UPO3000E Series
Ultra Phosphor Oscilloscope
User Manual

Introduction

Dear Users:

Hello! Thank you for choosing this brand new UNI-T device. In order to safely and correctly use this instrument, please read this manual thoroughly before use, 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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If the original purchaser sells or transfers the product to a third party within three years from the date of purchase of the product, the warranty period of three years shall be from the date of the original purchase from UNI-T or 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 warranty 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 (determined by UNI-T). Replacement parts, modules and products may be brand new, or perform at the same specifications as brand new products. All original parts, modules, or products which were defective become the property of UNI-T.

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This warranty shall not apply to any defects, malfunction or damages caused by accidental, machine parts' wear and tear, using outside the product's specifications, 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).

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General Safety Overview

This instrument strictly complies with the GB4793 electronic measuring instrument safety requirements and IEC 61010-1 safety standards 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 personnel 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 personnel.

Maintain proper ventilation.

Please do not operate in humid conditions.

Please do not operate in flammable and explosive environment.

Please keep the product surface clean and dry.

Safety Terms and Symbols

The following terms may appear in this manual:
Warning: Indicate the conditions and behaviors that may endanger life.
Note: Indicate the conditions and behaviors that 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 other 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 |

UPO3000E Series Ultra Phosphor Oscilloscope Introduction

UPO3000E Series Ultra Phosphor Oscilloscope includes the following 4 models:

Model	Analog channels	Analog bandwidth
UPO3152E	2	150MHz
UPO3252E	2	250MHz
UPO3154E	4	150MHz
UPO3254E	4	250MHz

UPO3000E Series Ultra Phosphor Oscilloscope is based on UNI-T's unique Ultra Phosphor technology. A multifunctional, high-performance oscilloscope that is easy to use, with excellent technical specifications, a perfect combination of many functionalities that help users to quickly complete testing. UPO3000E 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.

Main features:

- 250MHz/150MHz bandwidth, providing 2-channel and 4-channel models.
- Real-time sampling rate up to 2.5GS/s, allowing you to observe faster signals.
- Standard memory depth of 70Mpts per channel, which allows the oscilloscope to maintain a high sampling rate in a wider time base, and takes into account the waveform integrity and details.
- Waveform capture rate up to 200,000wfms/s.
- Hardware real-time waveform continuous recording and waveform analysis supports recordings up to 100,000 waveforms.
- 256-level grayscale display
- 8-inch WVGA (800×480) TFT LCD, ultra widescreen, vivid colors, clear display.
- Abundant trigger features, including a variety of advanced trigger options. Standard configuration interface: USB-Host, USB-Device, LAN, VGA and Pass/Fail.
- Automatic measurement of 34 waveform parameters.
- Supports USB storage and firmware upgrades, one click screen copy function.
- Simple and convenient numeric keypad.
- Supports plug and play USB device, which can communicate with the computer.

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Chapter 1 Getting Started Guide

This chapter introduces the precautions for 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 UPO3000E 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 A for the list of accessories. If any of the accessories are missing or damaged, please contact UNI-T distributor or local office 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 distributor or local office of this product.

If the equipment is damaged due to shipping, please keep the packaging and notify both the transportation department and the UNI-T distributor, 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 cord that came with the oscilloscope or any power supply cord 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 green.

(2) Boot Check

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

(3) Connect Probe

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

Probe compensation signal connector
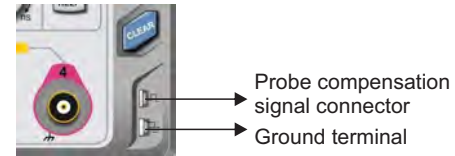
Ground terminal

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. An uncompensated probe may cause a measurement error. To adjust the probe compensation, please follow the following steps:

1. Set the probe menu attenuation coefficient to 10×, and set the switch on the probe to 10x then connect the probe to CH1. Make sure the probe's hooks 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". Turn on CH1 and press the AUTO button.

2. Observe the waveform displayed.
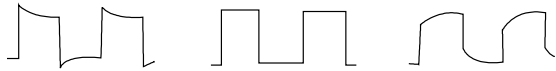
Excessive compensation   Correct compensation   Insufficient compensation
Picture 1-2 Probe compensation calibration

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
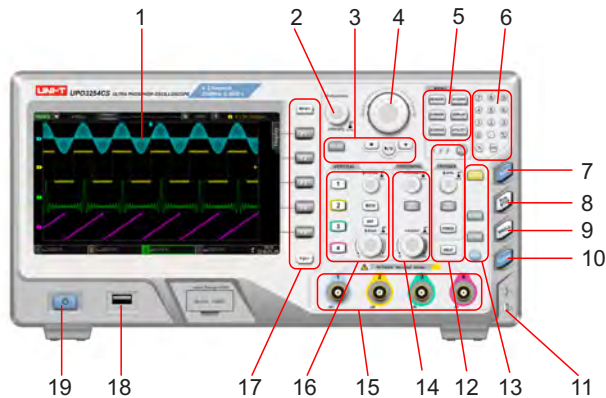
Picture 1-3 Oscilloscope Front Panel

1	Screen display area
2	Multipurpose knob
3	Waveform recording setting
4	Shuttle knob
5	Function menu
6	Numeric keypad
7	Automatic setting
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9	Single trigger
10	Clear all
11	Probe compensation signal connector and ground terminal
12	Factory setting, AWG (arbitrary waveform generator), protocol decoding, print screen
13	Trigger control area
14	Horizontal control area
15	Analog channel input
16	Vertical control area
17	Menu control
18	USB HOST interface
19	Power on/off

1.4 Rear Panel
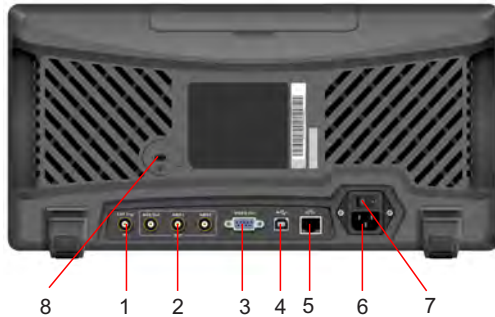
Picture 1-4Oscilloscope Rear Panel

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

②. Pass/Fail: Pass/Fail detection function output, support Trig_out output at the same time, AWG1 and AWG2 are arbitrary waveform generator output.

③. VIDEO Out: VGA video signal output

④. USB device: USB device interface, the oscilloscope can communicate with the PC through this interface.

⑤. LAN: The oscilloscope can be connected to the local area network for remote control.

⑥. AC power input socket: AC power input. Use the power cord provided in the accessories to connect the oscilloscope to the AC power supply (100 ~ 240V, 45 ~ 440Hz).

⑦. Power switch: When the AC socket is properly connect to the power supply, turn on this power switch, then press the power on/off on the front panel to turn on the oscilloscope.

⑧. Safety lock: You can use the safety lock (sold separately) to lock the oscilloscope in a fixed position.

1.5 Operation Panel

(1) Vertical Control

① 1, 2, 3, 4: Analog channel setting keys indicate CH1, CH2, CH3, and CH4. The four channel labels are identified by different colors also corresponding to the colors of the waveforms on the screen and the 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 M 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.

2. Horizontal control

a. HORI MENU : Displays extended window, independent time base and trigger hold-off.

b. Horizontal POSITION : When adjusting the knob, the trigger point moves left and right relative to the center of the screen, and the waveforms 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.。

c. Horizontal SCALE : Adjust the time scale of all channels. You can see the waveform is compressed or xpanded 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 step is 1-2-4. Press the knob to quickly switch between the main window and the extended window.

3.Trigger Control

a. MODE : Press this key to switch the trigger mode to Auto, Normal or Single, and the corresponding backlight of the current trigger mode will turn on.

b. LEVEL : Turn clockwise to increase the level, turn counterclockwise to decrease the level. During the adjustment process, the trigger level value [T 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 50% of the trigger signal.

c. TRIG MENU : Displays the contents of the trigger menu. For details, see "Trigger setting system".

d. FORCE : Force trigger button, press this button to force a trigger.

e. HELP : Displays the built-in help system contents.

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 sine wave, the frequency is required to be not less than 20Hz and the amplitude should be in the range of 20mVpp ~ 120Vpp. If this parameter condition is not met, the auto setting function may not be valid.

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 orange backlight will be on.

7.Clear All

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

8. Print Screen

Press this key to quickly copy the screen waveforms to a USB storage device in BMP bitmap format.

9. Multipurpose Knob

Intensity: In non-menu operation, turn this knob to adjust the brightness of the waveform display. The brightness adjusting range is 0% ~ 100%. You can also press the DISPLAY →waveform brightness to adjust it. Multipurpose: Turn the knob to select the sub-menu, then press the knob to confirm selection.

10. Shuttle Knob

For certain numeric parameters that can be set in a large range, this knob provides a quick-adjust function. Rotate clockwise (counterclockwise) to increase (decrease) the value. The inner knob can be fine-tuned, and the outer knob can be coarse tuned.

For example: When playing back the waveform, use the knob to quickly locate the waveform frames that need to be replayed. Similar parameters also include: Trigger hold-off time, pulse width setting, slope time, and so on.

11. Function Keys

MEASURE: Measure setting menu: you can set the 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, you can measure the time or voltage of the waveform manually with cursor.

DISPLAY: Select display settings, such as display type, format, grid brightness, waveform brightness, duration, color temperature, inverse color temperature.

STORAGE: Press this key to enter the storage interface. The types that can be stored include: settings, waveforms. You can store either in the oscilloscope internal or the external USB storage device.

UTILITY: The utility menu can perform the settings such as auto-calibration, system information, language, menu display, waveform recording, pass/fail, square wave output, frequency meter, output selection, backlight brightness, clear data, IP, RTC, etc.

12. Numeric Keypad

For some numerical parameters that can be set to a large range, you can directly enter the number plus the time unit, then press the Enter key to confirm if it is without a unit.

13. Waveform Recording

Stop   Pause/Play   Record
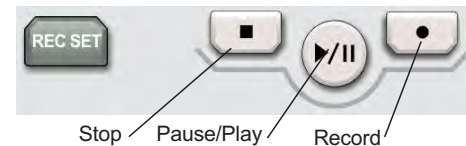
REC SET : Waveform recording setup menu for setting and operation. The setting items can set or display the recording interval, end frame, play delay, and maximum frame.

Stop : Press this key to stop the waveform being recorded or replayed.

Play/Pause : In the stop or pause state, press this key to playback the waveform, press again to pause playback.

Record : Press this key to start the waveform recording.

1.6 User Interface

Picture 1-5Oscilloscope display interface

①.Trigger Status Identification: Includes TRIGED (has been triggered), AUTO, READY, STOP, and ROLL (rolling).

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/ Memory Depth: Indicates the current sampling rate and storage depth.

④.Horizontal Displacement: Shows the horizontal displacement value of the waveform, which can be adjusted by turning the horizontal POSITION knob. Press the knob to return the displacement value 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 any kinds. For example, ✓ Indicates trigger at the rising edge.

d. Trigger coupling: The types are DC, AC, high frequency suppression, low frequency suppression, and noise suppression. 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. Adjust the LEVEL knob in the trigger control area to change this parameter.

⑥.CH1 Vertical Status: Displays CH1 activation state, channel coupling, bandwidth limitation, vertical scale, and probe attenuation coefficient.

   Channel activation state: 1 =100V 1X When the background includes the channel color, the channel is activated. Press the button 1, 2, 3, 4 to activate or open/close the corresponding channel.

   Channel coupling: Includes DC, AC, and grounding. For example, ▭ is DC coupling in CH1.

Bandwidth limitation: Enable and there will be a B icon shown on CH1 vertical status bar.

Vertical scale: When CH1 is activated, the vertical scale parameter can be adjusted by the SCALE knob in the vertical control area.

Probe attenuation coefficient: Displays CH1 probe attenuation coefficient: 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, 1000X.

⑦.USB Device Indicator: Displays the indicator when the USB device interface 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 the corresponding submenu content.

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

1.7 Special Symbols Introduction

Take the left menu as an example:

[symbol] : Indicates there is a next level menu.

[symbol] : Indicates there is a drop-down menu.

[symbol] : Indicates that the menu has two options.

[symbol] : Indicates that user can adjust by the Multipurpose knob.

[symbol] : The number of circles indicates the 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   key to turn the pages.

Take the left menu as an example:

Chapter 2 Vertical Channel Settings

UPO3000E 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 setting method 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.

Open: When the channel is close, press any of 1, 2, 3, 4 to open the corresponding channel.

Close: No waveform displays on the corresponding channel. For any open and activated channel, pressing its channel button can close that channel.

Activated: When multiple channels are opened at the same time, only one channel is activated (Only open state can be activated). Adjusting the POSITION knob and the SCALE knob in the vertical control area can change the settings of the activated channel. Any channel that has been opened but not yet activated could be activated by pressing its corresponding channel key, and the screen will show its corresponding channel menu.

Activated state	Open but not activated

2.2 Channel Coupling

Press 1 ➔ coupling to select DC, AC or grounding mode.

DC	AC	Grounding

2.3 Bandwidth limitation

Press 1 ➔ bandwidth limitation to turn on the bandwidth limitation (The B icon will appear on the vertical status bar). The bandwidth of the oscilloscope is limited to about 20MHz, and attenuates any signal above 20MHz. It is commonly used to reduce the high frequency noise within the signal.

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 step.
For example: 10mV ➔ 20mV ➔ 50mV ➔ 100mV
In the 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 grids of the display area, /div represents one grid.

2.5 Probe

In order to match the attenuation coefficient setting of the probe, it is necessary to set the corresponding coefficient in the channel operation menu. If the probe attenuation coefficient is 10:1, the probe coefficient in the channel menu should also be set to 10X to ensure correct voltage reading.
Press 1 ➔ probe to select 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, 1000X.

2.6 Invert

Press $\boxed{1}$ → invert to turn on the reverse phase. The waveform voltage value will be inverted, and the inverted flag $\boxed{1}$ will appear in the vertical status bar.

| Picture 2-1 Invert off | Picture 2-2 Invert on |

2.7 Bias

When the amplitude of the DC component in the signal is relatively large, waveform observation could be very inconvenient. As shown in picture 2-3, it is really hard to identify the waveform. Using the bias function and the superposition of a -10V bias voltage can eliminate the DC component of the waveform 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 $\boxed{1}$ → $\boxed{PgDn}$ → $\boxed{bias}$ to turn on the bias and rotate the Multipurpose knob counterclockwise to adjust the value to -10V.
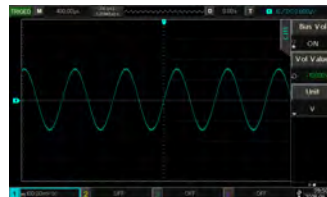
| Picture 2-3 Bias off | Picture 2-4 -10V Bias on |

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

2.8 Unit

Select the amplitude unit for the current channel. Press $\boxed{1}$ → $\boxed{PgDn}$ → $\boxed{unit}$ 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 unit by consecutively pressing the unit key, then press the Multipurpose knob to confirm, the corresponding unit will appear on the channel status bar.

Chapter 3 Horizontal System Settings
3.1 Horizontal Scale

Horizontal scale, also called 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 1-2-4 steps, i.e. 2ns/div, 4ns/div, 10ns/div, 20ns/div…… 40s/div. Turn clockwise to decrease the scale and turn counterclockwise to increase the scale, the scale information (as shown below) on the upper left corner of the screen changes in real time.
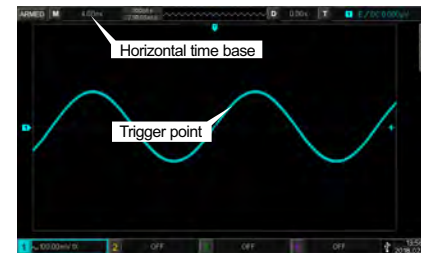
When changing the horizontal time base, the waveform will expand or compress according to the position of the trigger point.

Note: There is no 100ns/div in the horizontal time base, it is changed to 80ns/div.

Waveform before magnification

Extended time base

Main time base

Waveform after magnification

3.2 ROLL Mode

When the trigger mode is auto, adjust the SCALE knob in the horizontal control area to change the horizontal scale to be slower than 40ms/div, the oscilloscope will be in ROLL mode and will continuously plot the voltage-time trend chart of the waveform on the screen. The earliest waveform first appears on the right end of the screen, then gradually moves to the left, as shown below:
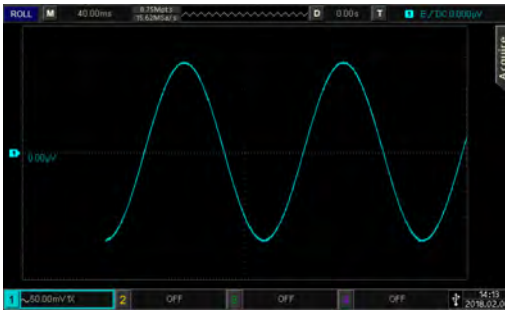
Use the slow sweep mode to observe the low frequency signal, it is recommended to set the "channel coupling" mode to "DC".

Note: "Horizontal displacement", "extended window", "protocol decoding", "pass/fail", "parameter measurement", "waveform recording', "waveform brightness", 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 to turn on the extended window. Or simply press the SCALE knob on the horizontal control area to directly enter the extended window, the screen will be divided into two display areas, as shown below:
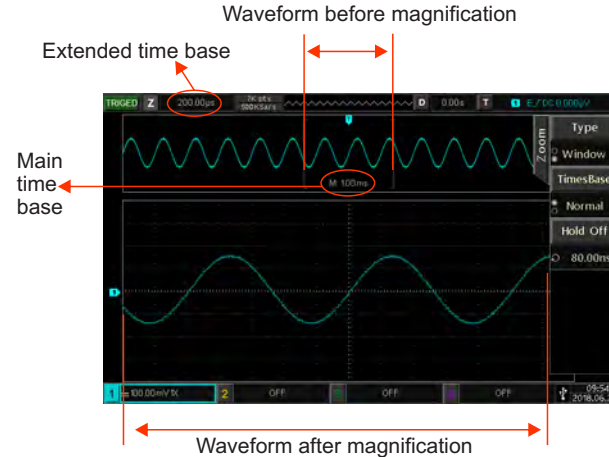
Waveform before Magnification:
The upper part of the screen displays the original waveform, which can be moved left and right through rotating the horizontal POSITION knob, or zoom in and out the selected area by rotating the horizontal SCALE knob.

Waveform after Magnification:
The lower part of the screen displays the horizontally extended waveform, 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 in the range of 20ms/div ~ 4us/div.

3.4 Independent Time Base

In independent time base, CH1~CH4 can be set to different time base so that user can observe different frequency signals in multiple channels at the same time. Press the HORI MENU → time base setting to enter the independent time base.

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As shown below, CH1 is a 10Hz sine wave, CH2 is a 1kH square wave, CH3 is a 10kHz triangular wave, CH4 is a 100kHz pulse wave. By using the independent time base, signals with different time base can be observed clearly at the same time. Press the CH1 button to activate CH1, then by adjusting the horizontal SCALE knob, user can change the CH1 time base scale, adjustment method for other channels are similar to this.
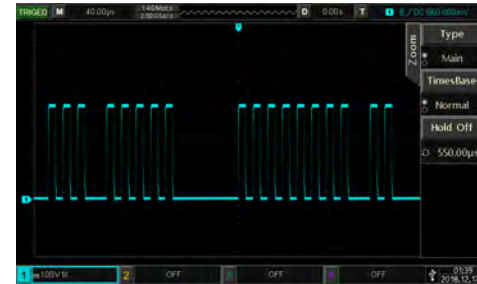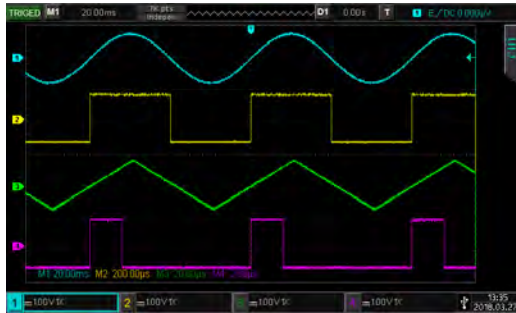
3.5 Trigger Hold-off

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 (shuttle knob or numeric keypad) 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 the 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.

Sample Menu

Functions	Options	Descriptions
Acquisition Mode	Normal sampling	Sampling in the normal way
	Peak sampling	Sampling in peak detection mode
	High resolution	Sampling in high-resolution mode
	Envelope	Sampling in envelope 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. The average number of times can be set to 2n, and n is an integer from 1 to 13.
Memory Depth	Auto	Set the memory depth to automatic, which is the normal memory depth
	7k	Set the memory depth to 7kpts
	70k	Set the memory depth to 70kpts
	700k	Set the memory depth to 700kpts
	7M	Set the memory depth to 7Mpts
	70M	Set the memory depth to 70Mpts

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 collects the digital data into waveform records. Finally, the waveform record is stored in the acquisition memory.

Analog input signal   Sampling points
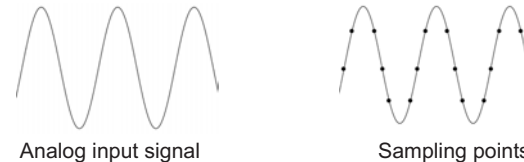
Sampling rate refers to the time interval between two sampling points. The maximum sampling rate of the UPO3000E series is 2.5 GS/s.
The sampling rate will be affected by the time base scale and the memory depth. UPO3000E oscilloscope displays the sampling rate in real time at the top status bar, user 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
1. Waveform distortion: Due to low sampling rate, the details of the waveform might be missing, the sampling waveform might be much different from the actual signal.
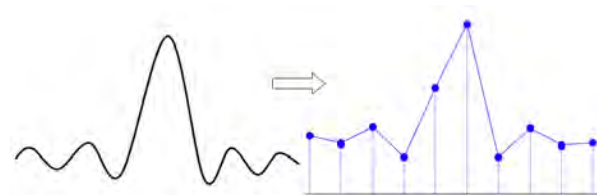
2. Waveform aliasing: Since the sampling rate is less than 2 times of the actual signal frequency (Nyquist Frequency), the frequency of the reconstructed signal will be less than the actual signal frequency.
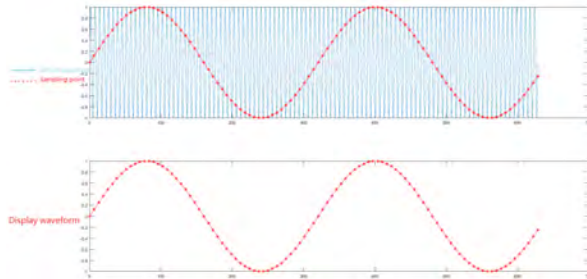
3. Waveform leakage: Due to low sampling rate, the reconstructed waveform might not reflect the entire actual signal.

Pulse disappear
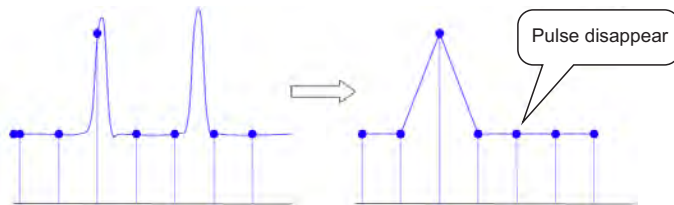
4.2 Acquisition Mode
To obtain a waveform from sampling points, press ACQUIRE ➔ acquisition mode to
switch between the acquisition methods.

(1) Normal Sampling
In this acquisition mode, the oscilloscope samples the signal at equal intervals and reconstruct the waveform. 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 a 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 the random noise on the input signal and produce a smoother waveform on the screen.

(4) Envelope
Acquires multiple waveforms, and calculates and displays the maximum and minimum values for all sampling points that are at the same time relative to the trigger points. The general envelope mode uses the peak detection mode for each individual acquisition.

(5) Average
In this acquisition mode, the oscilloscope acquires several waveforms and finds the average, and displays the final waveform. This method can reduce the random noise.
Observe the waveform changes by changing the acquisition mode settings. If the signal contains a large noise, the sample waveforms without average or with 32 times average are displayed below for comparison.

Waveform without average   Waveform with 32 times average

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

4.3 Memory Depth

The memory depth refers to the number of waveform points that the oscilloscope can store in one trigger acquisition. It reflects the 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

UPO3000E comes with 70Mpts memory depth (per channel). Press ACQUIRE ↦ Memory depth to set the memory depth to automatic, 7k, 70k, 700k, 7M or 70M. 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 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, the 4-channel UPO3XX4CS will be used as an example.

5.1 Trigger System Interpretation

(1) Trigger Source

A signal for generating a trigger. 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 front panel of the oscilloscope as a trigger signal.
- External Trigger: Select the EXT Trig (EXT or EXT /5 input terminal) input signal from the back of the oscilloscope 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 -1.8V ~ +1.8V can be set. EXT/5 trigger level range is increased to -9V ~ +9V.
- AC Line: Power supply. It can be 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. Press the MODE on the trigger control area to switch the trigger modes.

- Auto trigger: When there is no trigger signal, the system automatically runs and displays data. When the trigger signal is generated, it automatically switches to trigger scanning to synchronize with the signal.
Note: This mode allows 40ms/div or slower time scale without triggering in ROLL mode.

- Normal Trigger: The oscilloscope only collects 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 component of the signal will be transmitted to the trigger circuit. The coupling type includes DC, AC, low frequency suppression, high frequency suppression, and noise suppression.
- DC: Let all the signal components pass.
- AC: Blocks DC components and attenuates signals below 10Hz.
- High Frequency Suppression: Attenuates high frequency components above 80kHz.
- Low Frequency Suppression: Blocks DC components and attenuates low frequency components below 8kHz.
- Noise Suppression: Suppresses high frequency noise in the signal and reduces the probability of the oscilloscope being falsely triggered.

(4) Trigger Sensitivity

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

(5) Pre-trigger/ Delayed Trigger

Data collected before/after the trigger event.
Trigger position is usually set at the level of the screen, and you can observe 7 grids of pre-trigger and delayed 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 trigger mode, press the FORCE button to collect the signal baseline to check whether the acquisition is normal.

5.2 Edge Trigger

Edge trigger uses the rising or falling edge of the trigger signal to generate a trigger.
Press TRIG MENU → type , and select the edge by the Multipurpose knob, the default trigger type is edge. The trigger type can also be switched by consecutively pressing the type key, and 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 edge, trigger source is CH1, and it is the rising edge trigger with trigger level of 0.00V.

Edge Trigger Menu

Source:
Press the source key to select the trigger source of CH1, CH2, CH3, CH4, AC Line, EXT, and EXT/5. 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.

Edge Type:
Press the edge type key to select which edge the input signal will trigger on, user can select the rising edge, falling 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.

5.3 Pulse Width Trigger

The pulse width trigger determines the trigger time according to the pulse width, you can capture the pulse by setting the pulse width condition.
Press TRIG MENU ➤ type, select the pulse width by the Multipurpose knob. You can also switch the trigger type by pressing the type key, then press the Multipurpose knob to confirm.
At this time, the trigger setting information ▮ Р ДDC 0.000μV is displayed at the upper right corner of the screen, the trigger type is pulse width, the trigger source is CH1, and the trigger level is 0.00V.

Pulse Width Trigger Menu
Source:

Press the Source button to select the trigger source, you can select CH1, CH2, CH3, CH4, AC Line, EXT, and EXT/5. 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 steady 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 Multipurpose knob (shuttle knob or numeric keypad) to set the pulse widthtime.

Pulse Width Polarity:

Press the pulse width polarity key to select the positive pulse width and 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.
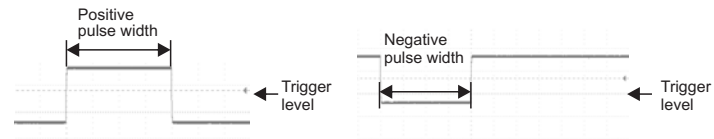
Trigger Setting:

Please refer to the "Trigger 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 UPO3000E 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 TRIG MENU ➤ type, and select video 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 ▮ V DC the upper right corner of the screen, the trigger type is video, and the trigger source is CH1.

Video Trigger Menu

Source:

Press the source button to select the trigger source, you can select CH1, CH2, CH3, CH4, EXT, and EXT/5. 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 steady trigger.

Video Format:

Press the video format button to select PAL，NTSC, 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, 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).

Tip: In order to observe the waveform details more clearly in the video signal, you can set the memory depth a little bigger. The UPO3000E series utilize the UNI-T original digital three-dimensional 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 or fall slope value matches the value in settings.

Press TRIG MENU type, and select slope 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 slope, the trigger source is CH1, and the threshold high level or low level is 0.00V.

Slope Trigger Menu

Source:

Press the source button to select the trigger source, you can 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 steady trigger.

Trigger Setting:

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

Slope Setting:

Press the slope setting button to enter the slope setting menu.

Slope:

Press the slope button to select the slope trigger edge: rising edge and 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 condition: ">", "<", "=".

(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 (shuttle knob or numeric keypad) to set the time setting.

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 LEVELknob.

(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 level, low level intersect with the trigger signal.
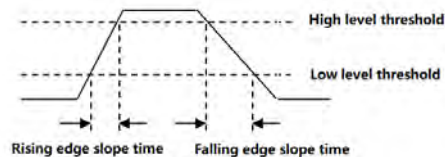
5.6 Runt Trigger

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.
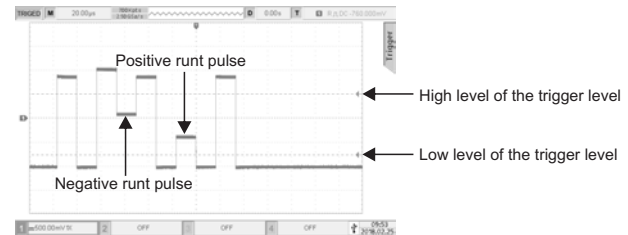
Press $\boxed{\text{TRIG MENU}}$ → type, and select runt by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

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 the trigger source, you can 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 steady trigger.

Polarity:
Press the polarity key to select the trigger polarity: 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 (shuttle knob or numeric keypad) to set the time.

Trigger Level:
Press $\boxed{\text{PgDn}}$ ➤ 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 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 $\boxed{\text{TRIG MENU}}$ ➤ 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 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.

Window Trigger Menu
Source:
Press the source key to select the source, you can 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 steady 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 the position key 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 (shuttle knob or numeric keypad) to set.

5.8 Delay 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.
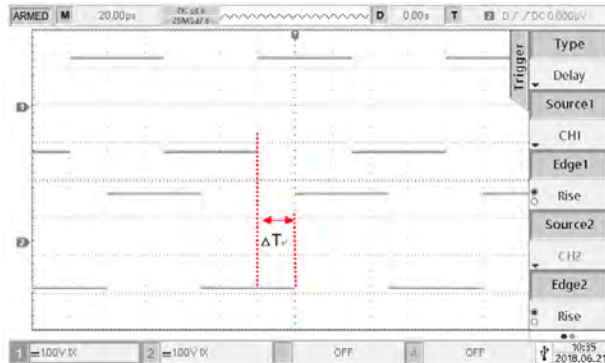
Set edge 1 and edge 2 as the rising edge, △T is the range marked in red in the above figure.

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 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 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 the trigger source, you can 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 steady 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 source2 key to select the trigger source, you can 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 steady trigger.

Edge 2:

Press the 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 (△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 (△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 (△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 (△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 (shuttle knob or numeric keypad) to set.

5.9 Timeout Trigger

Select the timeout trigger to trigger the signal that the time interval (△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.
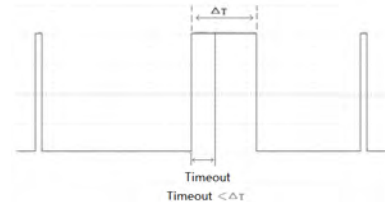
Timeout
Timeout < △T

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] [1] 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 key to select the trigger source, you can 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 steady 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 (shuttle knob or numeric keypad) 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.

CH1

CH2

CH3

CH4

Dur: CH1 HLHL CH4
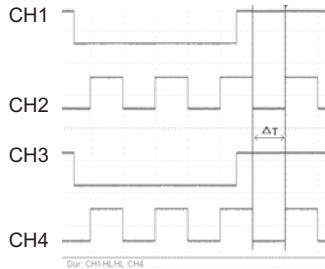
Picture 5-7 Duration trigger

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 1 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 key to select the trigger source, you can 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 steady trigger.

Code:
Press the code key to select H, L, X. The code setting of each channel is displayed at the bottom of the screen, as shown in the figure: ![Dur: CH1 HL XH CH4] .
(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.
(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 the time setting key 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 (shuttle knob or numeric keypad) to set.

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.

Data code: H
Edge type: rising edge

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 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 key to select CH1, CH2, CH3, or CH4.

Note: Only selecting the channel with connected signals as a trigger source can obtain a steady 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 key to select CH1, CH2, CH3, or CH4。

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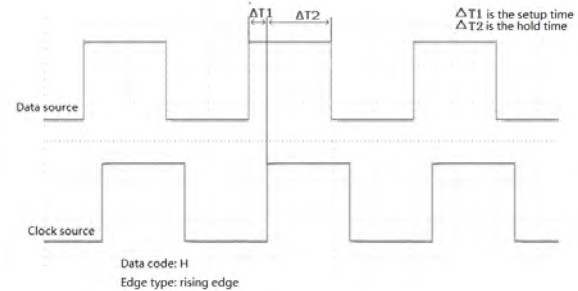
Time:

Press the ⌊PgDn⌋ ➞ key and adjust the Multipurpose knob (shuttle knob or numeric keypad) 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.
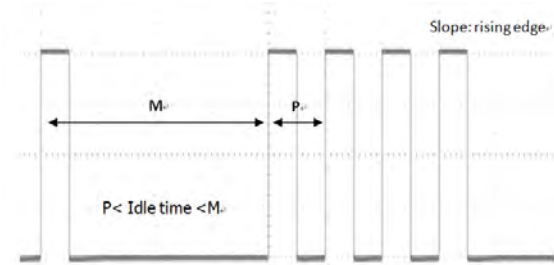
Press ⌊TRIG MENU⌋ ➞ type, and select Nth edge by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information [T ① N / DC 0.000μV] 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 key to select the trigger source, you can select 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 steady 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 (shuttle knob or numeric keypad) 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 (shuttle knob or numeric keypad) 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 pattern 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 pattern of all channels are set to "ignore", the oscilloscope will not trigger.
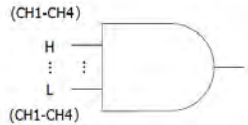
Press TRIG MENU ➙ type, and select code pattern by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

At this time, the trigger setting information ▮ P₁DC 0.000v 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 key to select the trigger source, you can select 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 steady 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

UPO3000E decodes the input signals of the analog channels using common protocols, including parallel, RS232, I2C, SPI, CAN, LIN, and FlexRay. 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 (Optional)

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:
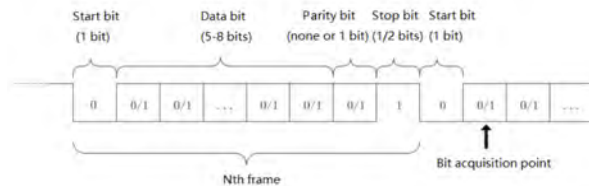
RS232 Selection:
Press DECODE → type, and select RS232 by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

Source:
Press the source key to select the trigger source, you can select 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 steady trigger and correct decoding.

Polarity:
Press the polarity key 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.

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 key to select 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, or user-defined. When selects the user-defined option, adjust the baud rate by the Multipurpose knob or the shuttle 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 Width:
Specifies the data bit width of the RS232 protocol signal that needs to be decoded. Press PgDn ⇢ bit width to select 5bits, 6bits, 7bits, or 8bits.

Bit Sequence:
Specify the data bits of the RS232 protocol signal that needs to be decoded are high bit in front (MSB) or low bit in front (LSB).
Press PgDn ⇢ bit sequence to select MSB or LSB.
(1) MSB: The high bit of the data transmits first.
(2) LSB: The low bit 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) Even 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 (Optional)

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 HOS-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:
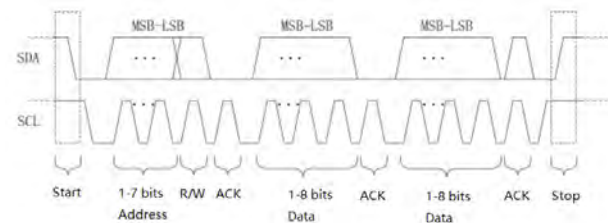
I2C Selection:

Press $\boxed{\text{DECODE}}$ ➡ 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 key to select the SCL source, you can set any of CH1~CH4 as the clock input of I2C.

SDA source:

Press the SDA source key 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 $\boxed{\text{PgDn}}$ ➡ 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 SCLis 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.

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 setup 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 USB Decode (Optional)

USB（Universal Serial Bus）is a serial bus standard for connecting computer systems to their peripheral devices, and it is also a technical specification for input and output interfaces. USB uses differential pairs to transmit signals, different protocol versions define different transmission rates such as low speed (1.5Mbps), full speed (12Mbps), high speed (480Mbps), and over speed (5Gbps). The UPO3000E provides both low speed and full speed rates.

USB Selection:

Press DECODE ↦ type, and select USB by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

D + Source:

Press the D + source key to set any of CH1 ~ CH4 as the USB D+ input.

D - Source:
Press the D - source key to set any of CH1 ~ CH4 as the USB D- input.

Speed:
Press the speed key to set low speed (1.5Mbps) or full speed (12Mbps).

Trigger Condition:
Press the trigger condition key to set the USB trigger condition. UPO3000E provides synchronization, reset, pause, restore, packet tail, token packet, data packet, handshake packet, and error.

When the trigger condition is token packet, set the following:
(1) Token Type: Includes 5 types: Any, OUT, IN, SOF, SETUP.
(2) Endpoint: Adjust the Multipurpose knob to set the endpoint position.
(3) Comparison Condition: Includes 8 types: = , != , < , > , >= , <= , <> and >< .
(4) Address: Adjust the Multipurpose knob to set the address value.

When the trigger condition is handshake packet, set the following:
Type: Select any, ACK, NAK, or STALL.

When the trigger condition is data packet, set the following:
(1) Data Type: Includes 3 types: Any, DATA0, DATA1.
(2) Bytes: Adjust the Multipurpose knob to set the number of bytes.
(3) Offset: Adjust the Multipurpose knob to set the offset value.
(4) Comparison Condition: Includes 8 types: = , != , <, > , >= , <= , <> and >< .
(5) Data Setting: Adjust the Multipurpose knob to set the data value.

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.

6.4 CAN Decode (Optional)

CAN (Controller Area Network) is a kind of serial communication protocol, which allows devices on the network to communicate with each other directly, and there is no need for the host to control the communication on the network. It adopts the differential signal transmission and uses the bit stuffing method for signal encoding. It will insert a complement bit after every 5 identical bits, and the high bytes data will be sent first. The CAN protocol signal format is shown in the figure below:
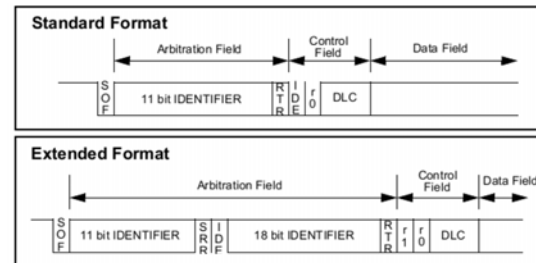
CAN Selection:
Press DECODE   type, and select CAN by the Multipurpose knob. You can also switch the trigger type by consecutively pressing the type key, then press the Multipurpose knob to confirm.

Signal Type:
Press the signal type key to set the CAN signal type: CAN_L, CAN_H, RX/TX and Diff.

Input +:
Press the input + key to set any of CH1 ~ CH4 as a signal of CAN decoding or differential bus.

Input -:
Press the input - key to set any of CH1~CH4 as a signal of differential bus.

Sample %：

Adjust the Multipurpose knob or shuttle knob to set the "Input -" sampling point ratio (1%~99%).

Trigger Condition:

Press PgDn ➡ trigger condition to set CAN trigger condition: Frame start, frame type, ID, data, missing ACK, fill error, ID and data, frame end.
Frame Start: Triggers at the start of the CAN protocol data frame.
Frame Type: Triggers on the specified frame type, including data frame, remote frame, error frame, and overload frame.
ID: Set the ID for the specified frame type, and triggers on the specified ID.
Data: A 2-digit hexadecimal number of 1~8 bytes can be set. When the actual CAN protocol signal and the set data meet the data qualification conditions, a trigger occurs. The data qualification includes <, >, ⩽, ⩾, =, !=.
Missing ACK: Triggers when the ACK Field of the data frame is lost.
Fill Error: Since the CAN signal encoding uses bit stuffing, a complement bit is inserted after every 5 identical bits, and it triggers when the complement bit is filled incorrectly.
ID and Data: Triggers when it meets the ID and data conditions at the same time.
Frame end: Triggers at the end of the data frame.

Frame Type:

When the trigger condition is frame type, you can set data frame, remote frame, error frame, and overload frame.
(1) Data Frame: Triggers on the data frame of the CAN protocol signal. The data frame format is as follows:
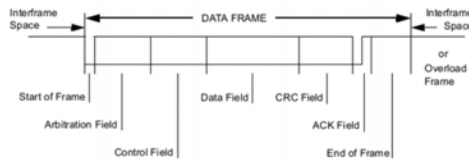
(2) Remote Frame: Triggers on the remote frame of the CAN protocol signal. Remote frames are the same as data frames except that there is no data field. Remote frames and data frames are differentiated by the arbitration field RTR bit.
(3) Error Frame: Triggers on the error frame of the CAN protocol signal. The error frame is represented by a 6-bit continuous level that breaks the bit stuffing rule followed by a recessive value (logic 1) of a minimum of 8 bits as the error delimiter. Error frames are divided into active error frames and passive error frames. Active error frames use 6-bit dominant values (logic 0), and passive frames use recessive values.
(4) Overload Frame: Triggers on the overload frame of the CAN protocol signal. The overload frame format is the same as the active error frame.

Press the type key and you can set the frame type.

ID Setting:

When the trigger condition is ID or ID/ data, ID setting is required.
Press PgDn ➡ ID setting to enter the ID setting menu:
Format: Set as standard frame or extended frame.
Standard: Standard ID can be 000 ~ FFF.
Extended: Extended ID can be 00000 ~ FFFFF.
Direction: Set the ID direction to read or write.
After setting the ID, press the back key to return to the previous setting menu.

Data Setting:

When the trigger condition is data or ID/data, data setting is required.
Press PgDn ➡ data setting to enter the data setting menu:
Comparison condition: Includes 6 types: = , != , < , > , <= , >=.
Bytes: 1 ~ 8 bytes can be set.
Data: Adjust the Multipurpose knob to set the data, press the knob to jump to the next digit to adjust.
After setting the data, press the back key to return to the previous setting menu.

Baud Rate:

Press PgDn → baud rate to set the rate of the CAN protocol signal that needs to be decoded, you can select 10kb/s, 20kb/s, 33.3kb/s, 50kb/s, 62.5kb/s, 83.3kb/s, 100kb/s, 125kb/s, 1Mb/s or user-defined.

In user-defined, customize the baud rate by adjusting the Multipurpose knob or shuttle knob.

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.

6.5 SPI Decode (Optional)

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 bytes, that is to say, higher byte first and then lower byte. 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:
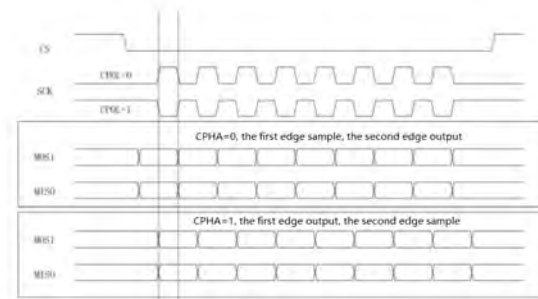
Note: At least 3 output channels are required. Therefore, this function is only available on the 4-channel product of UPO3000E series oscilloscopes.

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 key to set any of CH1~CH4 as the chip select input of the SPI decoded signal.

SCLK Source:

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

MOSI Source:

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

MISO Source:

Press the MISO source key 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 data bits of the SPI protocol signal are high bit in front (MSB) or low bit 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, 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 Operation

UPO3000E 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 ▶ 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, 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, 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 key to select any of CH1, CH2, CH3, 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 displays 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 ACcoupling.

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, CH4 as source 1 of logic operations.

Source 2:
Press the source 2 key to select any of CH1, CH2, CH3, 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 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 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 MATH → type, select digital filter to enter its menu.
Source:
Press the source key to select any of CH1, CH2, CH3, 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 that are 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 that are 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.
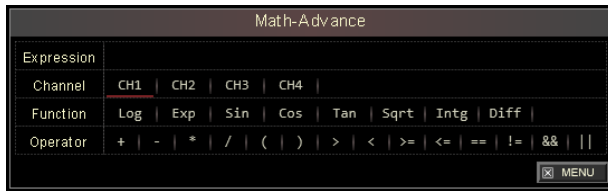
Note: The setting range of the frequency upper and lower limit is related to the current horizontal time base.

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 and select close 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 or shuttle knob to set the grid brightness.

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

Persist:
Press DISPLAY ↪ persist to select MIN, 50ms, 100ms, 200ms, 500ms, 1s, 2s, 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.
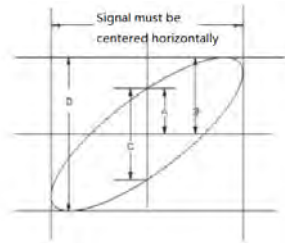
According to sinθ = A/B or C/D, θ is the phase difference angle between channels, and the definition of A, B and C, D are shown above, it can be calculated that the phase difference angle θ = ± arcsin (A/B) or θ = ± arcsin (C/D). If the main axis of the ellipse is in the quadrants I, III, then the calculated 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

UPO3000E series oscilloscope can automatically measure 34 kinds of parameters.

Voltage:
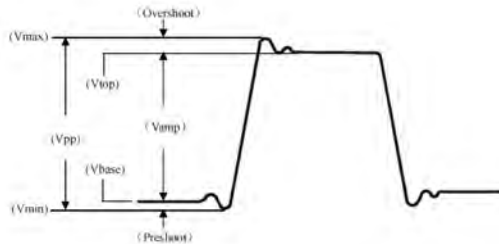
Vmax: Voltage value from the highest point to GND.

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:
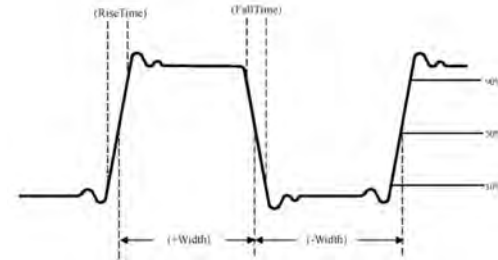
Period: Time between two consecutive, same-polarity edges of a repetitive waveform.

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 between the first rising edge of source 1 to the first rising edge of source 2

FRF: Time between the first rising edge of source 1 to the first falling edge of source 2

FFR: Time between the first falling edge of source 1 to the first rising edge of source 2

FFF: Time between the first falling edge of source 1 to the first falling edge of source 2

LRF: Time between the last rising edge of source 1 to the last falling edge of source 2

LRR: Time between the last rising edge of source 1 to the last rising edge of source 2

LFR: Time between the last falling edge of source 1 to the last rising edge of source 2

LFF: Time between 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.

	Off	Close this function.
Measurement Statistical Analysis	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.
Slave source	Ch1, CH2, CH3, CH4, MATH	Select the slave source that requires two channels for measurement.

Automatic Measurement Menu (page 2)

Functions	Options	Descriptions
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	Open parameter indicator.
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 color 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 F4 key, as shown below:

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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, "Y" indicates the voltage measurement.

Time:

The Multipurpose knob can adjust the vertical cursor AX, press the Multipurpose knob to switch to cursor BX, the adjustment method of cursor BX is the same as AX.

BX-AX: The time 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:
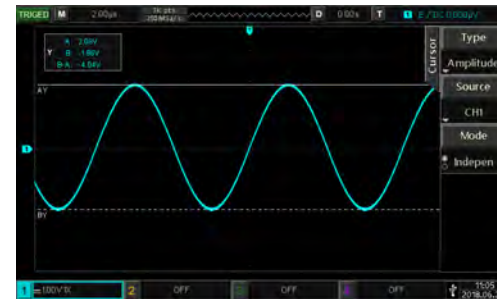
The Multipurpose knob can be used to adjust the horizontal cursor AY on the screen, press the Multipurpose knob to switch to cursor BY, the adjustment method of cursor BY is the same as AY.

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 Load

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, select setting to enter the setting storage menu.

Setting Storage Menu

Functions	Options	Descriptions
Type	Setting	
Disk	DSO	Press save to save the settings to the oscilloscope.
	USB	Press save to save the settings to an external USB storage device.

Filename		Filename can be chosen with the Multipurpose knob. Names can be chosen from set001, set002, …., 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.

Waveform Storage Menu

Functions	Options	Descriptions
Type	Waveform	
Source	CH1, CH2, CH3, CH4	Set which channel waveform to be saved.
Disk	DSO	Press save to save the waveforms to the oscilloscope.
	USB	Press save to save the waveforms to an external USB storage device.
	USB CSV	When save 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 can be chosen with the Multipurpose knob. Names can be chosen from wav001, wav002, …., 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 load to recall the waveform from the oscilloscope.
	USB	Press load to recall the waveform from the external USB storage device
Filename		Filename to be loaded can be chosen with the Multipurpose knob. Names can be chosen from wav001, wav002, …., 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
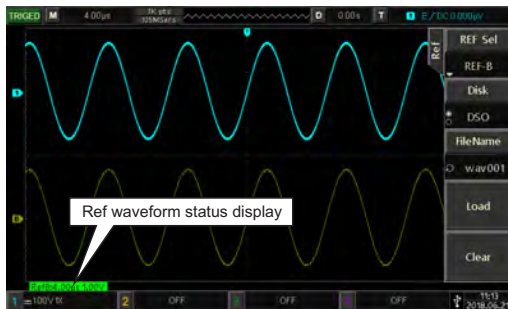
After loading, the Ref waveform status will be displayed in the lower left corner, including time base scale and amplitude scale. At this point you can use the vertical and horizontal control knob to adjust the Ref wavform's position on the screen, the time base scale, and the amplitude scale.

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, 10kHz.

Frequency meter:

Press [UTILITY] → [PgDn] → frequency meter, select on and ▮Freq ----▮ will be displayed at the top of the screen.

The frequency meter is the counter of trigger event frequency in the trigger channel, 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] → backlight brightness → F1 to clear the data stored in the device.

Network 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, select setting to make parameter settings for waveform recording. You can also press REC SET to quickly enter the recording setting interface.

Recording Interval:

Set the interval between each frame of the waveform recording.

Press the recording interval key and adjust the Multipurpose knob (shuttle knob or numeric keypad) to set.

End Frame:

Press the end frame key and adjust the Multipurpose knob (shuttle knob or numeric keypad) to set that the waveform recording will automatically stop recording when it reaches this frame.

Playback Delay:

Set the interval time between each frame during the waveform playback. Press playback delay, and adjust the Multipurpose knob (shuttle knob or numeric keypad) to set.

Max Frame Size:

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.

Record:

Press record to start recording. You can also press ▫ directly to start recording.

Stop:

Press stop to stop the waveform recording. You can also press ▫ to stop recording.

Play:

Press play and the waveform starts playing back, you can also press ⏯ directly to start playback, press this button again to pause. Adjust the Multipurpose knob (shuttle knob or numeric keypad) to jump to the specified number of frames.

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.
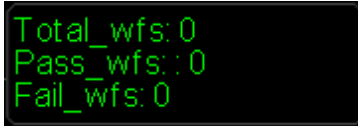
Source:

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:0
Pass_wfs::0
Fail_wfs:0
```

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 key and set the source to CH1.
⑤ Open message: Press the message key and select on.
   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.
⑥ Template setting: Press the template setting key to enter the menu; press reference waveform and select CH1; press the horizontal tolerance key and adjust 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.
⑦ Start test: Press PgDn ➔ operate and select on to start the test. See figure below:
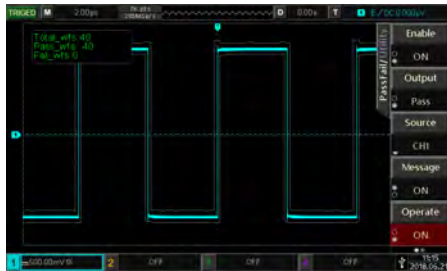
The Pass/Fail function will run continuously, and stop once 10 fail tests have been reached, or the user manually suspends the test (when operate is set to off).

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 hardware version of the device, 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 according to the input signal, choose appropriate time base scales, amplitude scales, and triggering parameters 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 10Hz, 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. UPO3000E series oscilloscope factory settings are as below:

System	Function	Factory Setting
	CH1	1V/DIV
	Vertical Displacement	0 (vertical midpoint)
	Coupling	DC
Vertical System	Bandwidth Limitation	Off
	VOLTS/DIV	Coarse tuning
	Probe	1×
	Invert	Off

Vertical System	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	100.00ns
	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%
Other System	Storage Type	Waveform
	Frequency Meter	Off
	Measurement	Off, clear all measurements
	Cursor	Off
	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: When the USB storage device is not connected, this prompt appears if you select a storage disk as USB.

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 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 and let us serve you.

(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 the analog channel of the input signal and that channel is open.

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 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 with the AUTO key.

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 UPS3000CS 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 thirty minutes.
- If the operating temperature range reaches or exceeds 5 degree Celsius, user must turn on the system function menu to perform self-correcting.

Input				
Input Coupling	DC, AC, GND			
Input Impedance	1MΩ±2% // 18pF ±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	UPO3152E	UPO3252E	UPO3154E	UPO3254E
Analog Bandwidth	150MHz	250MHz	150MHz	250MHz
Rise Time (Typical)	≤2.4ns	≤1.4ns	≤2.4ns	≤1.4ns
Channels	2	2	4	4
Vertical Resolution	8bit			
Vertical Scale	1mV/div ~ 20V/div (1-2-5 base)			
Vertical Displacement Range	1mV/div ~ 50 mV/div: ±2V; 100 mV/div ~ 1 V/div: ±40V; 2V/div ~ 20 V/div: ±400V			
Bandwidth Limit (Typical)	20MHz			

Low Frequency Response (AC coupling, -3dB)	≤5 Hz (on BNC)
DC Gain Accuracy	≤±3% (Sampling or average sampling method)
DC Offset Accuracy	≤±3% (Sampling or average sampling method)
Channel Isolation	DC to maximum bandwidth: >40 dB
Horizontal	
Timing Scale	2ns/div ~ 40s/div (1-2-4 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	200,000 wfms/s
Sampling	
Sampling Mode	Real-time sampling
Real-time Sampling Rate	2.5GS/s (single channel), 1.25GS/s (dual channel), 1.25GS/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, 7kpts, 70kpts, 700kpts, 7Mpts, 70Mpts optional

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Trigger	
Trigger Level Range	Internal: Center of the screen ±8 grids; External: ±1.8V; EXT/S:±9V
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	3.2ns ~ 10s
Runt Trigger	
Pulse Width Condition	>, <, =
Polarity	Positive, negative polarity
Pulse Width Range	6.4ns ~ 10s

Window Trigger	
Window Type	Rising edge, falling edge, any edge
Trigger Position	Window enter, exit, time
Window time	6.4ns ~ 10s
N-Edge Trigger	
Edge Type	Rising edge, falling edge
Idle Time	6.4ns ~ 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:6.4ns~10s; Lower time limit:6.4ns~10s; Upper time limit:28.8ns~10s
Timeout Trigger	
Edge Type	Rising edge, falling edge, any edge
Timeout	6.4ns~10s
Duration Trigger	
Code	H, L, X
Trigger Condition	Greater than, less than, within range
Duration Time	Normal:6.4ns~10s; Lower time limit:6.4ns~10s; Upper time limit:28.8ns~10s

Setup/Hold Trigger	
Edge Type	Rising edge, falling edge
Data Type	H, L
Setup Time	6.4ns~10s
Hold Time	6.4ns~10s
Slope Trigger	
Slope Condition	Positive slope (greater than, less than, specified range)
	Negative slope (greater than, less than, specified range)
Time Setting	6.4ns~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 (Optional)	
Trigger Condition	Start of frame, error frame, parity error, data
Baud Rate	2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, user-defined
Data byte width	5 bits, 6 bits, 7 bits, 8 bits

I2C Decode (Optional)	
Trigger Condition	Start, restart, stop, lost acknowledgment , address, data, address/data
Address byte 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 (Optional)	
Trigger Condition	Chip select, timeout
Idle Time	80ns~1s
Data bit size	4 bits to 32 bits
Data Setting	H, L, X
Clock Edge	Rising edge, falling edge
USB Decode (Optional)	
Signal Speed	Low speed, full speed
Trigger Condition	Synchronization, reset, pause, restore, packet tail, token packet, data packet, handshake packet, SOF, error.
CAN Decode (Optional)	
Signal Type	Rx/Tx, CAN_H, CAN_L, Difference
Trigger Condition	Frame start, frame type, ID, data, ACK missing, bit stuffing error, ID and data, frame end
Signal Rate	10kbps, 20kbps, 33.3kbps, 50kbps, 62.5kbps, 83.3kbps, 100kbps, 125kbps, 1Mbps, user-defined

Sampling Point	1% to 99%	
Frame Type	Data frame, remote frame, error frame and overload frame	
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	2^{24}
Duration	Minimum, 50ms, 100ms, 200ms, 500ms, 1s, 2s, 5s, 10s, 20s and infinite.
Menu Duration	1s, 2s, 5s, 10s, 20s, manual
Display Type	Point, vector
Interface	
Standard/Optional Interface	Standard: USB-Host, USB-Device, LAN, VGA, EXT Trig, AUX Out Optional: Signal source output interface (WaveGen), multimeter module (UT-M12)

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	370mm（W）×195mm（H）×125mm（D）
Weight	4. 2kg
Calibration Interval	
Recommend to perform calibration once a year	

Chapter 16 Accessories
Appendix A Accessories and Options

Model Number	UPO3152E/UPO3154E（150MHz）
	UPO3252E/UPO3254E（250MHz）
Standard Accessories	Power cord that complies with the country's standard
	USB data cable（UT-D14）
	2/4 passive probes（200MHz/300MHz）
	Quick guide
	CD-ROM（including user manual and application software）

All accessories（standard accessories and optional items）, please order from the 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 with a damp but not dripping soft cloth, wipe the instrument. 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, you can contact UNI-TREND TECHNOLOGY（CHINA）CO.，LTD. directly in mainland China. Products from regions outside of China, 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.

UNI-T®

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