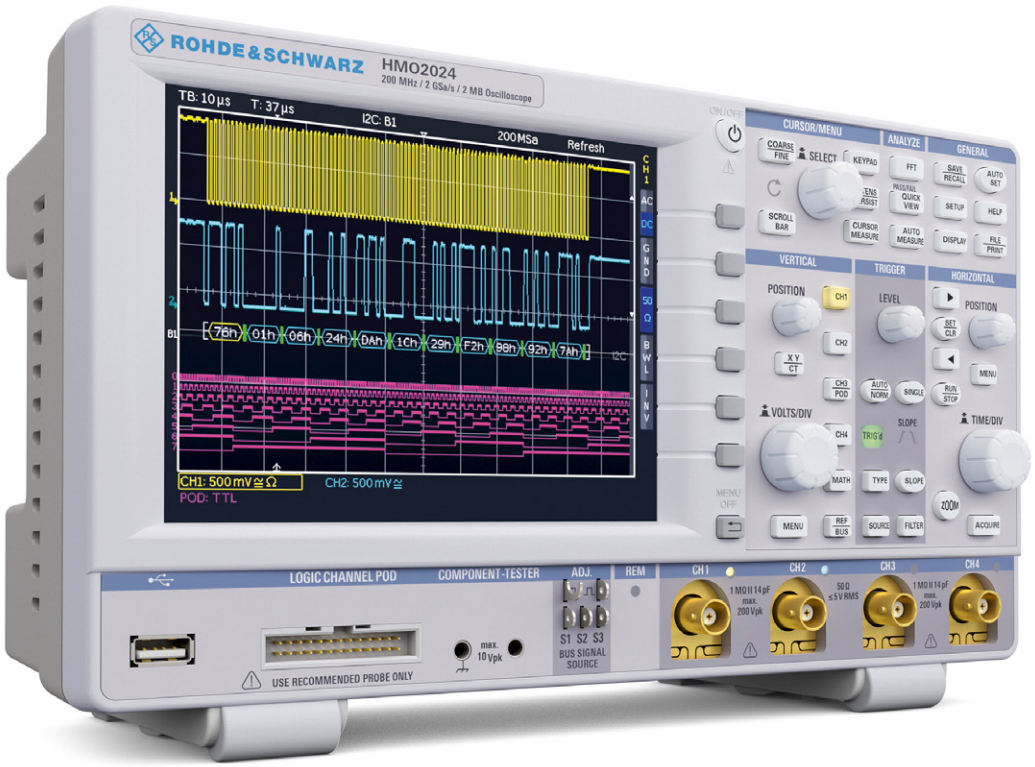
R&S®HMO Compact Series
Digital Oscilloscope
User Manual



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ROHDE&SCHWARZ

Test & Measurement

User Manual

Version 03

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2 Introduction

2.1 Front view

On the instrument frontside you can find the power key 1, in order to switch on the instrument or enter stand by mode. If the instrument is in stand by mode, this key light up red. If the instrument is switched off using the main power switch on the backside, the red light will also switch off (this will take some seconds). Furthermore you find on the front panel the control panel 2, A, B, C, D, the BNC connectors of the analog inputs 45 to 48, the probe adjustment output 51, the bus signal source 50,the connectors for the optional logic probe R&S®HO3508 53, a USB port for USB sticks 54, the TFT screen 55, the inputs for the component tester 52 and the LED 49 for showing activity on the remote interface. On two channel versions you can find the AUX connector for external trigger at the right side.

Use the connectors for the active logic probes 53 exclusively for the logic probes of type R&S®HO3508. Connecting other types may demolish the input.

2.2 Control panel

The controls in the front panel allow access to all basic functions while advanced settings are easily accessible through the menu structure and gray soft menu keys. The power button 1 is clearly set apart by its design. The most significant controls feature colored LEDs, indicating the current setting. The control panel is divided into four sections.

Section A

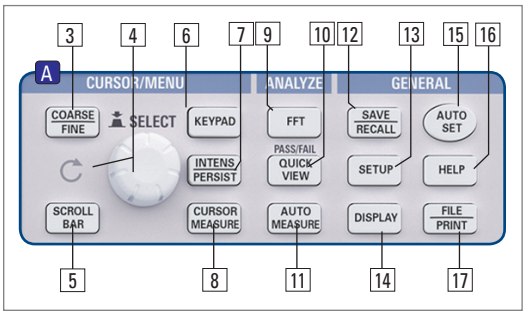

Fig. 2.2: Control panel of section A.

This section includes the CURSOR/MENU, ANALYZE and GENERAL sections.

The CURSOR/MENU section includes cursor functions 8, universal knob 4, Intens/Persist control switch 7, the option to select the virtual screen 6, the key for switching between fine and coarse resolution of the universal knob 3 and the key for the selection of virtual screen 5. The ANALYZE section allows users to directly access the FFT displays 9, the QUICK VIEW display 10 (all important parameters of the actual signal display), the PASS/FAIL mask test and the AUTO MEASURE settings 11 . The GENERAL section includes the Save/Recall key 12. With this option, you can control the settings to load and save instrument settings, reference signals, traces and screenshots. Additional keys enable the user to access general settings 13 such as language, DISPLAY 14, AUTOSET 15 as well as integrated HELP 16 and FILE/PRINT 17. Depending on how it is programmed, FILE/PRINT enables you to directly save instrument settings, traces or screenshots.

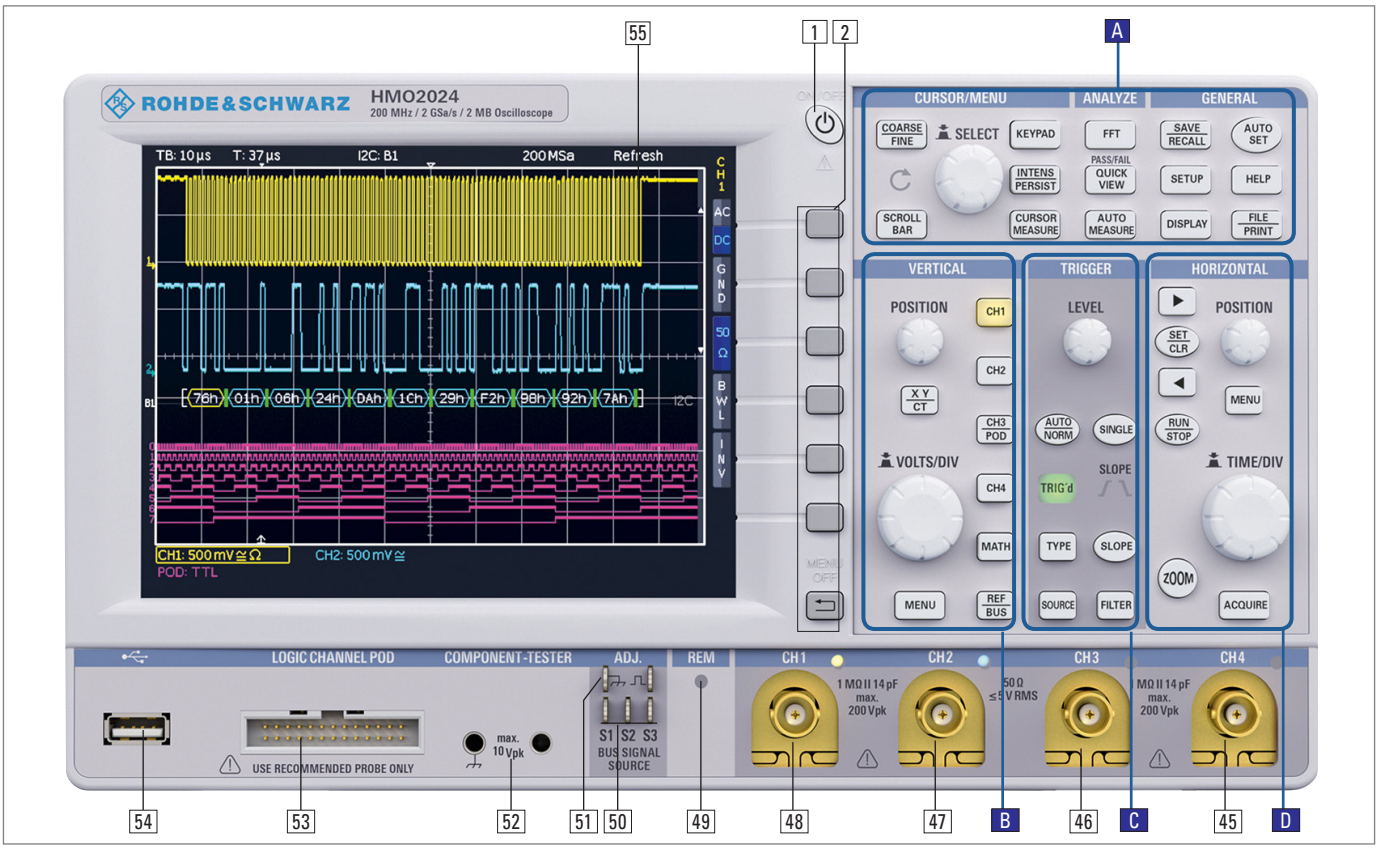

Fig. 2.1: Frontview of the R&S®HMO2024

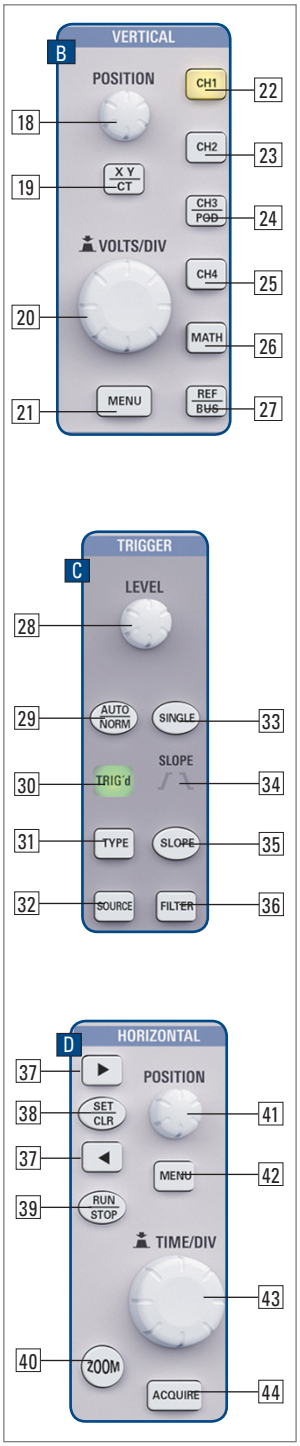

Fig. 2.3: Control panel of section B, C and D

Section B

The VERTICAL section features all controls for analog channels, such as the position control knob [18], the XY and component test mode [19], the vertical gain adjustment knob [20], the advanced menu options key [21], the channel select keys [22] to [25], (the two-channel versions have only [22] [23]) and the selection key for the optional logic probes [24] ([25]). You can also access the MATH key [26], the reference signal settings and bus signal settings key [27] .

Section C

The TRIGGER section includes all options to set the trigger level [28], to switch between Auto and Normal mode [29], to set the trigger type [31], the source [32], the single trigger [33], to switch the trigger slope [35] and to set the trigger signal filters [36] . Additionally, you can find status indicators, and you can see if a signal fulfills the trigger conditions [30] and which slope is used [34].

Section D

In the HORIZONTAL section, users can shift the trigger position horizontally or set and navigate markers manually, either step-by-step with the keys [37] [38] [39] or alternatively by using the smaller one of the knobs [41]. In the menu, you can also set search criteria for events. The illuminated key [39] allows the selection of the Run and Stop mode. When the stop mode is selected, the key will light up in red. [40] activates the zoom option, [44] selects the acquisition modes, [43] adjusts the time base speed and [42] enables access to the time base menus. To the left of the control panel, you also find the soft menu keys [2] to control the menu options.

2.3 Screen

The R&S®HMO Compact series is equipped with a 6.5" (16.51 cm) TFT color monitor with LED backlight and VGA resolution (640x480 pixels). In the default setting (no menus shown), the screen includes 12 scale divisions on the time axis. If menus are shown, this will be reduced to 10 divisions. Small arrows on the left of the display [1] indicate the reference potentials of the channels. The line above the graticule includes status and settings information such as time base, trigger delay and other trigger conditions, the current sampling rate and the acquisition mode. [2]. The short menu to the right of the graticule contains the most important settings of the currently active channel. You may select these settings using the soft menu keys.[3].

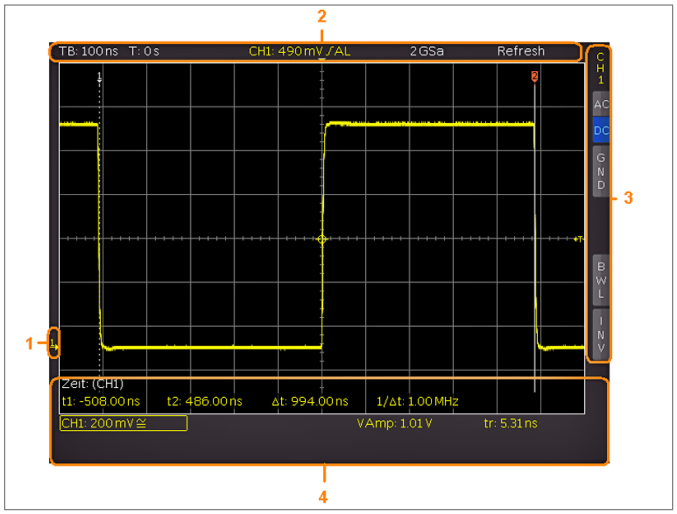

Fig. 2.4: Screen view

Measurement results for automated measurements and cursors, settings for the activated vertical channels, reference signals and mathematically derived curves are shown in the lower section of the screen [4]. Within the graticule, signals of the selected channels are displayed. By default, 8 scale divisions are shown. This can be extended virtually to 20 divisions which can be displayed using the Scroll/Bar [5] key.

2.4 General concept of instrument operation

The general operating concept is based on a few key principals, recurring with various settings and functions:

- Keys that do not open a soft menu (e.g. SCROLL BAR) activate a specific function; pressing this key a second time will deactivate this function.
- Keys that open a soft menu when pressed once will close the soft menu when pressed a second time.
- Depending on the requirements, the universal knob in the CURSOR/MENU section is designed to either select a numeric value or to navigate through submenus.
- The MENU OFF key below the soft menu keys closes the current menu or switches to the next higher level.
- Pressing the appropriate key will activate a deactivated channel. If a channel was already activated, selecting another channel will change operation to the channel whose key was pressed (its LED lights up).
- If cursor measurements are activated, the COARSE/FINE key will select the cursor with the activated universal knob in the CURSOR/MENU section. This key is used to select or confirm input in all menus for alphanumerical input and for the file manager.

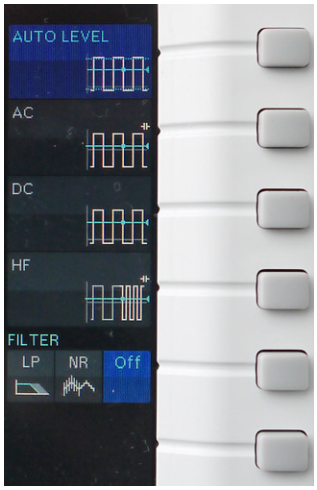

Fig. 2.5: Selection of basic soft menu elements

Fig. 2.6: Basic soft menu elements for settings and navigation

Fig. 2.7 shows, there are two basic soft menu parts. You can select the respective element by pressing the corresponding soft menu key, and the element will be marked in blue. Alternatively, you can press the soft menu key to toggle between function options. The menus are used as shown in Fig. 2.8. For functions that need to be activated and require value selections, you may toggle between OFF and the set value (e.g. DC OFFSET function). The round arrow in the menu window indicates that the value is to be set by means of the universal knob in the CURSOR/MENU control panel. If the respective function includes an additional menu level, it will be indicated by a small triangle on the bottom right of a menu item. If additional menu pages are available, you can navigate these on the same level by using the last menu item. It includes the number of menu pages on this level as well as the current page number. You can advance to the next page by pressing the appropriate soft menu key. Once the last page was listed, the display will loop back to the first page.

2.5 Basic settings and integrated help

You can access important basic settings such as language for user interface and help, general settings and interface settings in the menu that opens when you press the SETUP key in the GENERAL section. On the first page of the menu for the basic settings you can select the language for user interface and help. The menu item INTERFACE activates the menus to perform the interface configuration (USB or Ethernet). The menu item PRINTER includes settings for POSTSCRIPT and PCL compatible printers. When pushing this soft menu key, a submenu opens allowing the user to select the paper format and color mode. Using the assigned soft menu key, the top menu item PAPER FORMAT allows you to choose from A4, A5, B5, B6, Executive, Letter and Legal in either portrait or landscape format. Use the universal knob in the CURSOR/MENU section to select the appropriate format. Following the same setup procedure, the menu item COLOR MODE allows you to choose between Grayscale, Color and Inverted. The Grayscale mode converts the color image to a grayscale image which can be printed on a black-and-white postscript printer. The Color mode prints the image in color as shown on the screen (black background). The INVERTED mode prints the color image with a white background on a color printer thus saving toner and ink.

When using the INVERTED mode, you should set the intensity of the signals to about 70% to allow a high contrast print.

The menu item DEVICE INFORMATION opens a window with detailed information on hardware and software of the measuring instrument. The soft menu key DEVICE NAME allows you to define a name with up to 19 characters which will be listed when screenshots are printed. The soft menu MENU allows you to select whether soft menus are to be closed manually or automatically after 4-30s. Use the soft menu key LOGO IN SCREENSHOT to determine whether the R&S logo displays on the top right corner of printouts or not. The soft menu UPDATE for the instrument and help update and LICENCES to upgrade software options will be described in detail in the following chapters. The soft menu DATE & TIME is used to set the date and time. The soft menu SOUND is used to set the sound options. You can activate a sound as beeping during setup, in the event of an error and for the triggers. The integrated help can be activated by pushing the HELP key in the GENERAL section. This opens a window with explanatory text. The text in the

Differences within the HMO Compact series 72x...202x					
Unit	**Channels**	**Bandwidth**	**Vertical Settings at 1MOhm**	**Input Impedance**	**Offset Range**
R&S®HMO722	2	70MHz	1 mV. to 10V/Div	1 MOhm	-
R&S®HMO724	4	70MHz	1 mV. to 10V/Div	1 MOhm	-
R&S®HMO1022	2	100MHz	1 mV. to 10V/Div	1 MOhm	-
R&S®HMO1024	4	100MHz	1 mV. to 10V/Div	1 MOhm	-
R&S®HMO1522	2	150MHz	1 mV to 5 V/Div	1 MOhm / 50 Ohm	±0.2 to ±20 V
R&S®HMO1524	4	150MHz	1 mV to 5 V/Div	1 MOhm / 50 Ohm	±0.2 to ±20 V
R&S®HMO2022	2	200MHz	1 mV to 5 V/Div	1 MOhm / 50 Ohm	±0.2 to ±20 V
R&S®HMO2024	4	200MHz	1 mV to 5 V/Div	1 MOhm / 50 Ohm	±0.2 to ±20 V

For the complete and latest technical data of each oscilloscope of the HMO series please refer to www.rohde-schwarz.com

Tab. 2.1: Differences HMO Compact series

3 A quick introduction

The following chapter is intended to introduce you to the most important functions and settings of your new oscilloscope in order to allow you to use the instrument immediately. The internal calibrator signal output is used as the signal source, so you will not need any additional instruments for the first steps.

3.1 Setting up and turning the instrument on

Fold out the feets completly so the display will be inclined slightly upwards. (See chapter 1.2 for positioning) Plug the power cord into the rear panel connector. The instrument will be turned on by switching on the main power switch on the back and pushing the key On/Off [1] on the front panel. After a few seconds the display appears, and the oscilloscope is ready for measurements. Now press the key AUTOSET [15] for at least 3 seconds.

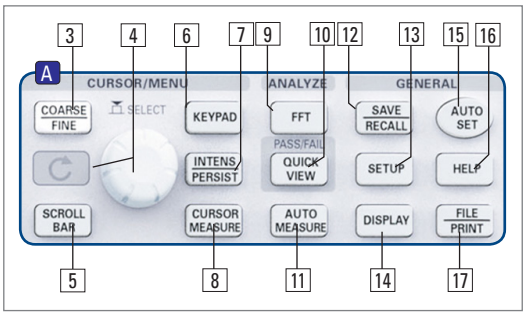

Fig. 3.1: Control panel A of the HMO

3.2 Connection of a probe and signal capture

Passive probes be compensated prior to first use. Please refer to the probe manual for the proper compensation procedure. Place the probe in the appropriate position on the ADJ. output such that the tip will be accepted by the hole of the right output while the ground connection is made to the left output, as shown in Fig. 4.3 in chapter 4.

Take one of the probes delivered with the instrument, detach the protective cap from the top. Apply the compensation box to the BNC connector of channel 1 and turn the black knob CW until it latches positively.

Active settings are marked in blue!

On the right hand side of the screen you will see a short menu of channel 1, the soft keys allow you to select frequently used settings. Press the top soft key once to change the input coupling to DC.

Now press the key AUTOSET [15] once shortly, after a few seconds the oscilloscope will have automatically selected

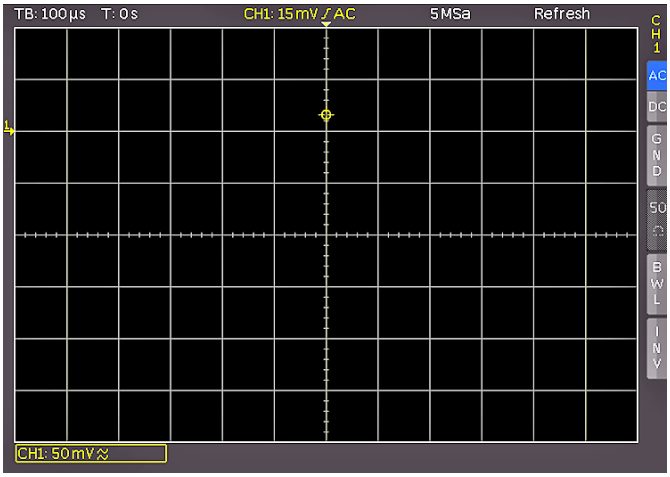

Fig. 3.2: Screen display after connection of the probe

appropriate vertical, horizontal time base and trigger settings. You will see now a square wave signal.

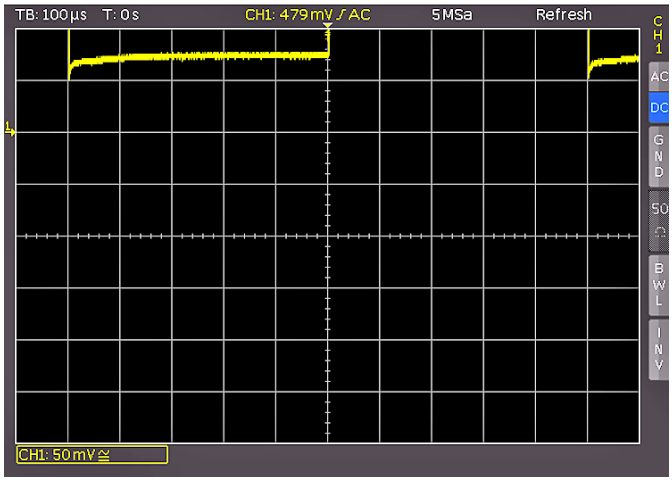

Fig. 3.3: Screen display after changing to DC coupling

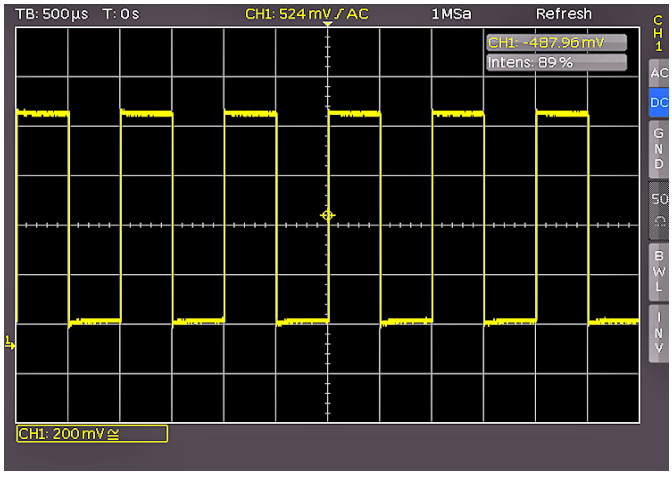

Fig. 3.4: Screen display after Autosetup

3.3 Display of signal details

With the knob [43] you can change the displayed time window: turning it CCW will slow the time base. The memory depth of 1 MB per channel allows you to capture wide time windows with high resolution. Continue to turn the knob CCW until you read „TB:5ms“ in the top left corner. Now press the ZOOM key [40].

You see now a two-window display: the display will show in the top area the complete captured signal, below an enlarged portion. Use the time base knob to select the zoom factor and the small knob for horizontal positioning.

By pressing the ZOOM key [40] again the zoom mode be will be deactivated.

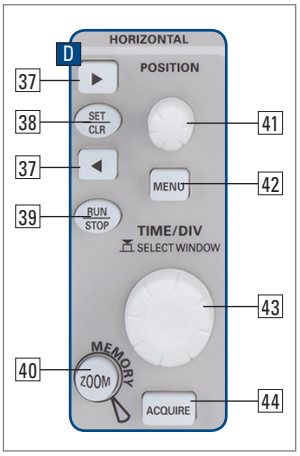

Fig. 3.5: Area of the control panel containing the ZOOM knob

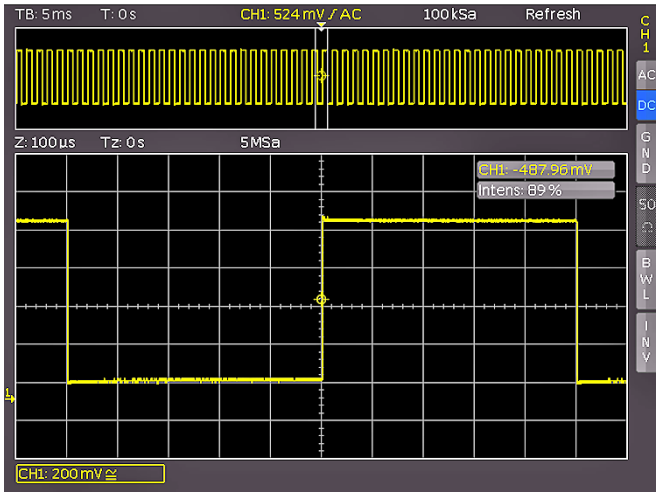

Fig. 3.6: ZOOM function

3.4 Cursor measurements

After displaying the signal and its details we now proceed to measuring it using the cursor functions. Press again shortly AUTOSET [15] and then the CURSOR/MEASURE key [8]. Now the cursor menu will open up, and you can select the kind of cursor. Press the top soft key in order to open the appropriate menu. Use the knob in the CURSOR/MENU area for the selection by turning it CCW until the V-marker is underlined, press the universal button or wait for some seconds in order to accept the selection. Now two cursors will be displayed along with the signal, and the measurement results in the bottom area of the grid. Select the active cursor by pushing the universal knob and position it by turning the knob.

The cursor measurement results will be displayed at the bottom of the grid. In this case the V-marker has selected the voltages at the two cursor positions, their difference, and the time difference between the positions will be shown. The cursors will be switched off by pressing the CURSOR/MEASURE key and the associated Cursors off soft key.

3.5 Automatic measurements

In addition to cursor measurements the most important signal parameters can be displayed.

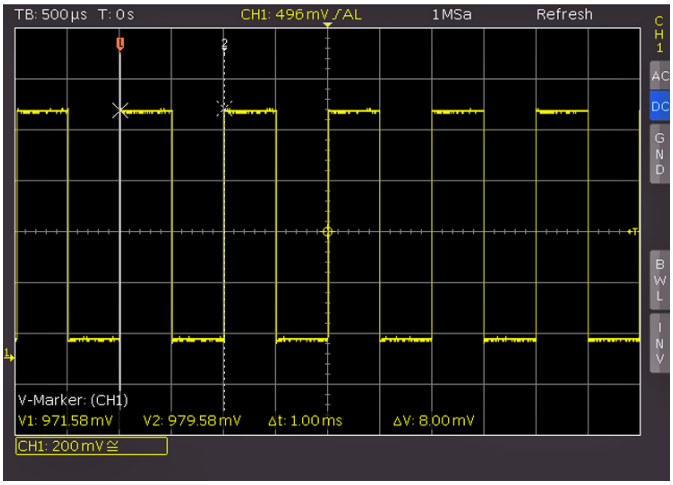

Fig. 3.7: Cursor measurements

Your oscilloscope offers these possibilities:

- the definition of the display of 6 parameters which may come from different sources
- a quick view of all important parameters of one source using the Quick View function.

Please change the time base to 100 µs per scale division and press the QUICKVIEW [10] key. You will see the following display:

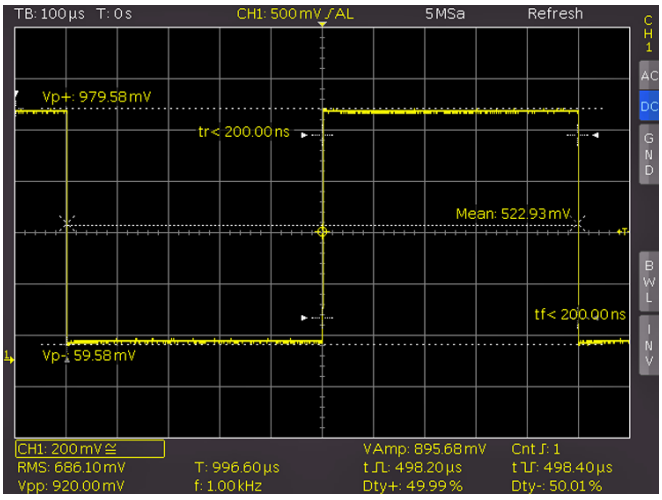

Fig. 3.8: Quick View parameter measurement

The following list features the most important parameters of a signal:

- positive and negative peak voltages,
- rise and fall times,
- mean voltage.

10 additional parameters are shown below the grid:

- RMS,
- frequency,
- amplitude,
- pos. pulse width,
- pos. duty cycle,
- peak-peak voltage,
- period,
- number of rising edges,
- neg. pulse width,
- neg. duty cycle.

Thus by simply pressing a key you see 14 parameters at a glance which characterize the signal. This function applies always to the acutal active channel.

You may also display up to six parameters of different signals. In order to achieve this deactivate the Quick View function by pressing the key again, then activate channel 2 by pressing the CH2 key. Open the following menu by pressing AUTOMEASURE [11]:

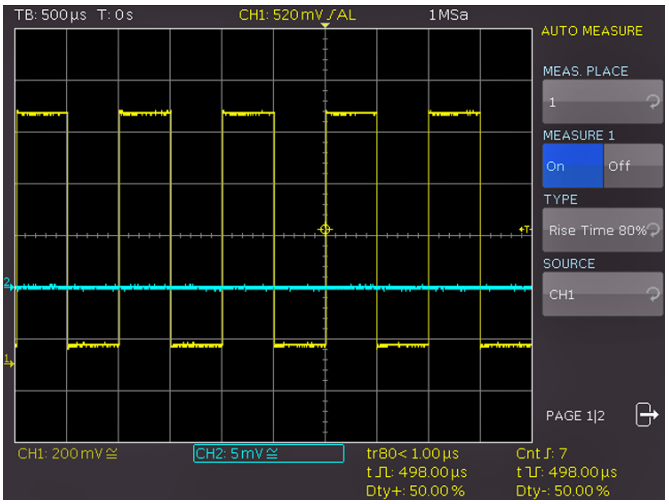

Fig. 3.9: Auto Measure menu

Press the softmenu key beside MEAS. PLACE and choose the number you want using the universal knob. You may define the parameter measurement using this menu. After switching on the MEASUREMENTS with the appropriate softkey's the parameter measurements are displayed below the grid. If you press the softkey beside TYPE you can choose the parameter you want from the list using the general knob. This procedure is used in all menus where choices are available. Please press the key TYPE and choose rise time.

Choose MEAS. PLACE 1 and use „mean" and source CH1. Afterwards choose MEAS. PLACE 2 and „rms" from CH2. On page 2 of this menu you can switch on a complete sta-

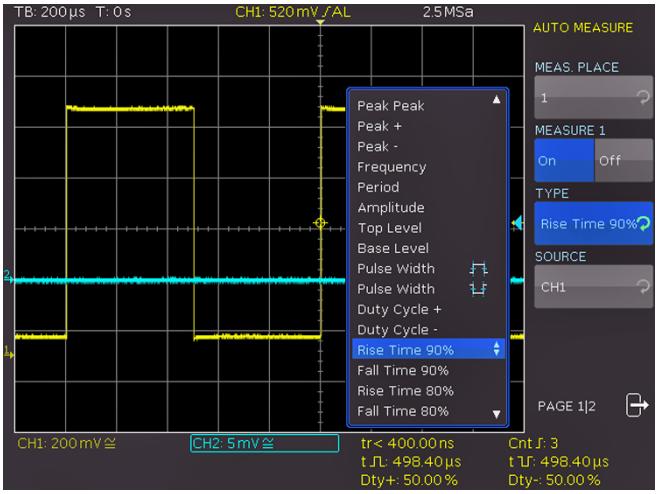

Fig. 3.10: Selection of parameters

tistic of these measurements, containing the actual value, the smallest, the largest, the mean, the standard deviation and the number of used measurements for that statistic. After the menu has been closed, the parameters can be identified by the colours of the respective channels, (here yellow for channel 1 and blue for channel 2.)

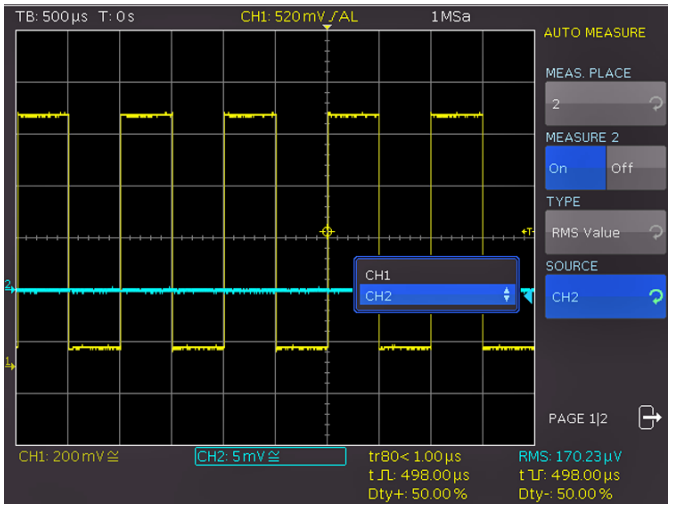

Fig. 3.11: Measuring the parameters of two sources

3.6 Mathematical functions

In addition to cursor and automatic measurements, your HMO can also apply mathematical operations to the signals. Pressing the MATH [26] key and the QM resp. the MENU key in the VERTICAL section opens a quick math

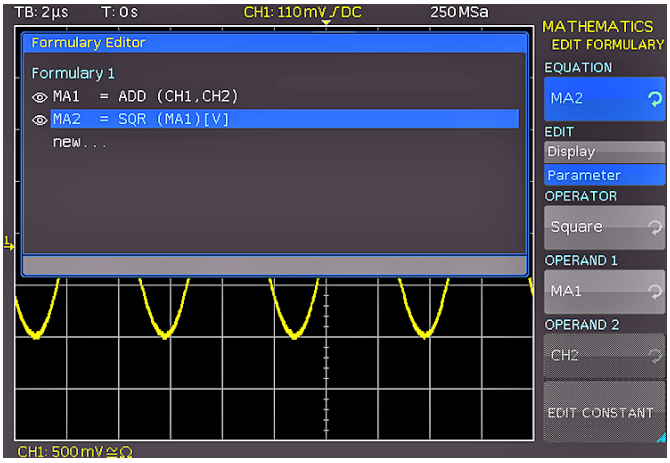

Fig. 3.12: Formula editor

menu (QM) enabling you to apply addition, subtraction, multiplication or division to two analog channels. This also displays the mathematical graph. The top soft menu key allows you to select the first operand. With the key below, you can select the operator (in quick mathematics you can choose between addition, subtraction, multiplication or division). The soft menu key below that allows you to select the second operand. Only activated and displayed channels are available for the operands. Press the bottom soft menu key FORMULARY. This opens the formula editor to select and define 5 potential sets of formulas with up to 5 mathematical functions each.

To change the settings, use the soft menu keys and the universal knob [4]. Here you can define and store the most frequently used formulas. After selecting the desired formula and pressing the soft menu key EDIT, you can edit individual formula functions. Once a mathematical function has been defined and activated by pressing the soft menu key VISIBLE (ON), the short menu for the mathema-

tical functions will display this function. The graph will be marked in the short menu by a red dot. The sources selected in the function must be activated so that the mathematical graph can be calculated and the result signals can be displayed.

3.7 Storing data

Your HMO can store 5 different kinds of data:

- Instrument settings
- Reference signals
- Signals (up to 24000 points)
- Screen displays
- Sets of formulae

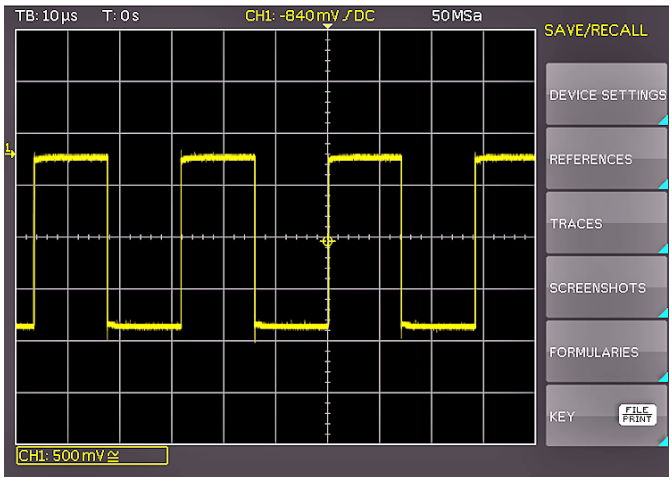

Fig. 3.13: Save/Recall menu

Signals and screen displays can only be stored on USB sticks. All other data can be stored either on a USB stick or in the instrument's non-volatile memories. In order to store data you have to define the kind of data and the destination. First attach a USB stick to the front panel connector. Press SAVE/RECALL 12 in order to call the respective menu. Select the kind of data by pressing the respective soft key (in this example Screenshots) in order to access the settings menu.

Please verify that the USB connector into which you plugged the USB stick (front or rear) is written in the top soft menue (You can change the destination by opening the respective menu if you press the softkey next to STORAGE). You can now save a screenshot if you press the softkey next to SAVE using the predefined name written in the menu below FILE NAME. You may name the destination memory with up to 8 characters; in order to do this select the menu item File name and define the name by using the universal knob (selecting a character by turn the knob and enter by pushing the knob .

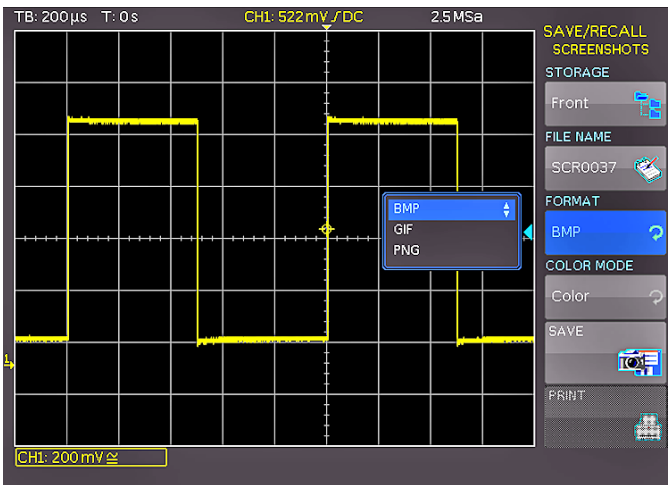

Fig. 3.14: Menu Screenshots

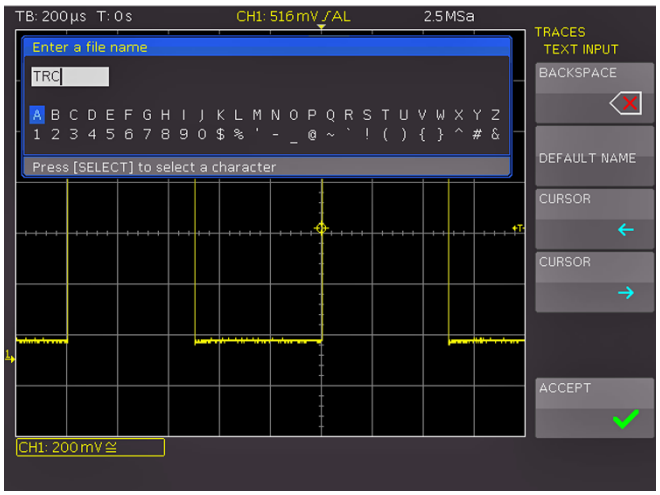

Fig. 3.15: Defining a file name

After the soft key next to ACCEPT was pressed the oscilloscope will have stored the name and return to the settings menu. Here you can now store the actual screen display by pressing the Store soft key. Alternatively, you can return to a lower menu level (by pressing the lowest Menu OFF key) and select the menu item key FILE/PRINT. In the following menu press the soft menu key next to Screenshots: this will assign the function screenshot to the key FILE/PRINT with the settings chosen. This enables you to store a bit map file on your USB stick by just pressing FILE/PRINT 17 at any time and in any menu.

4 Vertical system

For the vertical settings there are the knobs for the vertical position and the sensitivity, an always visible short menu and an extended menu.

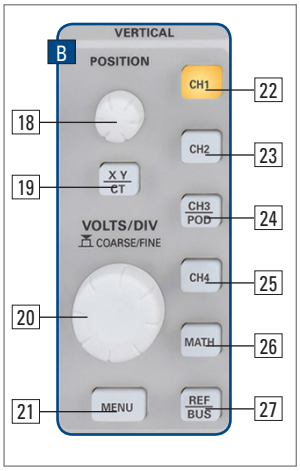

Fig. 4.1: Front panel area with vertical system controls

By pushing the respective key the channel will be selected for which these controls will be activated, this will be indicated by the key lighting up in the color of the channel. Additionally, the channel number on the screen will be framed and displayed lighter than the channels not activated. The appropriate short menu is always visible, the extended menu will be shown upon pushing the key MENU 21 .

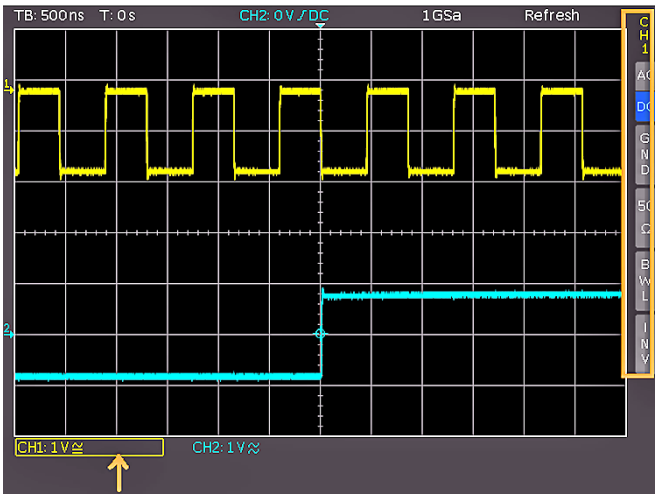

Fig. 4.2: Short menu for the vertical settings

4.1 Coupling

The first item to be selected is the input impedance: 1 MΩ or 50 Ω. (only at the HMO152x and HMO202x, the HMO72x and 102x does not offer 50 Ω inputs).

Do not connect the 50 Ω inputs to effective voltage higher than 5 volts!

The 50 Ω input impedance should only be selected if the signal source is 50 Ω, such as a generator with a 50 Ω output where the termination within the scope is to be used. In all other cases 1 MΩ is to be selected. Next DC or AC coupling has to be selected: with DC coupling all components of the signal will be displayed, with AC coupling the DC content will be removed, the lower bandwidth is 2 Hz. Up to 200 V_{rms} may be applied directly to the vertical inputs if 1 MΩ is selected. Higher voltages can be measured with probes (up to 40 kV_p). For general applications the probes supplied with the instrument will be used. They are specified for the 1 MΩ input. With the HMO72x and HMO102x are the HZ154 delivered, which offer a 10:1 / 1:1 switchable attenuation. Therefore the attenuation setting must be done manually in the channel menu. The HMO152x and HMO202x are delivered with the HZO10 a 10:1 probe with automatic attenuation read out, which will be read from the probe and factored in.

The passive probes must be adjusted to the inputs to which they are connected. See the probe manual for the adjustment procedure.

The PROBE ADJUST output of the HMO oscilloscope is only suitable for 1:1 and 1:10 probes. 100:1 or 1000:1 probes require special generators! Use the shortest possible ground connection to the PROBE ADJUST output as shown in Fig. 4.3.

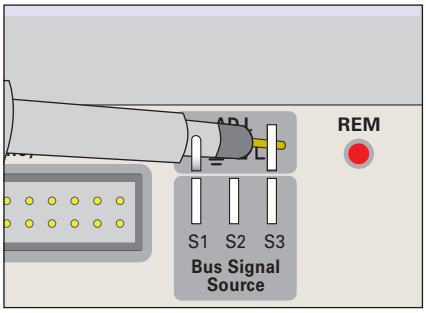

Fig. 4.3: Correct connection of the probe to the probe adjust output

The coupling is selected in the short menu: by just pushing the appropriate key the coupling is chosen, also the signal may be inverted. The menu is valid for the activated channel as indicated by the channel key light up. The channel number will be shown in the top of the menu. By pushing the respective key of another channel the menu will transfer to this channel.

4.2 Sensitivity, Y-Positioning, and Offset

The sensitivity of the analog inputs can be selected with the large knob in the VERTICAL section of the front panel in 1-2-5 steps from 1 mV/div to the respective maximal setting independent of the 50 Ω (only available at the HMO152x and HMO202x) or 1 MΩ selection. The knob is

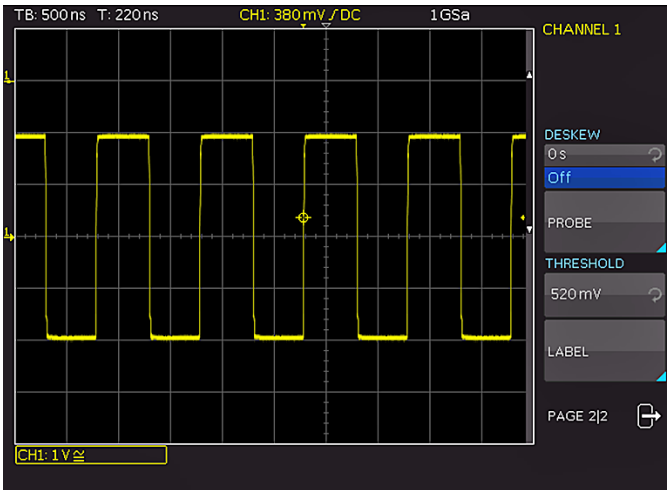

Fig. 4.4: Vertical offset in the extended menu

associated with the channel selected by pushing the respective key. The sensitivity can be changed to continuous control by pushing the knob once. The smaller one of the knobs is used for vertical positioning.

By pushing the MENU key the extended menu is called. On page 2 of this menu at the HMO152x and HMO202x a DC offset can be added to the signal. In order to switch this offset in the respective soft key must be pushed. The settings window will be backlit in blue, and the activity indicator next to the general knob will light up; the offset can now be adjusted with the knob. The offset voltage will be added to the signal at the vertical amplifier input offsetting it by that amount from the zero position. The possible amount of offset depends on the Volts/div setting chosen. The offset function being activated will be indicated by two channel markers on the left of the display, also visible if the menu was closed. One marker indicates the position, the other the offset (refer to Fig. 4.4). The offset is individually adjustable for each channel.

Each analog channel may also be shifted in time by ±15 ns. This adjustment is selected in the same menu and according to the same method as the DC offset; it is used for compensating for the different signal delays of voltage and current probes and different cable lengths.

4.3 Bandwidth Limit and Signal Inversion

An analog 20 MHz low pass can be inserted in the signal path in either the short or extended menu. This will eliminate all higher frequency interference. The filter is activated in the short menu by pushing the respective soft key; the information field will be backlit in blue, BW will be displayed in the channel information window.

Signal inversion is available in the short and the extended menus. If it is activated the information field will be backlit in blue, and there will be a bar above the channel number.

4.4 Probe attenuation selection

The HZO10 or optinal HZ355 probes are recognized by the instrument which automatically selects the appropriate factor. If any other probe without automatic recognition of the attenuation ratio or just a cable is connected to the instrument, the attenuation factor can be set manually in the extended menu. This is possible for x 1, x 10, x 100 x 1000 or as defined by the user from x 0.001 to x 1000.

In addition you can select the unit AMPERE in case you are using a current probe or measure current via a shunt. If you select A the menu shows the most common factors (1 V/A, 100 mV/A, 10 mV/A, 1 mV/A). Again you can also select any value between defined by the user. Doing so the measurements are always displayed with the correct unit and scale.

4.5 Level Setting

In this menu a level can be set. This level define the threshold for detecting a HIGH or a LOW if the analog channel are used as source for the serial bus analysis or logic trigger. After choosing the softmenu, the level can be set by turning the universal knob.

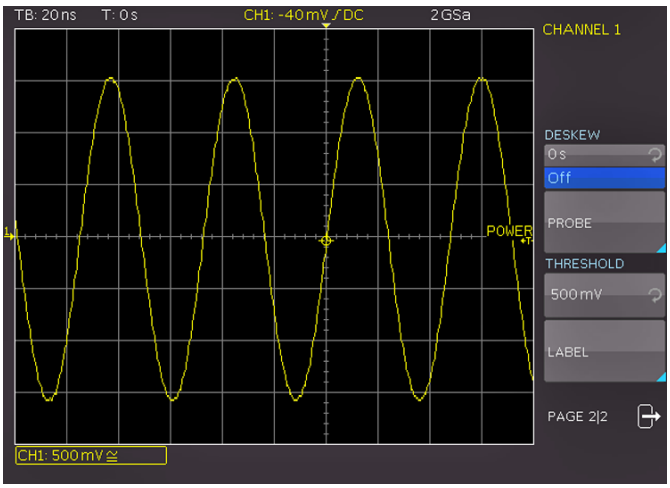

Fig. 4.5: Threshold setting and name allocation

4.6 Name a channel

The last entry of the channel menu open a submenu in order to allocate a name for a channel. This name will be shown at the display and at a print out. First of all you can switch on or off the display of the name. Below that softmenu button you find the soft button LIBRARY. After selecting this button you can choose a name from several different suggestions using the universal knob. After pushing NAME you can edit the pre-choosen name or enter a complete new name using up to 8 characters. This will be done by selecting the character from the virtual keypad using turning the universal knob and selecting by pushing the knob. Pushing the ACCEPT button switch on the name display on the right side of the grid. The name is fixed to the channel and will move over the screen whenever the channel will be moved.

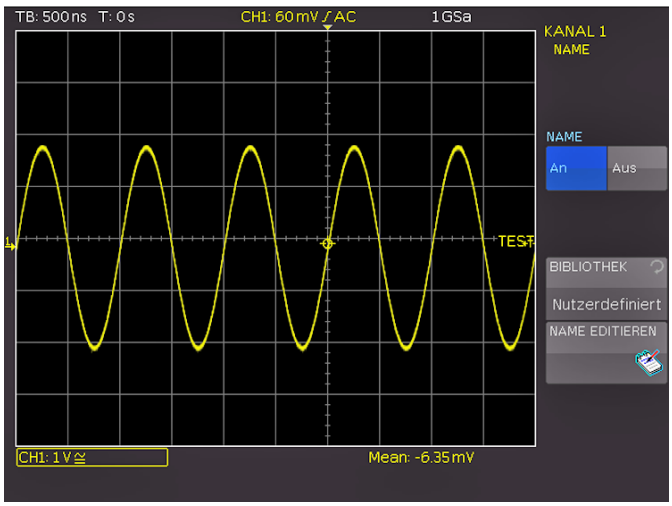

Fig. 4.6: Name selection

5 Horizontal System (Time Base)

As well as time base settings, the horizontal system comprises the selection of the trigger position, the zoom functions and the available modes of signal capture, the control for the marker function and the search fcuntions.

The knobs are used for the adjustment of the time base speed and the trigger position. The signal capture modes are selected in the respective menus. There is a key provided for activating the zoom function.

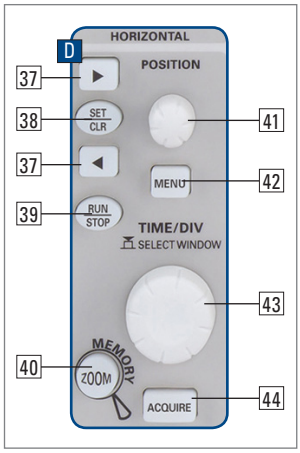

Fig. 5.1: Control panel of the horizontal system

5.1 Capturing modes RUN and STOP

The capturing modes can be selected with the key RUN/STOP. In RUN mode signals will be continuously captured; depending on the trigger conditions selected, and displayed, erasing the previously captured ones. If it is desired to store and further analyze a signal and to prevent it being overwritten, capture must be stopped by pushing the RUN/STOP key. While in STOP mode capture is disabled and the key will light up red.

5.2 Time base adjustments

The large knob in the Horizontal section of the control panel is used for the selection of the time base speed. The time base speed is displayed in the upper left hand corner above the graticule. (e.g. „TB:500 ns“) To the right there is the display of the trigger time position with respect to the normal position. The normal trigger position is in the center of the graticule such that 50 % of the signal display is before and 50 % is after this trigger position. The X Position knob allows continuous adjustment of the X position. The available maximum values depend on the time base setting. By pushing the key SET/CLR the value will be reset to its reference position. The arrow keys ◀ ▶ 37 allow you to change the X position by a fixed amount of 5 divisions in the respective direction. If marker or search function is chosen the arrow keys together with the SET/CLR button are used to navigate through and set/clear marker. The key menu opens a menu which allows you to set the X position to its minimum and maximum positions or chose the marker function by just a key touch. In addition, there is a submenu NUMER.INPUT which allows entry of an arbitrary X position. Within this menu the search functions can be activated and set. In addition the time reference can be set here (position for the trigger point in time, from -5 to +5 divisions, 0 is the middle of the screen and the standard setting).

5.3 Capture modes

The capture modes are selected by pushing the key ACQUIRE, this opens a display menu which offers the basic modes of capture:

5.3.1 Refresh

In this mode the signals are captured and displayed.

5.3.2 Roll

This acquisition mode is intended specifically for very slow signals, with the untriggered signal „rolling“ across the screen from right to left (requires signals slower than 200 kHz). The HMO uses a ring buffer to store the signal values in roll mode. Simply put, the instrument writes the first division to the first storage space, the second division to the second storage space, etc. Once the storage is full, the instrument overwrites the first storage space with the data of the most recent measurement value. This creates a „ring“ or cycle run, similar to a ticker.

The ZOOM feature is not available in the roll mode (also refer to Chap. 5.5 ZOOM Function)

5.3.3: ENVELOPE

In this mode, the display includes the normal capture of each signal and the maximum as well as the minimum values of each capture. Over time, this creates an envelope surrounding the signal.

5.3.4: AVERAGE

In this mode, you can use the universal knob in the Cursor/Menu section of the control panel to set the number of signal periods for averaging, available in powers of 2 from 2 to 1024 (requires repetitive signals).

5.3.5: FILTER

In this mode, you can activate a low pass filter with adjustable cut off frequency to suppress unwanted high frequency interferences. The cut off frequency can be set based on the sampling frequency. The minimum setting is 1/100 of the sampling frequency and the maximum value is 1/4 of the sampling rate. You can select this setting with the universal knob.

The second menu page is accessed by pushing the soft key next to the menu „Page 1I2“, here, extended functions are available:

5.3.6 Peak Detect

This mode is used for very large time base settings to detect even short signal changes. You can also deactivate this function within the menu or you can select the automatic switching mode. The following conditions must be met to activate the PEAK DETECT mode:

- Function HIGH RESOLUTION is deactivated
- None of the serial or parallel buses are active

the maximum value, for instance. You can use the soft menu key TIME REFERENCE to define where in the signal window to find the trigger point value “0”. The signal is scaled by this reference point. You can use the universal knob in the Cursor/ Menu section to select the desired setting.

5.7 Marker Function

Markers allow you to highlight specific positions on the screen, e.g. a rising or falling slope, an unexpected signal value or a search result. Markers can be used to identify specific signal sections to zoom in on and to analyze the data more closely.

Use the soft menu to activate the marker function. Press the MENU key in the HORIZONTAL section of the control panel to open the soft menu. Use the universal knob in the menu to select MARKER. Once this mode is activated, you can press the SET/CLR key to set a time marker at the 6th time unit (the menu in the center of the grid must be deactivated). The time markers are marked by a vertical line in gray-blue. The knob X Position allows you to move the signal including the set marker. After identifying an important signal position and setting it to the center of the screen using the position knob, you can set an additional marker. This procedure allows you to mark up to 8 interesting positions within the signal. You can toggle between markers by pressing the arrow keys ◀ ▶ 37. These keys also allow you to center the markers in the middle of the screen. This feature enables you to quickly compare marked signal sections in ZOOM mode.

To delete a marker, center it in the middle of the screen and press the SET/CLR key once again. You can also delete all time markers simultaneously in the marker soft menu.

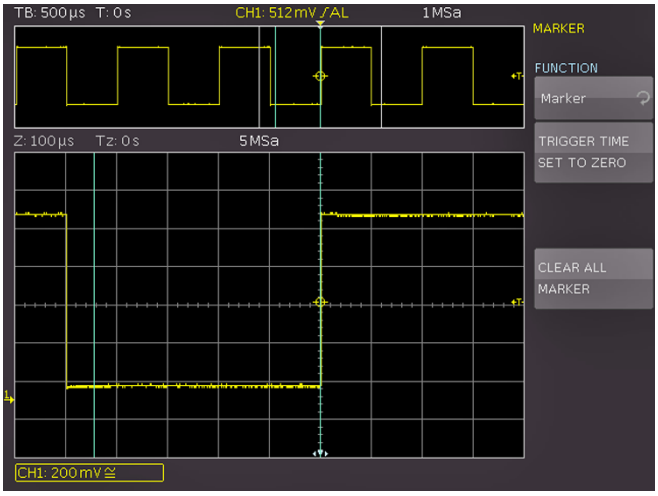

Fig. 5.6: Marker in zoom mode

5.8 Search Function

The search function in the HMO series enables you to search for all slopes, pulse widths, peaks or additional events in the detection mode that match the manually specified search criteria. Specific settings are available for each search type. Searches can be performed on any analog channel or mathematical signal. The searched time base section can be restricted by defining a level.

Press the MENU key in the HORIZONTAL section of the control panel to activate the search function in the soft menu. Use the universal knob to select the menu item SEARCH. Once this mode is activated, you can define events, e.g. a rise time with specific attributes, such as <12 ns. The search function will then look for these events in STOP mode in the most current capture. Press the menu item SEARCH TYPE and use the universal knob to select the desired search criteria.

The following functions are available:

- **Slope:** Comparable to the slope trigger; this function searches for slopes in the signal. The point in time of a detected slope corresponds to the point in time when the signal leaves the set hysteresis. The soft key LEVEL selects a level for the slope detection of the search function. The search function level matches the trigger level of the slope trigger, for instance. Level and hysteresis will display in the signal window. The hysteresis determines the area that the signal has to pass until a valid slope is detected. This area also defines the rise time of the slope. It is recommended to select a sufficiently large hysteresis to reduce noise on the signal slope.
- **Pulse width:** Comparable to the pulse width trigger; this function searches for pulses with a predetermined pulse width. A pulse always consists of a rising and a falling slope. Leaving the hysteresis defines the start and end time of the pulse. The level for the search function corresponds to the trigger level of the slope trigger, for instance. Level and hysteresis will display in the signal window. The adjustable comparison type is a search criterium for the detected time event width. The pulse width is the time period between start and stop slope of the pulse.
- **Peak:** The peak search function searches for pulses within the signal. The time of the event is the maximum value of the peak.
- **Rise time / fall time:** This function searches for slopes with a specific rise/fall time within the signal. The point in time of a detected slope corresponds to the point in time when the signal leaves the set hysteresis. The upper and lower level define the upper/lower position of the hysteresis. The adjusted level will display in the signal window. The adjustable comparison type is a search criterium for the detected time event width.
- **Runt:** A runt is an aborted pulse within a signal. This occurs when the rise times of the system are greater than necessary for the desired pulse width. A positive runt exceeds the lower level of the hysteresis, for instance, but does not reach the upper level. The analyzing digital circuits of this signal fail to detect the pulse which leads to transmission errors. The pulse width of the runt is defined by the entry and exit point from the hysteresis (duration between start and stop slope of the pulse). The adjustable comparison type is a search criterium for the detected time event width. The difference defines the maximum time range by which the specified event width may vary.

Once you have selected the appropriate search type, you can choose the desired SOURCE (choose from any of the activated analog channels including mathematical channels). Use the menu item SETUP to open a submenu where you can choose the settings for the selected search criterium (e.g. greater than a specific pulse width). Some of the adjustable parameters may be dependent on the time base (for a time base of 100 µs/Div the smallest time is 2 µs, for 1 µs/Div the corresponding time value is 20 ns). If events match the search criterium, they will be highlighted. The soft menu VIEW EVENT TABLE allows you to display the search results in a table format. Use the arrow keys or the universal knob to navigate the events in STOP mode. The Select option allows you to center the selected event. When the zoom function is activated, the selected event will automatically be centered in the zoom window.

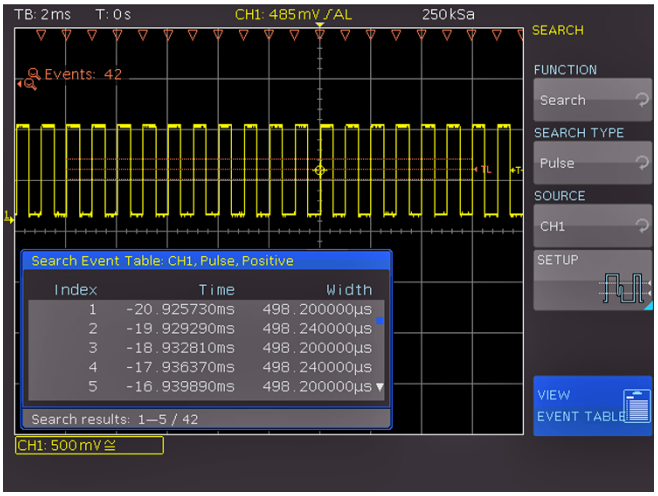

Fig. 5.7: Search mode with event list

6 Trigger System

The trigger system of the HMO is easy to handle by just observing the concept of instrument operation.
There are 4 keys destined for frequently used functions:

- **TYPE:** selection of trigger type EDGE (EDGE A/B), PULSE, LOGIC and VIDEO
- **SLOPE:** type of slope
- **SOURCE:** determines the triggers source
- **FILTER:** determines the exact trigger conditions

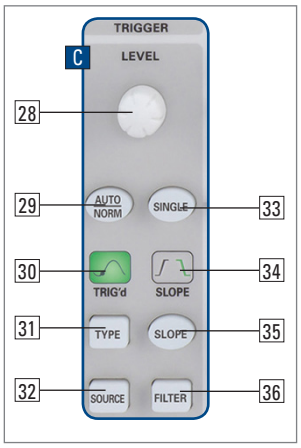

Fig. 6.1: Front panel control area of the trigger system

Additional keys are provided for the selection of the trigger modes: (AUTO. NORMAL, SINGLE).

6.1 Trigger modes Auto, Normal, Single

The basic trigger modes are directly selectable with the key AUTO NORM. In AUTO mode the key will not be lit. If the key is pushed it will light up red indicating NORMAL mode. The oscilloscope always presents a signal in AUTO mode and a signal will automatically yield a stable display if it fulfills the trigger conditions.

In NORMAL mode the signal will be displayed if it fulfills the trigger conditions, if it fails to do so the last stable triggered display will remain on the screen.

If it is desired to record a signal which fulfills the trigger conditions only once, the key SINGLE must be pushed, it will light up white. This indicates that the single trigger mode is active, the RUN/STOP key will blink. The next return of the signal will cause a single capture, the oscilloscope then goes into the STOP mode, indicated by the RUN/STOP key lighting up in red.

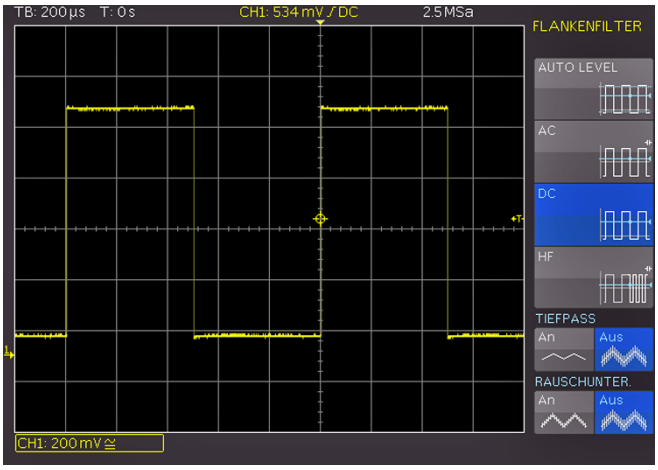

Fig. 6.2: Coupling modes with slope trigger

6.2 Trigger sources

Trigger sources are the 2 or 4 analog channels and the external trigger input. If the optional logic probe HO3508 with 8 or 16 logic channels is connected, also those up to 16 digital channels can serve as trigger sources. The soft menu key AC LINE enables you to trigger the trigger at system frequency. The trigger signal is extracted internally from the power supply.

6.3 Slope trigger

The easiest and by far the most frequently used trigger is the slope trigger. The oscilloscope triggers if slopes that were set with the SLOPE key occur within the signal selected in the SOURCE menu. The signal slope has to pass through the set trigger level.

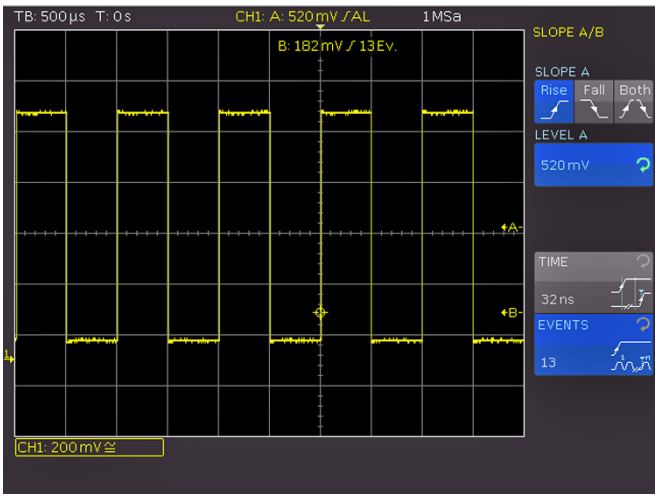

Fig. 6.3: The type B-Trigger

The trigger type Slope Trigger is selected in the Autosetup mode (AUTOSET key). If, for instance, you select the pulse trigger and press the AUTOSET key the setting will switch to Slope Trigger. The TYPE [31] key in the trigger control panel allows you to set the trigger type. This opens a menu with corresponding options. If the SLOPE type is not active (highlighted in blue), you can press the respective soft menu key to select this type. The slope type (rising, falling or both) can be set directly with the SLOPE key [35]. This will shift the setting forward by one, i.e. from rising to falling slope, to both slopes, and pressing the key yet one more time will trigger another rising slope. The center of the status line on the top of the display and the display above the SLOPE key [35] show which slope type has been selected.

The FILTER [36] key allows you to select how to couple the signal for the trigger circuit:

- **AUTO LEVEL:** Automatic filter setting (default setting).
- **AC:** The trigger signal is coupled via high pass filter with a minimum cut-off frequency of 5 Hz which suppresses the DC portion of the triggering signal. With a changing DC portion, the trigger level remains at the set point in the AC signal. The trigger type AUTO (AUTO/NORM key) includes the Peak-Peak mode which sets limits for the trigger in the AC signal. This setting means that the trigger condition will be met for any applied signal without having to set the level. For the trigger type NORM (AUTO/NORM key), the Peak-Peak mode is deactivated, allowing the trigger level to be moved past the peak values of the signal.
- **DC:** The trigger signal is coupled to the trigger circuit with all signal portions (AC and DC voltage). This has no impact on the triggering signal.
- **HF:** The trigger signal is routed via a 30 kHz (-3 dB) high pass filter. The trigger level is no longer adjustable. This mode should only be used with very high frequency signals.
- **LP (low pass)**: The trigger signal is coupled via low pass with a maximum cut-off frequency of 5 kHz. This filter removes high frequencies and is available with AC and DC coupling.
- **NR (noise reduction):** A low pass filter with a maximum cut-off frequency of 100 MHz will improve the noise performance for the trigger amplifier. This filter removes high frequencies and is available with AC and DC coupling.

The coupling types low pass and noise reduction may not be activated simultaneously.

The slope trigger can be coupled with a so called „B Trigger“. This option is available after pushing TYPE. This function allows you to adjust the trigger such that first condition „A“ must be met and then another condition „B“ before the trigger will respond (refer to Fig. 6.3).

E.g. it is possible to define a source (channel) and a level of 120 mV on the rising slope of that signal and for the second condition a level of 80 mV on the falling slope. Additionally, it is possible to define whether the B event should occur a time (min. 32 ns, max. 10 s) or a number (min. 1, max. 216) of times after the A event. The level or time or the number of events can be entered numerically with the universal knob or in a submenu. In order to do this first select the setting, then push the soft key next to NUMERIC INPUT. In the window which will open, you can enter numbers and units with the universal knob or numerical with KEYPAD button.

6.4 Pulse trigger

The pulse trigger allows triggering for specific pulse widths of positive or negative pulses or for pulse width ranges. The oscilloscope triggers if a pulse occurs within the signal selected in the SOURCE menu that matches the properties set in the FILTER menu. If a pulse fulfills the trigger conditions, the oscilloscope triggers on the trailing slope, i.e. for a positive pulse it triggers on the falling slope and for a negative pulse on a rising slope.

Activate the pulse trigger by pressing the TYPE key [31] in the trigger control panel. Press the FILTER key[36], then you can select additional settings for the pulse trigger in the soft menu.

There are 6 different options:

- **$t_i \neq t$:** The pulse width ti is unequal to the reference width t.

8 Measurements

There are two different kinds of measurements on signals: cursor measurements and automatic measurements. All results are stored in a buffer memory which is larger than the display memory. The QuickView mode delivers all available parameters of a signal curve. The integrated hardware counter shows the count results on the selected channel.

8.1 Cursor measurements

The most frequently used measurement method with an oscilloscope is the cursor measurement. This concept is oriented towards the expected results and thus provides not only one or two but in some modes, three cursors. Cursor measurements are controlled by the keys: CURSOR MEASURE and the universal knob. The kind of measurement can be defined in the menu which will open upon pushing the key CURSOR MEASURE.

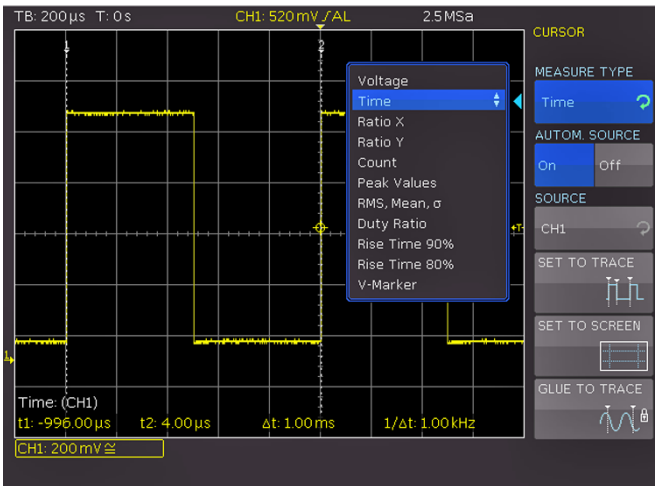

Fig. 8.1: Cursor measurements selection menu

The menu CURSOR MEASURE allows you to select cursor-based measurements for an activated signal source on the oscilloscope. The measurement source is indicated by the font color of the respective result. The results are displayed at the bottom of the screen. If “n/a” is displayed, the measurement is not applicable to the signal. For instance, this may be the case for a voltage measurement on a POD because only logic states without voltage reference are displayed here. If “?” is displayed, the display does not show a complete measurement result. For instance, the period to be measured may not display completely and can consequently not be identified.

As shown above, the selection of the kind of measurement can be done by pushing the respective soft menu key and selecting the kind of cursor measurement with the universal knob. The results will be displayed below the graticule. In order to move a cursor, select the desired cursor by pushing the universal knob and position the cursor with the universal knob. The kinds of measurements are:

VOLTAGE

This mode provides 2 cursors in order to measure 3 different voltages. The values V_1 and V_2 represent the voltages differences between the zero base line and the actual positions of the two cursors on the selected signal curve. ΔV represents the voltage difference between the cursors.

TIME

This mode provides 2 cursors in order to measure 3 different times and an equivalent frequency. The values t_1 and t_2 represent the times between the trigger and the position of the cursors. Δt represents the time between the cursors.

RATIO X

This mode provides 3 cursors in order to measure ratios in X direction (e.g. a duty cycle) between the first and the second and between the first and the third cursors. The values will be presented in 4 different formats: floating point, percent, degrees, radians.

RATIO Y

This mode provides 3 cursors in order to measure ratios in Y-direction (e.g. an overshoot) between the first and the second and between the first and the third cursors. The results will be presented in 2 formats: floating point, percent.

COUNT

This mode provides 3 cursors in order to count signal crossings of a level which can be set with the third cursor for a time span as defined by the distance between the first and the second cursors. The result will be presented in 4 different versions: number of rising and falling level crossings, number of positive and negative pulses.

PEAK LEVELS

This mode provides 2 cursors in order to measure the minimum and maximum values of a signal within the time span as defined by the two cursors. The values Vp- and Vp+ represent the minimum and maximum values of the voltage. The peak-to-peak value (Vpp) is equal to the difference between the minimum and maximum values.

RMS, MEAN, Standard deviation, σ

This mode provides 2 cursors in order to calculate the rms, the mean and the standard deviation σ values of a signal between the two cursors.

Duty cycle

This mode provides three cursors in order to calculate the duty cycle of the signal between the two horizontal cursors. The third vertical cursor will set the level at which the duty cycle is determined.

Rise time 90%

This mode provides 2 cursors in order to measure the rise and fall times between the two cursors. The rise and fall time are measured between 10% to 90% of the signal amplitude.

Rise time 80%

This mode provides 2 cursors in order to measure the rise and fall times between the two cursors. The rise and fall

time are measured between 20% to 80% of the signal amplitude.

V MARKER

This mode provides 2 cursors in order to measure two different voltages and a time span. The values V1 and V2 represent the voltages between the zero base line and the respective cursor. ΔV represents the voltage difference between the two cursors. Δt represents the time difference between them.

If the function AUTOM. SOURCE is activated (On), the currently targeted channel will be used as source for the measurement. If the setting is deactivated (Off), the channel set under SOURCE will be applied even if it is not targeted. The soft menu key SOURCE allows you to select a source for the measurement by using the universal knob. Pressing the soft menu key SET TO TRACE places the selected cursors in their optimal position on the signal curve. This allows very fast and typically optimal automatic positioning of the cursors. For the most part, only fine tuning is required at this point and the tedious major adjustments to the cursors will no longer be necessary. As previously described, the cursors can also be selected by pressing the universal knob and may be positioned by turning the universal knob. In case the automated function SET TO TRACE does not provide the anticipated results due to complex signals, you can press the key SET TO TRACE to position the cursors in a predefined starting position. This allows you to return distant cursors to the screen.

The soft menu key GLUE TO TRACE allows cursors to stay on the selected data point without changing the position in the measurement signal even if the scaling is modified (cursors will be „glued“ to the signal). This function can be activated or deactivated. If this mode is deactivated, the cursor stays in position on the screen if scaling occurs. With GLUE TO TRACE deactivated, the measured value changes while it remains unmodified when the mode is activated.

Pushing again the button CURSOR MEASURE switch off al cursors.

8.2 Auto measurements

The HMO series features cursor measurements and also various automatic measurements. These may be activated by pressing the key AUTO MEASURE [11] in the section ANALYZE of the control panel.

This menu allows you to select up to six automatic measurement functions by using the soft menu key MEAS. PLACE and the universal knob. A maximum of two measurements are possible simultaneously. These may originate from two different sources. The measurement source (soft menu SOURCE) is indicated by the font color of the respective result. The results are displayed at the bottom of the screen. If “n/a” is displayed, the measurement is not

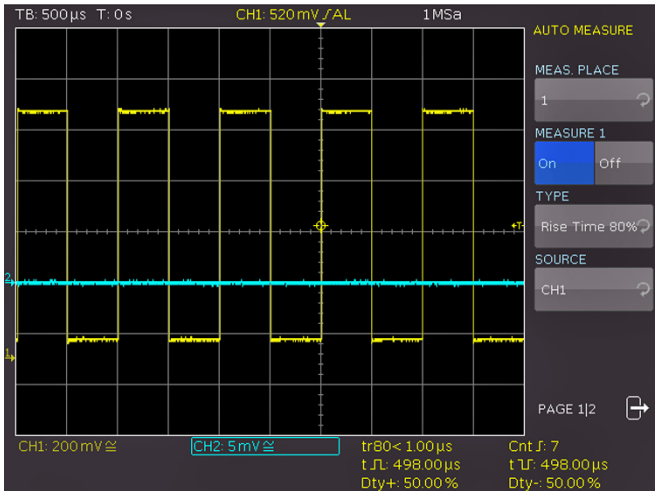

Fig. 8.2: Menu for the automatic measurements settings

applicable to the signal. For instance, this may be the case for a voltage measurement on a POD because only logic states without voltage reference are displayed here. If “?” is displayed, the display does not show a complete measurement result. For instance, the period to be measured may not display completely and can consequently not be identified.

The list of available sources only includes displayed channels (possible sources are analog, digital and mathematical channels).

The following kinds of measurement are available:

MEAN

This mode measures the mean value of the signal amplitude. If the signal is periodic, the first period on the left of the screen will be used for the measurement. The measurement will only be applied to the selected channel.

RMS

This mode identifies the effective value from the displayed view of the signal. If the signal is periodic, the first period on the left of the screen will be used for the measurement. The effective value is not applied to a sine signal will be calculated directly (so-called TrueRMS). The measurement will only be applied to the selected channel.

PEAK–TO–PEAK

This mode measures the difference in voltage between the maximum and the minimum peak value of the signal within the displayed view.

PEAK +

This mode measures the maximum voltage value in the displayed view of the screen. The measurement will only be applied to the selected channel.

PEAK –

This mode measures the minimum voltage value in the displayed view of the screen. The measurement will only be applied to the selected channel.

FREQUENCY
This mode identifies the frequency of the signal from the reci-procal value of the first signal period T. The measurement will only be applied to the selected channel.

PERIOD
This mode measures the duration of the signal period T. The period identifies the duration between two equal values of one periodically repeated signal.

AMPLITUDE
This mode measures the amplitude of a square wave signal. This mode calculates the difference in voltage between the upper and the lower level (V_{base} and V_{top}). The measurement will only be applied to the selected channel and requires a minimum of one complete period of a triggered signal.

UPPER LEVEL
This mode measures the mean voltage level of an upper square wave. This mode calculates the mean value of the slope (without overshoot). The measurement will only be applied to the selected channel and requires a minimum of one complete period of a triggered signal.

LOWER LEVEL
This mode measures the mean voltage level of the lower square wave. This mode calculates the mean value of the slope (without overshoot). The measurement will only be applied to the selected channel and requires a minimum of one complete period of a triggered signal.

PULSE WIDTH +
This mode measures the width of the positive pulse. A positive pulse consists of a rising slope followed by a falling slope. This measurement type identifies the two slopes and calculates the pulse width from their time difference. The measurement will only be applied to the selected channel and requires a minimum of one completely displayed period of a triggered signal.

PULSE WIDTH –
This mode measures the width of the negative pulse. A negative pulse consists of a falling slope followed by a rising slope. This measurement type identifies the two slopes and calculates the pulse width from their time difference. The measurement will only be applied to the selected channel and requires a minimum of one completely displayed period of a triggered signal.

DUTY RATIO +
This mode measures the positive duty ratio. In this mode, positive signal portions are identified over a specific period and will then be analyzed in relation to the signal period. The measurement will only be applied to the selected channel and requires a minimum of one complete period of a triggered signal.

DUTY RATIO –
This mode measures the negative duty ratio. In this mode, positive negative portions are identified over a specific period and will then be analyzed in relation to the signal period. The measurement will only be applied to the selected channel and requires a minimum of one complete period of a triggered signal.

RISE TIME 90%
This mode measures the rise time of the first rising slope in the displayed view of the screen. The rise time identifies the time in which the signal rises from 10% to 90% of its amplitude.

FALL TIME 90%
This mode measures the fall time of the first falling slope in the displayed view of the screen. The fall time identifies the time in which the signal falls from 90% to 10% of its amplitude.

RISE TIME 80%
This mode measures the rise time of the first rising slope in the displayed view of the screen. The rise time identifies the time in which the signal rises from 20% to 80% of its amplitude.

FALL TIME 80%
This mode measures the fall time of the first falling slope in the displayed view of the screen. The fall time identifies the time in which the signal falls from 80% to 20% of its amplitude.

σ-STD. DEVIATION
This mode measures the standard deviation of the signal amplitude in the displayed view of the screen. The standard deviation is the measurement for the deviation of a signal from its mean value. A low result indicates that the values are close to the mean value. A higher result illustrates that on average the difference between the values is greater.

DELAY
This mode measures the time delay between the set measurement source and the reference source. This mode searches for the slope of the measurement source that is closest to the time reference. Then, beginning from this point, it searches for the nearest slope of the reference source. This time difference indicates the measurement result. A submenu (DELAY SETTINGS) allows you to select the setting for measurement source, reference source and slopes.

PHASE
This mode measures the phase between two slopes of two channels in the displaced view of the screen. This mode measures the relation of the time delay between the set sources to the signal period of the measurement source. This mode searches for the slope of the measurement source that is closest to the time reference. Then, be-

ginning from this point, it searches for the nearest slope of the reference source. The time difference and the signal period indicate the measurement result in degrees. A submenu (MEASUREMENT SOURCE/ REFERENCE SOURCE) allows you to select the measurement source and the reference source.

COUNT +
This mode counts positive pulses in the displayed view of the screen. A positive pulse consists of a rising slope followed by a falling slope. The mean value is calculated from the amplitude of the measurement signal. A slope will be counted if the signal runs through the mean value. A pulse that passes the mean value only once will not be calculated. The measurement will only be applied to the selected channel.

COUNT –
This mode counts negative pulses in the displayed view of the screen. A negative pulse consists of a falling slope followed by a rising slope. The mean value is calculated from the amplitude of the measurement signal. A slope will be counted if the signal runs through the mean value. A pulse that passes the mean value only once will not be calculated. The measurement will only be applied to the selected channel.

COUNT +/
This mode counts signal changes (slopes) from Low Level to High Level in the displayed view of the screen. The mean value is calculated from the amplitude of the measurement signal. A slope will be counted if the signal runs through the mean value. The measurement will only be applied to the selected channel.

COUNT –/
This mode counts signal changes (slopes) from High Level to Low Level in the displayed view of the screen. The mean value is calculated from the amplitude of the measurement signal. A slope will be counted if the signal runs through the mean value. The measurement will only be applied to the selected channel.

TRIGGER FREQUENCY
This mode measures the frequency of the trigger signal bases on the period duration. The source for the measurement is the currently set trigger source. The frequency will be determined with a hardware counter with a high accuracy of 6 digits.

TRIGGER PERIOD
This mode measures the duration of periods of the trigger signal (with a hardware counter).

8.2.1 Statistics for Automatic Measurements

If automatic measurement functions are defined, you can view statistics for these parameters on page 2|2 of the AUTO MEASURE menu. The statistics allow you to evaluate a periodic signal over a number of measurements.

The results (current value, minimum, maximum, mean value, standard deviation and number of measurements) are shown in table format in the display window. Statistics are available for up to 1,000 captures, and you can define the desired number with the universal knob. The mean value and the standard deviation are identified by means of the most current n values where n corresponds to the set captures (soft menu key NO. OF AVERAGES). Minimum and maximum of the measurement value applies to the total number of measurements. The total number of measurements will be displayed in the statistics. The key RESET STATISTIC resets the statistics. All recorded values are erased. This function can be used to restart the statistics at a defined point. The key CLEAR MEASUREMENTS deactivates the automatic measurements.

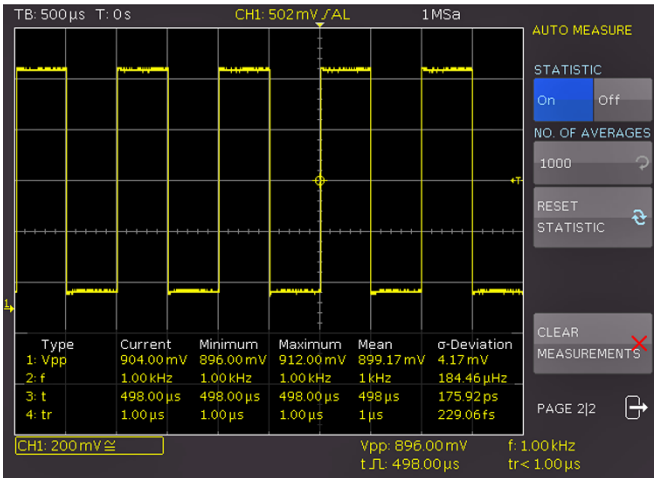

Fig. 8.3: Statistic for Automeasurements