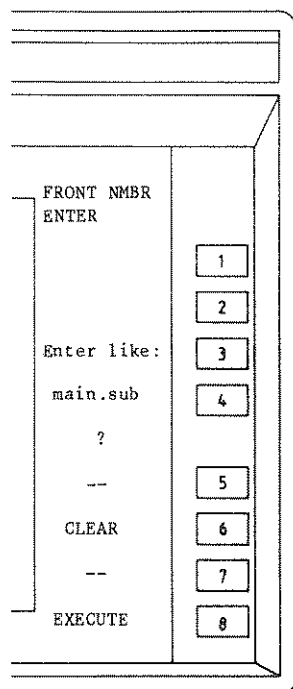
If softkey ENTER is pushed, the FRONT NMBR/ENTER
menu is displayed and a front number between
FRO. 01.00 and FRO. 99.99 can be entered using the
numeric keypad.
The selected frontnumber is visible in the
softkey text area.

```
FRONT NMBR
ENTER
                  ┌───┐
                  │ 1 │
                  └───┘
                  ┌───┐
                  │ 2 │
                  └───┘
Enter like:       ┌───┐
                  │ 3 │
main.sub          └───┘
                  ┌───┐
    ?             │ 4 │
                  └───┘
    --
                  ┌───┐
                  │ 5 │
                  └───┘
CLEAR             ┌───┐
                  │ 6 │
                  └───┘
    --            ┌───┐
                  │ 7 │
EXECUTE           └───┘
                  ┌───┐
                  │ 8 │
                  └───┘
```

4   1   --

4   2   --

4   3   --

4   4   --

4   5   --

4   6   CLEAR

If an error is made, the selected front number can be
cleared by pressing softkey CLEAR.

4   7   --

4   8   EXECUTE

By pressing softkey EXECUTE the selected front number is
recalled and a RETURN is performed resulting in the display
of the FRONT NUMBER menu.
If EXECUTE is pressed after CLEAR the previous front setting
remains.
The number is tested against the real setting memory and if
the number does not exist or can not be selected, one of the
following messages

Selected front doesn't exist.
FRONT number not changed.

or

FRONT 0 cannot be selected because it is
the actual front panel setting.

or

Front number cannot go beyond 99.

can be displayed.

5   NEXT

The action of the softkey NEXT depends on the MAIN SEQ setting.

If softkey NEXT is pushed, while SEQ is active, the next higher
front number of the selected sequence is displayed in the softkey
text area and made actual.
If NEXT goes to a number after the end of the sequence, the first
front in the sequence will be made actual and a message

End of sequence detected.
First front of sequence is selected.

is displayed.

If there is only one front in the sequence and softkey NEXT is
pushed, a message

There is no sequence to this main front

is displayed.

If softkey NEXT is pushed, while MAIN is active, the next higher
main front number is displayed in the softkey text area and made
actual.
If there is only one main front programmed, a message

There is only one main front in the memory.

is displayed.

At all NEXT actions the old front setting is saved in the backup front.

6   PREVIOUS

The action of the softkey PREVIOUS depends on the MAIN SEQ setting.

If softkey PREVIOUS is pushed, while SEQ is active, the next lower front number of the selected sequence is displayed in the softkey text area and made actual.
If PREVIOUS goes to a number before the begin of the sequence, the last front in the sequence will be made actual and a message

Begin of sequence detected.
Last front of sequence is selected.

is displayed.

If there is only one front in the sequence and softkey PREVIOUS is pushed, a message

There is no sequence to this main front

is displayed.

If softkey PREVIOUS is pushed, while MAIN is active, the next lower main front number is displayed in the softkey text area and made actual.
If there is only one main front programmed, a message

There is only one main front in the memory.

is displayed.

At all PREVIOUS actions the old front setting is saved in the backup front.

7   MAIN SEQ

With this softkey a selection can be made of the actions of the NEXT and PREVIOUS softkeys. These softkeys can step between main fronts (MAIN) or between fronts in a sequence (SEQ).
Pushing the softkey changes the selection from SEQ to MAIN or reverse. The active selection is displayed intensified.

8   PROGRAM>
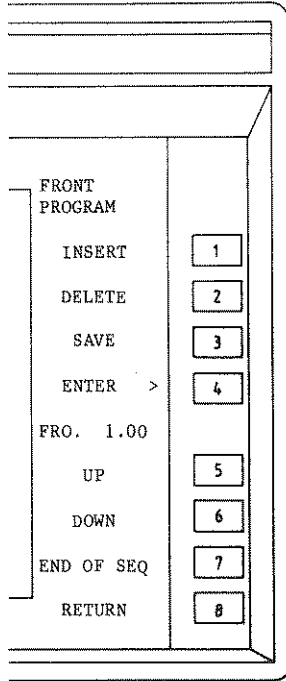
If softkey PROGRAM is pushed, the menu FRONT PROGRAM will be visible on the screen and new front setting sequences can be programmed or existing sequences can be altered.

Depending on the number of programmed fronts, a part of the softkey texts may not be displayed.

FRONT PROGRAM

INSERT   1

DELETE   2

SAVE   3

ENTER   >   4

FRO. 1.00

UP   5

DOWN   6

END OF SEQ   7

RETURN   8

8   1   INSERT

If softkey INSERT is pushed, the actual front setting is inserted after the front number which is displayed in the softkey text area. Next the number of the inserted front is displayed.
When the new front setting is inserted, all higher front numbers are increased by one.

ACTUAL FRONT
TO BE INSERTED (FRONT 01 WAS SELECTED)

OLD SEQUENCE   00 01 02 03 04 05   EOS

NEW SEQUENCE   00 01 02 03 04 05 06   EOS

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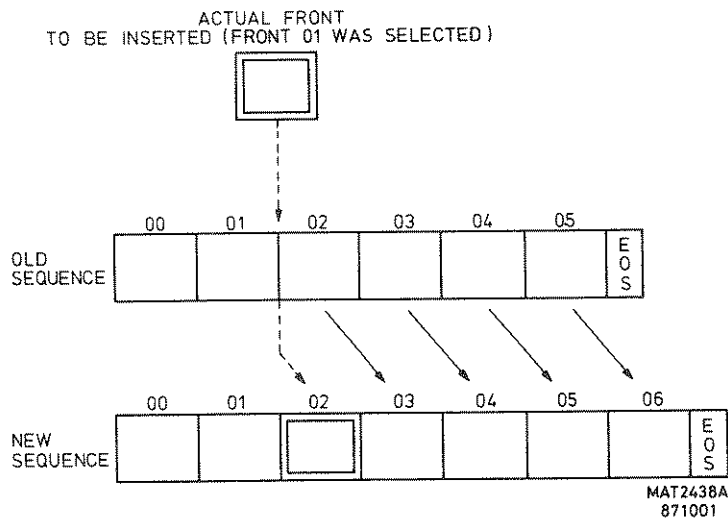
Figure 4.34 INSERT-action.

If there is not enough room in the front setting memory, a message

Not enough memory to SAVE or INSERT front.
DELETE a front before continue.

is displayed.

8   2   DELETE

If a programmed front setting should be removed from a
sequence, the number of this front setting has to be
selected first.
After pressing softkey DELETE, the selected front setting is
removed from the sequence and all higher front numbers are
decreased by one.
The deleted front setting is saved in the backup front.
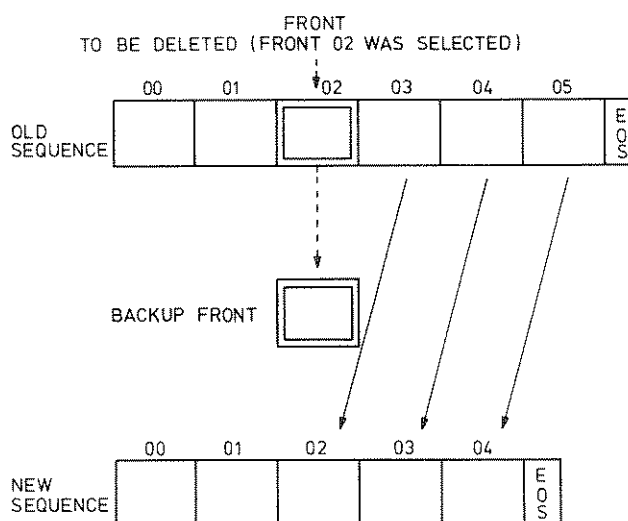
Figure 4.35 DELETE-action.

NOTE: If a main front number is deleted, the complete
         sequence of fronts is deleted!

8   3   SAVE

If SAVE is depressed, the actual front setting is saved
under the number which is visible in the softkey text area.
SAVE can only be used to create a main front or to overwrite
an already existing front.
The overwritten front setting is saved in the backup front.

ACTUAL FRONT
TO BE SAVED
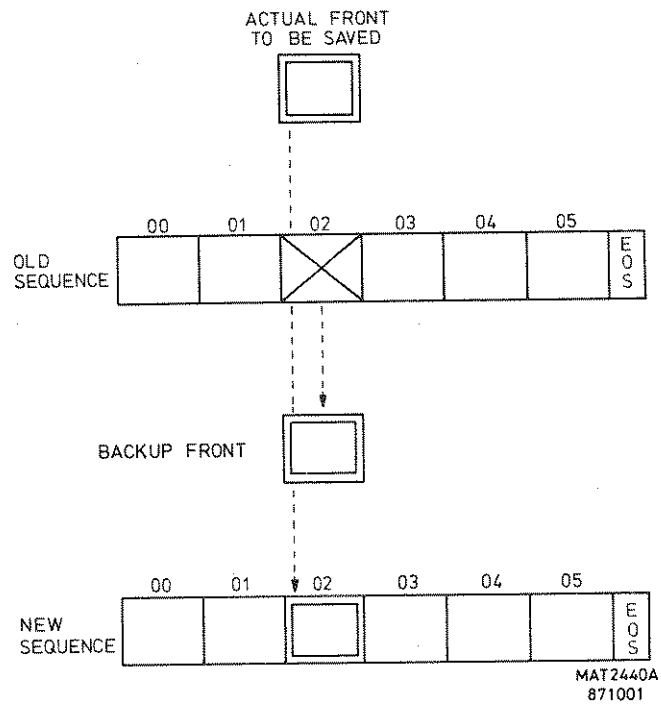
Figure 4.36 SAVE-action.

If there is not enough room in the front setting memory, a message

Not enough memory to SAVE or INSERT front.
DELETE a front before continue.

is displayed.

If SAVE is executed on the backup front, a message

BACK UP FRONT cannot be changed. Action not executed

is displayed.

8   4   ENTER>

```
┌─────────────────────────┐
│ ═══════════════════════ │
│ ═══════════════════════ │
│                         │
│ ┌─────────────────────┐ │
│ │ FRONT PROG          │ │
│ │ ENTER               │ │
│ │                     │ │
│ │ Memory for   ┌───┐  │ │
│ │              │ 1 │  │ │
│ │ 77 fronts    ┌───┐  │ │
│ │              │ 2 │  │ │
│ │ Enter like:  ┌───┐  │ │
│ │              │ 3 │  │ │
│ │ main.sub     ┌───┐  │ │
│ │              │ 4 │  │ │
│ │    ?                │ │
│ │              ┌───┐  │ │
│ │   ---        │ 5 │  │ │
│ │              ┌───┐  │ │
│ │ CLEAR        │ 6 │  │ │
│ │              ┌───┐  │ │
│ │   ---        │ 7 │  │ │
│ │              ┌───┐  │ │
│ │ EXECUTE      │ 8 │  │ │
│ └─────────────────────┘ │
└─────────────────────────┘
```

If softkey ENTER is pushed, the
FRONT PROG/ENTER menu is displayed and a
front number between FRO. 00.00 and   FRO.
99.99 can be entered using the numeric keypad.
The selected front number is visible in the
softkey text area.

8   4   1   --

8   4   2   --

8   4   3   ---

8   4   4   --

8   4   5   --

8   4   6   CLEAR

IF an error is made, the selected front number can
be cleared by pressing softkey CLEAR.

8   4   7   --

8   4   8   EXECUTE

By pressing softkey EXECUTE the selected front
number is entered and a RETURN is performed
resulting in the display of the FRONT PROGRAM menu.
If EXECUTE is pressed after CLEAR the previous front
setting remains.

If a selected front number does not exist, a message

Selected front doesn't exist.
Number set at last available front in sequence.

is displayed and the last front number in the sequence
is selected.

8   5   UP

By pressing softkey UP, the next higher front number of the
selected sequence is displayed in the softkey text area. UP
functions until the EOS (END OF SEQUENCE) is reached.
Then the following message

Begin or end of the sequence reached.

is displayed.

8   6   DOWN

By pressing softkey DOWN, the next lower front number of the
selected sequence is displayed in the softkey text area.
DOWN functions until the first front is the sequence is
reached.
Then the following message

Begin or end of the sequence reached.

is displayed.

8   7   END OF SEQ

If softkey END OF SEQ is pushed, the selected front number
becomes the last front number in the sequence and all the
fronts after the selected front are deleted.
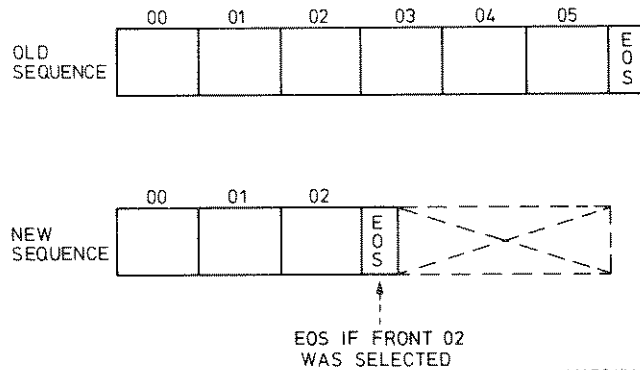
Figure 4.37 END OF SEQUENCE action.

NOTE: There is no way to restore the fronts that are
             deleted by the END OF SEQ action.

8   8   RETURN

If softkey RETURN is pushed, the FRONT NUMBER menu is
displayed again.

In a number of situations an old front setting is saved in the backup
front. This backup front can be made actual again by entering the
FRONT NMBR/ENTER menu, keying 9999 and pressing the softkey EXECUTE.

The backup front can also be used to restore a front, which is deleted
by mistake.
The example below shows how to do this.
It is assumed that front 13.13 is just deleted by mistake in the FRONT
PROGRAM menu.

Key	Comment
RETURN	Return to FRONT NUMBER menu.
ENTER	Enter FRONT NMBR/ENTER menu.
9999	Key backup front number.
EXECUTE	Make backup front actual and return to FRONT NUMBER menu.
PROGRAM	Enter FRONT PROGRAM menu.
ENTER	Enter FRONT PROG/ENTER menu.
13.12	Key front number minus one.
EXECUTE	Call front number 13.12 and return to FRONT PROGRAM menu.
INSERT	Insert actual front behind front number 13.12; so at 13.13.

4.2.12   MISCELLANEOUS FUNCTIONS AND REMOTE MODE
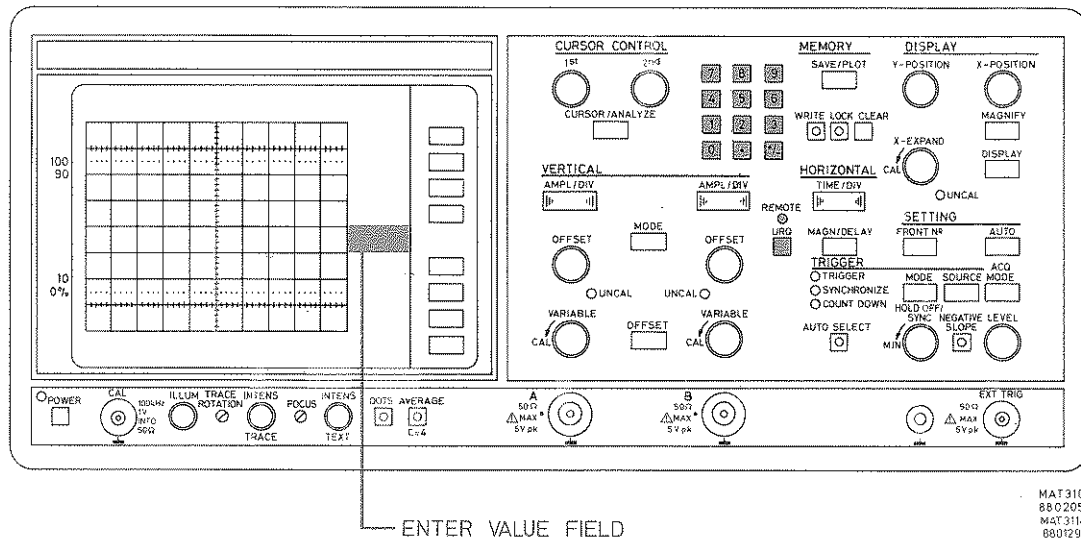
ENTER VALUE FIELD

ENTER VALUE FIELD

Figure 4.38 Front panel view.

7	8	9	Numeric key pad for data entering after selection of one of the following ENTER functions.
4	5	6	
1	2	3	
0	.	+/−	

ENTER VERTICAL OFFSET A	4.2.5.2
ENTER VERTICAL OFFSET B	4.2.5.2
ENTER TRIGGER EVENTS	4.2.7.1
ENTER TRIGGER DELAY	4.2.7.1
ENTER FRONT NUMBER	4.2.11.1

If an ENTER menu is selected, the data selected via the numeric keypad will be displayed in the ENTER VALUE FIELD of the softkey text area. Pushing softkey CLEAR, clears this enter value field. If too many digits or a too high value is entered, an automatic clear is performed and a message.

Too many digits: total entry is cleared.

is displayed.

The data entered via the numeric key pad, is activated after pressing softkey EXECUTE.

REMOTE

Pilot lamp indicating that the instrument is in its REMOTE-state and that the interface overrules all the manually selected front panel settings. The last with the exception of POWER ON, ILLUM, TRACE ROT, INTENS TRACE, FOCUS and INTENS TEXT and PROBE INDICATION.

Resetting the instrument back to its LOCAL-state can be provided from a controller or by switching the instrument OFF and ON.

URQ

The operator is able to ask an installed option for service by pushing the URQ (user request) pushbutton.
The kind of service which is given then depends on the user's program.

4.2.13   REAR PANEL
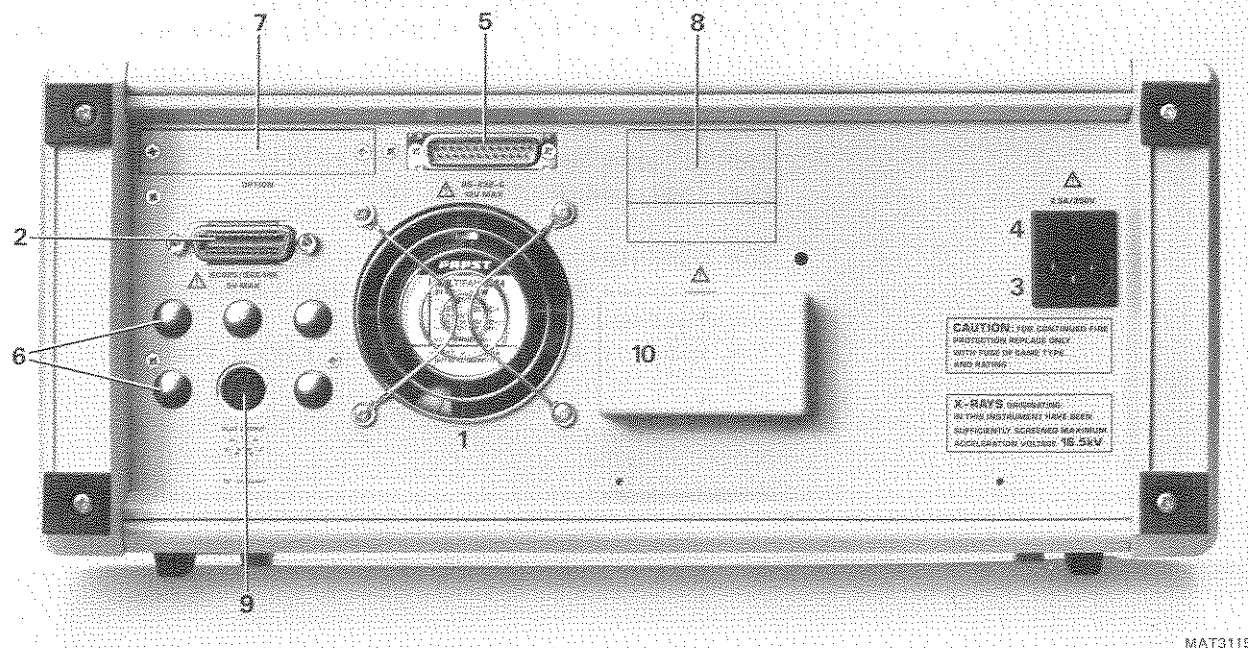
Figure 4.39 Rear panel view.

1 -   Fan.

2 -   IEEE-488 connector.

3 -   Mains input socket (90 V ... 264 Vac, 45 Hz ... 440 Hz). For
       safety instructions, read section 3.2.2.

4 -   Mains fuse holder (Fuse rating 2.5 A delayed action). For safety
       instructions, read section 3.2.2.

5 -   RS-232C connector.

6 -   Space for optional BNC sockets.

7 -   Space for optional connector.

8 -   Type plate with 12-number code and type number.

9 -   Analog plot output socket.

10 -   Memory back - up battery compartment with removable cover. For
       installation instructions, read section 3.3.

4.3   DETAILED OPERATING INFORMATION

4.3.1   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.It also gives a suitable starting routine before any measurements are made.
Before reading this chapter, it is recommended that Chapter 4.2., explanation of controls and sockets, is read first.

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

The following subjects are described:

Start up procedure	4.3.2
Use of internal registers	4.3.3
High frequency measurements	4.3.4
Use of probes	4.3.5
OFFSET adjustment	4.3.6
Added mode and common-mode measurements	4.3.7
Triggering	4.3.8
Trigger delay	4.3.9
Time-base acquisition modes	4.3.10
Signal processing modes	4.3.11
Horizontal magnifier	4.3.12
Vertical magnifier	4.3.13
A versus B mode	4.3.14
Analog PLOT-mode	4.3.15

4.3.2   Start-up procedure

Switch the instrument on, check that the power-on lamp is on and that the power-up routine is executed.

At the end of the power-up routine, the instrument is ready to accept input signals on the channel A and B input sockets.

Pushing pushbutton AUTO-SET will set the instrument for a triggered display on the C.R.T. screen. The INTENS controls can be set for a suitable trace and text intensity.

The channel A and B signals are stored now in register R0, which is one of the four internal registers R0, R1, R2 and R3, and the contents of register R0 are displayed. Eight of the ten vertical divisions are visible on the C.R.T. screen.
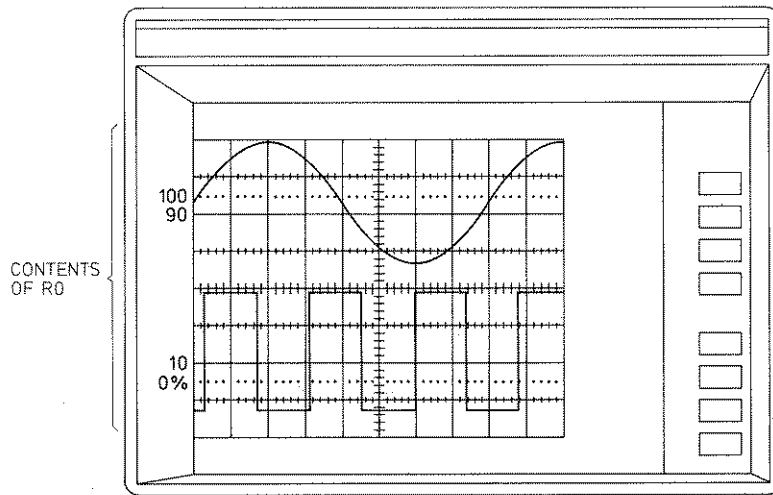
Figure 4.40 Screen of R0 contents in dual channel mode.

Both signals can vertically be shifted over the screen using the (softkey selectable) OFFSET facilities.
The signal amplitude and the number of displayed periods can directly be influenced by the AMPL/DIV controls and the TIME/DIV control. The selected settings can be read in the top text area on the C.R.T.

4.3.3   Use of internal registers

The procedure to save information in the internal registers or to clear the contents of these registers is now described.

Four internal registers R0, R1, R2 and R3 are available and in each of these registers a signal from channel A as well as a signal from channel B can be stored.

New signal information will always be stored in register R0 and the contents of this register can later be saved, if required, in one or more of the other three registers R1, R2 and/or R3 using the SAVE/PLOT menu by pressing the SAVE/PLOT pushbutton.

Using the DISPLAY menu by pressing pushbutton DISPLAY, gives the facility to the user to select one or more of the four internal registers to display their contents on the CRT screen.
Then displayed signals are overlapping each other on the screen.

To avoid this, the MAGNIFY menu can be selected by pressing pushbutton MAGNIFY to select the Y/5 magnify mode which results in the following display of four registers.
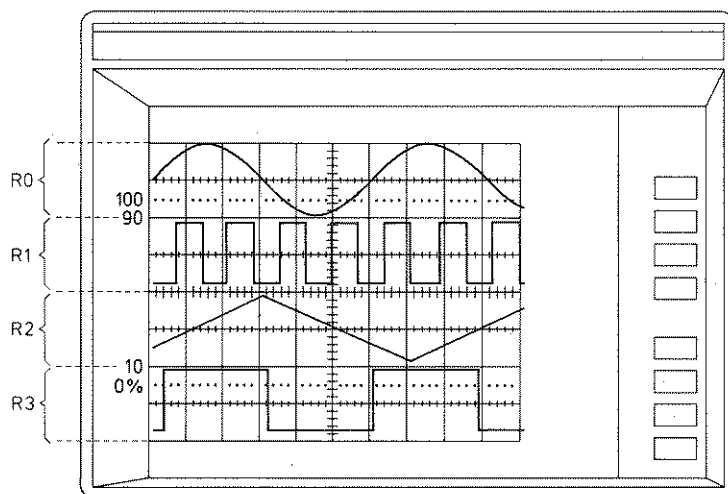
Figure 4.41 Display of four registers in Y/5 mode.

The memory system can be locked by depressing pushbutton LOCK and from
that moment on no new signal acquisition can take place.
By depressing pushbutton WRITE, the system can be enabled again for
new signal acquisition.

Register R0 can be cleared (in WRITE-mode only) using the CLEAR
pushbutton.
The other registers can be cleared then by saving the cleared contents
of register R0 in the selected register. In other words, clearing a
register R1, R2 or R3 can be done by saving the blank contents of
register R0 in the selected register.

4.3.4   High frequency measurements

A general measuring set-up for high frequency measurements has the
configuration as given in fig. 4.42. This configuration consists of a
signal source (the device-under-test), an interconnection cable and
the measuring oscilloscope.
The signal from the device under test must be displayed on the
oscilloscope screen with the highest possible accuracy.
The figure shows that the internal impedance of the device-under-test
and the input impedance of the oscilloscope both have the same value
of 50 ohms.

```
OPEN OUTPUT
VOLTAGE=U
                50Ω                                     VOLTAGE=0,5U

                                                    50Ω

DEVICE UNDER
    TEST                                          OSCILLOSCOPE
                                                    INPUT
```

MAT1631
840928
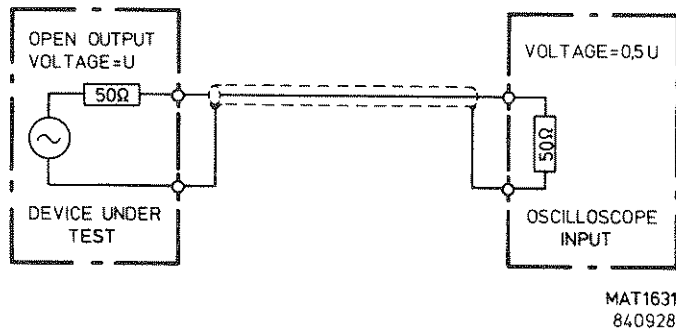
Fig. 4.42 General measuring set-up.

Also the coaxial interconnection cable must have a characteristic
impedance of 50 ohms. Impedance deviations will lead to pulse
reflections at the oscilloscope input and device-under-test output.
This results in measuring faults. The mechanical requirements of the
cable are the required length. Of course it must have suitable
connectors.

If the device-under-test has an internal impedance different from 50
ohms (e.g. 75 ohms), we must use an impedance adaptor from 75 into
50 ohm.
Such a device is often combined with an attenuator (e.g. 10:1).

Hints for measurements:
- When measuring with the oscilloscope, always ensure that the maximum
  input voltage is not exceeded.
  This is especially important when measuring a.c. voltages are
  superimposed on a d.c. voltage.
  A too high input voltage can damage the oscilloscope's sampling gate
  and 50 ohm termination resistor.
- An input voltage that is too high can be attenuated by a 10:1 or
  100:1 attenuator piece of good quality that must be inserted between
  the end of the cable and the oscilloscope's input socket.
- 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 a part of the device-under-
  test energy is applied to the oscilloscope input: the remaining
  energy is applied to the normal load.

Fig. 4.43 gives 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 ohm 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.
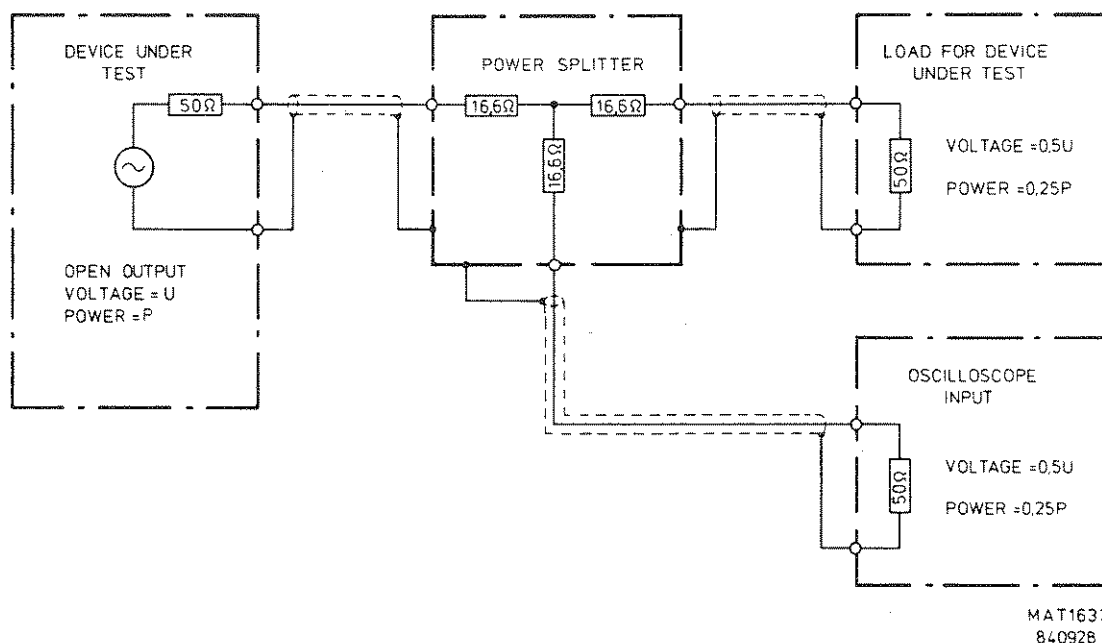
Fig. 4.43 Measuring configuration with power splitter.

4.3.5   Use of probes.

In the explanations in the previous chapter it is more of less assumed
that there is a coaxial cable between oscilloscope and one point
(e.g. the output socket) of the device-under-test. However in many
cases it is necessary the measure different spots on a printed circuit
board. For this purpose special 100:1 and 10:1 attenuator probes are
available that can be plugged on to the 50 ohm input of the
oscilloscope. The input impedance at the probe tip is 5 kiloohm for
the 100:1 type and 500 ohm for the 10:1 type.
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-freqency 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. An example of this is a
miniature coaxial socket that can be soldered on to a printed circuit
board and in which the probe tip fits.

4.3.6   OFFSET adjustment

The OFFSET adjustment gives the possibility to give a vertical
shift to the signal displayed on the screen. This can be done
seperately for channel A and B. Adjustment is possible both via a
rotary control OFFSET and via softkey menu's. The softkey menu's give
the possibility to make shifts in steps of one division, ten divisions
(one screen) and in predefined values entered via the numerical
keyboard.

The OFFSET gives us the possibility to bring the display of channel A and B at such a d.c. level that an optimal use can be made from the instrument's vertical resolution.

4.3.7   Add mode and common mode measurements

If the ADD mode is selected, the signal voltages of both vertical channels are added.
Depending on the selection of the INVERT-mode of the A or B channel, either the sum or the difference of the input signals is displayed.
The ADD mode also enables differential measurements to be made. With these measurements, advantage is taken on the common mode rejection in the ADD mode. When the channel B is selected for inversion (and channel A INVERT 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. 4.44).
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 vertical VARIABLE controls for minimum deflection on the screen.

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

CMR (common mode rejection)$=\dfrac{\hat{u}_{cm}}{\hat{u}_d}$

As drawn here CMR $\approx$ 10

MAT 574
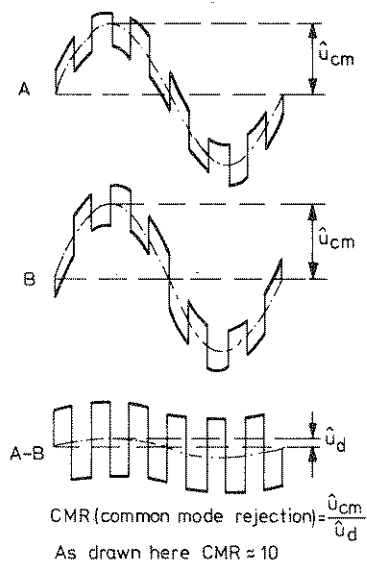
Figure 4.44 Suppression of common mode signals.

4.3.8   Triggering

Trigger sources.
The signal acquisition system can be triggered on one of the vertical channels A or B or on a signal applied to the EXTernal TRIGger input sockets. If you have the choice to trigger on two or even three time-related signals, a stable triggering is only obtained if you select the signal with the lowest frequency to trigger on.
Bear in mind that the trigger circuit is always a.c. coupled, so that triggering is not possible on low-frequency and d.c. signals.

LEVEL control and NEGATIVE SLOPE selection.
In the TRIGGER MODE TRIGG'ED and COUNTDOWN we are able to determine the starting point of the signal on the screen with the LEVEL control. In other words: the position of the LEVEL control determines the start of the signal acquisition system.

The circuit behind the LEVEL control functions as follows:
The trigger signal is fed to the input of a comparator and 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 control, a trigger pulse is generated by the comparator and the signal acquisition parts.
In this way, signal acquisition is started at a fixed point of the trigger signal, which means that by using the level control, it is possible to start the acquisition at any point of the waveform.

The NEGATIVE SLOPE pushbutton permits selection of the trigger slope. If NEGATIVE SLOPE is selected, the signal acquisition starts on the negative-going slope of the trigger signal, otherwise on the positive-going slope. NEGATIVE SLOPE can only be selected in TRIGG'ED.

TRIGGER MODE selection
The triggering can function in three different modes:
TRIGGER, SYNCHRONIZE or COUNT DOWN. Figure 4.45 indicates the approximate ranges of these modes depending on frequency and voltage of the trigger signal. These values are valid for all possible trigger sources being channel A, B, or EXT and for the sensitivity range SENS HIGH. The voltage levels must be multiplied by a factor of 10 if SENS LOW is active.

INPUT
VOLTAGE

```
5V

          TRIGGER              COUNTDOWN
          MODE                 MODE




30mV
20mV
10mV
                                         FREE  RUN  MODE
 5mV      SYNCHRONIZE
          MODE
 1mV
   100kHz            200MHz   500M 700M  1GHz   2GHz
```
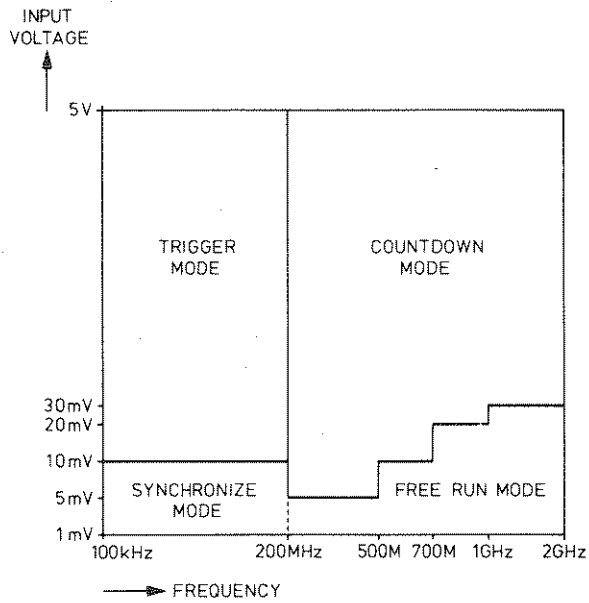
FREQUENCY

MAT3193
880205

Fig. 4.45 Possible modes as a function of input voltage and frequency

TRIGG′ED mode can be selected for displaying repetitive signals with a
frequency that does not exceed 200 MHz and with sufficient amplitude.

COUNTDOWN mode can be selected for displaying repetitive signals with
a frequency that exceeds 150 MHz and with sufficient amplitude.
In this mode the trigger signal is divided by 128 in a prescaler.

If the input signal is such that the signal can not trigger on it or
if there is no input signal at all the SYNC′ED mode must be
selected. In this mode an input signal can be made stable by means of
adjustment of the HOLD OFF/ SYNChronise control.

In the AUTO SELECT mode, the instrument always selects the most
suitable out of the three modes that are explained above. Switching
from TRIGGER to COUNTDOWN mode happens if the increasing signal
frequency passes 160 MHz approximately. Switching backwards occurs if
the decreasing frequency passes 150 MHz approximately.

4.3.9   Trigger delay

With the trigger delay facility the time between the trigger moment
and the start of the CRT display (left-hand side of the screen) can be
adjusted.
Trigger delay can be selected under softkey MAGN/DELAY.
The trigger delay ranges are always in divisions.
The range depends on TIME/DIV setting and the adjusted time base
MAGNifier position.
The table below indicates the possible combinations:

Time base magnifier:

	*1	*2	*5	*10	*20	*50
time/div possible delay	20us 0...10	10us 1...30	4us 2...90	2us 4...190	1us 8...390	400ns 20...990
time/div possible delay	10us 0...10	5us 1...30	2us 2...90	1us 4...190	500ns 8...390	200ns 20...990
time/div possible delay	5us 0...10	2.5us 1...30	1us 2...90	500ns 4...190	250ns 8...390	100ns 20...990
time/div possible delay	2us 0...10	1us 1...30	400ns 2...90	200ns 4...190	100ns 8...390	40ns 20...990
time/div possible delay	1us 0...10	500ns 1...30	200ns 2...90	100ns 4...190	50ns 8...390	20ns 20...990
time/div possible delay	500ns 0...10	250ns 1...30	100ns 2...90	50ns 4...190	25ns 8...390	10ns 20...990
time/div possible delay	200ns 0...10	100ns 1...30	40ns 2...90	20ns 4...190	10ns 8...390	4ns 20...990
time/div possible delay	100ns 0...10	50ns 1...30	20ns 2...90	10ns 4...190	5ns 8...390	2ns 20...990
time/div possible delay	50ns 0...10	25ns 1...30	10ns 2...90	5ns 4...190	2.5ns 8...390	1ns 20...990
time/div possible delay	20ns 0...10	10ns 1...30	5ns 2...90	2ns 4...190	1ns 8...390	500ps 20...990
time/div possible delay	10ns -1...9	5ns -2...28	2ns -5...85	1ns -10...180	500ps -20...370	200ps -50...940

Time base magnifier:	*1	*2	*5	*10	*20	*50
time/div possible delay	5ns -2...8	2.5ns -4...26	1ns -10...80	500ps -20...170	250ps -40...350	100ps -100...890
time/div possible delay	2ns -4...5	1ns -8...18	500ps -20...60	200ps -40...130	100ps -80...270	50ps -200...690
time/div possible delay	1ns -9...0	500ps -18...6	200ps -45...30	100ps -90...70	50ps -180...150	20ps -450...390

4.3.10   Time base acquisition modes

The time base can function in four different softkey selectable modes. These modes can be selected via the HORIZONTAL ACQ MODE menu over the entire TIME/DIV range of the instrument. The modes are:

RECURRENT mode:
This is the normal time-base mode in which the contents of register R0 is continuously refreshed on the receipt of new incoming trigger signals.

SINGLE mode:
When the SINGLE-mode is selected, the contents of register R0 is refreshed once after a trigger pulse and the selected delay-time, and the refreshed contents of register R0 is displayed on the C.R.T. screen.
As long as the instrument is waiting for a trigger pulse, the softkey text SING.ARMD (SINGLe ARMed) is intensified. After the trigger has occurred, only the word SING. is intensified.

MULTIPLE mode:
When the MULTIPLE-mode is selected, the previously described SINGLE-action is repeated four times. The result of the first SINGLE action in register R0 is copied to register R3, the second result is copied to register R2, the third to register R1 and the fourth stays in register R0. This is independent of the registers being displayed or not. As long as the instrument is waiting for a trigger pulse, the softkey text MULT. ARMD (MULTiple ARMed) is completely intensified. After the trigger has occurred, only the word MULT. is intensified.

The number of single actions to be executed is counted down in the top text area on the C.R.T.

MULT EYE
The MULTiple EYE pattern mode is a combination of the mode MULTIPLE
and EYE PATTERN: 12K memory is available for optimal display quality.
In this mode many functions are preset to a predefined value in order
to obtain optimal display quality for eye pattern signals. These
presets can be overruled afterwards by the user. The most important
presets are:
- X and Y MAGN are set to *1.
- X and Y positions in DISPLAY section are set to zero (CALIBRATE
  function is activated).
- Register R∅ off; R1, R2 and R3 are switched on.
- Cursors and signal processing modes are switched off.
- EYE PATTERN mode is switched on
- Y-POSITION knob is influencing register R1.
- DOT mode is switched on.

4.3.11   Signal processing modes.

The oscilloscope has a number of build-in modes that can be used to
display a voltage waveform on the screen with a maximum of quality.
These modes are:

AVERAGE mode:
This mode can be reached via VERTICAL MODE and then softkey PROCESSING.
AVERAGING is a way to suppress noise without losing bandwidth and can
only be used in RECURRENT mode.
Every dot is calculated after every sweep in the following way.

$$new = previous + \frac{measured - previous}{C}$$

In this formula "previous" is a sample on the same position of the
previous sweep.
If C=1 every new dot is the measured dot; AVERAGE if OFF. If C>1, the
dot positions change slower.
The bigger C is, the slower the dot positions change. The following
values for C can be selected:
C = 2, 4, 8, 16, 32 or 64.

The pushbutton AVERAGE C=4 allows direct selection of the averaging
factor C=4. This pushbutton is located under the C.R.T.

Note: AVERAGE is not effective during SINGLE and MULTIPLE SHOT mode.

MULTIPLE SAMPLING mode

This mode can be reached via VERTICAL MODE and then softkey
PROCESSING. In this mode you can select via softkeys a value for "M".
This value can be 2, 4, 8, 16 or 32. This value represents the number
of samples that is taken in sequence before the last sample is used to
display one point on the screen.
This mode reduces signal distortion in fast changing signals like
square waves. The higher "M" has been chosen, the lower the
distortion. A disadvantage of this mode is that the acquisition time
increases with the "M"-value.

EYE PATTERN mode

This mode can be reached via VERTICAL MODE and then softkey
PROCESSING. This mode is only necessary for displaying eye pattern
signals with a minimum of distortion. Eye pattern signals can be
measured in data communication systems. Because this mode results in
considerable distortion for other signal types, it must only be used
for eye patterns. In EYE PATTERN mode the acquisition works with a
high resolution of 4096 measured points. This instead of 512 measured
points, while the remaining points are obtained by means of
calculation.
A register containing a signal that is obtained in EYE PATTERN mode
cannot be expanded via the horizontal expansion mode under pushbutton
MAGNIFY. However expansion is still possible with the continuous
variable control X-EXPAND.

LOW RESOLUTION/FAST DISPLAY

This mode can be reached via HORIZONTAL MODE. Via the softkeys UP and
DOWN you are able to select a horizontal resolution of 512, 256, 128
or 64.
A complete picture consists of 4096 points of which normally 512 are
obtained by sampling the input signal. The points inbetween are
obtained by means of calculation. By means of softkey selection, the
number of sampled points can be reduced to respectively 256, 128 or
64. In this way a complete picture is obtained faster; however this
may lead to distortion of the displayed signal because the number of
measured points decreases while the number of calculated points
increases. It may be that we miss certain signal variations. Thus in
general a resolution of 512 points is advised. If you press softkey
FAST DISPlay, resolution of 64 is obtained instantly. This mode is
only advised to get quickly a rough indication how a signal looks like.

Possible combination of signal processing modes.

	AVERAGE MODE	MULTIPLE SAMPLING	EYE PATTERN MODE	LOW RESOL./ FAST DISPLAY
AVERAGE	−	YES	NO	NO
MULTIPLE S.	YES	−	NO	YES
EYE PATTERN	NO	NO	−	YES
LOW RESOL.	NO	YES	YES	−

4.3.12   Horizontal magnifier

When the continuous horizontal expand (X-EXPAND) control is used, the display on the screen expands horizontally to more than 2x the TIME/DIV setting. The reduced time window provides a more detailed display. Using the X POSITION control, any portion of the trace can be shifted into the display area.

Via the MAGNIFY menu the following horizontal expand factors can be selected:
*1, *2, *4, *8, *16, *32 and *64.

Note: The MAGNIFY menu gives horizontal magnification that is achieved in the display section of the oscilloscope.
The instrument has a second possibility to make horizontal magnification. This is done in the acquisition part via the softkey MAGN/DELAY and results in a change of the time base sweep speed.
However the horizontal display width stays always 10 divisions in this mode.

4.3.13   Vertical magnifier

Via the MAGNIFY menu, three different vertical expand factors, Y/5, Y*1 and Y*5 can be selected.

Y/5

All four registers R0, R1, R2 and R3 can be displayed in their own trace area, each with a vertical trace height of two divisions.
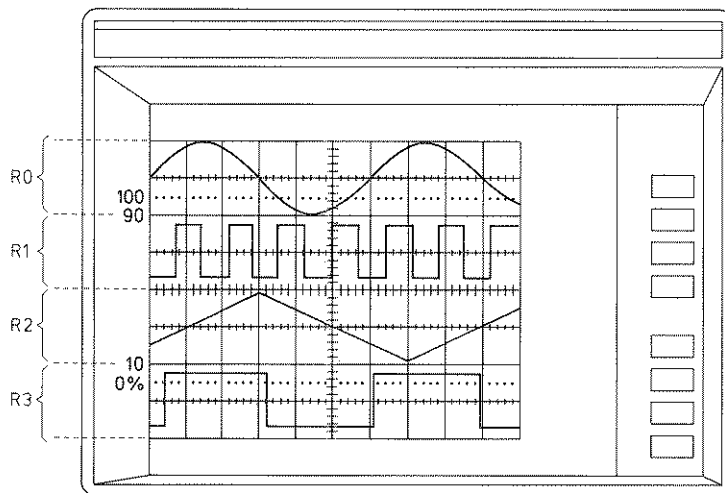
Figure 4.46 Y/5 mode.

In this mode it is also possible to add reduced register texts in the trace area of each register via the DISPLAY menu.

Y*1

This is the normal vertical expand factor, in which each register can be displayed over 10 vertical divisions of which 8 divisions are visible on the C.R.T. screen.
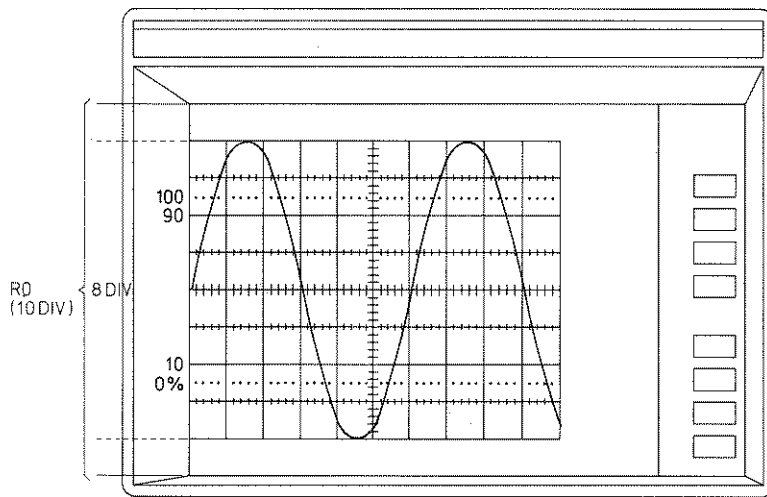
Figure 4.47 Y*1 mode.

Y*5

In this mode a vertical expand from 10 divisions to 50 divisions is possible of which only 8 divisions are visible on the C.R.T. screen.

Using the Y position control, any vertical portion of the trace can be shifted into the trace area of the C.R.T. screen.
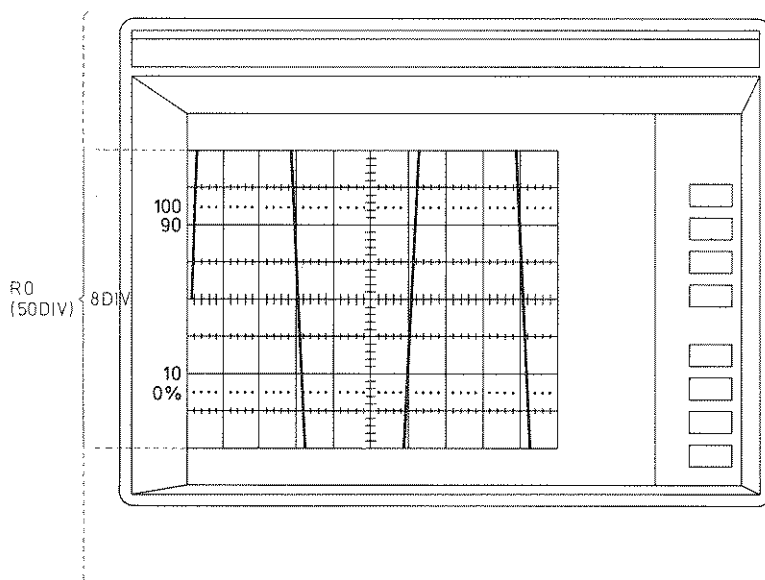
Figure 4.48 Y*5 mode.

4.3.14   A versus B mode

With a A versus B selected, XY display is obtained from the samples
derived from the channel A and channel B inputs.

The samples derived from the channel A input signal are used for
horizontal deflecton and the samples derived from the channel B input
for vertical deflection.

This A versus B mode is principally a different mode than the real
time X-Y mode in a real time oscilloscope.

In this case it is only a different way of displaying the contents
of the registers. The storage of signal information is influenced
by the position of the TIME/DIV switch, trigger selection and trigger
SLOPE and LEVEL, so the A versus B display of this information is also
influenced by these factors.

4.3.15   Analog plot mode

Two different PLOT-modes can be selected:

- Register PLOT via the SAVE/PLOT menu:

    The contents of the selected register can be plotted. The Y-
    POSITION, the X-POSITION, and the X-EXPAND controls and the MAGNIFY
    selection have no influence.

- Screen PLOT via the DISPLAY menu:

  The picture on the trace area of the C.R.T. screen can be plotted
  including the influence of the Y-POSITION, the X-POSITION and the X-
  EXPAND controls and the MAGNIFY selections.
  The picture will be similar to the picture on the screen.

The X and Y plot outputs on the rear panel of the oscilloscope
generate 1 V full memory or 1 V full screen. (See characteristics).

The PEN LIFT output is an open collector output; max 12 V (TTL
compatible).

Via the SAVE/PLOT menu the following selections can be done.

- PEN UP "0"
- PEN UP "1"
- PLOT speed
  Range: 20 ms/dot ... 2000 ms/dot.
- Register R0, R1, R2 or R3 (only for register PLOT).

During plotting, the oscilloscope is in the LOCK-mode, which means
that the contents of all registers cannot be changed.

In case of dual channel plotting, first channel A will be plotted and
then channel B.

The PLOT operation is provided with a short delay at the start and end
of the action to give sufficient time for manual pen positioning if no
automatic pen lift function is available on the recorder.

If the SINGLE-shot mode and register plot is selected, the AUTOPLOT
function can be activated.
The contents of register R0 is then automatically plotted after each
refreshment of the register when a valid trigger is received.

The progress of the plotting is indicated by a dot on the C.R.T.
screen, which moves from the left to the right and which is displayed
in the bottom text area.

VERTICAL SECTION

EYE PAT

FEEDBACK
ATTENUATOR

A-50Ω

TRIGGER
PICK OFF

DELAY LINE

SAMPLING
GATE

AMPLIFIER

C

VER

UNCAL

PROBE DET

PROBE DETECTION

OFFSET

AMPL / DIV

CAL

VARIABLE

PROBE DET

C

UNCAL

B-50Ω

TRIGGER
PICK OFF

DELAY LINE

SAMPLING
GATE

AMPLIFIER

C

EYE PAT

FEEDBACK
ATTENUATOR

TRIGGER AND
TIME BASE
SECTION

EXT TRIG

50Ω

TRIGGER
SOURCE
SELECTION

AMPLIFIER
X1 / X10

PRESCALER
÷128 / ÷1

TRIGGER
AMPLIFIER

C

C

C

C

A

B

EXT

HI SENS

LO SENS

COUNT DOWN

LEVEL

NEG
SLOPE

SOURCE

MODE

CONTROL
SECTION

PROBE DET

C

C

C

C

C

MICRO
PROCESSOR
MANAGEMENT
INTERFACE

CONVERSION AND PROCESSING SECTION

FEEDBACK
DAC

VERTICAL MODE

NORMAL / INVE

ADD

AVERAGE

AVERAGE

C=4

C

TICAL MODE

C

A

A AND B

B

CHANNEL
SWITCH

MULTIPLEXER

ADC

DATA
PROCESSING
CIRCUIT

μP

FEEDBACK
DAC

ACQ MODE

RECURRENT

MULTIPLE

SINGLE

C

FAST RAMP
GENERATOR

COMPARATOR

ACQUISITION AND
CONTROL LOGIC

C

C

TIME /
DIV

HOLD OFF
/ SYNC

TRIGGER

SYNCHRONIZE

COUNT DOWN

C

STAIR
DAC

ADDER

C

MAGN / DELAY

C

DELAY
DAC

μP

μP

μP

STORAGE SECTION

DISPLAY SECTION

MEMORY

CURSOR CONTROL

SAVE

$C\mu p$ $C\mu p$

1st   2nd

SAVE
TO R1
TO R2
TO R3

CURSOR/ANALYZE

WRITE   LOCK   CLEAR

⊗   ⊗

$C\mu p$

CURSORS
MULTIPLY
RMS
t/dt
MEAN
PEAK PEAK
RISE TIME

DISPLAY

REG SELECT
POS Rn
INVERT
A VERSUS B
REDUCED TEXT
FULL TEXT

$C\mu p$

Y-POSITION

$C\mu p$

TRACE MEMORY

| R0 |
| R1 |
| R2 |
| R3 |

TEXT MEMORY

VERTICAL
INVERT/
EXPAND

$C\mu p$ Y✳5
         Y✳1
         Y/5

ADDER

μp

X-POSITION

$C\mu p$

MAGNIFY

$C\mu p$

EXPAND
✳1...✳64

ADDER

HO

μp

ADDRESS
GENERATOR

HORIZONTAL
A-VERSUS-B
EXPAND

μp

X-EXPAND

CAL

$C\mu p$

μp

X-

ROM
MEMORY

RAM
MEMORY

FRONT №   AUTO

μp

μp

μp

μp

iNTENS

iNTENS

TRACE

FOCUS

TEXT

PLOT

Cµp

Cµp

DISPLAY (PLOT)

REG.PLOT

SCREEN PLOT

Z –
AMPLIFIER

PLOTZ

PLOTY

PLOTX

ANALOG
PLOT
OUTPUT

PLOT
OUTPUT
SOCKET

µP

.AL
IN

VERTICAL
FINAL
AMPLIFIER

CAL
GENERATOR

CAL

100kHz
1V INTO 50Ω

Cµp

C.R.T.

NTAL
IN

HORIZONTAL
FINAL
AMPLIFIER

TRACE
ROTATION

POWER SUPPLY SECTION

ILLUM

POWER

ON

OFF

MAINS
VOLTAGE

POWER
SUPPLY

EHT VOLTAGE

SUPPLY VOLTAGES

FRONT SECTION

ROTARY
SWITCHES

FRONT
CIRCUIT

PILOT
LAMPS

NUMERICAL KEYBOARD

7	8	9
4	5	6
1	2	3
0	.	+/-

Cµp
Cµp

Cµp
Cµp

RO -
SSOR

GIC

PUSH BUTTONS
+ SOFTKEYS

µP

µP

MAT 3096

INTENS TRACE

INTENS TEXT

FOCUS

PLOT

Cμp

DISPLAY (PLOT)

Cμp

REG.PLOT

SCREEN PLOT

PLOTZ

ANALOG PLOT OUTPUT

PLOT OUTPUT SOCKET

μp

PLOTY

PLOTX

Z- AMPLIFIER

VERTICAL DOT JOIN

VERTICAL FINAL AMPLIFIER

TICAL AC.

Cμp

Cμp

DOTS

Cμp

CAL GENERATOR

CAL

100kHz 1V INTO 50

C.R.T.

TRACE ROTATION

HORIZONTAL DOT JOIN

HORIZONTAL FINAL AMPLIFIER

ZONTAL AC.

POWER SUPPLY SECTION

ILLUM

POWER ON OFF

UNCAL

MAINS VOLTAGE

POWER SUPPLY

EHT VOLTAGE

PAND AC.

FRONT SECTION

ROTARY SWITCHES

FRONT CIRCUIT

PILOT LAMPS

REMOTE

URQ

MICRO- PROCESSOR + LOGIC

Cμp
Cμp
Cμp
Cμp

μp

PUSH BUTTONS + SOFTKEYS

μp

4.4   PRINCIPLE OF OPERATION

In this section, the principles of operation are discussed at block
diagram level, with special emphasis being applied to those parts of
the circuit that differ from normal oscilloscope practice; i.e. the
digital storage and control facilities.

4.4.1   General

This digital storage oscilloscope comprises the following sections:

- a signal acquisition section which can be divided in a vertical
  section, a trigger and time base section and a conversion and
  processing section.
- a storage section
- a display section
- a control section
- a front section
- a power supply section

Note: almost all the contols of this oscilloscope are red by a
      microprocessor. The microprocessor on its turn controls the
      relevant circuitry in the instrument.This occurs via the CONTROL
      SECTION. Where this happens it is indicated with C--> in this
      blockdiagram.

4.4.2   The signal acquisition section

Vertical section

The vertical section consists of two channels A and B. Because both
channels are identical, only channel A is explained in this
description.
The input signal must be applied to the N type input socket A.
This input socket is provided with a pin for the PROBE DETECTION. The
pin is connected with the microprocessor system of the oscilloscope.
If a probe with an indication ring is connected to the oscilloscope's
input, the microprocessor knows the type of probe. As a result of
this, the CRT read-out of the input sensitivity is adapted to the
attenuation factor of the probe.

The channel A input signal is applied to the TRIGGER PICK OFF. This
block incorporates a transformer that picks off a small part of the
input signal for triggering of the time base. Because of the fact that
a transformer is used, the trigger channel is a.c. coupled. Behind the
trigger pick off, the signal is applied to a 30 ns DELAY LINE that
compensates for propagation delays in the trigger circuits. As a
result of this, it is possible to observe also the leading edge of
fast rising signals.

The output signal of the DELAY LINE is applied to the input of the
SAMPLING GATE. This gates takes samples of the input signal at regular
time intervals. The sample moments are determined by sample pulses
generated in the TRIGGER AND TIME BASE SECTION. The SAMPLING GATE
receives also the adjustable d.c. OFFSET voltage that gives an
adjustable vertical shift of the input signal. The input signal of the
SAMPLING gate is added with a signal from a feedback loop. This
feedback is the inverted value of the preceeding sample that is
already stored in the instrument's memory. Because the contents of the
memory is digitised, the feedback loop contains the block FEEDBACK DAC
for conversion back to analog.
The loop gain is normally unity for the best possible drift reduction
and a high dynamic range. However if the input sensitivity is 1 or
2 mV/div, the loop gain is decreased in order to suppress noise. In
the EYE PATTERN mode the feedback loop is not operative and the
feedback input of the SAMPLING GATE is constantly at 0 volt. The
result is a reduction of stability, accuracy and dynamic range

The SAMPLING GATE is followed by an a.c.-amplifier that has an
adjustable gain in order to make the AMPL/DIV steps and the VARIABLE
gain.
In parallel with the amplification factors, the FEEDBACK ATTENUATOR in
the feedback loop is adjusted to keep the loop gain at unity.

The output signals of the AMPLIFIER of channel A and B are both
applied to the CHANNEL SWITCH. In this block the selection between
channel A only, channel B only or channel A and B together is done.
From the CHANNEL SWITCH the A and B signals are routed to the
CONVERSION AND PROCESSING SECTION where they are digitised and stored.

Trigger section

This section makes it possible to start the FAST RAMP GENERATOR at an
adjustable level of the signal displayed via vertical channel A or B
or via a signal applied to the EXTernal TRIGger input socket. The
block TRIGGER SOURCE SELECTION permits selection between channel A,
channel B or input EXT TRIG as trigger source. The selected trigger
source is applied to an AMPLIFIER with amplification factors of x1 and
x10. The x1 amplification is activated if LOW SENSitivity has been
selected. If HIGH SENSitivity has been selected the amplification is
x10. After selection and amplification, the signal is applied to the
PRESCALER :128/:1. This block divides the frequency by 128 if the
COUNTDOWN mode is active. This division is necessary if the frequency
of the trigger signal exceeds 160 MHz, because the TRIGGER AMPLIFIER
can not work properly on these signals. Prescaling is not necessary
for signals under 160 MHz: in this case the signal is applied directly
to the TRIGGER AMPLIFIER. The LEVEL control of the TRIGGER AMPLIFIER
determines at what level of the trigger signal a trigger pulse is
generated at the output of the trigger amplifier. Via the pushbutton
NEGATIVE SLOPE can be selected if this trigger pulse occurs at the
positive or at the negative slope of the trigger signal.

Time base section

The sampling principle that is used in this oscilloscope is called
SEQUENTIAL SAMPLING. This means that samples are taken from the
channel A and/or B input signals in the VERTICAL SECTION at regular
time intervals. These time intervals are determined by the time base.
The input signals are sampled during the time that the sampling pulse
generated by the time base is present. How the sampling pulses are
generated is illustrated with the following figure.
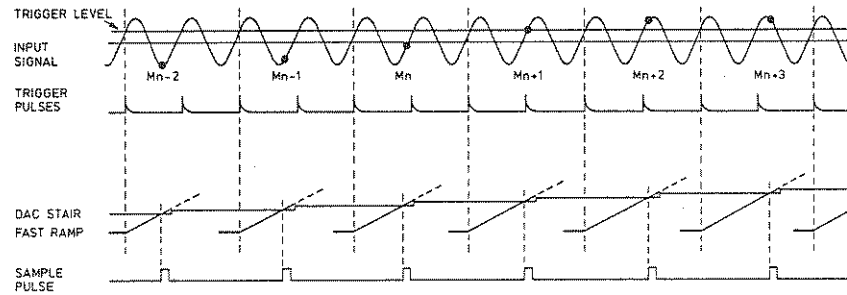
Figure 4.50 Sequential sampling principle.

At the moment that the TRIGGER AMPLIFIER applies a trigger pulse to
the FAST RAMP GENERATOR, the latter starts to generate a fast ramp.
This fast ramp is a sawtooth voltage of which the sweep time can be
adjusted with the TIME/DIV control. After every sweep there is a
certain time – of which the duration can be adjusted with the HOLD
OFF/SYNC control – that the FAST RAMP GENERATOR does not respond to a
trigger pulse. The COMPARATOR compares the fast ramp with a relatively
slow-rising "staircase" signal that is generated by the STAIR DAC. At
the moment where the fast ramp has the same voltage level as the slow-
rising staircase, a sampling pulse is generated and applied to the
sampling gates of vertical channel A and B. The staircase is increased
every time after a sample has been taken. As a result of this, the
sampling moment of the input signal (moment Mn-1 in fig. 4.50.) is
shifted in phase compared with the sampling moment of the preceeding
sample (moment Mn-2 in fig. 4.50.). Comparing the phase of the signal
where the succeeding samples Mn-2, Mn-1, Mn, Mn+1, Mn+2 and Mn+3
occur, shows us that every state of the sine-wave input signal is
captured if we take enough samples. So many signal periods are
necessary to capture one complete period in the instrument's memory.
The advantage of this process is that the circuitry of the vertical
channels behind the sampling gate only has to deal with low-frequency
signals. The only parts that carry very high frequency signals are
TRIGGER PICK OFF, DELAY LINE and SAMPLING GATE in channel a and B, the
TRIGGER SOURCE SELECTION and x1/x10 AMPLIFIER.

The instrument's DELAY function is achieved by a combination making
the rising of the staircase signals faster (less delay) or slower
(more delay) and adding this signal to an adjustable d.c. voltage from
the DELAY DAC. The addition of the staircase and the d.c. voltage is
done in the ADDER. The higher the d.c. voltage, the longer the delay.

Conversion and processing section

In the conversion and processing section the vertical input signals
are digitised, processed and stored in a digital memory. This is done
by an Analog to Digital Converter, which receives the vertical input
signals via a MULTIPLEXER from the VERTICAL CHANNEL SWITCH.
This MULTIPLEXER is provided with track and hold circuits, which can
hold samples that are taken from both channels at the same moment.
The samples are converted then in sequence by the ADC.
Data from the ADC is processed by the DATA PROCESSING CIRCUIT, which
performs e.g. the softkey selectable AVERAGE function.
Data from the DATA PROCESSING CIRCUIT is transported to the STORAGE
SECTION.
The MULTIPLEXER and ADC are controlled by the ACQUISITION AND CONTROL
LOGIC.

The ACQUISITION AND CONTROL LOGIC performs the following horizontal
modes:

- RECURRENT
- MULTIPLE
- SINGLE

The ACQUISITION AND CONTROL LOGIC also controls the pilot lamps
TRIGGER, SYNCHRONIZE and COUNTDOWN.

The ACQUISITION AND CONTROL LOGIC is controlled by the microprocessor
system, which also controls the DATA PROCESSING CIRCUIT.

4.4.3   The storage section

After each conversion of a sample into a 10-bits digital code, the
code will be stored in a digital memory in the DATA PROCESSING
CIRCUIT. The capacity of this memory is 4096 digital values, which is
a complete picture of ten horizontal divisions. This memory is
configurated as a shift register.
When a number of samples is converted and stored in this digital
memory, this memory contents is copied into register R0 of the TRACE
MEMORY. The number of samples depends on the time base setting. The
addresses for the TRACE MEMORY are generated by the ADDRESS GENERATOR
under microprocessor system control.
It is possible to save the contents of TRACE MEMORY register R0 in
one of the other registers R1, R2 or R3 by means of the softkey
functions under the SAVE/PLOT pushbutton.

Each of the four registers is able to store 4096 digital 10-bit codes
in single channel mode. With both input channels ON, each register
capacity is equally divided into 2048 digital 10-bit codes for each
input channel.

The TRACE MEMORY can be cleared by pushbutton CLEAR, locked by
pushbutton LOCK and enabled for new signal acquisition by pushbutton
WRITE.

A TEXT MEMORY is also part of the storage section. In this TEXT MEMORY
all display texts are stored under microprocessor control.

Cursor control can be operated via the frontpanel controls 1st and 2nd and the softkey menu under the frontpanel CURSOR/ANALYSE pushbutton. It is a microprocessor controlled function which uses the contents of the TRACE MEMORY as input for calculations and the determination of the position of the cursors, and which uses the TEXT MEMORY to store the cursors and the calculation results.

4.4.4   The display section

This section controls the display of the contents of registers R0, R1, R2 and R3 as well as the display of text on the CRT screen under the control of softkey functions.
The trace and text data is separated in a vertical and a horizontal component and applied to two signal paths for vertical and horizontal deflection.

Horizontal deflection

Each address of a register corresponds to a specified vertical line of the CRT display along the X-axis; i.e. the display of 10 divisions into 4000 lines.
The address sequence generated by the ADDRESS GENERATOR can be expanded in the HORIZONTAL A versus B / EXPAND circuit and influenced by an additional horizontal position information from the X-POSITION control before they are applied to a HORIZONTAL DIGITAL TO ANALOG CONVERTER.
To provide the discrete steps for the horizontal time base display, the output of the DAC is a linear staircase voltage, which is applied to the horizontal final amplifier via a DOT JOIN filter and from there to the horizontal deflection plates of the C.R.T.

Via the X-EXPAND DAC an horizontal expand information is applied to the HORIZONTAL FINAL AMPLIFIER for an additional horizontal expand. This information comes from the front panel X-EXPAND control.

Vertical deflection

The contents of each trace register is 4096 10-bit digital codes, each capable of indicating one out of 1024 different signal amplitudes.

These 10-bit digital codes can be inverted or expanded in the VERTICAL INVERT/EXPAND circuit and influenced by an additional position information from the Y-POSITION control before they are converted into the analog representation of the measured input signals by means of a VERTICAL DIGITAL TO ANALOG CONVERTER. From here the signal is applied to the VERTICAL FINAL AMPLIFIER and the vertical deflection plates of the C.R.T. via a VERTICAL DOT JOIN filter.
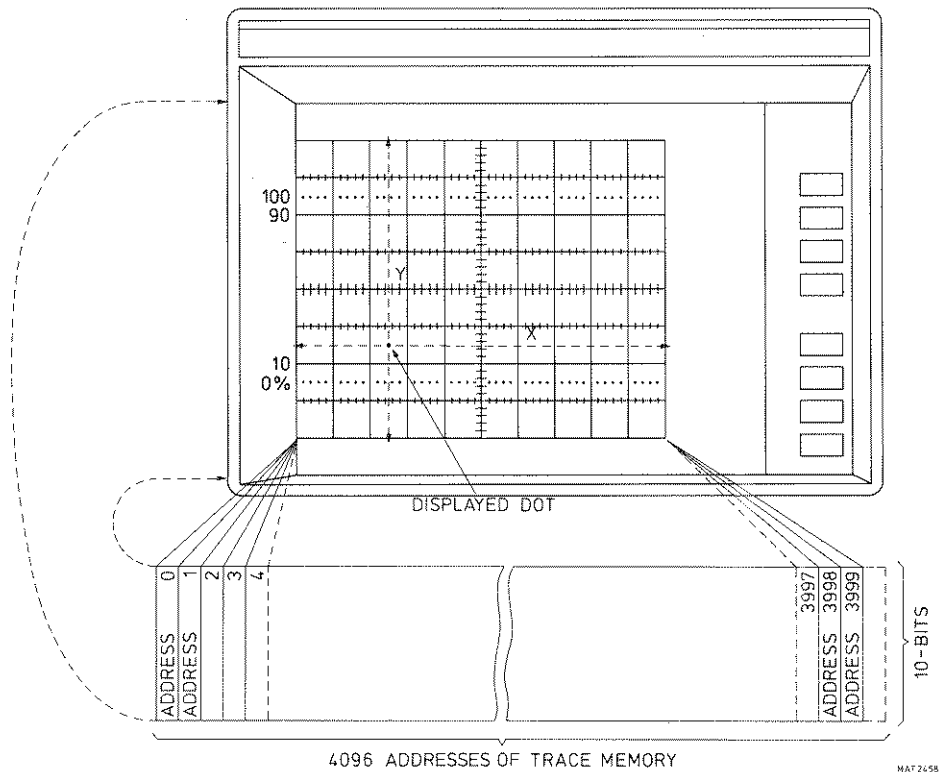
Figure 4.51 Display of trace memory contents.

Display functions

With the pushbutton DISPLAY, a softkey menu is activated which makes selection of the following functions possible:

- Register selection
- POSITION selection: assignment of the frontpanel controls Y-
                      POSITION, X-POSITION and X-EXPAND to a selected
                      register and channel.
- Register INVERT
- A versus B display
- Reduced register text display
- Full register text display

With pushbutton MAGNIFY, a softkey menu is activated for the following functions:

- HORIZONTAL EXPAND *1...*64
- VERTICAL EXPAND Y*5, Y*1 or Y/5

Z-control

The Z trace blanking/unblanking signal for the C.R.T. depends on a
number of factors, like register selection, A versus B or X=t display,
dot join, text and so on.
The Z-AMPLIFIER is therefore controlled by the microprocessor, a
control signal from the vertical and horizontal signal path, the
frontpanel INTENSity controls and the frontpanel FOCUS control.

Plot

Signals PLOT X, PLOT Y and PLOT Z are applied to the ANALOG PLOT
OUTPUT circuit and from there to the PLOT OUTPUT socket on the rear
panel.
Via the SAVE/PLOT menu a "register plot" function can be selected
and via the DISPLAY menu a "screen plot" function can be selected.

Cal

A CAL GENERATOR generates a 1 Vpp/100 kHz signal for calibration
purposes (if terminated into 50 ohm).

4.4.5   The control section

The control signals which are routed to the various circuits are
indicated with "C -->" for the MANAGEMENT INTERFACE and with "CuP -->"
for the MICROPROCESSOR.

A MICROPROCESSOR system including a ROM MEMORY for the system program
and a RAM MEMORY for the variable data is controlling the instrument.

The following functions are under its control:

- Watching the frontpanel rotary switches
- Reading the actual front panel keys and softkeys and displaying
  the actual softkey functions on the C.R.T. screen
- Setting of the acquisition circuits via the MICROPROCESSOR
  MANAGEMENT INTERFACE
- Performance of calculations
- Control of frontpanel pilot lamps
- CRT display control for traces as well as for text
- Plot output control.
- Performance of the AUTO-SET function (with pushbutton AUTO)
- Programming of the front settings (with pushbutton FRONT No)

Microprocessor management interface

All the frontpanel controls, except the CRT CONTROLS, ILLUM, INTENS,
INTENS TEXT, TRACE ROT and the POWER ON switch, are activating the
various circuits via the microprocessor control circuits and the
MICROPROCESSOR MANAGEMENT INTERFACE.
In this MANAGEMENT INTERFACE also various control signals for the
signal acquisition are generated under command of the microprocessor.

Interfaces

The pilot lamp REMOTE as well as the pushbutton URQ can be used when the IEEE-488/RS232-C interface card is operative.

4.4.6   The front section

All the frontpanel rotary switches, pushbuttons, numerical keyboard and softkeys inform the MICROPROCESSOR system about the user's settings via the FRONT CIRCUIT. The MICROPROCESSOR controls the frontpanel pilot lamps via this FRONT CIRCUIT.

4.4.7   The Power supply section

The power supply, which accepts most mains voltage ranges in use (90-264 Vac), produces the various voltages which are used for the electronic circuits, the EHT voltage for the CRT inclusive.

4.5 BRIEF CHECKING PROCEDURE

4.5.1 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.
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.
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).

No additional test equipment is necessary apart from a coaxial cable
with BNC-connectors and an adaptor from BNC into N-type of connector.

4.5.2. Preliminary settings

- Switch the oscilloscope on and check if the power-up routine is
  executed.
- Connect the CAL signal from the CAL output socket to the A input via
  the coaxial cable and the BNC into N adaptor.
- Press the green pushbutton AUTO; a square wave should become visible
  on the CRT screen.
- Set the two INTENS controls for the right intensities for trace and
  text.
- Adjust the FOCUS screwdriver control for a well defined sharp trace
  and text.
- Set the ILLUM control for the right intensity of the graticule
  illumination.

4.5.3. Trace rotation

- Disconnect the channel A input signal; a straight line should become visible on the screen.
- Set the trace of channel A in the vertical mid-position of the screen by turning the channel A OFFSET control.
- Check that the trace lies in parallel with the horizontal graticule lines; if necessary, readjust the TRACE ROT screwdriver control.
- Connect the channel A input signal again: a square wave becomes visible again on the screen.

4.5.4 Vertical

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

4.5.4.1 Vertical mode

- Press the green pushbutton AUTO; a square wave with a vertical amplitude of 5 divisions becomes visible on the screen provided that the vertical sensitivity is 200 mV/div.
- Press pushbutton VERTICAL MODE. Check that channel A is selected.
- Press softkey A and B. Channel B is visible as a straight line.
- Position the channel B line in the vertical mid of the screen with the OFFSET control.
- Press pushbutton VERTICAL MODE.
- Press softkey ADD; only the square wave is visible.
- Press softkey A.
- Press softkey A-INVERT; the square wave is inverted.
- Press softkey A-INVERT; the square wave is normal again (invert off)
- Press softkey PROCESSING; the VERTICAL PROCESSING menu is visible.
- Press softkey EYE PATtern and check that the amplitude of the square wave decreases a little. The belonging softkey text is intensified now.
- Press softkey EYE PATtern again and check that the amplitude of the square wave is again 5 divisions. The softkey text dims again.
- Press softkey AVERAGE: the vertical AVERAGE menu is visible.
- The softkey menu gives the possibility to select "C"-values between 2...64. Check that suppression of noise on the displayed square wave increases with the "C"-value.
- Press softkey OFF.
- Press softkey RETURN.
- Press softkey MULTiple SAMPling: the vertical MULT SAMPL menu is visible.
- The softkey menu gives the possibility to select "M"-values between 2...32. Check that the time between two succeeding screen updates increases with the "M"-value.
- Press softkey OFF.
- Press softkey RETURN.
- Press softkey RETURN; the VERTICAL MODE menu appears.

4.5.4.2 Vertical offset

- Press pushbutton VERTICAL OFFSET. You are in the vertical OFFSET menu.
- Turn the A OFFSET to the left until the warning "A-OFFSET out of range" appears in the bottom of the CRT.
- Press softkey AUTO and check that the square wave becomes visible approximately in the vertical mid of the screen.
- Turn the A OFFSET to the left until the warning "A-OFFSET out of range" appears in the bottom of the CRT.
- Press softkey ZERO and check that the bottom of the square wave becomes visible in the vertical mid of the screen.
- Press softkey ADJUST and thereafter UP or DOWN and check that the signal moves up or down in steps of 1 div (softkey function DIV intensified) or 1 screen/ 8 div (softkey function SCREEN intensified)
- Press softkey ENTER
- Enter via the numerical keyboard: 0,6 (volt)
- Press softkey EXECUTE and check for a vertical shift of 3 div.

4.5.4.3 Vertical controls

- Press UP/DOWN control AMPL/DIV on it's left side. Check that the amplitude of the square wave on the screen decreases.
- Press UP/DOWN control AMPL/DIV on it's right side. Check that the amplitude increases.
- Turn VARIABLE left. Check that the amplitude increases and pilot lamp UNCAL lights up.
- Turn VARIABLE right. Check that the amplitude decreases and pilot lamp UNCAL extinguishes.
- Turn OFFSET to the right to move the signal up and to the left to move it down.

4.5.5 Horizontal

- Press the green pushbutton AUTO; a square wave of a few periodsbecomes visible on the screen.
- Press pushbutton HORIZONTAL ACQ MODE. Check that RECURRENT is selected.
- Press softkey SING ARMD; after one sweep the screen should stay steady.
- Press softkey SING ARMD again. Check that a new sweep is done.
- Press softkey RECURRENT.
- Press UP/DOWN control TIME/DIV on it's left side. Check that more signal periods appear on the screen.
- Press UP/DOWN control TIME/DIV on it's right side. Check that the number of displayed periods decreases.

4.5.6 Triggering

4.5.6.1 Trigger source

- Press the green pushbutton AUTO.
- Press pushbutton SOURCE. Check that channel A is selected and the pilot lamp TRIGGER lights up.

- Press softkey B. Check that the oscilloscope is not triggered; the pilot lamp SYNCHRONIZE lights up and the displayed signal is unstable.
- Press softkey A, the oscilloscope is stable triggered.

4.5.6.2 Trigger delay

- Press the green pushbutton AUTO.
- Select 1 us/div via the TIME/DIV control.
- Press pushbutton MAGN/ DELAY.
- Press softkey UP. Check that the signal shifts 1 division to the left.
- Press softkey DOWN. Check that the signal shifts 1 divisions to the right.

4.5.7 Display

- Press the green pushbutton AUTO.
- Turn the X-POSITION control. Check that the signal shifts horizontally.
- Turn the Y-POSITION control. Check that the signal shifts vertically.
- Turn the X-EXPAND control. Check that the signal expands and shrinks and check if the pilot lamp UNCAL functions properly (off in CAL position).

4.5.7.1 Magnify

- Press pushbutton MAGNIFY. Check that *1 is selected.
- Press softkeys Y*5, Y*1 and Y/5 and check if vertical magnify functions correctly.
- Press softkey Y*1.
- Press softkey EXPAND several times until *64 is reached.
- Press pushbutton DOTS. Check that the pilot lamp in the pushbutton lights up and the dots are not joined anymore. Press DOTS again and check that dots are joined again and pilot lamp dims.
- Press pushbutton AVERAGE C=4 and check that the trace becomes less noisy and the pilot lamp in the pushbutton lights up.
- Press pushbutton AVERAGE C=4 again and check that the pilot lamp is off and that signal noise increases a little.
- Press softkey *1.

4.5.8 Memory

- Press pushbutton SAVE/PLOT. Check that the menu appears.
- Press pushbutton CLEAR and check that the screen is cleared and refreshed again.
- Press pushbutton LOCK and check that the screen becomes steady and the pilot lamp in the pushbutton lights up.
- Press pushbutton WRITE and check that the pilot lamp in the pushbutton lights up.

4.5.9   Cursor control

- Press the green pushbutton AUTO.
- Press pushbutton CURSOR/ANALYZE and check that the menu appears.
- Press softkey R0 A. Check that two cursors appear on the screen.
- Turn control "1st" and check that the left cursor moves along the signal and that the cursor read out on the C.R.T. is updated.
- Turn control "2nd" and check that the right cursor moves and the read out is updated.

5.0   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 THE CONTRAST FILTER

To clean or replace the contrast filter, proceed as follows:

- Push the bezel gently to the right and pull is from the instrument
  as shown in figure 5.1.

- Remove the contrast filter.

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

Figure 5.1 Removing the bezel and contrast filter.

5.3   REPLACING THE MEMORY BACK-UP BATTERIES

When message

Back up Battery power too low: consult manual

is displayed, the batteries have to be replaced.

To save the settings and traces which are stored in the memory, it is
recommended to switch-on the oscilloscope during the replacement of
the batteries.

The two 1.5 V penlight batteries (e.g. Philips LR 6 - see also section
6.15) must be installed as described under section 3.3.

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°.

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

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.

6.0   CHARACTERISTICS

a. General.

This instrument has been designed and tested in accordance with
IEC publication 348 for Class I instruments.
This publication is valid after the instrument has warmed up for
30 minutes.
Properties expressed in numerical values with tolerances stated,
are guaranteed by the manufacturer.
Numerical values without tolerances are typical and represent
the characteristics of an average instrument.
For definition of terms, reference is made to IEC publications
351,395 and 548.
For a more extensive specification of this instrument, refer to
the service manual.

b. Contents.

6.1. AUTOSET   Sets display, text, vertical settings, horizontal
                                 settings and triggering for instant overall-view
                                 display of input signals.

6.2. SIGNAL ACQUISITION

Sampling	Sequential
Sources	Ya, Yb
Modes	Single channel, dual-channel, added
Polarity	Each channel can be inverted
Processing	Normal, eye pattern (single- or dual channel modes only), average, multiple sampling, absolute min/max
Range	Vertical: 10 div.
	Horizontal: 10,2 x time/div.
Resolution	Vertical: 1:1024 (10 bit)
	Horizontal: 1:512, 1:256, 1:128, 1:64
	In fast display mode: 1:64
Min. acquisition time	< 25 ms for max horizontal resolution

6.3. Y CHANNELS

Input impedance	50 ohm ; + or − 1%
VSWR	1:1,3 up to 1 GHz
	1:1,4 up to 2 GHz
Input coupling	d.c.
Max. input voltage	5V peak, positive and negative
Deflection coefficient	1mV/div ... 200mV/div in 1, 2, 5 steps
Error limit	1,5%. In eye pattern mode 5mV/div ... 200mV/div: 10%.
Continuous control between steps	Range 3:1. Resolution 1:4096 (12 bit). Error limit 3%.
Frequency response	d.c. ... 2GHz (−3dB)
Pulse response	Rise time 175 ps (calculated value via formula $tr = 0,35/Bandwidth$)
Visible signal delay	9 ns
Dynamic range	− 0,8 V ... + 0,8 V
D.c. offset	
− range	− 1,6 V ... + 1,6 V
− resolution	0,01 div
Common mode rejection ratio	1 GHz: 40:1 } after adjustment of gain and
	2 GHz: 20:1 } phase
Channel isolation	2 GHz: 1000:1
Noise	5mV/div ... 200mV/div: 0,5 mV (rms)
	1mV/div, 2mV/div: automatic smoothing
Averaging	x2 ... x64 in powers of 2
Multiple sampling	x2 ... x32 in powers of 2

6.4. TIME BASE

Acquisition mode	Recurrent, single scan, multiple scan, multiple eye, save/stop on difference
Deflection coefficient	1ns/div ... 20 us/div
Error limit	3%
Magnifier	x1 ... x50 (fastest sweep speed 20 ps/div)
Error limit	Add 2% for magnifier x2 ... x 50
Delay	Controllable in steps of div or in screens
Max. negative delay	9ns
Max. positive delay	10 div at time base setting of 20us/div and magnifier x1
Hold-off time	30us ... 75us at max horizontal resolution

6.5. TRIGGERING

Sources	Ya, Yb, EXTernal
Input impedance	50 ohm; + or - 1%
Coupling	a.c. (RC time: 1us)
Max. input voltage	5V peak, positive and negative
Modes	Trigger, synchronize, countdown, autoselect
Sensitivity	Trigger mode: 10 mV up to 100 MHz
	Synchronize mode: 2 mV up to 100 MHz
	Countdown mode: 50 mV up to 2 GHz
Level range:	
- high sensitivity	+ 4 mV ... - 4 mV
- low sensitivity	+ 40 mV ... - 40 mV
Level resolution	1:16384 (14 bit)
Slope selection	+ and -
Jitter	< 7 ps (rms, time base at 1ns/div)

6.6. MEMORY

Memory	4 memories of 4K x 10 bit words
Functions	Clear, save, write, lock

6.7. DISPLAY

Modes	Dot join, dots only, invert, A versus B
Registers	Register R0, R1, R2 and R3 can be displayed in any combination
Expansion:	
- horizontal	1 ... 64 in powers of 2 (Y versus t)
	1 ... 8 in powers of 2 (A versus B)
	Continuous control between steps
- vertical	x0,2, x1, x5
- position	All registers can be positioned independently
	Horizontal: + 5 div ... - 5 div (expansion: x1)
	Vertical: + 5 div ... - 5 div (expansion: x1)

6.8. CURSORS

Vertical resolution	1:1024 (10 bit)
Vertical error limit	1,5%
Horizontal resolution	1:4096 (12 bit)
Horizontal error limit	3%

6.9. SETTING MEMORY

Memory size	251 front-panel settings
Functions	SAVE, INSERT, DELETE for storage on erasure of settings. RECALL, NEXT, PREVIOUS for recall of settings.

6.10. CALIBRATION OUTPUT

Square-wave voltage:	
- amplitude	1V + or - 1% into 50 ohm
- frequency	100kHz ; + or - 0,1%
- impedance	50 ohm + or - 1%
- rise-time	1,5ns

6.11. PLOT OUTPUTS

Analog plot output:	Screen dump or register dump
– output voltage	vertical: 1V
	horizontal: 1V
– error limits	3%
– pen lift	TTL compatible
– plot time	Adjustable between 20ms and 2s per dot
Digital plot out	HPGL and Philips language compatible up to 4
	screens on standard A4 size
Printer plot out	Compatible with Epson (FX40) and HP Thinkjet

6.12. CRT

Type	Philips 18cm rectangular PDA tube
Useful screen area	10cm x 12cm
Graticule	Internal, with variable illumination
Acceleration voltage	16kV

6.13. POWER SUPPLY

Voltage	90V ... 264V a.c.
Frequency	45Hz ... 440Hz
Power consumption	110W
Memory back-up	2 LR6 batteries
Retention time	2 Years

6.14. INTERFACES

Interface functions	IEEE-488/IEC625 interface} For full specification
	RS232C interface } refer to instruction/
	Real time clock } programming manual of
	PM8956A interface

6.15. MECHANICAL DATA

|	
Height	176 mm (6,9 inch)
	250 mm (9,8 inch) with feet and pouch
	5E in 19 inch rackmount version
Width	419 mm (16,5 inch)
	465 mm (18,3 inch) with handle
Depth	570 mm (22,5 inch)
	670 mm (26,4 inch) with handle
Weight	18,7 kg (41,2 lb), excl. accessories

6.16. ENVIRONMENTAL DATA   Meets environmental requirements of
MIL-T-28800D Type III, Class 5, Style D

Temperature range:
- operating within
  specification $+ 15^{o}C \ldots + 35^{o}C$
- limits of
  operation $0^{o}C \ldots + 50^{o}C$
- storage $- 40^{o}C \ldots + 70^{o}C$
Max. humidity   95% relative humidity
Max. altitude:
- operating   4,5 km (15 000 feet)
- non-operating   12 km (40 000 feet)
Vibration:
- frequency   5Hz ... 55Hz
- max. acceleration $30m/s^{2}$
Shock   6 Shocks on each axis, half sine-wave, pulse
duration 11ms, peak acceleration $300m/s^{2}$
Bench handling   MIL-STD-810 method 516, procedure V
EMI   MIL-STD-471 Class B, VDE 0871 and VDE 0875

6.17. SAFETY   Meets the requirements of of IEC 348 Class I, VDE
0411 Class I, UL 1244 and CSA 556 B

6.18. ACCESSORIES DELIVERED WITH THE INSTRUMENT

2 Passive probes   10:1, PM8911/08; for characteristics refer to
chapter 8.1.1. in this manual
Blue contrast filter
2 Adaptors BNC-N   Type: PM9063
Front cover
Adaptor probe-BNC   Type: PM9353
Operating manual
Programming manual
Quick operating guide
Plot out cable   For analog plot out function

6.19. ORDERING INFORMATION

PM3340/40   2GHz digitizing oscilloscope} Incl. IEEE488/
PM3340/80   19 inch rackmount version   } RS232C interface

Power cord options:
- option 001   Universal European 220V/16A, 50Hz
- option 003   Standard North American 120V/15A, 60Hz
- option 004   United Kingdom 240V/13A, 50Hz
- option 005   Switzerland 220V/10A, 50Hz
- option 008   Australia 240V/10A, 50Hz

Note   Refer also to chapter 7.0. in this manual
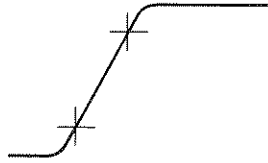
6.20. VOLTAGE MEASUREMENTS

RMS voltage	Including or excluding offset voltage
Mean voltage	Including or excluding offset voltage

Peak-to-peak
voltage

Peak-to-zero
voltage

Negative peak-to-
zero voltage

Overshoot

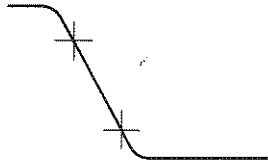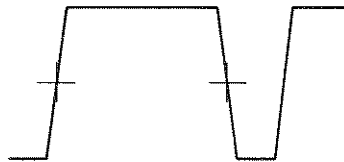Preshoot
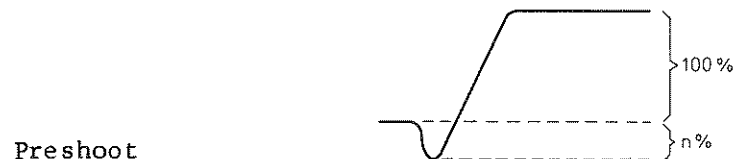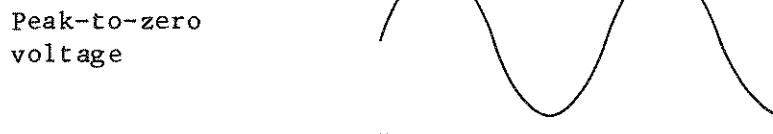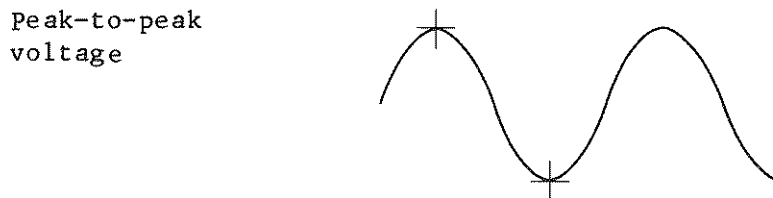
6.21 TIME MEASUREMENTS

Rise-time   Tr over 10%...90% or 20%...80% or
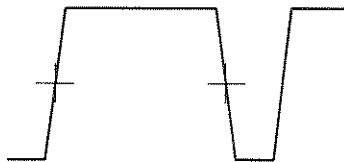   within variable boundaries

Fall-time   Tf over 10%...90% or 20%...80% or
                             within variable boundaries

Pulse width

Duty cycle   Expressed as a percentage of period

Frequency

Phase

6.22. MATHEMATICAL FUNCTIONS

Add   }
Subtract   } Result of calculation displayed in selected
Multiply   } register and scalable for optimum display
Divide   }
Differentiate}
Integrate   }
Amplitude histogram   Displays amplitude density versus absolute
                             amplitude of an input signal
FFT: Displays frequency domain presentation of input
                             signal
– window   Rectangular, Hamming, Hanning
– vertical scale   Linear or logaritmic
– dynamic range   49,8 dB
– horizontal scale   Linear
Filter   Digital filter of order 3, 5, 9, 17, 33, 65 and
                             129
Delay channel   Allows compensation of delay between channels or
                             signal probes

6.23. VERTICAL PROCESSING
      MODES

    Eye pattern   Displays pseudo-random pulse pattern, showing eye
                                  height and width
    Absolute min/max   Measures and stores maximum and minimum amplitudes
                                  of an input signal in a selected register
                                  (envelope mode)

6.24.

    HORIZONTAL
    PROCESSING MODES

    Save/stop on   Input signals outside the limits of a reference
    difference   signal are saved in a selectable register or
                                    stop the acquisition.

    Multiple eye   Displays eye pattern in 12K memory size for
                                    optimal signal representation

7.0   PM3340 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:

1   PM3340/XY   :in type number

2   12nc: 9444 W33 40XYZ   :in code number

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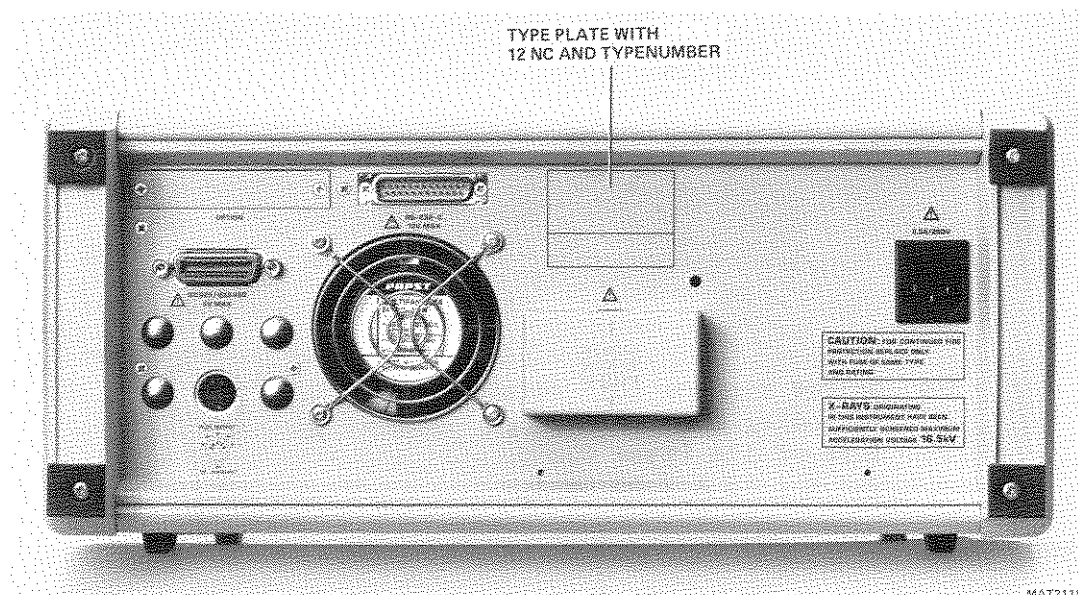These numbers are given in this section and each version is briefly
described.

Figure 7.1 Rear panel with indicated type plate position.

Typenumber: PM3340/XY

Codenumber: 9444 W33 40XYZ

W=0:   Standard version

XY=40   Basic instrument with IEEE 488/RS232-C
                              option installed.

XY=80   Basic instrument with IEEE 488/RS232-C
                              option installed and with 19 inch
                              rackmount parts.

W≠0:   Non standard version

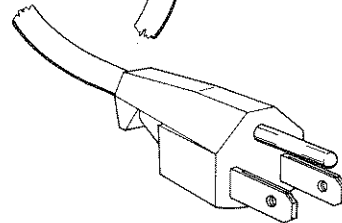Z: Power-cord-version indication

On type plate on instrument: Z always 0

In the codenumber on the packing in which the instrument was shipped
the indication is as follows:
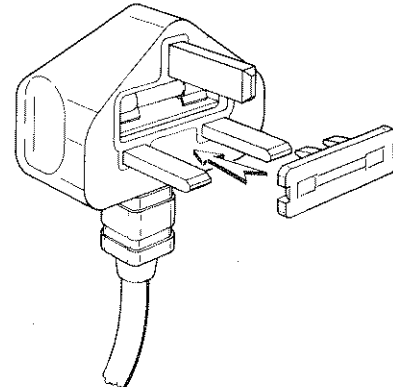
Z=1   Standard European version
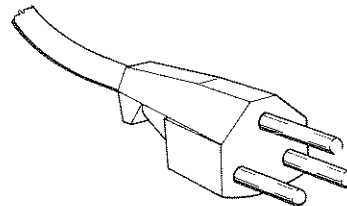   220 V / 16 A / 50 Hz
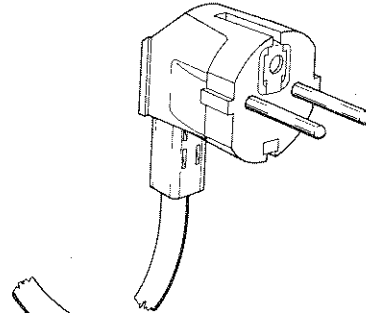
Z=3   U.S.A. version
      (U-version)
      120 V / 15 A / 60 Hz

Z=4   United Kingdom (UK) version
      including line cord plug
      fuse of 13A (type C)
      240 V / 13 A / 50 Hz

Z=5   Swiss version
      220 V / 10 A / 50 Hz

Z=8   Australian version
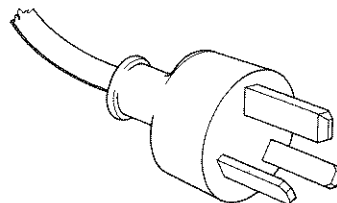   240 V / 10 A / 50 Hz

Figure 7.2 Mains connectors.

8.0   ACCESSORY INFORMATION

8.1   ACCESSORIES SUPPLIED WITH THE INSTRUMENT

8.1.1   Passive probe PM8911/08 with automatic range indication

8.1.1.1 Introduction

This 10 x attenuator probe is provided with a special male N plug with built-in resistor for automatic range indication to advance the V/DIV reading by 10x. The probe is designed for oscilloscopes with 50 ohm input impedance.

The probe consists of 2 separate units:

-the cable assembly, incl. N-connector with automatic range indication possibility

-the probe body.

The V/div reading of the oscilloscope is automatically adapted to the 10x attenuation of the probe by a resistor that is mounted in the holder of the N-connector. The resistor value is related to the type of probe.

8.1.1.2 Characteristics

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

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

Electrical

NOTE: These characteristics are valid with a termination of 50 ohm oscilloscope input.

Designation	Specification	Additional information
Attenuation (d.c.)	10 x + or - 2 %	
Input impedance		
-parallel resis-tance at d.c.	500 ohm + or - 2%	
-parallel capaci-tance up to 100 MHz	1 pF	(for parallel capacitance as function of frequency, see figure 8.1).

Bandwidth

-probe only band-   d.c. ... 4 GHz
 width at osc.   (-3 dB)
 input cap.

Signal delay   7,7 ns + or -   Measured between tip to
                       200 ps   N-output connector.

Maximum voltage:

-max. non destruc-   11V
 tive input voltage
 (d.c. + a.c. rms)

-max. non destruc-   100 V   Max. 50 mJ during any
 tive input voltage   100 ms
 (pulse peak)

-test voltage   2,42 kV   Probe not connected to
                                               oscilloscope input

-type test   1,7 kV   During 1 min

-performance check   1,7 kV   During 1 sec

Mechanical

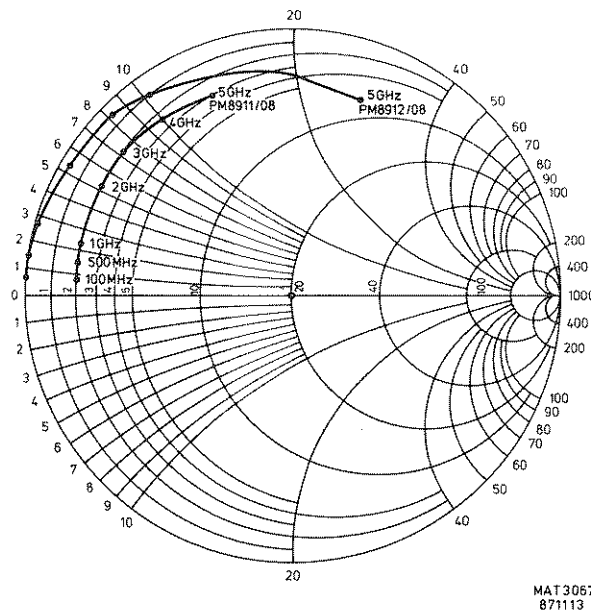-Dimensions   length   width

 probe body   37 mm   11 mm(max)
 cable assy   1500 mm   9,6 mm(max)
 pouch   275 mm   195 mm

-Mass   124 g   Standard probe with
                                               accessories in pouch.

MAT3067

Fig. 8.1 Admittance at h.f. (centre value: 20 mS)

Environmental

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

Operating temperature $-10\ ^{\circ}C\ \ldots\ +55\ ^{\circ}C$

Storage temperature $-51\ ^{\circ}C\ \ldots\ +71\ ^{\circ}C$

Maximum humidity   95 % relative humidity

Altitude:

-operating   To 4500 m

-non-operating   To 12000m

Vibration (operating)

* freq. 5...15 Hz   7 min each axis, excursion 1,5 mm
                                (p-p) and 7 m/s^2(0,7 g)
                                acceleration at 15 Hz.

* freq. 15...25 Hz   3 min each axis, excursion 1 mm (p-
                                p) and 13 m/s^2(1,3 g)
                                acceleration at 25 Hz.

* freq.25...55 Hz   5 min each axis, excursion 0,5 mm
                                (p-p) and 30 m/s^2(3 g)
                                acceleration at 55 Hz.

Resonance dwell   10 min at each resonance freq.

Shock (operating)   300 m/s^2 (30 g), half sine-wave
                                shock, duration is 11 ms.(3 shocks
                                per direction for a total of 18
                                shocks).

Accessories

-Accessory kit, contents: -Earth cable
                             -Spring-loaded test clip
                             -Set marking rings
                             -Mini connector (2x)
                             -Insulating cap
                             -SO cap and DIL cap
                             -Wrap pin adapter
                             -Earth bus

- Instruction manual

8.1.1.3   Description of accessories

Earth cable: To minimize ringing in a signal, an earth cable is
provided. This cable must first be plugged onto the probe body and
then be connected to the nearest earth point of the circuit to be
measured.

Spring-loaded test clip: This is a provision for hands-free connection
to a test point or component lead.

Marking rings: At delivery a set of 6 rings with 3 different colour
marking rings (red, white and blue) are provided. This can be used to
help identify the specific probes when using more than one probe on an
oscilloscope.

Mini connector: can be soldered on to a p.c.b. track of the circuit to
be measured. The probe tip fits exactly into this connector.

Insulating cap: An insulating cap is provided to cover the metal part
of the probe during measurements in densely wired circuits.

SO cap and DIL cap: this is a cap facilitating measurements on
respectively surface mounted and dual-in-line integrated circuits.

Wrap pin adapter: The wrap pin adapter is a provision to make hands-
free connection to a wire wrapped pin circuit.

Earth bus: This is a provision to minimize ringing in VHF signals,
when earthing must be as short as possible.
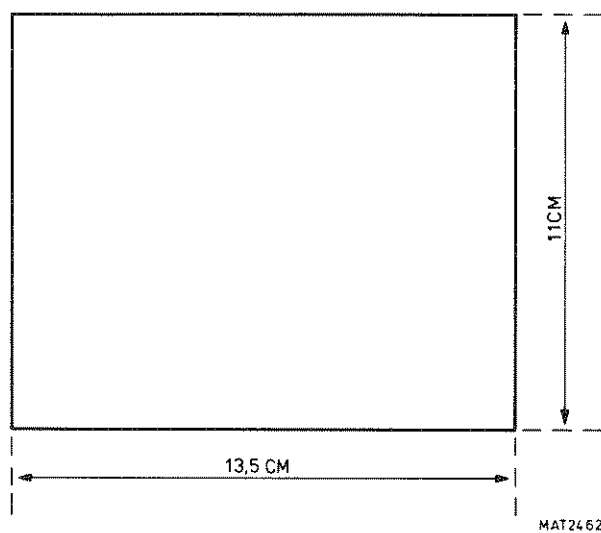
8.1.2 Blue contrast filter

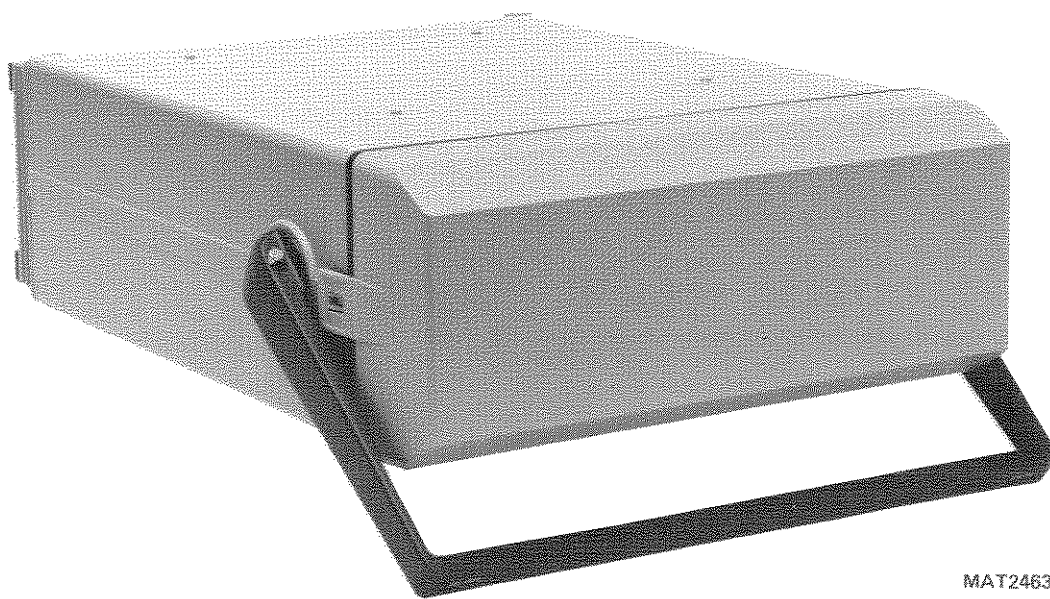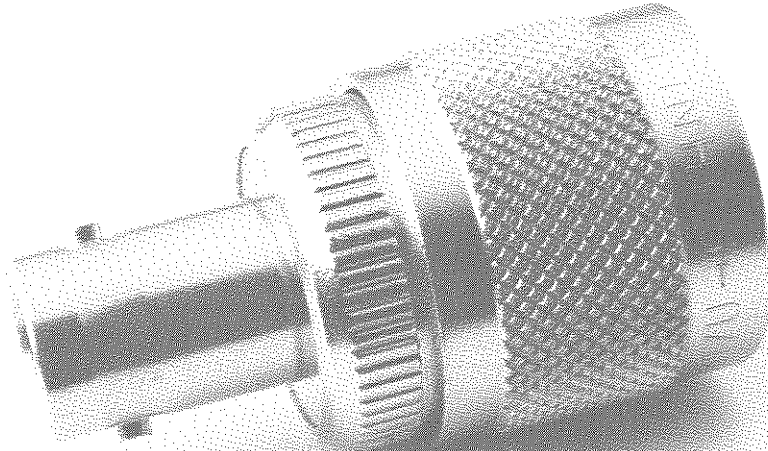Figure 8.2 Blue contrast filter. (Factory installed !)

8.1.3 Front cover

Figure 8.3 Oscilloscope with front cover.

8.1.4.   Adaptor BNC into N-type of connector.

Figure 8.4 Adaptor BNC into N-type of connector.