

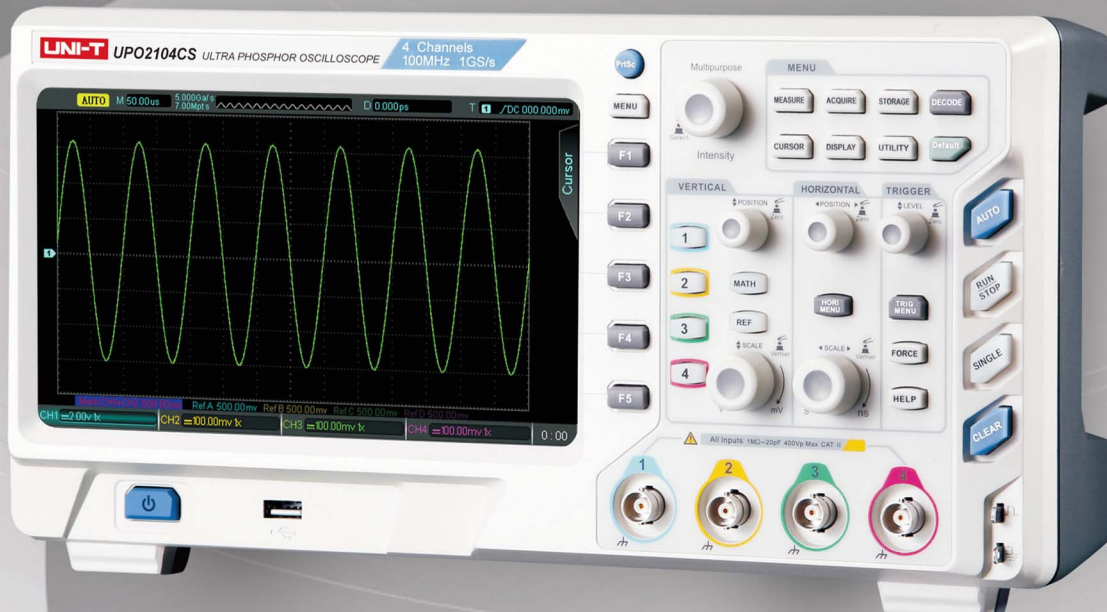
UNI-T®



Certificate No. 956661

UPO2000CS

User Manual



Ultra Phosphor Oscilloscope

Introduction

Dear Users:

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

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

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Copyright Information

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Trademark Information

- UNI-T is the registered trademark of Uni-Trend Technology (China) Limited.

Document Version

UPO2000CS-20160414-EN-V1.3

Statement

- **UNI-T** products are protected by patent rights in China and foreign countries, including issued and pending patents.
- **UNI-T** reserves the rights to any product specification and pricing changes.
- **UNI-T** reserves all rights. Licensed software products are properties of Uni-Trend and its subsidiaries or suppliers, which are protected by national copyright laws and international treaty provisions.
- Information in this manual supercedes all previously published versions.

Warranty

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

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

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

location, the customer shall be responsible for all shipping, duties, taxes, and any other expenses.

This warranty shall not apply to any defects or damages caused by acciendental, machine parts' wear and tear, improper use, and improper or lack of maintenance. UNI-T under the provisions of this warranty has no obligation to provide the following services:

- a) Any repair damage caused by the installation, repair, or maintenance of the product by non UNI-T service representatives.
- b) Any repair damage caused by improper use or connection to an incompatible device.
- c) Any damage or malfunction caused by the use of a power source which does not conform to the requirements of this manual.
- d) Any maintenance on altered or integrated products (if such alteration or integration leads to an increase in time or difficulty of product maintenance).

This warranty written by UNI-T for this product, and it is used to substitute any other express or implied warranties. UNI-T and its distributors do not offer any implied warranties for merchatability or applicability purposes.

For violation of this guarantee, UNI-T is responsible for the repair or replacement of defective products is the only remedy available to customers. Regardless of whether UNI-T and its distributors are informed that any indirect, special, incidental, or consequential damage may occur, the UNI-T and its distributors shall not be responsible for any of the damages.

General Safety Overview

This instrument strictly complies with the safety requirements for electronic measuring instrument GB4793 and IEC 61010-1 safety standard during design and manufacturing. Please understand the following safety preventative measures, to avoid personal injury, and to prevent damage to the product or any connected products. To avoid possible dangers, be sure to use this product in accordance with the regulations.

Only trained personnels can perform the maintenance program.

Avoid fire and personal injury.

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

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

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

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

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

Do not open the case cover or front panel during operation

Only use fuses with ratings listed in the technical index

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

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

Maintain proper ventilation

Please do not operate the product in humid conditions

Please do not operate in inflammable and explosive environment

Please keep the product surface clean and dry

Safety Terms and Symbols

The following terms may appear in this manual:

Warning: The conditions and behaviors may endanger life.

Note: The conditions and behaviors may cause damage to the product and other properties.

The following terms may appear on the product:

Danger: Performing this operation may cause immediate damage to the operator.

Warning: This operation may cause potential damage to the operator.

Note: This operation may cause damage to the product and devices connected to the product.

The following symbols may appear on the product:



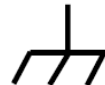
High Voltage



Caution!
Refer to Manual



Protective
Ground Terminal



Ground Terminal
for Chassis



Ground Terminal
for Testing

Preface

This manual introduces the operations of the UPO2000CS series digital oscilloscope, it includes the following sections:

[Chapter 1 – Introduction Guide](#)

[Chapter 2 – Vertical channel setup](#)

[Chapter 3 – Trigger system setup](#)

[Chapter 4 – Level system](#)

[Chapter 5 – Mathematical operations](#)

[Chapter 6 – Sampling system setup](#)

[Chapter 7 – The display system](#)

[Chapter 8 – Automatic measurements](#)

[Chapter 9 – Cursor measurements](#)

[Chapter 10 – Storage and callback](#)

[Chapter 11 – Auxiliary settings](#)

[Chapter 12 – Additional function keys](#)

[Chapter 13 – System and troubleshooting](#)

[Chapter 14 – Technical index](#)

[Chapter 15 – Appendix](#)

Appendix A: Accessories and options

Appendix B: Maintenance and cleaning

Appendix C: Warranty overview

Appendix D: Contact us

Introduction of UPO2000CS series digital phosphor oscilloscope

UPO2000CS series digital oscilloscopes contains the following 5 models

Model	Analog Channels	Bandwidth
UPO2104CS	4	100MHz
UPO2074CS	4	70MHz
UPO2102CS	2	100MHz
UPO2072CS	2	70MHz
UPO2202CS	2	200MHz

UPO2000CS series digital oscilloscope is based on UNI-T's unique Ultra Phosphor technology. A multi-functional, high performance oscilloscope that is easy to use, with excellent technical specifications, a perfect combination of many functionalities that can help users to quickly complete testings. UPO2000CS series is aimed at satisfying the most extensive oscilloscope markets, including communications, semiconductors, computers, aerospace defense, instrumentation, industrial electronics, consumer electronics, automotive electronics, field maintenance, R&D, education, etc.

The main features of the UPO2000CS series are:

- 200MHz/100MHz/70MHz bandwidth, providing 2-channel and 4-channel models
- Real-time sampling rate of up to 1GS/s, can also observe faster signals
- Standard storage depth of 28Mpts per channel, which allows the oscilloscopes to maintain a high sampling rate in a wider time base, taking into account the structure and details of the waveform
- Waveform capture rate of up to 50,000wfms/s
- Real-time continuous hardware waveform recording and waveform analysis support waveform recording up to 65,000 waveforms.
- Multilevel gray scale display
- 8-inch WVGA (800 * 480) TFT LCD, ultra widescreen, vivid color, clear display
- Abundant trigger features, including a variety of advanced trigger options
- Standard configuration interface: USB-Host, USB-Device, LAN, and Pass/Fail
- Automatic measurement of 34 waveform parameters
- Supports USB storage and firmware upgrades, one click screen copy function
- Plug and play USB device, can be used to communicate with computer

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Chapter 1 Introduction Guide

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

1.1 General Inspection

It is recommended to follow the steps below before using the UPO2000CS 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 or local distributors of this product.

(3) Machine Inspection


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

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


1.2 Before Use

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

(1) Connect to the Power Supply

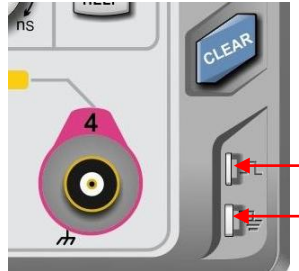
The power supply voltage range is from 100 VAC to 240 VAC, the frequency range is 45Hz to 440Hz. Connect the oscilloscope to the power supply line that came with the oscilloscope or any power supply line that meets the host country standards. Turn the power button on the back of the oscilloscope to ON.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

(2) Boot Check

Press the soft power button  and the light should change to yellow. 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 header to the BNC terminal of the oscilloscope. Connect the probe's main alligator clip to the "Calibration terminal" and the ground clip is connected to the "Ground terminal" shown below. The output of the sensor should be a $3V_{p-p}$ square wave, with a 1 kHz frequency.



Calibration and Ground Terminal

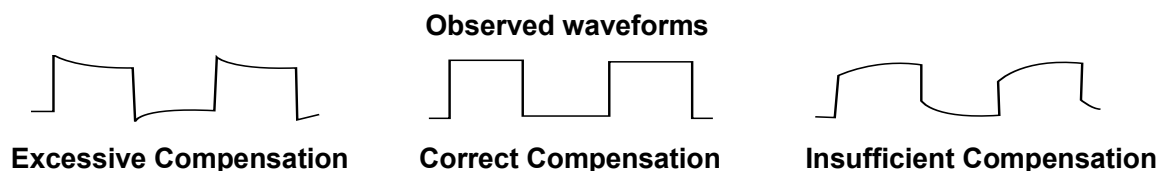
(4) Function Check

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

(5) Probe Compensation

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

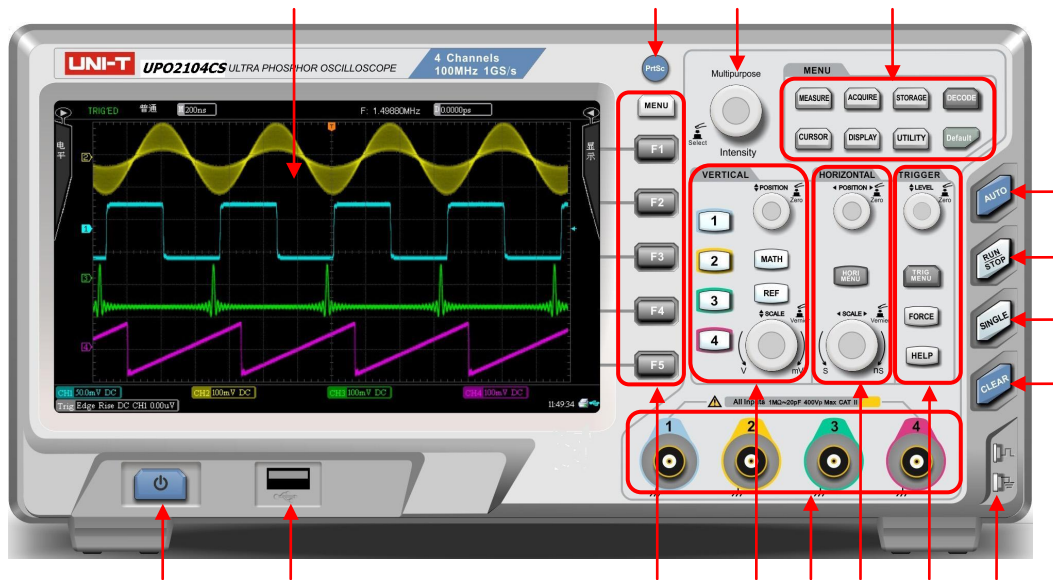
- ① Set the attenuation coefficient in the probe menu and the switch on the probe to 10x, and connect the probe to CH1. Make sure the probe's connector is properly connected with the oscilloscope. Connect the probe's main clip and ground clip to the oscilloscope's calibration and ground terminal respectively.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



- ② If the displayed waveform does not look like the above "correct compensation" waveform, use a non-metallic screwdriver to adjust the probe's variable capacitance until the display matches the "correct compensation" waveform.

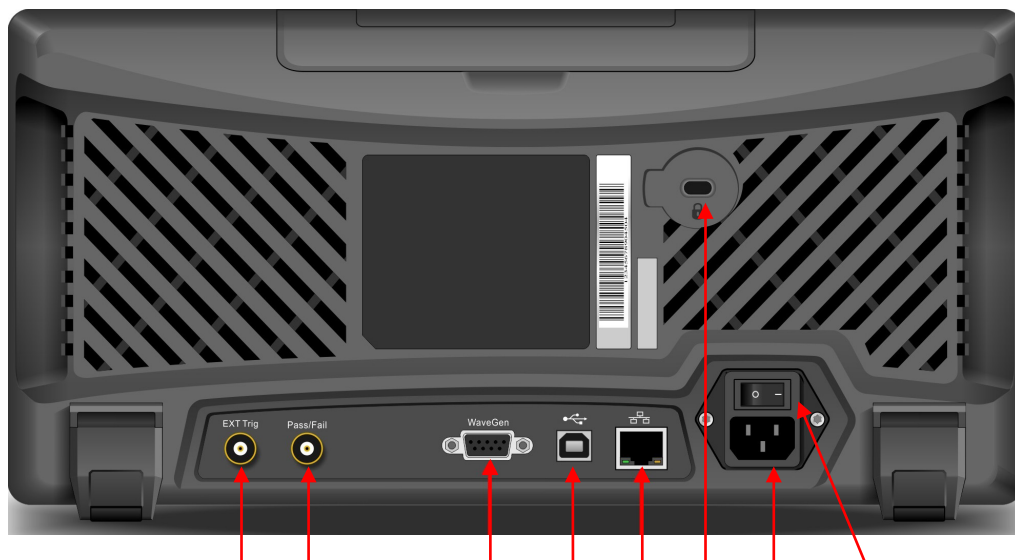
Warning: To avoid electric shock when measuring high voltage using the probe, please ensure that the probe insulation is in good condition and avoid physical contact with any metallic part of the probe.

1.3 Front Panel



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

1.4 Rear Panel

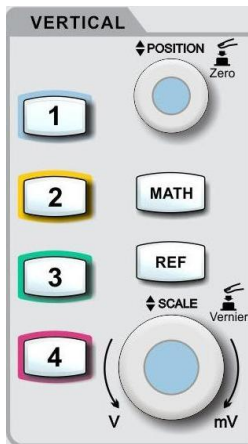


- ①. EXT Trig: External trigger input
- ②. Pass/Fail: Pass/fail test output, also supports Trig_out output
- ③. WaveGen: Function/arbitrary waveform output (optional)
- ④. USB Device: USB device interface, can be used to communicate with the PC
- ⑤. LAN: The oscilloscope can be connected to the LAN network for remote control
- ⑥. Safety Lock: Optional safety lock (sold separately) can be used for theft prevention
- ⑦. AC Power Socket: AC power terminal, power supply cord is provided within the accessory package (100 ~ 240 V, 45 ~ 440Hz)
- ⑧. Power Switch: Main power switch, when turned on, press the power on/off button on front panel to turn on the oscilloscope

1.5 Operation Panels

This section describes the front panel operations to help users to quickly familiarize with the UPO2000CS series.

(1) Vertical Control



- **[1], [2], [3], [4]**: Open or close the four channels display.
- **[MATH]**: Open the mathematical operations menu for add, subtract, multiply, divide, FFT, filtering, logic, and advanced operations.
- **[REF]**: Recall previously stored reference waveforms, can compare currently measured waveform with reference waveforms.
- **Vertical Position Knob**: Used to adjust the vertical position of the current channel waveform. Press this knob to return the channel display back to the midpoint position.
- **Vertical Scale Knob**: Used to adjust the vertical scale of the current waveform. The vertical scale has 1, 2, and 5 steps. Press the knob allows the vertical adjustment to switch between coarse and fine adjustment mode.

(2) Level Control



- **[HORI MENU]**: Displays window extension, independent timing, and holdoff time.
- **Horizontal Position Knob**: Adjusts the horizontal position of the current channel waveform. Press this knob to return the channel display back to the midpoint position.
- **Horizontal Scale Knob**: Used to adjust the vertical scale of the current waveform. The vertical scale has 1, 2, and 5 steps. Press the knob allows the vertical adjustment to switch between main and extensible window mode.

(3) Trigger Control



- **Trigger Level Knob**: Adjusts the currently selected trigger level. Press the knob to return the trigger level back to the midpoint position.
- **[TRIG MENU]**: Press to display the trigger menu.
- **[FORCE]**: Press to generate a trigger event once.
- **[HELP]**: Displays built-in help system.

(4)Auto Setting



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

(5)Run/Stop



Press the key to "run" or "stop" sampling. RUN state is indicated by green light. STOP state is indicated by red light.

(6)Single



Set to single trigger mode.

(7)Clear



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

(8)Screen Copy



Copy the screen to a BMP format image and store it to USB device.

(9)Multipurpose Knob



- During non-menu operations: Turn the knob to adjust display brightness. You can also press the **DISPLAY** button and choose the waveform brightness option, then use the knob to adjust the brightness.
- During menu operations: Turn the knob to select submenu, then press the knob to confirm selection.

(10)Function Keys



MEASURE: Measure setting menu: can set measure source to all parameters, custom parameters, perform measurement statistics, select measurement indicators, etc.

ACQUIRE: Sampling setting menu to set up acquisition mode

and deep storage.

STORAGE: Storage interface can select different types of storage and waveform settings, which can be stored internally or through USB device.

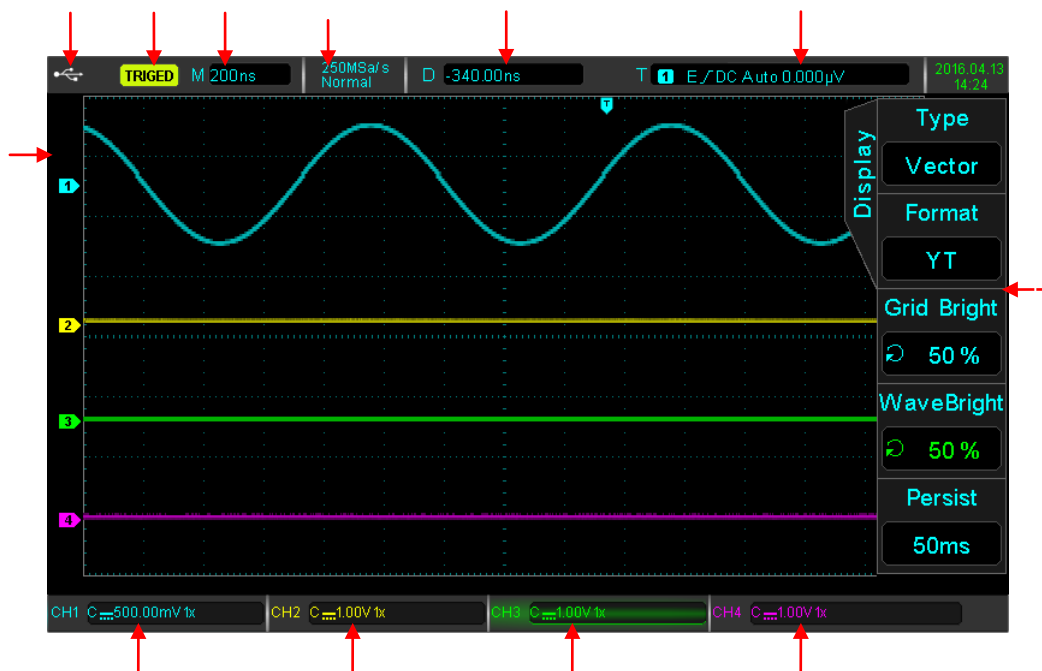
CURSOR: Cursor measurement menu can measure waveform's time and voltage manually with cursor.

DISPLAY: Select display settings, such as display type, format, duration, grid brightness, and waveform brightness.

UTILITY: The utility menu can choose between some less commonly used settings such as self-calibration, system information, language, menu display, waveform recording, pass test, square wave output, frequency meter, system upgrades, backlight brightness, output, etc.







DEFAULT: Restore to factory default settings.

1.6 User Interface



- ①. **USB Device Identification**: This icon will be displayed when an USB storage device is connected.
- ②. **Trigger Status Identification**: Include TRIGED (has been triggered), AUTO, READY, STOP, and ROLL (rolling)
- ③. **Timing Scale**: Indicates the amount of time represented by one square, which can be adjusted by the horizontal scale knob.
- ④. **Sampling Rate/Acquisition Mode**: Indicates the current sampling rate and storage depth.
- ⑤. **Horizontal Displacement**: Shows the horizontal displacement, which can be adjusted by turning the

horizontal position knob. Press in the knob returns the displacement back to 0.

- ⑥. **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,  is CH1.
 - b) *Trigger Type:* The types are edge, pulse width, video, slope, and advanced trigger. For example,  is an edge trigger.
 - c) *Trigger Slope:* The types are rising, falling, and rising/falling. For example,  is rising.
 - d) *Trigger Coupling:* The types are DC, AC, high frequency, low frequency and noise. For example,  indicates DC coupling.
 - e) *Trigger Level:* Indicates the current trigger level value, can be adjusted with the trigger level knob.
- ⑦. **CH1 Vertical Identification:** Displays CH1 activation state, channel coupling, bandwidth limit, vertical profile, and probe attenuation coefficient.
 - a) *Channel Activation State:*  When the background color is consistent with the channel color, the channel is activated. Press CH1~CH4 to open/close the corresponding channel.
 - b) *Channel Coupling:* Includes DC, AC, and grounding. For example,  is DC coupling.
 - c) *Bandwidth Limitation:* When the bandwidth limit function is turned on, a BW icon will appear in the display.
 - d) *Vertical Profile Position:* When CH1 is activated, the vertical profile can be adjusted with the vertical scale knob.
 - e) *Probe Attenuation Factor:* Displays CH1 probe attenuation coefficient: 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, and 1000X
- ⑧. **CH2 Vertical Identification:** Same as ⑦, but for CH2
- ⑨. **CH3 Vertical Identification:** Same as ⑦, but for CH3
- ⑩. **CH4 Vertical Identification:** Same as ⑦, but for CH4
- ⑪. **Operation Menu:** Displays the current operation menu. Use F1 ~ F5 to navigate through menu contents
- ⑫. **Analog Channels:** Displays CH1~CH4 waveforms with matching tag and waveform color.

Chapter 2 Vertical Channel Settings

UPO2000CS provides 4 or 2 analog input channels. The 4 analog channels are CH1~CH4, and the 2 analog channels are CH1 and CH2. The vertical system settings for all channels are exactly the same.

In this chapter, the vertical channel settings use the 4-channel UPO2XX4CS as example.

2.1 Open/Close Analog Channel

CH1~CH4 contains 3 states: open, activate, and shut down.

- Open:** Allows the corresponding channel waveform to display on the screen.
- Activation:** Only opened state can be activated. In the active state, the vertical menu and the vertical control knobs (POSITION, SCALE) are for changing activated channel setting. Any of the channels that have been opened but not activated could be activated by the corresponding channel keys
- Off:** No waveform appears on the display.

The table below describes the channel menu:

Functions	Options	Description
Coupling	DC	AC and DC components of the input signal
	AC	AC part of input signal only
	Ground	Displays ground signal with respect to input signal
Bandwidth	Off	Turns off bandwidth limit function
Limitation	Open	Limits bandwidth to 20MHz to reduce the display noise.
Vertical Sensitivity	Coarse Adjustment	The vertical sensitivity of the current channel can be set to 1, 2, and 5 order.
	Fine Adjustment	Set within the coarse range, adjusts in 1% of the current amplitude value steps for the channel's vertical sensitivity.
Probe		A value is automatically selected according to the probe's attenuation coefficient, to ensure consistency between the vertical profile readout and the displayed waveform.
Next page		Go to the second page of the channel menu
Reverse Phase	Off	Normal waveform display
	On	Reverse waveform
Bias	Off	Turn off the bias function
	On	Turn on the bias function
Bias Voltage		Adjust with the multipurpose knob, the bias voltage is used to offset the DC voltage the signal
Return to zero		Returns the bias voltage back to 0V
Return		Return to the first page of the channel menu

2.2 Channel Coupling

Using CH1 as an example, when a signal is connected to CH1 and activated, press **F1** and select channel coupling via the multipurpose knob. You can also switch to channel coupling by continuously pressing the F1 key. Press in the multipurpose knob to confirm selection.



Direct Current



Alternating Current



Ground

2.3 Bandwidth Limitation

When bandwidth limitation is open, 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. When the bandwidth limit function is on, the BW logo will appear in the vertical state flag shown below:



BW Logo

2.4 Vertical Sensitivity

The vertical sensitivity is divided into coarse and fine adjustments.

In the coarse adjustment, the sensitivity range is from 1mV/div ~ 20V/div, with 1 – 2 – 5 order.

For example: 10mV - >20mV - >50mV - >100mV

In fine adjustment, it adjusts in 1% of the current amplitude value steps.

For example: 10.00mV—>10.10mV—>10.20mV—>10.30mV

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

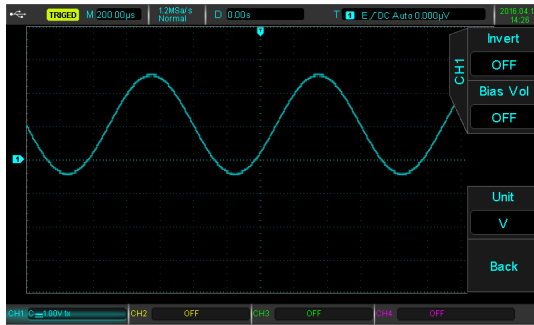
2.5 Probe

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

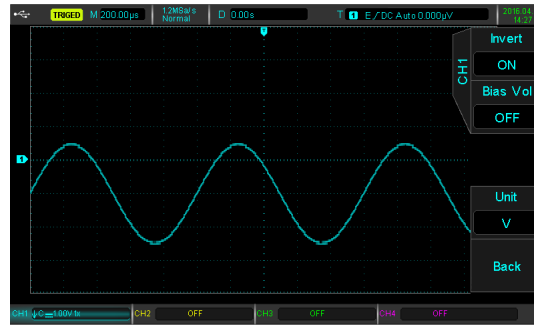
The coefficients can be set to 0.001X, 0.01X, 0.1X, 1X, 10X, 100X, and 1000X.

2.6 RP (Reverse Phase)

When reverse phase is turned on, the waveform flips 180 degrees. The vertical identification will appear a reverse phase logo



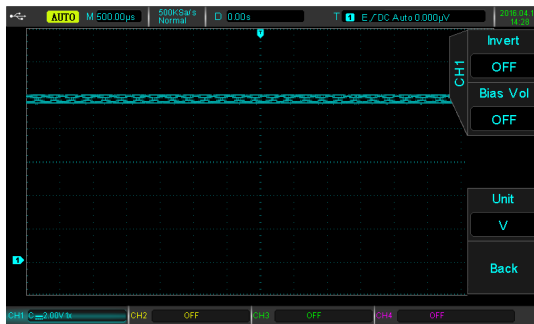
RP Closed



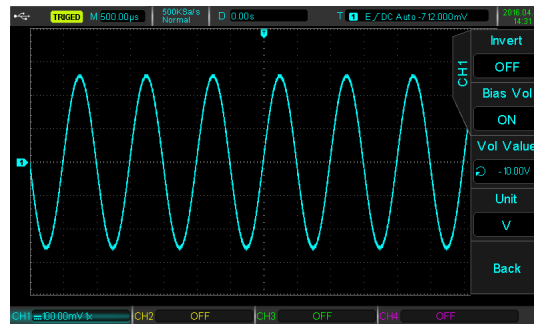
RP Open

2.7 Bias

When the amplitude of the DC component in the signal is relatively large, waveform observation could be very inconvenient. 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.



Bias Off



Bias On

Chapter 3 Trigger System

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 collects enough data to compose the waveform starting at the left of the trigger point, and continues until the trigger condition is met.

In this chapter UPO2XX4CS will be used as the example.

3.1 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), Line AC, 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 input Trig EXT from the back of the oscilloscope. For example, the external clock input can be used on the Trig EXT terminal as a trigger source. EXT signal trigger level ranges from $-1.8\text{V} \sim +1.8\text{V}$ can be set. The EXT/5 trigger signal divides the actual signal by 5, so the trigger level can be increased to $-9\text{V} \sim +9\text{V}$.
- **AC Line:** Power supply signal, used to observe the relationship between power signals such as lighting equipment and power supply equipment, to obtain stability in synchronization.

(2) Trigger Mode

Trigger mode determines the behavior of the wave during a trigger event. This oscilloscope provides three kinds of trigger modes: auto, normal, and single shot.

- **Auto trigger:** When there is no trigger signal, the system automatically runs and displays data. When the trigger signal is generated, it automatically switch to trigger scanning and signal synchronization.

Note: This mode allows 50ms/div or slower time shift without triggering in ROLL mode.

- **Normal trigger:** The oscilloscope can only collect data when the trigger condition is satisfied. When it is not triggered, the oscilloscope will wait for the triggered signal.
- **Single shot:** When the user presses the "run" button, the oscilloscope will wait for the trigger. When the instrument detects a trigger, the waveform is sampled and displayed, and enters the STOP state. Press the **SINGLE** button on the front panel of the oscilloscope to quickly enter the single trigger mode.

(3) Trigger Coupling

Trigger coupling determines which part of the signal will be transmitted to the trigger circuit. The coupled type

includes DC, AC, low frequency, high frequency suppression, and noise suppression.

- **DC:** All of the signal
- **AC:** Blocks the DC component and attenuates any signal components below 10Hz.
- **High frequency suppression:** Attenuates high frequency components over 50kHz.
- **Low frequency suppression:** Blocks the DC component and attenuates low frequency components below 5kHz.
- **Noise suppression:** Suppress high frequency noise in the signal, and reduces probability of error.

(4)Trigger Sensitivity

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

(5)Pre-trigger / Delayed Trigger

Data collected before / after the event.

Trigger position is usually set at the level of the screen, and you can observe 7 grids of pre-trigger and delay trigger information. The horizontal displacement of the wave can be adjusted by the horizontal displacement position knob in order to observe more pre-trigger information.

(6)Forced Trigger

Press the **FORCE** key to generate a forced trigger signal.

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

3.2 Edge Trigger

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

Press the **TRIG MENU** to enter the trigger menu. Press **F1** to select the trigger type, and select the trigger type with the multipurpose knob.

The edge trigger menu descriptions are shown below:

Functions	Options	Descriptions
Type	Edge	
Sources	CH1, CH2, CH3,	Set any one of the CH1~CH4 as a trigger signal

	CH4	
	EXT、EXT/5	Set external trigger or external trigger/5 as the source
	AC Line	Set AC line as trigger
Slope	Rise	Set the rising edge of the signal trigger
	Fall	Set the falling edge of the signal trigger
	Rise/fall	Set the rising edge and the falling edge as trigger
Trigger Setting		Enters the trigger settings menu, see below

Trigger Setting Menu

Functions	Options	Descriptions
Trigger Mode	Auto	When the signal input is not triggered, the system automatically collects the waveform data and displays the scan baseline on the screen. When a trigger signal is generated, it automatically turns to the trigger scan.
	Normal	The data acquisition stops when the signal is not triggered.
	Single	Generates a trigger and stops
Trigger Coupling	DC	Blocks the AC component of the signal
	AC	AC and DC components of the trigger signal
	High frequency suppression	Suppression of signal frequency above 50kHz
	Low frequency suppression	Suppression of signal frequency below 5kHz
	Noise suppression	Suppress the noise of the trigger signal, trigger sensitivity is halved.
Return		Return to first level menu

3.3 Pulse Width Trigger

Pulse width trigger can set the capture condition by the pulse width.

Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, and set the pulse width using the multipurpose knob.

The pulse width trigger menu is shown below:

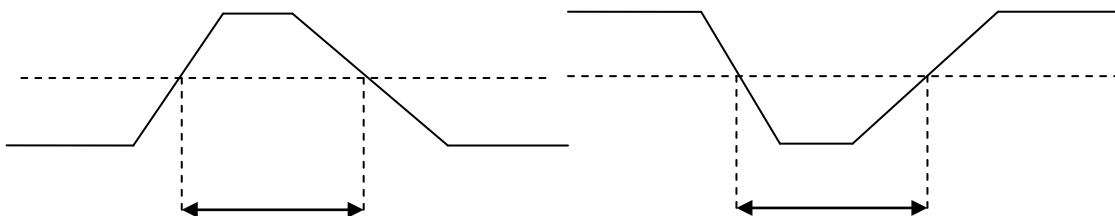
Functions	Options	Descriptions
Type	Pulse Width	
Sources	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal

	EXT、EXT/5	Set external trigger or external trigger/5 as the source
	AC Line	Set AC line as trigger
Condition	>	Trigger when the pulse width of the trigger signal is greater than the pulse width setting time
	<	Trigger when the pulse width of the trigger signal is smaller than the pulse width setting time
	=	Trigger when the pulse width of the trigger signal is equal to the pulse width setting time
Pulse Width Setting	4.0ns~10.0s	The pulse width time can be set from 4.0ns~10.0s using the multipurpose knob
Next Page		Enters Trigger Setting Menu (2)

Trigger Setting Menu (2)

Functions	Options	Descriptions
Type	Pulse Width	
Pulse Width Polarity	Positive	Set positive pulse width as trigger signal
	Negative	Set negative pulse width as trigger signal
Trigger Setting		Enters trigger setting menu
—		—
Return		Returns to previous menu

Pulse Width: The time difference between the trigger level and the positive pulse is defined as the positive pulse width, and the time difference between the trigger level and the negative pulse is defined as the negative pulse width, shown in the following diagram.



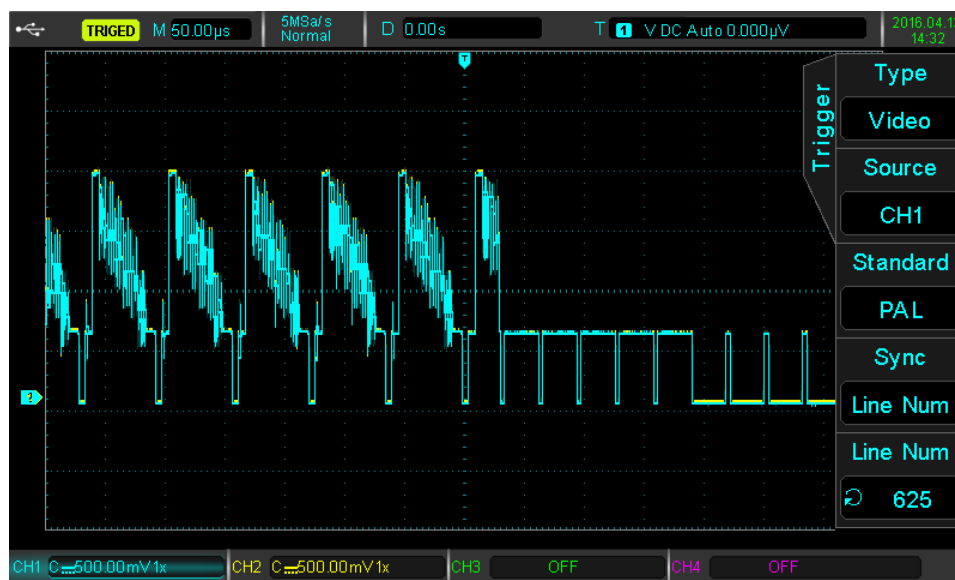
3.4 Video Trigger

The waveform of the video signal includes the image signal and the time sequence signal, and each kind of signal uses different standards and formats. UPO2000CS provides the basic measurement functions, which can be triggered in NTSC, SECAM, PAL, and other standard video formats.

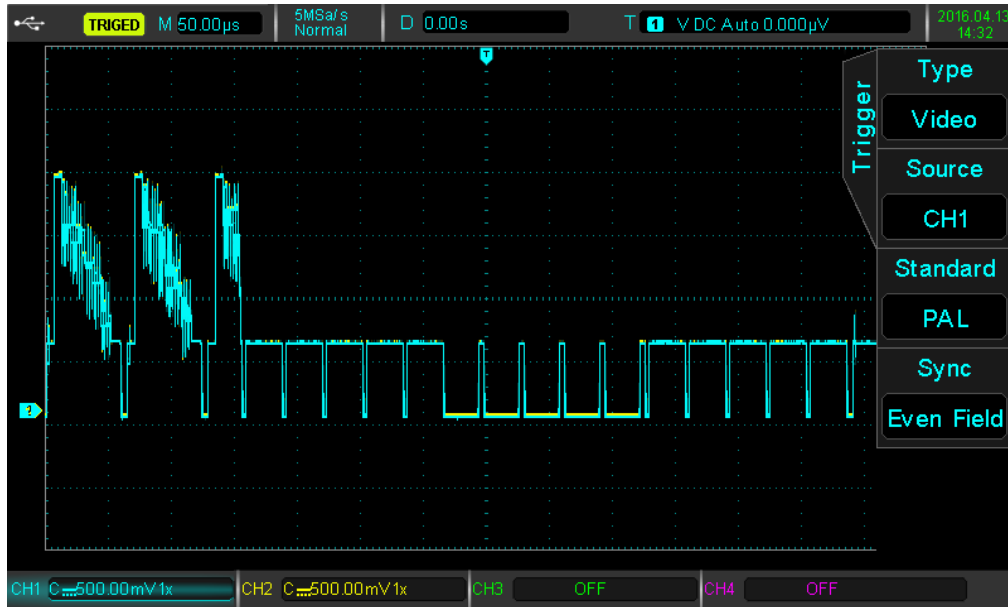
Press the **TRIG MENU**, Press **F1** to select the trigger type, set to video trigger using the multipurpose knob.

The video trigger menu with descriptions are shown below:

Functions	Options	Descriptions
Type	Video	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
	EXT、EXT/5	Set external trigger or external trigger/5 as the source
	AC Line	Set AC line as trigger
Format	PAL	Uses PAL format video signals
	NTSC	Uses NTSC format video signals
	SECAM	Uses SECAM format video signals
Video Sync	Even field	Set the video to sync and trigger on even field
	Odd field	Set the video to sync and trigger on odd field
	All lines	Set the video to sync and trigger on all lines
	Specific lines	Set the video to sync and trigger on specific lines
Specific Lines		When video sync is set at specific lines, use the multipurpose knob can adjust the number of lines: For PAL/SECAM: 1~625 lines. For NTSC: 1~525 lines



Video Line Sync



Video Field Sync

3.5 Slope Trigger

When slope trigger is selected, trigger occurs when the rise or fall slope value matches the value in settings.

Step: Press the **TRIG MENU**, press **F1** to select the trigger type, choose slope trigger using the multipurpose knob.

Slope Trigger Menu

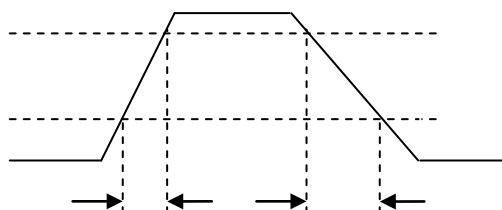
Functions	Options	Descriptions
Type	Slope	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Trigger Setting		Enters trigger setting menu
Slope Setting		Enters slope setting menu

Slope Setting Menu

Functions	Options	Descriptions
Slope	Falling	Triggers with falling slope
	Rising	Triggers with rising slope
Condition	<	When slew rate setting is smaller than signal slew rate, trigger occurs

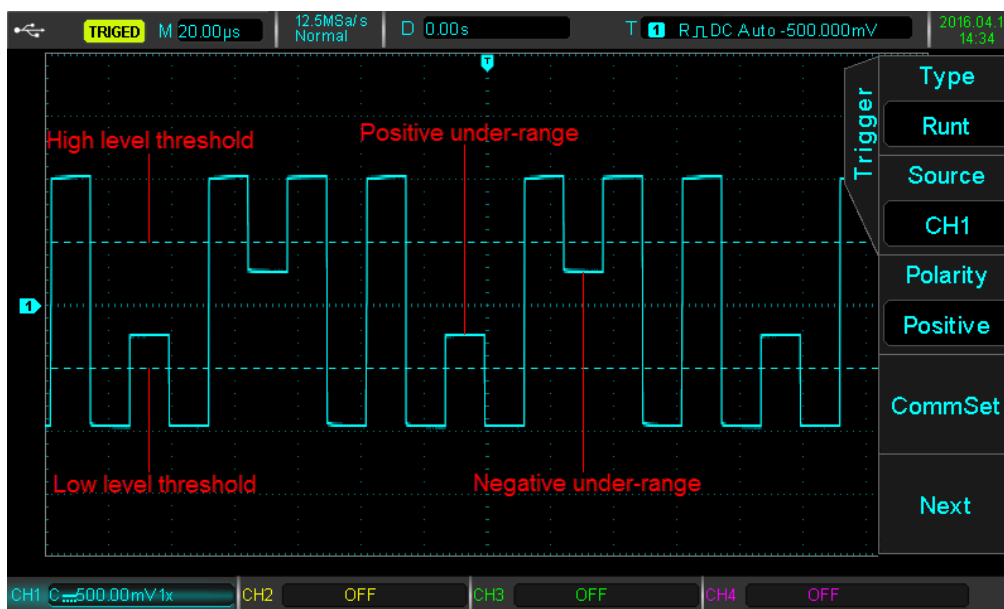
	>	When slew rate setting is greater than signal slew rate, trigger occurs
	=	When slew rate setting is equal to signal slew rate, trigger occurs
Time Setting		Use the multipurpose knob to set time, the slew rate shown on bottom of the screen also changes
Threshold	Low	The slope of the low threshold level can be adjusted with the LEVEL knob
	High	The slope of the high threshold level can be adjusted with the LEVEL knob
	High and Low	The slope of the high and low threshold level can be adjusted with the LEVEL knob
Return		Return to slope trigger menu

$$\text{Slew Rate} = (\text{High threshold level} - \text{Low threshold level}) / \text{Time}$$



3.6 Under-range Trigger

The under-range trigger occurs when a pulse crosses one trigger level but not the other, shown below.



Under-range Trigger Event

Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to under-range mode.

Under-range Trigger Menu:

Functions	Options	Descriptions
Type	Under-range	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Polarity	Positive	Set to positive under-range trigger
	Negative	Set to negative under-range trigger
Trigger Setting		Enters trigger setting menu
Slope Setting		Enters slope setting menu

Under-range Trigger Menu (Second Page)

Functions	Options	Descriptions
Condition	Irrelevant	Does not set under-range trigger condition
	<	Triggers when set pulse width is less than under-range pulse width
	>	Triggers when set pulse width is greater than under-range pulse width
	=	Triggers when set pulse width is equal to under-range pulse width
Setting	8.0ns~10ns	Using the multipurpose knob to set the pulse width time to be between 8.0ns~10.0s
Trigger Level	High	Using the LEVEL knob to adjust under-range trigger's high level threshold
	Low	Using the LEVEL knob to adjust under-range trigger's low level threshold
Return		Return to under-range trigger main menu

3.7 Beyond-range Trigger

When beyond-range trigger is selected, a high and a low trigger levels are chosen. The trigger event occurs when signal is higher than the high, or lower than the low trigger level.

Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to beyond-range mode.

Beyond-range Trigger Menu:

Functions	Options	Descriptions
Type	Beyond-range	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal

Slope	Rising Edge	Triggers when the input signal level at the rising edge is above the set level
	Falling Edge	Triggers when the input signal is at falling edge and voltage level is higher than high trigger level.
	Any Edge	Triggers when the input signal is at any edge and the voltage level meet trigger setting.
Trigger Setting		Enters trigger setting menu
Next Page		Enters Beyond-range Trigger Menu (2)

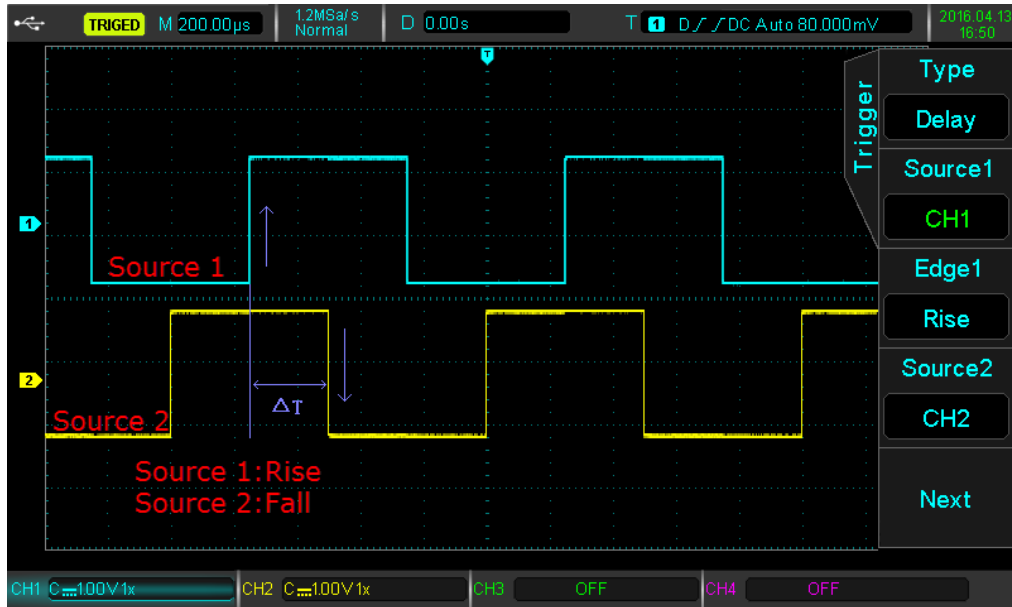
Beyond-range Trigger Menu (2)

Functions	Options	Descriptions
Position	Enter	Triggers when input signal enters trigger level range
	Return	Triggers when input signal leaves trigger level range
	Time	Triggers when time in trigger level mode matches set time
Trigger Level	High	The beyond-range high threshold level can be adjusted with the LEVEL knob
	Low	The beyond-range low threshold level can be adjusted with the LEVEL knob
Setting	8.0ns~10ns	Using the multipurpose knob to set the pulse width time to be between 8.0ns~10.0s
Return		Return to beyond-range trigger main menu

3.8 Delayed Trigger

To select delayed trigger mode, trigger source 1 and 2 need to be set. Trigger event occurs when the time between the two trigger sources is met.

Note: Source edges 1 and 2 must be neighboring edges.



Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to delayed trigger mode.

Delayed Trigger Menu:

Functions	Options	Descriptions
Type	Delayed	
Source 1	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Edge 1	Rising	Trigger occurs on rising edge of source 1
	Falling	Trigger occurs on falling edge of source 1
Source 2	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Next Page		Enters Delayed Trigger Menu (2)

Delayed Trigger Menu (2)

Functions	Options	Descriptions
Edge 2	Rising	Trigger occurs on rising edge of source 2
	Falling	Trigger occurs on falling edge of source 2
Condition	>	Triggers when time between signal 1 and 2 (ΔT) is greater than set time lower limit
	<	Triggers when time between signal 1 and 2 (ΔT) is less than set time lower limit
	<>	Triggers when time between signal 1 and 2 (ΔT) is greater than set time lower limit, but less than higher limit
	><	Triggers when time between signal 1 and 2 (ΔT) is less than set time lower limit, but greater than higher limit
Setting	8.0ns~10ns	Using the multipurpose knob to set the pulse width time to be

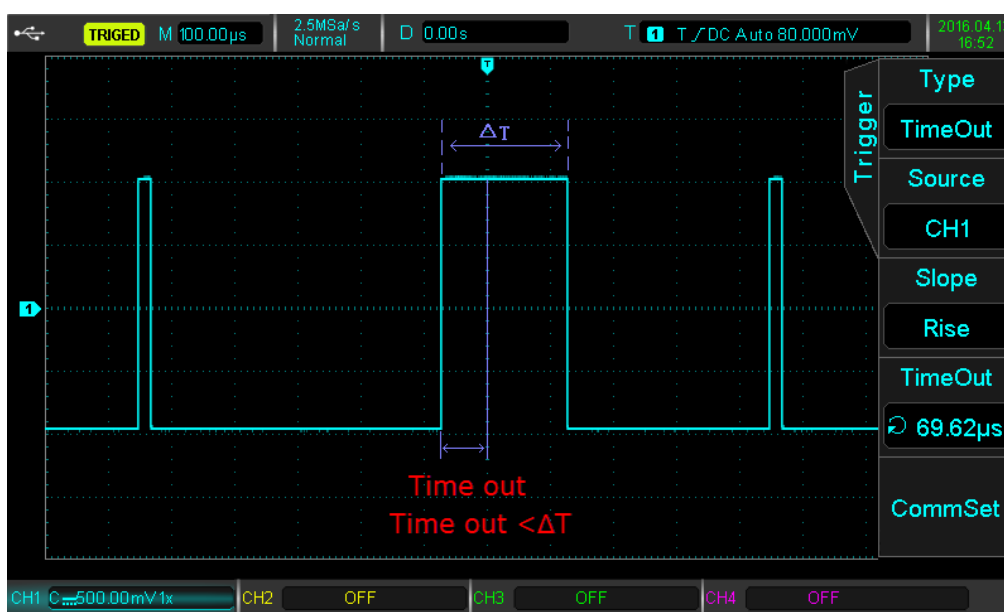
		between 8.0ns~10.0s
Next Page		Enters Delayed Trigger Menu (3)

Delayed Trigger Menu (3)

Functions	Options	Descriptions
Trigger setting		Enters trigger setting menu
Return		Return to delayed trigger main menu

3.9 Overtime Trigger

Overtime trigger occurs when the input signal's pulse width Δt (time between rising and falling edge) is greater than the overtime set time.



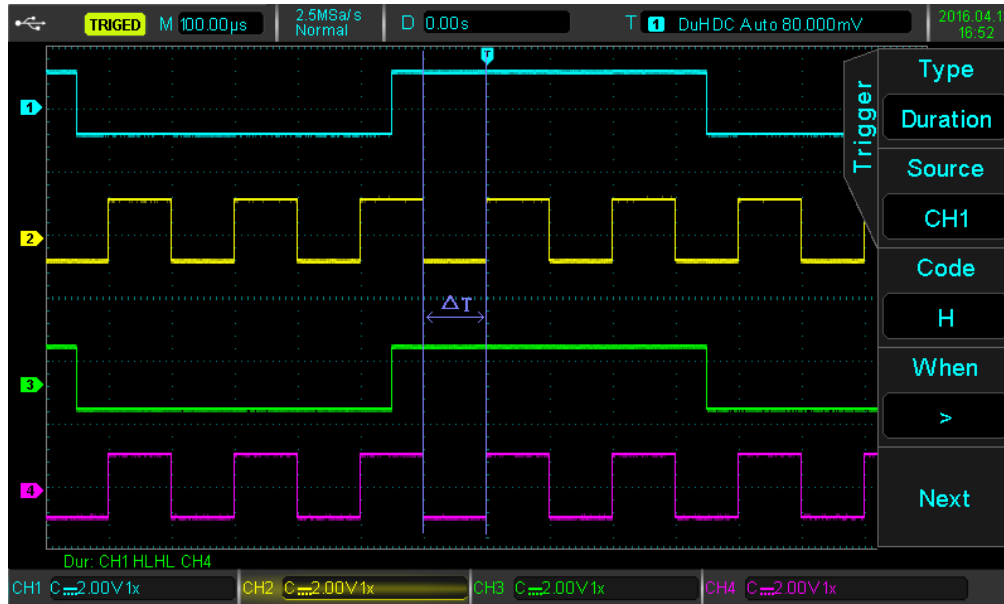
Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to overtime trigger mode.

Overtime Trigger Menu:

Functions	Options	Descriptions
Type	Overtime	
Source 1	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Slope	Rising	Time starts at the rising edge of signal
	Falling	Time starts at the falling edge of signal
	Any	Time starts at any edge of signal
Overtime Time	8ns~10s	Set overtime trigger time
Trigger Setting		Enters trigger setting menu

3.10 Duration Trigger

The duration trigger occurs when the time interval of a pulse Δt matches the duration set time. The code pattern is the combination of the channel logic "AND", the value of each channel can be H (high), L (low), or X (ignored).



Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to duration trigger mode.

Duration Trigger Menu:

Functions	Options	Descriptions
Type	Duration	
Source 1	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Code Pattern	H	When signal level is higher than the trigger level
	L	When signal level is lower than the trigger level
	X	Ignores selected channel to be part of the code pattern
Condition	>	Triggers when code pattern duration is larger than set time duration
	<	Triggers when code pattern duration is smaller than set time duration
	<>	Triggers when code pattern duration is smaller than set time duration's upper limit and larger than set time duration's lower limit
Next Page		Enters Duration Trigger Menu (2)

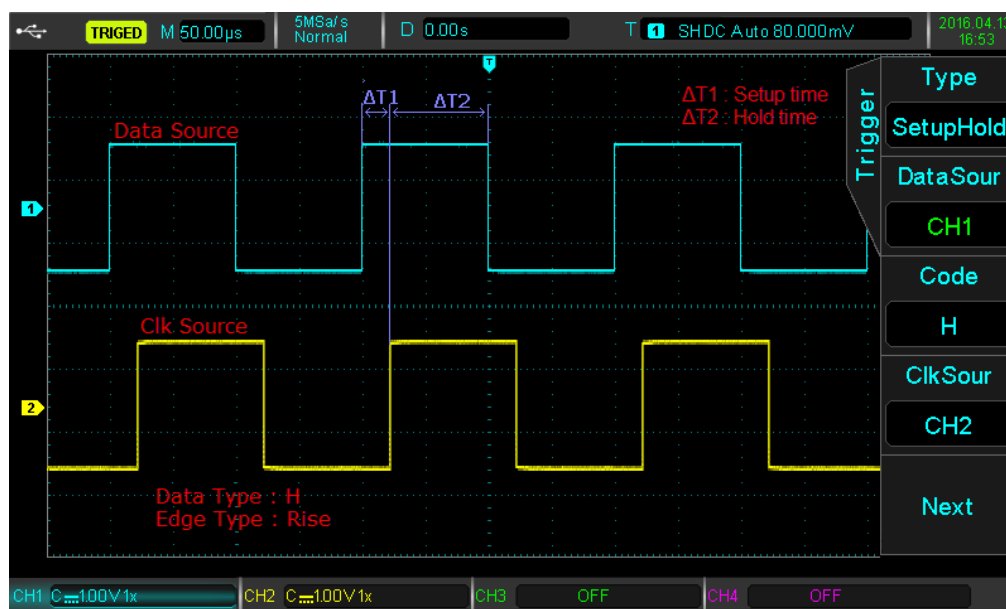
Duration Trigger Menu (2)

Functions	Options	Descriptions
Time	Normal	Set condition to > or < time

	Upper Limit	Set duration time's upper limit
	Lower Limit	Set duration time's lower limit
Setting		Normal: Duration can be set in the range of 8ns~10s Upper Limit: Duration can be set to 24ns~10s Lower Limit: Duration can be set to 8ns~10s
Trigger Setting		Enters trigger setting menu
Return		Return to duration trigger main menu

3.11 Setup/Hold Trigger

When setup/hold trigger is selected, two signals (data and clock) are needed. Setup time starts at a specified pattern and ends when trigger meets the clock edge. Hold time starts at the end of the setup time, and ends at the next edge of the data signal. Event is trigger when setup time or hold time is less than the set time.



Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to setup/hold trigger mode.

Setup/Hold Trigger Menu

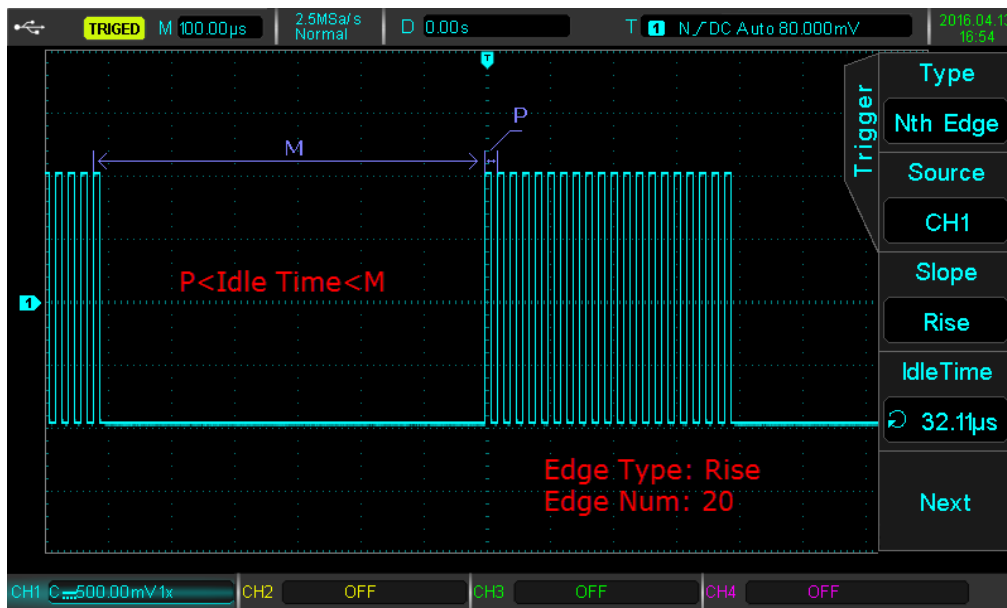
Functions	Options	Descriptions
Type	Setup/Hold	
Data Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Pattern	H	Data signal's valid pattern is set to High
	L	Data signal's valid pattern is set to Low
Clock Source	CH1、CH2、CH3、CH4	Set any one of the CH1~CH4 as a trigger signal
Next Page		Enters Setup/Hold Trigger Menu (2)

Setup/Hold Trigger Menu (2)

Functions	Options	Descriptions
Clock Edge	Rising	Set clock edge to rising
	Falling	Set clock edge to falling
Setup/Hold	Setup	Triggers when setup time is smaller than set time
	Hold	Triggers when hold time is smaller than set time
	Setup&Hold	Triggers when Setup AND Hold time are smaller than set time
Time		Set setup, hold, and setup&hold time to be in the range of 8ns~10s
Trigger Setting		Enters trigger setting menu
Return		Return to setup/hold trigger main menu

3.12 N-Edge Trigger

The N-edge trigger occurs after the Nth edge after a specified free time. For example, in the waveform below, trigger occurs after a specified free time and the second rising edge. The idle time is $P < \text{free time} < M$, where M is the time between the first rising edge and the next rising edge, P is the maximum time between the rising edges.



Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to N-edge trigger mode.

N-edge Trigger Menu

Functions	Options	Descriptions
Type	N-Edge Trigger	
Data Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal

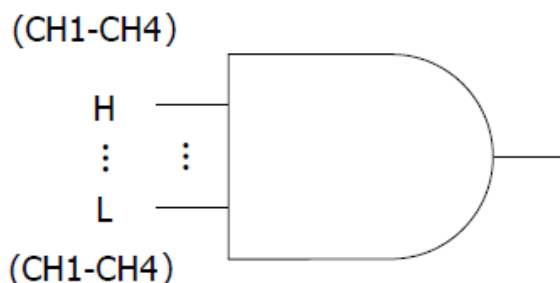
Slope	Rising	Triggers when at the rising edge, signal level meets the set level
	Falling	Triggers when at the falling edge, signal level meets the set level
Free Time	8ns~10s	Set the free time interval
Next Page		Go to second page of settings

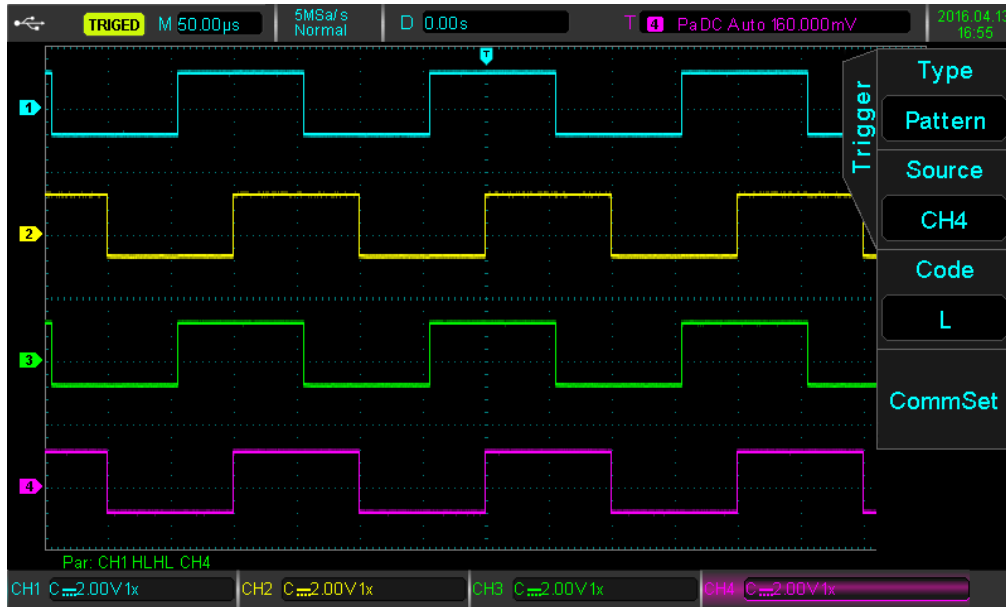
N-edge Trigger Menu (2)

Functions	Options	Descriptions
N	1~65535	Set N value to be between 1~65535
Trigger Setting		Enters trigger setting menu
Return		Return to N-edge trigger main menu

3.13 Code Pattern Trigger

Code pattern trigger occurs when the specified pattern is identified by the specified code type. 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 for 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 be triggered at the last edge of the code type "true". If all channels are set to "ignore", the oscilloscope will not trigger.



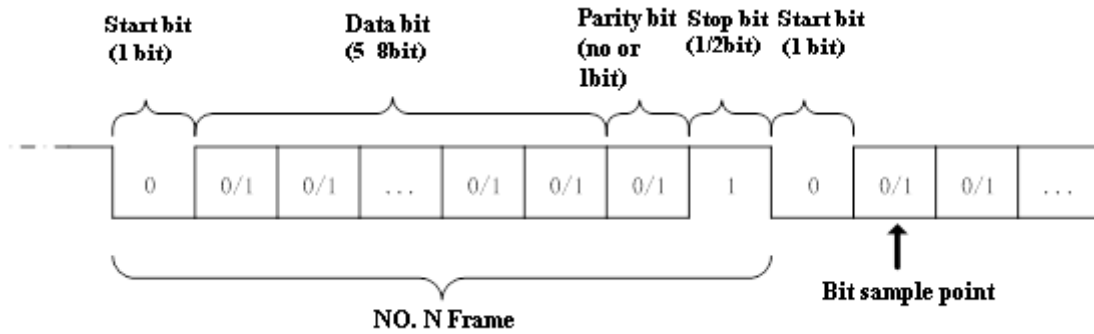


Press the **TRIG MENU** button to enter the trigger menu. Press **F1** to select trigger type, use the multipurpose knob to select to code pattern trigger mode.

Functions	Options	Descriptions
Type	Code Pattern Trigger	
Data Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as a trigger signal
Code Pattern	Rising	Set the code pattern to rising edge
	Falling	Set the code pattern to falling edge
Trigger Setting		Enters trigger setting menu

3.14 RS232 Protocol Trigger and Decode (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, 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 should be formed according to the following protocol: a start bit, 5 to 8 data bits, an optional parity bit, and ends with 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, zero parity, odd parity, or even parity can be selected, 1 or 2 stop bits can be chosen. In the following instruction, a data string transmission is called one frame, shown in the table below:



RS232 Start Trigger

Press the **DECODE** button at the right corner, choose the TYPE option to open the protocol type list. Rotate the **Multipurpose** knob to select to RS232 protocol mode, and press the **Multipurpose** knob to open RS232 protocol mode.

Trigger Source: Select the Source Channel

Select this option and the source font will become green. Press any signal source button to switch between CH1-CH4 as the source. The appropriate logic level can be adjusted when the corresponding signal source is selected. The way to adjust the signal level is the same with adjusting the trigger level. To avoid the effect of noise, it is suggested to set the level compare at the waveform center area to obtain accurate results.

Trigger Setting: Set the Trigger Selection

Select this option to enter the trigger setting menu. The **Trigger Mode** can be set to Auto or Normal. The **Trigger Coupling** can be set to DC, AC, low frequency, high frequency suppression, or noise suppression. Select **RETURN** to return to the previous menu.

Bit Setting: Set the Data Bit

Select this option to enter the bit setting interface.

- **Data Bit Width Setting:** Select **DATA BIT WIDTH SETTING**, and the data bit width selection list will pop up. Press the **DATA BIT WIDTH SETTING** selection key again to switch between 5/6/7/8 bits. The data bit width can also be selected using the **Multipurpose** knob after data bit width selection list pops up. Press the **Multipurpose** knob to confirm the selected data bit width.
- **Data Setting:** Rotate the knob under the bit setting interface to set the data. The upper and lower bounds of the data are directly related to the data bit width.
 - 5-bit corresponds to 0—31
 - 6-bit corresponds to 0—63
 - 7-bit corresponds to 0—127
 - 8-bit corresponds to 0—255
- **Stop Bits Setting:** Select the **STOP BITS** option to open the stop bits selection list. Press the **STOP BITS** option key again to switch between 1 or 2 bits. The **Multipurpose** knob can also be used for this function.
- **Parity Bit Setting:** Select the **PARITY BITS** option under the bit setting interface, and the parity selection list will pop up. Press the **PARITY BIT** option key again to switch between zero, odd, and even. Zero means no parity. Even and odd mean even parity and odd parity respectively. The Multipurpose knob can also set the parity bit.
- Press the **RETURN** option button key to return to the previous menu.

Press the **NEXT PAGE** option key to enter the following settings:

Condition: Trigger Condition Settings

For the UPO2000CS series RS232 protocol, there are four kinds of trigger methods: Start of frame, error frame, parity error, and data.

Press the **CONDITION** option button and the trigger condition list will pop up. Press the **CONDITION** button again to switch between the four modes. The **Multipurpose** knob can also set the trigger condition.

- **Start of Frame**: The waveform trigger is at the start bit of the RS232 protocol (referred to the drawing). Stable waveforms can be observed by choosing the start of frame when single string signals or multiple same string signals are sent. If the data being sent is changing, the waveform will also change correspondingly.
- **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 1st bit is odd for data bit and parity bit, the transmission will be correct.
 - Even parity: If the 1st bit is even for data bit and parity bit, the transmission will be correct.

This function can quickly check the transmission process with parity error during RS232 communication, for ease of analyzing and locating faults.
- **Error Frame**: The error frame can be classified to two kinds. One is parity error (odd or even error), the other is transmission error. The transmission error conditions are as follows:
 1. The signal is not set to 1 where there should be stop bits, then the frame data is wrong.
 2. When signals suddenly change and becomes unstable, this function can quickly test for transmission errors.
- **Data**: The waveform triggers when the data of **BIT SETTING** menu is equal to the data the oscilloscope is collecting. Note that the data setting range is related to the data bit width. This function can quickly find the transmitting signals of particular data set.

Polarity: Set the signal polarity.

Normally, the positive polarity is used in RS232 protocol. The high level and low level stands for logic 1 and 0 respectively. Some users might use negative polarity, which is that the high level and low level stands for 0 and 1 respectively. Therefore, the design is optimized to meet demands from different users.

Choose the **POLARITY** option key, and the polarity selection list will pop up. Press the **POLARITY** option key again to switch between positive polarity and negative polarity. The **Multipurpose** can also be used.

Bit Sequence: Set the data bit sequence

Normally, the lower bit is transmitted first in RS 232 communication. For example: if bit [7:0] is transmitted, the bit [0] will be transmitted firstly, and bit [7] transmitted last. Considering that users probably use MSB, that is, bit [7] is firstly. The transmitting methods can be set by users.

Select the **Bit Sequence** option key, and the bit sequence selection list will pop up. Press the bit sequence again to switch between LSB and MSB. The **Multipurpose** knob can also be used.

Baud Rate: Set the transmitting baud rate.

There are no clock signals for asynchronous serial communication. In order to analyze the data, the two 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 start bit, data bit, parity bit and sop bit are regarded as bit. Therefore, baud rate is not directly equal to valid data transmission rate. Oscilloscope will sample the Bit value according to the set baud rate.

Press the **BAUD RATE** option key, and the baud rate selection list pops up. Press the BAUD RATE key again to switch between different baud rates. The available baud rates are: 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, and customized. The customized baud rate can be provided from 1 to 5000000 (5 million). After selecting the customized baud rate, the customized value can be adjusted using the Multipurpose knob. Press the corresponding baud rate display button to increase the baud rate digit being controlled in order to quickly set to the desired baud rate.

It is recommended to adjust the hardware and software settings of RS232 communication, the transmission condition should be a distance of under 20m and with speed below 1Mbps. Outside of these ranges and the communication can be disturbed easily or become unreliable.

If a more detailed communication analysis is needed, the UPO2000CS protocol decoding function can be used. Oscilloscopes will capture the continuous communication data for you when using this function. The communication contents can be shown on screen or by the method in the event list.

Bus Setting: Press the **PRESS SETTING** option key to enter the decoding bus setting.

Bus Status: Press the **BUS STATUS** option key, and the bus control selection list pops up. The decoding function can be open or closed. The Multipurpose knob can also be used.

Display Format: Press the **DISPLAY FORMAT** option key, and four kinds of display methods can be used: hexadecimal, decimal, and binary, and ASCII. The Multipurpose knob can also be used.

Event List: Press the **EVENT LIST** option key, and the decoding events can be open or closed. The knob Multipurpose can also be used.

Pseudo Square Wave: Press the **PSEUDO SQUARE WAVE** option key, and the pseudo square wave function can be opened and closed. The Multipurpose knob can also be used. The pseudo square wave displays 0/1 collected by oscilloscope. The function can display logic 0 and 1 on the screen under the condition that the input waveform is severely distorted.

Press the **NEXT PAGE** option key to enter the following settings:

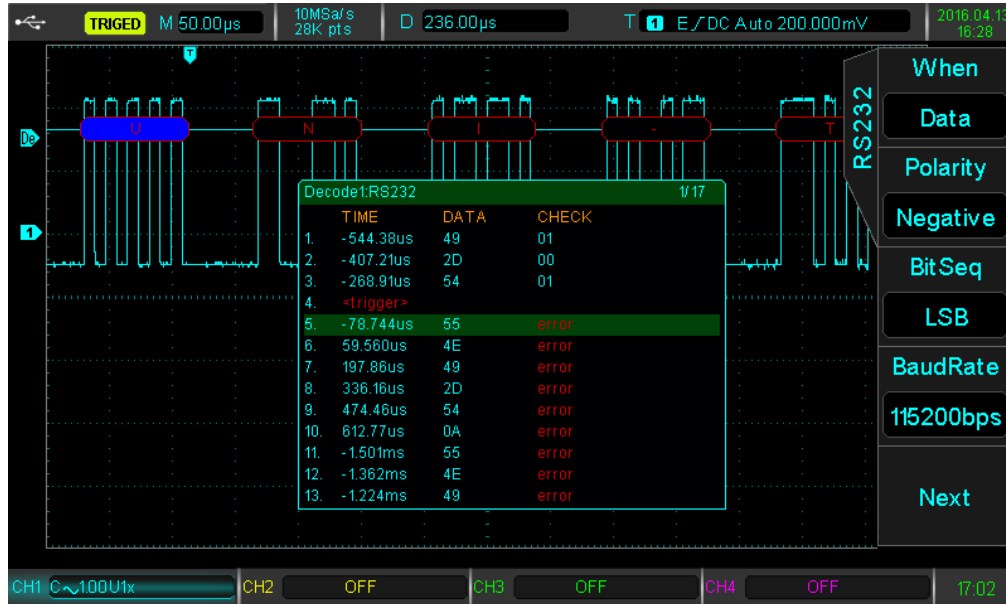
Vertical Position: Press the **VERTICAL POSITION** option key and rotate the Multipurpose knob to adjust the position of decoding data on the screen.

Event List Check: When the Oscilloscope is in the state of decoding, the **RUN/STOP** button is green. At this moment, press the **RUN/STOP** and the Oscilloscope will stop refreshing waveform and the button will turn red. The collected data will be stored in the Oscilloscope. The menu will display decoding data selection list, the button can display the captured times of transmission signals and the number the selected data.

The selected decoding data will be highlighted green. The Multipurpose knob can select any collected data.

Input signals are shown in figure below: data width is 8 bits, data bit is 0*55, and stop bit is 1 bit, even parity. The trigger condition is: data, negative polarity, the bit sequence is LSB, the baud rate is 115200bps.

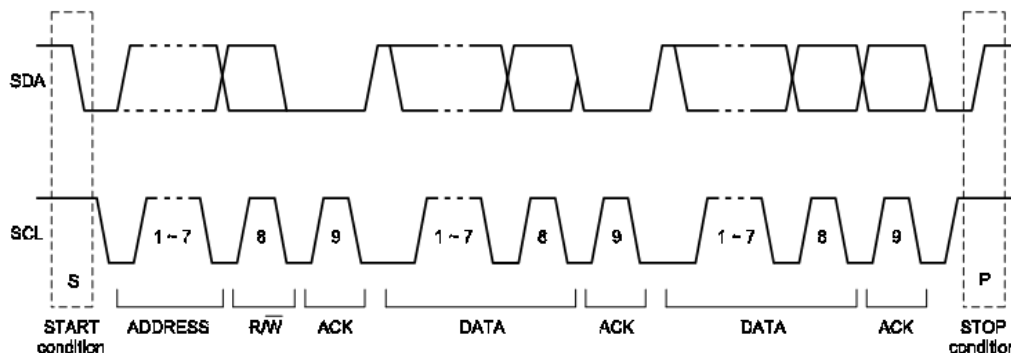
The bus settings are: Bus is open, the display format is ASCII, event list open.



As can be seen, the trigger position is the position of data 0*55 collected by oscilloscope (the corresponding ASCII is U). The decoding data displays “UNI-T”. The event list displays the capture data near trigger point, its corresponding capture time, and parity value. The capture data 1 is 0*49=0100_1001. The parity bit should be 1 when even parity is used. This time capture parity value is 1. Therefore, the parity is correct. Data 5 to 13 displays error because of parity error. The decoding data “UNI-T” displays red. Because the collected data is large, the oscilloscope classifies the collected data to 17 pages time. At present, page 1 of 17 is displayed. You can use the above functions to observe more decoding data.

3.15 I2C Protocol Trigger and Decode (Optional)

I2C protocol is usually used to connect microcontroller and its peripheral equipment, a widely used protocol in the field of microelectronics communication control. The bus protocol uses two wires to transmit. One is serial data cable SDA, the other is serial clock cable. The HOST-SLAVE mechanism is adopted, which is a 2-way communication between host and slave. The bus is multi-host which prevents data destruction through collision and arbitration mechanism detection. 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 cables 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 allow bus arbitration. The protocol requires that data SDA should kept stable when clock cable SCL is high. Normally, the data is transmitted by MSB.



The above picture is the I2C bus protocol diagram of a 7-bit address. After starting, the host transmits the address information and read-write direction information in the first byte (normally, 0 means write and 1 means read). After the slave send the respond signals, the data between the host and the slave begins transmitting. The host sends stop signal to end this communication after finishing the data transmission.

Handling 10 bit address is a little different from 7 bit address. The address information is made of the first byte after the start bit. The seven bits of the first byte is 11110XX. The XX is the two top bits among 10 bits. The eighth bit of the first byte is R/W which means read/write direction (0 is read, and 1 is write). The second byte is the remaining eight bits among 10 bits. If R/W bit is 1, the next byte is the data transmitted by the slave to the host.

The following are the I2C protocol functions:

I2C: I2C Start Trigger

Press the **DECODE** button at the right corner. Then press the **TYPE** option key to open protocol type list. Rotate **Multipurpose** knob to select the SPI protocol mode. Press **Multipurpose** knob to start the SPI protocol mode.

SCL: Select clock source

Press this option key and the present clock source font becomes green. Press the SCL button again to switch any channel among CH1-CH4 as clock source. The corresponding logic level can be adjusted when the corresponding signal source is selected. The way of adjusting is the same with that of trigger level. To avoid the effect of signal noise, it is suggested that the comparative level should be set in the waveform center area to obtain accurate results. Press the SCLK EDGE button to set the clock source as rising edge or falling edge.

SDA: Select data source

Press this option key and the present clock source font becomes green. Press the SDA button again to switch any channel among CH1-CH4 as clock source. The logic level can be adjusted when the corresponding signal source is selected. The way of adjusting is the same with that of trigger level. To avoid the effect of signal noise, it is suggested that the comparative level should be set in the waveform center area to obtain the accurate captured result.

Condition: Trigger Condition Selection

Press this option button and the trigger timing selection will pop up. The following are the trigger timing conditions:

- **Start:** Trigger at the starting moment. Namely, SDA occurs at falling edge when SCL is at logic high. Note that the restarting state is stored in I2C, the starting signal can occur again (restart) before first signal's stop signal. Both the start and the restart can produce trigger signal.
- **Restart:** Triggers at the restarting moment. When a start signal occurs before the previous signal ends, this situation is defined as restart signal.
- **Stop:** Triggers when the stop bit occurs. Namely, SDA goes from low to high when SCL is high.
- **Loss:** It is the loss confirmation trigger. Every time after 8 bits are transmitted in I2C protocol, the data receiver transmits the receiving signal, which is the answering bit in figure above. The SDA signal is low and SCL high. The loss confirmation trigger occurs on the receiving bit, when SCL and SDA and both high.
- **Addr:** It is address trigger. The address trigger will occur if the communication address is the same with the user setting address. It can help to quickly locate using address.
- **Data:** It is data trigger. The data trigger can occur with the following conditions: equal/greater/less/unequal. It is convenient to analyze data and capture abnormal data.
- **Addr Data:** It is address data trigger. The trigger occurs when the addresses are the same during transmitting and the data satisfies the setting condition. It is convenient to realize the I2C specified address trigger and data trigger, and help analyze the transmission.

Press the **NEXT PAGE** function key to enter additional I2C trigger settings:

Address Setting: Press the button to set the related address information

- **Width:** It is the address width selection. Press this option button and the address width selection list pops up. Press the **Width** function button again to select 7 or 10 bits width. Rotating the **Multipurpose** knob can also select the width. Press the **Multipurpose** knob to confirm selection.
- **Address:** Within this interface, directly rotate the Multipurpose knob to set the address value. Note that the set value is related to the present bit width. The seven bit address can be set from 0x0 to 0x7F and the ten bit address can be set from 0x0 to 0x3FF.
- **Direction:** Set the read-write direction. Select this option and the read/write selection list will pop up. Press the read/write option key to switch between each other. After the selection list pops up, the Multipurpose knob can also be used. Press the Multipurpose knob to confirm selection.

Press the **RETURN** option key to return to the previous menu.

Data Setting: Select this option to set the related data information

- **Byte:** Set the data byte. Select this option and the data byte selection list pops up. Press the button again to switch between 1, 2, 3, 4, and 5 bytes. The **Multipurpose** can also be used.
- **Bit:** Select the bit. Directly rotate the **Multipurpose** knob to select the bit under the data set interface. The selected bit will be highlighted red at the bottom left corner. Note that the selected bits are directly related to the set bytes. For example, the bit of 0 to 7 can be selected if 1 byte is set.
- **Data Bit:** Set every bit of data. The present data bit can be set to H/L as required. The bottom left corner will display the present data setting condition, and the value can be set with hexadecimal and MSB method.
- **All Bits:** Set the entire bit to the same value. It is helpful to quickly set the value and reset. Press the **NEXT PAGE** option key to enter additional I2C trigger settings.
- **Data Condition:** Use this option to set the relation between the captured and set data when data is triggering. The captured

data can be set to equal, greater, or less than the set data.

Press RETURN option key to return to the previous menu.

Trigger Setting: Set the trigger selection.

Use this option to enter the trigger setting menu. The trigger mode can be set to auto or normal. The trigger coupling can be set to: DC, AC, low frequency, high frequency suppression, and noise suppression. Press the RETURN to return to the previous menu.

If a more detailed communication analysis is needed, the UPO 2000CS protocol decoding function can be used. The oscilloscope will capture the continuous communication data. The communication data can be displayed directly by the screen or in event list to make communication analysis quicker, more accurate, and more convenient.

Bus Setting: Use this option to enter decode bus settings:

Bus Status: Use this function to enable bus control selection list, to open or close the decoding function. You can also operate using the Multipurpose knob after the selection list pops up.

Display Format: Use this feature and the display format can be switched between hexadecimal, decimal, and binary. The Multipurpose knob can also be used after the selection list pops up.

Event List: The event list can be open or closed using this feature. We can also operate through the Multipurpose knob. The event list contains the decoded data for continuous collection which can be directly displayed on the screen, which contains data capture time, data content, and parity status

Pseudo Square Wave: The pseudo wave function can be open or closed using this feature. The Multipurpose knob can also be used after opening the function list. The waveform is displayed using the 0/1 collected by the oscilloscope. This feature is useful when the input wave is severely distorted.

Press the NEXT PAGE option key to enter the following settings:

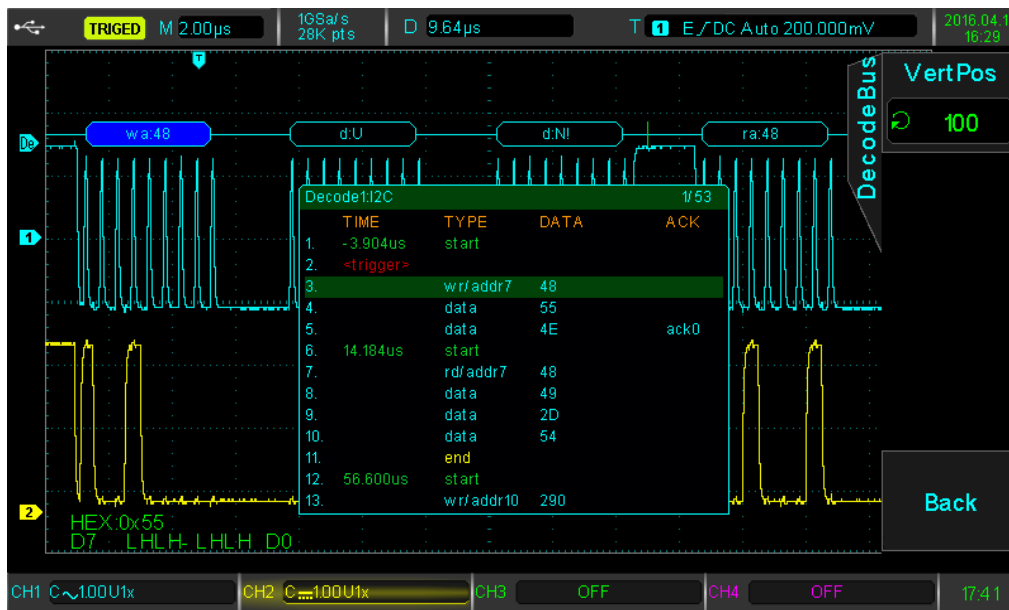
Vertical Position: Use this feature and rotate the Multipurpose knob to adjust the position of decoded data on the screen.

Event List Check: When the oscilloscope is in the state of decoding, RUN/STOP is green. At the moment when pressing RUN/STOP, RUN/STOP is red. The oscilloscope will stop refreshing waveform and the collected data will be stored in the oscilloscope. The menu will display decoded data selection. The button displays the times of captured transmission signal and the corresponding number of the present selected data. The selected decoding data will be highlighted green. The Multipurpose knob can select any collected data. This function can find the content of captured multiple transmission communication and help to debug the system conveniently.

Input the signal as shown the figure below. The oscilloscope is set up as follows. SCL selection is CH1. SDA selection is CH2. The condition is Addr. The set address is 7bits, 0x48 and the direction is writing. The data do not need to be set because data trigger is used.

The bus status is open during setting the bus. The displayed format is ASCII. Open the event selection and the

display is as follows:

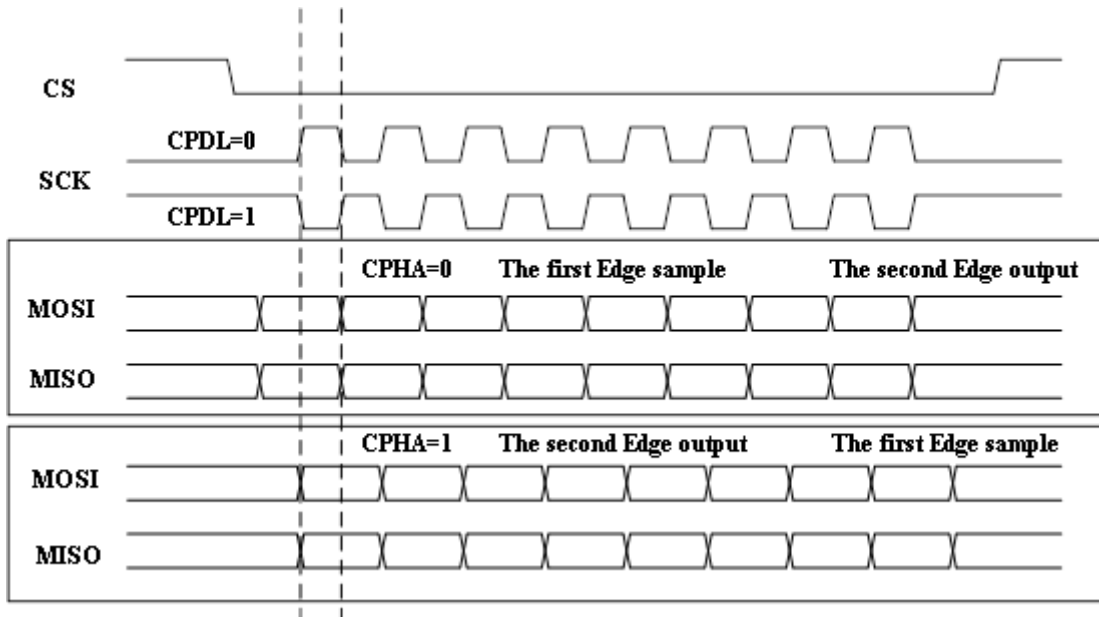


As shown in the picture, the trigger position is event 3; the type is wr/addr7; the address is 0x48; the direction is writing. The event 4 captured data is 0x55 (the corresponding letter is U), which gets response bit. The ACK series of the event list do not indicate. Event 5 captured data is 0x4E. Because there is no response bit, the ACK series indicates ack0. At the same time, the green “start” marks the time when I2C begin transmitting and the yellow “end” marks the time when I2C stop transmitting. The present event list display 1/53 of the all events. The above event list function can observe more decoding data.

3. 16 SPI Protocol Trigger and Decode(Optional)

SPI interface is a kind of synchronized 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 output; SCLK: time signal the host transmits; CS: the slave chip selection enable signal.

SPI interface is mainly used to transmit the serial data between the host and low speed peripheral devices. The data are transmitted according to the bit, that is to say, higher bit first and then lower bit. SPI interface do not need look for the slave address. The communication is of full duplex and the protocol itself is easier. So it is widely used. SPI protocol transmission is shown in the following picture.



- CS is usually effective low. It should kept low level during the entire transmission.
- Clock signal SCK has two kinds of polarity:
 - CPOL=0. If the clock is idle, the clock level is low.
 - CPOL=1. If the clock is idle, the clock level is high.
- The clock phase also has two kinds to select.
 - If CPHA is 0, the front edge of the clock cycle will collect data.
 - If CPHA is 1, the back edge of the clock cycle will collect data.

Note: As to the start and end position, the first data of MOSI and MISO in the practical application, different application situations have different requirements. The UPO 2000CS oscilloscope can help you conveniently analyze the waveform trigger of critical positions.

SPI: Start SPI trigger

Press **DECODE** at the right corner. And then press the **TYPE** option key to open protocol type list. Rotate **Multipurpose** knob to select to SPI protocol mode. Press **Multipurpose** knob to start the SPI protocol mode.

CS Setting: Set Chip Selection Enable Signal

Use this feature to enter the enable signal setting up interface. Press the CS SOURCE option button to switch any channel among CH1-CH4 as chip selection signal. The corresponding logic level can be adjusted when the corresponding signal source is selected. The way of adjusting is the same with that of trigger level. To avoid the effect of signal noise, it is suggested that the comparative level should be set in the waveform center area to obtain the accurate captured result. Press the CS POLARITY option button to set the positive or negative polarity of the chip selection signal. The normal SPI communication uses the transmission signal with negative polarity.

SCLK setting: Set the Clock Signal

Use this function to enter the clock signal setting interface. Press the SCLK button to switch any channel among

CH1-CH4 as clock source. The corresponding logic level can be adjusted when the corresponding signal source is selected. The way of adjusting is the same with that of trigger level. To avoid the effect of signal noise, it is suggested that the comparative level should be set in the waveform center area to obtain the accurate captured result. Press the SCLK EDGE button to set the clock source as rising edge or falling edge.

MOSI Setting: Set Master Output Slave Input Signal

Use this function and enter the MOSI signal setting interface. Press the MOSI Source button to switch any channel among CH1-CH4 as data source. If MOSI is off, there will be no corresponding data in decoded display. The corresponding logic level can be adjusted when the corresponding signal source is selected. To avoid the effect of signal noise, it is suggested that the comparative level should be set in the waveform center area to obtain accurate captured result. Press the MOSI POLARITY button to set the positive or negative polarity of the chip selection signal. The normal SPI communication uses the transmission signal with negative polarity.

Condition: Select the Trigger Condition

Use this function to switch the trigger condition between CS, Idle, CS&Data, and Idle&Data.

CS will trigger when chip selection enable is effective. Idle is idle trigger. CS&Data will trigger when enable is effective and the data is correct. Idle&Data will trigger when it is idle and the data is correct.

Condition Setting:

- Bit order: Set the bit order to MSB/LSB
- Data Setting: Set the comparative values
 - Bit Width: Set the data bit width need to be compared. The range is 4-32 bits
 - Bit: Select the bit. The Multipurpose knob can select bit under the data setting interface when a certain bit is needed to be set. The present selected bit will be highlighted red at the left corner. Note that the bit you can select is directly related to the byte you set. For example, if 1 byte is selected, the bit you can select is 0-7.
 - Data bit: Set every data. The present bit can be set to H/L as required. The present data setting status will be displayed at the left corner of the screen. The set value display by the method of hexadecimal and MSB.
 - All Bits Set: the all bits to the same value, which is helpful for you to set and reset quickly.

Press **NEXT PAGE** to enter the following settings:

- Trigger Channel: Press the button to select comparative data channel and switch between MOSI and MISO.
- Frame Length: The bit width of SPI communication is usually different due to the different situation. Now the Multipurpose knob can make the data bit of the decoding data switch among 4, 8, and 16.

Press the RETURN to return to the first level menu.

Idle Time: Set the idle time value. The Multipurpose knob can set the different overtime value.

Trigger Setting: Set the trigger selection

Press the button TRIGGER SETTING to enter the trigger setting menu. The Trigger Mode can be set to Auto or Normal.

The Trigger Coupling can be set: DC, AC, low frequency, high frequency suppression, and noise suppression. Press the RETURN to return to first level menu.

If you need more detailed communication analysis, you can use UPO2000CS protocol decoding function. The oscilloscope will capture the continuous communication data. The communication content can be displayed by the screen or the event list.

Bus Setting: Press **PRESS SETTING** to enter the decoding bus setting.

Bus Status: Press the button **BUS STATUS**, and the bus control selection list pops up. The decoding function can be open or closed. The knob can also Multipurpose set it.

Display Format: Press the button **DISPLAY FORMAT**, and then there are four kinds of display methods to switch: hexadecimal, decimal, and binary and ASCII. The knob Multipurpose can also set it after the list pops up.

Event List: Press the button **EVENT LIST**, and the decoding events can be open or closed. The knob Multipurpose can also set it after the list pops up.

Pseudo Square Wave: Select this option and the pseudo square wave function can be open and closed. The knob Multipurpose can also set it after the list pops up. The pseudo square wave displays 0/1 collected by oscilloscope. The function can display logic 0 and logic 1 on the screen under the condition that the input waveform is severely distorted.

Press the **NEXT PAGE** to enter the following settings.

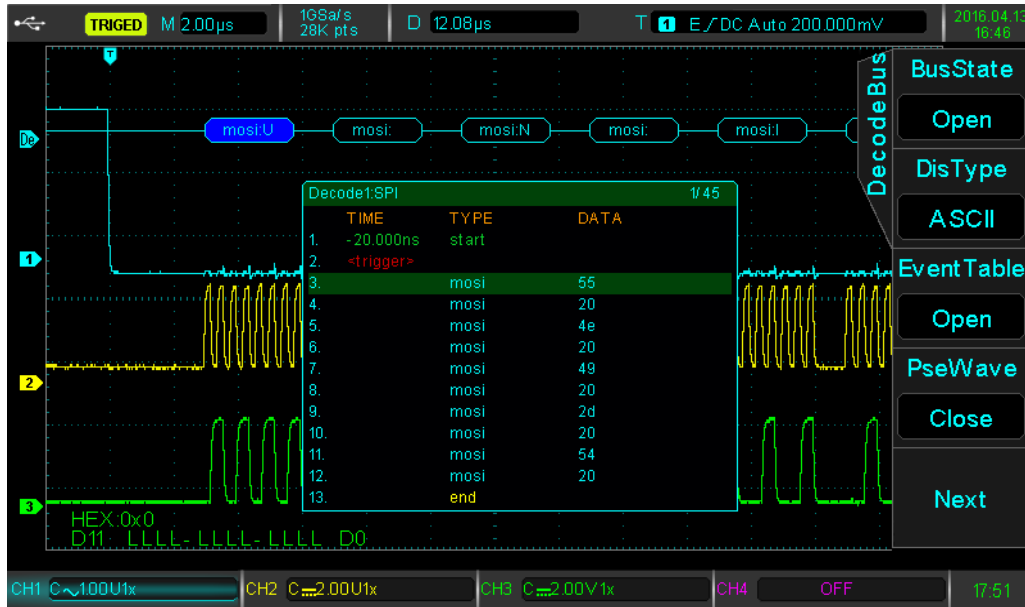
Vertical Position: Press the button and rotate the knob Multipurpose, which can adjust the position of decoding data on the screen. It is convenient for you to observe the waveform and decoding data.

Event List Check: When the oscilloscope is in the state of decoding, **RUN/STOP** is green. At the moment when pressing **RUN/STOP**, **RUN/STOP** is red. The oscilloscope will stop refreshing waveform and the collected data will be stored in the oscilloscope. The menu will display decoding data selection. The button displays the times of captured transmission signal and the corresponding number of the present selected data. The selected decoding data will be highlighted in green. The Multipurpose knob can select any collected data. This function can find the content of captured multiple transmission communication and help to debug the system conveniently.

Input the signal as shown in the following picture. Set the oscilloscope according to the following.

CS source is CH1. The CS polarity is negative. SCLK source is CH2. The SCLK edge is rising edge. MOSI source is CH3. The MOSI polarity is positive. MISO source is OFF. The condition is CS. The bit order is MSB in the condition setting. Data setting and idle time do not need to be set.

The bus state is open in the bus setting. The display format is ASCII. The event list is open, and the result is as shown in the following picture.



As we can see in the picture, the oscilloscope triggers when chip selection enable signal become low. We also can see the event 1 of the corresponding even list. The time list display the time when the enable signal starts. The green “start” means the enable signal starting. The yellow “end” means the enable signal ending. In turn the captured data is 0x55 (corresponding letter is U), 0x20 (the corresponding bit is blank), 0x4E (the corresponding letter is N) and so on. The captured decoding data display in turn in the even list. Now the picture display 1/45 among the multiple captured the result. You can use the above event list check function to observe more decoding data.

Chapter 4 Set Level System

4.1 ROLL mode

When the trigger is in automatic mode and using the SCALE knob to adjust the horizontal level to slower than 50ms/div, and the oscilloscope will be in ROLL mode. At this point, the trigger system will not work, the oscilloscope will be continuous on the screen to draw the waveform of the voltage - time chart.

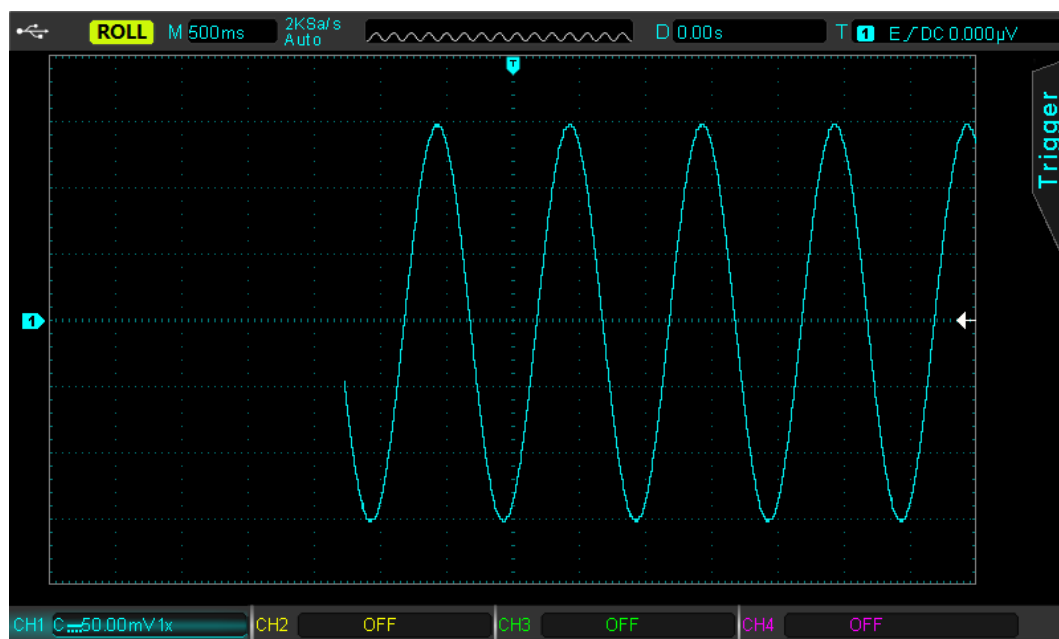
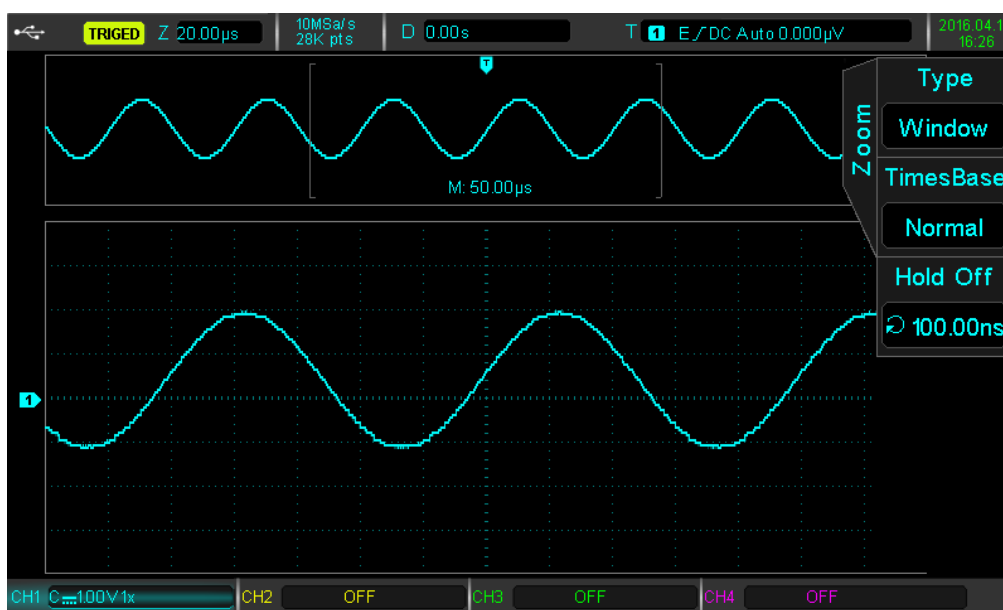


图 4-1 ROLL Mode Waveform

4.2 Extended Window

Used to enlarge waveform, the extended waveform setting cannot be slower than main waveform setting.



Press the button HORI MENU in the control panel. Press F1 to select the window scale.

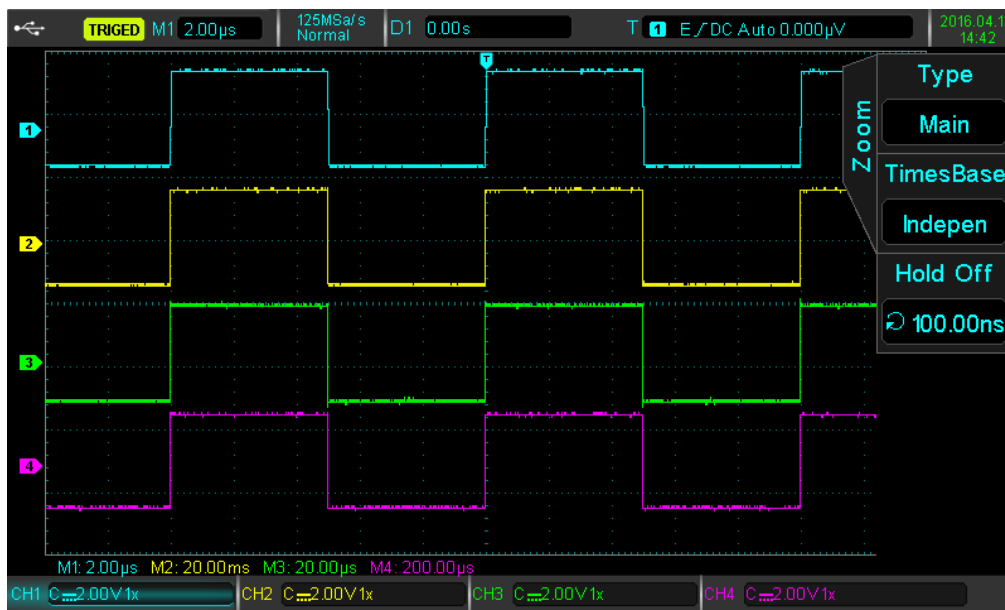
Under the window scale mode the screen is divided into two display areas as the above picture shows. The upper part displays the original waveforms, which can move left and right through rotating the knob horizontal POSITIONAL or can enlarge and reduce the selected areas through rotating the knob horizontal SCALE. The lower part displays the horizontal scale waveform. Note that scale time base improves definition compare with the main time base (as the above picture shows). Because the waveforms displayed by the whole lower part are corresponding to the areas selected by upper half part, rotating the knob horizontal SCALE to reduce the selected areas can improve the scale time base, namely , can improve the waveforms horizontal SCALE multiple.

Note: The max scale time base is 200ns/div.

4.2 Independent Time Base

In independent time base, CH1~CH4 can be arranged in timing, so that the channel can observe signals of different frequencies.

As shown below, CH1 is a 100kHz sine wave, CH2 is a 10 Hz square wave, CH3 10kHz triangular wave, CH4 1kHz pulse wave. By using the independent time base, frequency signals with large variation can be observed.



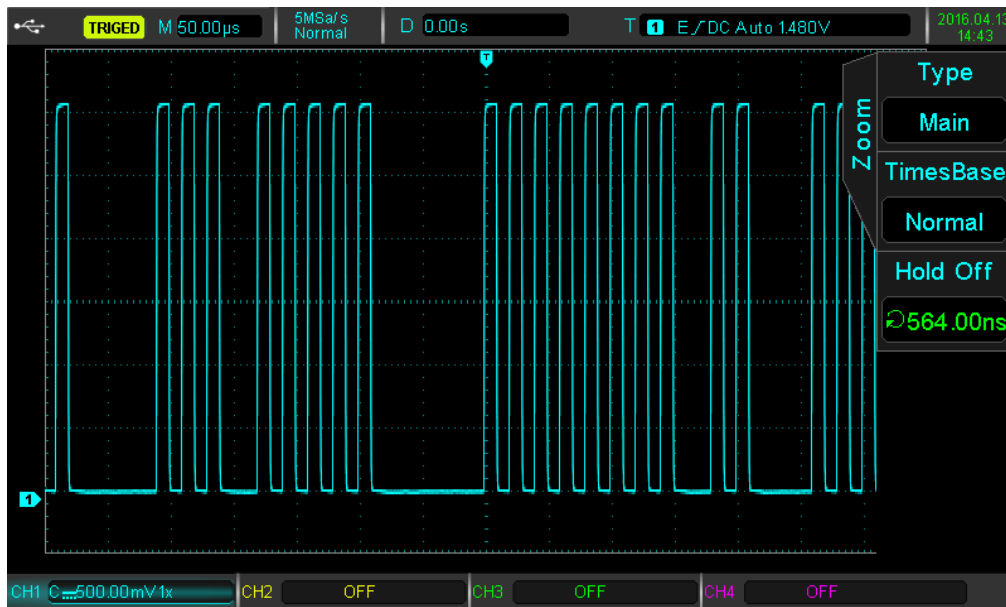
4-2 Various Frequencies Signal at Independent Time Base

4.3 Trigger Release

Trigger release can observe complex waveforms (such as pulse series). Release time is the time for the oscilloscope to re-enable the trigger. In the period of release and suppression, the oscilloscope will not be

triggered. For example, a set of pulse series, which is required to trigger on the first pulse, can set the release time to the pulse width.

Press the **HORI MENU** button to enter the level control menu. Use the multipurpose knob to select trigger release.



Chapter 5 Mathematical Operations

UPO2000CS series oscilloscope carries a variety of mathematical operations:

- Math: +, -, *, and /
- FFT: Fast Fourier Transform
- Logical: AND, OR, NOT, and XOR
- Custom Advanced Operations
- Digital Filter

Press the **MATH** button to enter the mathematical operation menu is. The **POSITION** and the **SCALE** knobs can be used to change the vertical position and the vertical profile of the mathematical operations. Under maths operation the horizontal position cannot be independently adjusted, it will change automatically according to the analog input channel signals.

5.1 Mathematical Function

Press **MATH** button, then press **F1** to choose the type math.

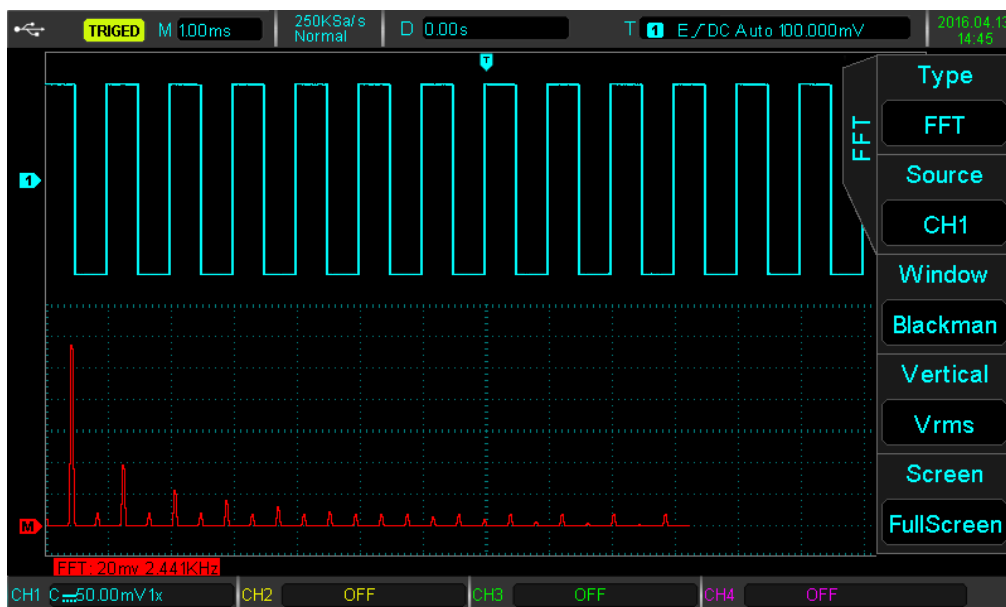
Math Menu

Functions	Options	Descriptions
Type	Math	
Source 1	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 as Math Source 1
Operator	+	Source 1 + Source 2
	-	Source 1 - Source 2
	*	Source 1 * Source 2
	/	Source 1 / Source 2
Source 2	CH1、CH2、CH3、CH4	Set any one of the CH1~CH4 as Math Source 2

5.2 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



Press **MATH** button, then press **F1** to select FFT to enter the FFT menu.

Functions	Options	Descriptions
Type	FFT	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 for FFT source
Window	Hamming	Use Hamming Window Function
	Blackman	Use Blackman Window Function
	Rectangle	Use Rectangle Window Function
	Hanning	Use Hanning Window Function
Vertical Unit	Vrms、dBVrms	Set vertical unit as linear or dB (log)

FFT Tips

Signals with DC components might cause mistakes or inaccuracies in FFT calculation. In order to reduce error, it is advised to set the channel to AC.

In order to reduce interference or noise from isolated events, the capture mode can be set to average.

(1) Select Window Function

UPO2000CS series provides 4 kinds of common window functions:

- Rectangle: The best frequency resolution is similar to the one with no window:

It is best suitable for transient or short pulses

- Hanning: Compared with the rectangular window, it has better frequency resolution, but less range. It is suitable for measuring sine, periodic and narrow-band random noise.

- Hamming: Slightly better in the frequency resolution than the Hanning window, suitable for measuring transient or

short pulse, large variance of before and after signals.

- Blackman: The best range resolution, the worst frequency resolution, it can be used to measure the single frequency signal, to find higher harmonics.

(2) Set Vertical Unit

Vertical units can be Vrms or dBVrms. Press **F4** to select the desired unit. Vrms and dBVrms show the vertical amplitude by means of logarithmic and linear. To display the FFT spectrum in a larger dynamic range, dBVrms can be used.

5.3 Logic Operations

Press **MATH** button, then press **F1** to select logic operations to enter the Logic menu.

Logic Operations Menu

Functions	Options	Descriptions
Type	Logic	
Operator	AND	Source 1 AND Source 2
	OR	Source 1 OR Source 2
	NOT	Source 1 NOT Source 2
	XOR	Source 1 XOR Source 2
Source 1	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 for logic as source 1
Source 2	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 for logic as source 2
Reverse	Open, Close	Reverse logic waveform

During operation, when the source channel voltage value is greater than the corresponding channel trigger value, the logic decision will be 1, otherwise it is 0. Waveform transform will be in binary operation. Four logical operations examples are shown in the table below.

Four logical operations

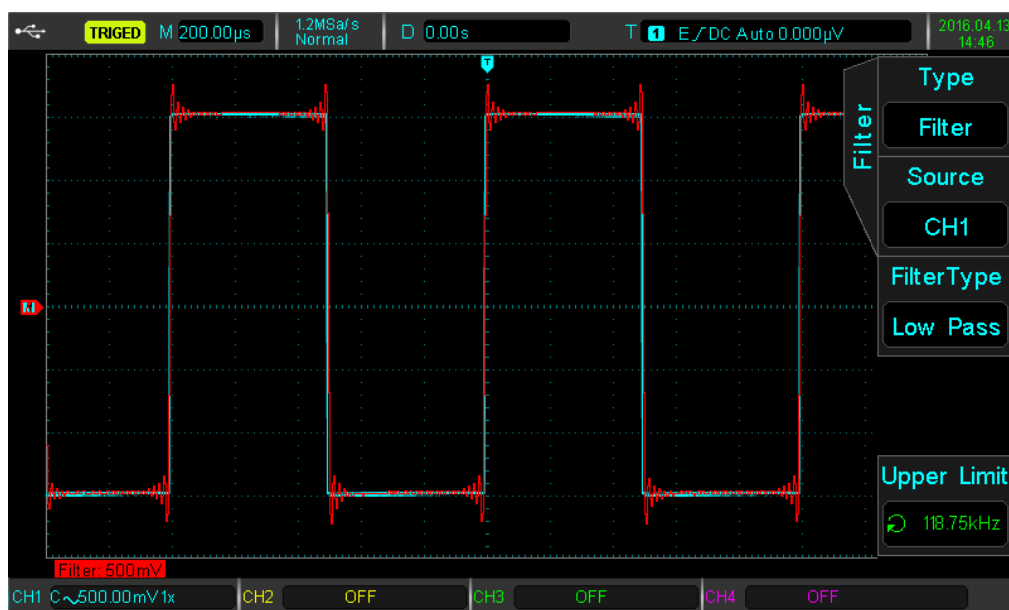
S1	S2	AND	OR	XOR		S1	NOT
0	0	0	0	0		0	1
0	1	0	1	1		1	0
1	0	0	1	1			
1	1	1	1	0			

5.4 Digital Filter

Press **MATH** button, then press **F1** to select digital filter to enter the menu.

Digital Filter Menu

Functions	Options	Descriptions
Type	Digital Filter	
Source	CH1, CH2, CH3, CH4	Set any one of the CH1~CH4 for digital filter source
Filter Type	Low Pass	Set filter to low pass
	High Pass	Set filter to high pass
	Band Pass	Set filter to band pass
Frequency Lower Limit		Only valid in high pass or band pass; Use Multipurpose knob to modify lower limit value
Frequency Upper Limit		Only valid in low pass or band pass; Use Multipurpose knob to modify upper limit value



Digital Filter

Chapter 6 Set Sampling System

Sampling is taking analog input and converts into a discrete points using analog to digital converter (ADC).

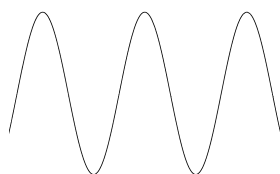
Press the **ACQUIRE** key to enter the sample menu.

Functions	Options	Descriptions
Sampling Mode	Normal	
	Peak	
	High Res	
	Envelope	
	Average	
—		—
Average	2~8192	In average sampling mode, use Multipurpose knob to set average time, number can be in the range of 2^n , where n is 1~13
Storage Depth	Auto	Automatic storage depth
	28k	Set storage depth to 28kpts
	280k	Set storage depth to 280kpts
	2.8M	Set storage depth to 2.8Mpts
	28M	Set storage depth to 28Mpts

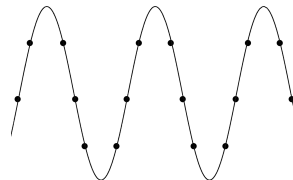
6.1 Sampling Rate

(1) Sampling and Sampling Rate

When the analog signal is sampled, the sample is then converted into digital data. The digital data is collected as the waveform is being recorded, and the recorded data is then stored in the memory.



Analog Singal



Sampling Points

Sampling rate refers to the time interval between two sampling points. The maximum sampling rate of the UPO2000CS series is **1 GS/s**.

The sampling rate will be affected by the timing scale and the change of storage depth. UPO2000CS oscilloscopes sampling rate is displayed in real-time at the top of the screen in the status bar. The horizontal SCALE knob can adjust the horizontal timebase or modify the memory depth.

(2) Low Sampling Rate Effect

- **Waveform Distortion:** Due to low sampling rate, the details of the waveform might be missing, the sampling waveform might be different than the actual signal.
- **Wave Mixing:** When the sampling rate is 2 times lower than the actual signal frequency (Nyquist frequency), the frequency of the reconstructed signal will be less than the actual signal frequency.
- **Waveform Leakage:** Due to low sampling rate, the reconstructed waveform might not reflect the actual signal.

6.2 Acquisition Mode

To obtain a waveform from sampling points, press the **ACQUIRE** key, then press **F1** key to switch between acquisition methods.

(1) Normal Sampling

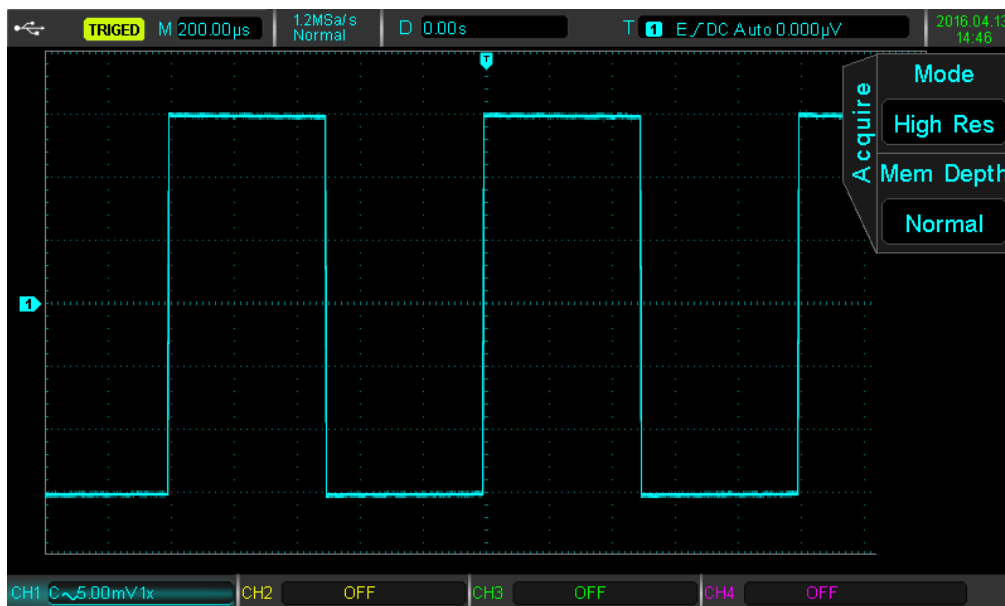
In this acquisition mode, the signal is sampled and reconstructed with equal time intervals. For most waveforms, the use of this mode can produce the best effect.

(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 mode. Noise might be enlarged in this mode.

(3) High Resolution

In this acquisition mode, the oscilloscope can reduce random noise from the input signal and generate smoother waveforms.

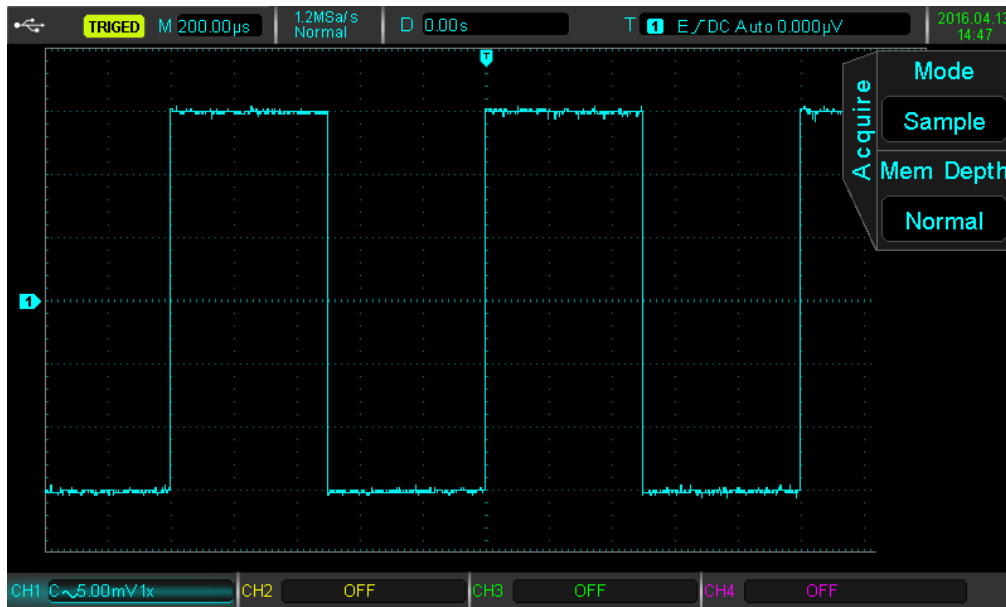


High Resolution mode to minimize noise from small signal

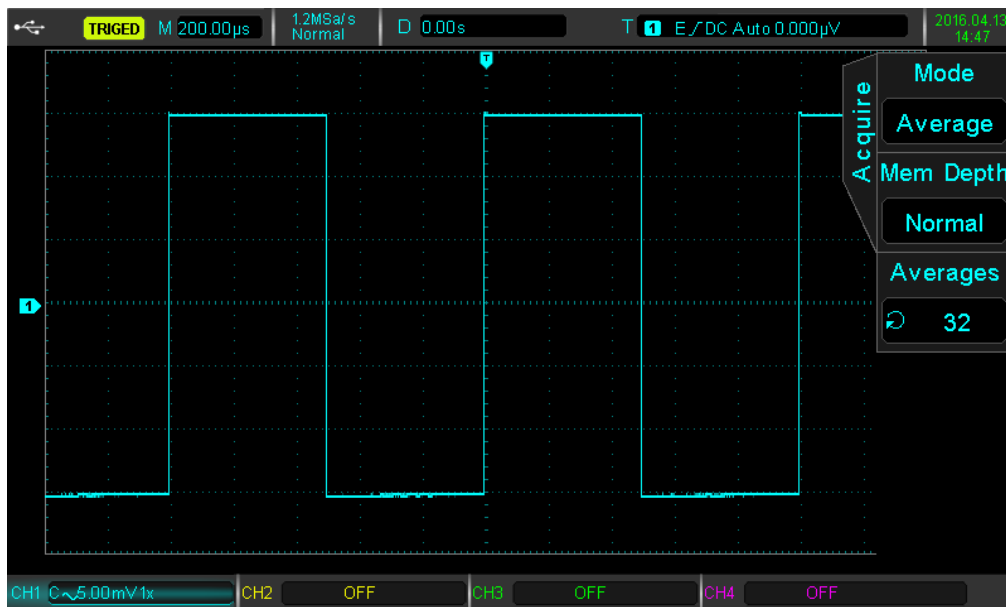
(4) Average

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

By changing the acquisition mode settings, the resulting waveform display changes. The unaveraged and the 32 times averaged waveform are displayed below for comparison.



Unaveraged



32X Averaged

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

(5) Envelope

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

6.3 Storage Depth

The storage depth is the number of waveforms that can be stored in the oscilloscope during a trigger acquisition. It reflects the memory storage capacity of the acquisition. UPO2000CS series' standard is 28 Mpts storage depth (per channel). Users can set up their own storage depth as automatic, 28K, 280K, 2.8M, and 28M.

Chapter 7 Set Display System

You can set the display type of the waveform, display format, duration, grid brightness, and waveform brightness. Press the **DISPLAY** key to enter the display menu.

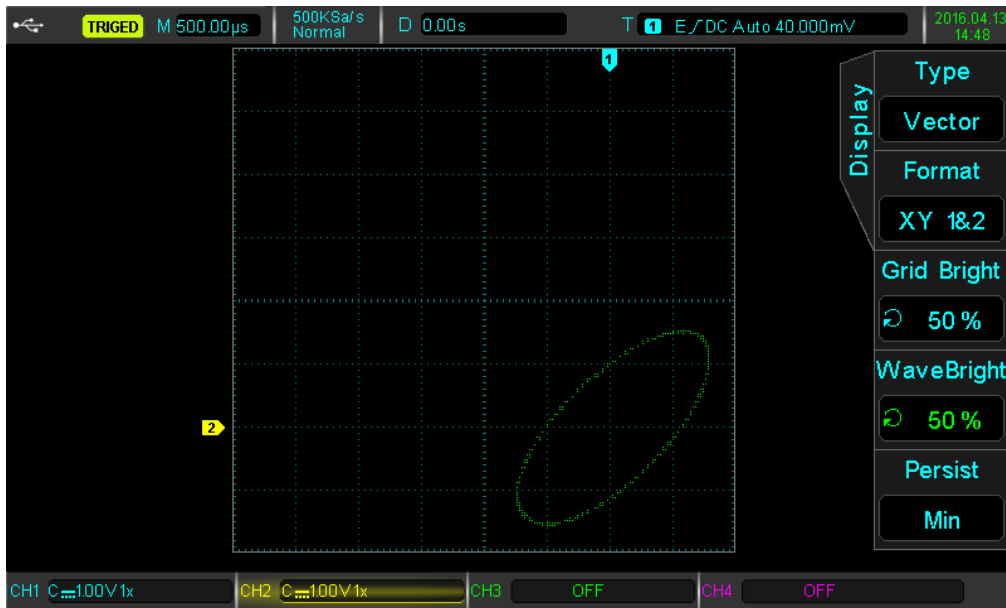
Functions	Options	Descriptions
Type	Vector	Using lines to display between samples
	Point	Displays points directly
Format	YT	Display level on time scale
	XY 1&2	Display Lissajous graph of CH1~CH2 waveforms
	XY 3&4	Display Lissajous graph of CH3~CH4 waveforms (UPO2XX4CS only)
Duration Time	Close	Displayed waveform refreshes at normal rate
	100ms/200ms/ 500ms/1s/2s/ 5s/10s	Displayed waveform refreshes after specified time
	Continuous	Waveform refreshes at a continuous rate
Grid Brightness	1%~100%	Set the grid brightness, Use Multipurpose knob to adjust settings
Waveform Brightness	1%~100%	Set the waveform brightness, Use Multipurpose knob to adjust settings

7.1 XY Pattern

The XY mode display is also called Lissajous graph.

- When XY 1&2 are selected, the CH1 signal will be entered on the horizontal axis (X), and the CH2 on the vertical axis (Y).
- When XY 3&4 are selected, the CH3 signal will be entered on the horizontal axis (X), and the CH4 on the vertical axis (Y). Only UPO2XX4CS have this feature.
- In X-Y mode, when CH1 or CH3 are activated, use the horizontal POSITION knob to adjust the graph horizontally. When CH2 or CH4 are activated, use the horizontal POSITION knob to adjust the graph vertically.

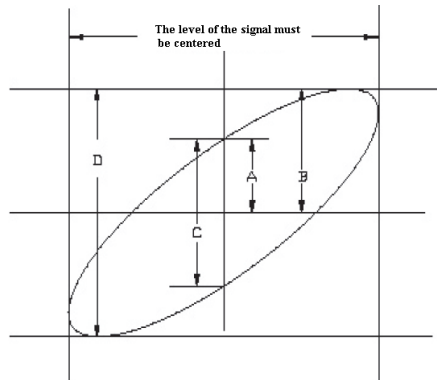
The vertical SCALE knob to be used to adjust each channel's amplitude level. The horizontal SCALE knob can be used to adjust the time position in order to obtain a well displayed Lissajous graph.



XY Display Mode

7.2 Application of XY Mode

The phase difference between the two signals of the same frequency can be easily observed by Lissajous method. The following chart gives the observation of phase difference.



Lissajous Graph

Since $\sin\theta = A/B$ or C/D , theta (θ) is the angle between the two signals, the definition of A, B and C, D is shown above. We can draw a difference angle $\theta = \pm \arcsin(A/B)$ or $\theta = \pm \arcsin(C/D)$. If the principal axis of an ellipse is in quadrants I and III, then the phase angle should be in I, IV quadrant, in 0 to $(\pi/2)$ or $(3\pi/2)$ to 2π . If the principal axis of an ellipse in II, IV quadrant, then the phase angle should be $(\pi/2)$ to π or π to $(3\pi/2)$.

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:

X:Y Frequency ratio	Phase					
	0°	45°	90°	180°	270°	360°
1:1						
1:2						
1:3						
1:4						

X-Y Phase Difference Table

Chapter 8 Automatic Measurement

UPO2000CS series digital fluorescence oscilloscope can automatically measure up to 34 parameters. Press the **MEASURE** button to enter the automatic measurement menu.

Automatic Measurement Menu

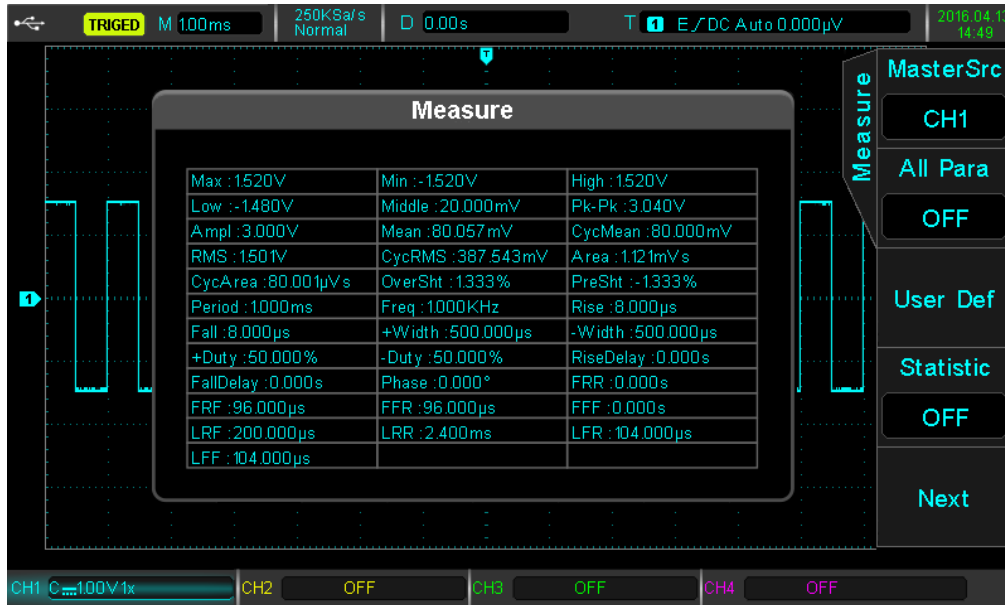
Functions	Options	Descriptions
Signal Source	CH1, CH2, CH3, CH4	Select data source from any one of the CH1~CH4
All Parameters	Off	Close all Parameters
	On	Pop-up window with all parameters is displayed
User Defined	On/Off	Open/Close menu for user defined paraters. When it is on, define all parameters required with the Multipurpose knob. It can customize and display up to 5 parameters at the same time.
Measurement Statistical Analysis	Off	Turn off feature
	Peak	Automatic calculation of user defined parameters of average, max, and min. Only applicable when user defined parameters are present.
	Difference	Automatic calculation of user defined parameters of average, difference, and number of measurements. Only applicable when user defined parameters are present.
Next Page		Go onto the next page

Automatic Measurement Menu (2)

Functions	Options	Descriptions
Signal Source	CH1, CH2, CH3, CH4	Select data source from any one of the CH1~CH4
Indicator Selection		Using the Multipurpose knob, up to 34 parameters can be selected.
Indicator	Off	Close parameter indicator
	On	Open parameter indicator
Clear		Clear all parameters
Return		Return to automatic measure main menu

8.1 All Parameters Measurement

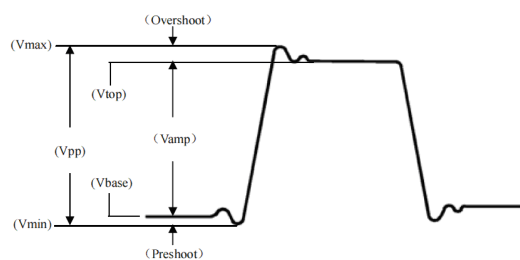
Press the **MEASURE** button to enter the automatic measurement menu. Then press **F1** to select the source of the measurement. **F2** can be used to select all 34 parameters.



Measured parameters color are consistent with the current channel.

When "-----" is shown, it indicates that the current source has no signal input, or the measurement result is not valid (too big or too small).

8.2 Voltage Parameters



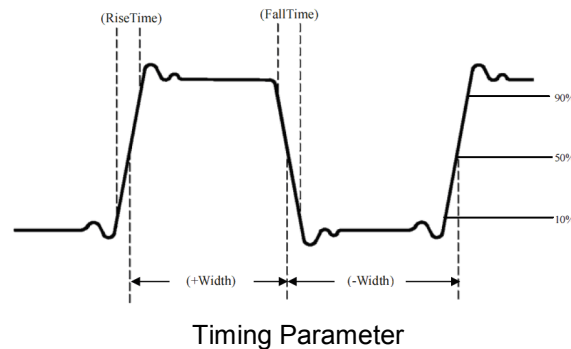
Voltage Parameter Diagram

UPO2000CS series oscilloscope can automatically measure the following parameters:

- Vmax: Voltage at the highest point with respect to GND
- Vmin: Voltage at the lowest point with respect to GND
- Vtop: Highest stable voltage
- Vbase: Lowest stable voltage
- Middle: Midpoint between highest and lowest stable voltage

- V_{pp} : $V_{max} - V_{min}$
- V_{amp} : $V_{top} - V_{base}$
- Mean: Average amplitude of the waveform on screen
- CycMean: Average amplitude of a 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
- Overshoot: The ratio of the difference between V_{max} and V_{top}
- Preshoot: The ratio of the difference between V_{min} and V_{base}
- Area: The product of time and voltage for all points on the screen
- CycArea: The product of time and voltage for all points in one period

8.3 Timing Parameters



- Period: The duration of one cycle of a repetitive waveform
- Frequency: The reciprocal of the period
- Rise time: The time it takes the waveform amplitude to increase from 10% to 90%
- Fall time: The time it takes the waveform amplitude to decrease from 90% to 10%
- +Width: The width of a positive pulse at 50% amplitude
- -Width: The width of a negative pulse at 50% amplitude
- +Duty: The ratio of positive pulse width to period
- -Duty: The ratio of negative pulse width to period

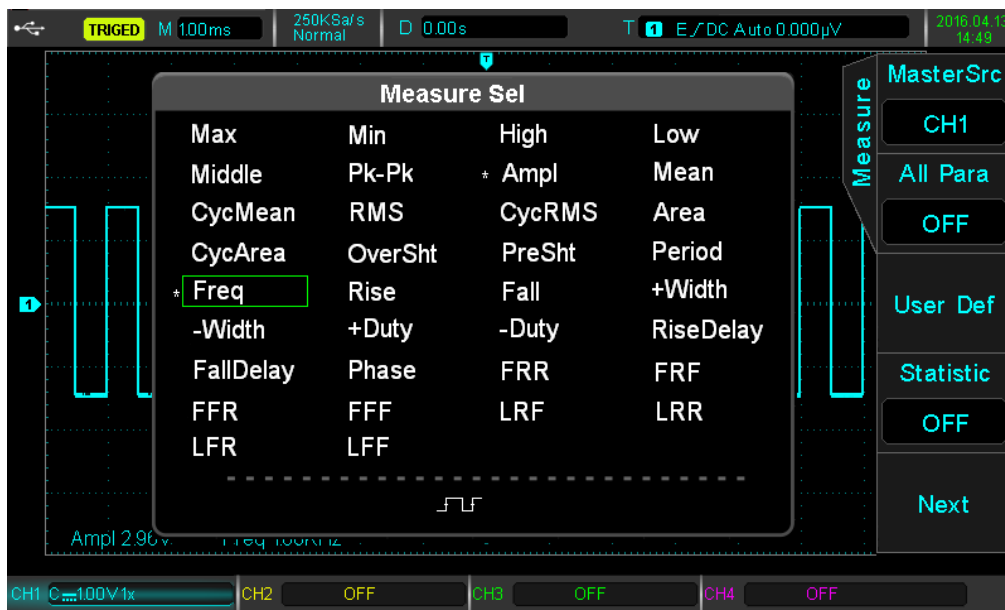
8.4 Delay Parameters

- 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

8.5 User Defined Parameters

Press the **MEASURE** button to enter the automatic measurement menu. Then press the **F1** key to select the source of the measurement. The user defined parameter selection interface can be chosen by **F4**.

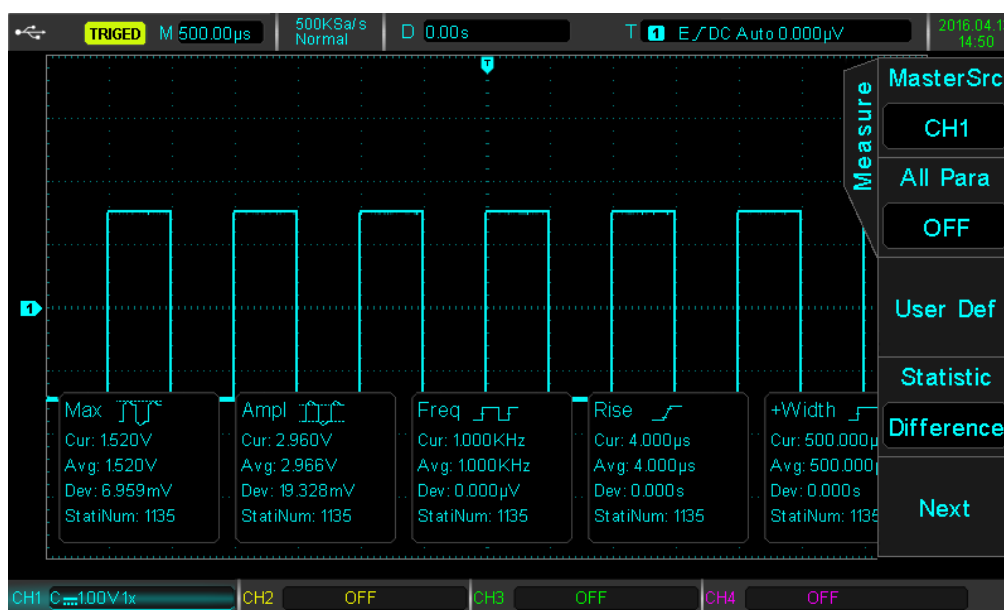


User Defined Parameter Selection

Adjust the parameters with the multipurpose knob, press the multipurpose knob button to confirm selection. For every selected parameter, a * symbol will appear in front of the parameter.

F3 can be pressed to turn off user defined parameter selection menu and the parameters will be display at the bottom of the screen. For convenience and immediate view 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.



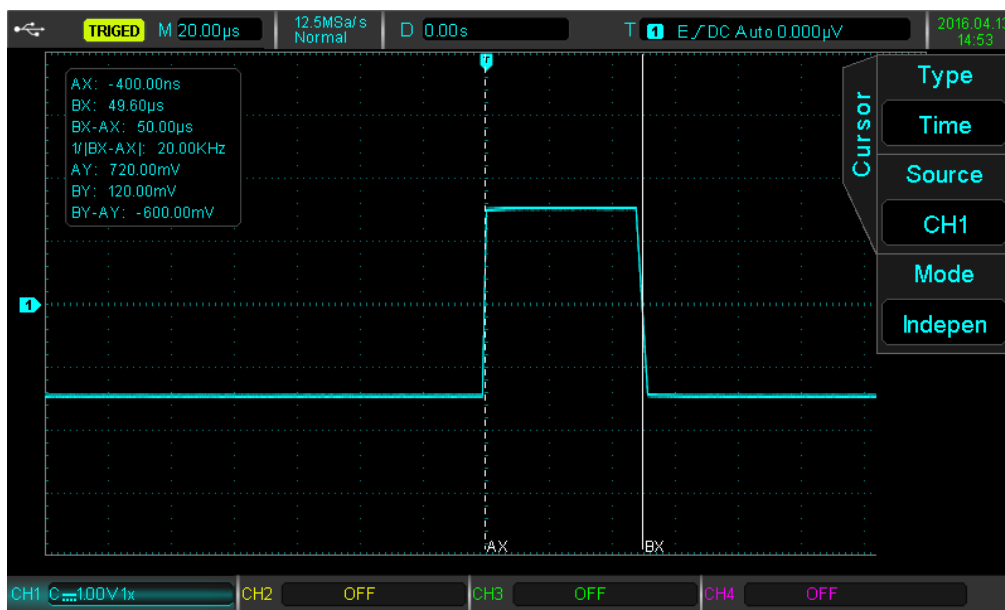
User Defined Parameter Statistics

Chapter 9 Cursor Measurement

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

9.1 Time Measurement

- Press the **CURSOR** key to enter the cursor measurement menu, then press **F1** to select the type to time.
- Press **F2** to select the source of the time measurement channel, and set the pattern to independent.
- The multipurpose knob can adjust the vertical cursor AX, press the multipurpose knob to switch to cursor BX.



The measured values are shown in the upper left corner of the waveform display area. The value of BX-AX is the time measurement, and $1/|BX-AX|$ is the reciprocal of time, or frequency.

For a periodic signal, if AX and BX are set at the rising edge of adjacent cycles, then BX-AX is the signal's period, and $1/|BX-AX|$ is the frequency.

Parameters can also display the voltage value at cursor's current position. That is AY, BY, and BY-AY.

The multipurpose knob can be used to adjust the BX and AX positions when setting is set to trace using the **F3** key.

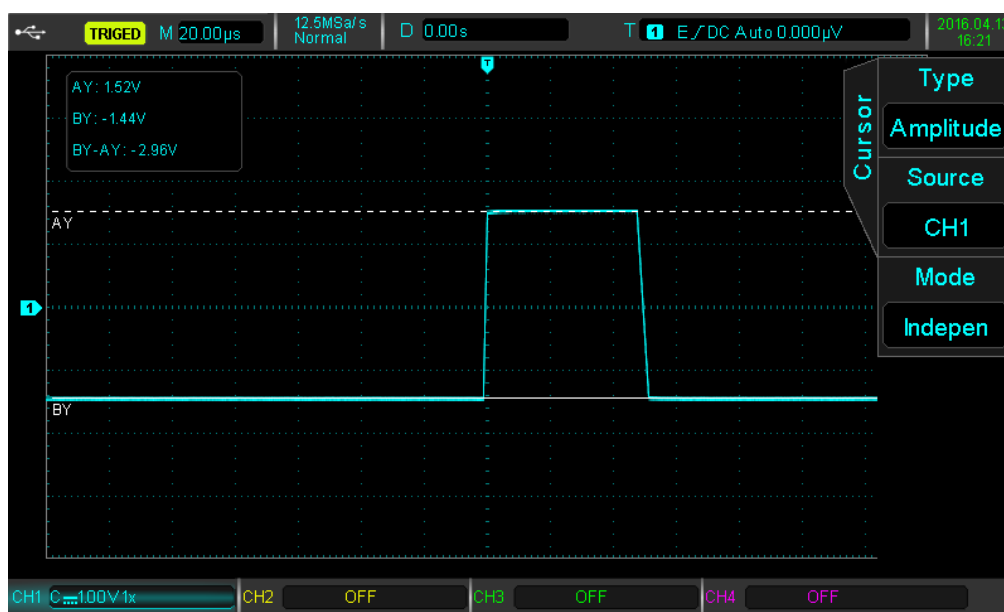
9.2 Voltage Measurement

- 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 **F1** to select the type as voltage.
- Press **F2** to select the source for channel's voltage measurement, and set the pattern to independent

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 value of BY-AY is the voltage measurement (V).

When the setting is set to trace mode with the **F3** key, the multipurpose knob can adjust both AY and BY at the same time.



On the upper left corner of the display area, BY and AY are represented by the current position of the cursor BY and AY respectively. BY-AY indicates the voltage difference between the two cursors.

Chapter 10 Storage and Callback

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

UPO2000CS series oscilloscope supports FAT format USB storage devices. It is not compatible with NTFS format.

10.1 Storage Setting and Callback

Press **STORAGE** button, then press **F1** to select the type to settings to enter the storage settings menu.

Functions	Options	Descriptions
Type	Storage Setting	
Disk	DSO	Data will be saved on the oscilloscope
	USB	Data will be saved on USB drive
Filename		Filename can be chosen with the multipurpose knob. Names can be chosen from set001, set002, ..., set225
Save		Saves settings to selected disk
Callback		Call back previously saved settings, returns the oscilloscope to the previously saved setting state

Remarks

- Oscilloscope can only select USB device when U disk or other external storage devices are plugged in.
- Callback only works when previously saved disk and the file name are consistent, or else it will fail to load.

10.2 Waveform Storage and Callback

Press the **STORAGE** button, then press **F1** to set the type as waveform to go into waveform storage menu.

Functions	Options	Descriptions
Type	Waveform Storage	
Source	CH1, CH2, CH3, CH4	Select waveform storage source from any one of CH1~CH4
Disk	DSO	When Save is pressed, waveform will be saved to the oscilloscope
	USB	When Save is pressed, waveform will be saved to external USB device

	USB CSV	When Save is pressed, waveform will be saved to external USB device in CSV format
Filename		Filename can be chosen with the multipurpose knob. Names can be chosen from wav001, wav002,, wav225
Save		Saves the waveform to selected disk

After the waveform is saved, you can use the **REF** key for callback. Press the **REF** key to enter the waveform callback menu.

Waveform Callback Menu

Functions	Options	Descriptions
Reference	Ref-A、Ref-B、Ref-C、Ref-D、	Select from any of the four references to callback waveform
Disk	DSO	When Save is pressed, waveform will be saved to the oscilloscope
	USB	When Save is pressed, waveform will be saved to external USB device
Filename		Filename to be called back can be chosen with the multipurpose knob. Names can be chosen from wav001, wav002,, wav225 and must be consistent with saved name
Callback		Callback previously saved waveform and display on screen
Clear		Close current REF waveform

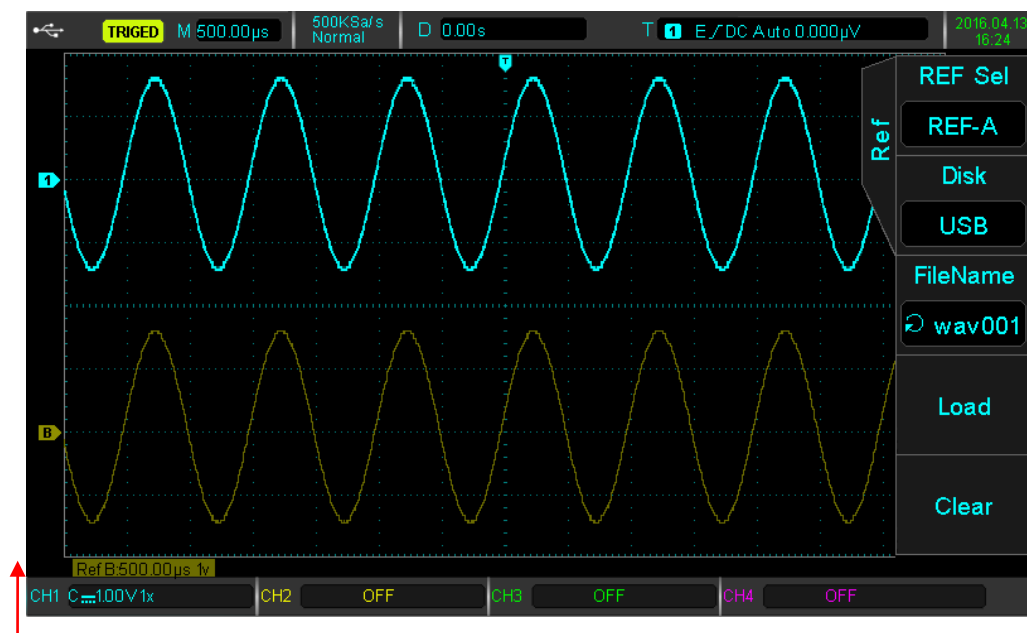


Fig. 10-1 Waveform Callback

After callback, the Ref waveform will be displayed in the lower left corner, including timing scale and amplitude shift. At this point you can use the vertical and horizontal control knob to adjust the ref waveform's position, time base, and amplitude shift.

10.3 Screen Copy

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 devices are connected.

Chapter 11 Auxiliary Function Setting

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

Auxiliary function setting menu (the first page)

Functions	Options	Descriptions
Self-correcting		Start self-correcting function
System Info		Displays oscilloscope model number, software version, firmware version, etc
Language		Displays menu language of oscilloscope
Menu Display	1s、2s、5s、10s、20s、Manual	Set the menu to auto hide after a specified time, or manually using MENU key Press MENU key to recall hidden menu
1/3		Enters Auxiliary function setting menu (2)

Auxiliary function settings menu (2)

Functions	Options	Descriptions
Waveform Recording		Enters Waveform Recording Menu
Pass Test		Enters Pass Test Menu
Square Wave Output	10Hz、100Hz、1kHz、10kHz	Set the probe compensation signal output frequency, the default is 1kHz (range = 3V, cannot be changed)
Frequency Meter	Off	Turn off frequency meter function
	On	Turn on frequency meter function
2/3		Enters Auxiliary function setting menu (3)

Note: The frequency meter is a counter for trigger events. The frequency meter is valid for edge or pulse width, but not for trigger source.

Auxiliary function settings menu (3)

Functions	Options	Descriptions
System Upgrade		Enters oscilloscope software update
Backlight Brightness	10%~100%	Use the multipurpose knob to select backlight brightness, from 10%~100%
Output Selection	Trigger	Set the PASS/FAIL output terminal behind the oscilloscope to trigger
	Pass Test	Set the PASS/FAIL output terminal behind the oscilloscope to pass test
3/3		Enters Auxiliary function setting main menu

11.1 Waveform Recording

Press **UTILITY** then press **F5** to enter auxiliary function settings menu (2). Press **F1** to enter the wave recording menu.

Waveform Recording Menu

Functions	Options	Descriptions
Record	Close	Close Record Function
	Settings	Enter Record Settings Menu
	Operation	Enter Record Operation Menu

Press **F1** to select **recording operation**, and set parameters for waveform recording.

Record Settings Menu

Functions	Options	Descriptions
Record	Settings	Set Record Parameters
Record Length	100ns~10s	Set waveform record interval between each frame
End Frame	1~65000	Set the frame where recording automatically ends
Playback Delay	10ms~1s	Set the delay between each frame set when playing
Largest Frame	65000	Shows the maximum number of frames which can be recorded (will change according to current storage depth)

After setting up the recording parameters, the recording operation can be performed by pressing **F1**.

Record Operation Menu

Functions	Options	Descriptions
Record	Operation	Carry out record, playback, and stop operation.
Playback		Playback the recorded waveform
Stop		Stop recording or playback waveform
Record		Start recording waveform

11.2 Pass Test

The pass (fail) test is by using a template to detect whether the input signal satisfies the template requirements.

(1) Function Introduction

Press **UTILITY**, then press **F5** to enter the secondary menu, then press **F2** to enter the test menu.

Pass Test Menu

Functions	Options	Descriptions
Allow Test	Close	Close Pass Test
	Open	Open Pass Test
Output	Fail	Set the Pass/Fail interface on the rear panel to a "failure" pulse and produce a buzzer
	Pass	Set the Pass/Fail interface on the rear panel to a "pass" pulse and produce a buzzer
Source	CH1、CH2、CH3、CH4	Set the source of the pass test
Display Info	Close	Turn off display information
	Open	Turn on display information
1/2		Enter Pass Test Menu (2)

Pass Test Menu (2)

Functions	Options	Descriptions
Operation	Close	Disable Pass Test
	Open	Enable Pass Test
Stop Setting		Enters Stop Settings Menu
Template Setting		Enters Template Settings Menu
2/2		Enter Pass Test Main Menu

After opening the pass test, you need to set the stop settings and template settings before you can perform the test function. Otherwise you'll be prompted "Function is Disabled". The stop setting and template settings menus are shown below.

Stop Settings Menu

Functions	Options	Descriptions
Stop Type	Pass Count	The test function stops after it reaches a specified pass count number
	Fail Count	The test function stops after it reaches a specified fail count number
Condition	>=、<=	Stop condition setting

Threshold		Use the multipurpose knob to select stop condition threshold
Return		Return to previous menu

Template Settings Menu

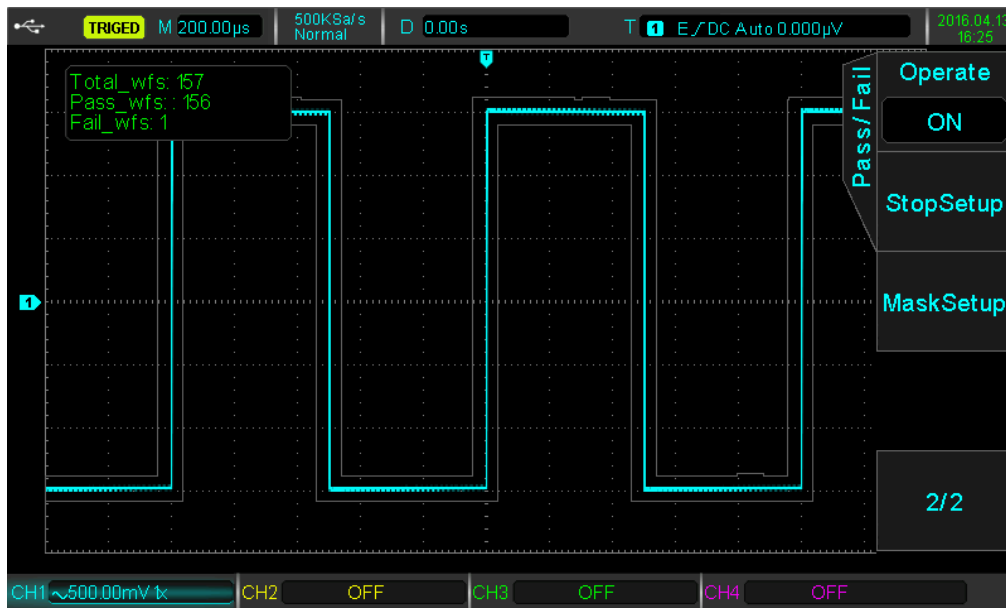
Functions	Options	Descriptions
Reference Waveform	CH1、CH2、CH3、CH4	Select a channel CH1~CH4 with horizontal and vertical tolerance as template
Horizontal Tolerance	1~255	Use the multipurpose knob to select the horizontal tolerance
Vertical Tolerance	1~255	Use the multipurpose knob to select the vertical tolerance
Create Template		Create template with above conditions
Return		Return to previous menu

(2) Application Example

CH1 1kHz, 3V square wave input, observe results of pass test below:

- ① To enter the test menu: Press **UTILITY**, then press **F5** to enter auxiliary menu second page, then press **F2** to enter the test menu.
- ② Set the test: press **F1** to enable the test set
- ③ Set the source: press **F3** to set the source to CH1
- ④ Template settings: press **F5** to enter the next page, then press **F3** to enter the template settings menu. Press **F1** to select the reference waveform to CH1; press **F2** and **F3**, set the level threshold with the multipurpose knob to 10, set the vertical threshold to 5, then press **F4** to create a template, press **F5** to return to the test menu
- ⑤ Stop setting: press **F2** to enter stop setting menu, set the stop type to pass count, and set the threshold to 10 with multipurpose knob, press **F5** to return to the test menu
- ⑥ Set the output conditions: press **F5** to return to the first page of the test menu, set the output condition to 'fail' using the **F2** key
- ⑦ Open display information: press **F4** to set display information to open

- ⑧ Start test: press **F5** to enter the second page of the test menu, then press **F1** to open the operation to start the test. See figure below:



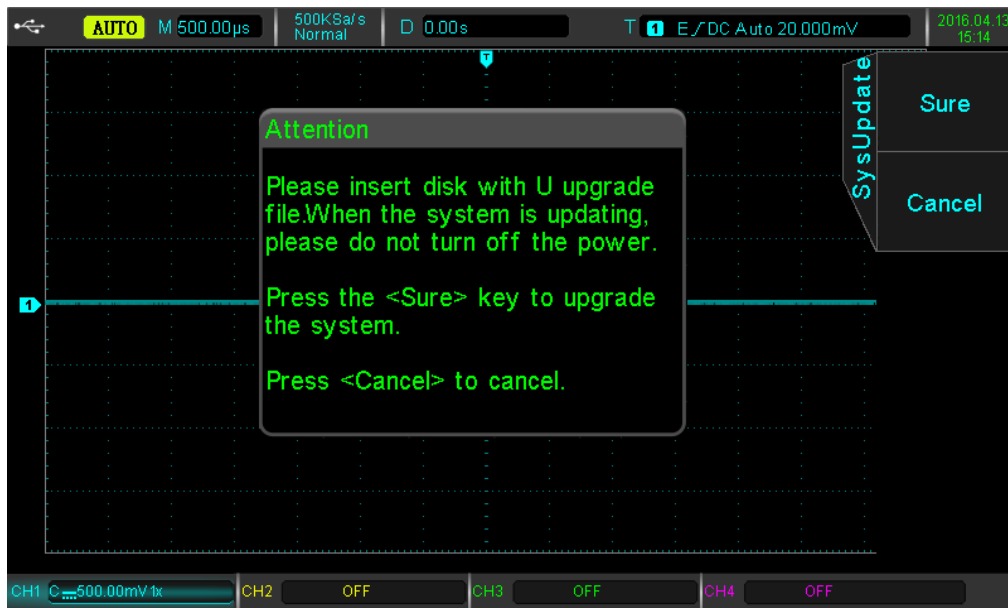
Pass Test

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

11.3 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, press **F1** to view system information, access the machine's model number, software, and hardware version information.
- ② Software upgrade file can be found on Uni-T website or Uni-T distributors. Software file is consistent with the machine model and hardware version. Software version higher than the current version is stored in the root directory of U disk.
- ③ Insert U disk, press **UTILITY** to enter the auxiliary function menu, press **F5** twice to enter the third page, press **F1** to select system upgrade. Press **F1** to confirm.



System Upgrade Screen

- ④ Upgrade process takes around 10s. After the upgrade, syetem will automatically restart in order to complete the upgrade.

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 12 Other Function Keys

12.1 Automatic Setting

Automatic settings will according to the input signal, choose appropriate time base files, range profile, 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 signal frequency is not less than 50Hz, the amplitude is not less than 30mVpp, and the square wave duty cycle is more than 5%
- ③ Only opened channel can be used for automatic setting

12.2 Run/Stop

When the **RUN/STOP** key is pressed, a green light will be on, indicating the RUN status. When the key is pressed again and a red light appears, it indicates the STOP status. The RUN state enables the oscilloscope to be in continuous acquisition, the upper screen will display AUTO. During the STOP state, the oscilloscope stops collecting data, and the upper screen displays STOP.

12.3 Factory Setting

By pressing the **DEFAULT** button, you can quickly restore to factory settings. UPO2000CS series oscilloscope factory settings are as below:

System	Function	Factory Setting
Vertical System	CH1	1V/DIV
	Vertical Displacement	0
	Coupling	DC
	Bandwidth Limit	Off
	Lattice	Coarse
	Probe	1×
	Reverse	Off
	Bias Voltage	Off
	CH2、CH3、CH4	Off

	MATH、REF	Off
Horizontal System	Extended Window	Off
	Horizontal Timebase	1 μ s/div
	Horizontal Displacement	0
Trigger System	Hold Time	100.00ns
	Trigger Type	Edge
	Source	CH1
	Slope Type	Rising
	Coupling Mode	DC
	Trigger Mode	Auto
Display	Type	Vector
	Format	YT
	Duration Time	100ms
	Grid Brightness	50%
	Waveform Brightness	60%
Other System	Storage Type	Waveform
	Frequency Meter	Off
	Measurements	Off, Clears all measurements
	Cursor	Off
	Language	Keep current
	Menu Display	Manual
	Square wave output	1kHz
	Backlight brightness	100%
	Output selection	Trigger

Chapter 13 System Hints and Troubleshooting

13.1 System Information Description

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

USB device is not inserted: When the USB storage device is not connected to the oscilloscope.

Load Failed: When the location did not store the setting or waveform needed.

13.2 Trouble Shooting

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

- a) Check the power supply connection
- b) 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
- c) If there is a sound, it indicates that the oscilloscope is activated. Try the following operation: press **DEFAULT** key, then press **F1** key, if device return to normal, it means backlight brightness is too low
- d) After completing the above steps, restart the oscilloscope
- e) If you still cannot solve this problem, 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 input signal of the analog channel and that channel is open
- ④ Make sure the probe is connected to the compensation piece and check whether the probe is normal
- ⑤ Check to see if there is a signal to be detected
- ⑥ Press **AUTO** button for signal re-acquisition

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

Make sure the probe attenuation coefficient 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 the signal and channel are consistent
- 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 or low frequency in order to suppress or remove noise caused by interference

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

- ① Check whether the trigger menu's trigger method is set to normal, and whether the trigger level has exceeded the waveform range. If it exceeded, center the trigger level or set the trigger mode to auto with the **AUTO** key
- ② Press the **AUTO** button to complete the above settings

(6) Waveform refresh rate is too slow:

- ① Check whether the acquisition is set average, and the number of times it averages
- ② You can speed up by display by reducing the average times or select other methods such as normal sampling

Chapter 14 Technical Index

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

Unless otherwise stated, all technical specifications are applicable to probe attenuation 10X and with UPO2000CS 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 exceeds 5 degrees Celsius from normal operating temperature, self calibration needs to be performed.

Input	
Input Coupling	DC, AC, GND
Input Impedance	1MΩ ± 2% // 20pF ± 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	UPO2104CS	UPO2074CS	UPO2102CS	UPO2072CS	UPO2202CS
Bandwidth	100MHz	70MHz	100 MHz	70MHz	200MHz
Rise Time (Typical)	≤3.5ns	≤5ns	≤3.5ns	≤5ns	≤1.8ns
Channels	4		2		
Vertical Resolution	8bit				
Vertical Scale	1mV/div~20 V/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	≤±4% (Sampling or average sampling method)				
Channel Separation	DC to maximum bandwidth: >40 dB				
Horizontal					
Timing Scale	5ns/div ~ 50s/div (1-2-5 base)				
	2ns/div ~ 50s/div (1-2-5 base) (UPO2202CS)				

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Timing Accuracy	$\leq \pm(50 + 2 \times \text{Service Life}) \text{ppm}$
Delay	Pre-trigger (Negative Delay) : ≥ 1 Screen Width Post-trigger (Positive Delay) : 1 s~50 s
Timebase	YT、XY、ROLL
Waveform Capture Rate	50,000 wfms/s

Sampling	
Sampling Mode	Teal-time Sampling
Real-time Sampling Rate	1GS/s(Single Channel), 500MS/s(Dual Channel), 250MS/s(Quad Channel) 1GS/s(Single Channel), 500MS/s(Dual Channel)(UPO2202CS)
Acquisition Mode	Sampling, peak detection, high resolution, envelope, and average
Average Value	After all channels reach N times sampling, N times in 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, and 8192
Waveform Interpolation	$\sin(x)/x$
Storage Depth	Auto, 28kpts, 280kpts, 2.8Mpts, 28Mpts

Trigger	
Trigger Level Range	Internal: Center of the screen ± 8 grids External: $\pm 0.8V$
Trigger Mode	Automatic, normal, single
Trigger Holdoff Range	100ns~10s
High Frequency Suppression	50kHz
Low Frequency Suppression	5kHz
Noise Suppression	Reduce Noise Waveform (10 mV/div~20 V/div, DC coupling trigger sensitivity reduced by 2 times)
Trigger Sensitivity	$\leq 1\text{div}$
Edge Trigger	
Edge Type	Rising, falling, any
Pulse Width Trigger	
Pulse Condition	>、<、=
Polarity	Positive, negative pulse width
Pulse Width Range	4ns ~ 10s
Under-range Pulse Trigger	

Pulse Condition	>, <, =
Polarity	Positive, negative
Pulse Width Range	8ns~10s
Beyond-range Pulse Trigger	
Beyond-range type	Rising, falling, any
Trigger Position	Entering, exiting, time
Beyond-range time	8ns~10s
N-edge Trigger	
Edge Type	Rising, falling
Free Time	8ns~10s
Edge Count	1~65535
Delay Trigger	
Edge Type	Rising, falling
Delay Type	Greater than, less than, within scope, outside scope
Delay Time	Normal: 8ns~10s Time lower limit: 8ns~10s Time upper limit: 36ns~10s
Overtime Trigger	
Edge Type	Rising, falling, any
Timeout	8ns~10s
Duration Trigger	
Pattern Type	H, L, X
Trigger Condition	Greater than, less than, within range
Duration Time	Normal: 8ns~10s Time lower limit: 8ns~10s Time upper limit: 36ns~10s
Setup/hold Trigger	
Edge Type	Rising, falling
Data Type	H, L
Setup Time	8ns~10s
Hold Time	8ns~10s
Slope Trigger	
Slope Condition	Positive slope (greater than, less than, specified range) Negative slope (greater than, less than, specified range)

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Time Setup	8ns~10s	
Video Trigger		
Signal System Frequency Range	Supports NTSC, PAL, and SECAM systems, rows range is 1~525 (NTSC) and 1~625 (PAL/SECAM)	
Code Type Trigger		
Code Set	H, L, X, rising, falling	
Measure		
Cursor	Manual	Voltage between cursors (ΔV) Time between cursors (ΔT) Frequency (Hz) (1/ΔT)
	Trace Mode	Voltage and time at waveform point
	Indicator	Allows auto display of cursor
Auto Measurement	Max, Min, Peak-Peak, Top, Bottom, Amplitude, Mean, Middle, Peroid Mean, RMS, Period RMS, Area, Period Area, Overshoot, Preshoot, Frequency, Period, Rise Time, Fall Time, Positive Pulse, Negative Pulse, Positive Duty Ratio, Negative Duty Ratio, Delay A->B , Delay A->B , Dela 5B->A , Delay B->A 1 . 5 7	
Measurement Number	Displays 5 at the same time	
Measurement Range	Screen or cursor	
Measurement Statistics	Average value, maximum value, minimum value, standard deviation and the number of measurements	
Frequency meter	6-bit	

Mathematical Operations	
Waveform Calculation	A+B, A-B, A×B, A/B, FFT, Logic Operation
FFT Window Type	Rectangle, Hanning, Blackman, Hamming
FFT Display	Split screen; time base files can be adjusted independently
FFT Vertical Scale	Vrms, dBVrms
Digital Filter	Low pass, high pass, band pass
Logical operation	AND, OR, NOT, XOR

Storage	
Setting	Internal (256), External USB
Waveform	Internal (256), External USB
Bitmap	External USB

Display	
Display	8-inch TFT LCD
Display Resolution	800 horizontal ×480 vertical (RGB)
Display Color	160,000,000
Duration	Min, 100ms, 200ms, 500ms, 1s, 2s, 5s, 10s, unlimited
Menu Duration	1s, 2s, 5s, 10s, 20s, manual
Display Type	Point, vector

Interface	
Standard/Optional	Standard: USB-Host, USB-Device, LAN, EXT Trig, AUX Out Optional: Waveform Generator

General Technical Specifications	
Probe compensated signal output	
Output Voltage	3Vp-p
Frequency	10Hz, 100Hz, 1kHz(default), 10kHz
Power Supply	
Power Supply Voltage	100V~240VACrms
Frequency	45Hz~440Hz
Fuse	3A, T level, 250V
Environment	
Temperature Range	Operational: 0°C~+40°C
	Non-Operational: -20°C~+60°C
Cooling	Forced cooling fan
Humidity range	Operational: below +35°C ≤90%Relative humidity
	Non-operational: +35°C~+40°C ≤60%Relative humidity
Altitude	Operational: Below 3000m; Non-operational: Below 15,000m
Mechanical Specifications	
Size	336mm(W)×164mm(H)×108(D)mm
Weight	3.5kg
Maintenance Period	
Recommend to perform calibration once a year	

Chapter 15 Accessories

Appendix A – Accessories and Options

Model Numbers	UPO2072CS/UPO2074CS(70 MHz)/UPO2202CS(200MHz)
	UPO2102CS/UPO2104CS(100 MHz)
Standard Accessories	Power line meets local country standard
	USB data cable (UT-D06)
	2/4 passive probes (100MHz)
	Quick guide
	CD (Includes manual and application software)

For all accessories (standard and optional), please order at UNI-T local dealers.

Appendix B – Maintenance and Cleaning

(1) General Maintenance

Do not store or place the instrument and liquid crystal display in direct sunlight. **Caution:** do not spray liquid or solvent on the instrument or probe.

(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 probes and the instrument.

When cleaning the LCD screen, please pay attention and protect the LCD screen.

Please disconnect the power supply, then with a damp but not dripping soft cloth, wipe the instrument.

Do not use any chemical abrasive cleaning agent on the instrument or probes.

Warning: Please confirm that the instrument is completely dry before use, to avoid damage caused by electrical short circuit caused by moisture.

Appendix C – Warranty Overview

Uni-T (Uni-Trend Technology (China) 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 for indirect, special, or consequential loss does not bear any responsibility.

Appendix D – Contact Us

If the use of this product has caused any inconvenience, you can contact Uni-Trend Technology (China) Limited directly in mainland China:

Between 8:30am to 5:30pm Beijing time, Friday to Monday or by email at: infosh@uni-trend.com.cn

Products from regions outside of China, please contact your local UNI-T dealer or sales center.

Many of the products that support UNI-T have an extended the warranty period plan and a calibration period, please contact your local UNI-T dealer or sales center.

To obtain the address list of our service centers, please visit our website at URL: <http://www.uni-trend.com>

This user manual may be revised without prior notice

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