UNI-T®

UPO2000E
Series Ultra Phosphor Oscilloscope
User Manual

www.uni-trend.com

Foreword

Dear Users:

Hello! Thank you for choosing this brand new UNI-T device. In order to use this instrument safely and correctly, please read this manual thoroughly, especially the Safety Notes part.

After reading this manual, it is recommended to keep the manual at an easily accessible place, preferably close to the device, for future reference.

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Warranty

UNI-T warrants that the product will be free from defects for a three-year period. If the product is re-sold, the warranty period will be from the date of the original purchase from an authorized UNI-T distributor. Probes, other accessories, and fuses are not included in this warranty.

If the product is proved to be defective within the warrenty period, UNI-T reserves the rights to either repair the defective product without charging of parts and labor, or exchange the defected product to a working equivalent product. Replacement parts and products may be brand new, or perform at the same specifications as brand new products. All replacement parts, modules, and products become the property of UNI-T.

The "customer" refers to the individual or entity that is declared in the guarantee. In order to obtain the warranty service, "customer" must inform the defects within the applicable warranty period to UNI-T, and to perform appropriate arrangements for the warranty service. The customer shall be responsible for packing and shipping the defective products to the designated maintenance center of UNI-T, pay the shipping cost, and provide a copy of the purchase receipt of the original purchaser . If the product is shipped domestically to the location of the UNI-T service center, UNI-T shall pay the return shipping fee. If the product is sent to any other location, the customer shall be responsible for all shipping, duties, taxes, and any other expenses.

This warranty shall not apply to any defects or damages caused by acciendental, machine parts' wear and tear, improper use, and improper or lack of maintenance. UNI-T under the provisions of this warranty has no obligation to provide the following services:
a) Any repair damage caused by the installation, repair, or maintenance of the product by non UNI-T service representatives.
b) Any repair damage caused by improper use or connection to an incompatible device.
c) Any damage or malfunction caused by the use of a power source which does not conform to the requirements of this manual.
d) Any maintenance on altered or integrated products (if such alteration or integration leads to an increase in time or difficulty of product maintenance).
This warranty is written by UNI-T for this product, and it is used to substitute any other express or implied warranties.
UNI-T and its distributors do not offer any implied warranties for merchatability or applicability purposes.

For violation of this guarantee, regardless of whether UNI-T and its distributors are informed that any indirect, special, incidental, or consequential damage may occur, UNI-T and its distributors shall not be responsible for any of the damages.

General Safety Overview

This instrument strictly complies with the safety requirements for electronic measuring instrument IEC 61010-1 safety standard during design and manufacturing. Please understand the following safety preventative measures, to avoid personal injury, and to prevent damage to the product or any connected products. To avoid possible dangers, be sure to use this product in accordance with the regulations.

Only trained personnels can perform the maintenance program.

Avoid fire and personal injury.

Use the correct power line:
Only use the dedicated UNI-T power supply appointed to the local region or country for this product.

Correct Plug:
Don't plug when the probe or test wire is connected to the voltage source.

Ground the product:
This product is grounded through the power supply ground wire. To avoid electric shock, grounding conductors must be connected to the ground. Please be sure that the product is properly grounded before connecting to the input or output of the product.

Correct connection of oscilloscope probe:
Ensure that the probe ground and ground potential are correctly connected. Do not connect ground wire to high voltage.

Check all terminal ratings:
To avoid fire and the large current charge, please check all the ratings and the marks on the product.
Please also refer to the product manual for details on the ratings before connecting to the product.

Do not open the case cover or front panel during operation

Only use fuses with ratings listed in the technical index

Avoid circuit exposure:
Do not touch exposed connectors and components after power is connected.

Do not operate the product if you suspect it is faulty, and please contact UNI-T authorized service personnel for inspection. Any maintenance, adjustment, or replacement of parts must be performed by UNI-T authorized maintenance personnels.

Maintain proper ventilation

Please do not operate the product in humid conditions

Please do not operate in inflammable and explosive environment

Please keep the product surface clean and dry

Safety Terms and Symbols

The following terms may appear in this manual:
Warning: The conditions and behaviors may endanger life.
Note: The conditions and behaviors may cause damage to the product and other properties.
The following terms may appear on the product:
Danger: Performing this operation may cause immediate damage to the operator.
Warning: This operation may cause potential damage to the operator.
Note: This operation may cause damage to the product and devices connected to the product.
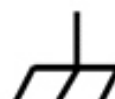The following symbols may appear on the product:

High Voltage	Caution! Refer to Manual	Protective Ground Terminal	Ground Terminal for Chassis	Ground Terminal for Testing

Preface

This manual introduces the operations of the UPO2000E series digital oscilloscope, it includes the following sections:

UPO2000E Series Ultra Phosphor Oscilloscope Introduction

UPO2000E series digital oscilloscopes contains the following 4 models

Model	Analog Channels	Bandwidth
UPO2072E	2	70MHz
UPO2102E	2	100MHz
UPO2074E	4	70MHz
UPO2104E	4	100MHz

UPO2000E series digital oscilloscope is based on UNI-T's unique Ultra Phosphor technology. A multi-functional, high performance oscilloscope that is easy to use, with excellent technical specifications, a perfect combination of multi functionalities that can help users to quickly complete testings. UPO2000E series is aimed at satisfying the most extensive oscilloscope markets, including communications, semiconductors, computers, aerospace defense, instrumentation, industrial electronics, consumer electronics, automotive electronics, field maintenance, R&D, education, etc.

The main features of the UPO2000E series are:

- 70MHz/100MHz bandwidth, providing 2-channel and 4-channel models
- Real-time sampling rate of up to 1GS/s, can observe faster signals
- Maximum storage depth of 56Mpts, which allows the oscilloscopes to maintain a high sampling rate in a wider time base, taking into account the structure and details of the waveform
- Waveform capture rate of up to 80,000wfms/s
- Real-time continuous hardware waveform recording and waveform analysis support waveform recording up to 65,000 waveforms.
- Common protocols decoding : RS232，I2C，SPI
- 256-level grayscale display
- Independent adjustable time base of each channel
- 8-inch WVGA (800 * 480) TFT LCD, ultra widescreen, vivid color, clear display
- Abundant trigger features, including a variety of advanced trigger options
- Standard configuration interface: USB-Host, USB-Device, LAN, and AUX
- Automatic measurement of 34 waveform parameters
- Supports USB storage and software upgrades, one click screen copy function
- Supports plug and play USB device, can be used to communicate with computer

Table of Content

Chapter 1 Introduction Guide

This chapter introduces on using the oscilloscope for the first time, the front and rear panels, the user interface, as well as the built-in help system.

1.1 General Inspection

It is recommended to follow the steps below before using the UPO2000E series for the first time.

(1) Check for Damages caused by Transport

If the packaging carton or the foam plastic cushions are severely damaged, please contact the UNI-T distributor of this product immediately.

(2) Check Attachment

Please check appendix for the list of accessories. If any of the accessories are missing or damaged, please contact UNI-T or local distributors of this product.

(3) Machine Inspection

If the instrument appears to be damaged, not working properly, or has failed the functionality test, please contact UNI-T or local distributors of this product.

If the equipment is damaged due to shipping, please keep the packaging and notify both the transportation department and UNI-T distributors, UNI-T will arrange maintenance or replacement.

1.2 Before Use

To perform a quick verification of the instrument's normal operations, please follow the steps below:

(1) Connect to the Power Supply

The power supply voltage range is from 100 VAC to 240 VAC, the frequency range is 45Hz to 440Hz. Connect the oscilloscope to the power supply line that came with the oscilloscope or any power supply line that meets the host country standards. Turn the power button on the back of the oscilloscope to ON. Now the soft power button ⏻ in the front of the oscilloscope should be lit red.

(2) Boot Check

Press the soft power button ⏻ and the light should change to green. The oscilloscope then will show a boot animation, and it will enter the normal interface afterwards.

(3) Connect Probe

Take the probe founded in the attachment and connect its BNC terminal to the BNC of channel 1 of the oscilloscope. Connect the probe's ground alligator clip to the "ground terminal" below the "probe compensation signal connector". The output of the probe compensation signal connector should be a 3Vp-p square wave, with a 1 kHz defaulted frequency.
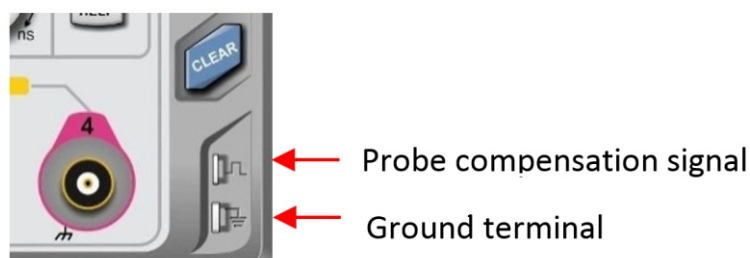
Picture 1-1 Probe compensation signal connector and Ground Terminal

(4) Function Check

Press the AUTO key, a 3Vp-p 1 kHz square wave should appear. Repeat step 3 for all channels. If the output is not a square wave with the above descriptions, please perform the probe compensation step in the next section.

(5) Probe Compensation

When the probe is connected to any input channel for the first time, this step might be required in order to match the probe and the input channel. Please follow the following steps:

① Set the attenuation coefficient in the probe menu and the switch on the probe to "10x", and connect the probe to CH1. Make sure the probe's hook is properly connected with the oscilloscope. Connect the probe to the probe compensation signal connector and connect the probe's ground alligator clip to the ground terminal respectively. Open CH1 and press the AUTO button.

② Observed waveforms.

| Excessive Compensation | Correct Compensation | Insufficient Compensation |
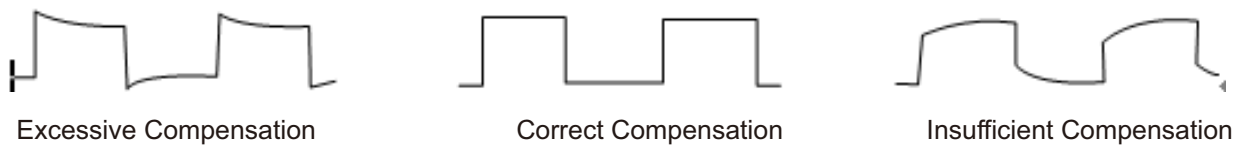
Picture 1-2 Probe compensation calibration

③ If the displayed waveform does not look like the above "correct compensation" waveform, use a non-metallic screwdriver to adjust the probe's variable capacitance until the display matches the "correct compensation" waveform.

Warning: To avoid electric shock when measuring high voltage using the probe, please ensure that the probe insulation is in good condition and avoid physical contact with any metallic part of the probe.

1.3 Front Panel
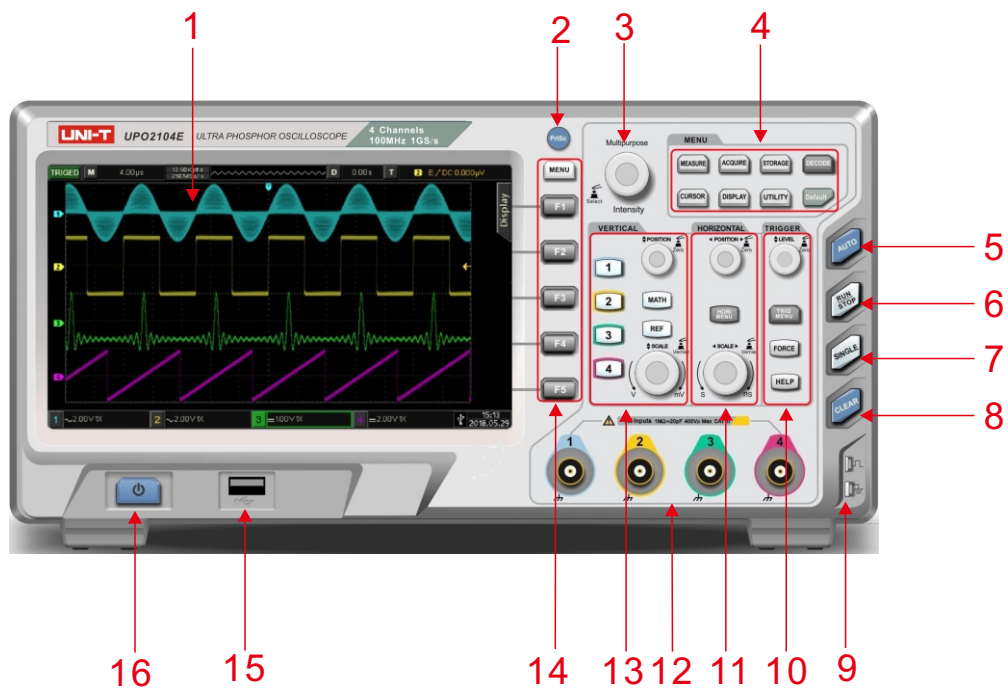
1	Screen display area
2	Copy/print screen
3	Multipurpose knob
4	Function menu
5	Automatic setting
6	Run/stop
7	Single trigger control
8	All clear
9	Probe compensation signal connector and ground terminal
10	Trigger control area
11	Horizontal control area
12	Analog channel inputs
13	Vertical control area
14	Control menu
15	USB HOST Interface
16	Power on/off

1.4 Rear Panel
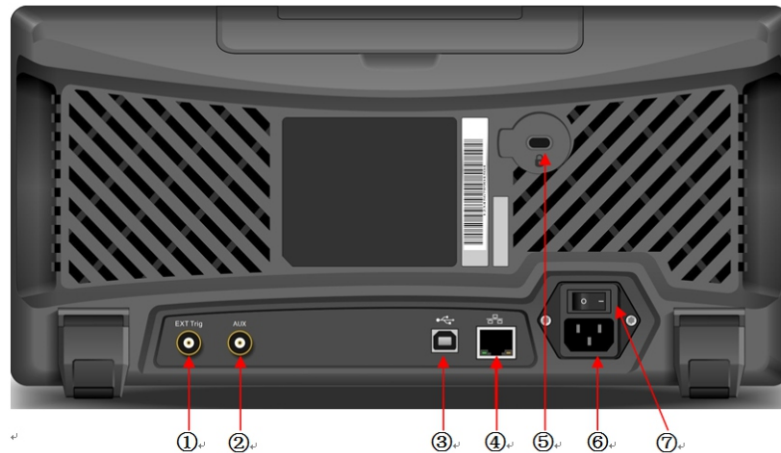
Picture 1-4 Oscilloscope Rear Panel

①. EXT Trig: External trigger or external trigger/5 input

②. AUX: Pass/fail test output, also supports Trig_out output

③. USB Device: USB device interface, can be used to communicate with the PC

④. LAN: The oscilloscope can be connected to the LAN network for remote control

⑤. Safety Lock: Optional safety lock (sold separately) can be used for theft prevention

⑥. AC Power Socket: AC power terminal, power supply cord is provided within the accessory package
   (100 ~ 240 V, 45 ~ 440Hz)

⑦. Power Switch: Main power switch, when turned on, press the power on/off button on front panel to turn on
   the oscilloscope

1.5 Operation Panels
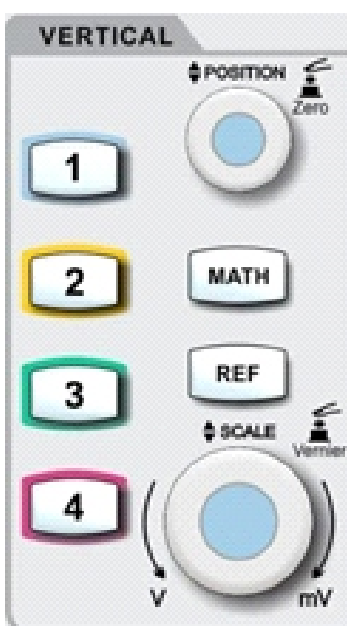
(1) Vertical Control

① 1, 2, 3, 4: Analog channel setting keys indicate CH1, CH2, CH3, and CH4, which are identified by different colors also corresponding to the colors of waveforms on the screen and channel input connectors. Press any key to open the related channel menu (or activate and close the channel).

② MATH: Press this key to open the mathematical operation menu for add, subtract, multiply, divide, FFT, logic, and advanced operations.

③ REF: Loads the previously stored reference waveform in the oscilloscope or the USB disk, you can compare the currently measured waveform with the reference waveform.

④ Vertical POSITION :Adjust the vertical position of the current channel waveform, and display the vertical offset value 240.00mV at the baseline cursor. Press this knob to return the channel display position back to the vertical midpoint.

⑤ Vertical SCALE : Adjust the vertical scale of the current channel. Turn clockwise to reduce in scale and turn counterclockwise to increase in scale. The waveform display amplitude will increase or decrease during the adjustment, and the scale information 1 =100V 1X at the bottom of the screen will change in real time. The vertical scale has 1, 2, and 5 steps. Press the knob allows the vertical scale adjustment to switch between coarse and fine tuning.

11

(2) Horizontal Control
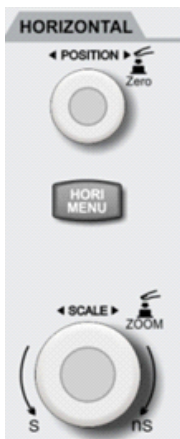
1）HORI MENU: Displays extended window, independent time base, and trigger hold-off.

2）Horizontal POSITION：When adjusting the knob, the trigger point moves left and right brelative to the center of the screen, and the waveform of all channels also move left and right. The horizontal displacement value D 0.00s at the top of the screen will change in real time. Press this knob to return the channel display position back to the horizontal midpoint.

3) Horizontal SCALE Adjust the time base scale of all channels. You can see the waveform is compressed or expanded in the horizontal direction on the screen during the process, and the time base scale M 100μs in the lower part of the screen changes in real time. The time base scale has 1, 2 and 5 steps. Press the knob to quickly switch between main and extensible window mode.

(3) Trigger Control

1) LEVEL: Turn clockwise to increase the trigger level and turn counterclockwise to decrease. During the adjustment process, the trigger level value T 0 E/DC 0.000μV at the top right of screen will change in real time. Press the knob to quickly return the trigger level to the 50% of trigger signal.

2) TRIG MENU：Displays the trigger menu. For details, see "Trigger setting system"

3) FORCE Force trigger button, press to force a trigger event once.

4) HELP Displays the built-in help system.

(4) Auto Setting

When this key is pressed, the oscilloscope will automatically adjust the vertical scale factor, sweep time base, and trigger mode according to the input signals.

Note: When using the auto setting function, if the measured signal is a sin wave, the frequency is required to be not less than 20Hz and the amplitude should be in the range of 20mVpp~120Vpp. The auto setting function may not be valid without this parameter condition.

(5) Run/Stop

Press this key to set the oscilloscope's operating state to "run" or "stop".
RUN state is indicated by green light.
STOP state is indicated by red light.

(6) Single Trigger

Press this key to set the trigger mode to "Single" and the yellow backlight will be on.

(7) Clear

Clear all waveforms on the screen. If the oscilloscope is in the "RUN" state, it will continue to display new waveforms.

(8) Print Screen
Copy the screen to a BMP format image and store it to USB device.

(9) Multipurpose knob
• Intensity : During non-menu operations, turn the knob to adjust display brightness. You can also press DISPLAY → Waveform brightness, then use the knob to adjust it.
• Multipurpose: During menu operations, turn the knob to select submenu, then press the knob to confirm selection.

(10) Function Keys
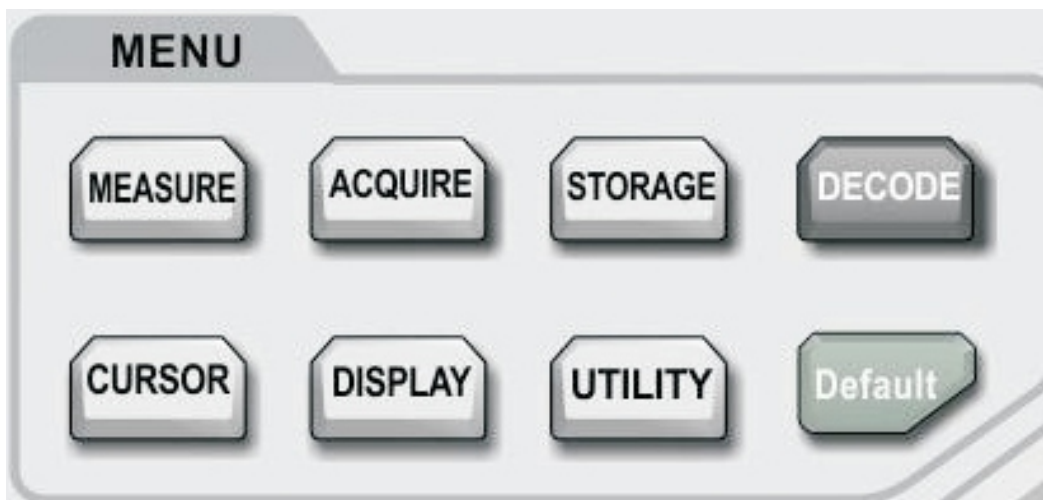
MEASURE : Measure setting menu: can set measure source, all parameters, user-defined, perform measurement statistics, select measurement indicators, etc. The user-defined includes a total of 34 kinds of parameter measurements, which can be quickly selected through the Multipurpose knob, and the measurement result will appear at the bottom of the screen.

ACQUIRE : Sampling setting menu for setting the acquisition mode and deep storage.

CURSOR : Cursor measurement menu, users can measure waveform's time and voltage manually with cursor.

DISPLAY : Press to select display settings, such as display type, format, grid brightness, and waveform brightness, duration, color temperature, inverse color temperature.

STORAGE : Press to enter storage interface, the settings/waveforms can be stored internally or in the USB storage devices.

UTILITY : Press to enter utility menu, can perform the settings such as self-calibration, system information, language, menu display time, waveform recording, pass test, square wave output, frequency meter, AUX output selecting, backlight brightness, data clearing, IP, RTC setting, etc.

DEFAULT : Restore to factory default settings.

1.6 User Interface
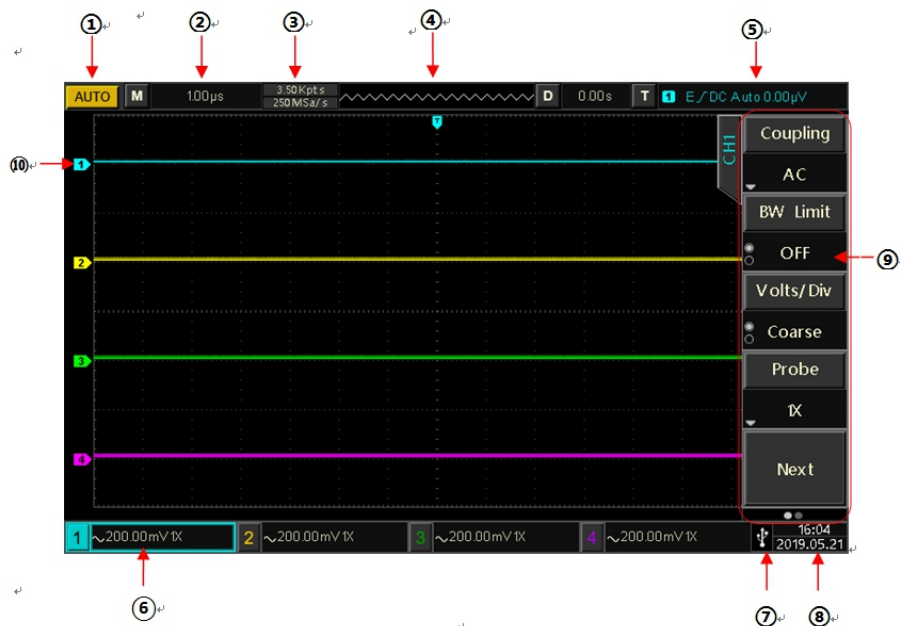
1. Trigger Status Identification: Include TRIGED, AUTO, READY, STOP, and ROLL.

2. Time Base Scale: Indicates the amount of time represented by one grid on the horizontal axis, which can be adjusted by the horizontal SCALE knob.

3. Sampling Rate/Acquisition Mode: Indicates the current sampling rate and storage depth.

4. Horizontal Displacement: Shows the horizontal displacement, which can be adjusted by turning the horizontal POSITION knob. Press in the knob returns the displacement back to 0.

5. Trigger Status: Displays trigger source, type, slope, coupling, level, etc.
   a) Trigger Source: There are seven states: CH1~CH4, AC Line, EXT, and EXT/5. CH1~CH4 will each be of a different trigger color. For example, ▮1 is CH1.
   b) Trigger Type: The types are edge, pulse width, video, slope, and advanced trigger. For example, E is an edge trigger.
   c) Trigger Edge: The types are rising, falling, and rising/falling. For example, ⌿ is rising.
   d) Trigger Coupling: The types are DC, AC, high frequency, low frequency and noise. For example, DC indicates DC coupling.
   e) Trigger Level: Indicates the current trigger level value, corresponding to the ◀ on the right side of the screen, can be adjusted with the trigger level knob.

6. CH1 Vertical Identification: Displays CH1 activation state, channel coupling, bandwidth limit, vertical scale, and probe attenuation coefficient.
   a) Channel Activation State: 1⎓100V1X The channel is activated when its color is consistent with the background color. Press CH1~CH4 to open/close the corresponding channel.
   b) Channel Coupling: Includes DC, AC, and grounding. For example, ▦ is DC coupling in CH1.
   c) Bandwidth Limitation: Enable and there will be a B icon shown on CH1 vertical status bar.
   d) Vertical scale: When CH1 is activated, the vertical scale paraments can be adjusted with the SCALE knob in the vertical control area.
   e) Probe Attenuation Factor: Displays CH1 probe attenuation coefficient: 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, and 1000X.

7. USB HOST Identification: Displays this indicator when the USB device is connected to a USB storage device such as a USB flash disk.

8. Current date and time

9. Operation Menu: Displays the current operation menu. Press F1 ~ F5 can change corresponding submenu contents.

10. Analog Channels and Waveforms: Displays CH1~CH4 channels and waveforms, the channel indicator is consistent with waveform color.

14

1.7 Special Symbols Introduction

Take the left menu as an example:

⊻ :Indicates there is a next level menu.

▼ :Indicates there is a drop-down menu.

◉ :Indicates the menu has two options.

↻ :Indicates the user can adjust by the Multipurpose knob.

●●● :The number of circles indicatesthe total pages of the menu. There is no small circle for one single page. For two pages or more, small circles will be shown. Press the next page key to turn the page.

Chapter 2 Vertical Channel Settings

UPO2000E provides 4 or 2 analog input channels. The 4 analog channels are CH1~CH4, and the 2 analog channels are CH1 and CH2. The vertical system settings for all channels are exactly the same.
This chapter uses 1 **(Channel 1) as an example to describe the vertical channel settings.**

2.1 Open/Activate/Close Analog Channel

CH1~CH4 contains 3 states: open, close, and activated
   a. Open: Press any of 1 , 2 , 3 , 4 under close state to open corresponding channel.
   b. Close: No waveform displays on the corresponding channel. .For any opened and activated channel, pressing its channel button can close that channel.
   c. Activated: Only one channel in opened state will be activated when multiple channels are opened at the same time. In the active state, the vertical menu and the vertical control knobs (POSITION, SCALE) are for changing activated channel setting. Any of the channels that have been opened but not activated could be activated by the corresponding channel keys, and displays the menu.

Activated state   Open but not activated

2.2 Channel Coupling

Press 1 → Coupling to select DC , AC or Grounding mode.

Direct Current   Alternating Current   Grounding

2.3 Bandwidth Limitation

Press 1 → Bandwidth limition to turn it on which is limited to about 20MHz, and attenuates any signal above 20MHz. It is commonly used to reduce the high frequency noise within the signal. When the bandwidth limit function is on, the B icon will appear in the vertical state flag shown below:

B icon appears when the bandwidth limitation is on

2.4 VOLTS/DIV

Press 1 → VOLTS/DIV → coarse tuning/fine tuning. Or press the SCALE knob to quickly switch between coarse tuning/fine tuning.

In the coarse tuning, the VOLTS/DIV range is 1mV/div～20V/div by 1－2－5 steps.

For example: 10mV→20mV→50mV→100mV

In fine tuning, it adjusts in 1% of the current vertical scale.

For example：10.00mV→10.10mV→10.20mV→10.30mV

Note: div indicates the display area square, and one div represents one grid

2.5 Probe

In order to match the attenuation coefficient setting of the probe, the probe coefficient needs to be set up in the channel operation menu. If the probe attenuation coefficient is 10:1, the probe coefficient should then be set to 10X to ensure correct voltage reading.

Press 1 → probe to select 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, and 1000X.

2.6 RP (Reverse Phase)

Press 1 → RP to turn on reverse phase. The waveform voltage value will be reversed, and the icon 1 will appear in the vertical bar.
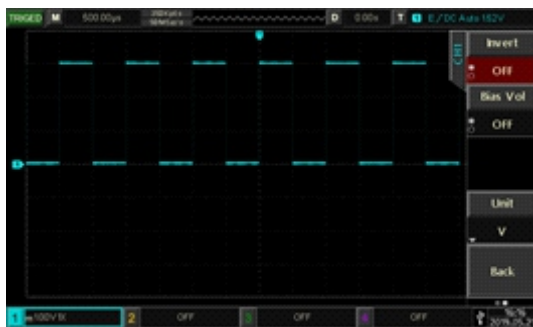
Picture 2-1 RP Closed
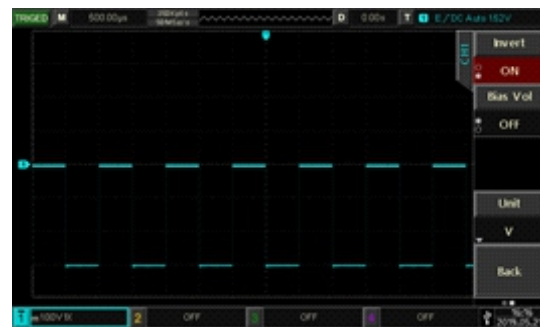
Picture 2-2 RP Open

2.7 Bias

When the DC component amplitude in the signal is relatively large, waveform observation could be very inconvenient. Using the bias function and the superposition of a -1V bias voltage can eliminate the DC component so the AC signal can be clearly observed, and at the same time user can know the DC component volume. As shown in picture 2-4,

press 1 → PgDn → Bias to turn on bias and rotate the Multipurpose knob countclockwise to adjust the value to -10V.
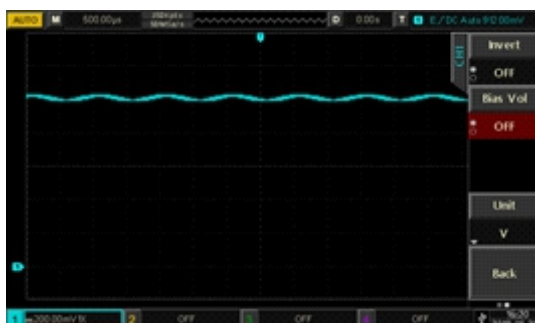
Picture 2-3 Bias off
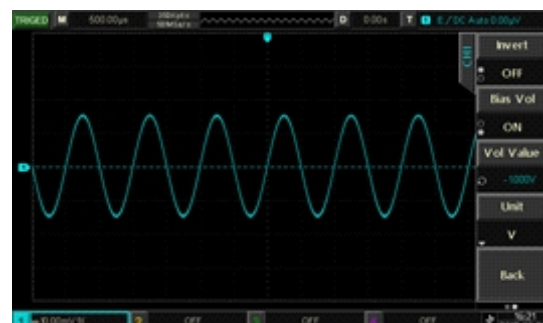
Picture 2-4 -1V bias on

Note: Press the Multipurpose knob to return the bias to zero.

2.8 Unit

Select the amplitude unit for the current channel. Press 1 → PgDn → Unit and adjust the Multipurpose knob to select the unit of "V", "A","W" or "U", the default unit is V. User can also switch the channel units by consecutively pressing the unit key, then press the Multipurpose knob to confirm, the correspoinding unit will appear on the channel status bar.

16

Chapter 3 Horizontal System Settings

3.1 Horizontal scale

Horizontal scale, also the horizontal time base, is the time value represented by each scale in the horizontal direction, which is usually expressed as s/div. With the SCALE knob in the horizontal control area, user can adjust the horizontal scale in 1 – 2 – 5 steps, i.e. 5ns/div, 10ns/div, 20ns/div, 50ns/div……50s/div. Turn clockwise to decrease the scale and turn counterclockwise to increase, the scale information on the upper left corner of the screen (as shown below) changes in real time.
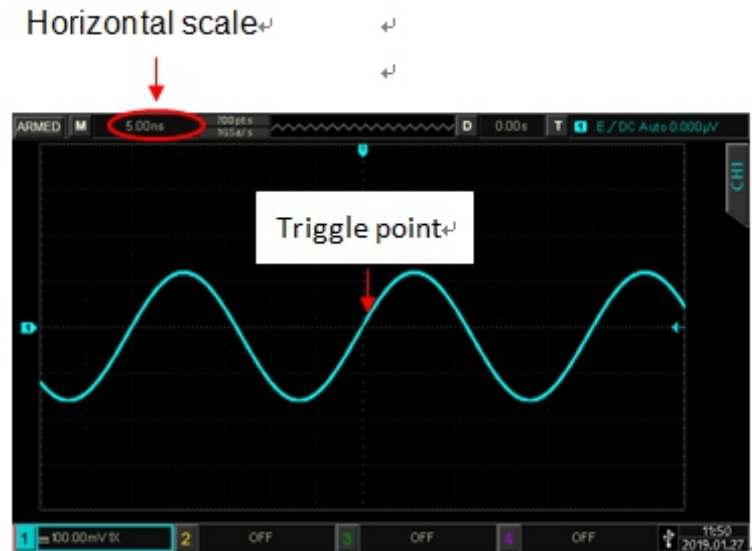
When changing the horizontal time base, the waveform will expand or compress according to the trigger point position.

3.2 ROLL mode

When the trigger mode is auto, adjust SCALE knob in the horizontal control area to change the horizontal scale to be slower than 50ms/div, and the oscilloscope will be in ROLL mode and will continuously plot the waveform voltage-time trend chart on the screen. The earliest waveform first appears on the right end of the screen, and then gradually moves to the left, as shown below:
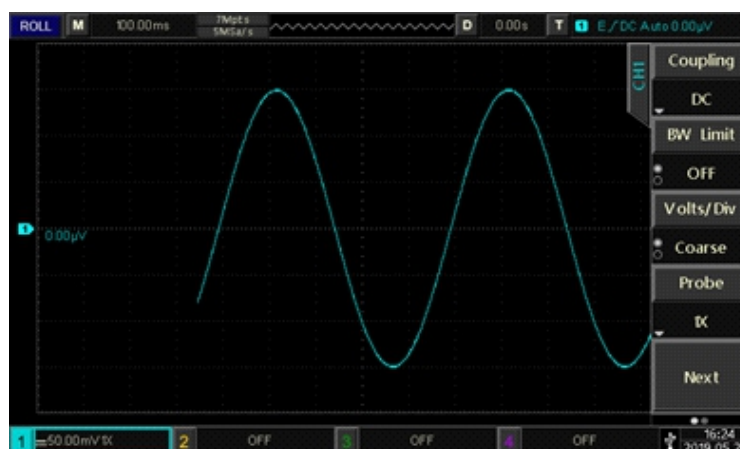
Use the slow sweep mode to observe low frequency signal, and setting "channel coupling" method to "DC" is recommended.

Note: "Horizontal displacement", "extended window", "protocol decoding", "pass/fail", "parameter measurement", "waveform recording" and "independent time base" are not available in ROLL mode.

3.3 Extended Window

The extended window can be used to magnify a waveform horizontally to view the waveform details.
Press the HORI MENU button on the horizontal control area, then press the type key can turn on the extended window.
Or simply press the SCALE knob to directly enter the extended window, the screen will be divided into two display areas, as shown below:

Waveform before magnification

Extended time base

Main time base

Waveform after magnification
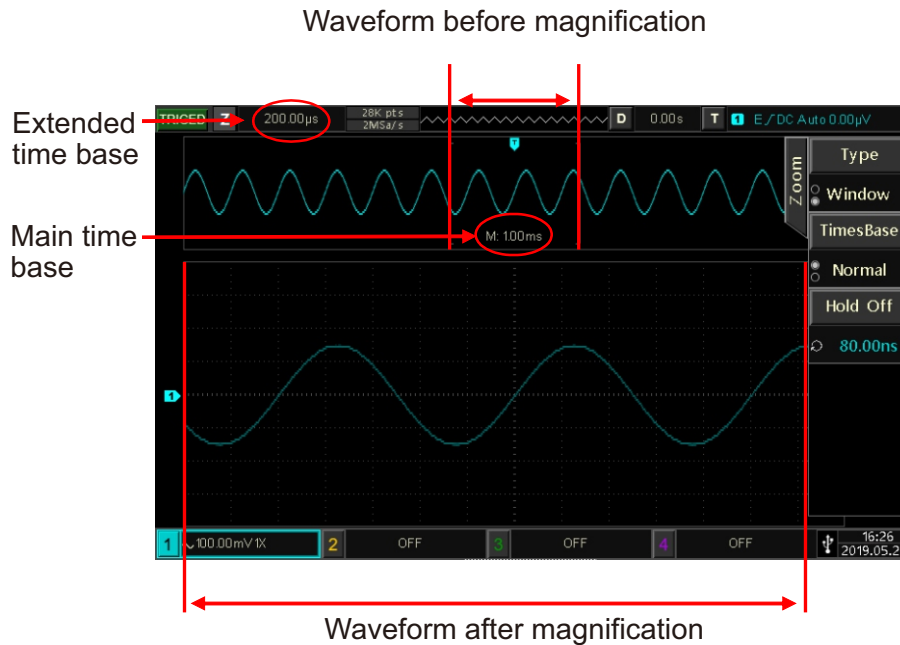
Waveform before magnification:
The upper part of the screen displays the original waveform, which can be moved left and right through rotating the horizontal POSITION knob, or zoom in and out the selected area by rotating the horizontal SCALE knob.

Waveform before magnification:
The lower part of the screen displays the horizontally extended waveform, and the extended window enhances the resolution relative to the main time base.

Note: The extended window function is only available when the horizontal time base is between 20ms/div~5us/div.

3.4 Independent Time Base

In independent time base, CH1~CH4 can be set as different time base scales so that signals of different frequencies can be observed by multiple channels. Press HORI MENU →Time base setting to enter the independent time base
As shown below, CH1 is a 10Hz sine wave, CH2 is a 1kHz square wave, CH3 10kHz triangular wave, CH4 100kHz pulse wave, so signals with great frequency difference can be observed simultaneously by independent time base. Press the CH1 button to activate CH1, then user can change the CH1 time base scale by adjusting the horizontal SCALE knob, and adjustment method for other channels are similar to this.
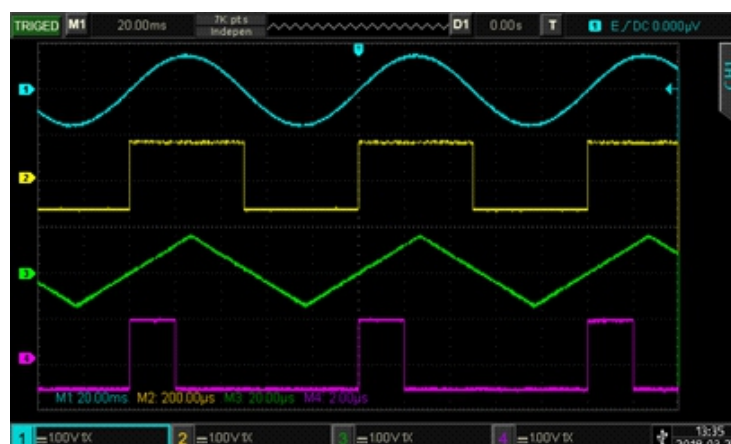
3.5 Trigger Hold-off

Trigger hold-off can observe the complex waveforms (such as pulse train). Hold-off time is the amount of time the oscilloscope waits before re-enabling the trigger circuit. During the hold-off period, the oscilloscope will not trigger until the hold-off time is over. For example, a set of pulse train, which is required to trigger on the first pulse, the hold-off time can be set to the pulse train width.

Press the HORI MENU on the horizontal control area and then adjust the Multipurpose knob to set the trigger hold-off time. Input a combined waveform to CH1, and adjust the trigger hold-off time until the waveform can be triggered steadily, as shown below:
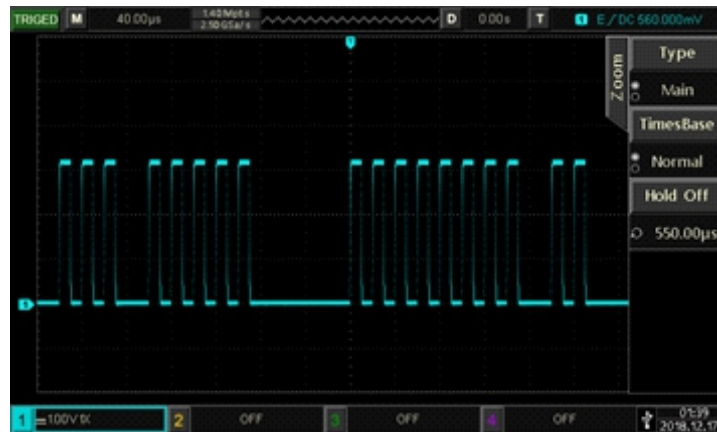
Chapter 4 Sampling System Settings

Sampling is taking analog input signal and converts it into discrete points by using the analog to digital converter (ADC).

Press the ACQUIRE key to enter the sample menu.

Functions	Options	Descriptions
Sampling Mode	Normal	Sampling in the normal way
	Peak	Sampling in peak detection mode
	High resolution	Sampling in high-resolution mode
	Envelope	Sampling in envelop mode
	Average	Sampling in an average way
Average	2~8192	In the average acquisition mode, you can adjust the Multipurpose knob to set the average number of times, which can be set to 2n, and n is an integer from 1 to 13.
Storage Depth	Auto	Set the memory depth to automatic, which is the normal memory depth
	28k	Set storage depth to 28kpts
	280k	Set storage depth to 280kpts
	2.8M	Set storage depth to 2.8Mpts
	28M	Set storage depth to 28Mpts
	56M	Set storage depth to 56Mpts

4.1 Sampling Rate

(1) Sampling and Sampling Rate

Sampling means that the oscilloscope samples the input analog signal, converts the sample to digital data, and then the digital data will be collected into waveform records stored in the acquisition memory.

| Analog Singal | Sampling Points |

Sampling rate refers to the time interval between two sampling points. The maximum sampling rate of the UPO2000E series is 1 GS/s.

The sampling rate will be affected by the time base scale and the memory depth. UPO2000E oscilloscopes displays the sampling rate in real time at the top status bar, user can change the horizontal time base by adjusting the horizontal SCALE knob or change the memory depth to change the sampling rate.

(2) Low Sampling Rate Effect

a. Waveform Distortion: Due to low sampling rate, the details of the waveform might be missing, which makes a great difference between sampling waveform and actual signal.
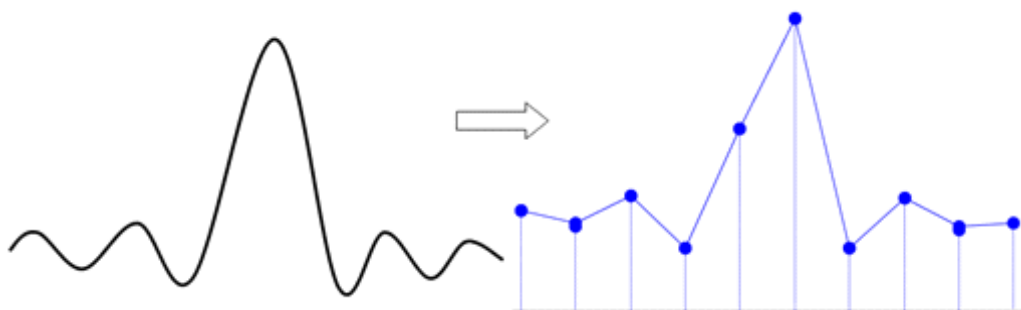
b. Wave Mixing: When the sampling rate is 2 times lower than the actual signal frequency (Nyquist frequency), the frequency of the reconstructed signal will be less than the actual signal frequency.
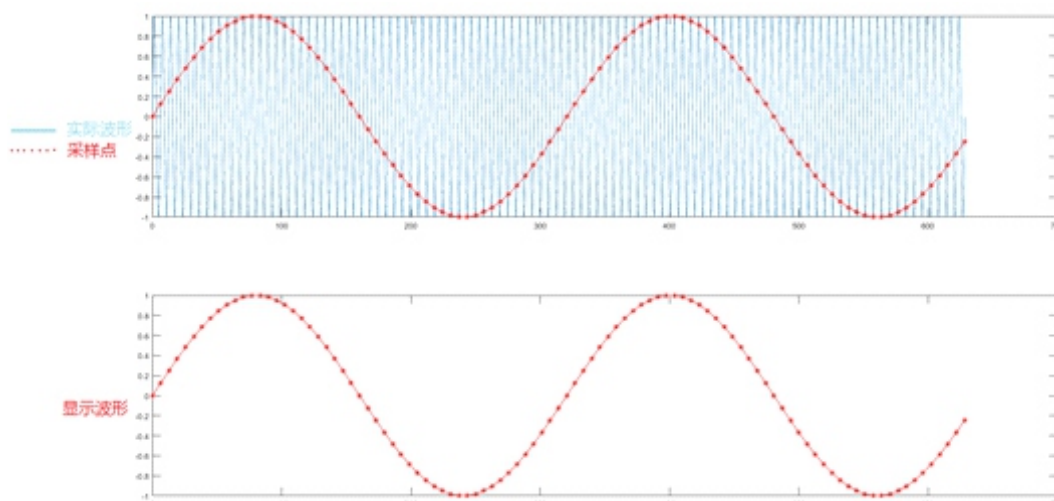
c. Waveform Leakage: Due to low sampling rate, the reconstructed waveform might not reflect the actual signal.

Pulse disappear
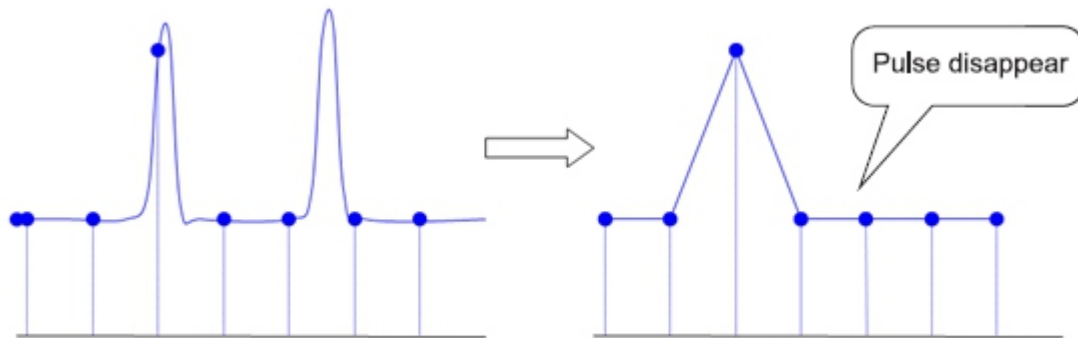
4.2 Acquisition Mode

To obtain a waveform from sampling points, press ACQUIRE → F1 to switch between acquisition modes.

(1) Normal Sampling

In this acquisition mode, the signal is sampled and reconstructed with equal time intervals. For most waveforms, the use of this mode can produce the best display.

(2) Peak Sampling

In this acquisition mode, the maximum and minimum values of the input signal are found at each sampling interval, and the waveform is displayed using these values. This way, the oscilloscope can acquire and display the narrow pulse, otherwise the narrow pulse might be missed in the normal sampling mode. Noise might be enlarged in this mode.

(3) High Resolution

In this acquisition mode, the oscilloscope averages the neighboring points of the sampled waveform, which can reduce random noise from the input signal and generate smoother waveforms.

(4) Envelope

The sampling points gathered at same time are calculated and the maximum and minimum values are displayed. Peak detection mode is used for individual acquisitions using general envelope mode.

(5) Average

In this acquisition mode, the oscilloscope obtains several waveforms and finds the average, and displays the final waveform. This method can reduce random noise.

By changing the acquisition mode settings, the resulting waveform display changes. The unaveraged and the 32 times averaged waveform are displayed below for comparison.
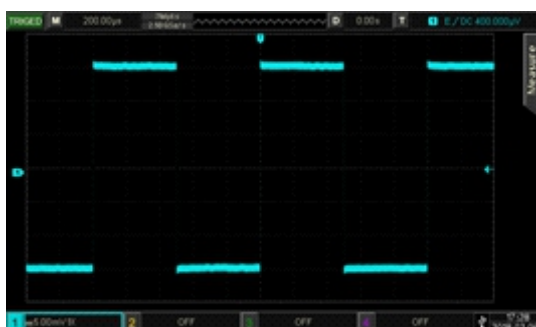
Waveform without average
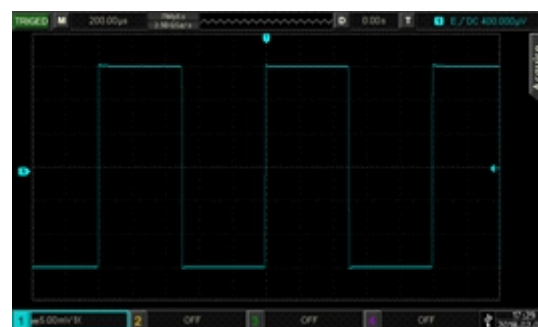
Waveform with 32 times average

Note: Average and high resolution uses different average methods. The former is multiple sampling average, the latter is single sampling average.

4.3 Storage Depth

The storage depth is the number of waveforms that can be stored in the oscilloscope during a trigger acquisition. It reflects the memory storage capacity of the acquisition.

Memory depth, sampling rate and wavelength should meet the following formula:
Memory depth = Sampling rate × Horizontal time base × Horizontal grids
UPO2000E comes with 56Mpts memory depth (per channel). Press ACQUIRE Memory depth to set the memory depth to automatic, 28k, 280k, 2.8M, 28M or 56M. The default is automatic.

Chapter 5 Trigger System Settings

Trigger determines when the oscilloscope starts to collect data and display waveform. Once the trigger is correctly set, it can convert unstable signals into meaningful waveforms. In the beginning of data acquisition, it first collects enough data to plot a waveform starting on the left of the trigger point, and continuously collects data while waiting for the trigger. When a trigger is detected, the device continuously acquires enough data for plotting a waveform to the right of the trigger point.
In this chapter UPO2XX4E will be used as the example.

5.1 Trigger System Interpretation

(1) Trigger Source
Trigger source is signal for trigger generating. Triggers can be obtained from a variety of sources such as input channels (CH1, CH2, CH3, CH4), external trigger (EXT, EXT/5), AC Line, etc.
- **Input channel**
  Select any one of the analog signal input terminal CH1~CH4 on the oscilloscope front panel as a trigger signal.
- **External Trigger**
  Select the EXT Trig (EXT or EXT /5 input terminal) input signal from the oscilloscope rear panel as a trigger signal.
  For example, the external clock input can be used on the EXT Trig terminal as a trigger source, including EXT and EXT/5. EXT trigger level ranges from -0.9V ~ +0.9V can be set. EXT/5 trigger level range is increased to -4.5V~ +4.5V.
- **AC Line**
  Power supply, used to observe signals related to mains, such as relationship between lighting equipment and power supply equipment, so as to achieve stable synchronization.

(2) Trigger Mode

Trigger mode determines the behavior of the oscilloscope during a trigger event. This oscilloscope provides three kinds of trigger modes: auto, normal, and single trigger.
- **Auto trigger:**
  When there is no trigger signal, the system automatically runs, collects and displays data. When the trigger signal is generated, it automatically switches to trigger scanning and signal synchronization.
  Note: This mode allows 100ms/div or slower time shift without triggering in ROLL mode.

- **Normal trigger:**
  The oscilloscope can only collect data when the trigger condition is satisfied. When it is not triggered, the oscilloscope will stop data acquisition and wait for the trigger signal.

- **Single trigger:**
  Press once the SINGLE key and the oscilloscope will wait for the trigger. When the instrument detects a trigger, the waveform is sampled and displayed, and enters the STOP state. Press the SINGLE button on the front panel of the oscilloscope to quickly enter the single trigger mode.

(3) Trigger Coupling

Trigger coupling determines which part of the signal will be transmitted to the trigger circuit. The coupled type includes DC, AC, low/high frequency suppression, and noise suppression.

DC: Allows all of the signal

AC: Blocks the DC component and attenuates any signal components below 10Hz.

High frequency suppression: Attenuates high frequency components over 80kHz.

Low frequency suppression: Blocks the DC component and attenuates low frequency components below 8kHz.

Noise suppression: Suppress high frequency noise in the signal, and reduces probability of error.

(4) Trigger Sensitivity

The minimum signal required to generate a correct trigger. For example, normally the input channel (CH1~CH4) trigger sensitivity is 1div, which means the source signal should be at least 1div.

(5) Pre-trigger / Delayed Trigger

Data collected before / after the event.

Trigger position is usually set at the level of the screen, and you can observe 7 grids of pre-trigger and delay trigger information. The horizontal displacement of the wave can be adjusted by the horizontal displacement POSITION knob in order to observe more pre-trigger information. By observing the pre-trigger data, you can observe the waveform situation before the trigger. For example, capturing the burr generated at the start of the circuit, by observing and analyzing the pre-trigger data, it can help to find out the cause of the burr.

(6) Forced Trigger

Press the FORCE key to generate a forced trigger signal.

If the waveform is not displayed in normal or single shot mode, press the FORCE button to collect signal baseline to ensure acquisition is normal.

5.2 Edge Trigger

The edge can be triggered by the rising or falling edge of the signal.

Press the TRIG MENU → type to select edge with the Multipurpose knob, and the defaulted trigger type is edge. User can also switch the trigger type by consecutively pressing the type button, and then press the Multipurpose knob to confirm. At this time, the trigger setting [T E/DC 0.000µV] is displayed at the upper right corner of the sreen, the trigger type is edge, the trigger source is CH1, rising edge triggered, and the trigger level is 0.00V.

The Edge Trigger Menu

Source:

Press the source button to select any of CH1, CH2, CH3, CH4, AC Line, EXT, and EXT/5. Thr selected source will be displayed on the upper right corner of the screen.

Note: only selecting the channel with connected signals as the trigger source can obtain a stable trigger.

Edge Type:

Press the edge type key to select the edge that the input signal will trigger on, user can select the rising edge, failing edge, and any edge. The current edge type will be displayed on the upper right corner of the screen.

（1）Rising edge: triggers at the rising edge of the signal.

（2）Falling edge: triggers at the falling edge of the signal.

（3）Any edge: triggers at the rising edge and the falling edge of the signal.

Trigger Setting:
Press the trigger setting key to enter the trigger setting menu.

Trigger Mode:
Press the trigger mode key to select automatic, normal or single mode, please refer to the content of Triggle Mode. The corresponding indication light will be on according to current trigger mode.

Trigger Coupling:
Press the trigger coupling key to select DC, AC, high/low frequency suppression, and noise suppression. For more details, please refer to the section of Trigger Coupling.

5.3 Pulse Width Trigger

The pulse width trigger determines the trigger time according to the pulse width, you can capture the eligible pulse by setting the pulse width condition.

Press the TRIG MENU → type , select pulse width with the Multipurpose knob. User can also switch the trigger type by continuously pressing the type button, and then press the Multipurpose knob to confirm.

At this time, the trigger setting T ⓿ P,ⴖDC 0.000μV is displayed at the upper right corner of the sreen, the trigger type is pulse width, the trigger source is CH1, and the trigger level is 0.00V.

The Pulse Width Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3, CH4, AC Line, EXT, and EXT/5. Thr selected source will be displayed on the upper right corner of the screen.
Note: only selecting the channel with connected signals as the trigger source can obtain a stable trigger.

Condition:
Press the condition key to select ">", "<", "=".
(1) >: Triggers when the pulse width of the trigger signal is greater than the pulse width setting time.
(2) <: Triggers when the pulse width of the trigger signal is less than the pulse width setting time.
(3) =: Triggers when the pulse width of the trigger signal is equal to the pulse width setting time

Pulse Width Setting:
Adjust the pulse width setup time with the Multipurpose knob.

Pulse Width Polarity:
Press the pulse width polarity button to select positive/negative pulse width.

In the oscilloscope, the time difference between the two points where the trigger level intersects with the positive pulse is defined as the positive pulse width; the time difference between the two points where the trigger level intersects with the negative pulse is defined as the negative pulse width, as shown in the figure below.
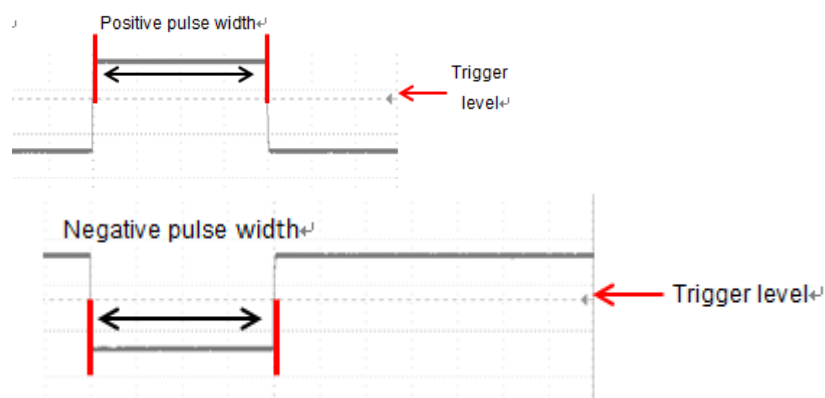
Trigger Setting:

Please refer to the Triggle Setting in the Edge Trigger section.

5.4 Video Trigger

The video signal may contain the image information and the time sequence information, and it has a variety of standards and formats. The UPO2000E can be triggered on the field or line of the NTSC (National Television Standards Committee), PAL (Phase Alternating Line), SECAM (Sequential Couleur A Memoire) standard video signals.

Press the TRIG MENU → type , and select video with the Multipurpose knob. User can also switch trigger type by continuously pressing the type button, and then press the Multipurpose knob to confirm.

At this time, the trigger setting is displayed at the upper right corner of the sreen, the trigger type is video, the trigger source is CH1.

The Video Trigger Menu

Source:

Press the source button to select any of CH1, CH2, CH3, CH4, EXT, and EXT/5. Thr selected source will be displayed on the upper right corner of the screen.

Note: only selecting the channel with connected signals as the trigger source can obtain a stable trigger.

Video Format:

Press the video format button to select PAL, NTAC and SECAM.

(1) PAL: The frame frequency is 25 frames per second, the TV scan line is 625 lines, the odd field is in the front and the even field is in the rear.

(2) NTSC: The field frequency is 60 fields per second, and the frame frequency is 30 frames per second. The TV scan line is 525 lines. The even field is in the front and the odd field is in the rear.

(3) SECAM: The frame frequency is 25 frames per second, the TV scan line is 625 lines, interlaced scanning.

Video Synchronization

Press the video synchronization button to select the even field, odd field, all lines and specified lines.

(1) Even field: Set to trigger and synchronize on the even field of the video signal.

(2) Odd field: Set to trigger and synchronize on the odd field of the video signal.

(3) All lines: Set to trigger and synchronize on the line signal of the video signal.

(4) Specified lines: Set to trigger and synchronize on the specified video lines. You can use the Multipurpose knob to specify the line number, and its setting range is from 1 to 625 (PAL/SECAM), or from 1 to 525 (NTSC).

Note: In order to observe the waveform details in the video signal, you can set the memory depth a little bigger.

The UPO2000E series utilize the UNI-T original digital 3D technology, it uses a multi-level grayscale display function so that different brightness can reflect the frequency of different parts of the signal. Experienced users can quickly judge the signal quality during the debugging process and find the unusual conditions.

5.5 Slope Trigger

When slope trigger is selected, trigger occurs when the rise/fall slope value matches the set value.

Step: Press the TRIG MENU → type , select slope with the Multipurpose knob. User can also switch the trigger type by continuously pressing the type button, and then press the Multipurpose knob to confirm.

At this time, the trigger setting ![T S/DC 0.000µV] is displayed at the upper right corner of the sreen, the trigger type is slope, the trigger source is CH1, and the trigger level is 0.00V.

Slope Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3 and CH4. The selected source will be displayed on the upper right corner of the screen.
Note: only selecting the channel with connected signals as the trigger source can obtain a stable trigger.

Trigger Setting:
Please refer to the content of Triggle Setting in the Edge Trigger section for more details.

Slope Setting:
Press the slop setup button to enter the slope setting menu.

Slope:
Press the slope button to select slope trigger edge, the rising edge or the falling edge.
    1）Rising edge: Performs slope trigger by using the rising edge of the trigger signal.
    2）Falling edge: Performs slope trigger by using the falling edge of the trigger signal.

Condition:
Press the condition button to select the trigger conditions: "　"," 　"," 　".
(1) >: Triggers when the slew rate of the trigger signal is greater than the set slew rate.
(2) <: Triggers when the slew rate of the trigger signal is less than the set slew rate.
(3) =: Triggers when the slew rate of the trigger signal is basically the same as the set slew rate.

Time Setting:
Adjust the Multipurpose knob to set the time.

Threshold Value:
Press the threshold button to select the threshold value: low level, high level, high and low level. You can also directly press the LEVEL knob in the trigger control area to quickly switch between selections.
(1) Low level: The low level threshold can be adjusted by the LEVEL knob.
(2) High level: The high level threshold can be adjusted by the LEVEL knob.
(3) High and low level: The high and low level thresholds can be simultaneously adjusted by the LEVEL knob.

Note: The formula for calculating the slew rate is
(High level threshold - Low level threshold) ÷Time

For the set slew rate, the time here is the time setting value. For the slew rate of the trigger signal, the time here refers to the time value between two intersection points where the high and low level intersect with the trigger signal.

26
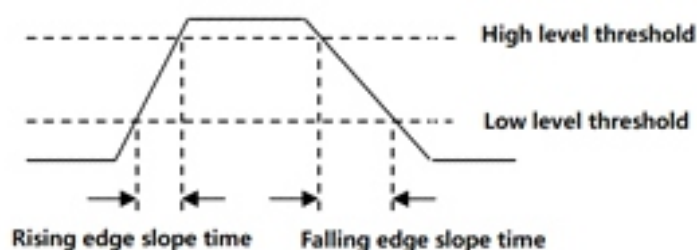
5.6 Runt Trigger Menu

The runt trigger is used to trigger a pulse that has crossed one trigger level but not the other. In this oscilloscope, the positive runt pulse is the pulse that crosses the lower limit of the trigger level but does not cross the upper limit of the trigger level; the negative runt pulse is the pulse that crosses the upper limit of the trigger level but does not cross the lower limit of the trigger level, as shown in the following figure.
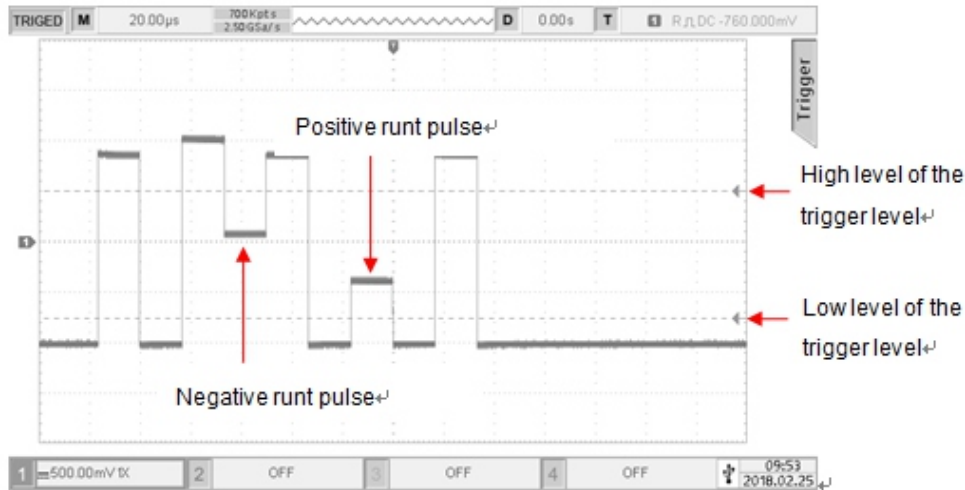
Press TRIG MENU → type , and select runt by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.
At this time, the trigger setting information   is displayed at the upper right corner of the screen, the trigger type is runt, the trigger source is CH1, and the low level of the trigger level is -760mV.

Runt Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Polarity:
Press the polarity button to select the trigger polarity of positive and negative.
(1) Positive: Set to trigger on the positive runt pulse.
(2) Negative: Set to trigger on the negative runt pulse.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

Condition:
Press the condition button to select the condition: None, ">", "<", "=".
(1) None: Does not set the runt pulse trigger condition.
(2) >: Triggers when the runt pulse width is greater than the set pulse width.
(3) <: Triggers when the runt pulse width is less than the set pulse width.
(4) =: Triggers when the runt pulse width is equal to the set pulse width.

Setting:
Press the PgDn key and adjust the Multipurpose knob to set the time.

Trigger Level:
Press PgDn → trigger level to select low/high level as trigger level. You can also directly press the LEVEL knob in the trigger control area to quickly switch between selections.
(1) Low level: The low level of the runt trigger can be adjusted by the LEVEL knob.
(2) High level: The high level of the runt trigger can be adjusted by the LEVEL knob.

5.7 Window Trigger

Select the window trigger, its trigger level has a high level and a low level. The oscilloscope triggers when the rising edge of the input signal crosses the high level or the falling edge crosses the low level.

Press TRIG MENU ⟶ type , and select window by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information ⬛ W/DC 124.000mV is displayed at the upper right corner of the screen, the trigger type is window, the trigger source is CH1, and the low level of the trigger level is 124mV.

Source:
Press the source button to select CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Slope:
Press the slope key to select which slope the input signal will trigger on, you can select the rising edge, falling edge, and any edge. The currently slope type is displayed at the upper right corner of the screen.
(1) Rising edge: Triggers on the rising edge of the input signal and when the voltage level is higher than the set high level.
(2) Falling edge: Triggers on the falling edge of the input signal and when the voltage level is lower than the set low level.
(3) Any edge: Triggers on any edge of the input signal and when the voltage level meets the set level.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

Position:
Press PgDn ➔ position to select the trigger position of enter, exit and time to further determine the trigger time.
(1) Enter: Triggers when the input signals enter into the specified trigger level range.
(2) Exit: Triggers when the input signals exit out of the specified trigger level range.
(3) Time: Triggers when the accumulated hold time after the window enter is greater than or equal to the set window time.

Trigger Level:
Press PgDn ➔ trigger level to select low level or high level. You can also directly press the LEVEL knob in the trigger control area to quickly switch between selections.
(1) Low level: The low level of the window trigger can be adjusted by the LEVEL knob.
(2) High level: The high level of the window trigger can be adjusted by the LEVEL knob.

Setting:
Press the PgDn key and adjust the Multipurpose knob to set the time.

5.8 Delayed Trigger

Delay trigger needs to set the trigger source 1 and source 2. The oscilloscope triggers when the time difference (T) between the edge 1 set by source 1 and the edge 2 set by source 2 meets the preset time limit. As shown in the following figure.
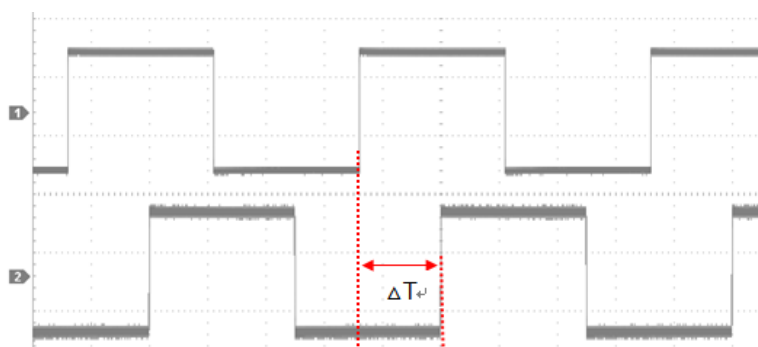
Set edge 1 and edge 2 as the rising edge, T is the range marked in red in the above figure.
Note: Edge 1 and edge 2 must be the adjacent edges.

Press TRIG MENU → type , select delay by the Multipurpose knob. You can also switch trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information [T] [2] D⟋ ⟋DC 0.000μV is displayed at the upper right corner of the screen, the trigger type is delay, the trigger source is CH2, and the low level of the trigger level is 0.00V.

Delay Trigger Menu

Source 1:

Press the source 1 key to select any of CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.

Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Edge 1:

Press the edge 1 key to select the trigger edge: rising edge, and falling edge.

(1) Rising edge: Set to trigger at the rising edge of source 1.

(2) Falling edge: Set to trigger at the falling edge of source 1.

Source 2:

Press the source 2 key to select any of CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.

Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Edge 2:

Press PgDn → edge 2 key to select the trigger edge: rising edge, and falling edge.

(1) Rising edge: Set to trigger at the rising edge of source 2.

(2) Falling edge: Set to trigger at the falling edge of source 2.

Condition:

Press PgDn → condition to select: ">", "<", "< >", :> <".

(1) >: Triggers when the time difference ($\triangle$T) between the edge set by source 1 and the edge set by source 2 is greater than the set time limit.

(2) <: Triggers when the time difference ($\triangle$T) between the edge set by source 1 and the edge set by source 2 is less than the set time limit.

(3) < >: Triggers when the time difference ($\triangle$T) between the edge set by source 1 and the edge set by source 2 is greater than the set lower time limit and less than the set upper time limit.

(4) > <: Triggers when the time difference ($\triangle$T) between the edge set by source 1 and the edge set by source 2 is less than the set lower time limit and greater than the set upper time limit.

Time:

Press PgDn → time to choose: normal, upper time limit, and lower time limit.

(1) Normal: When the trigger condition is ">" or "<", this key can only be normal.

(2) Upper time limit: User can select this option when the trigger condition is "< >" or "> <".

(3) Lower time limit: User can select this option when the trigger condition is "< >" or "> <".

Setting:

Press the PgDn key and adjust the Multipurpose knob to set the time.

5.9 Timeout Trigger

Select the timeout trigger to trigger the signal that the time interval ($\triangle$T) from the rising edge (or falling edge) of the input signal crosses the trigger level to the adjacent falling edge (rising edge) crosses the trigger level is greater than the set timeout time. As shown in the following figure.
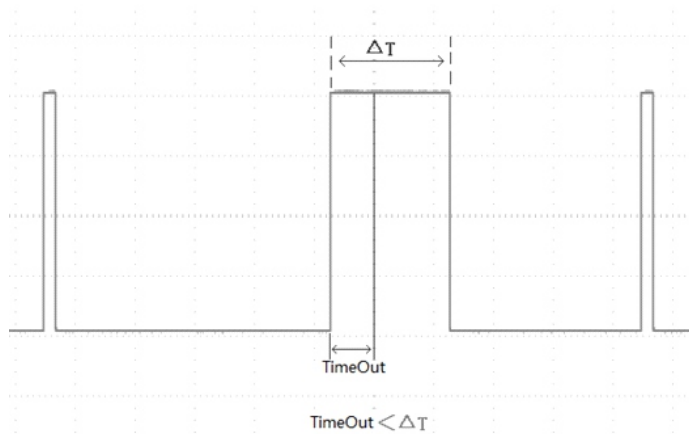
TimeOut

TimeOut $<\triangle T$

Press TRIG MENU → type , and select timeout by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information T ⬛ T∕DC 0.000μV is displayed at the upper right corner of the screen, the trigger type is timeout, the trigger source is CH1 and it is triggered at the rising edge, the trigger level is 0.00V.

Timeout Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Slope:
Press the slope key to select which edge the input signal will trigger on, you can select the rising edge, falling edge, and any edge. The currently edge type is displayed at the upper right corner of the screen.
(1) Rising edge: Set to start timing when the rising edge of the input signal passes the trigger level.
(2) Falling edge: Set to start timing when the falling edge of the input signal passes the trigger level.
(3) Any edge: Set to start timing when any edges of the input signal pass the trigger level.

Timeout Time:
Adjust the Multipurpose knob to set the timeout time.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

5.10 Duration Trigger

With duration trigger selected, the oscilloscope identifies the trigger condition by looking for the duration of the specified codes. The codes are the combination of channel logic "AND", and the value of each channel can be H (high), L (low), or X (ignored). When the duration ($\triangle T$) of the code meets a preset time, trigger occurs. As shown below.

Picture 5-7 Duration trigger

Press | TRIG MENU | → | type |, select duration by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information ▯▯ T✓DC 0.000μV is displayed at the upper right corner of the screen, the trigger type is duration, the trigger source is CH1 and it is triggered at the rising edge, the trigger level is 0.00V.

Duration Trigger Menu

Source:

Press the source button to select any of CH1, CH2, CH3, and CH4. The currently selected source is displayed at the upper right corner of the screen.

Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Code:

Press the code key to select H, L or X. The code setting of each channel is displayed at the bottom of the screen, as shown in the figure: .

(1) H: Set the code value of the selected channel to "High", that is, the voltage level is higher than the trigger level of the channel.

Dur: CH1 H L X H CH4

(2) L: Set the code value of the selected channel to "Low", that is, the voltage level is lower than the trigger level of the channel.

(3) X: Set the code value of the selected channel to "Ignored", that is, the channel is not part of the codes. The oscilloscope will not trigger if all channels in the codes are set to "ignored".

Condition:

Press the condition key to select: ">", "<", "< >".

(1) >: Triggers when the code duration is greater than the set time.

(2) <: Triggers when the code duration is less than the set time.

(3) < >: Triggers when the code duration is less than the set upper time limit and greater than the set lower time limit.

Time Setting:

Press | PgDn | → | time setting | to choose: normal, upper time limit, and lower time limit.

(1) Normal: When the trigger condition is ">" or "<", this key can only be normal.

(2) Upper time limit: User can select this option when the trigger condition is "< >".

(3) Lower time limit: User can select this option when the trigger condition is "< >".

Setting:

Press the | PgDn | key and adjust the Multipurpose knob to set the time.

Trigger Setting:

Please refer to the Trigger Setting in the Edge Trigger section for more details.

5.11 Setup/Hold Trigger

In setup/hold trigger, you need to set up the data signal line and clock signal line. The setup time begins when the data signal crosses the trigger level and ends when the specified clock edge arrives. The hold time begins when the specified clock edge arrives and ends when the data signal crosses the trigger level again (as shown below). The oscilloscope will trigger when the setup time or the hold time is less than the preset time.

Press `TRIG MENU` ➔ `type`, and select setup/hold by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information ![SHDC 0.000µV] is displayed at the upper right corner of the screen, the trigger type is setup/hold, the trigger source is CH1, and the trigger level is 0.00V.

Setup/Hold Trigger Menu

Data Source:
Press the data source button to select CH1, CH2, CH3, or CH4.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Code:
Press the code key to select H or L.
(1) H: Set the valid code of the data signal to high level.
(2) L: Set the valid code of the data signal to low level.

Clock Source:
Press the clock source button to select CH1, CH2, CH3, or CH4。
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Clock Edge:
Press the clock edge key to select the clock edge type: rising edge, or falling edge.
(1) Rising edge: Set the clock edge type to rising edge.
(2) Falling edge: Set the clock edge type to falling edge.

Setup/Hold:
Press `PgDn` ➔ setup/hold to select setup, hold, setup & hold.
(1) Setup: Triggers when the setup time is less than the set value.
(2) Hold: Triggers when the hold time is less than the set value.
(3) Setup & Hold: Triggers when the setup time and the hold time are less than the set value.

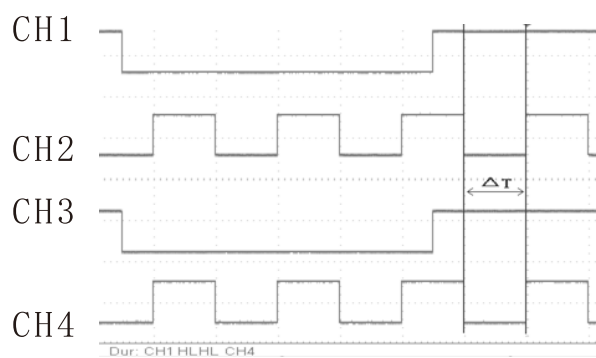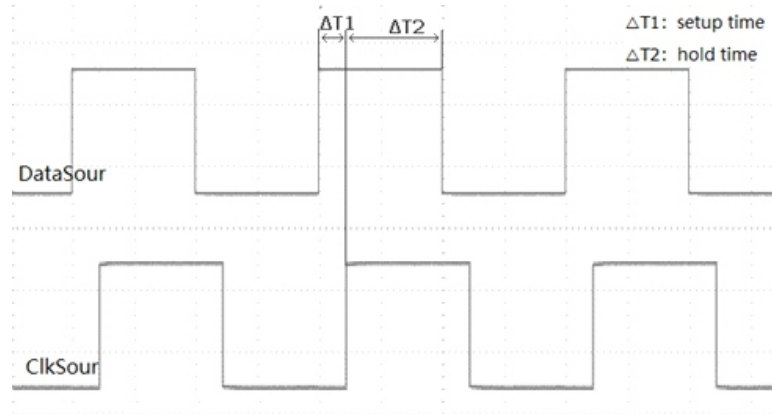**Time:**
Press the `PgDn` key and adjust the Multipurpose knob to set the time.

Trigger Setting:
Please refer to the **Trigger Setting** in the Edge Trigger section for more details.

5.12 Nth Edge Trigger

The Nth edge trigger is triggered on the Nth edge after the specified idle time. For example, in the following waveform, it is set to trigger on the 2nd rising edge after the specified idle time (the time between two adjacent rising edge), then set the idle time as P< idle time <M, M is the time between the 1st rising edge and the next rising edge, P is the maximum time between the counting rising edge.
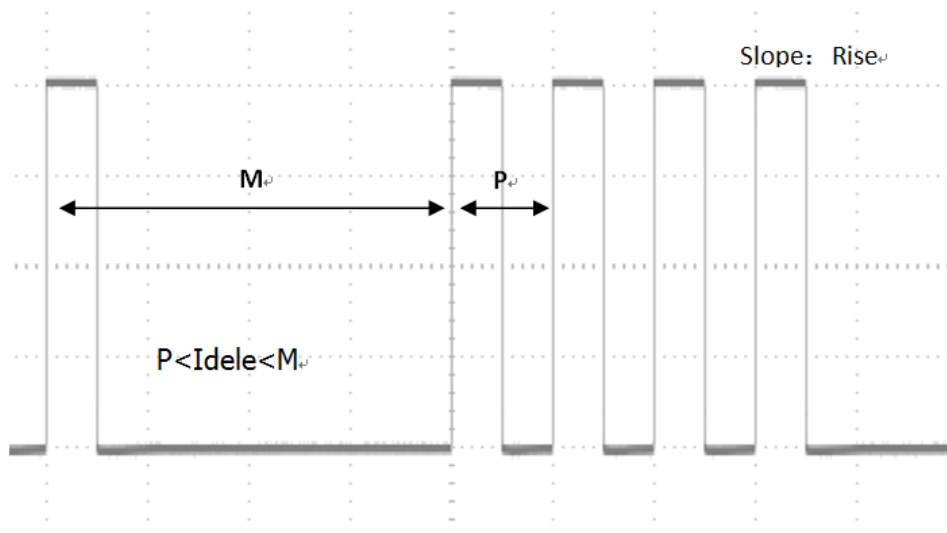
Press ☐TRIG MENU → ☐type , and select Nth edge by the Multipurpose knob. You can also switch trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information ☐ is displayed at the upper right corner of the screen, the trigger type is Nth edge, the trigger source is CH1, it is triggered at the rising edge and the trigger level is 0.00V.

Nth Edge Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3, or CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Slope:
Press the slope key to select which edge the input signal will trigger on, you can select the rising edge, falling edge, and any edge. The current edge type is displayed at the upper right corner of the screen.
(1) Rising edge: Set to trigger on the rising edge of the signal.
(2) Falling edge: Set to trigger on the falling edge of the signal.

Idle Time:
Adjust the Multipurpose knob to set the idle time.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

Edge Value:
Press the PgDn key and adjust the Multipurpose knob to set the number of edges.

5.13 Code Pattern Trigger

The code pattern trigger identifies the trigger condition by looking for the specified code patterns. The code type is the combination of the channel logic "AND", each channel can be set to H (high), L (low), X (ignored). You can also specify a path in the code type as a rising edge or falling edge (only one edge can be specified). If the code patterns of the other channels are "true" (i.e., the actual code is consistent with the default code type), the oscilloscope will trigger on the specified edge. If the edge is not specified, the oscilloscope will trigger at the last edge of the code type "true". If the code patterns of all channels are set to "ignore", the oscilloscope will not trigger.
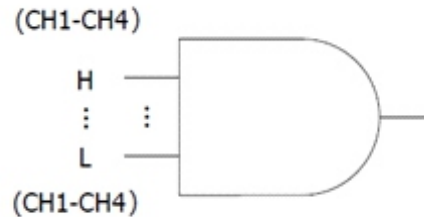
Press TRIG MENU → type , and select code pattern by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information $\boxed{\text{T}}$ $\boxed{\text{0 } \text{P}_a\text{DC 0.000µV}}$ is displayed at the upper right corner of the screen, the trigger type is code pattern, the trigger source is CH1, and the trigger level is 0.00V.

Nth Edge Trigger Menu

Source:
Press the source button to select any of CH1, CH2, CH3, or CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger.

Code Pattern:
Press the code key to select H, L, X, rising edge, or falling edge. The code pattern setting of each channel is displayed at the bottom of the screen, as shown: Par: CH1 HHHH CH4 。

(1) H: Set the code pattern value of the selected channel to "High", that is, the voltage level is higher than the trigger level of the channel.
(2) L: Set the code pattern value of the selected channel to "Low", that is, the voltage level is lower than the trigger level of the channel.
(3) X: Set the code pattern value of the selected channel to "Ignored", that is, the channel is not part of the code pattern. The oscilloscope will not trigger if all channels in the code pattern are set to "ignored".
(4) Rising edge: Set the code pattern to the rising edge of the selected channel.
(5) Falling edge: Set the code pattern to the falling edge of the selected channel.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

Chapter 6 Protocol Decoding

UPO2000E decodes the input signals of the analog channels using common protocols, including parallel, RS232, I2C, SPI. Users can easily find errors, debug hardware, and speed up development progress by protocol decoding, which provides guarantees for completing projects with high speed and high quality.

6.1 RS232 Decoding

RS232 interface is the standard asynchronous transmission interface established by Electronic Industries Association. Normally, there are two application types: DB-9 and DB-25, it is suitable for data transmission rate between 0 to 20000b/s, which are widely used in PC communication interface. According to the protocol, the data will be combined to form a group of specific serial bits, and sent out using asynchronous serial method. The data sent each time is composed according to the following rules: a start bit is sent first, followed by 5~8 data bits, then an optional parity bit, and finally 1 or 2 stop bits. The data bits size should be decided by the two communication parties, which can be chosen between 5 to 8 data bits; there may be no parity bits, or the odd parity or even parity can be selected; and the stop bit can be 1 bit or 2 bits. In the following instruction, a data string transmission is called one frame, shown in the figure below:
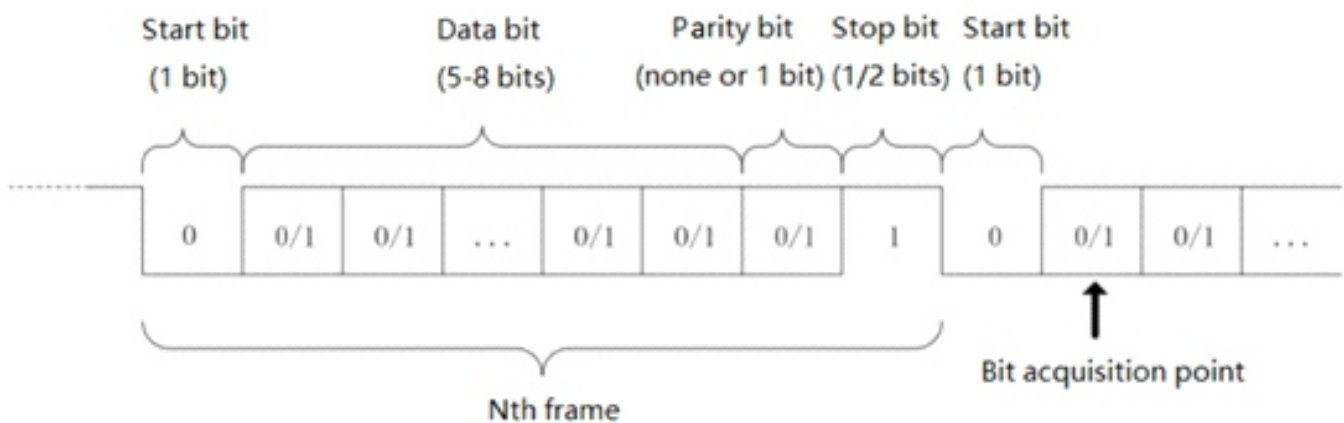
Rs232 Selection:
Press DECODE → type, and select RS232 by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

Source:
Press the source button to select any of CH1, CH2, CH3, or CH4. The currently selected source is displayed at the upper right corner of the screen.
Note: Only selecting the channel with connected signals as a trigger source can obtain a stable trigger and correct decoding.

Polarity:
Press the polarity button to choose the trigger polarity: positive polarity or negative polarity.
(1) Negative polarity: Opposite logic level polarity, i.e. high level is 0, low level is 1.
(2) Positive polarity: Normal logic level polarity, i.e. high level is 1, low level is 0.

Bit Width:
Specifies the data bit width of the RS232 protocol signal that needs to be decoded.
Press bit width to select 5bits, 6bits, 7bits, or 8bits.

Baud Rate:

RS232 communication is an asynchronous transmission communication without clock signals during the data transmission process. In order to solve the data bit problems, the protocol specifies that both communication parties need to agree on the baud rate. Normally, the baud rate is defined as bits transmitted within 1 second. For example, 9600bps means that 9600 bits can be transmitted within 1 second. Note that the start bit, data bit, parity bit and stop bit are all regarded as bits. Therefore, baud rate is not directly equal to valid data transmission rate. The oscilloscope will sample the Bit value according to the set baud rate.

Press the polarity button to select 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, or user-defined, which users adjust the baud rate by the Multipurpose knob

It is recommended to make reasonable settings based on your RS232 communication hardware and software. Limited by the basic model of the transmission protocol, the RS232 protocol is usually used in short distance (below 20m) and low speed (1Mbps) transmission occasions. Communication beyond these ranges can be disturbed easily or become unreliable.

Bit Sequence:

Specify high bytes in front (MSB) or low bytes in front (LSB) to be the data bits of the RS232 protocol signal that needs to be decoded.
Press PgDn → bit sequence to select MSB or LSB.
(1) MSB: The high byte of the data transmits first.
(2) LSB: The low byte of the data transmits first.

Stop Bit:

Press PgDn → stop bit to set the stop bit for each frame of data, you can set it to 1 bit or 2 bits.

Parity:

Press PgDn → parity to set the parity mode for data transmission, you can choose none, even parity or odd parity.

Trigger Condition:

Press PgDn → trigger condition to select start of frame, error frame, parity error, and data.
(1) Start of Frame: The waveform trigger is at the start bit of the RS232 protocol (refer to figure). Stable waveforms can be observed by choosing the start of frame trigger when single string signals or multiple same string signals are sent. If the data being sent is changing, the waveform will also change correspondingly.
(2) Error Frame: 0 occurs in the stop state or a data error occurs in the middle of the data bits during the receiving process.
(3) Parity Error: Set the RS232 parity bit to 0 or 1 according to the parity principles, the principles are as follows:
    Odd Parity: If the total number of 1 in the data bits and parity bits is odd, the transmission is correct.
    Even Parity: If the total number of 1 in the data bits and parity bits is even, the transmission is correct.
    With this option, you can quickly find the parity errors during the RS232 communication process, which is convenient for fault analysis and positioning.
(4) Data: Triggers when the data acquired by the oscilloscope is equal to the 2 hexadecimal values set by the user. With this option, you can quickly find the transmission signal with specific data that you are interested in.

Data:

Valid when the trigger condition is data, it can be 00 ~ FF (hexadecimal number).
Set the data using the Multipurpose knob.

Decode Bus:

Press PgDn → decode bus to enter the decode bus menu.
(1) Bus Status: Set the decode bus to on or off.
(2) Display Format: Set the display format of decode bus, you can set hexadecimal, decimal, binary or ASCII.

(3) Event List: Displays the decoded data, corresponding line number, time and error information of the data line in a tabular form for easily observe the longer decoded data.

(4) Pseudo Square Wave: Select on and the bus shows a square wave with logic 1 for high level and logic 0 for low level.

(5) Vertical Position: Adjust the Multipurpose knob to change the bus display position.

(6) Data Packet: After the device is paused, user can view the decoded data packets.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

6.2 I2C Decode

I2C protocol is usually used to connect a microcontroller and its peripheral equipment, and it is widely used in the field of microelectronics communication control. The bus protocol uses two lines to transmit. One is serial data line SDA, the other is serial clock line. The host-slave mechanism is adopted, which is a 2-way communication between host and slave. The bus is multi-host which prevents data destruction through collision detection and arbitration mechanism. It's remarkable that I2C bus has two kinds of address width: 7 bits and 10 bits. The two are compatible and can be combined. Both SCL and SDA are connected to power through pull-up resistors. When the bus is vacant, the two lines are at high level. When any component of bus outputs low level, the bus signals will become low. That is to say, the signals of multi-components are wired AND logic. The special logic relationship is the key point to realize bus arbitration. The protocol requires that data SDA should keep stable when clock line SCL is high. Normally, the data is transmitted by MSB format, as shown below:
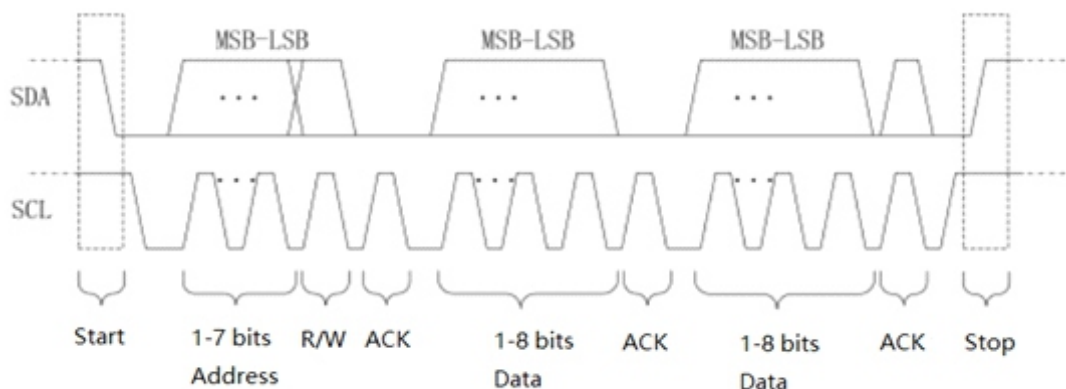
I2C Selection:
Press DECODE ➝ type , and select I2C by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

SCL Source:
Press the SCL source button to select the SCL source, you can set any of CH1~CH4 as the clock input of I2C.

SDA source:
Press the SDA source button to select the SDA source, you can set any of CH1~CH4 as the data input of I2C.

Address Mode:
Press the address key to select the address mode and set the address bit width of I2C signal that needs to be triggered, you can select 7bits or 10bits.

Operation Direction:
Press PgDn ➝ operation direction to select write or read.
(1) Write: Triggers when the "read/write" bit of the I2C protocol is "write".
(2) Read: Triggers when the "read/write" bit of the I2C protocol is "read".

Trigger Condition:
Press PgDn → trigger condition to set the I2C trigger condition: Start, restart, stop, loss, address, data, address & data.
(1) Start: Triggers at the start time, that is, while the SCL is in high level, the SDA signal has a falling edge.
(2) Restart: Triggers at the restarting moment, that is, after a start signal, and before it stops, the start signal appears again.
(3) Stop: Triggers when the stop bit occurs, that is, while the SCL is in high level, the SDA signal jumps from low to high.
(4) Loss: In I2C protocol, every time after 8 bits of information are transmitted, the data receiver needs to send an acknowledgement signal, which is the ACK bit in the above figure when the SCL is in high level, the SDA signal is low. The loss trigger will occur while the SCL and SDA signal at the ACK bit are both high.
(5) Address: Triggers when the communication address is the same with the user setting address. It can help to quickly locate the address transmission.
(6) Data: Triggers when the detected data is equal to/ greater than/ less than/ not equal to the set Value. This feature is convenient for the data analysis and can capture the abnormal data.
(7) Address & Data: Triggers when the addresses are the same and the data relationship meets the set conditions during the transmission process. This trigger condition makes it easy to implement the I2C's specified address and data trigger, and help to analyze the transmission.

Address:
Press PgDn → address, and set the data address by Multipurpose knob. The ranges are 0~0x7F, 0~0xFF and 0~0x3FF depend o different setttings in address mode.

Data Setting:
Press PgDn → data setting to enter the data setting menu.
(1) Comparison condition: Used to determine the data, you can select ">", "<", "=".
   >: Valid when the trigger condition is data or address/data, triggers when the actual I2C protocol data is greater than the set data.
   <: Valid when the trigger condition is data or address/data, triggers when the actual I2C protocol data is less than the set data.
   =: Valid when the trigger condition is data or address/data, triggers when the actual I2C protocol data is equal to the set data.
(2) Bytes: Valid when the trigger condition is data or address/data, set the data byte size of the specified data from 1 ~ 5.
(3) Data: Valid when the trigger condition is data or address/data, each byte length can be set from 00 ~ FF (hexadecimal number). You can set the data by the Multipurpose knob, and press the back key to return to the previous setting menu.

Decode Bus:
Please refer to the RS232 Decode Bus.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

6.3 SPI Decode

SPI interface is a kind of synchronous serial peripheral interface, which can make the host and all kinds of peripheral equipment undertake communication through the serial methods. It is a kind of synchronous communication bus of full duplex. It usually uses four signal lines: MOSI: the host data output, the slave data input; MISO: the host data input, the slave data output; SCLK: clock signal generated by the host; CS: the slave chip selection enable signal.

SPI interface is mainly used for synchronous serial data transmission between the host and low speed peripheral devices. Under the shift pulse of the host, the data is transmitted in bits, that is to say, higher bit first and then lower bit. Since the SPI interface does not need to look for the slave address and is full duplex communication, the protocol itself is relatively simple and therefore is widely used. SPI protocol transmission is shown in the following picture:
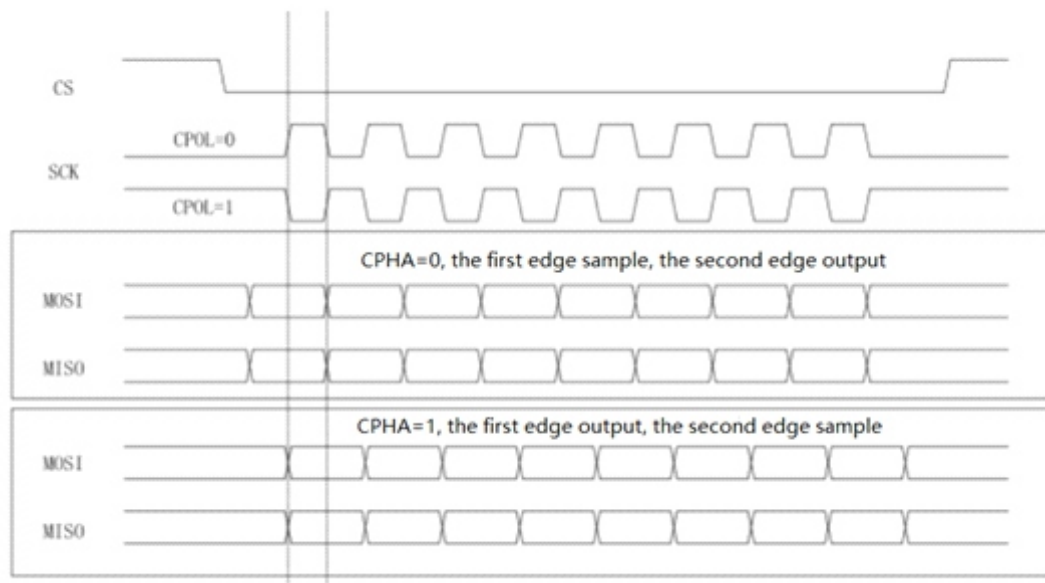
Note: At least 3 output channels are required. Therefore, this function is only available on the 4-channel product of UPO2000E series oscilloscopes.

SPI Selection:
Press ⌈DECODE⌋ → ⌈type⌋, and select SPI by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

CS Source:
Press the CS source button to set any of CH1~CH4 as the chip select input of the SPI decoded signal.

SCLK Source:
Press the SCLK source button to set any of CH1~CH4 as the clock input of the SPI decoded signal.

MOSI Source:
Press the MOSI source button to set any of CH1~CH4 as the data MOSI input of the SPI decoded signal.

MISO Source:
Press the MISO source button to set any of CH1~CH4 as the data MISO input of the SPI decoded signal.

CS Polarity:
Press ⌈PgDn⌋ → ⌈CS polarity⌋, to set the polarity of the chip select signal: positive polarity or negative polarity.
Positive polarity: Valid when the chip select signal is positive.
Negative polarity: Valid when the chip select signal is negative.

SCLK Edge:
Press PgDn → SCLK edge to set the clock signal edge: rising edge or falling edge.
Rising edge: Triggers at the rising edge of the clock signal.
Falling edge: triggers at the falling edge of the clock signal.

MOSI Polarity:
Press PgDn → MOSI polarity to set the MOSI polarity of the data signal: positive polarity or negative polarity.

MISO Polarity:
Press PgDn → MISO polarity to set the MISO polarity of the data signal: positive polarity or negative polarity

Bit Sequence:
Press PgDn → bit sequence to set the the data bits of the SPI protocol signal are high bytes in front (MSB) or low bytes in front (LSB).

Bit Width:
Press PgDn → bit width to set the bid width of each frame of the SPI protocol signal, it can be 4 ~ 16.

Trigger Condition:
Press PgDn → trigger condition to set the SPI trigger condition: Enable chip select or idle time.
Enable chip select includes CS, CS & MOSI, CS & MISO, CS & Any. It triggers on the edge where the chip select level jumps from invalid to valid.
Idle time includes Idle, Idle & MISO, Idle & MOSO, and Idle & Any. The idle trigger is triggered at the beginning of a new segment of data after a certain idle time.

Idle Time:
Press PgDn → idle time and adjust the Multipurpose knob (shuttle knob or numeric keypad) to set the idle time, the idle time counter counts when the SCK is unchanged, and judges whether the count value exceeds the preset value at the SCK valid edge, if exceeds, the oscilloscope will trigger at the valid edge and clear the counter.

Frame Length:
Press PgDn → frame length and adjust the Multipurpose knob to set the length of the data frame.

Data:
Press PgDn → data and adjust the Multipurpose knob to set the data, press the knob to jump to the next digit to adjust.

Decode Bus:
Please refer to the RS232 Decode Bus.

Trigger Setting:
Please refer to the Trigger Setting in the Edge Trigger section for more details.

Chapter 7 Mathematical Operations

UPO2000E series oscilloscope carries a variety of mathematical operations:
- Math: Source 1 + source 2, source 1 - source 2, source 1 * source 2, source 1 / source 2
- FFT: Fast Fourier Transform
- Logic operation: AND, OR, NOT, XOR
- Digital filter
- Advanced operation

Press the ☐MATH☐ button on the vertical control area to enter the mathematical operation menu. The ☐POSITION☐ and the ☐SCALE☐ knobs can be used to change the vertical position and the vertical scales of the waveforms. The horizontal time base scale cannot be adjusted independently for the math operation waveforms, it will change automatically according to the horizontal time base scale of the analog input channel.

Math operation cursor ☐M☐ marks the result of a mathematical operation.

7.1 Mathematical Function

Press ☐MATH☐ → ☐type☐, and select math to enter the math menu.

Source 1:

Press the source 1 key to select any of CH1, CH2, CH3 or CH4 as source 1 of mathematical operations.

Operator:

Press the operator key to select "+", "-", "*", "/".
(1) +: The waveforms of source 1 and source 2 are added point by point.
(2) -: The waveforms of source 1 and source 2 are subtracted point by point.
(3) *: The waveforms of source 1 and source 2 are multiplied point by point.
(4) /: The waveforms of source 1 and source 2 are divided point by point.

Source 2:

Press the source 2 key to select any of CH1, CH2, CH3 or CH4 as source 2 of mathematical operations.

7.2 FFT

Using FFT (Fast Fourier Transform) mathematical operations, the time domain signal (YT) can be converted into frequency domain signal. The following types of signals can be easily observed using FFT:
- Harmonic content and distortion in measurement system
- Performance of noise in DC power supply
- Vibration Analysis
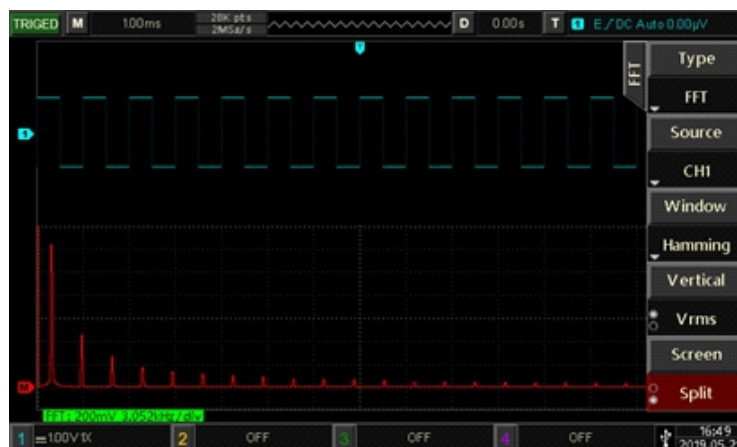
Picture 5-1FFT frequency spectrum

Press MATH → type and select FFT to enter the FFT menu.

Source:
Press the source button to select any of CH1, CH2, CH3 or CH4 as the source of FFT operations.

Window:
Window function, press the window key to select Hamming, Blackman, Rectangle, or Hanning.
(1) Rectangle: It has the best frequency resolution and the worst amplitude resolution, which is similar to the one with no window. It is suitable for measuring the following waveforms:
- Transient or short pulse, the signal level is almost equal before and after this.
- Equal amplitude sine wave with very similar frequency.
- Wide-band random noise in a slowly changing spectrum.
(2) Hanning: Compared with the rectangle window, it has better frequency resolution, but poorer amplitude resolution. It is suitable for measuring sine, periodic and narrow-band random noise waveforms.
(3) Hamming: The frequency resolution is slightly better than that of Hanning window, and it is suitable for measuring transient or short pulse, and the waveform with great difference before and after the signal level.
(4) Blackman: It has the best amplitude resolution, and the worst frequency resolution. It is suitable for measuring the single frequency signals or seeking higher harmonics.

Vertical Unit:
The unit of the FFT operation result. Press vertical unit to select Vrms or dBVrms. Vrms and dBVrms display the vertical amplitude in a logarithmic way and a linear way. If you need to display the FFT spectrum in a large dynamic range, dBVrms is recommended.

Screen Setting:
Press the screen setting key to set full screen or split screen.
(1) Split screen: Displays the source waveform and the waveform of FFT operation result separately.
(2) Full screen: Displays the source waveform and the FFT operation results on the same window that you can observe the spectrum more clearly and make more accurate measurements.

FFT Operation Tips
Signals with DC components or deviations can cause errors or deviations in the FFT waveform components. To reduce the DC component, the channel can be set to AC coupling.
To reduce the random noise and aliasing frequency components of the repetitive or single pulse, you can set the oscilloscope acquisition mode to average acquisition.

7.3 Logic Operation

Press MATH → type and select logic operation to enter its menu.

Expression:
Press the Expression key to select AND, OR, NOT, XOR.
(1) AND: Performs "AND" logic operation for every point of source 1 and source 2.
(2) OR: Performs "OR" logic operation for every point of source 1 and source 2.
(3) NOT: Performs "NOT" logic operation for every point of source 1, source 2 will not be displayed at this moment.
(4) XOR: Performs "XOR" logic operation for every point of source 1 and source 2.
Performs logic operations for all points of the source waveform voltage and displays the results. During operation, when the source channel voltage value is greater than the threshold value, it is determined as logic "1", otherwise it is logic "0". Converting waveforms to binary for logical operations is shown below:

Source 1	Source 2	AND	OR	XOR		Source1	NOT
0	0	0	0	0		0	1
0	1	0	1	1		1	0
1	0	0	1	1			
1	1	1	1	0			

Source 1:

Press the source 1 key to select any of CH1, CH2, CH3 or CH4 as source 1 of logic operations.

Source 2:

Press the source 2 key to select any of CH1, CH2, CH3 or CH4 as source 2 of logic operations.

Invert:

Press the invert key to select on or off. Select on to invert the waveform of the logic operation.

Threshold 1:

Press the $\boxed{\text{PgDn}}$ key, and adjust the Multipurpose knob to change the value of Threshold 1. When the voltage value of the source channel is greater than the value of Threshold 1, it is identified as logic "1", otherwise it is logic "0".

Threshold 2:

Press the $\boxed{\text{PgDn}}$ key, and adjust the Multipurpose knob to change the value of Threshold 2. When the voltage value of the source channel is greater than the value of Threshold 2, it is identified as logic "1", otherwise it is logic "0".

7.4 Digital Filter

Press $\boxed{\text{MATH}} \longrightarrow \boxed{\text{type}}$, select digital filter to enter its menu.

Source:

Press the source button to select any of CH1, CH2, CH3 or CH4 as the source of digital filter.

Filter Type:

Press the filter type key to select low pass, high pass, band pass or band stop.

(1) Low pass: Only signals with the source frequency lower than the current frequency upper limit are allowed to pass.

(2) High pass: Only signals with the frequency higher than the current frequency lower limit are allowed to pass.

(3) Band pass: Only signals with the frequency higher than the current frequency lower limit and lower than the current frequency upper limit are allowed to pass.

(4) Band stop: Only signals with the frequency lower than the current frequency lower limit or higher than the current frequency upper limit are allowed to pass.

Frequency Lower Limit:

Adjust the Multipurpose knob to change the value of the frequency lower limit. When in low pass, the frequency lower limit is invalid and the menu is hidden.

Frequency Upper Limit:

Adjust the Multipurpose knob to change the value of the frequency upper limit. When in high pass, the frequency upper limit is invalid and the menu is hidden.

Note: The setting range of the frequency upper and lower limit is related to the current horizontal time base.

7.5 Advanced Operation

Press MATH   type, select advanced operation to enter its menu.

Expression:

Press the expression key to select on or off. If you select on, it will pop up a Math-Advance dialog box, as shown below:
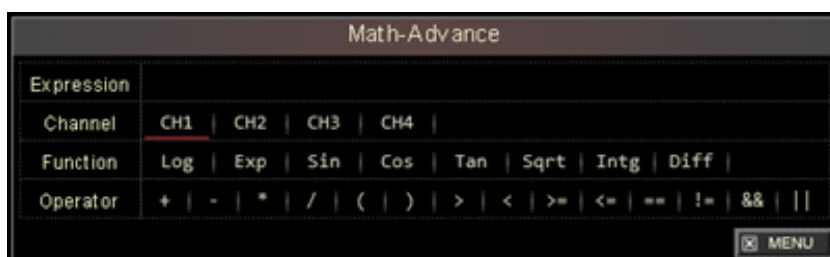
Adjust the Multipurpose knob to select "Channel", "Function", or "Operator", then press the knob to display the options in the list after Expression.

When editing the expression, you can press the delete key to delete the characters in the list after expression, press the clear key to clear all the characters in the list after expression.

After the expression is edited, press the apply key and the oscilloscope will perform calculations based on the set expression and display the result. Press the expression key to close in order to observe the result of the expression operation.

Math-Advance Description

(1) Expression: Here refers to the formula consisting of channels, functions, variables, and operators.
The length of the expression must not exceed 36 characters.
(2) Channel: You can select CH1, CH2, CH3, or CH4.
(3) Function: Function options are as follows:

Functions	Descriptions
Log	Calculates the logarithm of the selected source.
Exp	Calculates the index of the selected source.
Sin	Calculates the sine value of the selected source.
Cos	Calculates the cosine value of the selected source.
Tan	Calculates the tangent value of the selected source.
Sqrt	Calculates the square root of the selected source.
Intg	Calculates the integral of the selected source.
Diff	Calculates the discrete-time differential of the selected source.

Note: The device automatically adds "(" after a function is entered, it will be more convenient for your use.

(4) Operator: The description of each operator is as follows:

Functions	Descriptions
+, -, *, /	Arithmetic operators: add, subtract, multiply, divide.
( )	Parenthesis, it is used to increase the operation priority within parenthesis.
<, >, <=, >=, ==, !=	Relational operators: less than, greater than, less than or equal to, greater than or equal to, equal, not equal to.
||, &&	Logical operators: or, and.

Chapter 8 Display System Settings

8.1 Waveform Display Setting

You can set the waveform display type, display format, duration, grid brightness, waveform brightness, and color temperature.

Display Type:
Press DISPLAY ➜ type to select vector or point display.
(1) Vector: This mode provides the most realistic waveforms in most cases, allowing users to easily view the steep edges of the waveforms (such as square waves).
(2) Point: Displays the sampling points directly.

Display Format:
Press DISPLAY ➜ format to select YT, XY 1&2, XY 3&4.
(1) YT: Displays voltage value on time scale (horizontal scale).
(2) XY 1&2: Displays the Lissajous figure of CH1~CH2 waveforms, you can easily measure the phase difference between the two signals of the same frequency.
(3) XY 3&4: Displays the Lissajous figure of CH3~CH4 waveforms, you can easily measure the phase difference between the two signals of the same frequency. (Only for 4-channel models).

Grid Brightness:
Press DISPLAY ➜ grid brightness , and adjust the Multipurpose knob to set the grid brightness.

Waveform Brightness:
Press DISPLAY ➜ waveform brightness , and adjust the Multipurpose knob to set the waveform brightness.

Persist:
Press DISPLAY ➜ persist to select MIN, 50ms, 100ms, 200ms, 500ms, 1s, 5s, 10s, 20s or infinite.

Color Temperature:
Press DISPLAY ➜ PgDn ⟶ color temperature , select on and it will directly reflect the probability of waveform signal occurrence. A waveform with a high frequency of occurrence is displayed in warm colors, and a waveform with a low frequency of occurrence is displayed in cool color.

Inverse Color Temperature:
Press DISPLAY ➜ PgDn ⟶ inverse color temperature and select on, this function is opposite to the color temperature function.
Note: The inverse color temperature is available only when the color temperature is set to on.

8.2 XY Mode

The waveform displayed in XY mode is also called the Lissajous figure.

When XY 1&2 are selected, the CH1 signal is input on the horizontal axis (X axis), and the CH2 signal is input on the vertical axis (Y axis).
When XY 3&4 are selected, the CH3 signal is input on the horizontal axis (X axis), and the CH4 signal is input on the vertical axis (Y axis). Only 4-channel models have this function.

In X-Y mode, when CH1 or CH3 is activated, use the horizontal POSITION knob to move the XY figure in the horizontal direction. When CH2 or CH4 is activated, use the vertical POSITION knob to move the XY figure in the vertical direction.

Adjust the vertical SCALE knob to change the amplitude of each channel, and adjust the horizontal SCALE knob to change the time base to get a better display effect of the Lissajous figures. The waveform in XY mode is shown in the following figure:
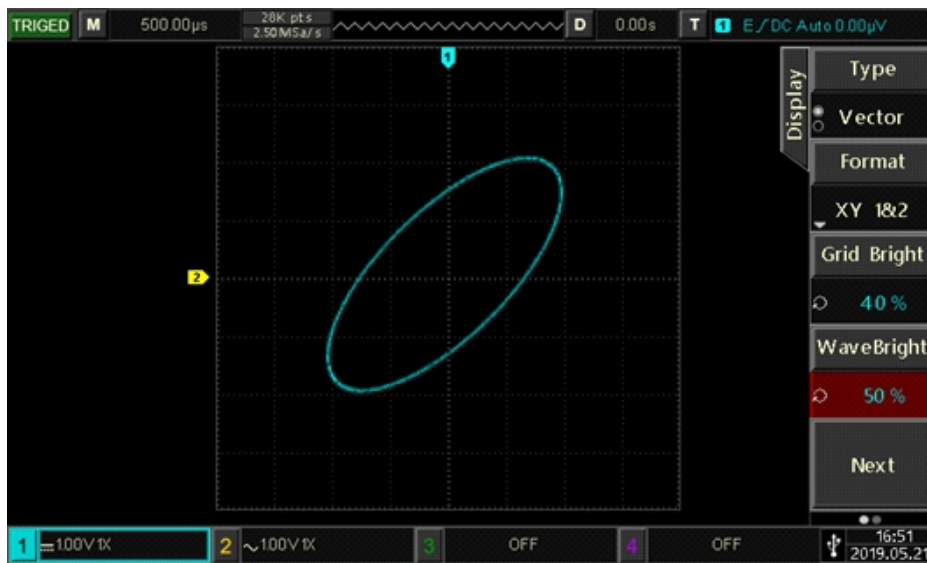
Picture 7-1 Waveform display in XY mode

8.3 Application of XY Mode

The Lissajous method makes it easy to observe the phase difference between two signals of the same frequency. The following figure shows the observation of phase difference.
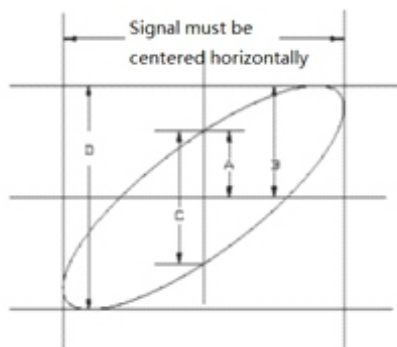
According to sinθ = A/B or C/D, θ is the phase difference angle between channels, and the definition of A, B and C, D are shown above, it can be calculated that the phase difference angle θ = ± arcsin (A/B) or θ = ± arcsin (C/D). If the main axis of the ellipse is in the quadrants I, III, then the calculated phase difference angle should be in the quadrants I, IV, i.e. within (0~π/2) or (3π/2~2π); If the main axis of the ellipse is in the quadrants II, IV, then the calculated phase difference angle should be within (π/2~π) or (π~3π/2).

In addition, if the frequency or phase difference of the two detected signals is an integer, the frequency and the phase relationship between the two signals can be calculated according to the pattern in the following chart:

Chapter 9 Automatic Measurement

9.1 Parameter Measurement

UPO2000E series oscilloscope can automatically measure 34 kinds of parameters.

Voltage:
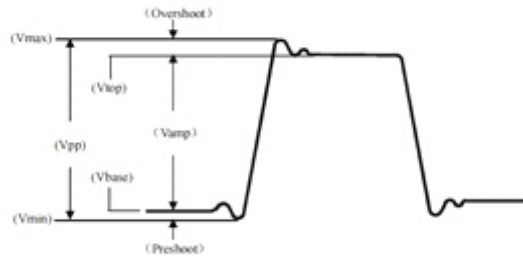
Vmax: Voltage value from the highest point to GND.
Vmin: Voltage value from the lowest point to GND.
Vtop: Voltage value from the flat top to GND.
Vbase: Voltage value from the bottom to GND.
Middle: (Vtop + Vbase) / 2
Vpp: Vmax – Vmin
Vamp: Vtop – Vbase
Mean: Average amplitude of the waveform on screen
CycMean: Average amplitude of the waveform in one period
RMS: The effective value. According to the energy produced by the AC signal in the conversion, the equivalent energy that the DC voltage corresponds to.
CycRMS: The RMS of one period.

Time:
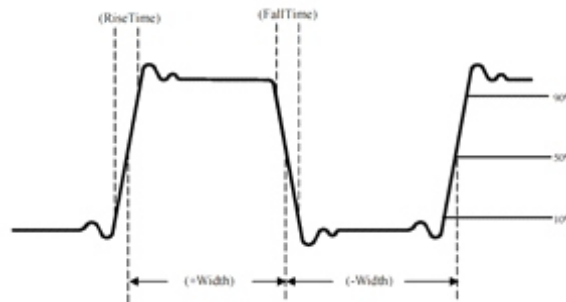
Period: Time between two consecutive, same-polarity edges of a repetitive waveform.
Frequency: The reciprocal of the period
Rise time: Time needed for waveform amplitude rising from 10% to 90%.
Fall time: Time needed for waveform amplitude falling from 90% to 10%.
+Width: The width of a positive pulse at 50% amplitude
-Width: The width of a negative pulse at 50% amplitude

FRR: Time from the first rising edge of source 1 to the first rising edge of source 2
FRF: Time from the first rising edge of source 1 to the first falling edge of source 2
FFR: Time from the first falling edge of source 1 to the first rising edge of source 2
FFF: Time from the first falling edge of source 1 to the first falling edge of source 2
LRF: Time from the last rising edge of source 1 to the last falling edge of source 2
LRR: Time from the last rising edge of source 1 to the last rising edge of source 2
LFR: Time from the last falling edge of source 1 to the last rising edge of source 2
LFF: Time from the last falling edge of source 1 to the last falling edge of source 2

Others:

+Duty: Ratio of positive pulse width to period.

-Duty: Ratio of negative pulse width to period.

OverSht: (Vmax - Vtop) / Vamp

PreSht: (Vmin - Vbase) / Vamp

Area: Algebraic sum of the voltage and time product of all points on the screen.

CycArea: The area of one period.

Phase: The phase difference between the master source and the slave source.

9.2 Automatic Measurement Menu

Press the MEASURE button on the front panel to enter the automatic measurement menu.

Automatic Measurement Menu (page 1)

Functions	Options	Descriptions
Signal Source	Ch1, CH2, CH3, CH4, MATH	Select any of CH1, CH2, CH3, CH4, MATH for automatic parameter measurement
All Parameters	Off	Close all parameters
	On	Pops up a dialog box of all parameters on the waveform display area
User Defined		A user-defined parameter selection interface pops up on the waveform display area, adjust the Multipurpose knob to select and press the knob to confirm to show the parameter on the screen. Press the user defined key again to close the user-defined parameter dialog box.
Measurement Statistical Analysis	Off	Close measurement statistical function.
	Peak	Automatic calculates and displays the current user defined parameters of the average, maximum, and minimum. Only applicable when user defined parameters are present.
	Difference	Automatic calculates and displays the current user defined parameters of the average, standard deviation, and measurement times. Only applicable when user defined parameters are present.

Automatic Measurement Menu (page 2)

Functions	Options	Descriptions
Signal Source	Ch1, CH2, CH3, CH4, MATH	Select signal source 2 that needs 2 channels for measurement
Indicator Selection		Adjust the Multipurpose knob to select the parameter indicated by the indicator among the 34 parameters of automatic measurement.
Indicator	Off	Close indicator.
	On	Indicates physical significance of indicator parameters intuitively by line
Clear		Clear all user defined parameters.

9.3 All Parameters Measurement

Press MEASURE → all parameters , select on to measure 34 parameters at one time, as shown below:

Measured parameters colors are consistent with the current channel (source).
When "----" is shown, it indicates that the current source has no signal input, or the measurement result is not valid (too large or too small).

9.4 User Defined Parameters

Press MEASURE → user defined , the user-defined parameter selection interface is displayed. As shown below:
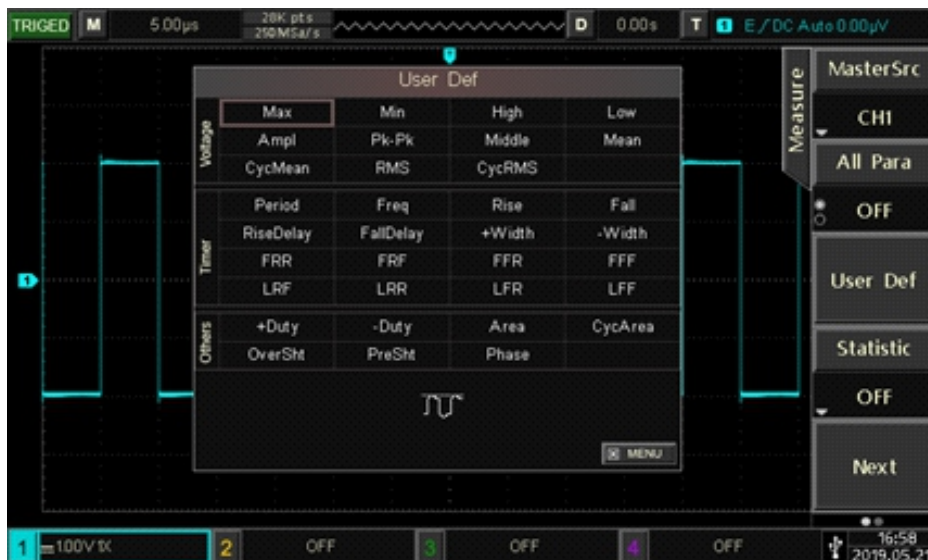
Select the parameters by adjusting the Multipurpose knob, and press the knob to confirm. For every selected parameter, a * symbol will appear in front of the parameter.

Press the user defined (F3) key to close the user defined parameter selection menu and the parameters will be displayed at the bottom of the screen. For convenience and immediate view of the automatic measurement results of these parameters, up to 5 parameters can be defined at the same time.

Users can also choose to open the measurement statistical function with the measurement statistical (F4) key, as shown below:

Chapter 10 Cursor Measurement

The cursor can be used to measure the X axis value (time) and the Y axis value (voltage) of the selected waveform. Press the CURSOR button to enter the cursor measurement menu.

10.1 Time Measurement

Press the CURSOR key to enter the cursor measurement menu, then press type to select time; press source to select the channel to be measured; press mode to select independent (default). As shown in the figure below:
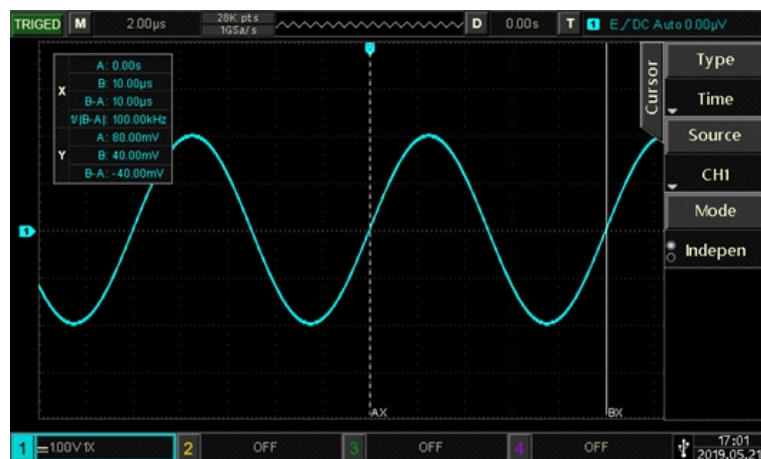
The upper left corner of the display area shows the cursor measurement information:
"X" indicates the time measurement, and "Y" indicates the voltage measurement.

Time:
Adjust the Multipurpose knob to move the vertical cursor AX, press the knob to switch to cursor BX, the adjustment method of cursor BX is the same as AX.
BX-AX: The time of measurement.
1/|BX-AX|: The reciprocal of time, or frequency.
For a periodic signal, if the AX and BX are set at the same position on the rising edge of two adjacent cycles, then BX-AX is the period of the signal, and 1/|BX-AX| is the frequency of the signal.

Voltage:
Indicates the waveform voltage value of the current cursor position, that is, AY, BY, and BY-AY.
Press mode to select tracking, adjust the Multipurpose knob and the cursor AX and BX will move simultaneously.

10.2 Voltage Measurement

The method for voltage measurement is similar to the method for time measurement, only that the vertical cursor becomes the horizontal cursor.

Press the CURSOR key to enter the cursor measurement menu, then press type to select amplitude; press source to select the channel to be measured; press mode to select independent (default). As shown in the figure below:
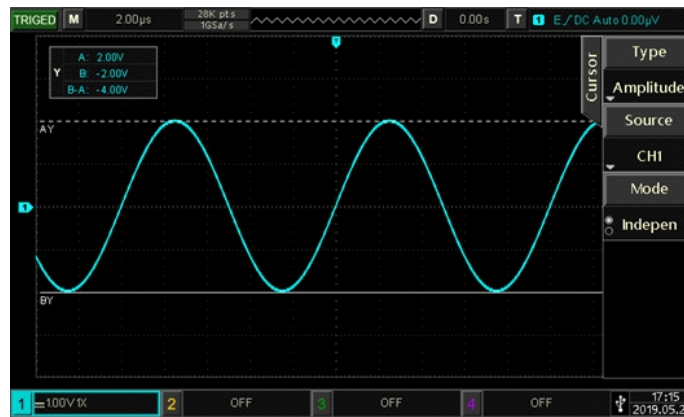
The Multipurpose knob can be used to adjust the horizontal cursor AY on the screen, press the Multipurpose knob to switch to cursor BY, the adjustment method of cursor BY is the same as AY.

Press mode to select tracking, adjust the Multipurpose knob and the cursor AY and BY will move simultaneously.

The upper left corner of the display area shows the cursor measurement information:
AY, BY: Voltage values represented by the current positions of cursor AY and BY.
BY - AY: Voltage difference between two cursors.

Chapter 11 Storage and Callback

With the storage function, you can save the oscilloscope's settings, waveforms, and screen images to the oscilloscope or external USB storage devices, and load the saved settings or waveforms anytime. Press the STORAGE key to enter the storage function setting interface.

Note: For the external USB storage device, only supports FAT format, the NTFS format is not compatible.

11.1 Setting Storage and Load

Press STORAGE → type can select setting to enter the setting storage menu.
Setting Storage Menu

Functions	Options	Descriptions
Type	Setting	Press the save key to save the settings to the oscilloscope.
Disk	DSO	Press the save key to save the settings to an external USB storage device.
Filename	USB	Filename can be chosen with the Multipurpose knob from set001 to set255.
Save		Saves settings to a specified storage location.
Load		Loads the previously saved settings in the specified memory location to return the oscilloscope to the previously saved setting state.

11.2 Waveform Storage and Load

Press STORAGE → type , select waveform to enter the waveform storage menu.

10-2 Waveform Storage Menu

Functions	Options	Descriptions
Type	Waveform	
Source	CH1, CH2, CH3, CH4	Set which channel waveform to be saved.
Disk	DSO	Press the save key to save the waveforms to the oscilloscope.
	USB	Press the save key to save the waveforms to an external USB storage device.
	USB CSV	When the save key is pressed, the waveform will be saved to an external USB storage device in .csv format. This format can be opened on the PC directly through software such as Excel.
Filename		Filename saved in waveforms can be chosen with the Multipurpose knob from wav001 to wav255.
Save		Saves waveforms to a specified storage location.

After the waveform is saved, you can select the REF key on the vertical control area to enter the REF waveform load menu.
REF Waveform Load Menu

Functions	Options	Descriptions
Reference	Ref-A, Ref-B, Ref-C, Ref-D.	Select any of the four references to load waveforms.
Disk	DSO	Press the load key to recall the waveform from the oscilloscope.
	USB	Press the load key to recall the waveform from the external USB storage device
Filename		Filename to be loaded can be chosen with the Multipurpose knob from wav001 to wav255 and must be consistent with saved name
Load		Loads the previously saved waveform and displays it on screen
Clear		Close current REF waveform

The loaded REF waveform is shown below:

Ref waveform status display
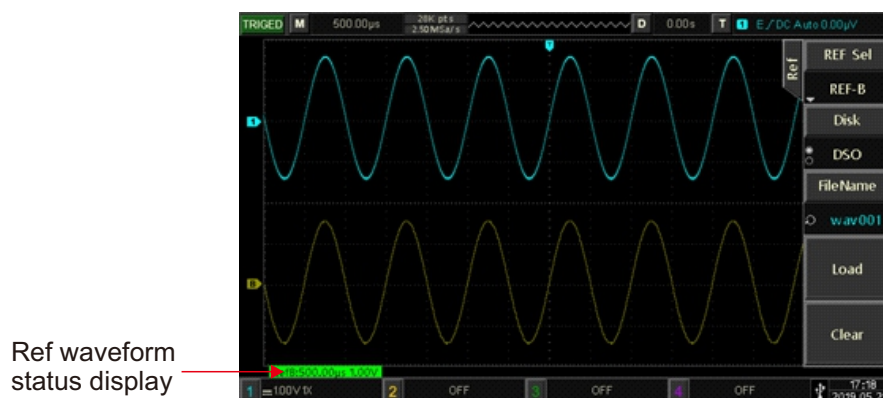
After loading, the Ref waveform status will be displayed in the lower left corner, including time base scale and amplitude scale. At this point you can use the vertical and horizontal control knob to adjust the Ref wavform's position on the screen, the time base scale and the amplitude scale.

Remark:
- Only when the oscilloscope is connected to an external USB storage device such as a USB flash drive can you select the disk as USB, and then save the settings to the USB storage device. When the USB storage device is not connected, it will prompt "USB device is not inserted".
- When loading, the disk and file name must be set to match the one previously saved, if the settings have not been saved to the selected location before, it will prompt "Load Failed".

11.3 Print Screen

The PrtSc key can be used to store the current screen in BMP format to an external USB storage device. The bitmap can be opened directly on the PC. This function can only be used when external USB storage device is connected.

Chapter 12 Auxiliary Function Settings

Press the UTILITY key to enter the auxiliary function settings menu.

12.1 System Function Settings

Self-correcting:
Self-correcting allows the oscilloscope to work optimally to obtain the most accurate measurements. You can perform this function at any time, especially when the ambient temperature range reaches or exceeds 5℃. Before performing the self-correcting operation, make sure that the oscilloscope is operating for more than 20 minutes.
Press UTILITY → self-correcting and a warning dialog box pops up: "Please confirm that no signal is connected to any channel". After confirming, press OK to start self-correcting, it takes about 5mins.

System Information:
Press UTILITY → system information to view the oscilloscope's model number, software and hardware version number.

Language:
Press UTILITY → language to select simplified Chinese or English.

Menu Display:
The time of the menu display. You can press to show or hide the menu.
Press UTILITY → menu display, you can select 1s, 2s, 5s, 10s, 20s, or manual by adjusting the Multipurpose knob.

Square Wave Output:
Press UTILITY → PgDn → square wave output to set the square wave output frequency: 10Hz, 100Hz, 1kHz and 10kHz.

Frequency meter:
Press UTILITY → PgDn → frequency meter, select on and will be displayed at the top of the screen.
The frequency meter is the counter of trigger event frequency in the trigger channel, and it is valid when trigger type is edge or pulse width.

AUX Output Selection:
Press UTILITY → PgDn → output selection to select trigger or Pass/Fail.
Trigger: AUX output terminal outputs the trigger synchronization signal.
Pass/Fail: AUX outputs the pass/fail signal.

Backlight Brightness:

Press UTILITY ➜ PgDn ➜ backlight brightness, and adjust the brightness of the screen by the Multipurpose knob.

Clear Data:

Press UTILITY ➜ PgDn ➜ clear data to clear the data stored in the device.

IP Settings:

Connect the device with a valid network cable, then press UTILITY ➜ PgDn ➜ IP to enter the IP setting interface.

IP Type:

Press the type key to switch the IP access mode: manual or automatic.

IP Address:

The format of the IP address is nnn.nnn.nnn.nnn, the range of the first nnn is from 1 to 223, the range of the other three nnn is from 0 to 255. It is recommended that you consult your network administrator for an available IP address.
Press IP address to enter the IP address setting menu. When the access mode is manual, set the IP address by adjusting the Multipurpose knob. When the access mode is automatic, you can only view the IP address.

Subnet Mask:

The format of the subnet mask is nnn.nnn.nnn.nnn, the nnn range is from 0 to 255. It is recommended that you consult your network administrator for an available subnet mask.
Press subnet mask to enter the subnet mask setting menu. When the access mode is manual, set the subnet mask by adjusting the Multipurpose knob. When the access mode is automatic, you can only view the subnet mask.

RTC Setting:

Press UTILITY ➜ PgDn ➜ RTC setting to enter the date and time setting menu. Adjust the digits by Multipurpose knob, after the first digit is adjusted, press the Multipurpose knob and the cursor will jump to the second digit, the adjustment method is similar to the first digit, the latter digit and so on. After all adjustments, press OK to save the settings.

12.2 Waveform Recording

Press UTILITY ➜ waveform recording to enter its menu.

Setting:

Press record operation to select setting to make parameter settings for waveform recording.

Recording Interval:

Set the interval between each frame of the waveform recording.
Press the recording interval key and adjust the Multipurpose knob to set.

End Frame:

Press the end frame key and adjust the Multipurpose knob to set an ending frame number that the waveform recording will automatically stop recording when it reaches this number.

Playback Delay:

Set the interval time between each frame during the waveform playback.
Press playback delay, and adjust the Multipurpose knob to set playback delay.

Maximum Number of Frames:

Displays the maximum number of frames that can be recorded in the current situation (The maximum number of frames varies based on the current memory depth).

Operate:

Press recording operation, select operate to enter the operation interface.

12.3 Pass/Fail

The Pass/Fail uses a template to detect whether the input signal satisfies the template requirements. If the input signal exceeds the limited range of the template, it is judged as failed.

(1) Function Introduction

Press UTILITY   PgDn   pass/fail to enter its menu.

Enable:

Press enable, select on to make the relevant settings for the Pass/Fail.

Output:

Press output to select fail or pass.

① Fail: Set the AUX interface on the back panel of the oscilloscope to output pulses when "fail" and produce beeps.

② Pass: Set the AUX interface on the back panel of the oscilloscope to output pulses when "pass" and produce beeps.

Note: AUX output selection needs to be switched to Pass/Fail.

Source:

Press source, select CH1, CH2, CH3, or CH4 to set the test source of Pass/Fail.

Message:

Press message, select on and the test result statistics will be displayed at the upper left corner of the screen, as shown below:
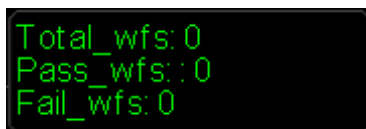
Total_wfs means the total number of frames tested; Pass_wfs means the number of frames passed; Fail_wfs means the number of frames failed.

Stop Setting:

Press PgDn ⟶ stop setting to enter its menu as follows:

Functions	Options	Descriptions
Stop Type	Pass Count	Set the Pass/Fail function to stop the test automatically after it reaches the specified threshold value of pass
	Fail Count	Set the Pass/Fail function to stop the test automatically after it reaches the specified threshold value of failure
Condition	>=, <=	Set the stop condition
Threshold		Use the Multipurpose knob to set the stop condition threshold
Return		Returns to previous menu, the Pass/Fail menu

Template Setting:

Press PgDn ⟶ template setting to enter its menu. As shown below:

Functions	Options	Descriptions
Reference Waveform	Ch1, CH2, CH3, CH4	Select a channel waveform in CH1~CH4 and plus the horizontal and vertical tolerance as the conditions for creating a template
Horizontal Tolerance	1 ~ 255	Use the Multipurpose knob to select the horizontal tolerance
Vertical Tolerance	1 ~ 255	Use the Multipurpose knob to select the vertical tolerance
Create Template		Creates a template with above conditions
Return		Returns to previous menu, the Pass/Fail menu

Operate:
After the above settings are completed, press the operate key and select on, the device will start recording the waveforms.
Note: After selecting the enable as on, you need to set the stop settings and template settings before you can perform the Pass/Fail function. Otherwise it will prompt "Function is Disabled".

(2) Application Example
Input the 1kHz, 3V square wave to CH1, and observe the results under the specified Pass/Fail conditions.
① Enter Pass/Fail menu: Press UTILITY → PgDn → Pass/Fail.

② Set Enable: Press the enable key and select on.

③ Set output condition: Press the output key and select fail.

④ Set source: Press the source button and set the source to CH1.

⑤ Open message: Press the message key and select on.

⑥ Stop setting: Press the stop setting key to enter the stop setting menu; set the stop type to fail times and adjust the Multipurpose knob to set the threshold to 10; then press F5 to return to the Pass/Fail menu.

⑦ Template setting: Press the template setting key to enter the menu; press reference waveform and select CH1; press the horizontal tolerance key and a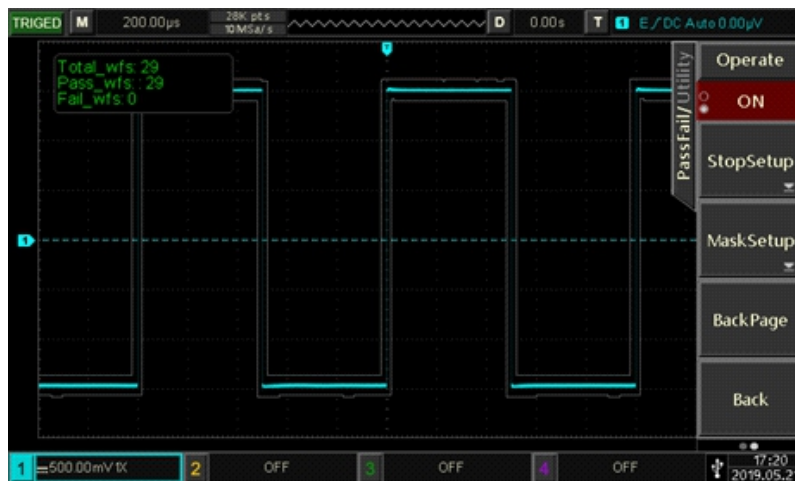djust the Multipurpose knob to set the horizontal tolerance to 10 and the vertical tolerance to 5; then press the create template key. Press the back key to return to the Pass/Fail menu.

⑧ Start test: Press operate and select on to start the test. See figure below:

The Pass/Fail function will run continuously, and stop once 10 fail tests have been reached, or the user manually suspends the test (when operate is set to off).

12.4 System Upgrade
This series oscilloscope can use U disk to upgrade the software to give users a more convenient and flexible experience.
To use this feature, please follow the following steps:
① Press UTILITY to enter the auxiliary function menu, then press system information to view the machine's model number, software and hardware version information.

② Download the upgrade file from the UNI-T website or get it from the UNI-T distributor. The upgrade file is consistent with the model and the device hardware version, and the software version is higher than the original version. Please save the upgrade file in the root directory of the U disk.

③ When the device is in the off state, insert the U disk and turn it on, after entering the upgrade interface, press F1 to confirm the upgrade.

④ The upgrade process takes about 5mins. After the upgrade, shut down the device and unplug the USB flash disk.

⑤ Turn on the device to check whether the system information is the same as the provided version information, the same indicates that the upgrade was successful.
Note: please make sure that the power supply is on throughout the upgrade process in order to avoid the incomplete upgrade. If the system is not completely upgraded, it might not be able to restart.

Chapter 13 Additional Function Keys

13.1 Auto Setting

Automatic settings will choose appropriate time base scales, amplitude scales and triggering parameters according to the input signal so that the waveform automatically properly displays on the screen. Press the AUTO key to enable automatic settings.

Automatic setting applies only to the following conditions:

① Automatic setting is suitable for setting up simple single frequency signals, and not for complex combination waves.

② The measured signal frequency is not less than 20Hz, the amplitude is not less than 20mVpp, and the square wave duty cycle is more than 5%.

③ The automatic setting is only for the open channels and not for the closed channels.

13.2 Run / Stop

Use the RUN/STOP key on the front panel for control. When the key is pressed and the green light is on, it indicates the RUN state, and if the red light is on after the key press, it is the STOP state. In the running state, the oscilloscope is continuously acquiring waveforms and the upper part of the screen shows "AUTO"; in the stop state, the oscilloscope stops the acquisition and the upper part of the screen shows "STOP". Press the RUN/STOP key to switch the waveform sampling between the run and stop states.

13.3 Clear

Press the CLEAR button on the front panel of the oscilloscope to clear the loaded REF waveform on the screen.

13.4 Factory Setting

By pressing the DEFAULT button, you can quickly restore to factory settings. UPO2000E series oscilloscope factory settings are as below:

System	Function	Factory Setting
Vertical System	CH1	1V/DIV
	Vertical Displacement	0 (vertical midpoint)
	Coupling	DC
	Bandwidth Limitation	Off
	VOLTS/DIV	Coarse tuning
	Probe	1×
	Invert	Off
	Bias Voltage	Off
	CH2, CH3, CH4	Off
	MATH, REF	Off
Horizontal System	Extended Window	Off
	Horizontal Time Base	1µs/div
	Horizontal Displacement	0 (Horizontal midpoint)
Trigger System	Hold-off Time	80.00ns
	Trigger Type	Edge
	Source	CH1
	Slope Type	Rising
	Coupling Mode	DC
	Trigger Mode	Automatic
Display	Type	Vector
	Format	YT
	Duration	50ms
	Grid Brightness	40%
	Waveform Brightness	40%

	Storage Type	Waveform
	Frequency Meter	Off
	Measurement	Off, clear all measurements
	Cursor	Off
Other System	Language	Keep the settings that saved at shutdown
	Menu Display	Manual
	Square Wave Output	1kHz
	Backlight Brightness	30%
	Output Selection	Keep the settings that saved at shutdown

Chapter 14 System Prompts and Troubleshooting

14.1 System Prompt Information Description

Operation at limit: In the current state, adjustment has reached the limit and cannot continue. When the vertical scale knob, time base knob, level shift, vertical shift or trigger level, etc. reaches the adjustment limit, the prompt will show up.

USB device is not inserted: This prompt appears if you select USB as storage disk but not connected with USB storage device.

Load Failed: When loading a saved setting or waveform, this prompt appears if there is no stored setting or waveform in the memory location.

14.2 Trouble Shooting

(1) When the power button is pressed and the oscilloscope is black screen:

① Check the power supply connection and check power supply is normal or not.

② Make sure the power switch at the back of the oscilloscope is open, press the front panel power key and confirm green light and a relay sound is present.

③ If there is a relay sound, it indicates that the oscilloscope starts normally. Try the following operations: press the DEFAULT key, then press F1, if device returns to normal, it means backlight brightness is too low.

④ After completing the above steps, restart the oscilloscope.

⑤ If you still cannot use this product normally, please contact UNI-T.

(2) After signal acquisition, waveform does not appear on display:

① Check if the probe is connected to the signal test point.

② Check if the signal line is connected to the analog channel input.

③ Check if the analog channel input of the input signal is consistent with the opened channel.

④ Connect the probe to the probe compensation signal connector on oscilloscope's front panel and check whether the probe is normal.

⑤ Check to see if there is a signal to be detected (solve the problem by comparing the channel with signal generated and the one with problem).

⑥ Press AUTO button for signal re-acquisition.

(3) The measured voltage amplitude value is 10 times larger or smaller than the actual value:

Make sure the probe attenuation coefficient in the channel matches the attenuation of the probe used.

(4) There is a waveform displays but not stable:

① Check the trigger source in the trigger menu and confirm that it matches the input channel of the actual signal.

② Check the trigger type: Normal signals should use edge trigger mode. Stable waveform will be displayed only by setting to the correct trigger mode.

③ Try changing the trigger coupling to high frequency suppression or low frequency suppression in order to filter out the high or low frequency noise which might interfere the trigger.

(5) Pressing the RUN/STOP key and no waveform is displayed:

① Check whether the trigger mode is normal or single, and whether the trigger level has exceeded the waveform range. If so, center the trigger level or set the trigger mode to AUTO.

② Press the AUTO key to complete the above settings automatically.

(6) Waveform refresh rate is too slow:

① Check whether the acquisition mode is average, and the average times is large.

② You can speed up the refresh rate by reducing the average times or select other acquisition mode such as normal sampling.

Chapter 15 Technical Index

Aside from specification labeled "typical", all specifications are guaranteed.

Unless otherwise stated, all technical specifications are applicable to probes with attenuation 10X and UPO2000E series oscilloscope. Oscilloscope must first meet the following two conditions in order to achieve these standards:

- The instrument must be operated at the specified operating temperature for more than 30 minutes.
- If the operating temperature range reaches or exceeds 5 degree Celsius, user must open the system function menu to perform self-correcting.

Input	
Input Coupling	DC, AC, GND
Input Impedance	1MΩ ± 2% // 21pF ± 3pF
Probe Attenuation Coefficient	0.001×, 0.01×, 0.1×, 1×, 10×, 100×, 1000×
Maximum Input Voltage	CATI 300 Vrms, CATII 100 Vrms, Transient Overvoltage 1000 Vpk

Vertical				
Model	UPO2104E	UPO2074E	UPO2102E	UPO2072E
Analog Bandwidth	100MHz	70MHz	100 MHZ	70MHz
Rise Time (Typical)	≤3.5ns	≤5ns	≤3.5ns	≤5ns
Channels	4		2	
Vertical Resolution	8bit			
Vertical Scale	1mV/div ~ 20 V/div (1-2-5 base)			
Vertical Displacement Range	1mV/div ~ 200 mV/div: ± 2V 500 mV/div ~ 2 V/div: ± 40V 5V/div ~ 20 V/div: ± 400V			

Bandwidth Limit (Typical)	20MHz
Low Frequency Response (AC coupling, -3dB)	≤5 Hz (on BNC)
DC Gain Accuracy	≤±4% (Sampling or average sampling method)
DC Offset Accuracy	≤±4% (Sampling or average sampling method)
Channel Isolation	DC to maximum bandwidth: >40 dB

Horizontal

Timing Scale	5ns/div ~ 50s/div (1-2-5 base)
Timing Accuracy	≤± (50+ 2×Service Life)ppm
Delay Range	Pre-trigger (negative delay) : ≥1 screen width
	Post-trigger (positive delay) : 1s ~ 50s
Time Base Mode	YT, XY, ROLL
Waveform Capture Rate	80,000 wfms/s (single channel, horizontal time base 50ns/div, point diasplay, auto memory depth)

Sampling

Sampling Mode	Real-time sampling
Real-time Sampling Rate	1GS/s (single channel), 500MS/s (dual channel), 250MS/s (quad channel)
Acquisition Mode	Sampling, peak detection, high resolution, envelope, and average
Average Value	After all channels have reached N samples at the same time the number of N can be selected between 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096 and 8192.
Waveform Interpolation	sin(x)/x
Memory Depth	Auto, 28kpts, 280kpts, 2.8Mpts, 28Mpts, 56Mpts

Trigger

Trigger Level Range	Internal: Center of the screen ± 8 grids
	External: ± 0.9V
	External/5: ±4.5V
Trigger Mode	Automatic, normal, single
Trigger Hold-off Range	80ns ~ 10s
High Frequency Suppression	80kHz
Low Frequency Suppression	8kHz
Noise Suppression	Reduces waveform noise (10 mV/div ~ 20 V/div, the sensitivity of DC coupling trigger is reduced 2 times)
Trigger Sensitivity	≤1div

Edge Trigger	
Edge Type	Rising, falling, any

Pulse Width Trigger	
Pulse Width Condition	〉, 〈, =
Polarity	Positive, negative pulse width
Pulse Width Range	4ns ~ 10s

Runt Trigger	
Pulse Width Condition	〉, 〈, =
Polarity	Positive/negative
Pulse Width Range	8ns ~ 10s

Window Trigger	
Window Type	Rising edge, falling edge, any edge
Trigger Position	Window enter, exit, time
Window time	8ns ~ 10s

N-Edge Trigger	
Edge Type	Rising edge, falling edge
Idle Time	8ns ~ 10s
Number of Edges	1 ~ 65535

Delay Trigger	
Edge Type	Rising edge, falling edge
Delay Type	Greater than, less than, within range, out of range
Delay time	Normal: 8ns ~ 10s Lower time limit: 8ns ~ 10s Upper time limit: 32ns ~ 10s

Timeout Trigger	
Edge Type	Rising edge, falling edge, any edge
Timeout	8ns ~ 10s

Duration Trigger	
Code	H, L, X
Trigger Condition	Greater than, less than, within range
Duration Time	Normal: 8ns ~ 10s Lower time limit: 8ns ~ 10s Upper time limit: 32ns ~ 10s

Setup/Hold Trigger	
Edge Type	Rising edge, falling edge
Data Type	H, L
Setup Time	8ns ~ 10s
Hold Time	8ns ~ 10s

Slope Trigger	
Slope Condition	Positive slope (greater than, less than, specified range) Negative slope (greater than, less than, specified range)
Time Setting	8ns ~ 10s

Video Trigger	
Signal System Horizontal Scanning Frequency Range	Supports standard NTSC, PAL and SECAM broadcast system with line numbers ranging from 1 ~ 525 (NTSC) and 1 ~ 625 (PAL/SECAM).
Code Trigger	
Code Setting	H, L, X, rising edge, falling edge

Rs232 Decode	
Trigger Condition	Start of frame, error frame, parity error, data
Baud Rate	2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, user-defined
Data Bit Width	5 bits, 6 bits, 7 bits, 8 bits

I2C Decode	
Trigger Condition	Start, restart, stop, lost acknowledgment , address, data, address/data
Address Bit Width	7 bits, 10 bits
Address Range	0 to 119, 0 to 1023
Byte Size	1bit to 5bits
Data Qualifier	Equal to, greater than, less than

SPI Decode	
Trigger Condition	Chip select, timeout
Idle Time	80 ns ~ 1s
Data Bits	4 bits to 32 bits
Data Setting	H, L, X
Clock Edge	Rising edge, falling edge

Measure			
Cursor	Manual		Voltage difference between cursors (△V) Time difference between cursors (△T) The reciprocal of △T (Hz) (1/△T)
	Tracking Mode		Voltage and time at waveform point
	Indicator		Allows cursor display during automatic measurement
Automatic Measurement	Maximum, minimum, peak-to-peak, median, top, bottom, amplitude, period average, average, periodic RMS, RMS, overshoot, preshoot, frequency, period, rise time, fall time, positive pulse width, negative pulse width, rise delay, fall delay, FRR, FRF, FFR, FFF, LRF, LRR, LFR, LFF, positive duty ratio, negative duty ratio, phase, area, cycle area.		
Number of Measurement	Displays 5 measurements at the same time		
Measurement Range	Screen or cursor		
Measurement Statistics	Average, maximum, minimum, standard deviation and the number of measurements		
Frequency Meter	6-bit hardware frequency meter		
Mathematical Operations			
Waveform Calculation	A+B, A-B, A×B, A/B, FFT, logic operation, digital filtering, advanced operation		
FFT Window Type	Rectangle, Hanning, Blackman, Hamming		
FFT Display	Split screen; time base can be adjusted independently		
FFT Vertical Scale	Vrms, dBVrms		
Digital Filter	Low-pass, high-pass, band-pass and band-stop		
Logic Operation	AND, OR, NOT, XOR		
Advanced Operation	Log, Exp, Sin, Cos, Tan, Sqrt, Inth, Diff		

Storage	
Setting	Internal (256), external USB storage device
Waveform	Internal (256), external USB storage device
Bitmap	External USB storage device, it can also store the relevant parameter information.

Display	
Display Type	8-inch TFT LCD
Display Resolution	800 horizontal×RGB×480 vertical pixels
Display Color	24bits true color
Duration	Minimum, 50ms, 100ms, 200ms, 500ms, 1s, 5s, 10s, 20s and infinite.
Menu Duration	1s, 2s, 5s, 10s, 20s, manual
Display Type	Point, vector

Interface	
Standard Interface	Standard: USB-Host, USB-Device, LAN, EXT Trig, AUX Out

General Technical Specifications

Probe Compensation Signal Output	
Output Voltage	About 3Vp-p
Frequency	10Hz, 100Hz, 1kHz (default), 10kHz

Power Supply	
Power Supply Voltage	100V ~ 240VACrms
Frequency	45Hz ~ 440Hz
Fuse	2.5A, T, 250V

Environment		
Temperature Range	Operational: 0℃ ~ +40℃	
	Non-Operational: -20℃ ~ +60℃	
Cooling Method	Fan forced cooling	
Humidity Range	Operational: below +35℃ ≤ 90％ relative humidity	
	Non-Operational: +35℃ ~ +40℃≤ 60％ relative humidity	
Altitude	Operational: below 3000m	
	Non-Operational: below 15,000m	

Mechanical Specifications	
Size	336mm(W)×164mm(H)×108mm(D)
Weight	3.5kg

Calibration Interval
Recommend to perform calibration once a year

Chapter 16 Accessories

Appendix A Accessories

Model Number	UPO2072E / UPO2074E (70 MHz)
	UPO2102E / UPO2104E (100 MHz)
Standard Accessories	Power cord that complies with the country's standard
	USB data cable (UT-D06)
	2/4 passive probes (100MHz)
	CD-ROM (including user manual and application software)

Please order all accessories from local UNI-T dealers.

Appendix B Maintenance and Cleaning

(1) General Maintenance
Do not store or place the instrument in places where the LCD monitor will be exposed to direct sunlight for a long time.
Caution: Do not allow sprays, liquids and solvents to be stained on the instrument or probe to prevent damage.

(2) Clean
Refer to the operating conditions of the instrument and probe and perform frequent checks. Clean the outer surface of the instrument according to the following steps:
- Please use a soft cloth to wipe the dust off the instrument and the probes. When cleaning the LCD screen, please pay attention and protect the transparent LCD screen.
- Please disconnect the power supply, then wipe the instrument with a damp but not dripping soft cloth. Do not use any abrasive chemical cleaning agent on the instrument or probes.

Warning:
Please confirm that the instrument is completely dry before use, to avoid electrical shorts or even personal injury caused by moisture.

Appendix C Warranty Overview

UNI-T (UNI-TREND TECHNOLOGY (CHINA) CO., LTD.) ensures the production and sale of products, from authorized dealer's delivery date of three years, without any defects in materials and workmanship. If the product is proven to be defective within this period, UNI-T will repair or replace the product in accordance with the detailed provisions of the warranty. To arrange for repair or acquire warranty form, please contact the nearest UNI-T sales and repair department.
In addition to permit provided by this summary or other applicable insurance guarantee, UNI-T does not provide any other explicit or implied guarantee, including but not limited to the product trading and special purpose for any implied warranties. In any case, UNI-T does not bear any responsibility for indirect, special, or consequential loss.

Appendix D Contact Us

If the use of this product has caused any inconvenience, please contact your local UNI-T dealer or sales center.
Service support: Many UNI-T products have the option of extending the warranty and calibration period, please contact your local UNI-T dealer or sales center.
To obtain the address list of our service centers, please visit our website at URL: http://www.uni-trend.com

UNI-T

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