OX 8050
60 MHz ANALOG / DIGITAL
OSCILLOSCOPE

User's manual

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1. GENERAL INSTRUCTIONS

You have just purchased a 60 MHz oscilloscope; we congratulate you on your choice of this high quality product.

This apparatus complies with IEC safety standard 1010-1 (BS 4743 - VDE 411), single insulation, dealing with electronic measurement instruments. Please read these instructions carefully and respect the usage precautions, in order to obtain the best use from it.

1.1. Precautions and safety measures

1.1.1. Before use

- This instrument was designed for use indoors in an environment with a degree of pollution 2 at an elevation of less than 2000 m, a temperature between 0°C and 40°C, and a relative humidity of 80 % up to 31°C.

- It can be used for measurements on 300 V category II installation.

- <u>Definition of installation categories</u> (see publication IEC 664-1):

  <u>CAT I</u> :   CAT I circuits are protected by devices limiting transient overvoltages to a low level.
  <u>Example</u>: protected electronic circuits

  <u>CAT II</u> :   CAT II circuits are power supply circuits for domestic or digital devices that may include transient overvoltages with an average value.
  <u>Example</u>: power supply for household appliances and portable tools.

  <u>CAT III</u> :   CAT III circuits are power supply circuits for power equipment that may include large transient overvoltages.
  <u>Example</u>: power supply for industrial machines or equipment

  <u>CAT IV</u> :   CAT IV circuits may include very high transient overvoltages.
  <u>Example</u>: energy arrivals

- Check that your electricity distribution network is within the range 94 to 264 V.

> ⚠ ***The replacement fuse must be identical to the original fuse. It is located inside the apparatus in a housing on the cathode ray tube support part (see § 7.1.1.).***

- Earth all metallic parts that are accessible to touch (including the working table).

- Probes and the three-phase network power supply cable (phase, neutral and earth) delivered with the apparatus are conform with IEC standard 1010. Check that they are in perfect working condition before use.

- Plug the cable into a socket fitted with an earth connection.

1.1.2. During use

- For your own safety, only use the cables, measurement probes and appropriate accessories delivered with the apparatus or approved by the manufacturer as optional accessories.

- Select vertical sensitivity and timebase ranges adapted to the measurement.

- Never touch an unused terminal when the apparatus is connected to measurement circuits.

- Carefully read all notes preceded by the ⚠ symbol.

☞ **Failure to respect warnings and/or usage instructions may damage the apparatus and/or its components and may be dangerous to the user.**

1.1.3. Symbols

⚠ Refer to the user's manual.
Incorrect use may result in damage to the device or its components.

⚠ Risk of electric shock   ⏚ Earth

1.1.4. Instructions

- Any repair, maintenance or adjustment of the oscilloscope when it is **energized** may only be done by qualified personnel, after reading the instructions in this manual.

- A **"qualified person"** is a person who is familiar with the installation, construction and use and the dangers present. He is authorized to switch the installation and equipment on and off in accordance with the safety rules.

- **Before opening the apparatus,** always disconnect it from the mains power supply and measurement circuits, and make sure that you are not charged with static electricity which could damage internal components.

⚠ **Some internal capacitors may retain a dangerous potential, even after the apparatus has been switched off.**

1.2. Guarantee

This oscilloscope is guaranteed against any material defect or manufacturing vice in accordance with the general conditions of sale.

During the guarantee period (2 years), the apparatus may only be repaired by the manufacturer, and the manufacturer will be free to decide to repair or replace all or part of the apparatus. The guarantee conditions state that the manufacturer will pay for return transport.

The guarantee is not applicable in the following cases:

1. any improper use of the equipment or if it is used in association with incompatible equipment;

2. modification of the equipment without explicit authorization by the manufacturer's technical departments;

3. work done by a person not approved by the manufacturer;

4. adaptation to a specific application not included in the definition of the equipment or by the operating instructions;

5. a shock, drop or flooding.

☞ *Our products are patented in France and in other countries. Logotypes have been deposited. We reserve the right to modify their characteristics and prices made necessary by technological changes.*

The contents of this manual may not be copied in any form whatsoever without our agreement.

1.3.   Maintenance and metrological verification

Return your instrument to your distributor for any work to be done within or outside the guarantee.

1.4.   Unpacking - Repacking

All equipment has been mechanically and electrically checked before shipping. All precautions have been taken so that the instrument reaches you without damage.

However, it is always useful to make a fast check to detect any deterioration that could have occurred during transport; if necessary, please contact our sales department quickly and make legal reserves with the transporter.

☝ *For reshipment, it is always better to use the original packaging and indicate the reasons for return as clearly as possible in a note attached to the equipment.*

1.5.   Servicing

Clean the instrument with a wet cloth and soap. Never use abrasive products or solvents.

2. DESCRIPTION OF APPARATUS

2.1. Operating modes

This oscilloscope is a hybrid analog/digital apparatus, with two channels, which includes the advantages of both operating modes to satisfy the most demanding users:

Analog
- Signal read out in real time from 0 to 40 MHz
- "READ-OUT", cursors, automatic measurements
- Timebase equipped with a trigger delay

Digital
- Bandwidth from 0 to 60 MHz
- Storage of signals and capture of non-recurrent phenomena
- Post-acquisition analysis
- Observation of very slow signals with no loss of light (200 s/div.)
- Pre-trigger
- Hardcopy
- Transfer files to a computer

2.2. Performances

Analog
- Two 40 MHz channels from 10 mV/div. to 20 V/div.
- High input range: 1 mV to 20 V/div.
- Trigger up to 75 MHz
- Timebase up to 10 ns/div.
- Adjustable sweep delay

Analog / Digital
- Automatic configuration (AUTOSET) with channel and trigger selection
- Text display in analog and digital mode, with separate intensity control
- Synchronization on TV signals with integrated line counting
- Measurements by cursors or automatic (17 different selectable parameters)
- Complete programming of the instrument (SCPI language)
- RS232 and CENTRONICS interfaces (single output connector at the back)

Digital
- Two 60 MHz channels from 10 mV/div.
- Sampling
  - Real time: 100 MS/s maximum (REFRESH mode)
  - Equivalent time: 20 GS/s Equivalent Time Sampling (ETS)
- Acquisition depth: selectable among 1 k, 8 k or 16 k
- Screen copy (plotter, printers; 4 selectable transfer formats)

2.3. Ergonomy

- The control devices are grouped in functional blocks:
  menu management, measurement acquisition, inputs, trigger, timebase,
  screen management, automatic configuration.
- Active functions are displayed by light indicators.
- Parameters are displayed on the screen (vertical sensitivity, timebase, etc.) together with a large number of help messages that efficiently guide the user.
- The most recent configuration used is memorized and restored automatically when the apparatus is switched on again.
- Controls identified on the front in blue are only available in digital mode.
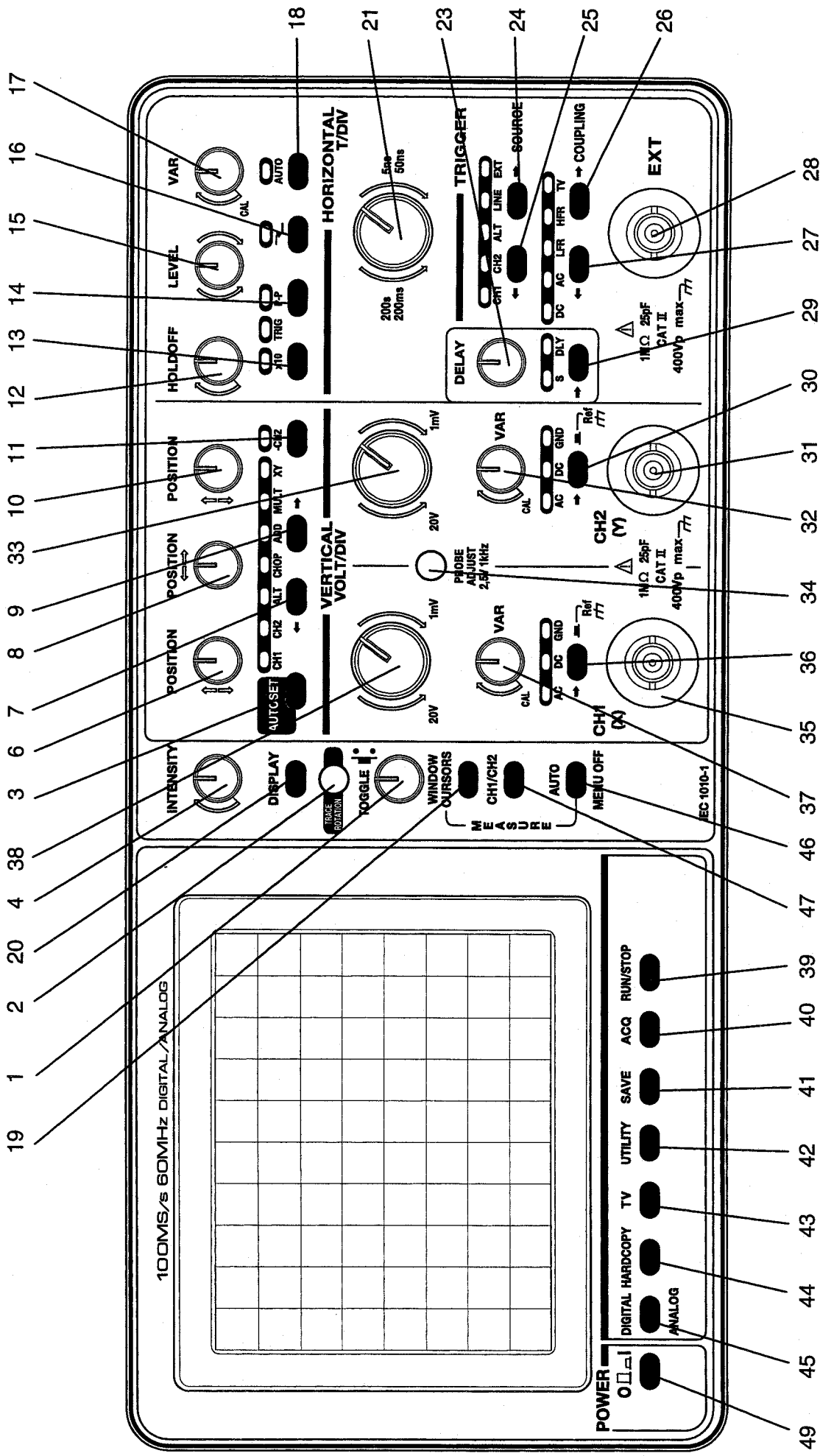
Figure 1: Getting started

3.   GETTING STARTED

-   Set the rotary controls as shown in the following table:

Positions of knobs					
Mark (4)	**Marks (6) (8) (10)**			**Mark (12)**	**Mark (15)**	**Mark (17)**
INTENSITY	POSITION POSITION POSITION			HOLDOFF	LEVEL	VAR

-   Push in the POWER key (49): the most recent configuration memorized in analog mode is restored.

-   Validate the AUTO key (18).

-   This apparatus has separate intensity controls for tracing and for text:

    • TRACE :   turn the INTENSITY button (4)

    • TEXT :   press the DISPLAY key (20), then turn the WINDOW
                    knob (1) ; quit using the MENU OFF key (46)

    • FOCUS :   press the DISPLAY key (20), then press push button (1) and finally
                    turn the WINDOW knob (1) to adjust the focus.

-   If you want to delete the text displayed on the screen, turn the WINDOW knob (1) until after the text has completely disappeared.

☞   *In analog mode, text writing takes priority over signal sweep. If a large number of periods are displayed (> 20), the signal may occasionally be erased while this text is being written. Eliminating the text gives a better signal display quality.*

-   Apply the signal to be displayed to channel CH1 or CH2.
-   Press intermittently on the AUTOSET key (3).
-   Menus: press the MENU OFF key (46) when you want to close a menu.

3.1.   AUTOSET

• AUTOSET automatically makes the following searches:
    channel, vertical sensitivity, horizontal deflection coefficient, level, trigger slope, trigger source.

• AUTOSET systematically sets the oscilloscope in the following configuration:
    AUTO mode, PTP synchro, AC coupling of the connected channel, horizontal expansion x 1, DC coupling of the trigger source, DELAY deactivated.

• AUTOSET does not affect:
    POSITION (H and V), VAR, INTENSITY.

Signal not detected
The configuration on the instrument inputs is restored and the *"No signal found"* message is temporarily displayed in area 13 shown in figure 2.

☞   *Vertical framing is not adjusted. Please make sure that the rotary position controls (6) and (10) are properly centered.*
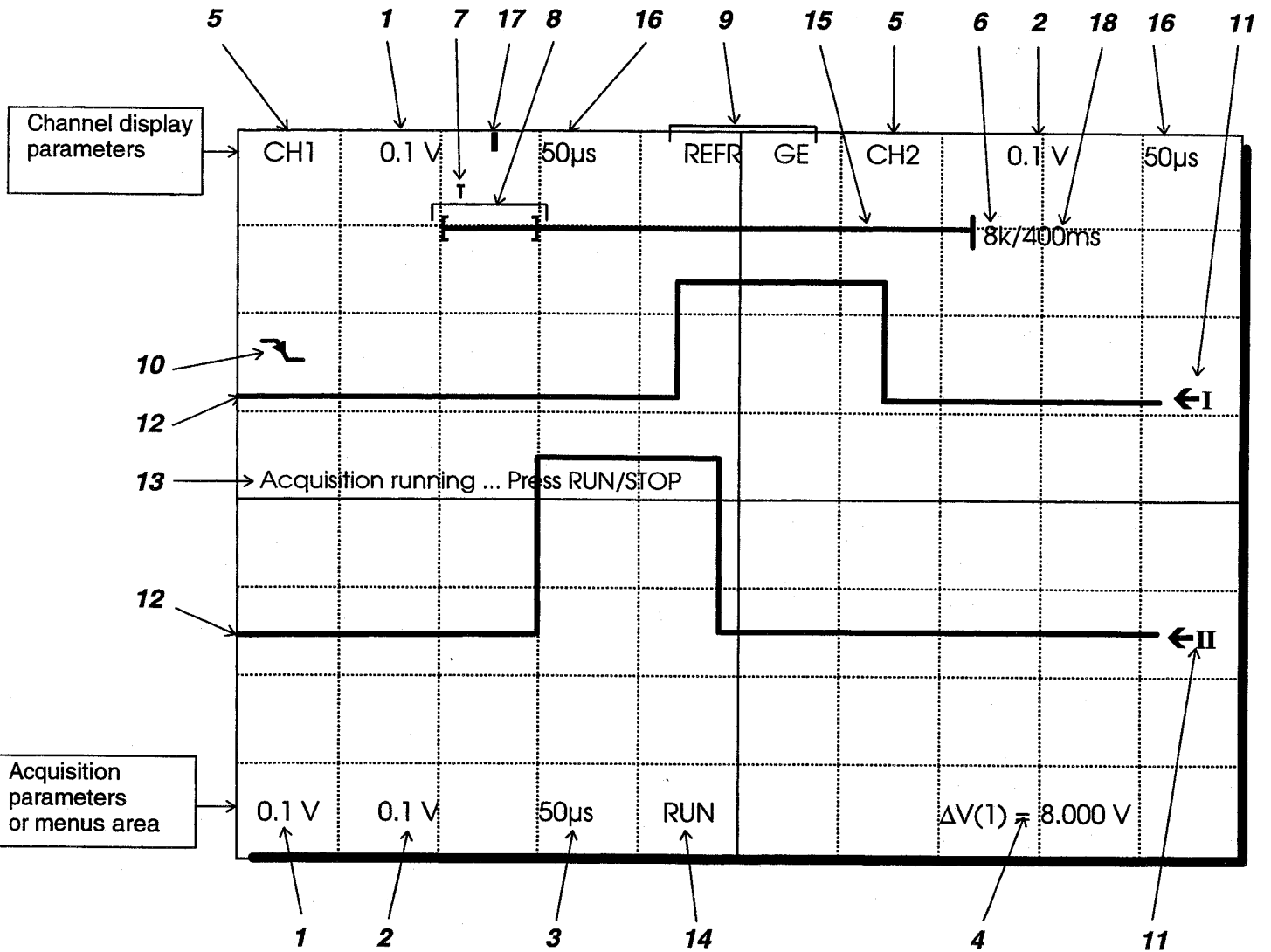
Figure 2: Screen in digital mode

Area 1 - Vertical sensitivity CH1
Area 2 - Vertical sensitivity CH2
Area 3 - Acquisition timebase coefficient
Area 4 - Result of automatic or manual measurement on the selected channel
Area 5 - Displayed channels
Area 6 - Acquisition depth
Area 7 - Position of the TRIGGER in the memory
Area 8 - Memory portion displayed on the screen
Area 9 - Acquisition mode indication
Area 10 - TRIGGER level and slope indicator
Area 11 - Vertical position indicators for the reference level of each channel
Area 12 - Traces
Area 13 - Display temporary help messages
Area 14 - Display the acquisition status: RUN, STP, RDY
Area 15 - Memory use bargraph
Area 16 - Timebase for displaying channels on the screen
Area 17 - Temporal position of the TRIGGER in the screen
Area 18 - Recording duration or line number in TV mode

☞ *The "channel display parameters" area is only displayed if the information contained in it is different from the acquisition parameters.*

4. FUNCTIONAL DESCRIPTION

4.1. Operating modes

This instrument can display or analyze a signal in two different ways (analog and digital).

Press the DIGITAL/ANALOG key (45) to change from one mode to the other:

- <u>digital mode</u>:

  The signal is sampled and is then displayed on the screen (figure 2). The sampling frequency depends on the timebase coefficient and the acquisition mode (see § 6.2.3. Specifications table).
  The memory bargraph is displayed in area 15 (figure 2). Controls specific to digital mode are grouped around the screen and appear in blue on the front.

- <u>analog mode</u>:

  The amplified analog signal is sent directly to the cathode ray tube. The memory bargraph is not displayed.

- Controls displayed in black on the front affect both operating modes.

☞ *During acquisition, scale information about digital signals change to reflect changes in the current parameters on the front that are displayed on the bottom line of the screen.*

When acquisition is finished, the sensitivities of the digital signals are fixed; timebases vary depending on the width of the window. In all cases, digital signal scale information matches the recorded and displayed wave shapes.
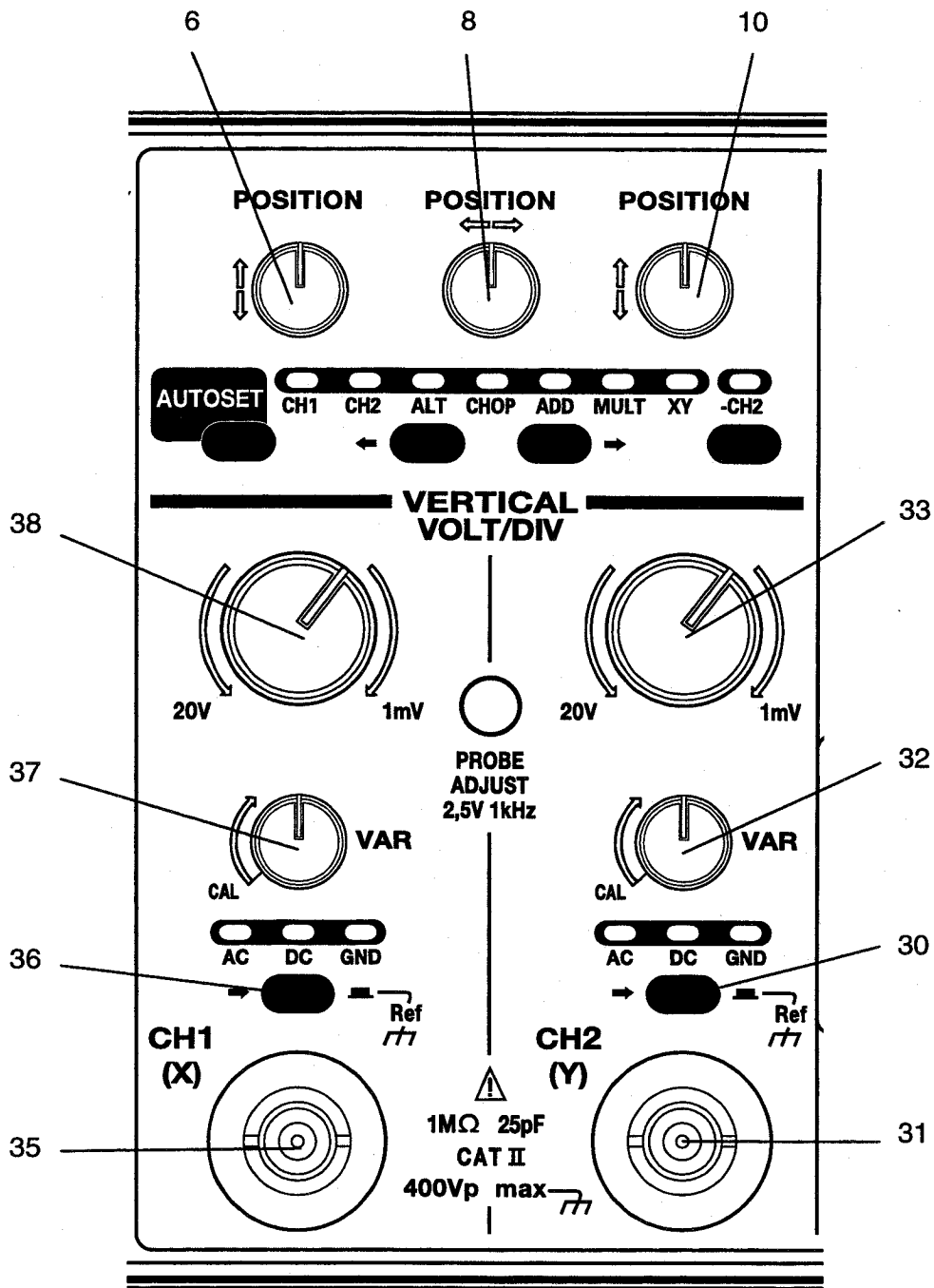
Figure 3

4.2. Vertical channels

(6) - (10)   **POSITION** - *Vertical framing of traces.*

The 0 V references are shown by the ◄I or ◄II symbols at the right of the screen. These references can be moved with buttons (6) and (10).

(8)   **POSITION** - Horizontal framing of traces in analog mode only.

This control acts on CH1 and CH2 simultaneously.

(33) - (38)   **VOLT/DIV** - Vertical sensitivity : 14 positions (1 mV to 20 V/div.).

Input of probe coefficient: UTILITY menu (42).

✎	*Examples*	*p 1 x 1*	*channel 1*	*probe coefficient*
		p 1 x 10	*channel 1*	*probe coefficient 1/10*
		p 2 x 100	*channel 2*	*probe coefficient 1/100*

☞   *The sensitivities displayed in areas 1 and 2 in figure 2, and all measurement results, take account of the selected probe coefficients.*

(32) - (37)   **VAR** - Continuous adjustment of the vertical sensitivity.

When the button is not locked at the left stop, the deflection coefficient is preceded by the warning symbol ">" 0.1 V/div. (area 1 or 2 in figure 2).

(30) - (36)   **AC - DC - GND**

Intermittent press: Selection of the input coupling

Display the AC component (elimination of the DC component).

Display the complete signal (including the DC component): DC coupling.

Coupling of the channel to the ground (without short circuit in the input signal).
Enables accurate positioning of the trace on the screen using the POSITION controls (6) and (10).
In this case, the 0 V reference symbol in area 11 and the trace is coincident in AUTO sweep.

☞   *Select AUTO sweep (key 18).*

Permanent press: Display the 0 V reference using the CH1 (36) or CH2 (30).

Displays the trace facing the 0 V reference that can be modified vertically using buttons (6) and (10).

(31) - (35)   **CH1 and CH2** - Signal inputs to be observed on BNC connectors.
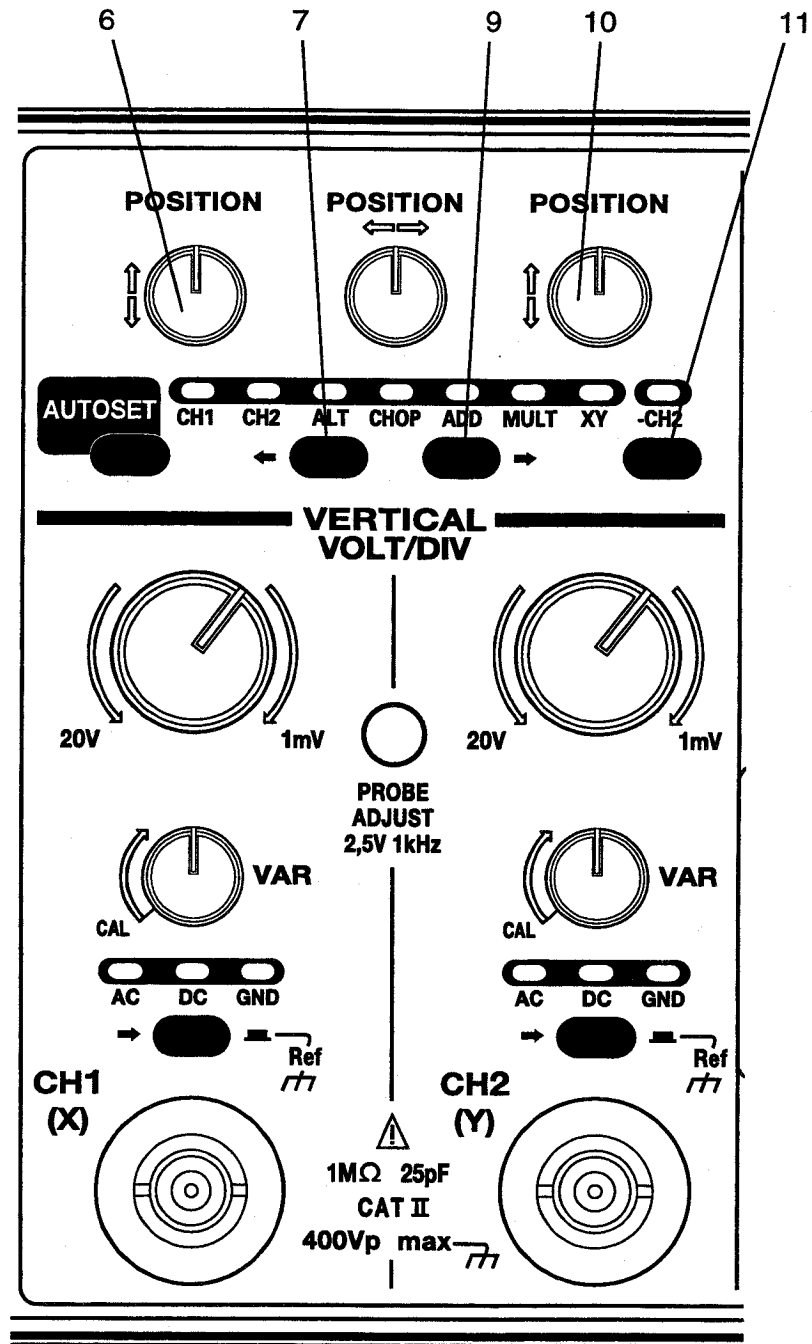
Figure 4

4.3. Vertical display modes

(7) - (9) CH1 - CH2 - ALT - CHOP - ADD - MULT - XY

Selection using the ← (7) or → (9) keys:

CH1 CH2 ALT CHOP ADD MULT XY	Display channel CH1 only.

CH1 CH2 ALT CHOP ADD MULT XY	Display channel CH2 only.

CH1 CH2 ALT CHOP ADD MULT XY

<u>Analog mode</u>:
Display channels CH1 and CH2 in alternate mode.

<u>Digital mode</u>:
Dual curve display.

CH1 CH2 ALT CHOP ADD MULT XY

<u>Analog mode</u>:
Display channels CH1 and CH2 in chopped mode during a single scan, the channel changes from CH1 to CH2 at the chopping frequency (about 200 kHz).

<u>Digital mode</u>:
Dual curve display.

CH1 CH2 ALT CHOP ADD MULT XY

Display the sum of channels CH1 and CH2 ; the difference between channels CH1 and CH2 is displayed if inversion of channel CH2 is active (11).
Measurement units "VOLT" if the sensitivities of CH1 and CH2 are identical and calibrated, otherwise "DIV".

CH1 CH2 ALT CHOP ADD MULT XY

Display the product of channels CH1 and CH2.

MULT deflection = CH1 deflection x CH2 deflection

☞	***This number may be dimensionless if the CH1 and CH2 sensitivities are different.***

CH1 CH2 ALT CHOP ADD MULT XY

Display channels CH1 and CH2 in orthogonal coordinates (CH1 in X, CH2 in Y).

The timebase is disabled (in analog mode), vertical framing is done using control (10) (CH2) and horizontal framing is done using control (6) (CH1).

(11)   -CH2

-CH2

Inversion of channel CH2, by pressing on key (11).
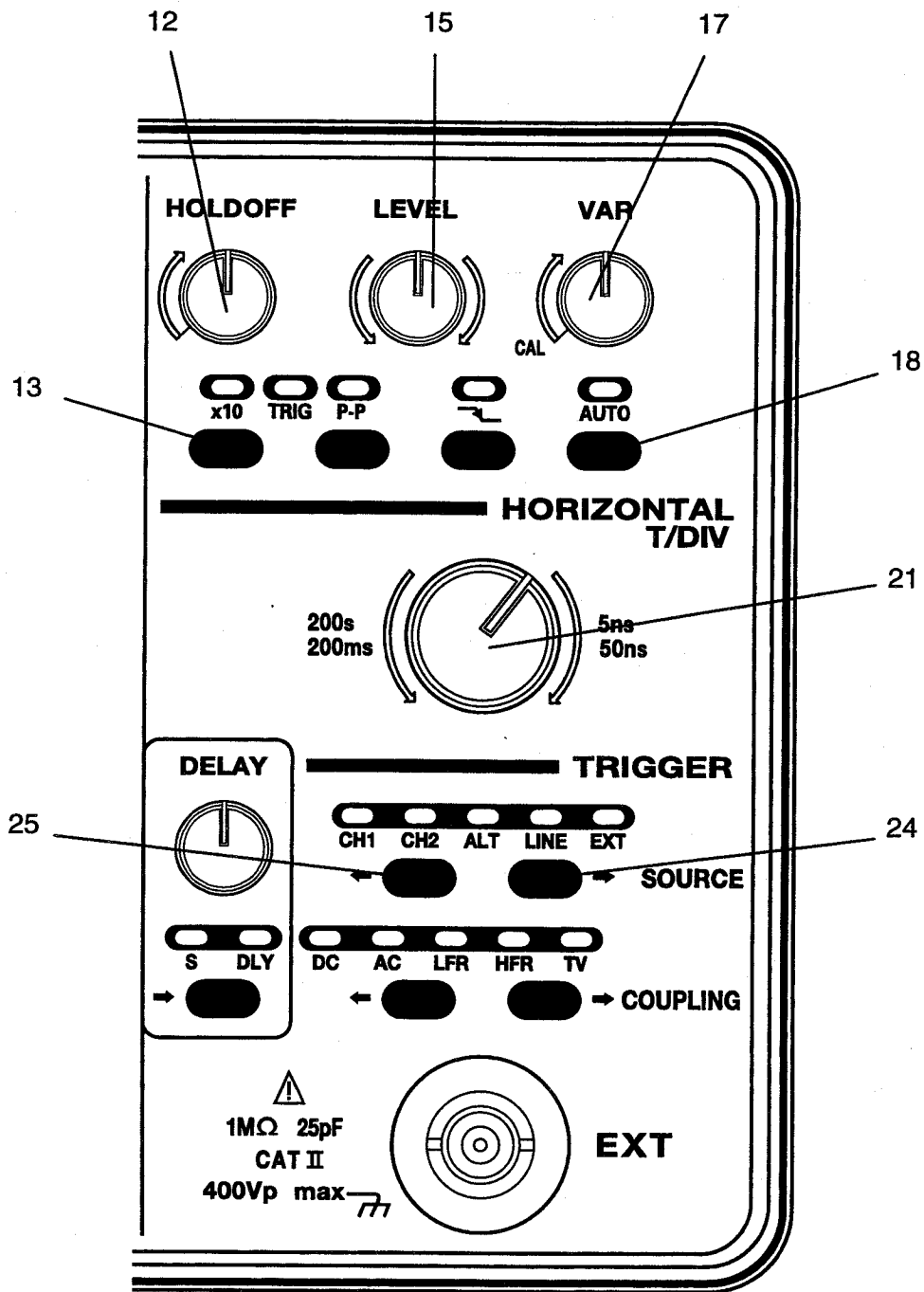
Figure 5

4.4. Timebase

(21) **T/DIV** - Sweep coefficient

- 21 positions (50 ns to 200 ms/div.) in analog mode
- 33 positions (5 ns to 200 s/div.) in digital mode (blue silk screen printing)

The timebase button (21) fulfills two different functions:

- control of the speed of the timebase during acquisition
- control of horizontal compression/expansion (post-acquisition processing)

(17) **VAR** - Continuous adjustment of the timebase sweep coefficient (in analog only)
When the button is not locked at the left stop, the ">" warning symbol precedes the display of the timebase speed (area 3) on the screen.

(12) **HOLDOFF** - Continuous adjustment of the minimum time separating two successive sweeps
This control is active in digital and analog mode, and inhibits accidental triggering events (multiple triggering conditions of the observed signal in the same period). This button is locked at the left stop (click) during normal use.

(13) **x10** - Horizontal expansion (x10). This function is inactive in XY mode (indicating light off) and in all digital display modes (a temporary help message is displayed on the screen).

4.5. Trigger

(24) - (25) **SOURCE** - Selection by pressing on the ➜ (24) or ⬅ (25) key:
The same source is used for the synchronization of timebases A and B.

Synchronization by channel CH1.

Synchronization by channel CH2.

Trigger source defined depending on display mode :

Display mode	Triggering channel
CH1	CH1
CH2	CH2
ALT	channel 1 synchronized with CH1
	channel 2 synchronized with CH2
CHOP	CH1
ADD or ADD (CH1-CH2)	CH1
-CH2	CH2

Synchronization by frequency of the mains power supply. The synchronization coupling control is disabled.

Synchronization by external source.

(18) **AUTO** - Automatic triggering of the timebase.
Traces visible even if there is no triggering event.

Figure 6

(15)   **LEVEL** - Adjustment of the triggering level
The vertical position of the triggering point is displayed on the screen in real time
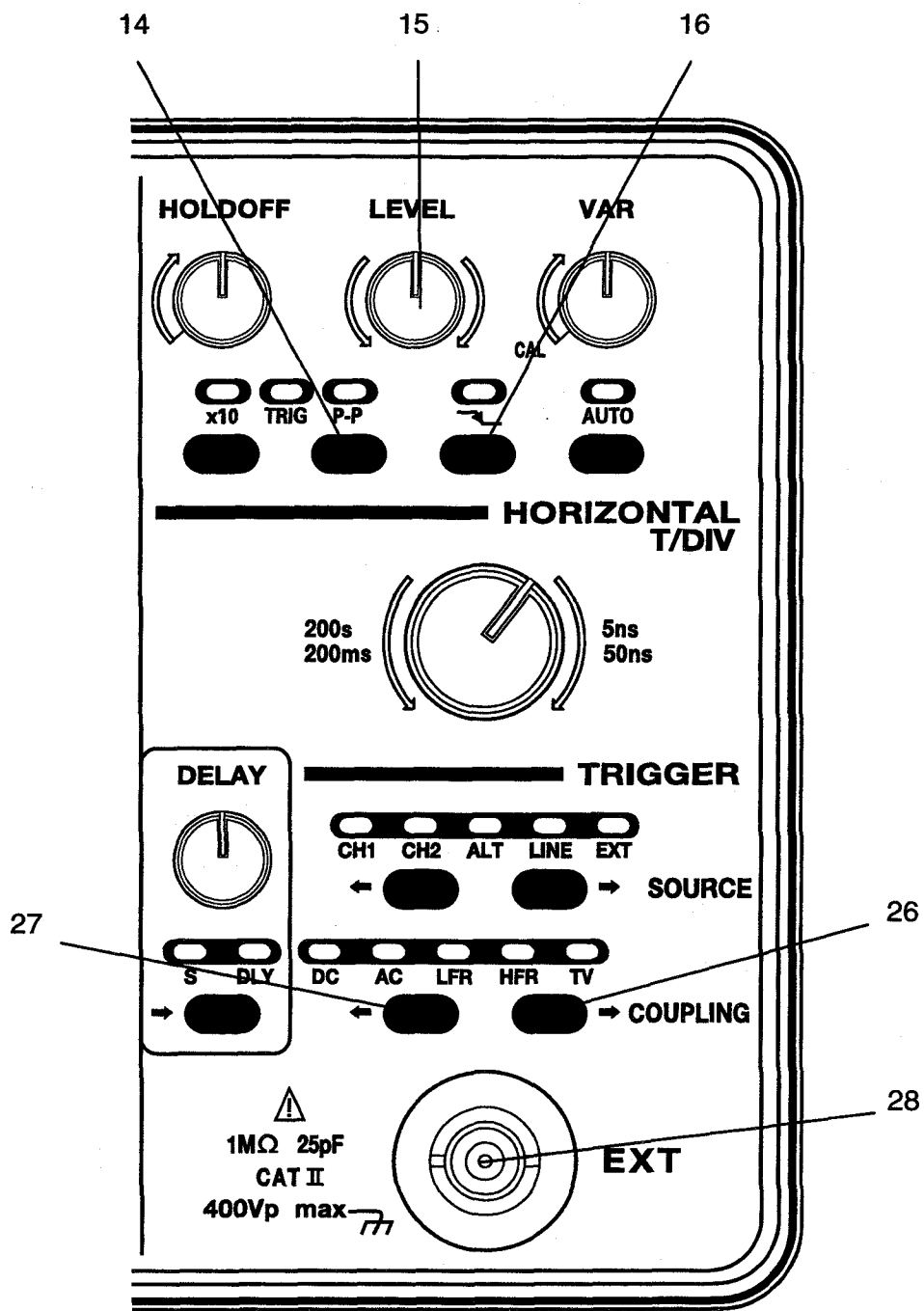using the ⌐ or ⌐ symbol depending on whether the trigger slope is positive or
negative.
The TRIG indicating light is on when a triggering event is detected.

(16)   **Trigger slope**

Light on: trigger on rising slope.
Light off: trigger on falling slope.

☞	**This function is inactive in analog XY mode (light off).**

_ʃ   Symbol on screen indicating a trigger rising slope.
⌐   Symbol on screen indicating a trigger falling slope.

(28)   **EXT** - External synchronization signal input through the BNC connector.
(See chapter 6. SPECIFICATIONS).

(26)-(27) **COUPLING** - Coupling of the trigger source
Selection by pressing on the ← (26) or → (27) key:

DC coupling (0 to 75 MHz).
DC AC LFR HFR TV

AC coupling (10 Hz to 75 MHz).
DC AC LFR HFR TV

Rejection of source signal frequencies < 10 kHz for
triggering (to facilitate observation of signals with a DC
component).
DC AC LFR HFR TV

Rejection of source signal frequencies > 10 kHz for
triggering (to facilitate observation of signals with high
frequency noise).
DC AC LFR HFR TV

Triggering on a selected line in the TV frame.
The "TV" (43) menu accesses the following options:
DC AC LFR HFR TV
  ↳ choice of positive or negative video
  ↳ choice of the frame: ODD or EVEN
  ↳ choice of the standard s525 or s625 (number of lines).
Use the WINDOW knob (1) to choose the number of TV
lines.
Recommended sweep coefficient for examining a TV line:
0.5 µs to 20 µs/div.

☞	**This function is inactive in analog XY mode (lights off).**

(14)   **P - P** - Peak to peak triggering
The trigger reference level (precise adjustment by LEVEL) is automatically
between the low peak and high peak of the chosen signal, which guarantees
triggering regardless of the amplitude or DC component of the source signal (80%
of the signal amplitude for f = 100 Hz).

☞	**This function is inactive in analog XY mode (light off).**

P-P triggering is not recommended for very low frequency signals.
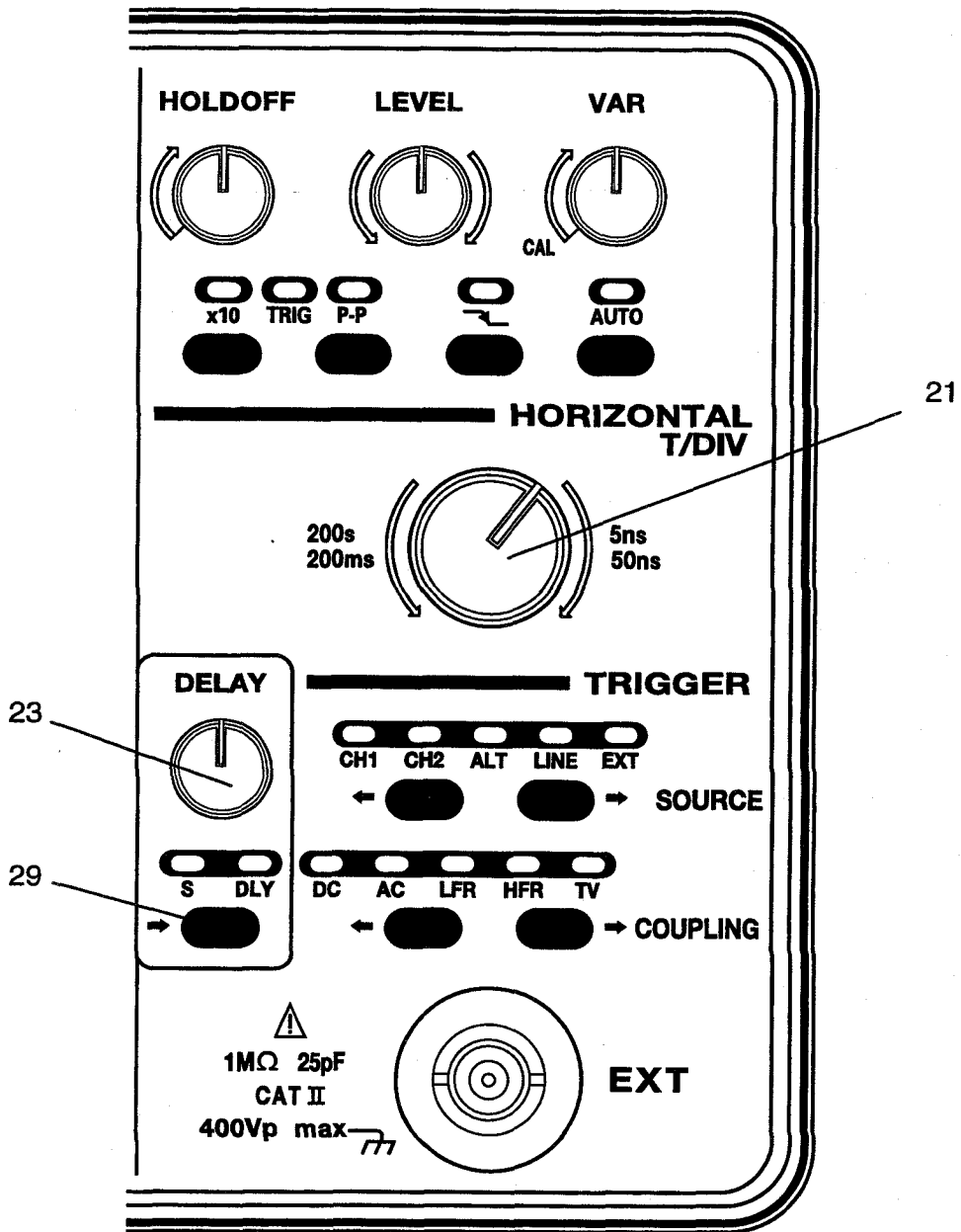
Figure 7

4.6. Triggering delay (DELAY)

This mode is used to examine a portion of the signal subsequent to the selected triggering event in a detailed manner (at high sweep speed).
The DELAY control (23) enables continuous adjustment of the delay (at least up to 10 div.).
The trigger delay system is provided with 18 automatically switched ranges as a function of the sweep coefficient.

(29) **DELAY** - Select by pressing on the ➜ (29) key:

Normal mode:
Scanning starts immediately (triggering event at the far left of the trace).

SEARCH or "S" mode (in analog mode only):
Triggering is identical to normal mode but the right part of the trace is brighter. Use the DELAY button (23) to position a limit between the two sections, slightly to the left of the detail to be examined.

DELAY or "DLY" mode (in analog mode only):
The timebase trigger occurs at the instant determined in SEARCH mode (the searched detail is at the left of the screen).

✎ Press on T/DIV again in order to expand the detail to be displayed.

✎ If necessary, refine the centering of the detail using the DELAY button (23). This button positions the part of the trace to be examined at any point on the screen.

| ✍ | *The minimum value of the adjustable delay is 0.5 µs.* |

| ☞ | *You must choose the appropriate sweep coefficient using the T/DIV button (21) before validating SEARCH or DELAY mode.* |
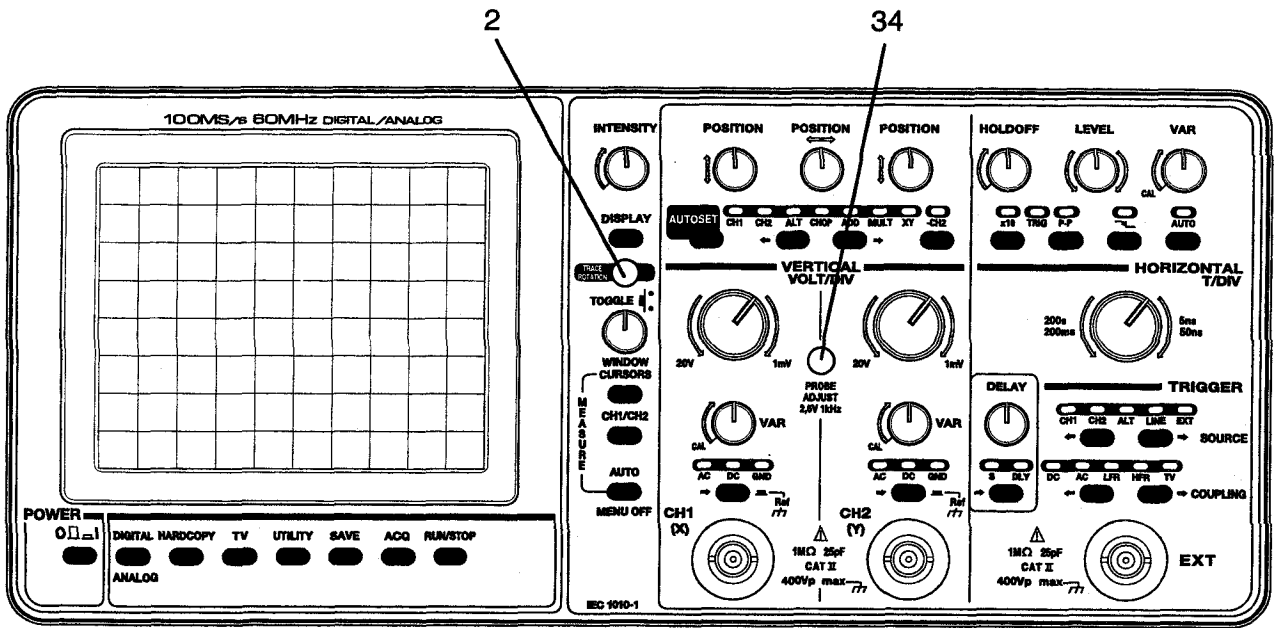
Figure 8
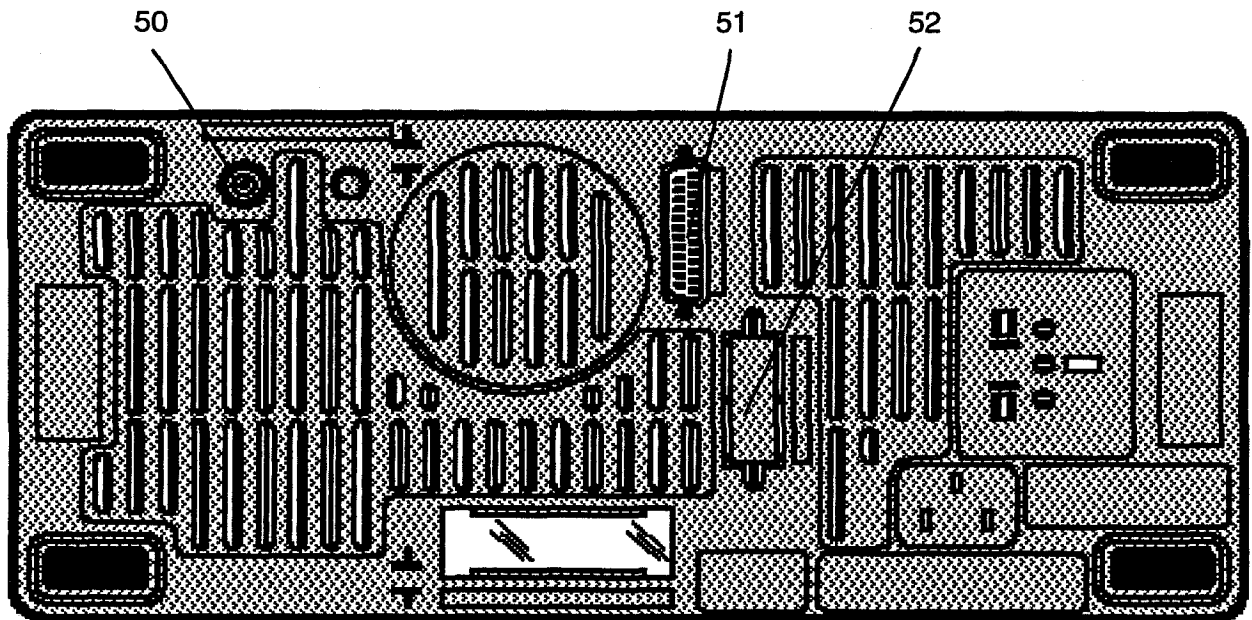
Figure 9

4.7.   Other functions

(34)   **PROBE ADJUST**- Generation of a rectangular signal (2.5 V peak to peak, 1 kHz)
This signal is used for compensation of measurement probes or for checking
vertical amplifiers or the timebase (see § 5.1 Displaying the calibration signal).
This signal compensates probes in LF and in HF.

(2)   **TRACE ROTATION** - Adjustment of the parallelism of traces with respect to the
horizontal axes of the reticle (this adjustment is made using a screwdriver).

(50)   **Z MODULATION** - Input through BNC connector (50) on the back (figure 9), of a
TTL signal to cancel the trace in digital or analog mode (high level 5 V = trace
on, low level 0 V = trace off) and light modulation with proportional control.
Furthermore, this input enables the use of an external time reference signal
(marker).

(51)   **RS232** or **CENTRONICS INTERFACE** - Single output connector on the back
(automatic configuration by detection of the connected peripheral).

(52)   **GPIB INTERFACE** - optional (ref. HA 1341).

4.8. Digital mode

See screen presentation (figure 2).

4.8.1. Acquisition control (ACQ)

Press on the ACQ key (40) to display the ACQ menu:
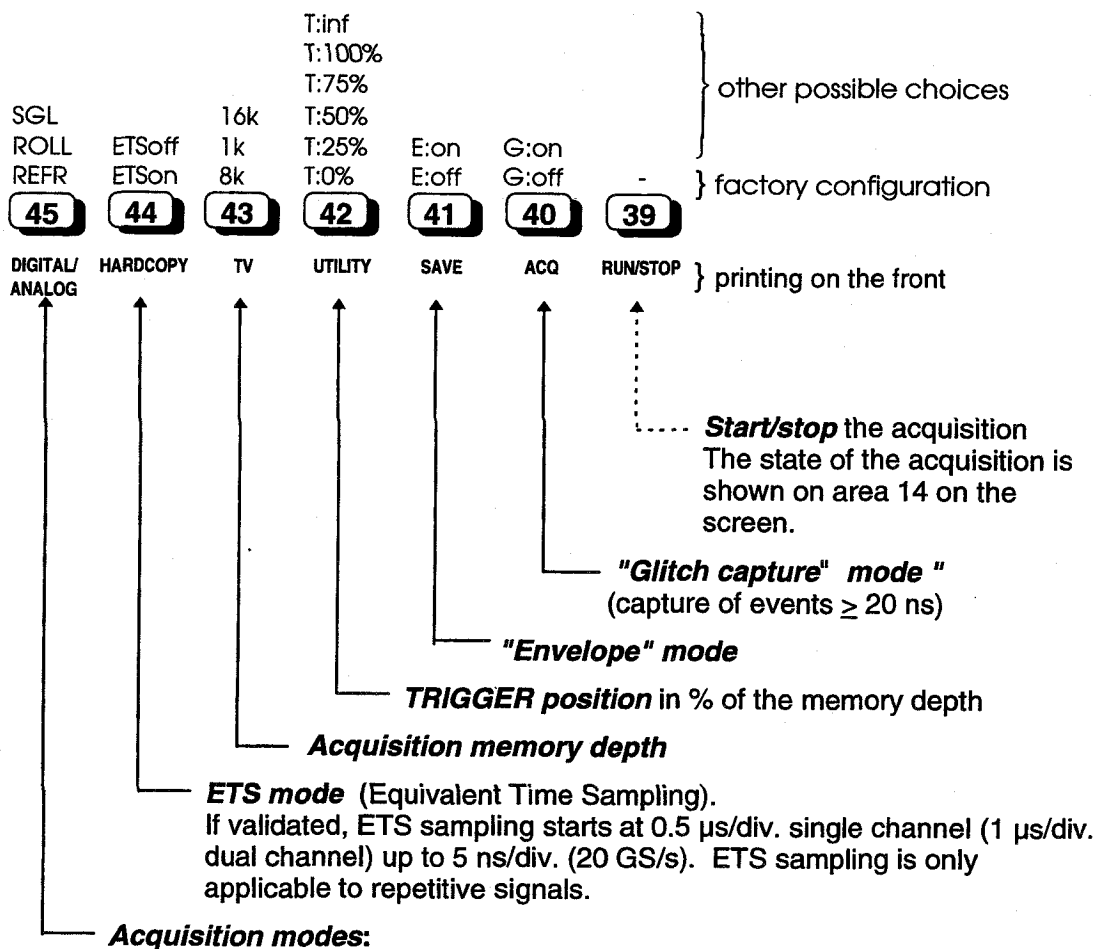
Acquisition modes:

- SGL : single time; reset with RUN/STOP (39). The state of the acquisition STP (stop), RDY (set), RUN (running) is shown in area 14 on the screen.

- ROLL : acquisition with scrolling from right to left corresponding to time base speeds of between 100 ms/div. and 200 s/div.

  - *Single time ROLL mode:*
    The acquisition starts when RUN is pressed. The end of acquisition takes place when a TRIGGER occurs or when STOP is pressed. The memory filling ratio is shown on the bargraph (area 15).

  - *Permanent ROLL mode:*
    Choose T:Inf (42). Starting and stopping no longer depend on the status (RUN or STOP). When the ROLL acquisition is finished, the screen is refreshed as a function of the position of the window in memory. If this refreshment is unwanted (skip effect of the curve), timebase the window to the end of acquisition.

- REFR : repetitive mode
  Acquisitions and displays are permanently refreshed. The process may be stopped using the RUN/STOP control (39).

4.8.2. Post-acquisition processing

4.8.2.1. Save acquisitions

Only saved acquisitions will be restored after the power has been switched off. When a channel has been saved, an "S" will appear in front of the channel title (e.g. "SCH1" - area 5). Its vertical sensitivity is fixed and it becomes impossible to refresh it. All that is possible is post-acquisition processing (framing, compression/expansion, measurements) following access using the SAVE key (41).

4.8.2.2. Vertical deframing

Vertical deframing is active in digital mode including on a memorized signal (outside acquisition); the POSITION potentiometers (6) and (10) frame CH1 and CH2 traces respectively.

☞   *The zero volt reference is shown continuously (area 11).*

4.8.2.3. Horizontal deframing

Horizontal deframing is done by shifting the displayed memory portion (display window). Turn the knob (1) and observe:

- the horizontal displacement of the signal

- the displacement of the identifying marks (area 8) on the bargraph (area 15).

The horizontal deframing range is limited by the sizes of the acquisition and the display window respectively (area 8).

4.8.2.4. Temporal Compression/Expansion

These two actions modify the timebase speed after an acquisition.

Start an acquisition and then stop.

- Turn the T/DIV knob clockwise, observe the expansion of the signals and how area 8 contracts; also observe the change in the speed of the timebase for the channel considered (area 16).

- Turn the T/DIV knob in the anti-clockwise direction, observe the compression of the signals and the change in the display parameters in the opposite direction.

4.9. Measurements

The oscilloscope has manual measurements using cursors and 17 automatic measurements.

4.9.1. Measurements by cursors (CURS)

- The CURSORS key (19) provides access to the following modes in sequence:

ΔV voltage measurements (in XY, horizontal cursors are assigned to CH2)

Δt time measurements (measurement impossible in XY)

$1/\Delta t$ frequency measurements (measurement impossible in XY)

φ phase measurement with 3 cursors (measurement impossible in XY)

off   exit

- Select the measurement channel: use the CH1/CH2 key (47). The channel number is shown in the result [e.g.: $\Delta V(1)$ in area 1].

- The mobile cursor is shown as a tightly spaced dashed line, the fixed cursor as a widely spaced dashed line. Press the WINDOW button (1) to swap these two cursors.

- Move the mobile cursor by turning the WINDOW knob (1). Observe the change of the result in area 4.

- Phase measurement: position the two outside cursors on a complete period. The phase measurement is made between the left cursor and the central cursor.

4.9.2. Automatic measurements (AUTO)

Selection of automatic measurements by pressing on the menu key (46).

4.9.2.1. Definitions

Selection of the measurement channel: use the CH1/CH2 key (47). The channel number is shown in the result [e.g.: Vpp(1) in area 1].

17 automatic measurements are available:

Vpp	peak to peak voltage (Vmax - Vmin)
Vrms	rms voltage
Vavg	average voltage
F	frequency (1/T)
T	period
tr	rise time (10 to 90 %)
tf	fall time (10 to 90 %)
W+	positive pulse width at 50 % of Vamp
W-	negative pulse width at 5 % of Vamp
DC+	cyclic ratio (W+/T) * 100

DC-	cyclic ratio (W-/T) * 100
Vmax	maximum voltage
Vmin	minimum voltage
Vh	high set up voltage
Vlow	low set up voltage
Vamp	amplitude (Vh - Vlow)
φ	phase

4.9.2.2. Measurement conditions

The measurement is done on the part displayed on the screen (1000 points) using CH1 or CH2 as reference. Any change to the displayed signal will immediately update the measurement (window width and offset, interpolation, new acquisition, change in vertical mode).

Automatic measurements require at least one and a half periods, except for the Vrms and Vavg (if less than one and a half periods, the calculation will be done on the 1000 points on the screen). Otherwise a "failed" message is displayed instead of the results. The measurement precision is maximum when two periods are displayed on the screen.
If several periods are displayed, the measurement is made for the first period found starting from the left of the screen.

Vh corresponds to the voltage determined from the most frequent points above 50% of Vamp. Vlow is the voltage determined from the most frequent points below 50% of Vamp.

4.9.3. Special cases

Results may not be displayed in some cases. A message then appears in area 4:

XY	Measurement incompatible with the XY display.
CH1	The automatic phase measurement can only take place in dual curve display mode. Choose ALT or CHOP.
failed	The number of analysis periods is too small. Change the timebase speed.
no display	At timebase speeds of between 200 s/div. and 100 ms/div., the measurement result is displayed as soon as possible. Therefore in REFRESH mode, the result is purged at each start of an acquisition cycle.

Figure 10: Definition of automatic measurements
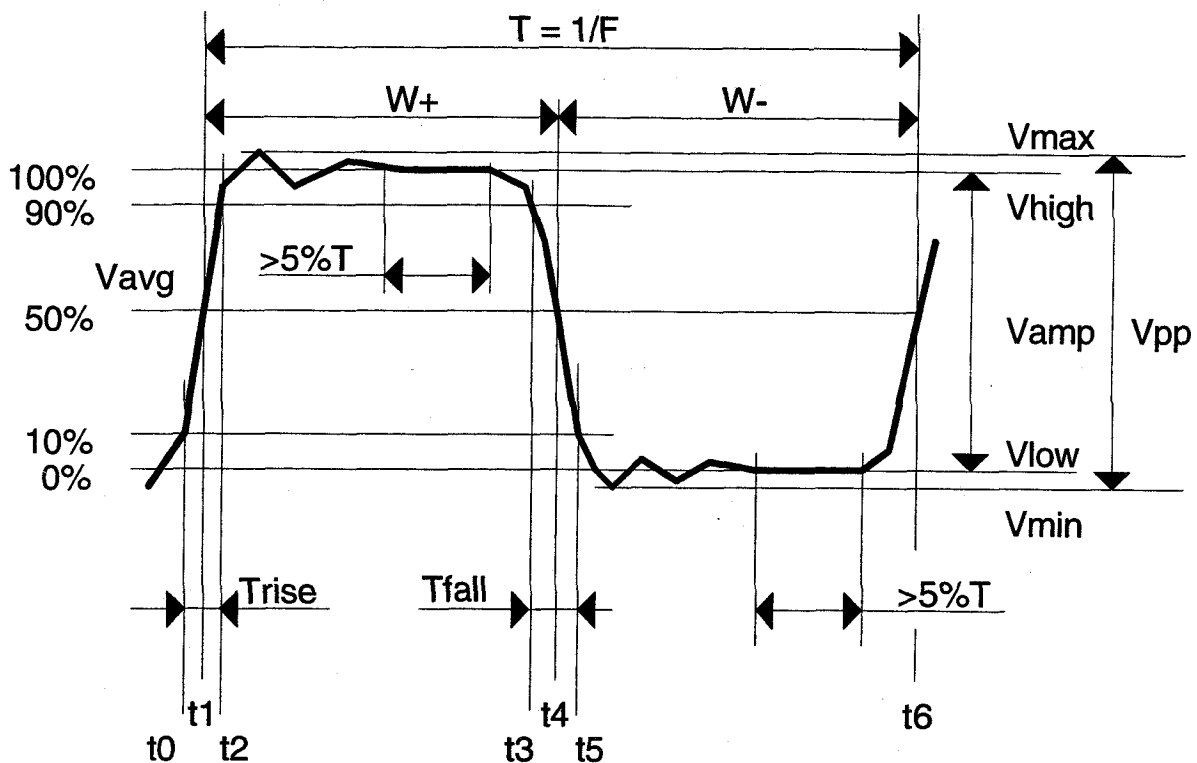
- Vrms = $[\dfrac{1}{n}\sum_{i=0}^{i=n}(y_i - y_{GND})^2]^{1/2}$

- Vavg = $\dfrac{1}{n}\sum_{i=0}^{i=n}(y_i - y_{GND})$

- Y_{GND} = value of the point representing zero volts

Displayed values are averaged by using an exponential averaging algorithm using the following formula :

new displayed value = (old displayed value x 15 + measured value) / 16

The device will be reinitialized when the measured value is more than 5 % different from the displayed value

4.9.3.1. Starting the measurement

See figure 10.

Press on the AUTO / MENU OFF key (46). The following menu is displayed:

off	Vpp	Vrms	Vavg	F	T	More
45	44	43	42	41	40	39

The MORE key (39) accesses other automatic measurements.

tr	tf	W+	W-	DC+	DC-	More
45	44	43	42	41	40	39

Vmax	Vmin	Vh	Vlow	Vamp	φ	More
45	44	43	42	41	40	39

To start a measurement, press on the corresponding key: the menu disappears and the result of the measurement is displayed in area 4 on the screen.

To stop measurements, press on the AUTO key (46) and then press off (45). The measurement result disappears. The MENU OFF key (46) will make the menu disappear.

4.10. Utilities

The UTILITY key (42) displays the following menu:

Vers	RS232	GPIB:31 .... GPIB:1	HC/REM	-	p1x100 p1x10 p1x1	p2x100 p2x10 p2x1
45	44	43	42	41	40	39
DIGITAL/ ANALOG	HARDCOPY	TV	UTILITY	SAVE	ACQ	RUN/STOP

— Adjustment of CH2 probe coefficients

— Adjustment of CH1 probe coefficients

— Configuration of the hard-copy HC (see § 4.11.2.) and the remote control (§ 4.11.3.)

— Adjustment of the GPIB address

— Configuration of the serial interface (see § 4.11.1.)

— Permanent display of a message identifying the instrument version

☞ **Choices are made by pressing several times on the keys.**
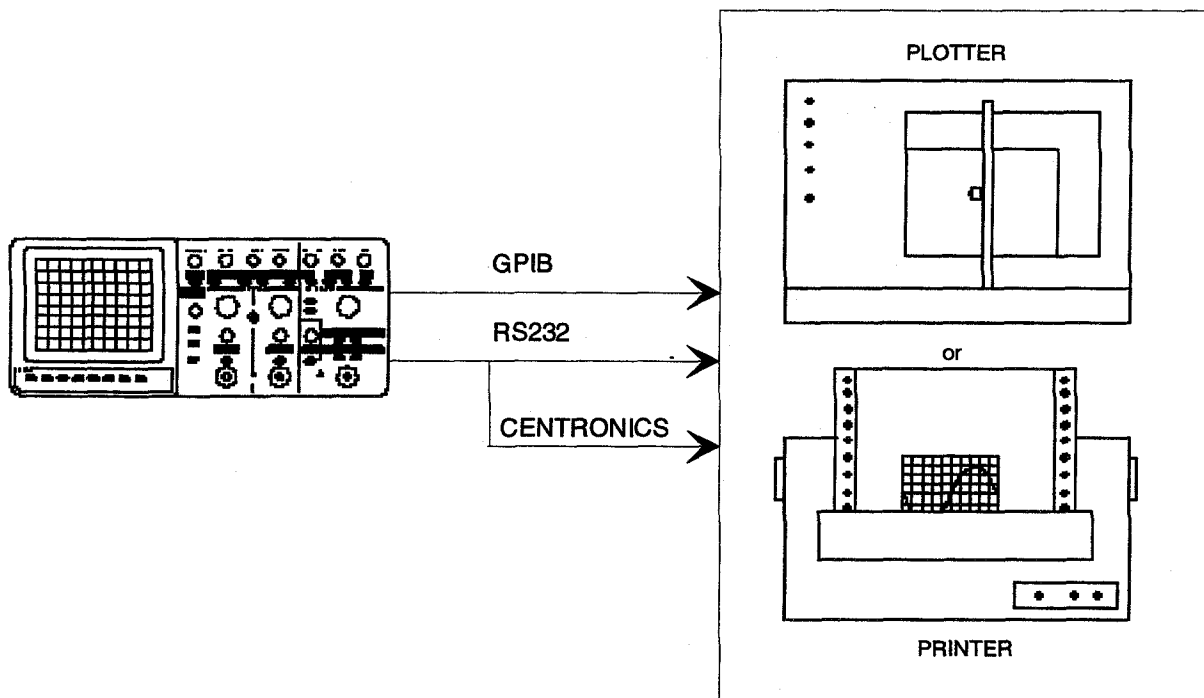
Figure 11: Interfaces for hardcopy

4.11. External communication interfaces

4.11.1. Configuration of interfaces

Interfaces are configured from the UTILITY menu (42).

- RS232 and CENTRONICS
- GPIB (option)

The RS232 and GPIB interfaces are used for:

- remote programming of the instrument through a PC or any terminal
- connection to a print peripheral for the hardcopy.

The CENTRONICS interface is used for connection to a print peripheral. The RS232 or CENTRONICS interface of the peripheral used is automatically detected.

4.11.1.1. RS232 Interface

The transfer speed is selected by pressing several times on the key (44) in the UTILITY menu (see § 4.10.).

```
            75
          ......
          4800    Odd
          9600    Even    Ln7    Stp2    RTS
    -     19200   No      Ln8    Stp1    Xon      -
  ( 45 )  ( 44 ) ( 43 )  ( 42 ) ( 41 )  ( 40 )  ( 39 )
 DIGITAL/ HARDCOPY  TV   UTILITY SAVE    ACQ    RUN/STOP
 ANALOG
```

- Choice of protocol (∗)
- Number of stop bits
- Information length
- Parity type
  No : no parity
  Even : even
  Odd : odd
- Transfer speed
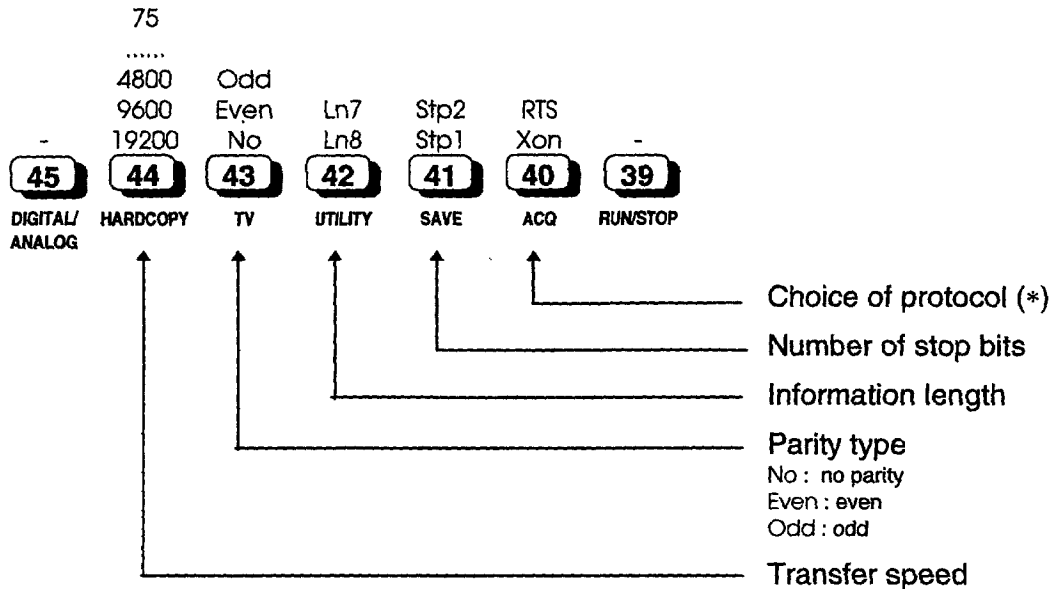
Parameters are selected by pressing keys (40) to (44) several times.

(∗) <u>Xon/Xoff protocol</u>
Software protocol enabling the use of a 3-wire link.

<u>RTS protocol</u>
Hardware protocol requiring a complete cable - Ref. X00040A00A

☞ ***In both cases, make sure that the connected peripheral supports the same type of protocol.***

4.11.1.2. GPIB interface

The GPIB address of the instrument between 1 and 31 is selected by pressing several times on key (43) in the UTILITY menu (see § 4.10).

4.11.2. Configuration of the hardcopy

4.11.2.1. Configuration

Press on the HC/REM key (42) in the UTILITY menu (see § 4.10.).

```
HC:HPGL
HC:ESC P2          GPIB
HC:HP-PCL          RS232      Gr:Y       St:Y
HC:IBM pr          CENTRO     Gr:N       St:N                     REM: ≠
  [45]     [44]     [43]      [42]      [41]      [40]      [39]
DIGITAL/  HARDCOPY   TV       UTILITY   SAVE      ACQ      RUN/STOP
ANALOG
```

Print the instrument status
(Yes/No)

Print the graticule
(Yes/No)

Peripheral used for the hard
copy
(CENTRO is only displayed when a
CENTRONIX printer is connected).

Print language:
HPGL	digital plotters
IBM Pr	IBM Proprinter, ...
ESC P2	Epson Stylus, ...
HP-PCL	HP Laserjet, Deskjet, ...

4.11.2.2. Start/Stop

If no menus are displayed, press on the HARDCOPY key (44) to start the hard-copy. A temporary message appears in area 13 :

or
"Plotting screen... Press HARDCOPY to abort"

"Printing screen... Press HARDCOPY to abort"

4.11.3. Configuration of the remote control

Press on the HC/REM key (42) in the UTILITY menu (see § 4.10.).

```
                                                            REM: GPIB
                                                            REM: RS232
HC:IBM pr          CENTRO     Gr:N       St:N               REM: ≠
  [45]     [44]     [43]      [42]      [41]      [40]      [39]
DIGITAL/  HARDCOPY   TV       UTILITY   SAVE      ACQ      RUN/STOP
ANALOG
```

Choice of the peripheral
used for remote control of
the instrument
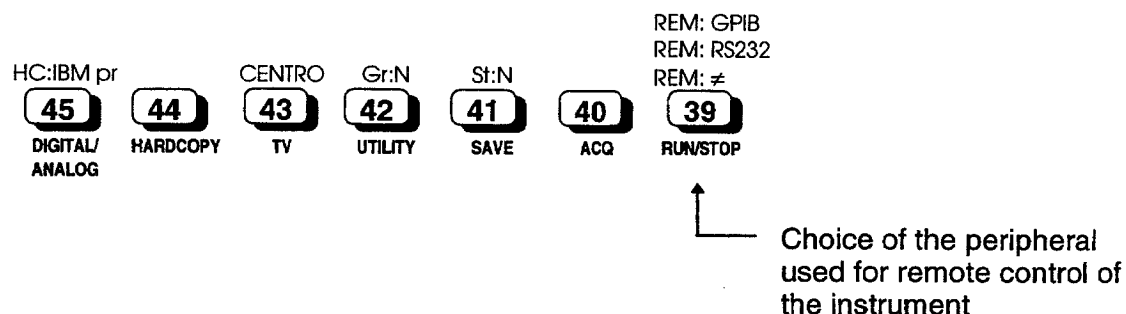
The "≠" symbol means that the RS232/CENTRONICS hybrid interface is used in CENTRONICS mode for the hardcopy. Remote control is not possible with this type of interface.

5.   APPLICATIONS

Envelope mode application "ENVELOPE":   analysis of a signal variations with time (vertical drift) (v) or horizontal drift (jitter)

Envelope mode consists in storing the maximum and minimum values during several successive acquisitions (repetitive signal in REFRESH mode) for each abscissa (0 to 1000).

Envelope mode is disabled in SINGLE mode and in ROLL mode.
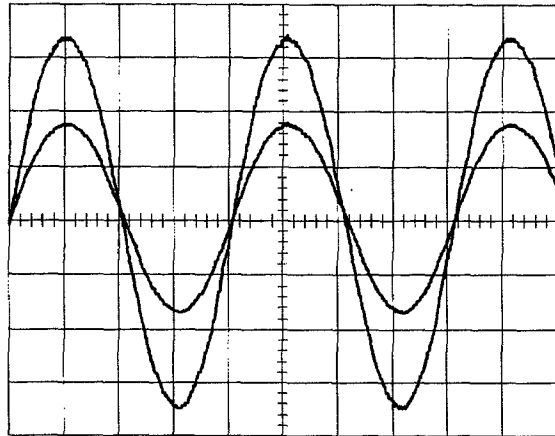
Figure 12

Glitch capture mode application "GLITCH":

Application 1 : acquisition of a comb pattern

Signal
* period   2 ms
* pulse width   10 µs

Timebase   10 ms/div.

Sampling period   100 µs/div.

The sampling period is greater than the pulse width; without parasite capture mode, pulses would be missing in the record (figure 13). With parasite capture mode, all pulses will be displayed (figure 14).
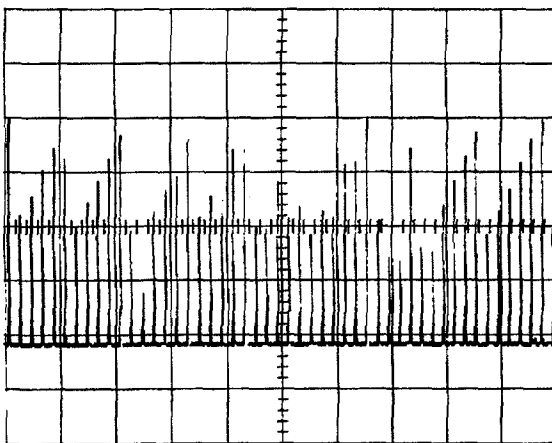
Figure 13
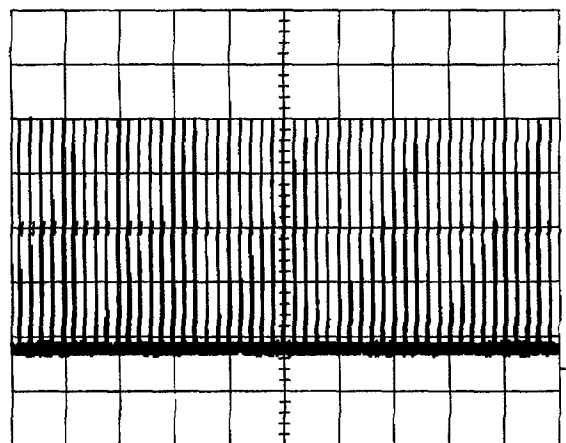
Figure 14

Signal
- frequency   1.002 MHz
- period   1 µs

Timebase   100 µs/div.

Sampling period   1 µs/div.

Incorrect records may be obtained when the signal is undersampled (figure 15).   Glitch capture mode records the minimum and maximum between each sample;   in this case, the maximum and minimum peaks confirming false display are obtained (figure 16).   False display can also be detected by comparing figures of signals observed in analog mode and in digital mode.
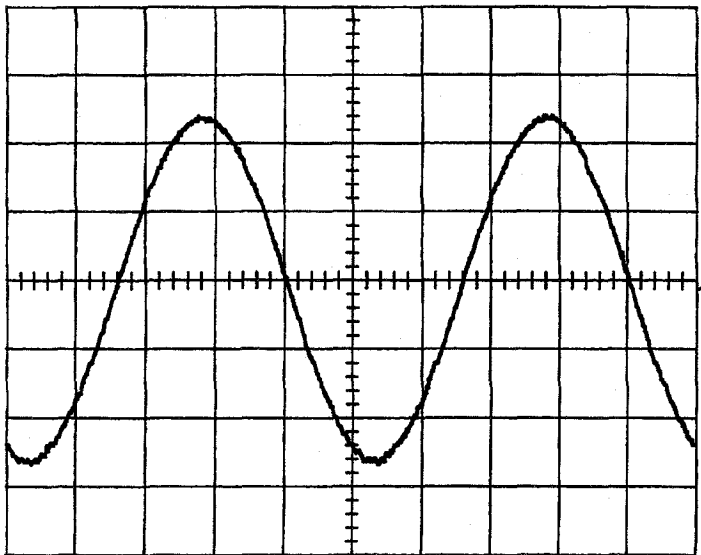
Figure 15
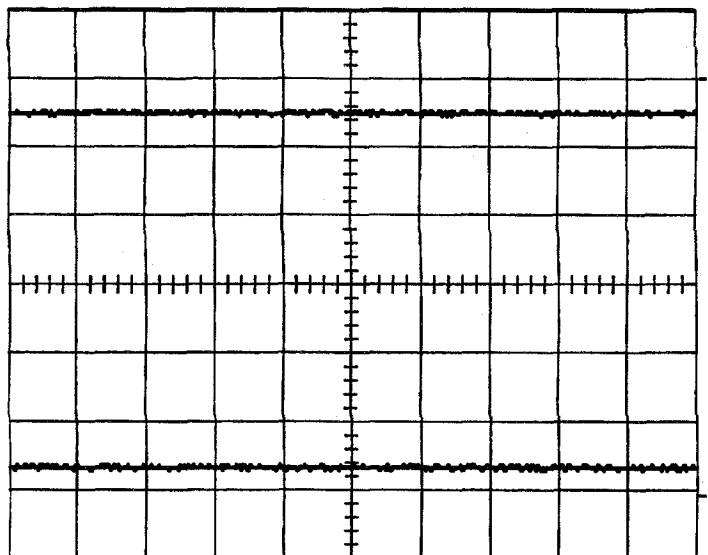
Figure 16

5.1. Connecting a probe

5.1.1. Inputting the probe coefficient

- Enter the UTILITY menu (see § 4.10).

- Assign the attenuation coefficient of the probe to the corresponding channel using the menu keys (39) and (40).

> ✍ **Example**   **CH1**   **probe 1/10**   **p1 x 10**
>   **CH2**   **probe 1/1**   **p2 x 1**

5.1.2. LF compensation   *[CH1 probe connected to PROBE ADJUST (34)]*

- CH1 sensitivity: 0.5 V/div.
- Scanning :   0.2 ms/div.
- Coupling :   DC or AC
- Source :   CH1
- Channel :   CH1
- Trigger :   AUTO
- Mode :   analog

- Correct the vertical and horizontal framing if necessary, using the POSITION controls (6), (8) and (10).

- Adjust the probe LF adjustment to obtain a rectangular signal.
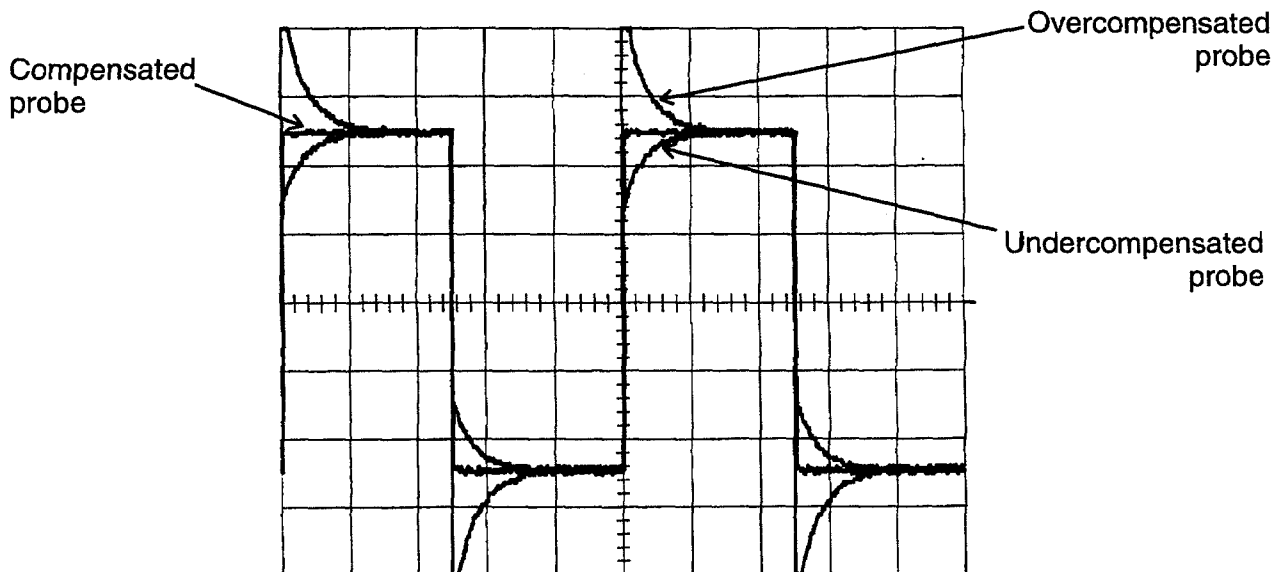
Figure 17

5.1.3. HF compensation

- Select the following parameters:

  - Mode :   digital
  - Acquisition :   run
  - Scanning :   10 ns/div.
  - TRIGGER position: 50 %
  - Front :   ⌐_

- Center the rising front of the calibration signal in the screen using the WINDOW knob (1).

- Make sure that the probe ground ring is in good contact with the calibrator output ground. A ground fault would cause a bouncing response (figure 18).

- Adjust the probe HF setting such that the front is as steep as possible without overrun (figure 19).

Ripple due to a ground fault

Figure 18

Compensated probe
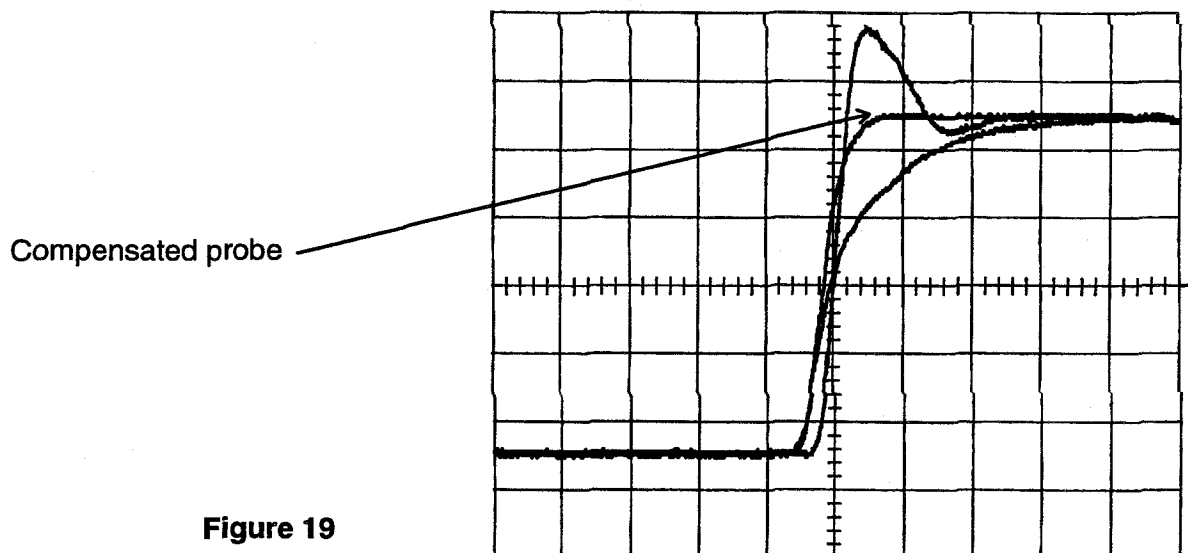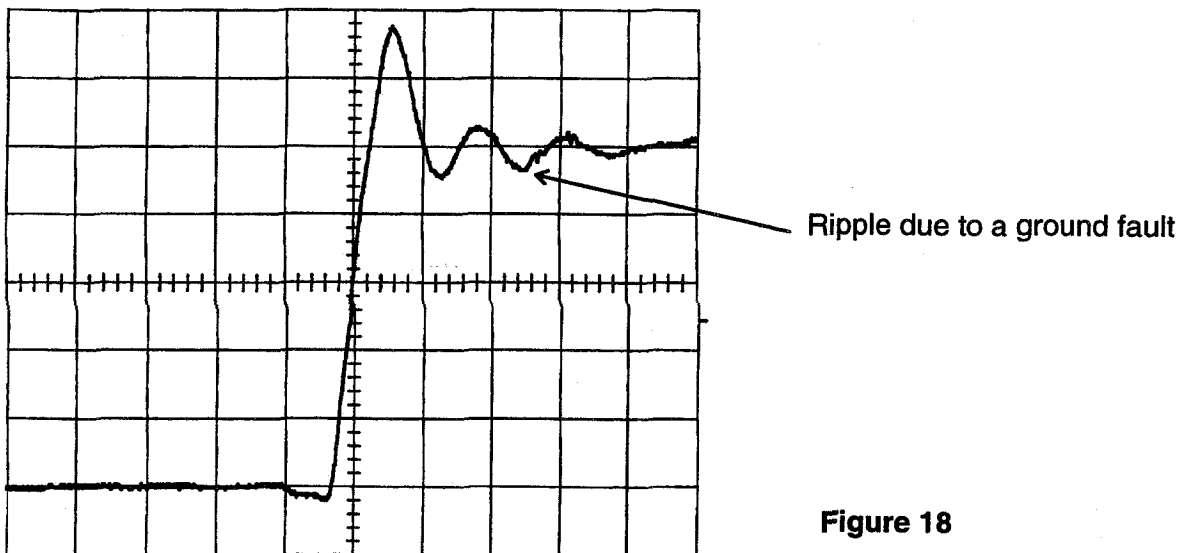
Figure 19

5.1.4. Amplitude and frequency measurements

- Start the automatic amplitude measurement (figure 20) :

- press on the AUTO key (46) ;
- press the More key (key 39) twice to display the menu containing the amplitude measurement Vamp ;
- press under Vamp (key 41).

- Start the automatic frequency measurement:

- press on the AUTO key (46) ;
- press under F (41).

The following result is displayed in area 4 on the screen:

F(1)=1.000kHz
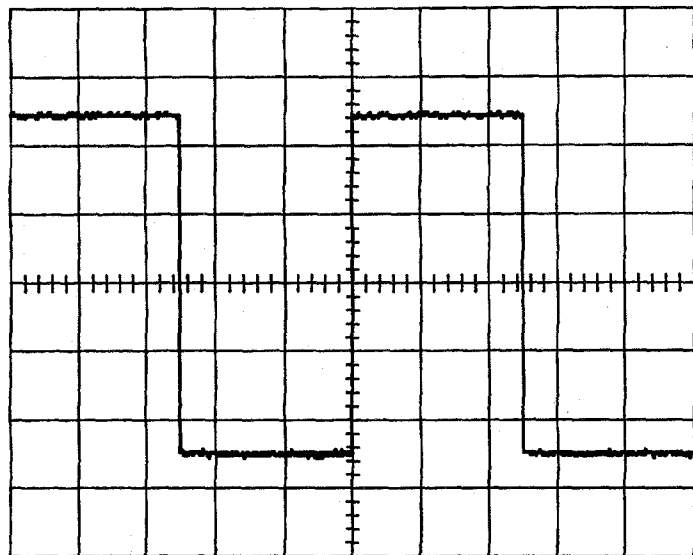
Figure 20

5.2. Phase shift measurements by cursors

Two out-of-phase signals must be available.

- Press on the CURSORS key (19) 4 times to select the phase measurement in area 4 on the screen.

- Position the two end cursors at the beginning and end of the reference signal period (figure 21).

- Position the median cursor on the beginning of the period for the out-of-phase signal.

- Read the result in area 4 on the screen.
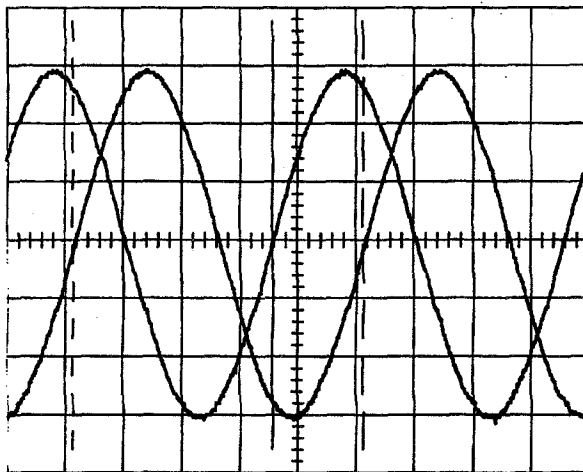
Figure 21

5.3. Display of a video signal

The purpose of this example is to illustrate TV synchronization functions.

Examination of a TV signal

- Inject a composite video TV signal on channel CH1 with the following characteristics:

  - positive modulation,
  - vertical bands in grey scales.

- Configure the oscilloscope in digital mode [press on the (45) key].

- Configure REFRESH mode [ACQ (40) menu then key (45) until REFR is displayed in area 9].

- Start the acquisition [press on the RUN/STOP key (39)]: the RUN status appears in area 14.

- Optimize the timebase speed to observe several complete TV lines (20 µs/div.).

- Configure coupling on TV [key (26) or (27)]: synchronization is done by counting line synchronization pulses. The line number is chosen using the TV menu and the WINDOW knob (1):

• 625 line standard	odd frame	lines "1" to "313"
	even frame	lines "314" to "625"
• 525 line standard	odd frame	lines "1 o" to "263 o"
	even frame	lines "1 e" to "262 e"

Detailed examination of the BURST (figure 22)

- Exit from the TV menu [MENU OFF key (46)].

- Increase the speed of the timebase to 1 μs/div. The burst now appears in detail with no loss of light (constant sweep speed in digital).

- Adjust the WINDOW knob (1) to center the BURST in the screen. If necessary increase the memory depth in order to widen possible displacements.
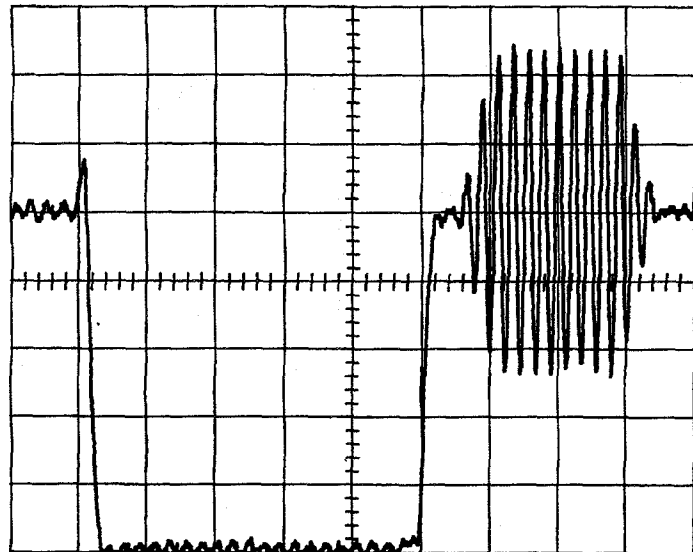
Figure 22

Examination of a TV frame

- Choose the odd or even frame in the TV menu and select line number = 1 or 313 depending on the frame.

- Change the timebase speed to 1 ms/div.

- Select analog mode using the DIGITAL / ANALOG key (45).

The observed image corresponds to the first 10 milliseconds in the TV frame. The synchronization stream is perfectly visible at the beginning of the screen. The image is composed of the superposition of the even and odd frames of the composite signal.

---

60 MHz analog/digital oscilloscope

6. SPECIFICATIONS

The only guaranteed values are values with tolerances or limits (after half an hour of operation). Values without tolerances are given for information.

6.1. Analog mode technical characteristics

6.1.1. Vertical deflection

CH1 - CH2	Specifications		Comments
Characteristics	Digital	Analog	
Bandwidth at - 3 dB	> 60 MHz from 10 mV to 20 V/div. > 35 MHz on 1, 2, 5 mV	> 35 MHz 1, 2, 5 mV/div. > 40 MHz 10 mV to 20 V/div.	Bandwidth measured on 6 div.
Rise time	< 6 ns from 10 mV to 20 V/div.	< 9 ns	
Vertical deflection coefficients (sensitivity)	Ranges : 1 mV/div. to 20 V/div. ± 3 %		14 positions, sequences 1-2-5
Variable vertical deflection coefficients	Multiplication of the V/div. range by 1 to 2.5 (amplitude reduction)		Calibrated position: control at left stop
Max. input voltage	Protection : ± 400 V (DC + AC peak at 1 kHz)		
Limitation of the F (frequency) level	from 0 to 1.8 MHz 400 V peak from 1.8 to 60 MHz - 20 dB/decade		
Focused trace thickness		< 2 mm	
Chopping frequency (CHOP)		about 200 kHz	
AC coupling cutoff frequency	< 10 Hz without probe < 1Hz probe 1/10		
Input impedance	1 MΩ ± 1 % // 25 pF		
Response in rectangular signals	Overrun < 3 % Aberration at 10 mV/div. : • on the level < 1 mm • before the front < 2 mm		1 kHz to 1 MHz 1 MHz (Tm gene < 100 ps)
Crosstalk	1 mV/div. to 5 mV/div. 30 dB typ. 10 mV/div. to 5 V/div. 40 dB typ.		Reference at 35 MHz same sensitivity on CH1 and CH2, Signal amplitude: • 8 div. digital • 6 div. analog
Display modes	CH1 CH2 ALT CHOP ADD MULT XY	CH1 CH2 ALT CHOP ADD XY	ALT = alternating channels CHOP = chopped ALT and CHOP are the same in digital mode: simultaneous display of both channels

6.1.2. Horizontal deflection (analog timebase)

Characteristics	Specifications		Comments
	Digital	**Analog**	
Sweep coefficients	5 ns at 200 s/div. ± 2 % 35 ranges	50 ns to 200 ms/div. ± 3 % 21 ranges	Sequences 1-2-5
Expansion x 10	no	Accuracy: ± 5 %	Used to obtain 10 ns/div.
Variable coefficient	no	Multiplication of the ms/div. range 1 to 2.5	Calibrated position: control at left stop (horizontal signal contraction)
Sweep disable time (HOLDOFF)	Variable from 1 to 10 t/div		for each of the 21 ranges in the analog timebase
XY mode X Bandwidth	ditto Y (t)	0 to 2 MHz $\Delta\varphi < 3°$ at 120 kHz	**Digital** XY mode uses the timebase. Choose a speed related to the applied signals.

6.1.3. Trigger system

Characteristics	Specifications		Comments
CH1 / CH2 sensitivity	**Digital and Analog**		
0 to 5 MHz 5 to 50 MHz 50 to 75 MHz	0.5 div. 2 div. 3 div.		Normal mode
ALT			Source depending on vertical mode:
			CH1 CH1 trigger
			ALT CH1 then CH2 trigger
			CHOP CH1 trigger
			ADD CH1 trigger
			CH2 CH2 trigger
			-CH2 CH2 trigger
LINE	Synchro to mains		
EXT sensitivity	min. applicable amplitudes		Ze = 1 MΩ // 25 pF
0 to 10 MHz 10 to 50 MHz 50 to 75 MHz	60 mVpp 150 mVpp 500 mVpp		protection ± 400 V (DC + AC peak, f < 1 MHz)
Filters	Cutoff frequency		
AC LFR HFR	10 Hz 10 kHz 10 kHz		LFR : rejection of low frequencies HFR : rejection of high frequencies
TV	synchronization of a video signal on a given line number in the frame or the image according to standards		
Horizontal mode	**Digital**	**Analog**	
AUTO Normal SINGLE	yes yes yes	yes yes no	Relaxed mode Freq > 5 Hz Triggered mode Single shot mode
Slope	Falling edge Rising edge		

Level range
      P-P
 	
      Normal
	between the minimum and maximum of the F > 50 Hz signal
	± 12 divisions		

6.1.4. Trigger delay coefficient

Scanning time range	Delay range (approximately)
50 ns/div.	0.5 μs to > 5 μs
0.1 μs/div.	0.5 μs to > 5 μs
0.2 μs/div.	0.5 μs to > 5 μs
0.5 μs/div.	0.5 μs to > 5 μs
1 μs/div.	1 μs to > 10 μs
2 μs/div.	2 μs to > 20 μs
5 μs/div.	5 μs to > 50 μs
10 μs/div.	10 μs to > 100 μs
20 μs/div.	20 μs to > 200 μs
50 μs/div.	50 μs to > 0.5 ms
100 μs/div.	100 μs to > 1 ms
200 μs/div.	200 μs to > 2 ms
500 μs/div.	500 μs to > 5 ms
1 ms/div.	1 ms to > 10 ms
2 ms/div.	2 ms to > 20 ms
5 ms/div.	5 ms to > 50 ms
10 ms/div.	10 ms to > 100 ms
20 ms/div.	20 ms to > 200 ms
50 ms/div.	50 ms to > 500 ms
100 ms/div.	100 ms to > 1 s
200 ms/div.	100 ms to > 1 s

6.2. Technical characteristics of digital mode

6.2.1. Acquisition

Parameter	Specifications	Comments
Resolution	8 bits 1 converter per channel	
Real time sampling	100 MS/s max. single channel 50 MS/s max. two curves	accuracy 100 ppm
Equivalent time sampling	20 GS/s	random mode
Acquisition depth	1 k, 8 k or 16 k per channel	configurable

6.2.2. Display

Displayed window	:	1 k by default on the screen
Compression	:	• 1 k mem: no compression possible
		• 8 k mem: from 1 to 8
		• 16 k mem: from 1 to 16
Display	:	"Normal", "Glitch capture", "Envelope"
Indications	:	• TRIGGER level
		• Ground ref. level
		• Vertical overruns by up or down arrow
Simultaneous traces	:	2

6.2.3. Digital timebase and sampling frequency

Timebase speed	Real time sampling frequency	ETS sampling frequency	GLITCH sampling frequency	ACQUISITION mode
5 ns/div.	50 MS/s	20 GS/s	-	REFR,SGL
10 ns/div.	50 MS/s	10 GS/s	-	REFR, SGL
20 ns/div.	50 MS/s	5 GS/s	-	REFR, SGL
50 ns/div.	50 MS/s	2 GS/s	-	REFR, SGL
.1 μs/div.	50 MS/s	1 GS/s	-	REFR, SGL
.2 μs/div.	50 MS/s	500 MS/s	-	REFR, SGL
.5 μs/div.	50 MS/s	200 MS/s	-	REFR, SGL
1 μs/div. double channel	50 MS/s	100 MS/s	-	REFR, SGL
1 μs/div. single channel	100 MS/s	-	-	REFR, SGL
2 μs/div.	50 MS/s	-	-	REFR, SGL
5 μs/div.	20 MS/s	-	-	REFR, SGL
10 μs/div.	10 MS/s	-	50 MS/s	REFR, SGL
20 μs/div.	5 MS/s	-	50 MS/s	REFR, SGL
50 μs/div.	2 MS/s	-	50 MS/s	REFR, SGL
.1 ms/div.	1 MS/s	-	50 MS/s	REFR, SGL
.2 ms/div.	.5 MS/s	-	50 MS/s	REFR, SGL
.5 ms/div.	.2 MS/s	-	50 MS/s	REFR, SGL
1 ms/div.	.1 MS/s	-	50 MS/s	REFR, SGL
2 ms/div.	50 kS/s	-	50 MS/s	REFR, SGL
5 ms/div.	20 kS/s	-	50 MS/s	REFR, SGL
10 ms/div.	10 kS/s	-	50 MS/s	REFR, SGL
20 ms/div.	5 kS/s	-	50 MS/s	REFR, SGL
50 ms/div.	2 kS/s	-	50 MS/s	REFR, SGL
.1 s/div.	1 kS/s	-	50 MS/s	REFR, SGL, ROLL
.2 s/div.	.5 kS/s	-	50 MS/s	REFR, SGL, ROLL
.5 s/div.	.2 kS/s	-	50 MS/s	REFR, SGL, ROLL
1 s/div.	.1kS/s	-	50 MS/s	REFR, SGL, ROLL
2 s/div.	50 S/div.	-	50 MS/s	REFR, SGL, ROLL
5 s/div.	20 S/s	-	50 MS/s	REFR, SGL, ROLL
10 s/div.	10 S/s	-	50 MS/s	REFR, SGL, ROLL
20 s/div.	5 S/s	-	50 MS/s	REFR, SGL, ROLL
50 s/div.	2 S/s	-	50 MS/s	REFR, SGL, ROLL
100 s/div.	1 S/s	-	50 MS/s	REFR, SGL, ROLL
200 s/div.	.5 S/s	-	50 MS/s	REFR, SGL, ROLL

6.2.4. Measurements

1. Relative accuracy of Pa amplitude measurements

* Pa (%) = 3 + 8 div. / Amplitude   for 8 div. : Pa = 4 %

2. Relative accuracy of Pt time measurements

- REFRESH and ETS

$$Pt\ (\%) = 0.01 + 2 \times [t/div. (\mu s) / T \text{ measured } (\mu s)]$$

- SINGLE TIME
  * T/DIV > 1 µs div.   Pt (%) = 0.01 + 2 x [t/div. (µs) / T measured (µs)]
  * T/DIV < 2 µs div.   Pt (%) = 0.01 + 2 (µs) / [T measured (µs)]

3. Relative accuracy of Pf frequency measurements

- REFRESH and ETS

$$Pf\ (\%) = 0.01 + 2 \times [t/div. (\mu s) \times F \text{ measured } (MHz)]$$

- SINGLE TIME
  * T/DIV > 1 µs div.   Pf (%) = 0.01 + 2 x [t/div. (µs) x F measured (MHz)]
  * T/DIV < 2 µs div.   Pf (%) = 0.01 + 2 (µs) x [F measured (MHz)]

6.2.5. Hardcopy

Media

Format
HPGL   HPGL peripherals (e.g. digital plotters)
IBM Pr   Quadruple density dot matrix printers (e.g. IBM Proprinter XL24)
ESC P2   Ink jet printers (e.g. Epson Stylus 800+)
HP-PCL   Laser printers (e.g. HP Laser Jet IIP)

6.2.6. Communication interfaces

RS232
Baud rate   : 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
Parity   : none, even, odd
Data bits   : 7 or 8
Stop bits   : 1 or 2
Protocol   : Xon/Xoff or RTS
Connector   : DB 25-pin female on the back panel

CENTRONICS
on the same connector as the RS232 interface
Automatic selection as a function of the connected peripheral

GPIB
Interface   : optional on a separate board (HA 1341)
Addresses   : 1 to 31
Interpreter : conform with the SCPI standard

Print possibilities
- print the graticule
- print the status
- print the text

6.3. Miscellaneous

Calibration signal
Shape   :   rectangular
Amplitude   :   0 - 2.5 V ± 1 %
Frequency   :   1 kHz ± 1 %

Z modulation Z
Input   :   BNC on the back
Sensitivity   :   TTL level for on/off modulation
                       1.3 < level < 2.6 V for progressive modulation
High level   :   on
Low level   :   off
Max. frequency   :   4 MHz
Input resistance :   2 kΩ
Max. voltage   :   ± 20 VDC

6.4. AUTOSET mode

- Signal search time ≈ 3 s
- 25 Hz ≤ signal frequency ≤ 35 MHz
- 15 mV$_{pp}$ ≤ amplitude without probe ≤ 160 V$_{pp}$
- Automatic switching in CHOP for T/DIV ≤ 0.5 ms/div.
- In 2 channels, priority to displaying the signal of CH1 channel.
- For asymmetric signals (cyclic ratio ≠ 50 %), the choice of the trigger front gives priority to displaying the shortest alternation.

6.5. General characteristics

Cathode ray tube
Type   rectangular with 13 cm diagonal internal reticle

Graticule   8 vertical divisions with 5 subdivisions
                      10 horizontal divisions with 5 subdivisions
                      1 division = 1 cm

Screen   GY phosphorus with average persistence

Contrast screen   green

Trace   trace rotation adjustment
                      focus adjustment
                      light intensity adjustment

Text   separate

Acceleration voltage about 2 kV

Power supply
Network   automatic selection 94 to 264 Vrms, CAT II
Frequency   45 Hz to 440 Hz
Mains power supply cable 3 pins, unpluggable
Winder   with plug support at the back of the apparatus
Consumption   < 50 W

Environment

|			
Usage	indoors		
Elevation	< 2 000 m		
Reference temperature	+ 18 °C	to	+ 28 °C
Usage temperature	+ 10 °C	to	+ 40 °C
Operating temperature	0 °C	to	+ 40 °C
Storage temperature	- 20 °C	to	+ 70 °C
Relative humidity	< 80 % RH	up to 31 °C	

EMC
Emission according to NF EN 61326-1 class A
Immunity according to NF EN 61326-1

Safety
according to CEI 1010-1 [NFC 42-020 (1993)]

Mechanical properties

Apparatus	stackable, with handle used as a stand
Dimensions	see figure below
Weight	≈ 5.5 kg
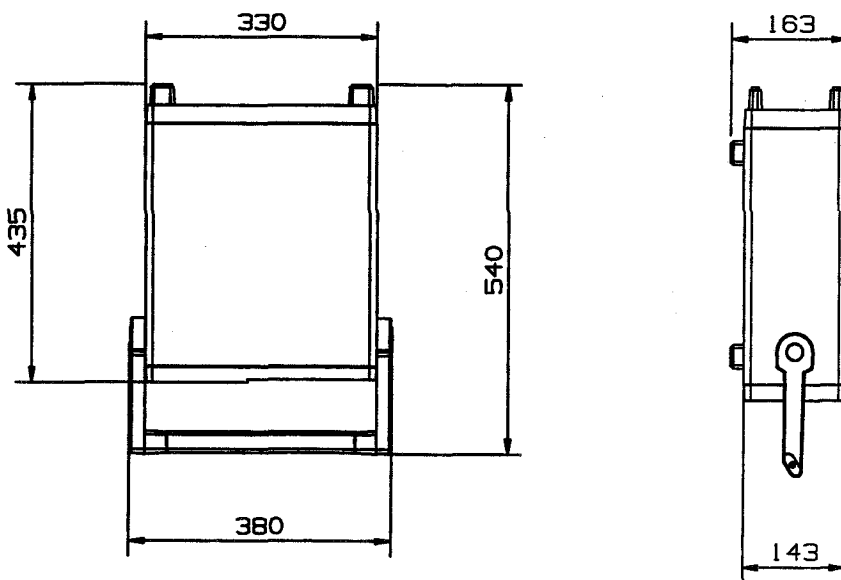
Packing

Dimensions	550 x 460 x 280 mm
Weight	≈ 7 kg

7. SUPPLIES AND OPTIONS

7.1. Accessories

7.1.1. Delivered with the apparatus

- Operating instructions   906121457
- Programming instructions   906121478
- Power supply cable   AG0416
- Ceramic spare fuse T 2.5 A / 5x20 / 250 V
  located inside the apparatus in a housing on the
  cathode ray tube support part   AT0090
- 2 1/10 attenuating probes   HA1315

7.1.2. Provided as options

- 9-pin male / 25-pin female adapter   AS0204
- Male banana / 2 female banana
  BNC safety adapter   EP7043
- 1 male / 2 female BNC T   PA3285
- 50 Ω BNC passage load   PA4119-50
- 1/100, 200 MHz, 2 kV probe   HA1317
- 15 MHz differential probe   MX9003
- 1/10, 200 MHz attenuating probe   HA1316
- 1/10, 400 MHz attenuating probe   HA1323
- Male 25-pin / female 9-pin RS232 serial cable   X00040A00A
- 50 Ω BNC/BNC cable   PA2249-C48
- 100 A current clip for oscilloscope   AM0030N
- 600 A current clip for oscilloscope   AM0031N
- GPIB cable, length 1 m   AG0368
- GPIB interface board   HA1341
- PC transfer software   SX-METRO 3.0
- Labwindows and Labview Drivers(VISA standard) available
  on the NATIONAL INSTRUMENTS site (www.natinst.com)
- Compact printer   HA1327
- HPGL A3/A4 plotter   TX7131
- Carry bag   AE0189

7.2. Rack assembly option

- Rack assembly kit (4U - 19")   RK 0008

  There exists a package version with the HA1341
  GPIB interface.

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