



MSO Series

Portable Mixed Signal Digital Storage Oscilloscope

User Manual

■ **MSO7062TD**

■ **MSO7102TD**

■ **MSO8102T**

■ **MSO8202T**

www.owon.com.cn



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1. General Safety Requirements

Before any operations, please read the following safety precautions to avoid any possible bodily injury and prevent this product or any other products connected from damage. In order to avoid any contingent danger, this product is only used within the range specified.

Only the qualified technicians can implement the maintenance.

To avoid Fire or Personal Injury:

- **Connect the probe correctly. The grounding end of the probe corresponds to the grounding phase. Please don't connect the grounding end to the positive phase.**
- **Use Proper Power Cord.** Use only the power cord supplied with the product and certified to use in your country.
- **Connect or Disconnect Correctly.** When the probe or test lead is connected to a voltage source, please do not connect and disconnect the probe or test lead at random.
- **Product Grounded.** This instrument is grounded through the power cord grounding conductor. To avoid electric shock, the grounding conductor must be grounded. The product must be grounded properly before any connection with its input or output terminal.

When powered by AC power, it is not allowed to measure AC power source directly, because the testing ground and power cord ground conductor are connected together, otherwise, it will cause short circuit.

When powered by battery, the product must ground connection. To avoid electric shock, there must be a ground wire connect between ground and the ground port (on the back of product panel).

- **Check all Terminal Ratings.** To avoid fire or shock hazard, check all ratings and markers of this product. Refer to the user's manual for more information about ratings before connecting to the instrument.
- **Do not operate without covers.** Do not operate the instrument with covers or panels removed.
- **Use Proper Fuse.** Use only the specified type and rating fuse for this instrument.
- **Avoid exposed circuit.** Do not touch exposed junctions and components when the instrument is powered.
- **Do not operate if in any doubt.** If you suspect damage occurs to the instrument, have it inspected by qualified service personnel before further operations.
- **Use your Oscilloscope in a well-ventilated area.** Make sure the instrument installed with proper ventilation, refer to the user manual for more details.
- **Do not operate in wet conditions.**
- **Do not operate in an explosive atmosphere.**
- **Keep product surfaces clean and dry.**

2. Safety Terms and Symbols

Safety Terms

Terms in this manual. The following terms may appear in this manual:



Warning: Warning indicates the conditions or practices that could result in injury or loss of life.



Caution: Caution indicates the conditions or practices that could result in damage to this product or other property.

Terms on the product. The following terms may appear on this product:

Danger: It indicates an injury or hazard may immediately happen.

Warning: It indicates an injury or hazard may be accessible potentially.

Caution: It indicates a potential damage to the instrument or other property might occur.

Safety Symbols

Symbols on the product. The following symbol may appear on the product:



Hazardous Voltage



Refer to Manual



Protective Earth Terminal



Chassis Ground



Test Ground

To avoid body damage and prevent product and connected equipment damage, carefully read the following safety information before using the test tool. This product can only be used in the specified applications.



Warning:

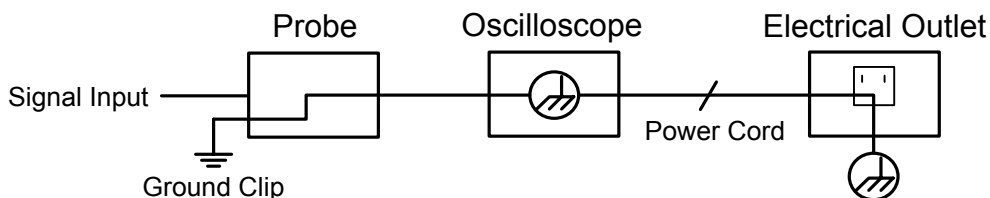
The two channels of the oscilloscope are non-isolated electrically. The channels should adopt common basis during measuring. To prevent short circuits, the 2 probe ground must not be connected to 2 different non-isolated DC level.



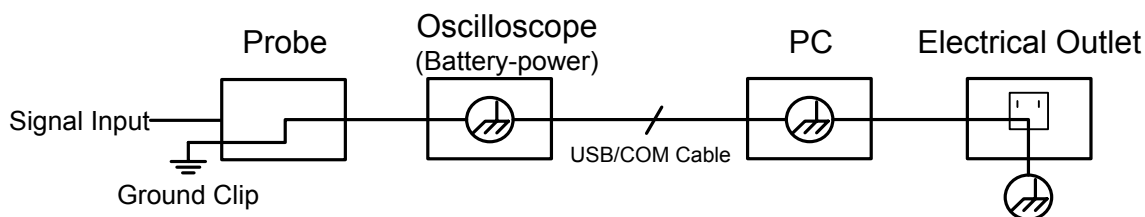
Warning:

The channels should adopt common basis during measuring. To prevent short circuits, the 2 probe ground must not be connected to 2 different non-isolated DC level.

The diagram of the oscilloscope ground wire connection:



The diagram of the ground wire connection when the battery-powered oscilloscope is connected to the AC-powered PC through the ports:



It is not allowed to measure AC power when the oscilloscope is AC powered, or when the battery-powered oscilloscope is connected to the AC-powered PC through the ports.



Warning:

To avoid fire or electrical shock, when the oscilloscope input signal connected is more than 42V peak (30Vrms) or on circuits of more than 4800VA, please take note of below items:

- Only use accessory insulated voltage probes and test lead.
- Check the accessories such as probe before use and replace it if there are any damages.
- Remove probes, test leads and other accessories immediately after use.
- Remove USB cable which connects oscilloscope and computer.
- Do not apply input voltages above the rating of the instrument because the probe tip voltage will directly transmit to the oscilloscope. Use with caution when the probe is set as 1:1.
- Do not use exposed metal BNC or banana plug connectors.
- Do not insert metal objects into connectors.

3. General Characteristics

Digital Storage Oscilloscope

- | Model | Bandwidth | Sample Rate |
|-----------|-----------|---|
| MSO7062TD | 60MHz | 1GS/s half channel*, 500MS/s each channel |
| MSO7102TD | 100MHz | 1GS/s half channel*, 500MS/s each channel |
| MSO8102T | 100MHz | 2GS/s half channel*, 1G S/s each channel |
| MSO8202T | 200MHz | 2GS/s half channel*, 1G S/s each channel |
- Dual channel, 2M points on each channel for the Record length;
 - Reading-out with the cursor;
 - Twenty automatic measurement functions;
 - Autoscale function;
 - Color liquid crystal display of high resolution and high contrast with adjustable back light;
 - Storage and call-out of waveforms;
 - Automatic setting function provided capable of fast setting;
 - Multiple-waveform calculation function;
 - Built-in FFT function;
 - Implementation of detecting the average and peak values of the waveform;
 - Digital real-time oscilloscope;
 - Edge, video, alternate, pulse and slope triggering function;
 - RS232 or USB communication ports;
 - Different continuous displaying time;
 - Multiple Language User Interface.

***Half channel is when only one channel is turned on.**

Logic Analyzer

- 16 input channel;
- 4M max Storage for each channel;
- Plenty of trigger Mode;
- Convenient data measurement & data search;
- Freely setting of all kinds of threshold level.

4. Junior User Guidebook

This chapter deals with the following topics mainly:

Digital Storage Oscilloscope

- Introduction to the front panel and the user's interface of the MSO series oscilloscope
- How to implement the general inspection
- How to implement the function inspection
- How to make a probe compensation
- How to set the probe attenuation coefficient
- How to use the probe safely
- How to implement an auto-calibration
- Introduction to the vertical system
- Introduction to the horizontal system
- Introduction to the trigger system

Logic Analyzer

- User interface introduction
- How to acquire data
- How to observe and analyze the data
- Display system
- Trigger system
- Threshold voltage system
- Sampling system

4.1 Introduction to the Front Panel and the User's Interface

When you get a new-type oscilloscope, you should get acquainted with its front panel at first and the MSO series mixed digital storage oscilloscope is no exception. This chapter makes a simple description of the operation and function of the front panel of the MSO series mixed oscilloscope, enabling you to be familiar with the use of the MSO series mixed oscilloscope in the shortest time. The MSO series mixed oscilloscope offers a simple front panel with distinct functions to users for their completing some basic operations, in which the knobs and function pushbuttons are included. The knobs have the functions similar to other oscilloscopes. The 5 buttons in the column on the right side of the display screen are menu selection buttons (defined as F1 to F5 from top to bottom respectively), through which, you can set the different options for the current menu. The other pushbuttons are function buttons, through which, you can enter different function menus or obtain a specific function application directly.

Front panel

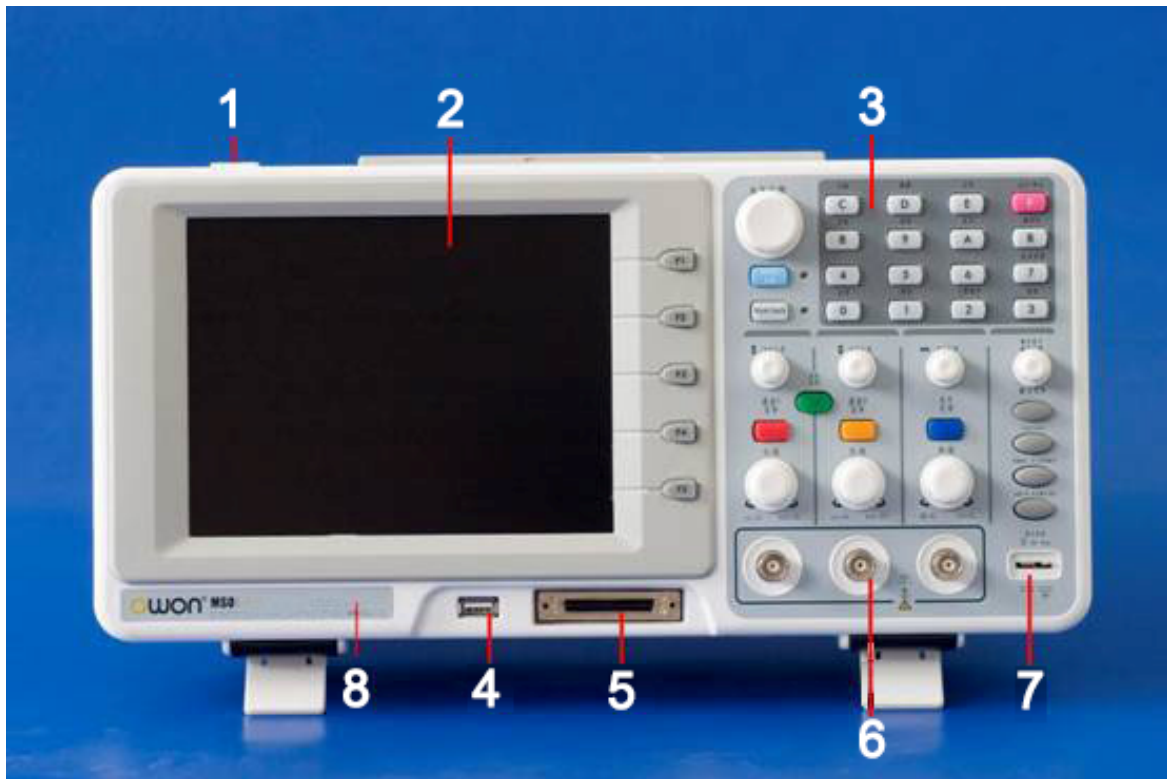


Fig. 4-1 Front panel overview

- 1、 Power on/off
- 2、 Display area
- 3、 Control (key and knob) area
- 4、 U slot
- 5、 LA signal input
- 6、 DSO signal input
- 7、 Measurement signal output
- 8、 Power and charging indication: Green light indicates AC supply and battery

full charged; yellow light indicate under charging.

Control(key and knob) area



Fig. 4-2 Keys Overview

1、 Menu option setting: F1~F5

2、 Switch

Switch includes two keys and one knob. Press "OSC/LA" to switch between DSO and LA.

For DSO "cursor" knob and "info" key are idle. But the "cursor" knob takes effect in magnifying or minifying the waveform after FFT operation when the mode is FFT.

For LA, "cursor" knob to adjust current cursor position and "info" key to loading setting info for acquired waveform and current waveform.

3、 Function key area

For DSO 0~5 keys are idle and 6~F refer to different DSO function menu.

For LA, 3.4.5.6.7 refers to figure and other keys refer to digit or function menu.

4、 Vertical control area

It's including 3 keys and 4 knobs.

For DSO: "CH1 menu" and "CH2 menu" correspond to setting menu in CH1 and CH2, "Wave Math" key refer to math menu, the math menu consists of six kinds of operations, including CH1-CH2、 CH2-CH1、 CH1+CH2 、 CH1*CH2、 CH1/CH2 and FFT .Two "Vertical position" knobs control the vertical position of CH1. CH2, and two "Volts/Div" knob control voltage scale of CH1, CH2.

4. Junior User Guidebook

For LA, "CH1 menu", "CH2 menu", "Wave math" keys and "CH2 Volts/Div" knob are idle. "CH1 Vertical", "CH2 Vertical" to adjust the M1, M2 position in Cursor menu when cursor display is on "CH1 Volts/Div".

5、 Horizontal control area with 2 knob and 1 key.

For DSO, "Horizontal position" knob control trigger position, "Volts/Div" control time base, "Horizontal menu" key refer to horizontal system setting menu.

For LA, "Horizontal menu" key is idle. "Horizontal position" knob to adjust the position of value displayed currently quickly. "Sec/Div" knob to adjust value resolution displayed currently.

6、 Trigger control area with 4 keys and 1 knob.

For DSO, "Trig adjust" knob is to adjust trigger voltage. Other four keys refer to trigger system setting.

For LA, "Force trig" key is idle. "Trig menu" refer to trigger menu control. "Trig adjust" knob to adjust trigger position in memory, "SET 50%" is to set trigger position as 50% and "SET Zero" set trigger position as 0.

4.2 Digital Storage Oscilloscope

User interface introduction

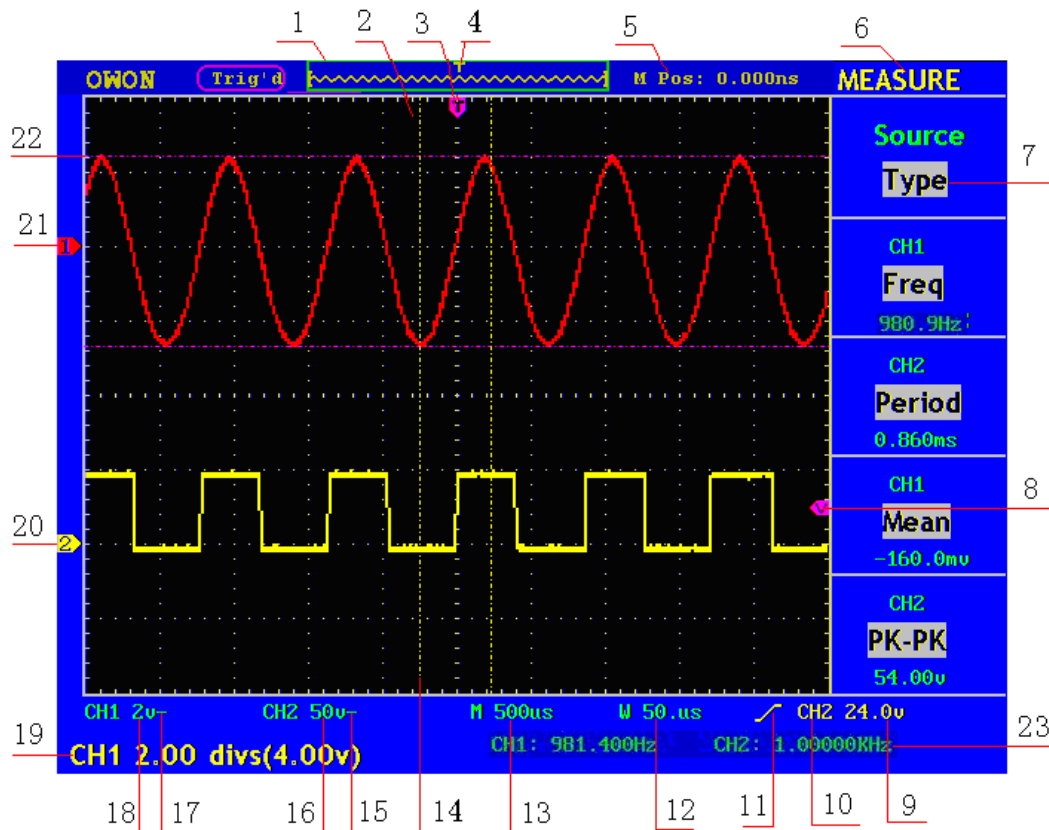


Fig. 4-3 Illustrative Drawing of Display Interfaces

1. The Trigger State indicates the following information:
 - Auto: The oscilloscope is under the Automatic mode and is collecting the waveform under the non-trigger state.
 - Trig' d: The oscilloscope has already detected a trigger signal and is collecting the after-triggering information.
 - Ready: All pre-triggered data have been captured and the oscilloscope has been already ready for accepting a trigger.
 - Scan: The oscilloscope captures and displays the waveform data continuously in the scan mode.
 - Stop: The oscilloscope has already stopped the waveform data acquisition.
2. Waveform Viewing Area.
3. The purple pointer indicates the horizontal trigger position, which can be adjusted by the horizontal position control knob.
4. The pointer indicates the trigger position in the internal memory.

5. This reading shows the time deviation between the horizontal trigger position and the window center line, which is regarded as 0 in the window center.
6. It indicates the current function menu.
7. It indicates the operation options for the current function menu, which changes with the function menus.
8. The purple pointer shows the trigger level position.
9. The reading shows the trigger level value.
10. The reading shows the trigger source.
11. It shows the selected trigger type:



Rising edge triggering



Falling edge triggering



Video line synchronous triggering



Video field synchronous triggering

12. The reading shows the window time base set value.
13. The reading shows the main time base set value.
14. The two yellow dotted lines indicate the size of the viewing expanded window.
15. The icon shows the coupling mode of the CH2 channel.

"—" indicates the direct current coupling

" ~" indicates the AC coupling

" \perp " indicates GND coupling.

16. The reading shows the vertical scale factor (the Voltage Division) of the CH2 channel.

17. The icon indicates the coupling mode of the CH1 channel:

The icon "—" indicates the direct current coupling

The icon " ~" indicates the AC coupling

The icon " \perp " indicates GND coupling.

18. The reading indicates the vertical scale factor (the Voltage Division) of the CH1 channel.

19. The information shows the zero point positions of CH1 or CH2 channel.

20. The yellow pointer shows the grounding datum point (zero point position) of the waveform of the CH2 channel. If the pointer is not displayed, it shows that this channel is not opened.

21. The red pointer indicates the grounding datum point (zero point position) of the

- waveform of the CH1 channel. If the pointer is not displayed, it shows that the channel is not opened.
22. The positions of two purple dotted line cursors measurements.
 23. The reading shows the frequency of the two channels. It is a 6 digits cymometer. Its measurement range of frequency is 2Hz to full bandwidth. When the triggering mode is edge triggering, it is a one channel cymometer and it can only measure the frequency of the triggering channel. When the triggering mode is alternating triggering, it is a two channel cymometer and it can measure the frequency of two channels.

How to implement the General Inspection

After you get a new MSO series oscilloscope, it is recommended that you should make a check on the instrument according to the following steps:

- 1. Check whether there is any damage caused by transportation.**

If it is found that the packaging carton or the foamed plastic protection cushion has suffered serious damage, do not throw it away first till the complete device and its accessories succeed in the electrical and mechanical property tests.

- 2. Check the Accessories**

The supplied accessories have been already described in the "Appendix A: Enclosure" of this Manual. You can check whether there is any loss of accessories with reference to this description. If it is found that there is any accessory lost or damaged, please get in touch with the distributor of OWON responsible for this service or the OWON's local offices.

- 3. Check the Complete Instrument**

If it is found that there is damage to the appearance of the instrument, or the instrument can not work normally, or fails in the performance test, please get in touch with the OWON's distributor responsible for this business or the OWON's local offices. If there is damage to the instrument caused by the transportation, please keep the package. With the transportation department or the OWON's distributor responsible for this business informed about it, a repairing or replacement of the instrument will be arranged by the OWON.

How to implement the Function Inspection

Make a fast function check to verify the normal operation of the instrument, according to the following steps:

- 1. Connect the Instrument to the Power and Push down the Power Switch Button.**

The instrument carries out all self-check items and shows the prompt "**Press any Key Enter system**". Press the "**8 (UTILITY)**" button to get access to the "FUNCTION" menu and push down F2 the menu selection button to call out the function "Recall Factory". The default attenuation coefficient set value of the probe in the menu is

10X.

2. Set the Switch in the Oscilloscope Probe as 10X and Connect the Oscilloscope with CH1 Channel.

Align the slot in the probe with the plug in the CH1 connector BNC, and then tighten the probe with rotating it to the right side.

Connect the probe tip and the ground clamp to the connector of the probe compensator.

3. Press the "7(AUTOSET)" Button.

The square wave of 1 KHz frequency and 5V peak-peak value will be displayed in several seconds (see Fig. 4-4).

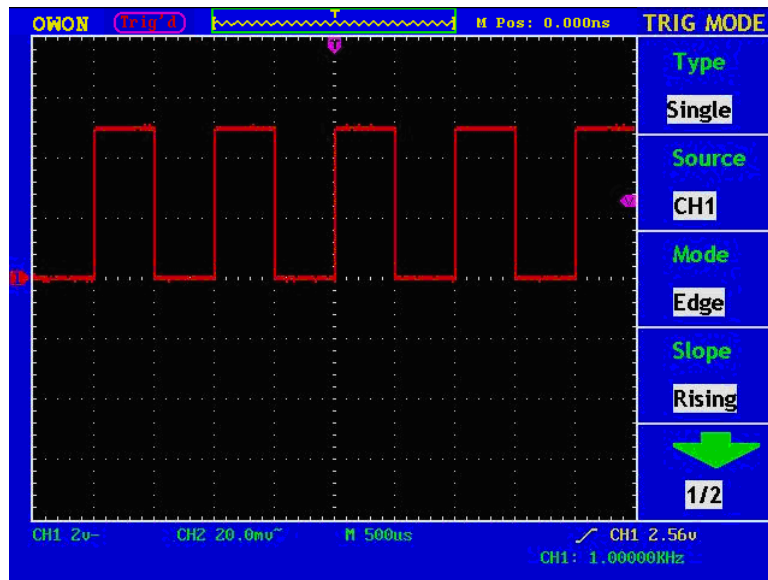


Fig.4-4 Auto set

Check CH2 by repeating Step 2 and Step 3.

How to Implement the Probe Compensation

When connect the probe with any input channel for the first time, make this adjustment to match the probe with the input channel. The probe which is not compensated or presents a compensation deviation will result in the measuring error or mistake. For adjusting the probe compensation, please carry out the following steps:

1. Set the attenuation coefficient of the probe in the menu as 10X and that of the switch in the probe as 10X, and connect the oscilloscope probe with the CH1 channel. If a probe hook tip is used, ensure that it keeps in close touch with the probe. Connect the probe tip with the signal connector of the probe compensator and connect the reference wire clamp with the ground wire connector of the probe connector, and then press the button "7(AUTOSET)".
2. Check the displayed wave forms and regulate the probe till a correct compensation is achieved (see Fig.4-5 and Fig.4-6).

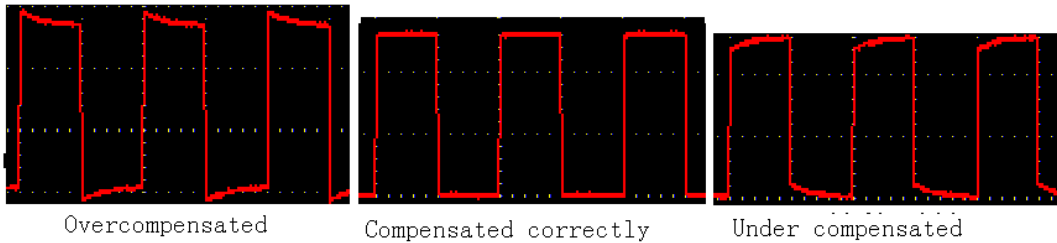


Fig. 4-5 Displayed Wave Forms of the Probe Compensation

3. Repeat the steps mentioned if necessary.

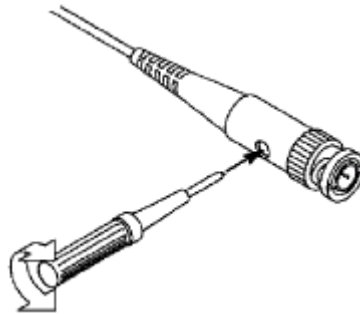


Fig. 4-6 Adjust Probe

How to Set the Probe Attenuation Coefficient

The probe has several attenuation coefficients, which will influence the vertical scale factor of the oscilloscope.

If it is required to change (check) the set value of the probe attenuation coefficient, press the function menu button of the channels used, then push down the selection button corresponding to the probe till the correct set value is shown.

This setting will be valid all the time before it is changed again.



Note: The attenuation coefficient of the probe in the menu is preset to 10X when the oscilloscope is delivered from the factory.

Make sure that the set value of the attenuation switch in the probe is the same as the menu selection of the probe in the oscilloscope.

The set values of the probe switch are 1X and 10X (see Fig. 4-7).

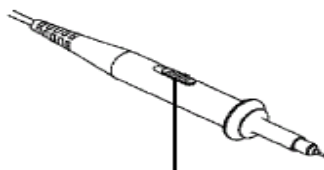


Fig.4-7 Attenuation Switch



Note: When the attenuation switch is set to 1X, the probe will limit the bandwidth of the oscilloscope in 5MHz. If it is needed to use the whole bandwidth of the oscilloscope, the switch must be set to 10X.

How to Use the Probe Safely

The safety guard ring around the probe body protects your finger against the electric shock, shown as Fig. 4-8.

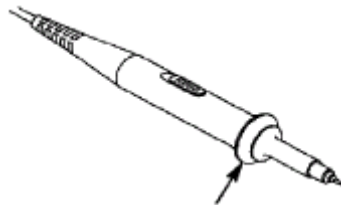


Fig. 4-8 Finger Guard



Warning: In order to avoid suffering from the electric shock, please keep your finger behind the safety guard ring of the probe body during the operation.

In order to protect you from suffering from the electric shock during your using the probe, do not touch the metal part of the probe tip when the probe is connected to the power supply.

Before making any measurements, please connect the probe to the instrument and connect the ground terminal to the earth.

How to Implement Auto-calibration

The auto-calibration application can make the oscilloscope reach the optimum condition rapidly to obtain the most accurate measurement value. You can carry out this application program at any time, but when the range of variation of the ambient temperature is up to or over 5°C, this program must be executed.

For the performing of the self-calibration, all probes or wires should be disconnected with the input connector first. Then, press the "8(UTILITY)" button to call out the **FUNCTION** menu; push down the F3 menu selection button to choose the option "Do Self Cal"; finally, run the program after confirming that everything is ready now.

Introduction to the Vertical System

Shown as Fig.4-9, there are a series of buttons and knobs in **VERTICAL CONTROLS**. The following practices will gradually direct you to be familiar with the using of the vertical setting.



Fig. 4-9 Vertical Control Zone

1. Use the button "**VERTICAL POSITION**" knob to show the signal in the center of the waveform window. The "**VERTICAL POSITION**" knob functions the regulating of the vertical display position of the signal. Thus, when the "**VERTICAL POSITION**" knob is rotated, the pointer of the earth datum point of the channel is directed to move up and down following the wave form.

Measuring Skill

If the channel is under the DC coupling mode, you can rapidly measure the DC component of the signal through the observation of the difference between the wave form and the signal ground.

If the channel is under the AC mode, the DC component will be removed by filtration. This mode helps you display the AC component of the signal with a higher sensitivity.

2. Change the Vertical Setting and Observe the Consequent State Information Change.

With the information displayed in the status bar at the bottom of the waveform window, you can determine any changes in the channel vertical scale factor.

- Rotate the vertical "**VOLTS/DIV**" knob and change the "**Vertical Scale Factor (Voltage Division)**", it can be found that the scale factor of the channel corresponding to the status bar has been changed accordingly.
- Press buttons of "**CH1 MENU**", "**CH2 MENU**" and "**MATH MENU**", the operation menu, symbols, wave forms and scale factor status information of the corresponding channel will be displayed in the screen.

Introduction to the Horizontal System

Shown as Fig.4-10, there are a button and two knobs in the "**HORIZONTAL CONTROLS**". The following practices will gradually direct you to be familiar with the setting of horizontal time base.



Fig. 4-10 Horizontal Control Zone

1. Use the horizontal "**SEC/DIV**" knob to change the horizontal time base setting and observe the consequent status information change. Rotate the horizontal "**SEC/DIV**" knob to change the horizontal time base, and it can be found that the "**Horizontal Time Base**" display in the status bar changes accordingly. The horizontal scanning speed steps from
 2 ns up to 100s in the sequence of 1-2-5 ----- MSO7062TD,7102TD,8102T;
 1 ns up to 100s in the sequence of 1-2-5 ----- MSO8202T.
2. Use the "**HORIZONTAL POSITION**" knob to adjust the horizontal position of the signal in the waveform window. The "**HORIZONTAL POSITION**" knob is used to control the triggering displacement of the signal or for other special applications. If it is applied to triggering the displacement, it can be observed that the wave form moves horizontally with the knob when you rotate the "**Horizontal Position**" knob.
3. With the "**HORIZONTAL MENU**" button pushed down, you can set and initiate the Window Expansion.

Introduction to the Trigger System

Shown as Fig.4-11, there are a knob and four buttons in the "**TRIGGER CONTROLS**". The following practices will direct you to be familiar with the setting of the trigger system gradually.

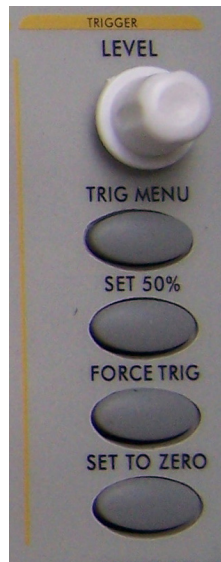


Fig.4-11 Trigger Control Zone

1. Press the "**TRIG MENU**" button and call out the trigger menu. With the operations of the 5 menu selection buttons, the trigger setting can be changed.
2. Use the "**LEVEL**" knob to change the trigger level setting.
With the rotation of the "**LEVEL**" knob, it can be found that the trigger indicator in the screen will move up and down with the rotation of the knob. With the movement of the trigger indicator, it can be observed that the trigger level value displayed in the screen changes.
3. Press the button "**SET TO 50%**" to set the trigger level as the vertical midpoint values of the amplitude of the trigger signal.
4. Press the "**FORCE TRIG**" button to force a trigger signal, which is mainly applied to the "Normal" and "Single" trigger modes.
5. The "**SET TO ZERO**" button is used to reset the trigger horizontal position.

4.3 Logic Analyzer

LA input connection

Insert the plug of OL-16 LA module 50P into the LA signal input on front panel and fix two screw. Then 16 channel clamp of OL-16 LA connect to target signal and ready for measurement

User interface introduction

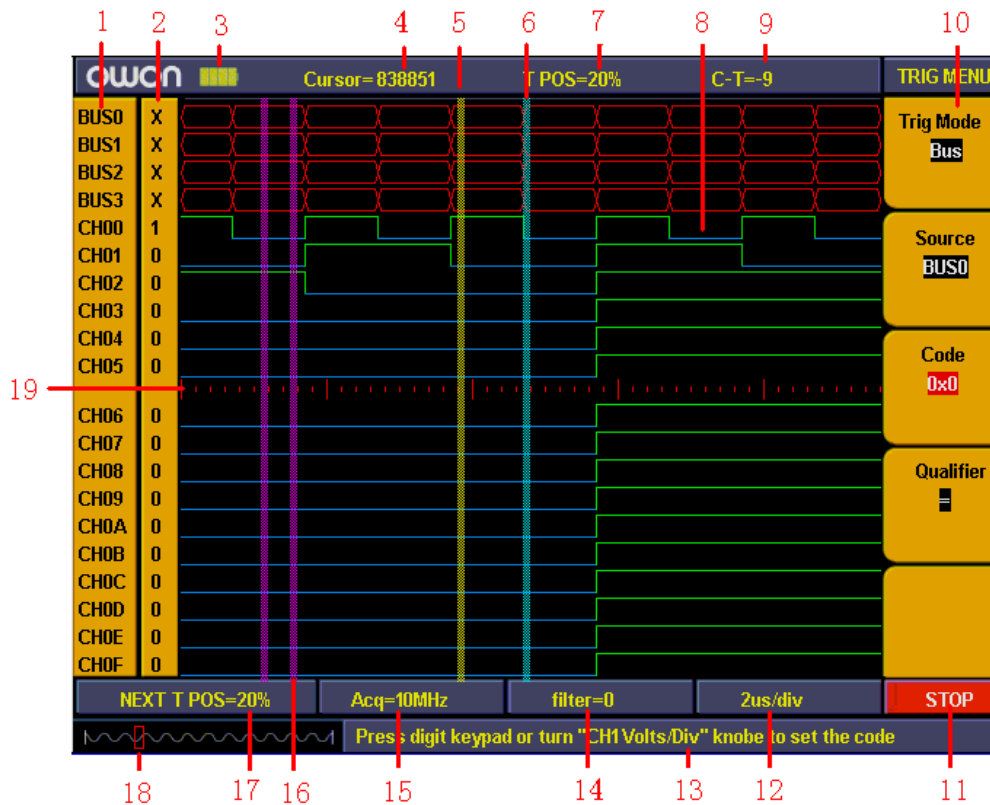


Fig.4-12: User interface of logic analyzer

- 1、 Channel and Bus indicate: display current working channel and bus .
- 2、 Channel binary value display: display binary system value for the channel position in current cursor .
- 3、 Battery powers indicate: indicate battery power when battery inside.
- 4、 Decimal system value indicate the position of current cursor in storage area.
- 5、 Yellow line indicates current cursor.
- 6、 Blue line indicates current trigger position.
- 7、 Percentage value indicate current trigger position in storage area.
- 8、 Sample data area indication: red for bus, blue and green for "0", "1" in each channel data.
- 9、 Decimal system value indicate the position of current cursor relate to current trigger.
- 10、 Operation options indicate current function menu and different function menu have different display.
- 11、 Sample status indicate: "RUN" for sampling and wait for trigger, "TRIG" for trigger

- detected and wait for sample finished. "STOP" for sampling finished.
- 12、 Value indicate current time base.
 - 13、 Info windows: different operation display different info.
 - 14、 Value display current filter modulus setting.
 - 15、 Value display current sample rate setting.
 - 16、 Two purple lines for cursor 1 and cursor 2 in cursor measurement.
 - 17、 Percentage value indicate trigger position for next sampling in storage area.
 - 18、 Red square indicate the current sampling data position in storage area.
 - 19、 Red scale line indicates the time base width in sampling data display area and totally 4.8 divisions. The width between two long scale lines is 1 division and between short scale lines are 0.1 divisions.

How to acquire data

When you start to acquire LA begins sampling data from the probes. Then each time clock occurs the data will be sampled.

Then sampled data is sent to trigger function block and store in main memory. The trigger program checks specific events with the sampled data and take specific action. The trigger program can check events as rising edge, data values, and data ranges etc. LA module enables a post trigger delay counter when trigger reach specified value and to allow post trigger portion of the acquisition memory to fill before data acquisition stops.

Press "F" to get into data acquisition mode after finish setting for trigger and sampling. Then running status display as "RUN" and running status display "TRIG" when detected trigger signal and display "STOP" when data acquisition finished. Then you can start to analyze data. Data acquisition can be stopped by press "F" again during the process.



Note:

When running status display as "RUN"、"TRIG" during data acquiring process ,only "F" key for operate and other keys or knobs are idle. Only till status display as "STOP" then others operations are working.

How to observe and analyze the data

Follow up below steps to observe and analyze the current data acquired:

1. Turn "**Sec/Div**" knob to adjust the time length for data display in each division (to adjust the data resolution displayed).
2. Turn "**Cursor**" knob to observe more details for the data of current cursor position. The data of binary value for current cursor position display in binary system area and power on measure menu then bus value for current cursor position will display in measurement window.
3. Turn "**horizontal position**" knob can move the current displayed data to left/right position in storage area quickly.

We will use a simple measurement example to explain the primary setting for LA measurement.

We need to measure a three lines SPI signal, three signals are enable, clock and data. Clock is in effect when enable is low clock data, and clock frequency is 1M, data width is 32 digits, every clock corresponds to one data. Signal voltage is 3.3V.

Display systems

We need only three channels as what we measure is 3 signals. And other channel and bus can be off. In this way the display resolution in using channel will be increased.

Display system mainly to set on/off for measure channel. We use CH00、CH01、CH02 as measure channel correspond to signal enable, clock, data accordingly. Other channel and bus is off.

- 1、 Press "A (DISPLAY) " and display menu appears.
- 2、 Press "F1" till signal sources display as "Channel".
- 3、 Press "F2" or turn "CH1 Volts/Div" knob till channel No. display as "CH00".
- 4、 Press "F3" and set the signal sources as "ON". Repeat operation of steps 3.4 and set CH01, CH02 as "ON" and CH03-CH0F as "OFF". Refer to Fig.4-13.
- 5、 Press "F1" till sources display as" BUS".
- 6、 Press "F2" till Bus No. display as"BUS0".
- 7、 Press "F3" and set signal sources as "OFF". Repeat operation of steps 6.7 and set BUS1、BUS2、BUS3 all as "OFF". Ref to Fig.4-14.

Now the screen only show CH00、CH01、CH02 and others channel and bus are all off. Ref to Fig.4-15

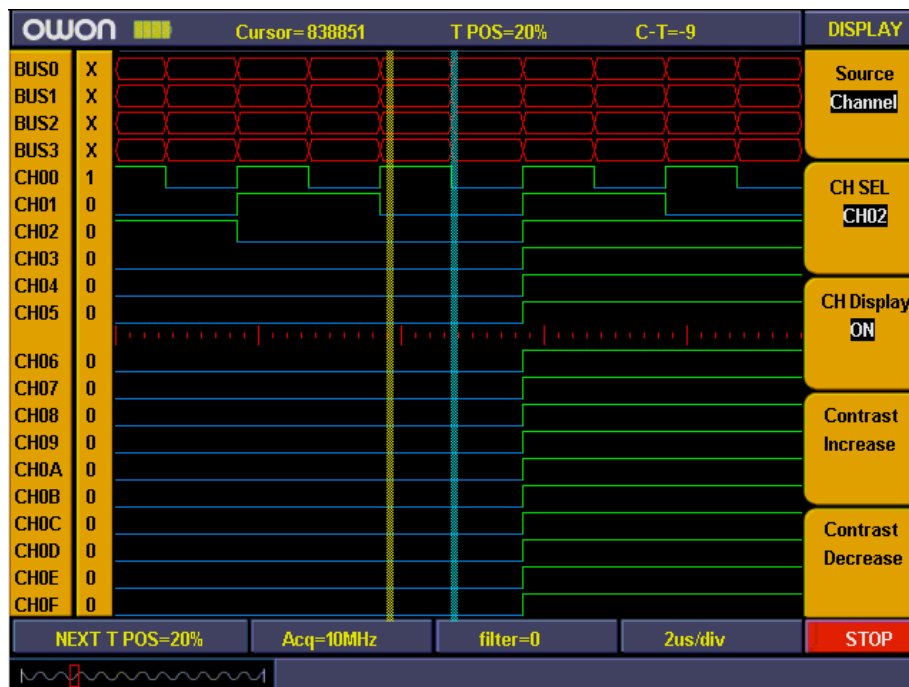


Fig.4-13

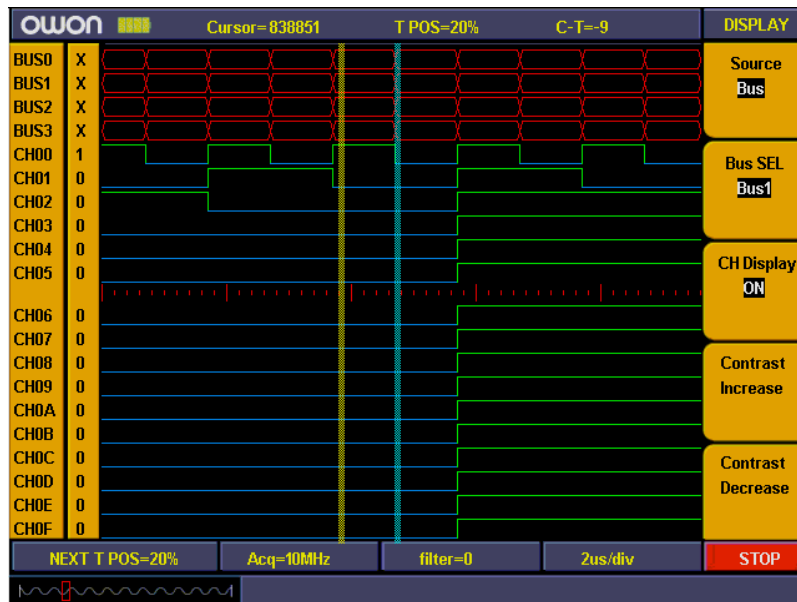


Fig.4-14

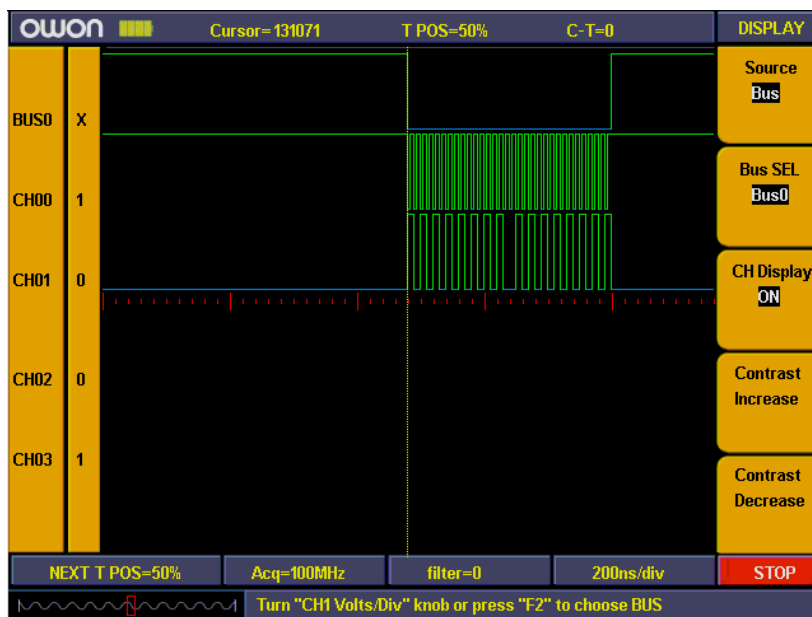


Fig. 4-15

Trigger system

LA is same as DSO and need to make trigger to synchronize data. The trigger system mainly to set trigger sources, trigger mode and trigger position.

We make CH00 as trigger source and trigger mode as falling edge, trigger position in 50%. Trigger system setting steps as below:

1. Press "**Trig menu**" and menu appears.
2. Press "**F1**" till trigger mode display as "**Edge**".
3. Press "**F2**" or turn "**CH1 Volts/Div**" till trigger sources display as "**CH00**".
4. Press "**F3**" till trigger type display as "**Falling**".
5. Turn "**Trigger adjust**" knob or press "**SET 50%**" till "**NEXT T POS**" window display as "**50%**"

Then trigger system setting finished (ref to Fig.4-16).

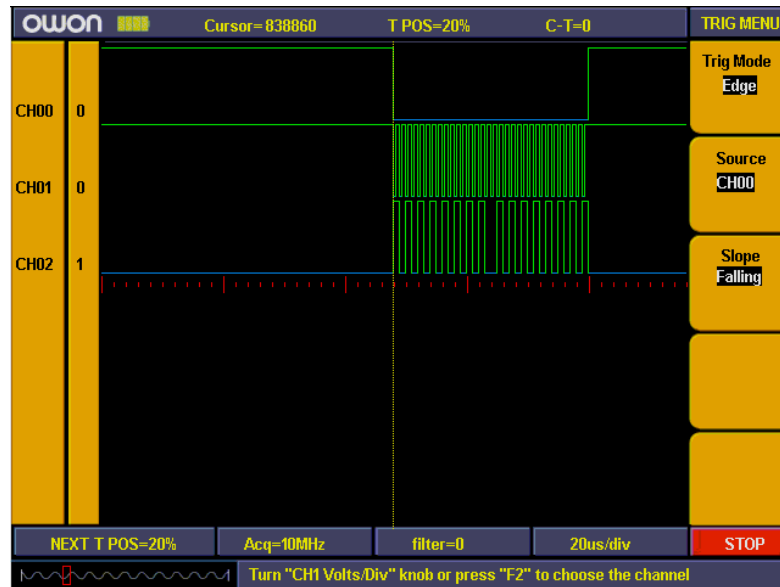


Fig. 4-16

Threshold voltage system

Threshold voltage system is to set high/low of the trigger voltage. The system already fixed the setting for normal logic voltage as CMOS, LVCMOS etc. And you can set any trigger voltage using custom setting.

The signal voltage is 3.3V and we set threshold voltage as "LVCMOS 3.3/1.7V" as below steps:

1. Press "1 (Threshold)" key and the menu appears.
2. Press "F1" key till Channel display as "CH00~CH03"
3. Press "F2" key till threshold display as "LVCMOS 3.3/1.7V".

Then the threshold setting is finished (ref to Fig.4-17).

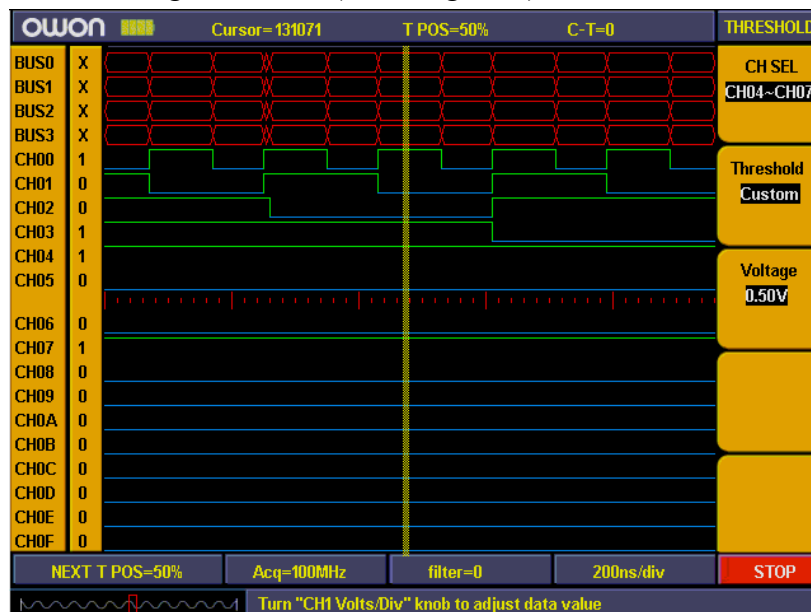


Fig. 4-17

Sampling system

The waveform accuracy reverts from sample data depend on sample rate for measured signals. The waveform reverted in LA is referring to the sample signals storage in the memory. The recorded data will display in error if the sample rate is too lower. Below figures explains how sample rate influence the waveform recorded in LA.

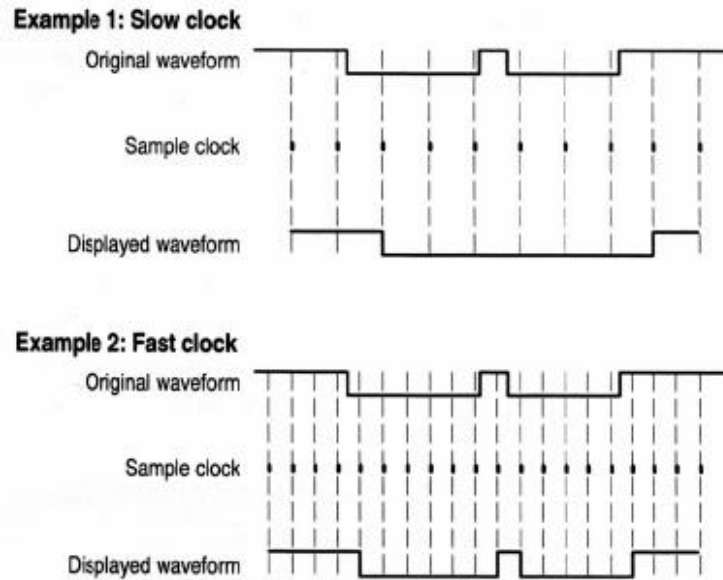


Fig.4-18

There is an importance compromise between recorded signal resolution and its continuance (relate to time). The sample memory depth of LA is fixed and once adding sample rate then resolution will get better accordingly. But it will decrease the continuance for acquire signal. In a word, if the sample rate is quicker, the continuance for recorded signal will get smaller but with better resolution.

Sampling system can set difference sample rate and storage depth.

We use 10 times sampling rate to measure the signal clock frequency of 1M, and storage depth set as "Normal". Sampling system setting steps as below:

1. Press "E(ACQUIRE)" and menu appears.
2. Press "F1" or turn "CH1 Volts/div" knob till sample rate setting display as "10M".
3. Press "F2" till storage depth display as "General".

Sampling system setting finished (ref to the fig.)

Then press "F" and start to sampling data. Display show as fig. 4-19 when sampling finished.

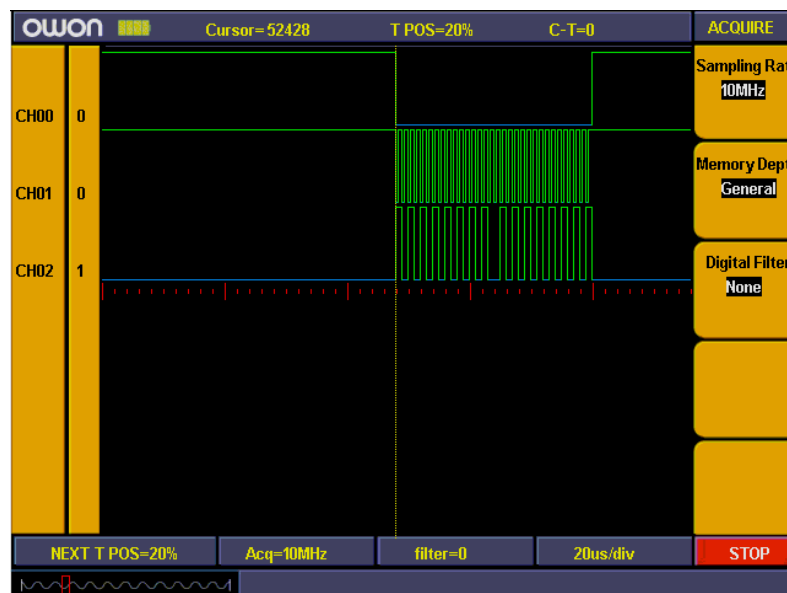


Fig. 4-19

5. Advanced User Guidebook

Up till now, you have already been familiar with the initial operations of the functions of the function areas, buttons and knobs in the front panel of the MSO series oscilloscope. Based the introduction of the previous Chapter, the user should have an intimate knowledge of the determination of the change of the oscilloscope setting through observing the status bar. If you have not been familiar with the above-mentioned operations and methods yet, we advise you to read the section of "Chapter One Junior Users' Guidebook".

This chapter will deal with the following topics mainly:

Digital Storage Oscilloscope

- **How to Set the Vertical System**
- **How to Set the Horizontal System**
- **How to Set the Trigger System**
- **How to Implement the Sampling Setup**
- **How to Set the Display System**
- **How to Save and Recall Wave Form**
- **How to Implement the Auxiliary System Function Setting**
- **How to Implement the Automatic Measurement**
- **How to Implement the Cursor Measurement**
- **How to Use Autoscale function**
- **How to Use Executive Buttons**

Logic analyzer

- **How to set sampling system**
- **How to set trigger system**
- **How to set threshold**
- **How to set display system**
- **How to set BUS**
- **How to measure**
- **How to save and recall**
- **How to use USB Mass storage device to storage**
- **How to search**
- **How to review setting info**
- **How to use cursor measurement**

- **How to set Utility**

It is recommended that you read this chapter carefully to get acquainted the various measurement functions and other operation methods of the MSO series oscilloscope.

5.1 Digital Storage Oscilloscope

How to Set the Vertical System

The **VERTICAL CONTROLS** includes three menu buttons such as **CH1 MENU**, **CH2 MENU** and **MATH MENU**, and four knobs such as **VERTICAL POSITION**, **VOLTS/DIV** (one group for each of the two channels).

Setting of CH1 and CH2

Every channel has an independent vertical menu and each item is set respectively based on the channel.

With the "**CH1 MENU**" or "**CH2 MENU**" menu button pushed down, the system shows the operation menu of the corresponding channel (see Fig. 5-1). By pressing **F1**,**F2**,**F3**,**F4** etc., you can change and select the settings. The following table explains more details of these function and settings.

CH1 SETUP	Function Menu	Setting	Description
Coupling AC	Coupling	AC DC	Block the DC component from input signal. Pass both AC and DC components from input signal.
Band Limit OFF 100MHz	Band Limit	GROUND OFF 100MHz ON 20MHz	Input signal is interrupted. Get full bandwidth. Limits the channel bandwidth to 20MHz to reduce display noise.
Channel ON	Channel	OFF ON	Close the measurement channel. Open the measuring channel.
Probe 10 X	Probe	1X 10X 100X 1000X	Choose one according to the probe attenuation factor to make the vertical scale reading accurate.
Inverted OFF	Inverted	OFF ON	Display original waveform. Display inverted waveform.

Fig.5-1
Channel
Setting
Menu

1. Setting Coupling for selected Channel

A square waveform is used as an input in this example.

Press the **CH1 MENU** button to show submenu **CH1 SETUP**.

- Press **F1** next to Coupling and select "AC", now DC component is blocked

from input signal. See Fig.5-2.

- Press **F1** again to set "DC" mode, both AC and DC components get passed. See Fig.5-3.

The wave forms are shown as Fig.5-2 and Fig.5-3.

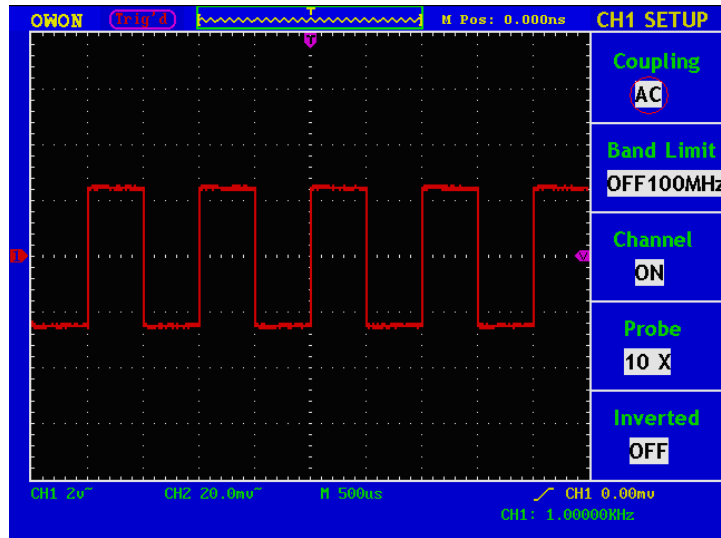


Fig. 5-2 AC Coupling Oscillogram

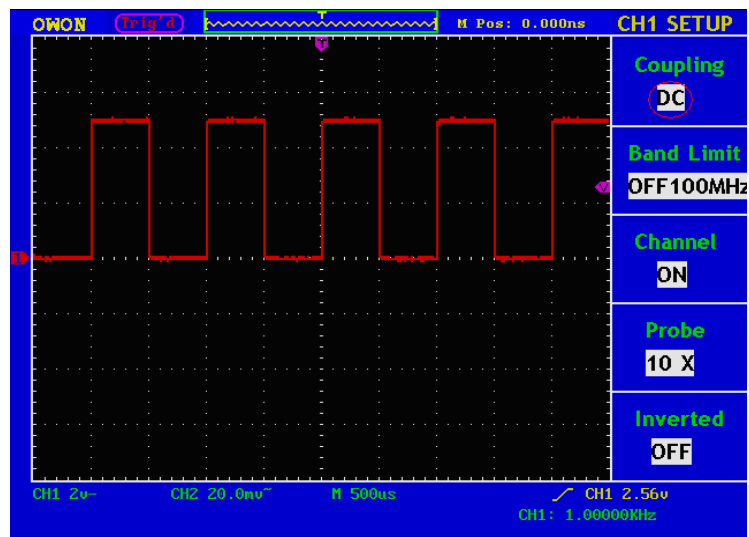


Fig. 5-3 DC Coupling Oscillogram

2. Setting the "Band Limit"

Taking the Channel 1 for example, the operation steps are shown as below:

- (1). Press the **CH1 MENU** button and call out the **CH1 SETUP** menu.
- (2). Press the **F2** menu selection button and select the Band Limit as **OFF 100MHz**, with Channel 1 Band Limit switched off.
- (3). Press **F2** menu selection button again, select the Band Limit as **ON 20MHz**, with Channel 1 Band Limit is switched on.

3. Setting the Channel "ON/OFF"

Taking the Channel 1 for example, the operation steps are shown as below:

- (1). Press the **CH1 MENU** button and call out the **CH1 SETUP** menu.
- (2). Press the **F3** menu selection button and select the Channel as **OFF**, with Channel 1 switched off.
- (3). Press **F3** menu selection button again, select the channel as **ON**, with Channel 1 is switched on.

Note: In FFT mode, both CH1 and CH2 are not allowed to be ON when F3 is pressed. See Fig.5-4.

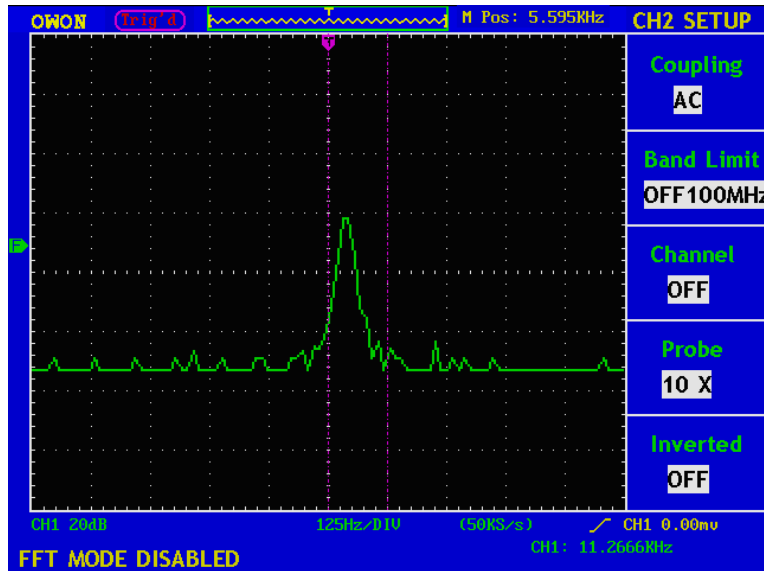


Fig. 5-4 Channel CH1 is disable under FFT mode

4.Regulate the Attenuation Ratio of the Probe

In order to match the attenuation coefficient of the probe, it is required to adjust the attenuation ration coefficient of the probe through the operating menu of the Channel accordingly. If the attenuation coefficient of the probe is 1:1, that of the oscilloscope input channel should also be set to 1X to avoid any errors presented in the displayed scale factor information and the measured data.

Take the Channel 1 as an example, the attenuation coefficient of the probe is 10:1, the operation steps is shown as follows:

- (1). Press the **CH1 MENU** button, access CH1 SETUP menu.
- (2). Press the **F4** menu selection button and select 10X for the probe.

The Fig.24 illustrates the setting and the vertical scale factor when the probe of the attenuation coefficient of 10:1.is used.

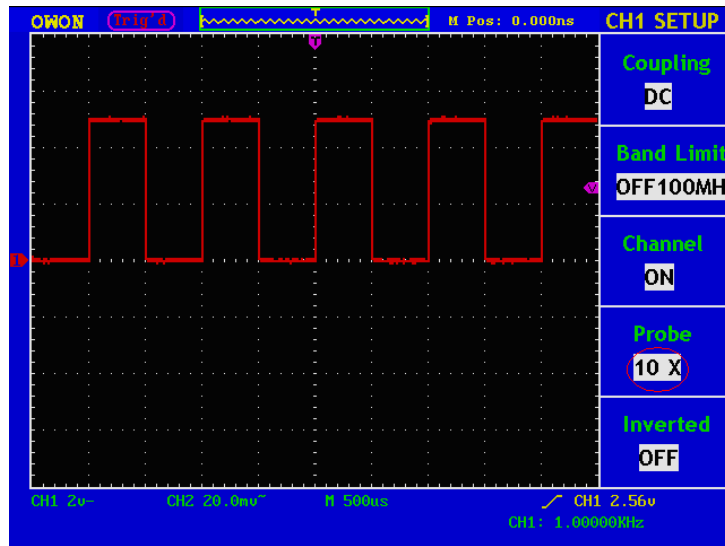


Fig. 5-5 Regulation of the Attenuation Ratio of the Probe

A List of the Attenuation Coefficient of Probes and the Corresponding Menu Settings:

Attenuation Coefficient of the Probe	Corresponding Menu Setting
1:1	1X
10:1	10X
100:1	100X
1000:1	1000X

5. Setting of Wave Form Inverted

Wave form inverted: the displayed signal is turned 180 degrees against the phase of the earth potential.

Taking the Channel 1 for example, the operation steps are shown as follows:

- (1). Press the **CH1 MENU** button and get access to the **CH1 SETUP** menu.
- (2). Press the **F5** menu selection button and select **ON** in the **Inverted**. The wave form inverted function is initiated.
- (3). Press the **F5** menu selection button again and select **OFF** for **Inverted** item. The function of wave form inverted is closed off.

For the screen display, see Fig. 5-6 and Fig. 5-7

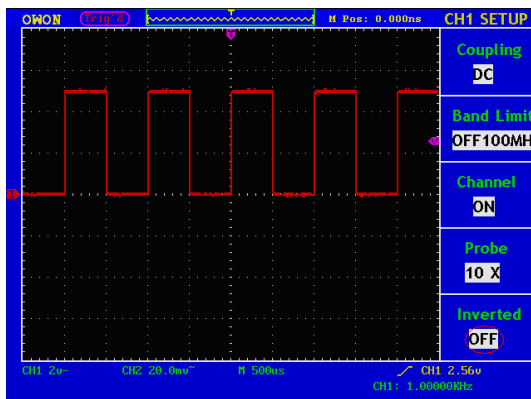


Fig. 5-6 Wave Form not inverted

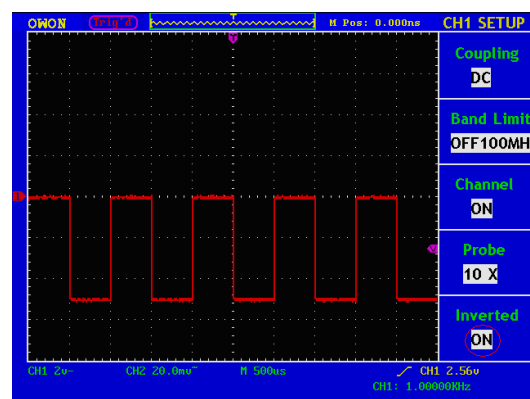


Fig. 5-7 Wave Form Inverted

Implementation of Mathematical Manipulation Function

The **Mathematical Manipulation** function is used to show the results of the additive, multiplication, division and subtraction operations between Channel 1 and Channel 2, and the FFT operation of CH1 or CH2 .

The corresponding FCL (Functional Capabilities List) of the **Wave Form Calculation**

Setting	Description
CH1-CH2	Subtract the Channel 2 wave form from the Channel 1 wave form.
CH2-CH1	Subtract the Channel 1 wave form from the Channel 2 wave form.
CH1+CH2	Add the Channel 1 wave form to the Channel 2.
CH1*CH2	Multiply Channel 1 wave form by Channel 2 wave form.
CH1/CH2	Channel 1 wave form is divided by the Channel 2 wave form.
FFT	Waveform of Corresponding FFT operation.

Taking the additive operation between Channel 1 and Channels 2 for example, the operation steps are as follows:

1. Press the **MATH MENU** button and call out the **WAVE MATH** menu.
2. Press the **F3** menu selection button and choose **CH1+CH2**. The green calculated wave form M is displayed in the screen; press the **F3** menu selection button again, the wave form M is closed off (see Fig.5-8).

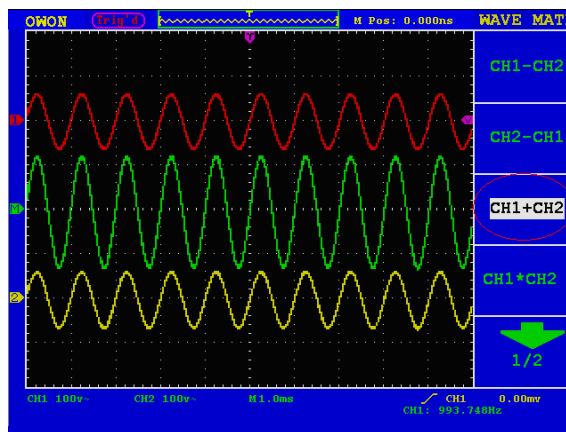


Fig. 5-8 Wave Form resulted from CH1 +CH2 Mathematical Manipulation

Using FFT function

An FFT breaks down signals into component frequencies, which the oscilloscope uses to display a graph of the frequency domain of a signal, as opposed to the oscilloscope's standard time domain graph. You can match these frequencies with known system frequencies, such as system clocks, oscillators, or power supplies.

FFT in this oscilloscope can transform 2048 points of the time-domain signal into its frequency components and the final frequency contains 1024 points ranging from 0Hz to Nyquist frequency .

The following table describes the FFT menu:

5. Advanced User Guidebook

Function Menu	Setting	Instruction
FFT	ON	Turn on FFT function.
	OFF	Turn off FFT function.
Source	CH1	DO FFT on Channel 1
	CH2	DO FFT on Channel 2
Window	Rectangle	Type of window for FFT.
	Blackman	
	Hanning	
	Hamming	
Format	dB	Display in dB
	Vrms	Display in Vrms
Zoom	*1	multiple *1
	*2	multiple *2
	*5	multiple *5
	*10	multiple *10

Taking the FFT operation for example, the operation steps are as follows:

1. Press **F1** once to turn on FFT, Press again to turn it off. Be aware that only to use FFT when Horizontal Menu is set for main Timebase Not on Window setting mode. Again, the green waveform is displayed as a result of FFT.
2. Press **F2** to switch the FFT between CH1 and CH2.
3. Press **F3** to choose WINDOW for FFT, there are four options here, including Rectangle、Hamming、Hanning and Blackman. We will give details of these options later.
4. Press **F4** to switch between dB and Vrms.
5. Press **F5** to zoom in/out, options including multiplied *1, *2, *5, *10.
6. Adjust the "**Horizontal**" knob in horizontal control zone to move the waveform and the shown frequency of M Pos is the exact frequency of the cursor point in the middle of spectrum.
7. Press **F1** to turn off FFT and then press **math menu** to go back to WAVE MATH menu.

Selecting an FFT Window

■ The FFT feature provides four windows. Each one is a trade-off between frequency resolution and magnitude accuracy. What you want to measure and your source signal characteristics help you to determine which window to use. Use the following guidelines

to select the best window.





Type	Description	Window
Rectangle	<p>This is the best type of window for resolving frequencies that are very close to the same value but worst for accurately measuring the amplitude of those frequencies. It is the best type for measuring the frequency spectrum of non-repetitive signals and measuring frequency components near DC.</p> <p>Use rectangle for measuring transients or bursts where the signal level before and after the event are nearly equal. Also, use this window for equal-amplitude sine waves with frequencies that are very close and for broadband random noise with a relatively slow varying spectrum.</p>	
Hamming	<p>This is a very good window for resolving frequencies that are very close to the same value with somewhat improved amplitude accuracy over the rectangle window. It has a slightly better frequency resolution than the Hanning.</p> <p>Use Hamming for measuring sine, periodic and narrow band random noise. This window works on transients or bursts where the signal levels before and after the event are significantly different.</p>	
Hanning	<p>This is a very good window for measuring amplitude accuracy but less so for resolving frequencies.</p> <p>Use Hanning for measuring sine, periodic, and narrow band random noise. This window works on transients or bursts where the signal levels before and after the event are significantly different.</p>	
Blackman	<p>This is the best window for measuring the amplitude of frequencies but worst at resolving frequencies.</p> <p>Use Blackman-Harris for measuring predominantly single frequency waveforms to look for higher order harmonics.</p>	

Fig.5-9, 5-10, 5-11, 5-12 show four kinds of window function referring to sine wave of 1KHz.

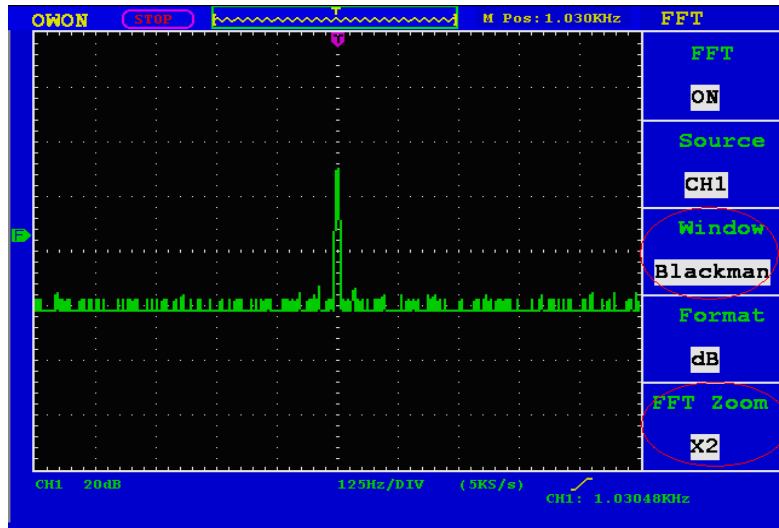


Fig.5-9. Blackman window

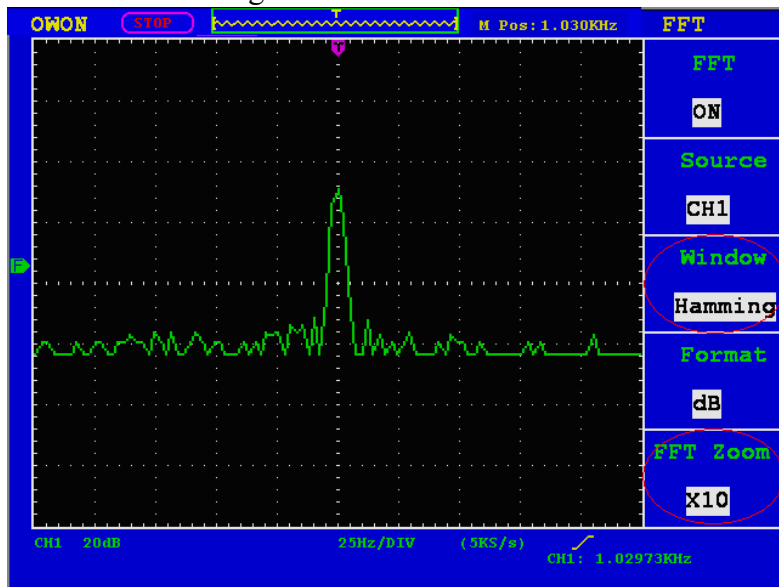


Fig.5-10 Hamming window

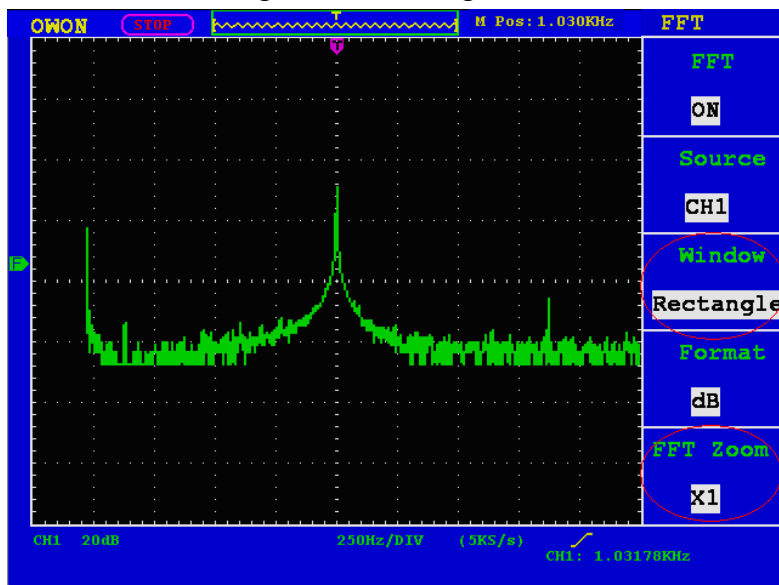


Fig.5-11. Rectangle window

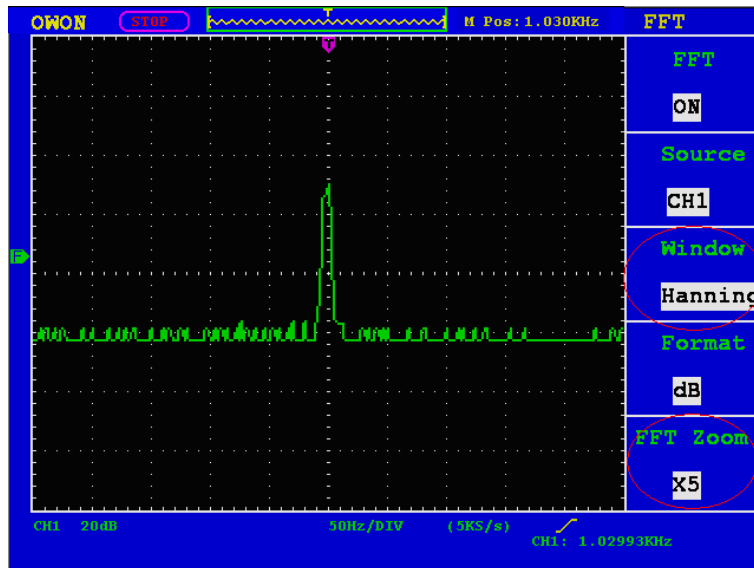


Fig.5-12 Hanning window

Quick Tips

- If desired, use the zoom feature to magnify the FFT waveform.
- Use the default dBV RMS scale to see a detailed view of multiple frequencies, even if they have very different amplitudes. Use the linear RMS scale to see an overall view of how all frequencies compare to each other.
- Signals that have a DC component or offset can cause incorrect FFT waveform component magnitude values. To minimize the DC component, choose AC Coupling on the source signal.
- To reduce random noise and aliased components in repetitive or single-shot events, set the oscilloscope acquisition mode to average.

Term interpretation

Nyquist frequency: The highest frequency that any Real Time Digital Oscilloscope can measure is exactly half of the sampling rate under the condition of no mistakes, which is called Nyquist frequency. If under-sampling occurs when the frequency sampled is higher than Nyquist frequency, "False Wave" phenomenon will appear. So pay more attention to the relation between the frequency being sampled and measured.

NOTE:

While FFT mode is turned on, DO NOT USE THESE SETTINGS:

- 1) Horizontal window setting.
- 2) Change source channel in CH1/CH2 Setup menu
- 3) Turn on XY Format
- 4) Trigger control "SET 50%"
- 5) Auto-scale function

Application of VERTICAL POSITION and VOLTS/DIV Knobs

1. The **.VERTIVAL POSITION** knob is used to adjust the vertical positions of the wave forms of all Channels (including those resulted from the mathematical operation).
The analytic resolution of this control knob changes with the vertical division.
2. The **VOLTS/DIV** knob is used to regulate the vertical resolution of the wave forms of all channels (including those obtained from the mathematical manipulation), which can determine the sensitivity of the vertical division with the sequence of 1-2-5. The vertical sensitivity goes up when the knob is rotated clockwise and goes down when the knob is rotated anticlockwise.
3. When the vertical position of the channel wave form is adjusted, the screen shows the information concerning the vertical position at the lower left corner (see Fig.5-13).

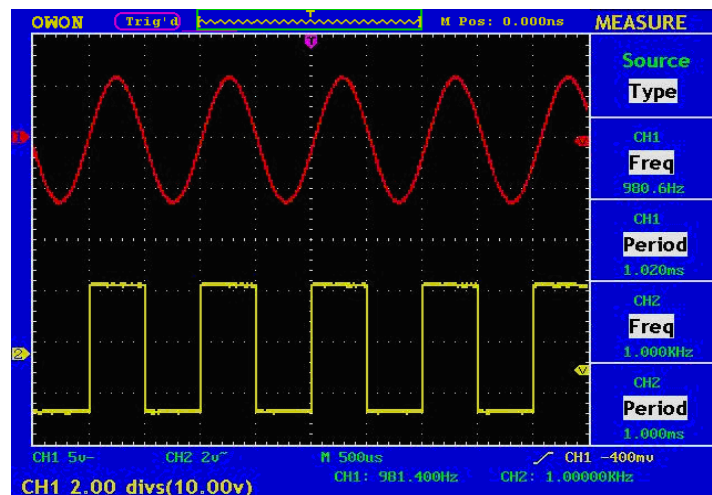


Fig. 5-13 Information about Vertical Position

How to Set the Horizontal system

The **HORIZONTAL CONTROLS** includes the **HORIZONTAL MENU** button and such knobs as **HORIZONTAL POSITION** and **SEC/DIV**.

1. **HORIZONTAL POSITION** knob: this knob is used to adjust the horizontal positions of all channels (include those obtained from the mathematical manipulation), the analytic resolution of which changes with the time base.
2. **SEC/DIV** knob: it is used to set the horizontal scale factor for setting the main time base or the window.
3. **HORIZONTAL MENU** button: Press this button to active **TIME MODE** shown as below with description of each function (see Fig. 5-14).

TIME MODE	Function Menu	Setting	Description
Main TimeBase	Main Time Base		The setting of the horizontal main time base is used to display the wave form.
Set Window	Set Window		A window area is defined by two cursors.
Zone Window	Zone Window		The defined window area for display is expanded to the full screen.

Fig. 5-14 Time Mode

Main Time Base

Press the **F1** menu selection button and choose the **Main Time Base**. In this case, the **HORIZONTAL POSITION** and **SEC/DIV** knobs are used to adjust the main window. The display in the screen is shown as Fig.5-15

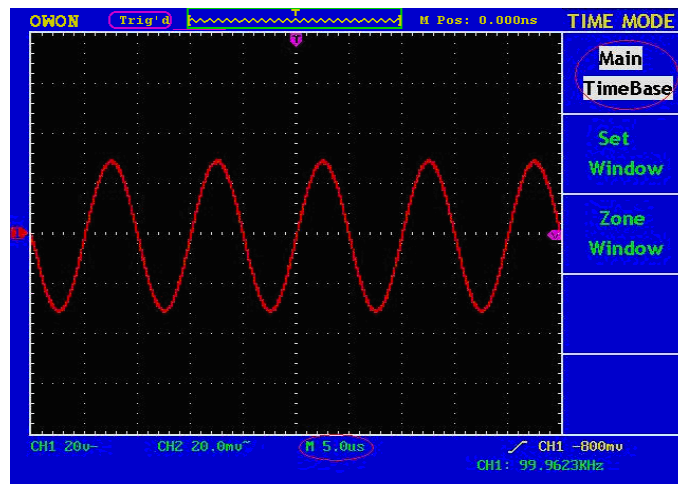


Fig. 5-15 Main Time Base

Set Window

Press the **F2** menu selection button and choose **Set Window**. The screen will show a window area defined by two cursors. In this case, the **HORIZONTAL POSITION** and **SEC/DIV** knobs can be used to adjust the horizontal position and size of this window area. Press **F2** menu button under the FFT mode ,it will notice "FFT mode disable". See Fig.5-16.

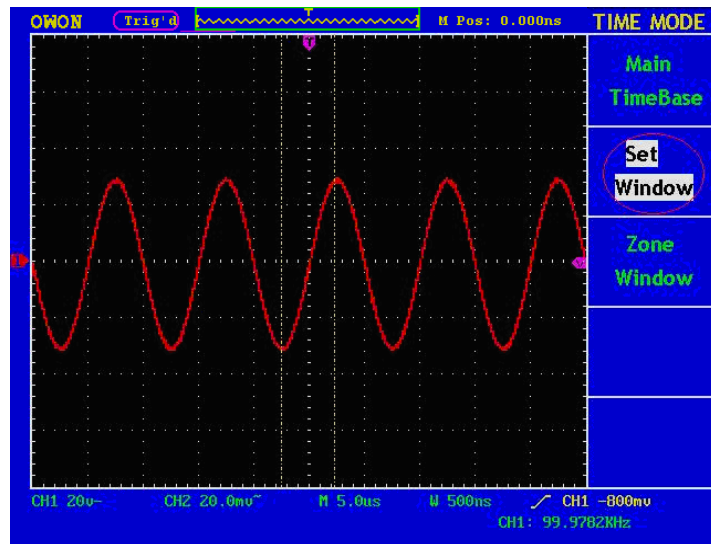


Fig. 5-16 Window Setting

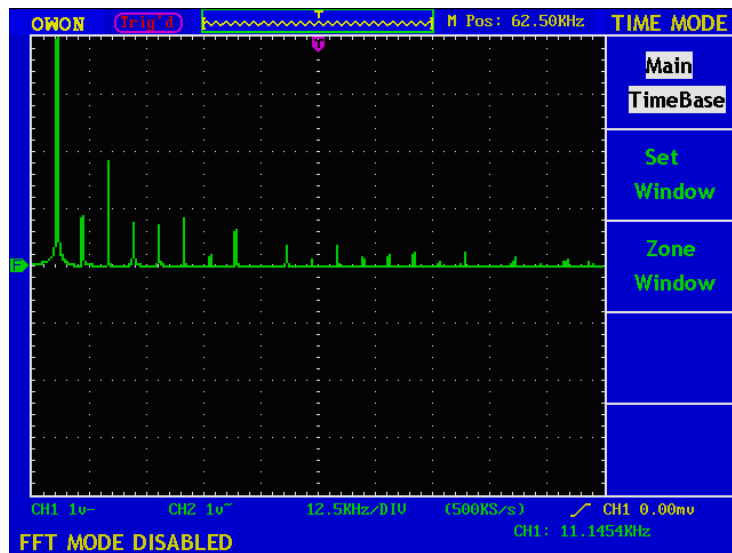


Fig. 5-17 Set Window disable under FFT mode

Zone Window

Press the **F3** menu selection button and choose **Zone Window**. As a result, the window area defined by two cursors will be expanded to the full screen size (see Fig. 5-18).



Fig. 5-18 Zone Window

How to set trigger system

When the oscilloscope begins to collect the data and display the wave form depends on a trigger. Once it is set correctly, the trigger can transfer the unstable display into a meaningful wave form.

When beginning to collect data, the oscilloscope will collect adequate data to draw the wave form at the left side of the trigger point at first. It will continuously perform the data acquisition while waiting for the trigger condition. After a trigger is detected, the oscilloscope will continuously collect data enough to draw the wave form at the right side of the trigger point.

One knob and four function menu buttons are included in the trigger control zone.

TRIG LEVEL: Trigger the level control knob and set the signal voltage corresponding to the trigger point.

SET TO 50%: Set the trigger level as the vertical midpoint value of the amplitude of the trigger signal.

FORCE TRIG: It is a force trigger button for the generation of a trigger signal, which is mainly used in the "Normal" and "Single" triggering modes.

SET TO ZERO: Trigger the resetting of the horizontal position.

TRIG MENU: It is a trigger menu button. When it is pressed, an operation menu will be presented in the screen.

Trigger Control

The oscilloscope provides two trigger types: single trigger and alternate trigger. Press F1 to choose.

Single trigger: Use a trigger level to capture stable waveforms in two channels simultaneously

Alternate trigger: Trigger on non-synchronized signals.

The **Single Trigger** and **Alternate Trigger** menus are described respectively as follows:

Single trigger

Single trigger has four modes: edge trigger, video trigger, pulse trigger and slope trigger .

Edge Trigger: It happens when the trigger input passes through a given level along the set direction.

Video Trigger: Carry out field or line video trigger on the standard video signal.

Pulse Trigger : Use this trigger type to catch pulses with certain pulse width..

Slope Trigger : The oscilloscope begins to trigger according to the signal rising or falling speed.

The four trigger modes in Single Trigger are described respectively as follows:

Edge Trigger

Under the Edge Trigger mode, a trigger happens in the trigger threshold value of the

input signal edge. When the **Edge Trigger** is selected, a trigger will occur in the rising or falling edge of the input signal.

The **Edge Trigger Menu** is shown as Fig.5-19

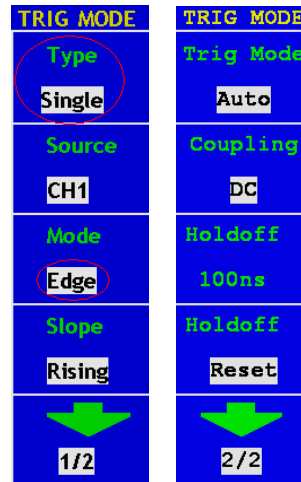


Fig. 5-19 Edge trigger menu

Edge menu list:

MENU	SETTING	INSTRUCTION
Source	CH1 CH2 EXT EXT/5 AC LINE	Channel 1 as the trigger source. Channel 2 as the trigger source. Use external source. 1/5 of the External Trigger Source for increasing range of level. AC Line as resource trigger signal.
Mode	Edge	Set vertical channel trigger type for edge trigger.
Slope	Rising Falling	Trigger on the rising edge. Trigger on the falling edge.
Trigger mode	Auto Normal Single	Acquire data and display waveform with or without a trigger. Acquire data and display waveform when trigger. Acquire data and display waveform when detecting a trigger and stop sampling.
Coupling	AC DC HF LF	Block the direct current component. Unblock all components. Block the high-frequency signal and only unblock the low-frequency component. Block the low-frequency signal and only unblock the high-frequency component.
Holdoff	100ns~ 10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to 100ns

Video Trigger

Choose video trigger to trigger on fields or lines of NTSC, PAL, or SECAM standard video signals. Trig menu refer to Fig.5-20

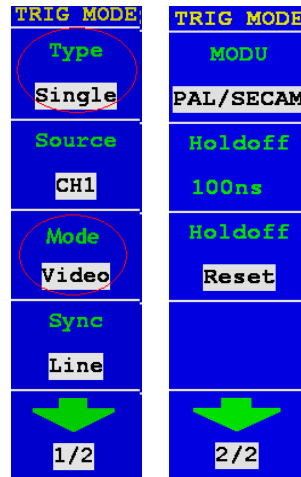


Fig. 5-20 Video trigger menu

Video menu list

MENU	SETTING	INSTRUCTION
Source	CH1 CH2 EXT EXT/5	Channel 1 as the trigger source. Channel 2 as the trigger source. Use external source. 1/5 of the External Trigger Source for increasing range of level.
Mode	Video	
Sync	Line Field Odd Field Even Field Designed Line	Trigger the time base on the line of input video signal. Trigger the time base on the field of input video signal.. Trigger the odd fields of input video signal. Trigger the even fields of input video signal. Trigger the time base on chosen line of input video signal.
Modulation	NTSC PAL/SECAM	Format of video signal.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to 100ns

Pulse Width Trigger

Pulse trigger occurs according to the width of pulse. The abnormal signals can be detected through setting up the pulse width condition.

The **Pulse Width Trigger Menu** is shown as **Fig. 5-21**.

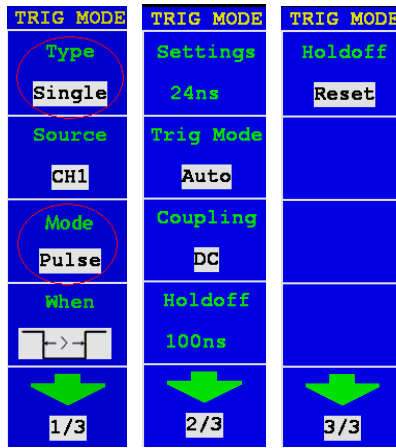


Fig. 5-21 Pulse Width Trigger menu

Pulse Width Trigger menu list

MENU	SETTING	INSTRUCTION
Source	CH1 CH2	Channel 1 as the trigger source. Channel 2 as the trigger source.
Mode	Pulse	
when		To select pulse width condition
Time setting	24ns~10s	Turn "TRIG LEVEL" knob to set time
Trigger mode	Auto Normal Single	Acquire waveform whatever detect trigger condition or not Only acquire waveform when match trigger condition Only acquire waveform for single time when detect trigger condition then stop
Coupling	AC DC HF LF	Block the direct current component. Unblock all components. Block the high-frequency signal and only unblock the low-frequency component. Block the low-frequency signal and only unblock the high -frequency component.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to 100ns

Slope Trigger

Slope trigger sets the oscilloscope as the positive/negative slope trigger within the specified time.

The **Slope Trigger Menu** is shown as **Fig. 5-22**.

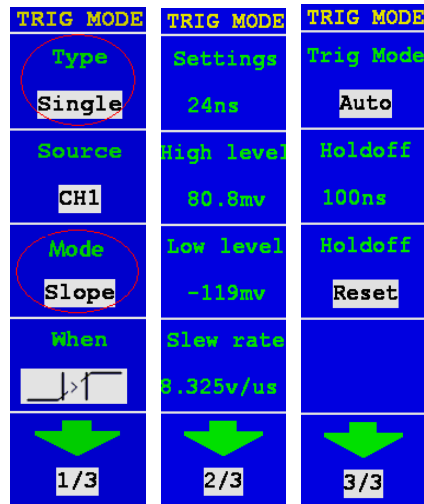


Fig. 5-22 Slope Trigger menu

Slope Trigger menu list

MENU	SETTING	INSTRUCTION
Source	CH1 CH2	Channel 1 as the trigger source. Channel 2 as the trigger source.
Mode	Slope	
When		Set slope condition
Settings	24ns~10s	Turn "TRIG LEVEL" knob to set slope time
High level		Turn "TRIG LEVEL" knob to set the High level
Low level		Turn "TRIG LEVEL" knob to set Low level
Slew rate		$Slew\ rate = (High\ level - Low\ level) / Settings$
Trigger mode	Auto Normal Single	Acquire waveform whatever detect trigger condition or not Only acquire waveform when match trigger condition Only acquire waveform for single time when detect trigger condition then stop.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to 100ns

Alternate trigger

Trigger signal comes from two vertical channels when alternate trigger is on. This mode is used to observe two unrelated signals. You can choose different trigger modes for different channels. The options are as follows: edge, video, pulse or slope.

Alternate trigger(Trigger mode: Edge)

Alternate trigger(Trigger Type: Edge) Menu is shown as Fig.5-23.

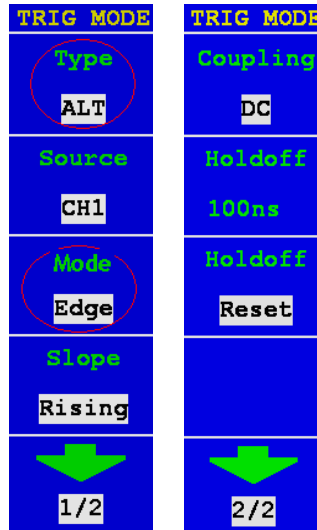


Fig.5-23 Alternate trigger(Trigger Type: Edge) Menu

Alternate trigger(Trigger Type: Edge) Menu list:

MENU	SETTING	INSTRUCTION
Source	CH1 CH2	Channel 1 as the trigger source. Channel 2 as the trigger source.
Mode	Edge	Set vertical channel trigger type for edge trigger.
Slope	Rising Falling	Trigger on the rising edge. Trigger on the falling edge.
Coupling	AC DC HF LF	Block the direct current component. Unblock all components. Block the high-frequency signal and only unblock the low-frequency component. Block the low-frequency signal and only unblock the high-frequency component.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to 100ns

Alternate trigger(Trigger Mode: video)

Alternate trigger(Trigger Type: video) Menu is shown as Fig.5-24.

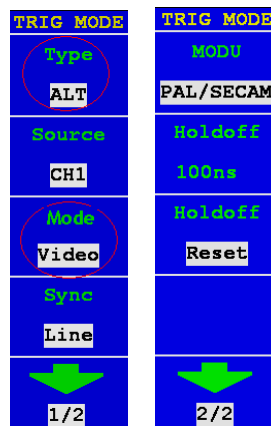


Fig.5-24 Alternate trigger(Trigger Type: video) Menu

Alternate trigger(Trigger Type: video) Menu list:

MENU	SETTING	INSTRUCTION
Source	CH1	Channel 1 as the trigger source.
	CH2	Channel 2 as the trigger source.
	EXT	Use external source.
	EXT/5	1/5 of the External Trigger Source for increasing range of level.
Mode	Video	
Sync	Line	Trigger the time base on the line of input video signal.
	Field	Trigger the time base on the field of input video signal..
	Odd Field	Trigger the odd fields of input video signal.
	Even Field	Trigger the even fields of input video signal.
	Designed Line	Trigger the time base on chosen line of input video signal.
Modulation	NTSC PAL/SECAM	Format of video signal.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to default value (100ns).

Alternate trigger(Trigger Mode: Pulse)

Alternate trigger(Trigger Type: Pulse) Menu is shown as Fig.5-25.

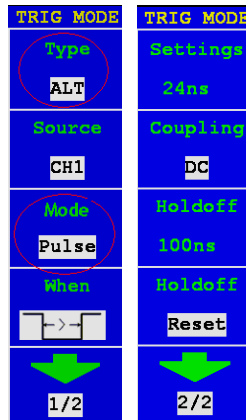


Fig.5-25 Alternate trigger(Trigger Type: Pulse) Menu

Alternate trigger(Trigger Type: Pulse) menu list

MENU	SETTING	INSTRUCTION
Source	CH1	Channel 1 as the trigger source.
	CH2	Channel 2 as the trigger source.
Mode	Pulse	
when	(+pulse width less than) (+pulse width more than) (+Pulse width equal to) (-Pulse width less than) (-Pulse width more than) (-Pulse width equal to)	To select pulse width condition
settings	24ns~10s	Turn "TRIG LEVEL" knob to set time

Coupling	AC	Block the direct current component.
	DC	Unblock all components.
	HF	Block the high-frequency signal and only unblock the low-frequency component.
	LF	Block the low-frequency signal and only unblock the high -frequency component.
Holdoff	100ns~10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to default value (100ns).

Alternate trigger(Trigger Mode: Slope)

Alternate trigger(Trigger Type: Slope)Menu is shown as Fig.5-26.

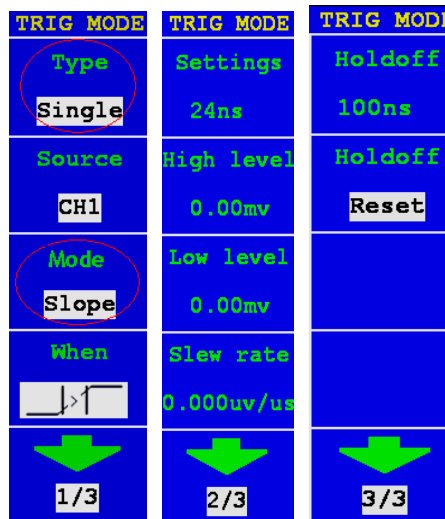


Fig.5-26 Alternate trigger(Trigger Type: Slope)Menu

Alternate trigger(Trigger Type: Slope) menu list:

MENU	SETTING	INSTRUCTION
Source	CH1	Select CH1 as the trigger source.
	CH2	Select CH2 as the trigger source.
Mode	Slope	
Slope Condition		Rising Edge and more than.
		Rising Edge and less than.
		Rising Edge and equal to .
		Falling Edge and more than
		Negative pulse and less than
		Negative pulse and equal to
settings	24ns~10s	Turn "TRIG LEVEL" knob to set slope time
High level		Turn "TRIG LEVEL" knob to set the High level
Low level		Turn "TRIG LEVEL" knob to set Low level
Slew rate		Slew rate=(High level- Low level)/ Settings
Coupling	AC	Block the direct current component.
	DC	Unblock all components.
	HF	Block the high-frequency signal and only unblock the

	LF	low-frequency component. Block the low-frequency signal and only unblock the high-frequency component.
Holdoff	100ns~ 10s	Set interval by using TRIG LEVEL control, value range from 100ns~10s.
Holdoff Reset		Reset hold time to default value (100ns).

Term interpretation

1. Source: Trigger can occur from several sources: Input channels (CH1, CH2), AC Line, Ext, Ext/5.

- **Input** :It is the most commonly used trigger source. The channel will work when selected as a trigger source whatever displayed or not.
- **Ext Trig:** The instrument can trigger from a third source while acquiring data from CH1 and CH2. For example, you might want to trigger from an external clock or with a signal from another part of the test circuit. The Ext, Ext/ 5 trigger sources use the external trigger signal connected to the EXT TRIG connector. Ext uses the signal directly; it has a trigger level range of +1.6 V to -1.6 V. The EXT/ 5 trigger source attenuates the signal by 5X, which extends the trigger level range to +8 V to -8 V. This allows the oscilloscope to trigger on a larger signal
- **AC Line:** AC power can be used to display signals related to the power line frequency, such as lighting equipment and power supply devices. The oscilloscope gets triggered on its power cord, so you do not have to input an AC trigger signal. When AC Line is selected as trigger source, the oscilloscope automatically set coupling to DC, set trigger level to 0V.

2. Trigger Mode:

The trigger mode determines how the oscilloscope behaves in the absence of a trigger event. The oscilloscope provides three trigger modes: Auto, Normal, and Single.

- **Auto:** This sweep mode allows the oscilloscope to acquire waveforms even when it does not detect a trigger condition. If no trigger condition occurs while the oscilloscope is waiting for a specific period (as determined by the time-base setting), it will force itself to trigger.
- **Normal:** The Normal mode allows the oscilloscope to acquire a waveform only when it is triggered. If no trigger occurs, the oscilloscope keeps waiting, and the previous waveform, if any, will remain on the display. Single: In Single mode, after pressing the RUN/STOP key, the oscilloscope waits for trigger. While the trigger occurs, the oscilloscope acquires one waveform then stop.
- **Single:** In Single mode, after pressing the RUN/STOP key, the oscilloscope waits for trigger. While the trigger occurs, the oscilloscope acquires one waveform then stop.

3. Coupling:

Trigger coupling determines what part of the signal passes to the trigger circuit. Coupling types include AC, DC, LF Reject and HF Reject.

- **AC:** AC coupling blocks DC components.
- **DC:** DC coupling passes both AC and DC components.
- **LF Reject:** LF Reject coupling blocks DC component, and attenuates all signal with a frequency lower than 8 kHz.

- **HF Reject:** HF Reject coupling attenuates all signals with a frequency higher than 150 kHz.

4. Holdoff: A time interval before the oscilloscope responds to next trigger signal. During this Holdoff period, the trigger system becomes "blind" to trigger signals. This function helps to view complex signals such as an AM waveform. Press Holdoff button to activate "TRIG LEVEL" knob, then turn it to adjust Holdoff time.

How to Operate the Function Menu

The function menu control zone includes 7 function menu buttons and 3 immediate-execution buttons: **SAVE/RCL**, **MEASURE**, **ACQUIRE**, **UTILITY**, **CURSOR**, **DISPLAY**, **AUTOSCALE**, **AUTOSET**, **RUN/STOP** and **U-DISK COPY**.

How to Implement Sampling Setup

Press the **ACQUIRE** button and the menu is displayed in the screen, shown as **Fig.5-27**.

ACQU MODE	Function Menu	Setting	Description
Sample	Sample		Normal sampling mode.
Peak Detect	Peak Detect		Use to capture maximal and minimal samples. Finding highest and lowest points over adjacent intervals.
Average	Average		Use to reduce random noises, four options are available as followed.
Averages 16	Averages	4, 16, 64, 128	Four options, indicating the number of averages.

Fig.5-27 ACQU MODE Menu

Here is an example for using Peak Detect function, the input is a standard test square waveform. You can see the "burrs" on the falling edge of signal is detected with noise when it is turned on.

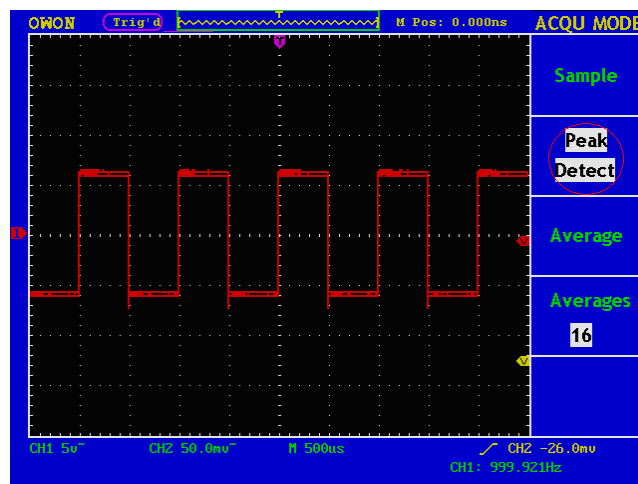


Fig.5-28 Peak Detect mode

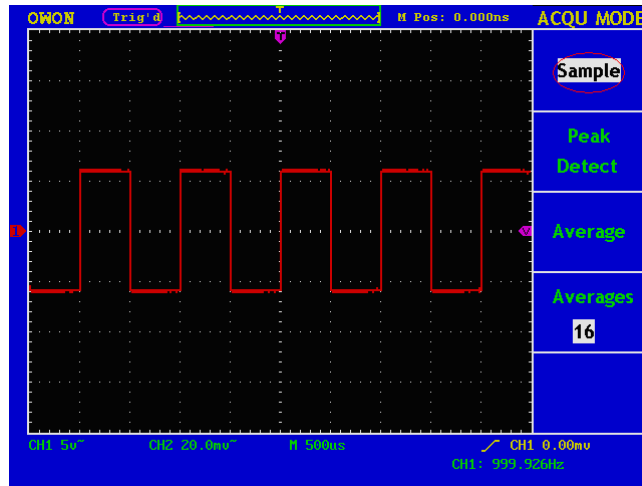


Fig.5-29 Common ACQU Mode display, in which no burr can be detected.

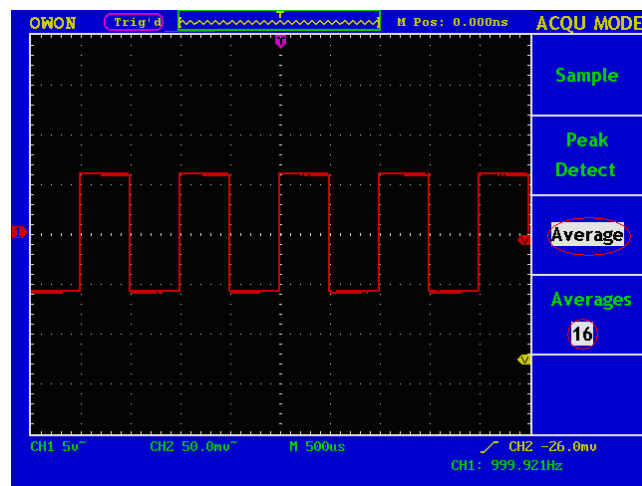


Fig.5-30 Average on with reduced noise on waveform

How to Set the Display System

Push down the **DISPLAY** button and the menu displayed in the screen is shown as Fig.5-31.

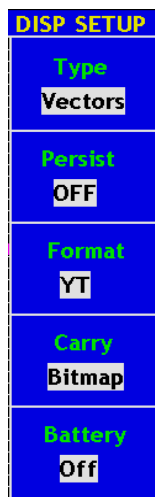


Fig.5-31 Display Set Menu

Function Menu	Setting	Description
Type	Vectors Dots	The adjacent sampling points are joined by vector form. Only displaying sampling points captured..
Persist	OFF 1sec 2sec 5sec Infinite	Options for setting the persistence time for each sampling point.
Format	YT XY	Show waveform as voltage against time. Show waveform as CH1(X) against CH2(Y)
Carry	Bitmap Vectors	This setting affects the format of the files saved to the inserted USB storage device by pressing " COPY " button.
Battery	On Off	Show battery level Turn off battery level

Press **F1** next to **Type** to change from **Vectors** to **Dots**. Fig.5-32 and Fig.5-33 show waveform in different type.

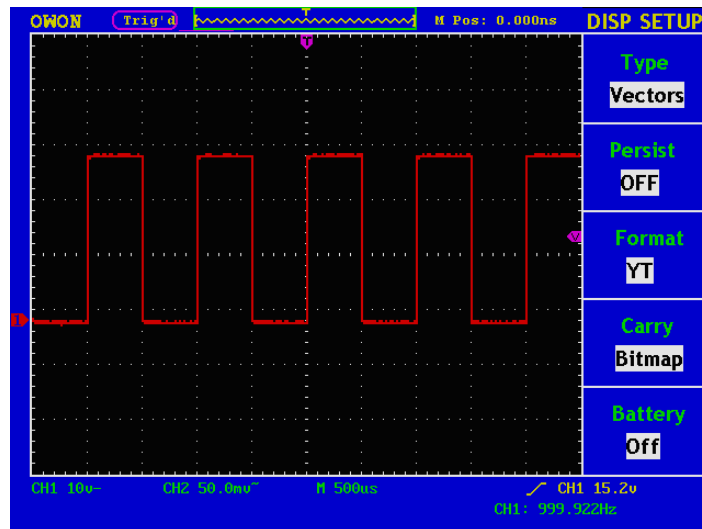


Fig.5-32 Display in the Vector Form

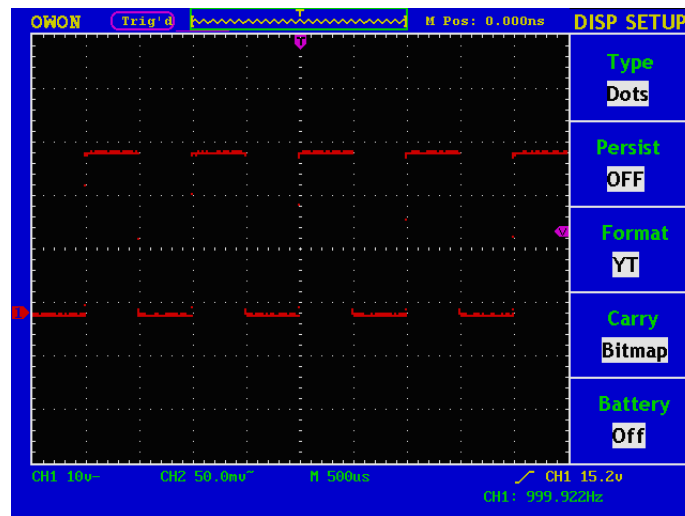


Fig.5-33 Display in Dots form

Persist

When the **Persist** function is used, the persistence display effect of the picture tube oscilloscope can be simulated: the reserved original data is displayed in fade color and the new data is in bright color. With the **F2** menu selection button, different persistence time can be chosen: **1sec**, **2sec**, **5sec**, **Infinite** and **Closed**. When the "**Infinite**" option is set for **Persist** time, the measuring points will be stored till the controlling value is changed (see Fig.5-34).

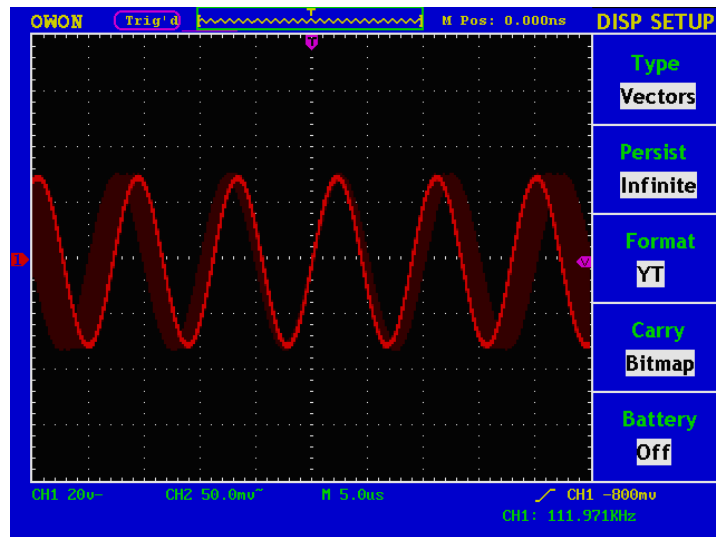


Fig.5-34 Infinite Persistence Display

XY Format

This format is only applicable to Channel 1 and Channel 2. After the XY display format is selected, Channel 1 is displayed in the horizontal axis and Channel 2 in the vertical axis; the oscilloscope is set in the un-triggered sample mode: the data are displayed as bright spots and the sampling rate is 1MS/s and can not be changed.

The operations of all control knobs are as follows:

- The **Vertical VOLTS/DIV** and the **Vertical POSITION** knobs of Channel 1 are used to set the horizontal scale and position.
- The **Vertical VOLTS/DIV** and the **Vertical POSITION** knobs of Channel 2 are used to set the vertical scale and position continuously.

Notes: The following functions would be disabled when XY Format is set.

- Reference or Any calculated wave form
- Cursor Function
- All time base controls
- All Trigger controls

Use XY Format

1. Apply input signals to both CH1 and CH2
2. Press the **DISPLAY** to activate **DISP Set** menu.
3. Press **F1** to set Vectors as type, **F2** to set Infinite for persist and **F3** to set XY as Format as shown as Fig. 5-35

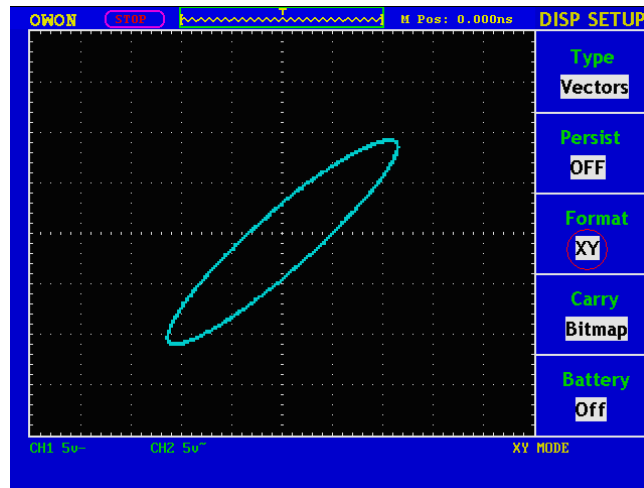


Fig.5-35 Display in XY Format

At the mode of FFT, if switching YT to XY, "FFT MODE is unavailable" prompts as Fig.5-36

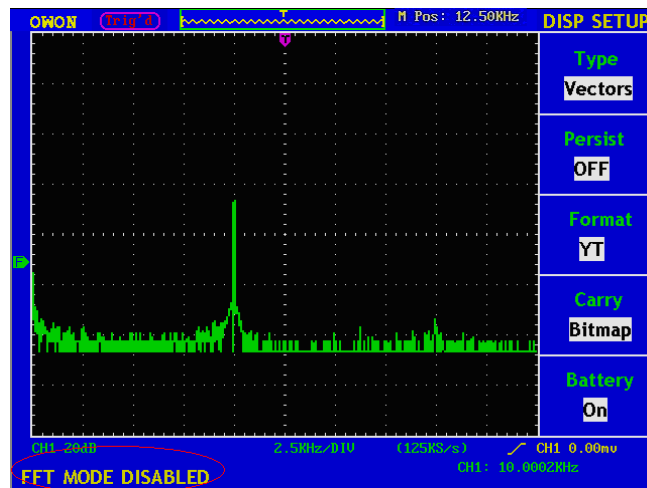


Fig.5-36 FFT mode XY Format Disable

How to Save and Recall a Wave Form

Press the SAVE/RCL button, you can save and call out the waveforms in the instrument. The menu displayed in the screen is shown as Fig.5-37.

Function Menu	Setting	Description
Source	CH1 CH2 MATH	Source of wave form to be saved. Available sources:CH1,CH2,MATH
WAVE	A , B C , D	Location where selected waveform to be saved or recalled.
Save		Action to save selected waveform to selected location.
CH(X) X=A,B,C,D	OFF ON	Turn Display on/off for selected and stored waveform.

Fig.5-37 Wave Form Save Menu

Save a waveform

A sine wave form input CH1. Follow these steps to save waveform from CH1.

- Under WAVE SAVE MENU, press **F1** next to Source to select CH1.
- Press **F2** next to WAVE to assign Location A for this waveform.
- Press **F3** next to Save to store the waveform captured from CH1.

Recall a stored waveform

Once the waveform is stored you can recall and display it on the screen. The waveform would remain there until the next one is stored at the same location, hence, the previous stored waveform would be overwritten by the new one.

To recall a stored waveform, activate WAVE SAVE menu

- Press **F2** next to Wave to select from one of four locations, the CH(X) would show the location you've chosen.
- Press **F4** next to CH(X) to change to ON. Now you will see a stored waveform displayed on the screen with whatever waveforms are already on there.
- Example to save/recall a waveform from location A. Fig.5-38.

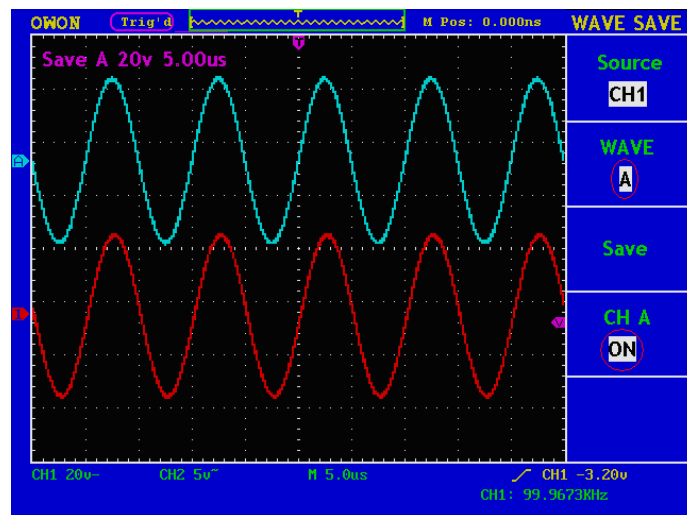


Fig.5-38 Wave Saving

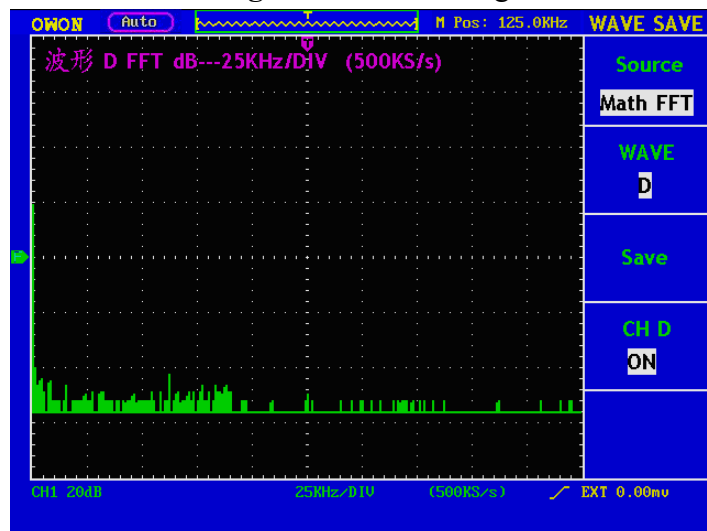


Fig.5-39 FFT wave saving

How to Implement the Auxiliary System Function Setting

Press the **UTILITY** button and the menu is displayed in the screen as **Fig.5-40**.

FUNCTION	Function Menu	Setting	Description
System Status	System Status		Display the system function menu.
Recall Factory	Recall Factory		Call out the factory settings.
Do Self Cal	Do Self Cal		Carry out the self-calibration procedure.
Language	Language	Chinese English ...	Choose the display language of the operating system.
English	Time	Time ON OFF	Press the F1 button to show/hide the time display
Time		Min Hour	Press the F2 button to switch, turn the knob to set
		Day Mon	Press the F3 button to switch, turn the knob to set
		Year	Turn the knob to set

Fig.5-40
Function
Menu

Carry out a Self-Calibration

We have a built-in Self-Calibration procedure, by performing a Self-Calibration would help to maintain the accuracy of your oscilloscope under ambient temperature. It is recommended to carry a self-Calibration if the change of the ambient temperature is up to or exceeds 5°C.

Notes: Disconnect all inputs before carrying out a self-calibration. Fail to do so may cause damage to your oscilloscope.

Here are the procedures for carrying a self-calibration.

- Disconnect all inputs, including probes and wires etc.
- Press **UTILITY** to activate Function menu.
- Press **F3** next to Do Self-Cal.

Now there is a yellow window popping up to ask for a confirmation. Press **F3** again, the Oscilloscope starts the self-calibration and yellow window remains the calibration is done. **Please be aware that no contacts to any inputs channels until the calibration is done.**

SYS STAT (System State)

Press the **F1** menu selection button and choose "**SYS STAT**" item. The menu pops up in the screen as **Fig.5-41**.

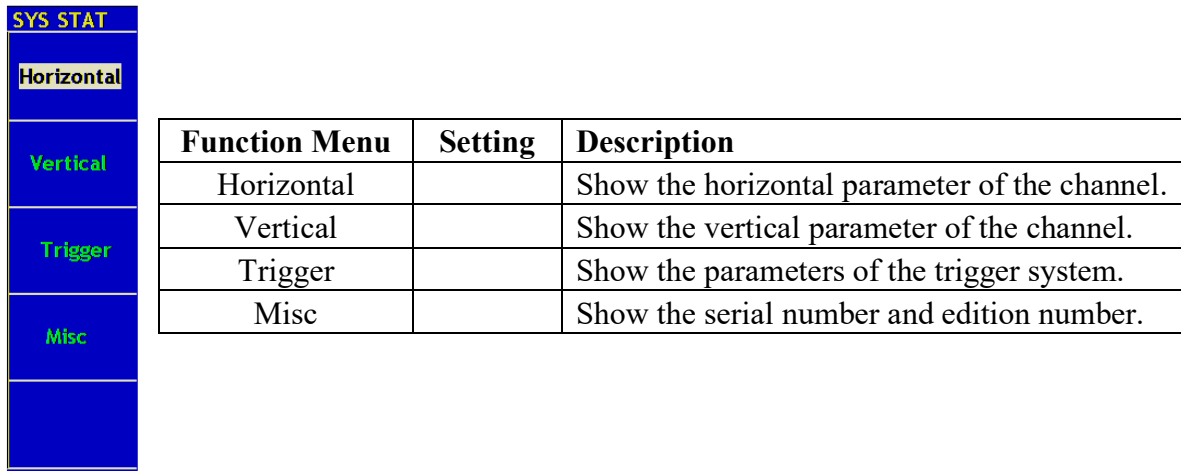


Fig.5-41 SYS STAT Menu

After entering into the SYS STAT menu, choose the corresponding function, with the corresponding parameters shown in the screen. If press the **F1** menu selection button and choose the function item "**Horizontal**", the Horizontal System State will be displayed in the screen. Press any other function button and exit from the SYS STAT menu (see Fig.5-42).

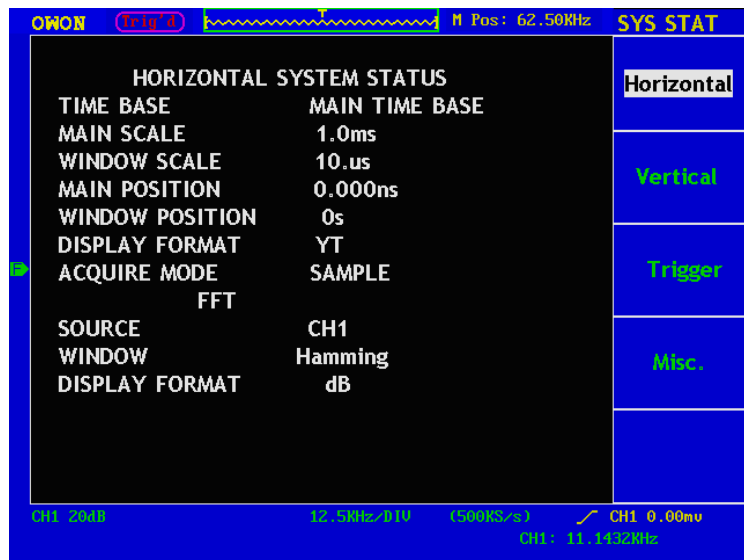


Fig.5-42 Horizontal System State

How to Implement the Automatic Measurement

This is where users would come across every time they use our scopes. It is take the measurements by using oscilloscope. Our oscilloscope does this automatic every time user press Measure button. It is capable to work out 20 different types of measurements, and there are 4 measurements can be displayed on the screen at one time.

The 20 types automatic measurements include frequency, cycle, average value, peak-to-peak value , root mean square value, Vmax, Vmin, Vtop, Vbase, Vamp,

Overshoot, Preshoot, RiseTime, Fall Time, +Width, -Width, +Duty, -Duty, Delay A→B ↔ and Delay A→B ↵ .

To use Measure, simply Press Measure button would activate MEASURE menu. Press F1 next to Source/Type to allow you to switch between Source and Type.

Source is the signal from the channel which user to carry out a measurement, and Type is one of the 20 measurements user wants Oscilloscope to work out. Under the Type as you can see in Fig. 5-43 is what the actual measurement reading is. The reading would show sign of "?" if there isn't a measurement can be worked out from the source signal. As in Fig. 5-43, both Channel1 and Channel2 are chosen as source, measurements are taken for Frequency, Pk-Pk value, Mean and RMS.

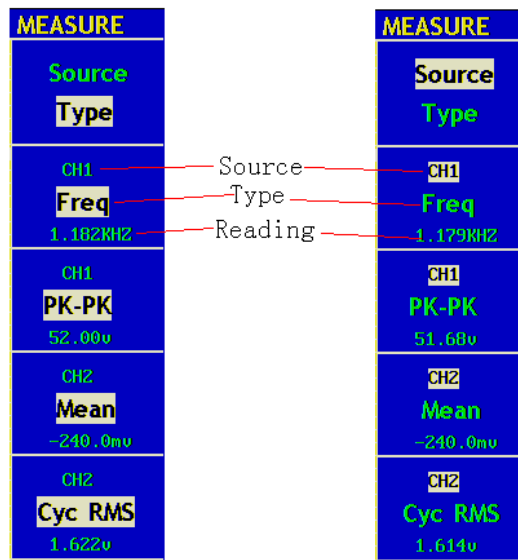


Fig.5-43 Measure Menu

Term interpretation

Abbreviation	Descriptions
Vpp	Peak-to-Peak Voltage.
Vmax	The maximum amplitude. The most positive peak voltage measured over the entire waveform.
Vmin	The minimum amplitude. The most negative peak voltage measured over the entire waveform.
Vamp	Voltage between Vtop and Vbase of a waveform.
Vtop	Voltage of the waveform's flat top, useful for square/pulse waveforms.
Vbase	Voltage of the waveform's flat base, useful for square/pulse waveforms.
Overshoot	Defined as $(V_{max}-V_{top})/V_{amp}$, useful for square and pulse waveforms.
Preshoot	Defined as $(V_{min}-V_{base})/V_{amp}$, useful for square and pulse waveforms.

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Average	The arithmetic mean over the entire waveform.
Vrms	The true Root Mean Square voltage over the entire waveform.
Rise Time	Time that the leading edge of the first pulse in the waveform takes to rise from 10% to 90% of its amplitude.
Fall Time	Time that the falling edge of the first pulse in the waveform takes to fall from 90% to 10% of its amplitude.
+Width	The width of the first positive pulse in 50% amplitude points.
-Width	The width of the first negative pulse in the 50% amplitude points.
Delay 1→2 ⚡	The delay between the two channels at the rising edge.
Delay 1→2 ⚡	The delay between the two channels at the falling edge.
+Duty	+Duty Cycle, defined as +Width/Period.
-Duty	-Duty Cycle, defined as -Width/Period

We now take you through an example to use Automatic measurement. Before using them, all sources of channels have to be switched on. These can be done through CH menu as mentioned before. Please be aware that this function only applies to waveform captured from input channels at YT format. It would not work on saved waveforms, calculated waveforms and waveform in XY or SCAN format. In this example, we apply square wave to Channel 1 and sine wave to Channel 2, and we want to measure the frequency, Peak-to-Peak value of Channel 1, and mean value and RMS value for Channel 2. Here is how we set them up:

- Press MEASURE to active MEASURE MENU.
- Press F1 next to Source/Type to highlight Source.
- Press F2 to choose first sources as CH1.
- Press F3 to choose second source again as CH1.
- Press F4 to choose third source as CH2.
- Press F4 to choose fourth source as CH2.
- Press F1 again to highlight Type.
- Press F2 to select Freq. A reading of 1.000Khz appears automatically.
- Press F3 to select Pk-Pk, reading appears immediately under highlighted type.
- Press F4 to select Mean for CH2, reading appears immediately.
- Press F5 to select Cyc RMS, reading appears immediately.

The measured value will be displayed in the reading window automatically (see Fig.5-44)

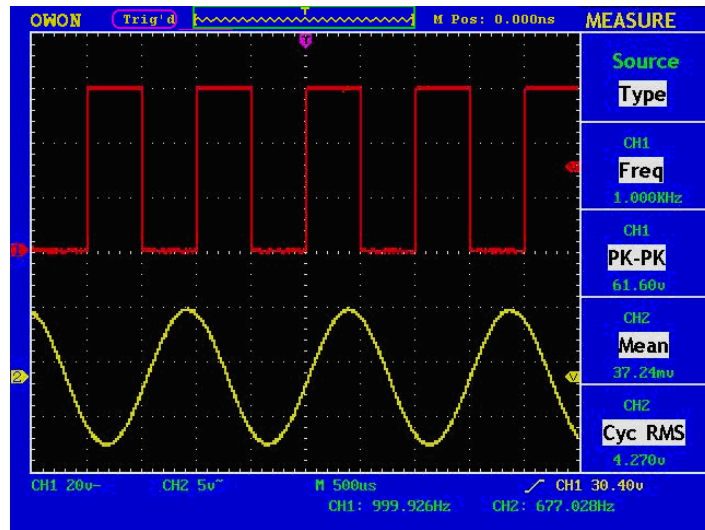


Fig.5-44 Automatic Measurement

How to Implement the Cursor Measurement

Press the **CURSOR** button to display the cursor measurement function menu (**CURS MEAS**) in the screen.

The Cursor Measurement for normal model:

The cursor measurement includes **Voltage Measurement** and **Time Measurement** at normal model, shown as Fig.5-45.

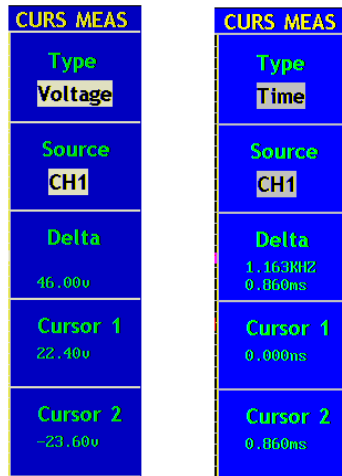


Fig.5-45 CURS MEAS Menu

The description of the **cursor measurement menu** is shown as the following table:

Function Menu	Setting	Description
Type	OFF	The cursor is off, no measurement taking.
	Voltage	Turn on horizontal cursors and display their voltage value.
	Time	Turn on vertical cursors and display their time value.
Source	CH1, CH2	Source signal for cursor measurement.
Delta		Absolution value of the difference between two cursors.

Cursor 1		Reading of Cursor 1. Time: read time from start position-the horizontal trigger point (0s). Voltage: read voltage from ground level (0 v).
Cursor 2		Read the position of Cursor 1 (the Time is read with reference to the horizontal trigger position and the Voltage is to the ground point).

You can adjust the positions of Cursors by using POSITION controls, marked with CURSOR 1 and CURSOR 2. Now we take you through two examples to set up and use cursors for Voltage and Time measurements respectively. An input signal of waveform is used throughout this example.

Voltage Cursor measurement

- Press **CURSOR** to activate **CURS MEAS** menu.
- Press **F1** to select Voltage and Type, there are two purple horizontal lines appeared on the screen, representing CURSOR 1(on the top) and CURSOR2 (on the bottom)
- Press **F2** to select **CH1** as the **Source**. The results are shown on the screen. (See Fig.5-46).

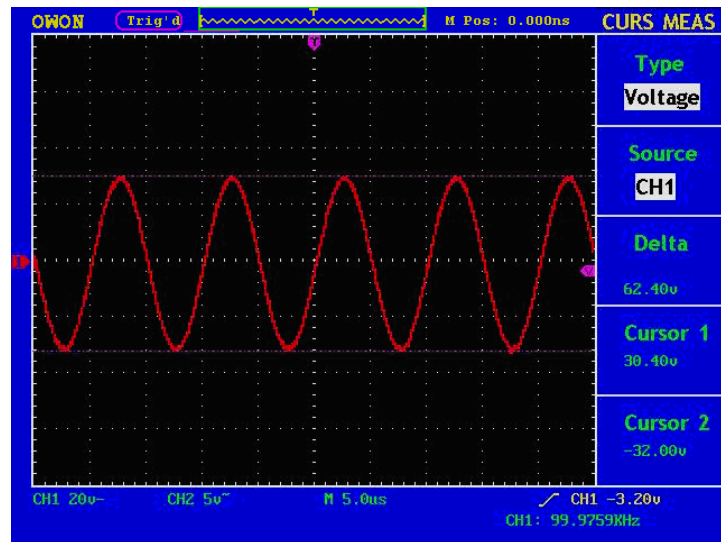


Fig.5-46 Waveform of Voltage Cursor Measurement

Time Cursor measurement

1. Press **CURSOR** to activate **CURS MEAS** menu.
2. Press **F1** to select **Time** and Type, there are two purple vertical lines appeared on the screen, representing CURSOR 1(on the left) and CURSOR2 (on the right)
3. Press **F2** to select **CH1** as the **Source**.
4. Move CURSOR1 and CURSOR2 and the results change accordingly as in Fig. Fig.5-47

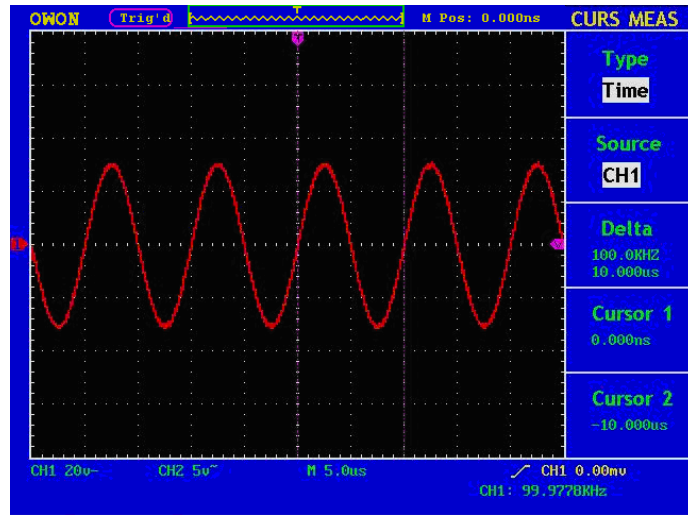


Fig.5-47 Wave Form of Cursor Measurement

The Cursor Measurement for FFT model:

Press the CURSOR button to display the cursor measurement function menu (CURS MEAS) in the screen, which includes Vamp Measurement and Freq Measurement at the mode of FFT, shown as Fig.5-48.

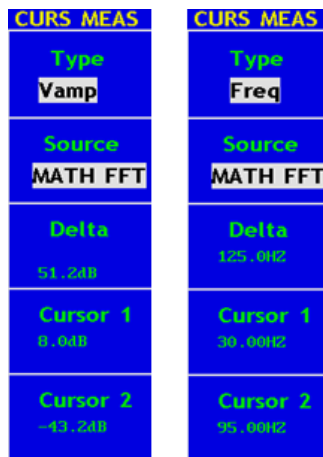


Fig.5-48 CURS MEAS Menu

The description of the **cursor measurement menu** is shown as the following table:

Function Menu	Setting	Description
Type	OFF Vamp Freq	Switch off the cursor measurement. Display the Vamp measurement cursor and menu. Display the Freq measurement cursor and menu.
Source	MATH FFT	Display the channel for the cursor measure.
Delta		Read the difference between cursors.
Cursor 1		Read the position of Cursor 1 (the Freq is read with reference to the start point of freq spectrum and the Vamp is to the cursor F).
Cursor 2		Read the position of Cursor 2 (the Freq is read with reference to the start point of freq spectrum and the Vamp is to the cursor F).

When carrying out the cursor measurement, the position of Cursor 1 can be adjusted with the CURSOR1 (VERTICAL POSITION) knob of Channel 1, and that of Cursor 2 can be adjusted with the CURSOR2 (VERTICAL POSITION) knob of Channel 2. Perform the following operation steps for the Vamp cursor measurement :

1. Press **CURSOR** and recall the CURS MEAS menu.
2. Press **F1** and choose Vamp for Type, with two purple dotted lines displayed along the horizontal direction of the screen indicating CURSOR1 and CURSOR2.
3. Adjust the positions of CURSOR1 and CURSOR2 according to the measured waveform, with the absolute value of the Vamp amplitude difference between Cursor 1 and Cursor 2 displayed in the increment window. The current position of Cursor1 is displayed in the Cursor1 window and that of Cursor2 is displayed in the Cursor2 window (see **Fig.5-49**).

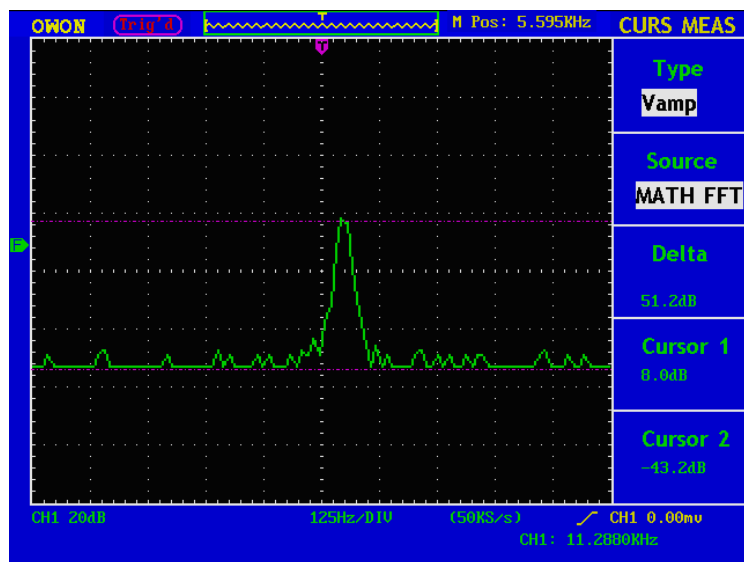


Fig.5-49 wave of Vamp cursor measurement

Carry out the following operation steps for the Freq cursor measurement :

1. Press **CURSOR** and recall the CURS MEAS menu.
2. Press **F1** and choose Freq for Type, with two purple dotted lines displayed along the vertical direction of the screen indicating the corresponding Cursor 1 and Cursor 2
3. Adjust the positions of CURSOR1 and CURSOR2 according to the measured waveform, with the period and frequency of Cursor1 and Cursor 2 displayed in the increment window. The current position of Cursor1 is displayed in the Cursor1 window and that of Cursor2 is displayed in the Cursor2 window (see **Fig.5-50**).

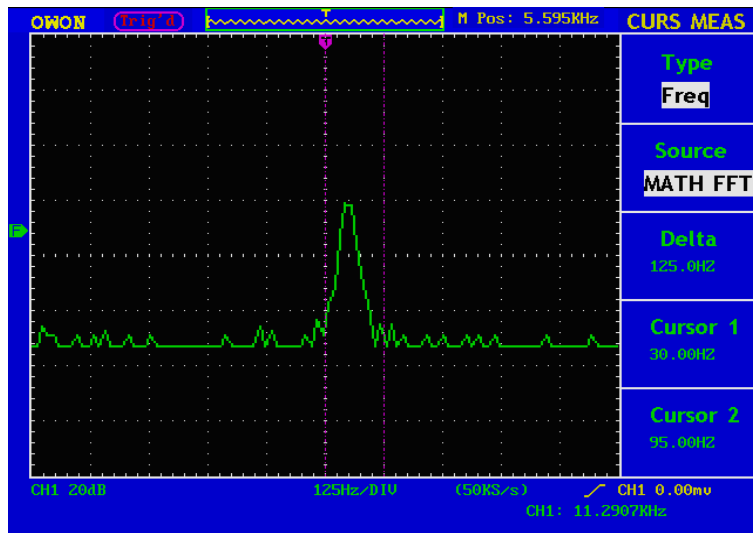




Fig.5-50 wave of Freq cursor measurement

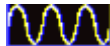

How to use Autoscale

The function is applied to follow-up signals automatically even if the signals change at any time. Autoscale enables the instrument to set up trigger mode, voltage division and time scale automatically according to the type, amplitude and frequency of the signals.

The menu is as follows:

Function Menu	Setting	Instruction
Autoscale	OFF	Turn off Autoscale
	ON	Turn on Autoscale
Mode	Vertical	Only adjust vertical scale according to input signal.
	Horizontal	Only adjust horizontal scale according to input signal.
	HORI—VERT	Adjust both vertical and horizontal scales according to input signal.
Wave		Display only one or two cycles in waveform.
		Display Multi-cycles in waveform.

The function can work on both Channel 1 and Channel 2 simultaneously. Here is an example for how to use the function:

1. Press **Autoscale** to activate its menu.
2. Press **F1** next to Autoscale to select **ON**.
3. Press **F2 Mode** to select Horizontal- Vertical.
4. Press **F3** to choose  and press F3 to change to . See Fig. 5-51 for details.

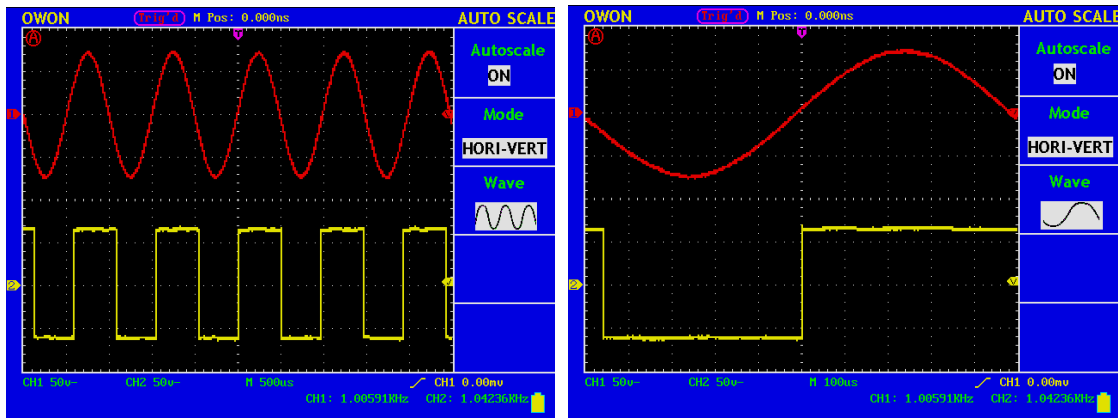



Fig.5-51: Multi cycles mode

single cycle mode

Note: Things you should be ware when turning on Autoscale.

1. The symbol  is flickering on the top left corner of screen every half second.
2. The oscilloscope is setting Triggers automatically for the incoming signal based on its best approach. Access from front panel to trigger controls is disabled. A warning message will be displayed on the bottom left corner of the screen when trying to change submenus of Trigger controls.
3. If the display mode is in XY and STOP is turned on, pressing **AUTO SET** to enter into Autoscale. The oscilloscope will be set to YT mode and ATUO triggering.
4. Oscilloscope is set as DC coupling with AUTO Triggering. A warning message is displayed when trying to change these settings.
5. The oscilloscope will turn off **Autoscale** if user is trying to adjust vertical position, voltage division, trigger level or time scale for CH1 or CH2. To back to **Autoscale**, Press **AUTOSET**.
6. The oscilloscope is always on main time base.
7. The oscilloscope is turned into Peak Detection mode if it is in Average mode.
8. When video triggering, the horizontal time scale is 50us. If one channel is showing edge signal, the other channel is showing video one, the time scale refers to 50us as video one as standard.

How to Use Executive Buttons

AUTOSET

It's a very useful and quick way to apply a set of pre-set functions to the incoming signal, and display the best possible viewing waveform of the signal and also works out some measurement for user as well. The following table gives the details of functions applied to the signal when using **AUTOSET**.

Function Items	Setting
Acquisition Mode	Current
Vertical Coupling	DC
Vertical Scale	Adjust to the proper division.
Bandwidth	Full
Horizontal Level	Middle

Horizontal Sale	Adjust to the proper division
Trigger Type	Current
Trigger Source	Show the minimum number of channels.
Trigger Coupling	Current
Trigger Slope	Current
Trigger Level	Mid-point Setting
Trigger Mode	Auto
Display Format	YT

RUN/STOP

Enable or disable sampling on input signals.

Notes:

When there is no sampling at STOP state, user is still able to change vertical division or time base for waveform within a certain range. If the time base is $\leq 50\text{ms}$, the time base can be adjusted 4 divisions downwards.

U-DISK COPY

Insert U disk into USB port, then press "COPY" button and you can save the waveform data into the U disk. To change between available formats, see the "Carry" option in the "Display" Settings menu as described on P47.

There is two formats available for choice: Vector format and Bitmap which the corresponding name will be WAVE1.BIN、WAVE2.BIN、WAVE3.BIN.....or WAVE1.BMP、WAVE2.BMP、WAVE3.BMP..... Then you can open the files in computer by connecting USB disk to computer.

Notes:: During the U disk saving procedure, some notes such as "Waveform saving" 、"Waveform saved" 、"USB already connected" 、"USB connection interrupt " etc. will be prompted.

USB disk Requirements

The supported format of the USB disk: FAT32 file system, the allocation unit size cannot exceed 4K, mass storage USB disk is also supported. If the USB disk doesn't work properly, format it into the supported format and try again. Follow any of the following two methods to format the USB disk: using system-provided function and using the formatting tools. (The USB disk of 8 G or 8 G above can only be formatted using the second method – using the formatting tools.)

Use system-provided function to format the USB disk

1. Connect the USB disk to the computer.
2. Right click **Computer**-→ **Manage** to enter Computer Management interface.
3. Click Disk Management menu, and information about the USB disk will display on the right side with red mark 1 and 2.

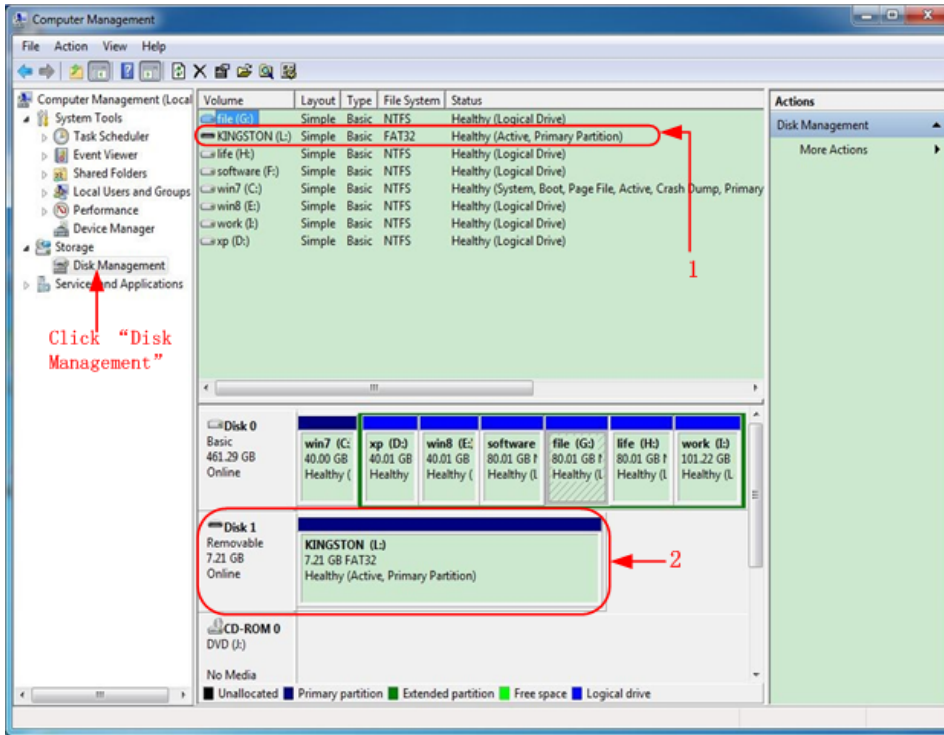


Figure: Disk Management of computer

- Right click 1 or 2 red mark area, choose **Format**. And system will pop up a warning message, click **Yes**.

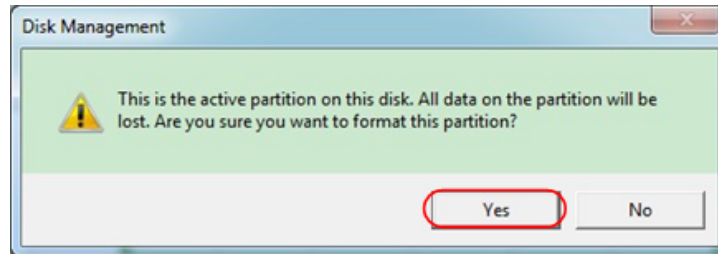


Figure: Format the USB disk warning

- Set File System FAT32, Allocation unit size 4096. Check "**Perform a quick format**" to execute a quick format. Click **OK**, and then click **Yes** on the warning message.

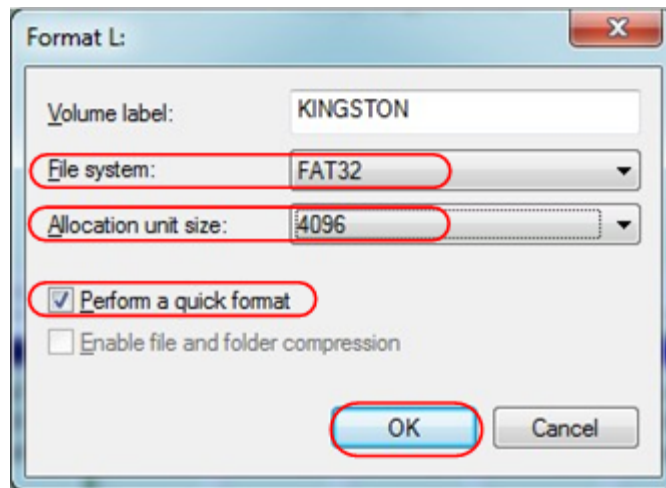


Figure: Formatting the USB disk setting

6. Formatting process.

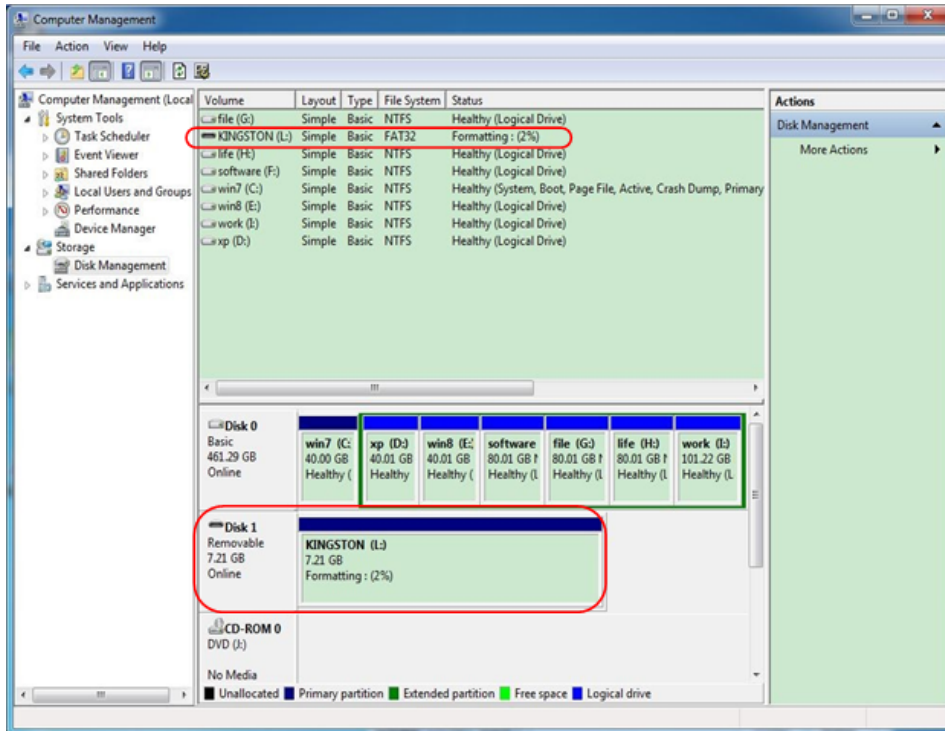


Figure: Formatting the USB disk

7. Check whether the USB disk is FAT32 with allocation unit size 4096 after formatting.

Use Minitool Partition Wizard to format

Download URL: <http://www.partitionwizard.com/free-partition-manager.html>

Tip: There are many tools for the USB disk formatting on the market, just take Minitool Partition Wizard for example here.

1. Connect the USB disk to the computer.
2. Open the software **Minitool Partition Wizard**.
3. Click **Reload Disk** on the pull-down menu at the top left or press keyboard F5, and information about the USB disk will display on the right side with red mark 1 and 2.

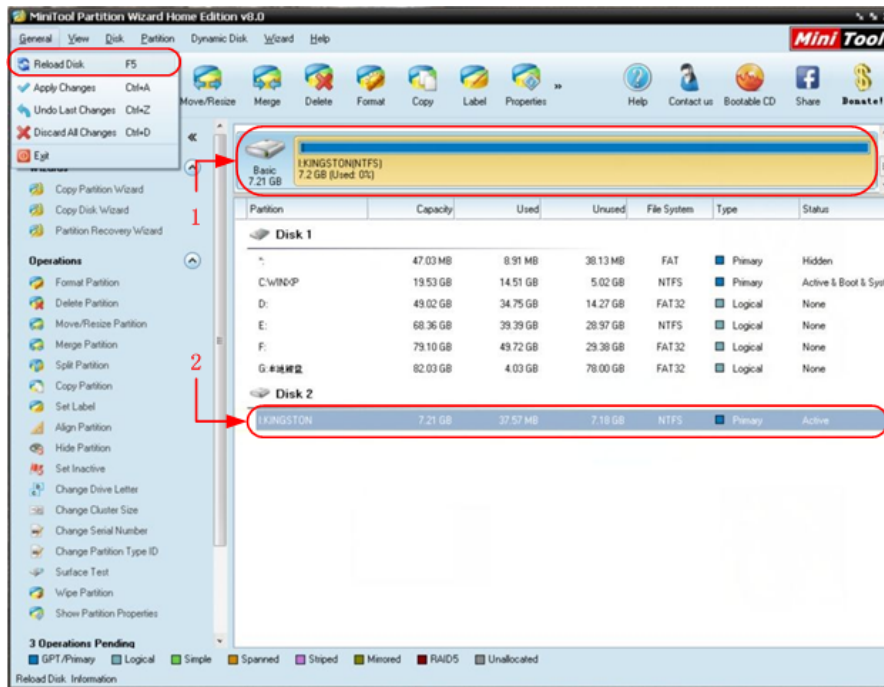


Figure: Reload Disk

- Right click 1 or 2 red mark area, choose **Format**.

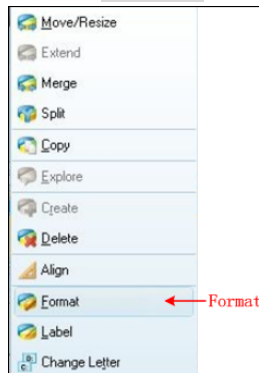


Figure: Choose format

- Set File System FAT32, Cluster size 4096. Click **OK**.

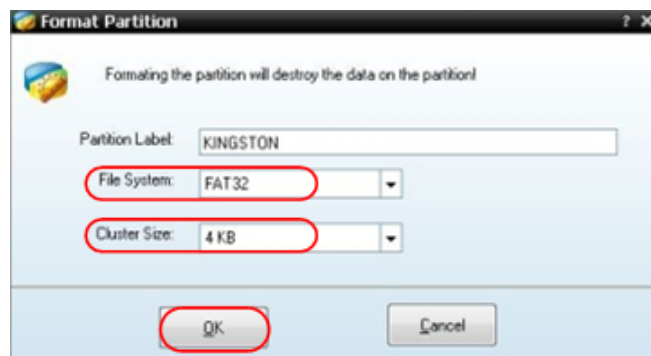


Figure: Format setting

- Click **Apply** at the top left of the menu. Then click **Yes** on the pop-up warning to begin formatting.

5. Advanced User Guidebook

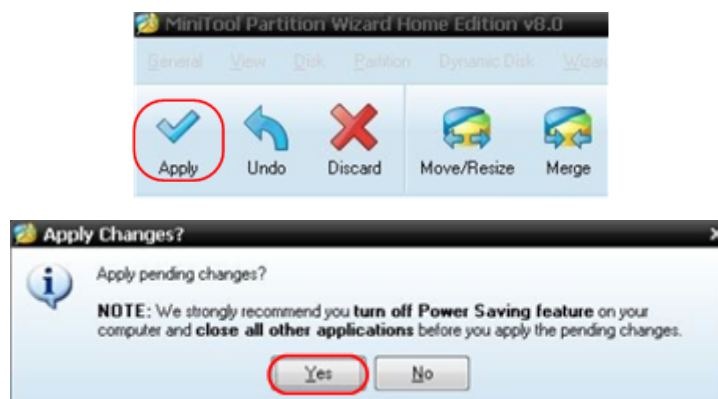


Figure: Apply setting

7. Formatting process

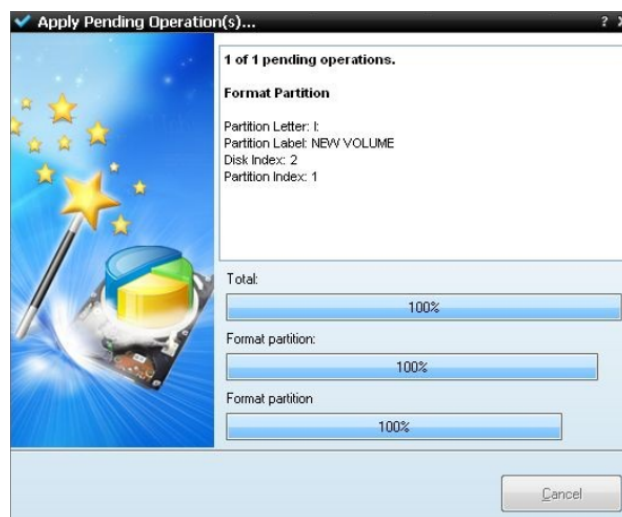


Figure: Format process

8. Format the USB disk successfully



Figure: Format successfully

5.2 Logic analyzer

How to set sampling system

Sampling system is to set sample rate, storage depth and filter. Different sampling setting will result in different measure results. In the same storage depth, the higher sample rate set, the shorter the continuance time for signal will be. If the sample rate set too low, narrower pulse signal may get lost. So the sample rate and storage depth should be set correctly according to the actual measuring signal. Press "E (ACQU)" and display menu as the Fig.5-52:

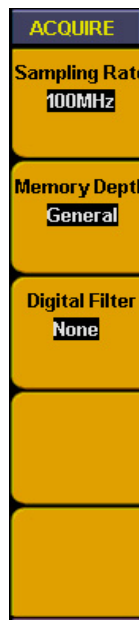


Fig.5-52: Sampling menu

Sample menu function list:

Function	Setting	Instruction
Sample rate	20S/s to 1GS/s	
Storage depth	Low memory General Deep memory	Storage depth of 16K Storage depth of 256K Storage depth of 4M
Digital Filter	None 1 2	Filter closed Filter one pulse of sample width Filter two pulse of sample width

5. Advanced User Guidebook

Listing of corresponding continuance time to different sample rate and storage depth:

Sample rate	Storage depth	Continuance time	Sample rate	Storage depth	Continuance time
1GHz	Low memory	16us	100kHz	Low memory	160 ms
				General	2.56 s
				Deep memory	40 s
500MHz	Low memory	32 us	50kHz	Low memory	320 ms
				General	5.12 s
				Deep memory	80 s
250MHz	Low memory	64 us	20kHz	Low memory	800 ms
				General	12.8 s
				Deep memory	200 s
125MHz	Low memory	128 us	10kHz	Low memory	1.6 s
	General	2.048 ms		General	25.6 s
	Deep memory	32 ms		Deep memory	400 s
62.5MHz	Low memory	256 us	5kHz	Low memory	3.2 s
	General	4.096 ms		General	51.2 s
	Deep memory	64 ms		Deep memory	800 s
25MHz	Low memory	640 us	2kHz	Low memory	8 s
	General	10.24 ms		General	128 s
	Deep memory	160 ms		Deep memory	2000 s
12.5MHz	Low memory	1.28 ms	1kHz	Low memory	16 s
	General	20.48 ms		General	256 s
	Deep memory	320 ms		Deep memory	4000 s
5MHz	Low memory	3.2 ms	500Hz	Low memory	32 s
	General	51.2 ms		General	512 s
	Deep memory	800 ms		Deep memory	8000 s
2.5MHz	Low memory	6.4 ms	200Hz	Low memory	80 s
	General	102.4 ms		General	1280 s
	Deep memory	1.6 s		Deep memory	20000 s
1MHz	Low memory	16 ms	100Hz	Low memory	160 s
	General	256 ms		General	2560 s
	Deep memory	4 s		Deep memory	40000 s
500kHz	Low memory	32 ms	50Hz	Low memory	320 s
	General	512 ms		General	5120 s
	Deep memory	8 s		Deep memory	80000 s
200kHz	Low memory	80 ms	20Hz	Low memory	800 s
	General	1.28 s		General	12800 s
	Deep memory	20 s		Deep memory	200000 s

Follow up steps to set the measurement for data bus of 33M clock:

Sample rate: 125M Storage depth: 4M

Filter: none

Setting steps as below:

1. Press "E(ACQUIRE)" and sample menu appears.
2. Press "F1"repeatedly or turn "CH1 Volts/div" knob till sample rate set as "125M"

3. Press "F2" till storage depth display as "Deep Memory".
 4. Press "F3" till digital filter display as "None".
- Then sample system setting finished (refer to Fig.5-53).

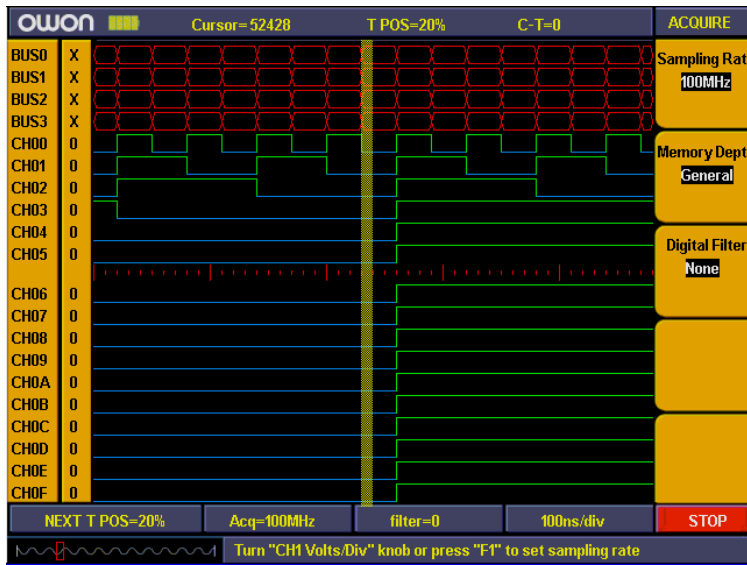


Fig. 5-53: Sampling setting

How to set trigger system

Trigger system including "Trigger level" adjust knob, "Trigger menu", "SET 50%", "Set to Zero". Trig level adjust knob is to adjust trigger position. Since the digital storage depth is fixed so the proportion of storage data between pre-trigger points and re-trigger ones depend on trigger position. Trigger mode including: Edge trigger, bus trigger, pattern trigger, sequential queue trigger, distributed queue trigger.

1. **Edge trigger**: make a channel as trigger source and set rising edge, falling edge or either edge as trigger condition to generate trigger. Edge trigger menu refer to Fig.5-54.



Fig.5-54: Edge trigger menu

Edge trigger function menu as below:

Function	Settings	Instructions
Signal choice	CH00~CH0F	CH00-CH0F can be set as trigger resource
Slope	Rising	Trigger on the rising edge.
	Falling	Trigger on the falling edge.
	Either	Trigger either on rising edge or falling edge.

For example: to measure a 3 lines SPI signal which includes enable, clock and data. The data get into effective when enable is low voltage. We use CH00、CH01、CH02 to measure the data, CH00 to measure enable signal, CH01 and CH02 to measure clock and data.

Trigger setting steps as below:

- A. Press "**Trigger menu**" and menu appears.
- B. Press "**F1**" till trigger mode display as "**Edge**".
- C. Press "**F2**" till source display as "**CH00**"
- D. Press "**F3**" till type display as "**Falling**".

Then trigger setting is finished (refer to Fig.5-55) and ready for data acquisition.

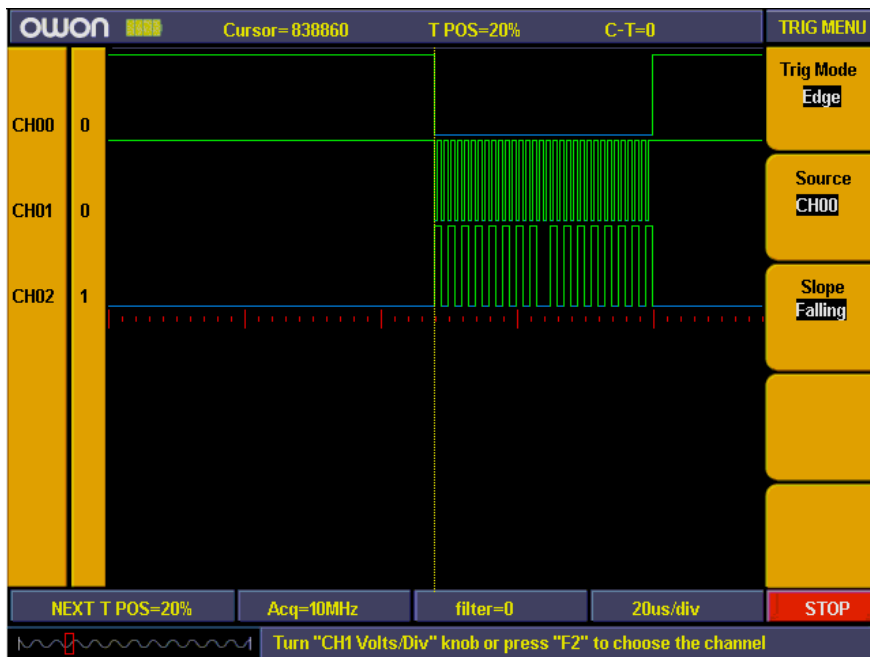


Fig.5-55: Edge trigger setting

2. **BUS trigger**: set BUS as trigger source and make data on BUS as the trigger condition to make trigger. BUS trigger menu refer to Fig.5-56



Fig.5-56: Bus trigger menu

Bus trigger menu as below:

Function	Setting	Instruction
Source	BUS0~BUS3	BUS0 to BUS3 can be set as trigger source
Code	0x0000~0xffff (HEX) 0~65535 (DEC)	Can be set discretionarily between 0x0000 and 0xffff (HEX) or between 0 and 65535 (DEC) according to the bus and code setting.
Qualifier	= >= <=	Trigger occur when the Bus value equal to the set code. Trigger occur when the Bus value is more than or equal to the set code Trigger occur when the Bus value is less than or equal to the set code

For example, to measure an 8 bit data signal we need to observe when data value as 0X18 how the data changed before and after. We set the BUS0 to include CH00~CH07 and use channel CH00~CH07 to measure the signal. Trigger setting steps as below;

- A. Press "**Trigger menu**" and menu appears.
- B. Press "**F1**" till trigger mode display as "**Bus**"
- C. Press "**F2**" till signal source display as "**BUS0**"
- D. Press "**F3**" and data in code type as red background and green digital indicator on, then insert data value "18" and set code as "**0X18**". Press "**F3**" again and red background disappeared. Repeat operation of step D if setting error or need to be modified,
- E. Press "**F4**" till type display as "="
- F. Turn "**Trigger level** " adjust knob or press "**set 50%**"till trigger position display as "**NEXT T POS = 50%**".

BUS trigger setting is finished and ready for data acquisition (ref to Fig.5-57).

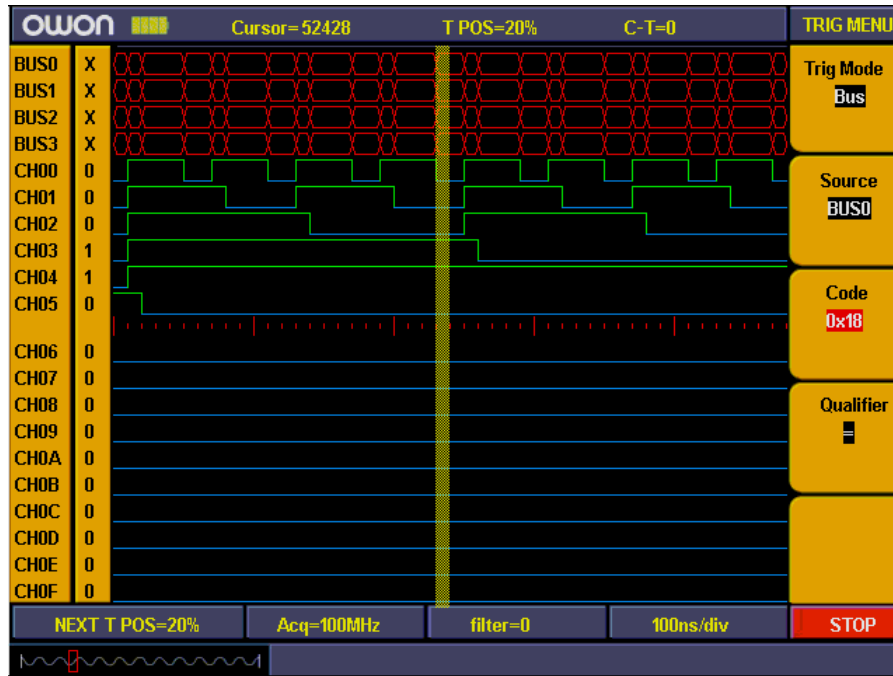


Fig.5-57: Bus trigger

3. **Pattern trigger:** Set channel as signal source and make high/low voltage for channel as trigger condition combination to get trigger (refer to Fig.5-58).



Fig.5-58: Pattern trigger menu

Pattern trigger menu as below:

Function	Setting	Instruction
Channel choice	CH00~CH0F x0100000 00000000	Select the channel to set signal pattern. 16 channel status indicator. X: don't care 0: low 1: high

CH00~CH0F	Don't Care Low High	No trigger occurs. Trigger occur when signal on the low level Trigger occurs when signal on the high level.
-----------	---------------------------	---

To observe the 16 channel data need to know how data changed before and after when "BIT0-BIT3" STATE is "0111".

- A. Press "**Trigger menu**" and menu appears.
- B. Press "**F1**" till trigger mode display as "**Pattern**"
- C. Press "**F2**" or turn "**CH1 Volts/div**" knob till "**CH SEL**" display as "**CH00**"
- D. Press "**F3**" till F3 window display as "**CH00/High**" and "**CH00**" in F2 window display as "**1**".
- E. Repeat operation of step D and set CH01, CH02 to "**High**" and CH03 as "**Low**", CH04~CH0F set as "**Don't care**".

Pattern trigger setting finished (refer to Fig.5-59) and ready for data acquisition.

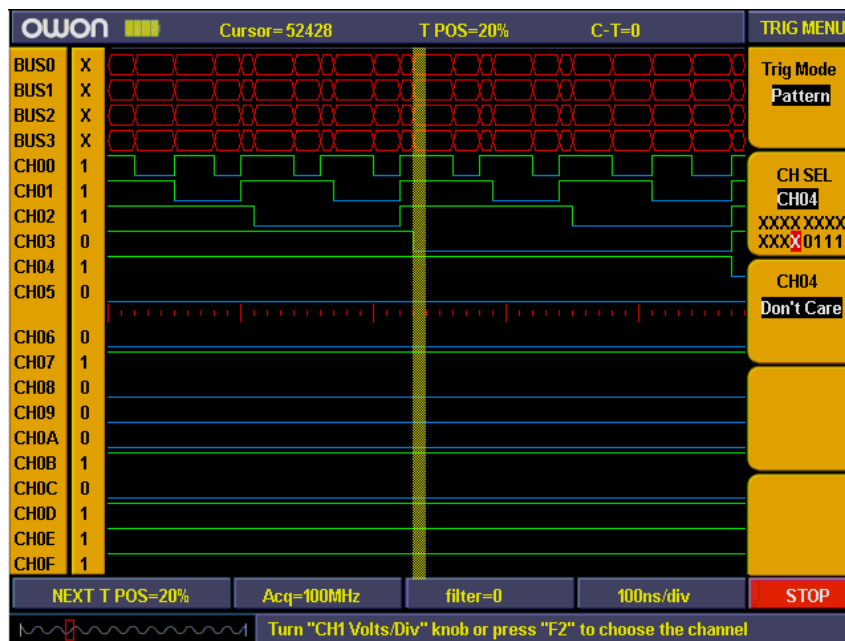


Fig.5-59: Pattern trigger

4. **Sequential queue trigger**: make BUS as trigger source and continuous setting data in BUS as trigger condition to generate trigger and also can set 8 data at the same time.(See Fig.5-60)

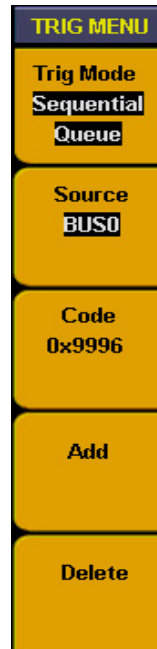


Fig.5-60: Sequential queue trigger

Sequential queue trigger function as below:

Function	Setting	Instruction
Source	BUS0~BUS3	Select the trigger source from BUS0~BUS3
Code	0x0000~0xffff (HEX) 0~65535 (DEC)	Can be set discretionarily between 0x0000 and 0xffff (HEX) or between 0 and 65535 (DEC) according to the bus and code setting.
Add		Add the code type to the queue
Delete		Delete the code type from the queue

For example, to set a 16 bit data Bus signal, there will have 4 value as 0X9999、0X9998、0X9997、0X9996 in the bus. We set BUS0 to include 16 measure channels and make above 4 values as trigger condition to observe the data bus. Trigger setting follow up below steps:

- A. Press "**Trigger MENU**" and menu appears.
- B. Press "**F1**" till trigger mode display as "**Sequential Queue**".
- C. Press "**F2**" till signal source display as "**BUS0**"
- D. Press "**F3**" and data in code type as red background and green digital indicator on, then insert data value "**0X9999**" and set code as "**0X9999**". Press "**F3**" again and red background disappeared. Repeat operation of step D if setting error or need to be modified,
- E. Press "**F4**" and add setting value into the trigger queue, then info window will display the value of "**0X9999**".
- F. Repeat the operation of step D. E, and add "**0X9998**"、"**0X9997**"、"**0X9996** to trigger queue. Then info window will display value of "**0X9999**"、"**0X9998**"、"**0X9997**"、"**0X9996**".
- G. Press "**F5**" and delete the queue value if queue adding in error and add again.
- H. Turn "**Trigger level**" adjust knob or press "**set 50%**"till trigger position display as "**NEXT T POS = 50%**".

Then sequential queue trigger setting finished (refer to Fig.5-61) and data ready for acquisition.

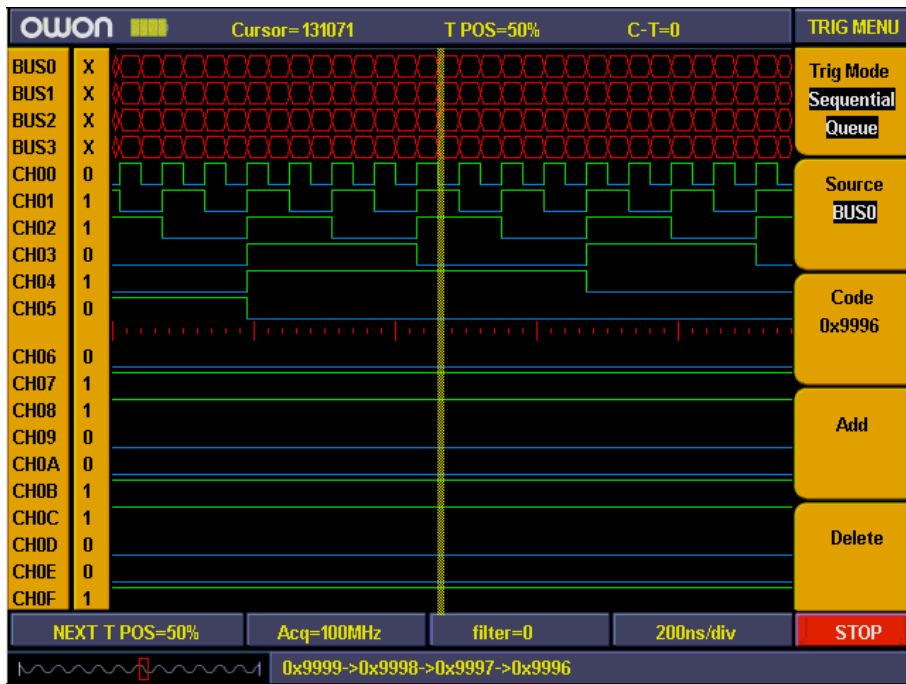


Fig.5-61: Sequential queue trigger

5. **Distributed queue trigger:** make BUS as trigger source and dis-continuous setting data in BUS as trigger condition to generate trigger and also can set 8 data at the same time.

Distributed queue trigger menu refer as Fig.5-62

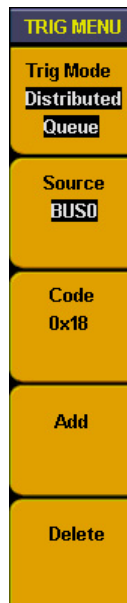


Fig.5-62: Distributed queue trigger menu

Distributed queue trigger function as below:

Function	Setting	Instruction
Source	BUS0~BUS3	Select the trigger source from BUS0~BUS3
Code	0x0000~0xffff (HEX) 0~65535	Can be set discretionarily between 0x0000 and 0xffff (HEX) or between 0 and 65535 (DEC) according to the bus and code setting.

	(DEC)	
Add		Add the code type to the queue
Delete		Delete the code type from the queue

Setting operation are same as sequential trigger setting.

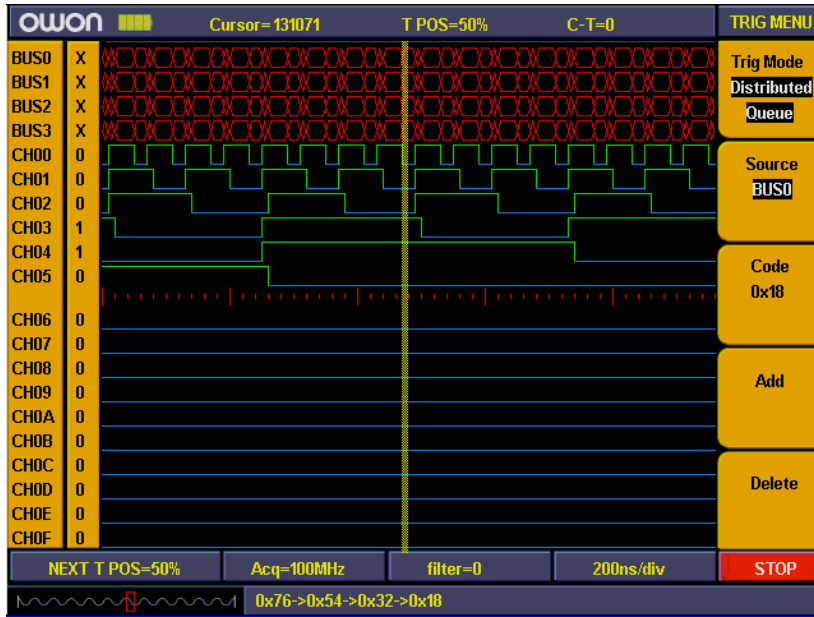


Fig.5-63: Distributed queue trigger

6、 **Data width queue trigger:** Make BUS as trigger source and continuous duration in BUS as trigger condition to generate trigger. Duration trigger menu refer to Fig.90

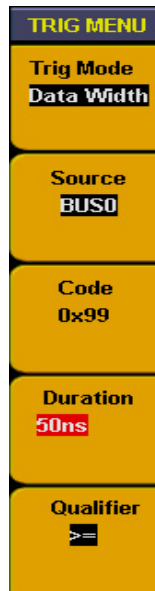


Fig.5-64: Duration trigger menu

Duration trigger function as below:

Function	Setting	Instruction
Source	BUS0~BUS3	Select the trigger source from BUS0~BUS3
Code	0x0000~0xffff (HEX) 0~65535 (DEC)	Can be set discretionarily between 0x0000 and 0xffff (HEX) or between 0 and 65535 (DEC) according to the bus and code setting.

5. Advanced User Guidebook

Duration	10ns~50s	The duration width can be set from 10ns (1-2-5) to 10.00us (1-2-5) according to the sampling rate from high to low.
Qualifier	>=	Trigger occur on condition that the bus value is equal to the code type and the duration is more than or equal to the duration width.
	<=	Trigger occur on condition that the bus value is equal to the code type and the duration is less than or equal to the duration width.

For example: measure a 16 bit data bus signal, bus will appear data of "0X99" and continuous time is 50ns. We set BUS0 to include 16 measurement channels and sample rate as "100M", trigger setting as duration trigger. Setting steps as below:

- A、 Press "**Trigger MENU**" and menu appears.
- B、 Press "**F1**" till trigger mode display as "**Data Width**"
- C、 Press "**F2**" till signal resource display as "**BUS0**"
- D、 Press "**F3**" and data in code type as red background and green digital indicator on, then insert data value "**0X99**". Press "**F3**" again and red background disappeared. Repeat operation of step D if setting error or need to be modified,
- E、 Press "**F4**" and duration in menu setting window correspond to F4 display red background. Turn "**CH1 Volts/Div**" knob and set duration as "**50ns**".
- F、 Press "**F5**" till qualifier display as ">="
- G、 Turn "**Trigger level**" adjust knob or press "**set 50%**"till trigger position display as "**NEXT T POS = 50%**".

Then duration trigger setting finished (refer to **Fig.5-65**) and ready for data acquisition.

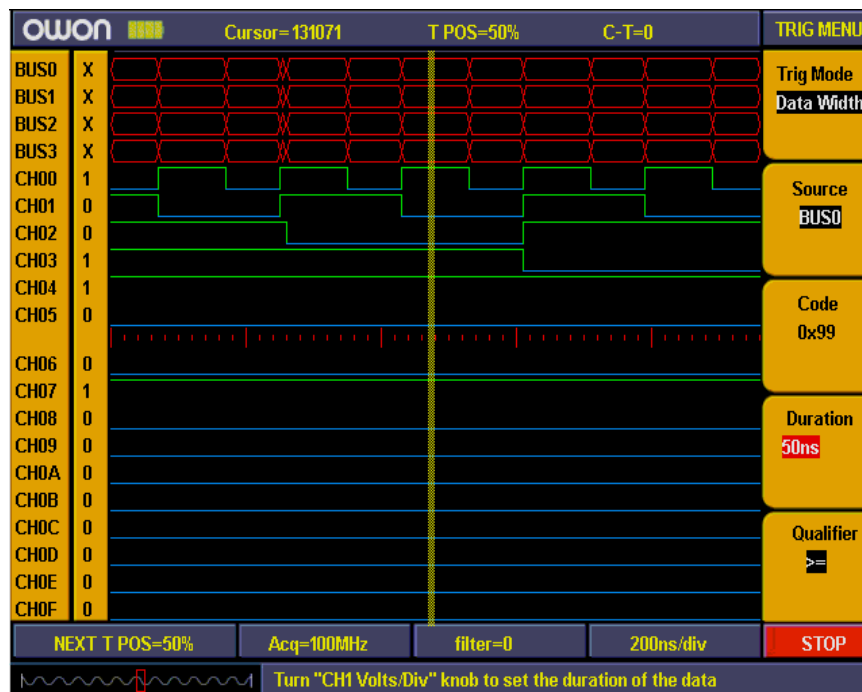


Fig.5-65: Data width trigger

How to set threshold

Threshold setting is quite important because wrong setting will result in wrong

measurement. For example, if measure signal is LVCMOS1.8V and set threshold as "CMOS/ (2.5V) " then all the measurement data will become "0". Threshold setting menu refer to Fig.5-66

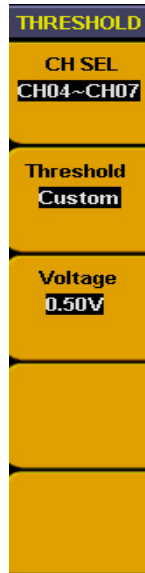


Fig.5-66: Threshold setting menu

Threshold menu function as below

Function	Setting	Instruction
CH SEL	CH00~CH03 CH04~CH07 CH08~CH0B CH0C~CH0F	16 channels can be divided into 4 groups to have individual setting
Threshold voltage	CMOS/(2.5V) LVCMOS3.3/(1.7V) LVCMOS2.5/(1.3V) LVCMOS1.8/(0.9V) Custom	CMOS level and set threshold voltage as 2.5V LVCMOS3.3V level and set threshold voltage as 1.7V LVCMOS2.5V level and set threshold voltage as 1.3V LVCMOS1.8V level and set threshold voltage as 0.9V Level can be set discretionarily.
Voltage	-10~ +10V(forward by 0.05V pace)	In custom, the voltage can be set from -10V to +10V with the pace of 0.05V.

For example, Measure a batch of CMOS voltage data signal in channel of CH00~CH03 and a batch of 1V voltage data in CH04~CH07. Threshold voltage setting steps as below:

- A、 Press "1 (threshold) " and menu appears.
- B、 Press "F1" till channel source display as "CH00~CH03"
- C、 Press "F2" to choose threshold as "CMOS/ (2.5V) "
- D、 Press "F1" till channel source display as "CH04~CH07"
- E、 Press "F2" to choose threshold as "custom". Menu setting correspond to F3 display the setting voltage value.
- F、 Turn "CH1 Volts/div" knob and set voltage value as "0.50V"

Threshold voltage setting finished (refer to Fig.5-67).

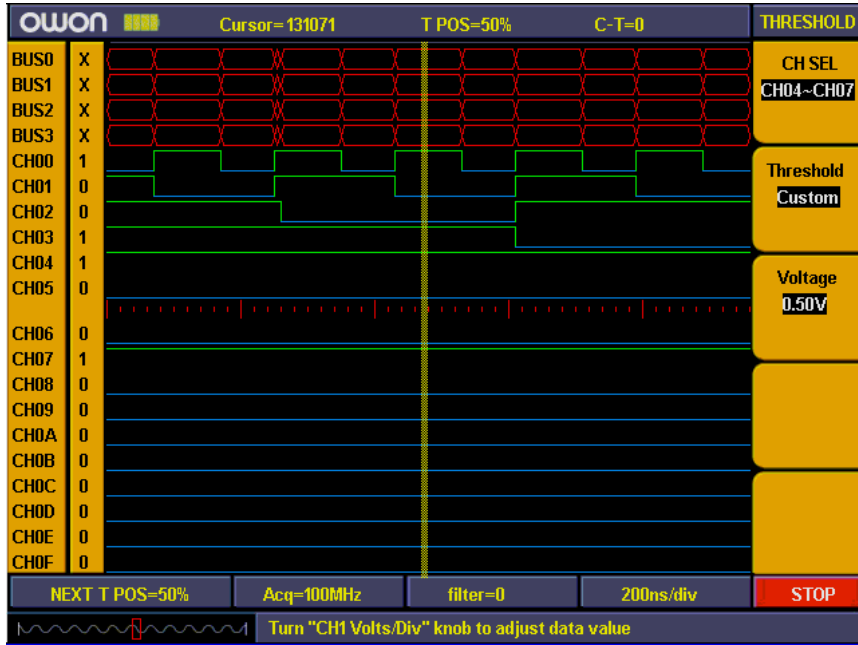


Fig.5-67: Threshold custom setting

How to set display system

Display system is to set on/off for channel and BUS, also to adjust the contrast of panel display. Press "A(DISPLAY)" and panel display as Fig.5-68

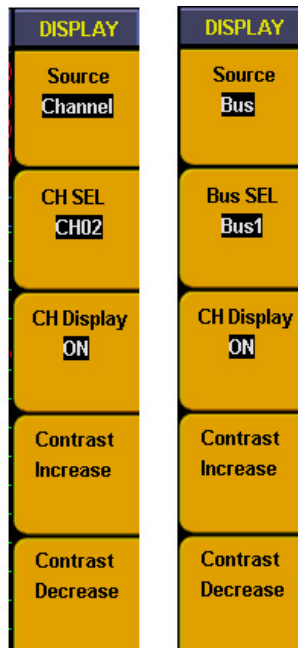


Fig.5-68: Display menu

Display function menu as below;

Function	Setting	Instruction
Source	BUS Channel	Choose resource as BUS Choose resource as channel
BUS SEL. CH SEL	BUS0~BUS3 CH00~CH0F	Among BUS0~BUS3 Among CH00~CH0F

display	ON OFF	BUS or Channel on Bus or Channel off
contrast Increase		Increase panel display contrast
contrast Decrease		Decrease panel display contrast

For example, display channel as CH00~CH03 and BUS as BUS0, other channels and BUS all off. Follow up below steps:

- 1、 Press "A(DISPLAY)" and display menu appears
- 2、 Press "F1" till signal source display as "BUS"
- 3、 Press "F2" till BUS No. display as "BUS0"
- 4、 Press "F3" to choose signal display as "ON".
- 5、 Press "F2" till BUS No. display as "BUS1".
- 6、 Press "F3" to choose signal display as "OFF". Repeat the operation of steps 5.6 and set BUS2, BUS3 as "OFF".
- 7、 Press "F1" till signal source display as "Channel"
- 8、 Press "F2" or turn "CH1 Volts/div" knob till channel display as "CH00".
- 9、 Press "F3" to choose signal source as "ON".
- 10、 Repeat operation of steps 8.9 and set CH01、 CH02、 CH03 as "ON".
- 11、 Press "F2" or turn "CH1 Volts/Div" knob till channel display as CH04.
- 12、 Press "F3" to choose signal display as "OFF".
- 13、 Repeat operation of steps 8.9 and set CH05~CH0F all as "OFF".

Channel display setting finished (refer to Fig.5-69)

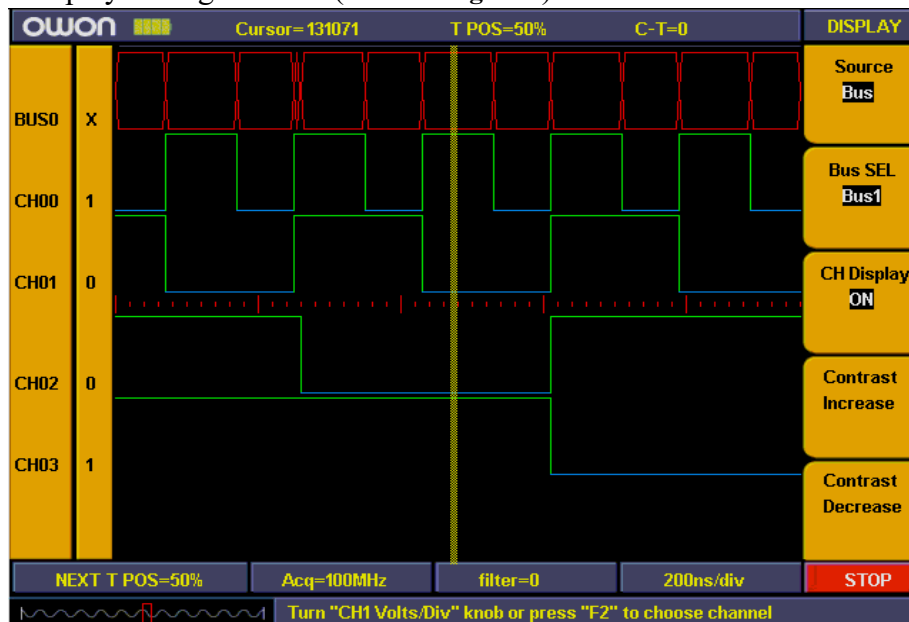


Fig.5-69: Display setting

How to set BUS

LA includes four groups BUS (BUS0~BUS3). Every group can cover any channel even all channels. BUS menu display as Fig.5-70



Fig.5-70: Bus menu

BUS setting menu as below:

Function	Setting	Instruction
BUS	BUS0~BUS3	Choose BUS for operating
Channel	CH0F~CH00 1X111111 11111111	Choose any channel among CH00~CH0F BUS channel complex indication: 1 for include; X for exclude
CH0F~CH00	Include Exclude	The bus selected includes this channel The bus selected excludes this channel.
Code Type	HEX DEC	All of the code type and measured value are HEX All of the code type and measured value are DEC

For example, to set BUS0 as BUS to include CH00, CH01, CH02, CH03 and code as hex system. Follow up as below:

1. Press "**0(BUS)**" to and BUS menu appears
 2. Press "**F1**" till BUS display as "**BUS0**"
 3. Press "**F2**" or turn "**CH1 Volts/div**" knob till channel display as "**CH00**"
 4. Press "**F3**" and set CH00 as "**Include**". Then Channel CH00 refer to display of "**1**"
 5. Repeat the operation of steps 2. 3 and set CH01, CH02, CH03 as "Include" and other channel as "exclude". Then "**CH SEL**" display as "**XXXXXXXXXXXX1111**". BUS setting finished.
 6. Press "**F4**" and set code type as "**HEX**"
- BUS setting is finished (refer to Fig.5-71).

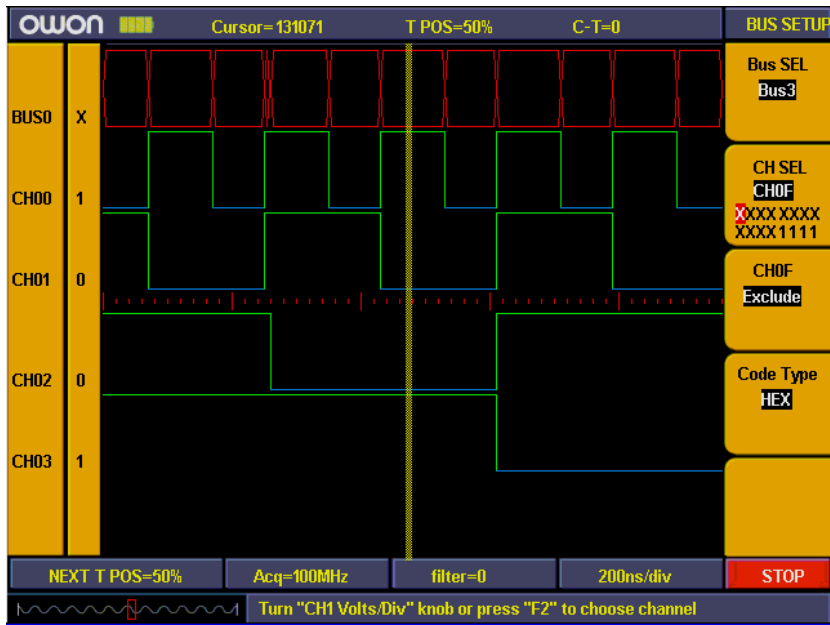


Fig.5-71: Bus setting

How to measure

Measurement can take auto measure for values of 4 BUS synchronously. Press "measure" and BUS value for current cursor position will display directly in measurement window. BUS0 include CH00~CH03, BUS1 include CH00~CH07, BUS2 include CH00~CH0B, BUS3 include CH00~CH0F. 4 BUS auto measurement display as Fig.5-72

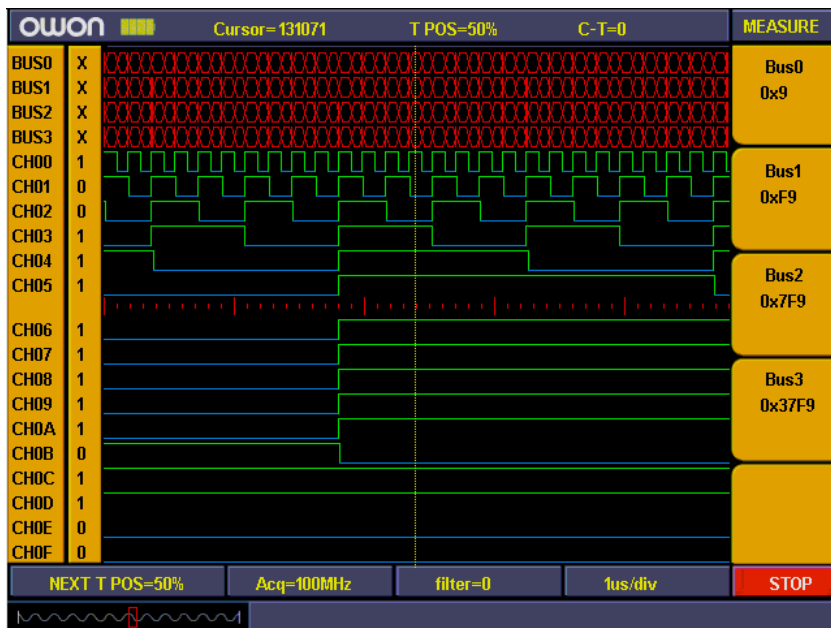


Fig.5-72: Bus measurement

How to save and recall

Use the storage menu to save or recall waveforms and setting. The storage depth of waveform for sampling storage is normal (256K) and low storage (16K). And it can be divided into 4 groups. Memory setting includes current sampling setting, BUS setup,

display setting, threshold setting and trigger setting. And it is possible to save 10 groups of settings. Waveform storage and setting storage menu display as Fig.5-73.

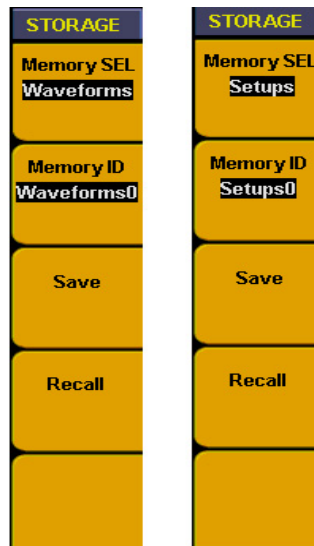


Fig.5-73.: Storage menu

Storage menu instruction as below:

Function	Setting	Instruction
Memory SEL	Waveform Setups	Waveform for storage or recall Setups for storage or recall
Memory ID	Waveform0~Waveform3 Setups 0~Setups 9	Storage 4 groups of waveform Storage 10 groups of setups
Save		Save current waveform/setting in designated No.
Recall		Recall waveform/ setups in designated No.

For example, to set "WAVE 0" in memory ID to save current waveform and "setting 0" to save current setting. Follow up below steps:

1. Press "C(SAVE/REL)" after data acquisition finished and storage menu appears
2. Press "F1" till storage display as "Waveform"
3. Press "F2" till memory ID. Display as "Waveform 0"
4. Press "F3" to save current display waveform. Info window will show "Waveform saving" then show as "Waveform saved successfully" when storage finished.
5. Press "F1" till memory SEL as "Setups"
6. Press "F2" till memory ID. display as "Setups 0"
7. Press "F3" to save current various settings. Info window show "Setting saved successfully".
8. Press "F4" to recall the memory waveform or settings (refer to Fig.5-74)

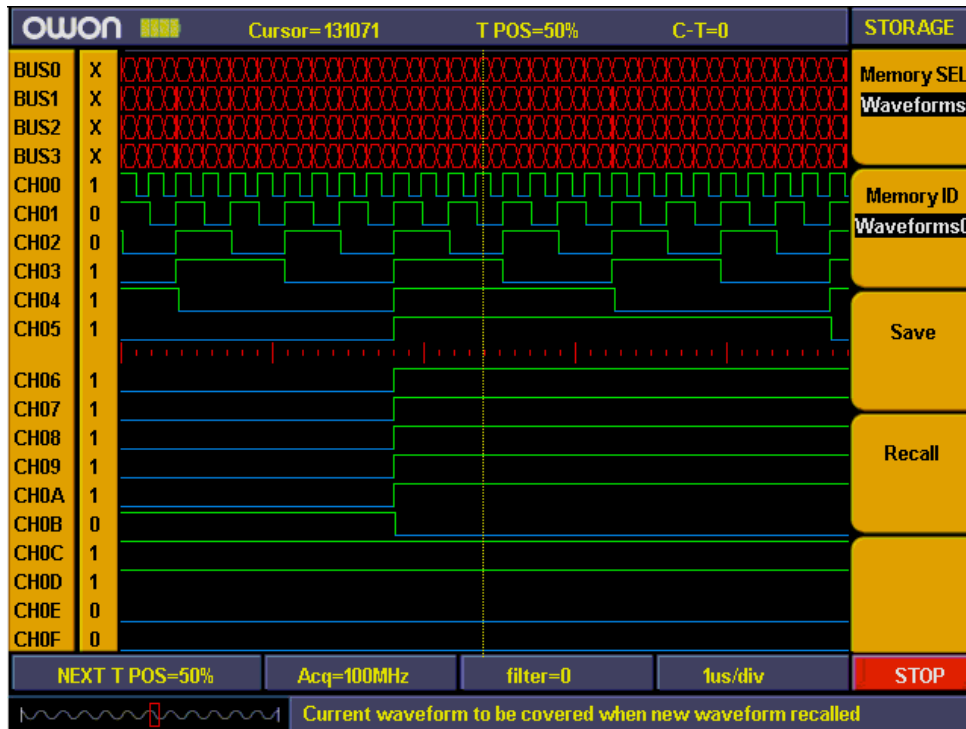


Fig.5-74: Waveform saving

How to use USB flash disk to storage

□ Use USB flash disk is to storage acquired data. Insert U disk into USB port, then press "B" key and you can save the waveform data into the U disk. There is two formats available for choice: Vector format and Bitmap which the corresponding name will be WAVE1.BIN、WAVE2.BIN、WAVE3.BIN.....or WAVE1.BMP、WAVE2.BMP、WAVE3.BMP..... Then you can open the files in computer by connecting USB disk to computer.

Noted: During the U disk saving procedure, some notes such as "Waveform saving" 、 "Waveform saved" 、 "USB already connected" 、 "USB connection interrupt " etc. will be prompted.

How to search

Searches have different operation according to different targets. Search target including trigger position, BUS value, and pattern.

1、 Search triggers position as following steps:

- A、 Press "2(SEARCH)" and menu appears.
- B、 Press "F1" till target display as "**Trig position**"
- C、 Press "F2" to start searching and current cursor will stop in the trigger position

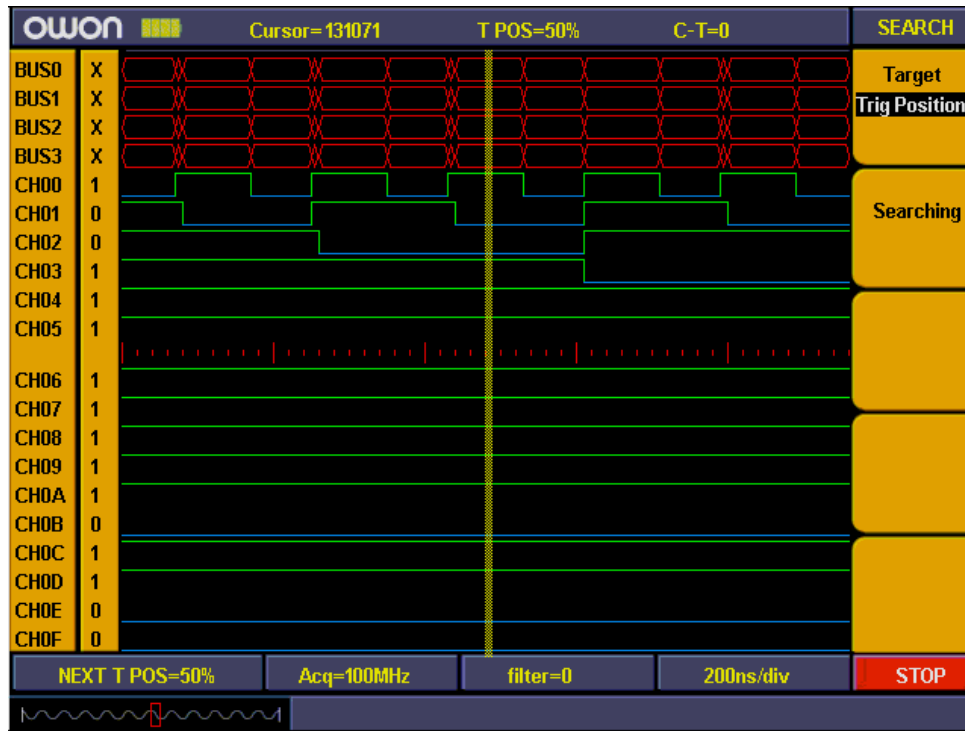


Fig.5-75: Search trigger position

2. Search specified value in BUS

Searching BUS menu as below:

Function	Setting	Instruction
BUS	BUS0~BUS3	Choose searching BUS
Code type	0x0000~0xffff (HEX) 0~65535 (DEC)	Can be set discretionarily between 0x0000 and 0xffff (HEX) or between 0 and 65535 (DEC) according to the bus and code setting.
Previous		Search the matched value prior to current cursor
Next		Search the matched value after current cursor.

For example, follow up below steps to search the data of 0x18 values in BUS0

- A、 Press "2(SEARCH)" and menu appears.
- B、 Press "F1" till target display as "BUS".
- C、 Press "F2" till BUS SEL as "BUS0".
- D、 Press "F3" and choose "Code Type ", value under displayed with red background and green digital indicator in the panel is on. Then insert the value of "18" by digital key in the panel to get start.
- E、 Press "F3" again and red background for value under code is disappeared and value setting finished. Repeat operation of steps D. E if need to modify the value.
- F、 Press "F4" and choose "Previous" to searching the matched value prior to current cursor. Cursor will stop in this value if it has and info window show "Got the target" and if it hasn't it will show "Search failed".
- G、 Press "F5" and choose " Next" to searching the matched value after current cursor.

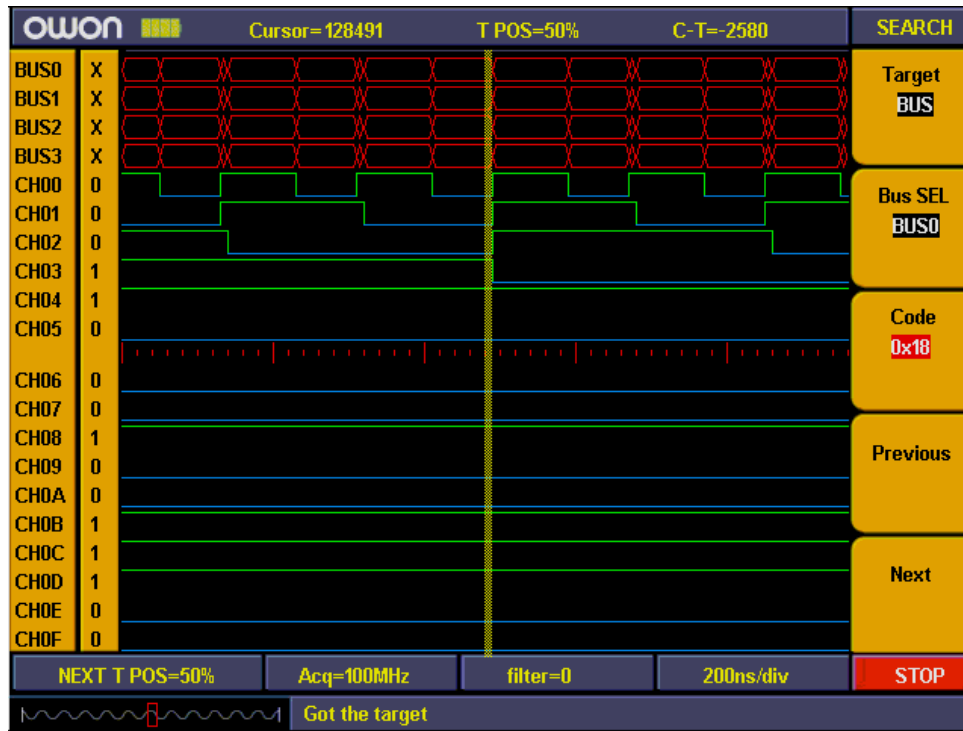


Fig.5-76.: Search Bus

3. **Searching target is pattern:** pattern refers to the complex of different channel according to high/low voltage or unrelated condition.

Pattern type searching menu as below

Function	Setting	Instruction
CH SEL	CH0F~CH00 x0100000 00000000	Select the channel to set the signal pattern. 16 channel pattern indication. X: Don't care 0: Low 1: High
CH00~CH0F	Don't Care Low High	Don't care the signal pattern in this channel. The signal pattern in this channel is low. The signal pattern in this channel is high.
Previous		Search the matched value prior to current cursor
Next		Search the matched value after the current cursor.

For example, follow up below steps to search signal complex of "00000000000010X1"

- A、 Press "2(SEARCH)" and menu appears.
- B、 Press "F1" till target display as "Pattern"
- C、 Press "F2" or turn "CH1 Volts/div" knob to choose channel as "CH00"
- D、 Press "F3" and set CH00 as "high". Then CH00 in "CH Sel" refer to "1"
- E、 Repeat the operation of steps C. D and set other channels status corresponding to "00000000000010X1"
- F、 Press "F4" and choose "Previous" to search the matched value prior to current cursor. Cursor will stop in this code if it has and info window show "Got the target" and if it hasn't it will show "Search failed".
- G、 Press "F5" and choose "Next" to search matched signal complex after current cursor.

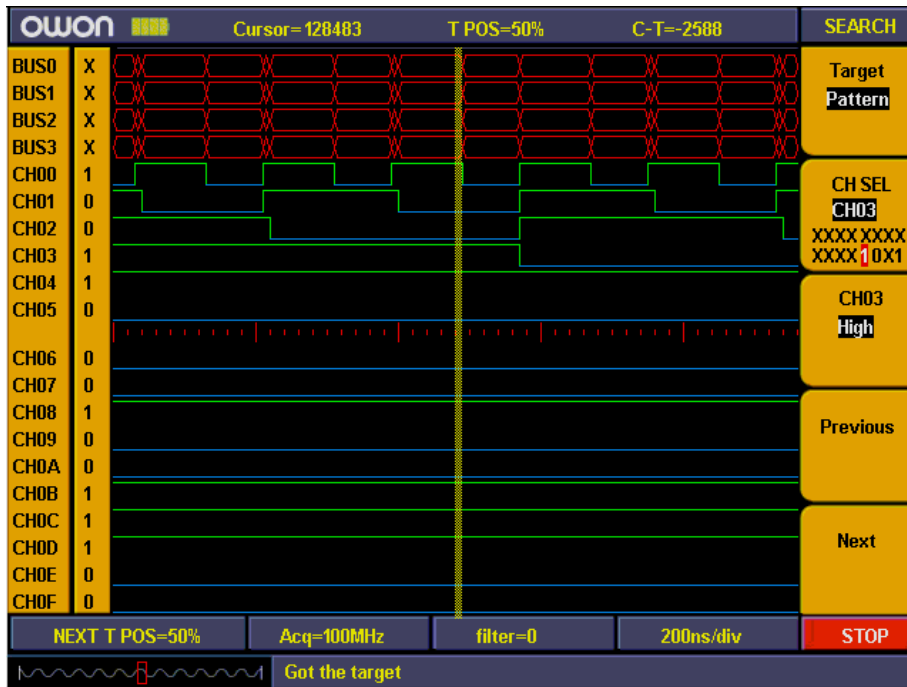


Fig.5-77.: Search Code type

How to review setting info

You can choose system information display to be "On" or "OFF" by press "INFO" key. System information includes all settings for acquired waveform and next acquisition.



Fig.5-78.: System info

How to use cursor measurement

You can measure manually the time difference between two either data in display or position difference in memory area by cursor measurement.

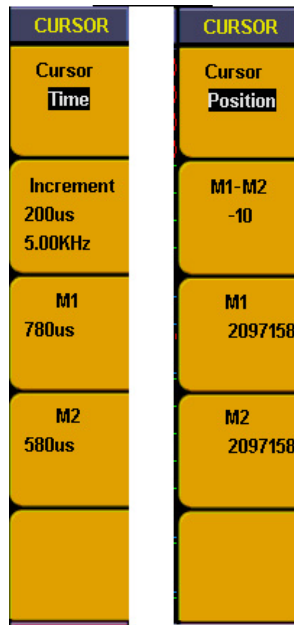


Fig.5-79: Cursor measurement menu

Cursor measurement time menu as below:

Function	Setting	Instruction
Increment	Time	The time difference between two cursors.
	Frequency	The frequency difference between two cursors.
Cursor 1	Time	The time display of cursor 1 corresponds to trigger position.
Cursor 2	Time	The time display of cursor 2 corresponds to trigger position.

Follow up below steps to measure data pulse frequency in CH00 with cursor measurement:

1. Press "**9(CURSOR)**" and cursor menu appears
2. Press "**F1**" till cursor display as "**Time**". Two purple vertical lines display in panel and refer to Cursor 1 and Cursor 2 separately.
3. Turn "**CH1 POSITION**" knob and set Cursor 1 position in falling edge of CH00.
4. Turn "**CH2 POSITION**" knob and set Cursor 2 position in next falling edge of CH00
5. Now the time increment display between two cursors is "**200us**" and frequency is "**5KHz**". The time display of Cursor 1 correspond to trigger position is "**780us**" in "F3". The time display of Cursor 2 correspond to trigger position is "**580us**" in "F4".

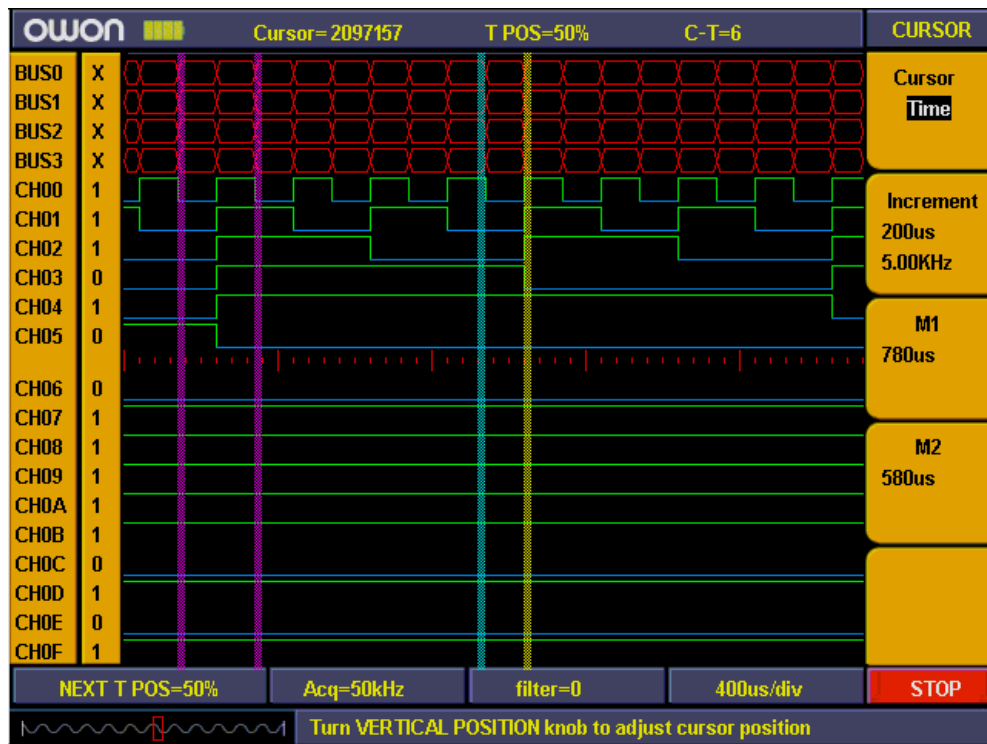


Fig.5-80: Cursor time measurement

Cursor measure position menu as below:

Function	Display	Instruction
M1-M2	Position	The position difference between two cursors in memory area.
Cursor 1	Position	The position of cursor 1 corresponds to trigger in memory area.
Cursor 2	Position	The position of cursor 2 corresponds to trigger in memory area.

Follow up below steps to measure data width of pulse with cursor measurement

1. Press "9(CURSOR)" and Cursor menu appears.
2. Press "F1" till cursor display as "Position". Two purple vertical lines display in panel and refer to Cursor 1 and Cursor 2 separately.
3. Turn "CH1 POSITION" knob and set Cursor 1 position in falling edge of CH00
4. Turn "CH2 POSITION" knob and set Cursor 2 position in next falling edge of CH00.
5. Now the position difference between two cursors display in "F2" is "-10" which means there is 10 acquired data between two cursors. The position of Cursor 1 corresponds to trigger in memory position display in "F3" as "2097158". The position of Cursor 2 corresponds to trigger in memory position display in "F4" as "2057168".

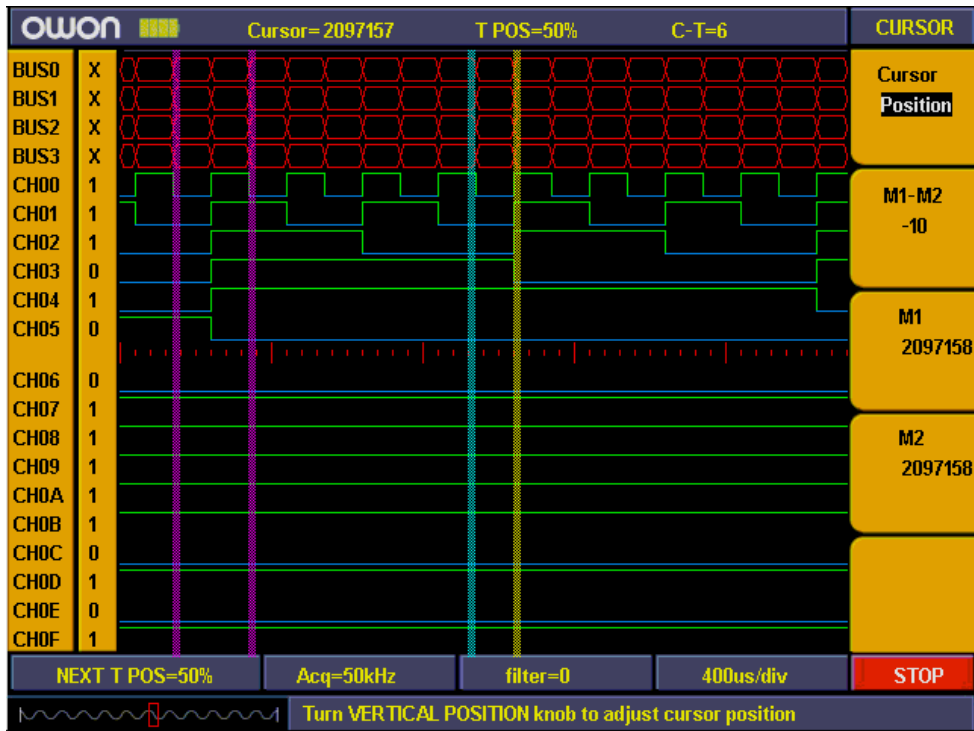


Fig.5-81: Cursor position measurement

How to set Utility

Utility function includes recall factory, Language, Carry.

Utility menu as below

Function	Setting	Instruction
Recall factory		Default setting for LA
Language	Chinese English ...	Support multi-languages, choose you preferred system language.
Carry	Vector	Set data format to be vector and loading data display with "Bin" format
	BMP	Set data format to be BMP and loading data display with "BMP" format.

6. Demonstration

Notice: The following is to take MSO7102T model as an example.

Example 1: Measurement of Simple Signals

The purpose of this example is to measure the frequency and peak-to-peak value of a given signal.

Step 1

Go to CH1 menu and Probe menu to set attenuation coefficient as 10X, turn the switch on the Probe to 10X as well.

Step 2

Connect the Probe through Channel 1 to the signal source.

Step 3

Press AUTOSET button to let oscilloscope run through a pre-set functions and apply them to incoming signal.

Step 4

Take the measurements by going through these settings.

1. Press **MEASURE** to activate measurement function menu.
2. Press **F1** next to **Source** to highlight **Source**.
3. Press **F2**, **F3**, **F4** and **F5** one by one to set them to **CH1**.
4. Press **F1** again and highlight **Type**.
5. Press **F2** and set to **Freq**.
6. Press **F3** and set to **Period**.
7. Press **F4** and set to **Mean**.
8. Press **F5** and set to **Pk-Pk**.

Now you have your measurement results displayed in Fig. Fig.6-1

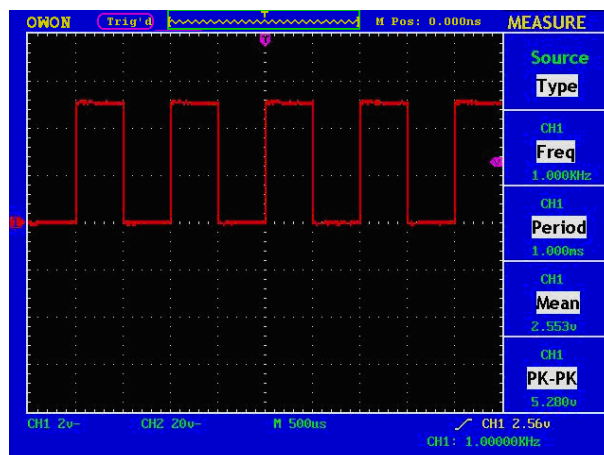


Fig.6-1 Waveform of Automation Measurement

Example 2: Working out the Gain of the Amplifier in the Metering Circuit

The purpose of this example is to work out the Gain of an Amplifier in a Metering Circuit. First we use Oscilloscope to measure the amplitude of input signal and output signal from the circuit, then to work out the Gain by using given formulas.

Step 1

Go to both CH1 menu and CH2 menu and then their Probe menu to set attenuation coefficient as 10X, turn the switch on the Probe to 10X as well.

Step 2

Connect the Probe through Channel 1 to the signal source the input signal in the circuit. Connect the Probe 2 through Channel 2 to its signal source the output signal in the circuit.

Step 3

Press AUTOSSET button to let oscilloscope run through a pre-set function and apply them to both signals coming into Channel 1 and Channel 2.

Step 4

1. Press **MEASURE** to activate measurement function menu.
2. Press **F1** next to **Source** to highlight **Source**.
3. Press **F2** to set Source as **CH1**.
4. Press **F3** to set Source as **CH2**.
5. Press **F1** to highlight **Type**.
6. Press **F2** to set **Pk-Pk**.
7. Press **F3** to set **Pk-Pk**.
8. Get Pk-Pk readings of Channel 1 and Channel 2. (See Fig. 6-2).
9. Calculate the amplifier gain with the following formulas.

$$\text{Gain} = \text{Output Signal} / \text{Input signal}$$

$$\text{Gain (db)} = 20 \times \log (\text{gain})$$

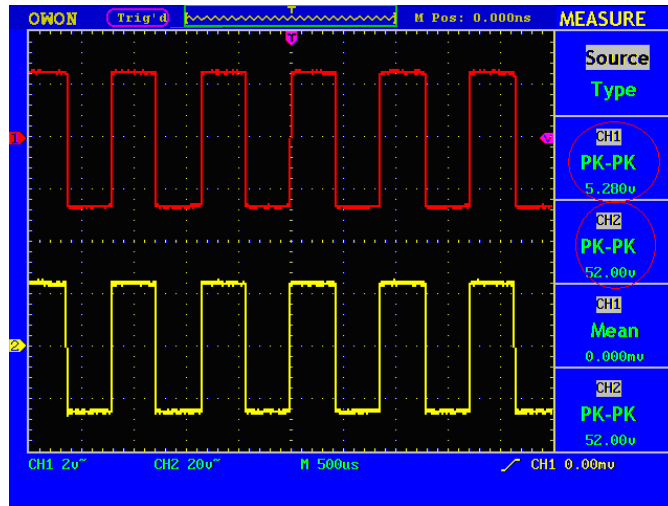


Fig.6-2 Wave Form of Gain Measurement

Example 3: Capture the Single Signal

The digital storage oscilloscope takes the lead in providing the convenience capturing of such non-periodic signals as pulse and burr, etc. If you intent to capture a single signal, you can not set the trigger level and the trigger edge unless you have particular priori knowledge of this signal. For example, if the pulse is the logic signal of a TTL level, the trigger level should be set to 2 volts and the trigger edge be set as the rising edge trigger. If it is uncertain as to the signal, you can make an observation of it in advance under the automatic or ordinary mode to determine the trigger level and the trigger edge.

The operation steps are as follows:

1. Set the probe menu attenuation coefficient to 10X and that of the switch in the probe to 10X.
2. Adjust the **VOLTS/DIV** and **SEC/DIV** knobs to set up a proper vertical and horizontal ranges for the signal to be observed.
3. Press the button **ACQUIRE** to display the **ACQUIRE Mode** menu.
4. Press the **F2** menu selection button and choose **Peak Detect**.
5. Press the **TRIG MENU** button to display the **Trigger Mode** menu.
6. Press the **F1** menu selection button and choose **Single** as the type.
7. Press the **F3** menu selection button and choose **Edge** as the mode.
8. Press the **F4** menu selection button and choose **Rising** as the slope.
9. Press the **F5** menu selection button to next menu.
10. Press the **F2** menu selection button and choose **Single** as the trigger mode.
11. Rotate the **LEVEL** knob and adjust the trigger level to the mid-value of the signal to be measured.
12. If the **Trigger State Indicator** at the top of the screen does not indicate **Ready**, push down the **RUN/STOP** button and start **Acquire**, waiting the emergence of

the signal in conformity with the trigger conditions. If a signal reaches to the set trigger level, one sampling will be made and then displayed in the screen. With this function, any random occurrence can be captured easily. Taking the burst burr of larger amplitude for example, set the trigger level to the value just greater than the normal signal level, and then presses the **RUN/STOP** button and waits. When there is a burr occurring, the instrument will trigger automatically and record the wave form generated during the period around the trigger time. With the **HORIZONTAL POSITION** knob in the horizontal control area in the panel rotated, you can change the horizontal position of the trigger position to obtain the negative delay, making an easy observation of the waveform before the burr occurs (see **Fig.6-3**).

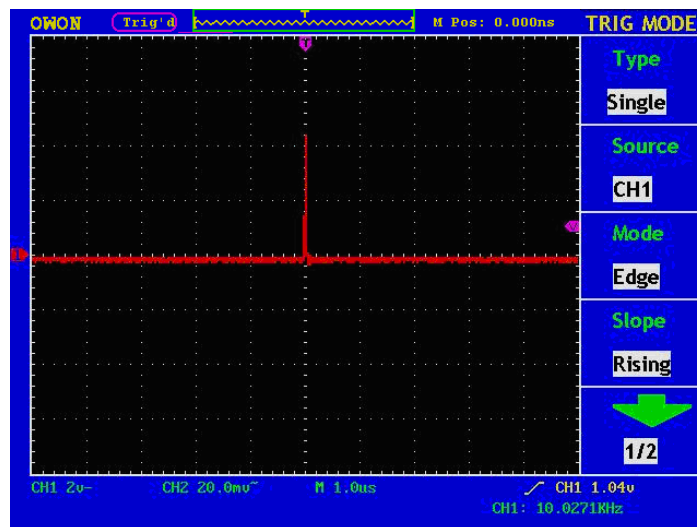


Fig.6-3 Capture the Single Signal

Example 4: Analyze the Details of a Signal

Noise is very common inside most of the electronic signal. To find out what's inside the noise and reduce the level of noise is very important function our oscilloscope is capable to offer.

Noises Analysis

The level of noise sometime indicates a failure of electronic circuit. The **Peak Detect** function acts an important role to help you to find out the details of this noise. Here is how we do it:

1. Apply Square waveform to CH1 as source signal, press **ACQUIRE** button to active **ACQU MODE** menu.
2. Press **F2** to select Peak Detect function. The signal displayed on the screen containing some noise, by turning on Peak Detect function and changing time base to slow down the incoming signal, any peaks or burr would be detected by the function. (See **Fig.6-4**).

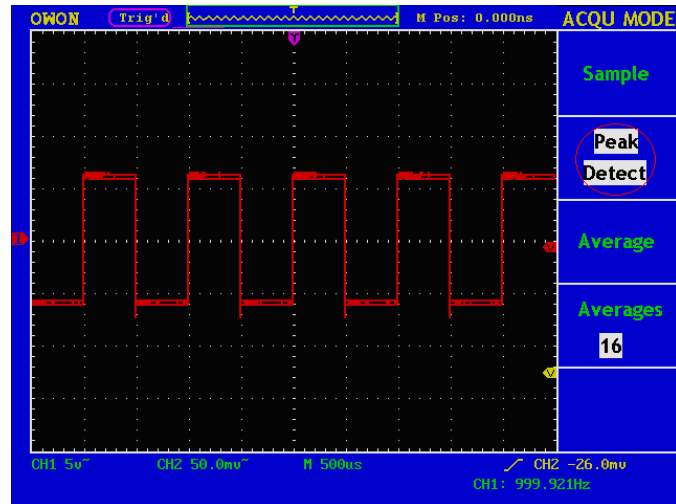


Fig.6-4 Signal with Noises

Reduce the effect of noises from your signal

When focusing on signal itself, the important thing is to reduce the noise level as lower as possible, this would enable user to have more details about the signal. The **Average** function offered by our Oscilloscope can help you to achieve this

Here are the steps for how to enable Average function.

1. Apply square waveform to CH1 as a source signal. Press **ACQUIRE** button to bring up **ACQU MODE** menu.
2. Press **F3** selection **Average**, Press **F4** to select number of data points for average. Available choices of number are 16, 32, 64, 128. The higher the number, the better result user will get.

User would see a much reduced random noise level and make it easy to see more details of the signal itself. As it is in Fig.68, after applying Average, user can easily identify the burrs on the rising and falling edges of some part of the signal(see Fig.6-5).

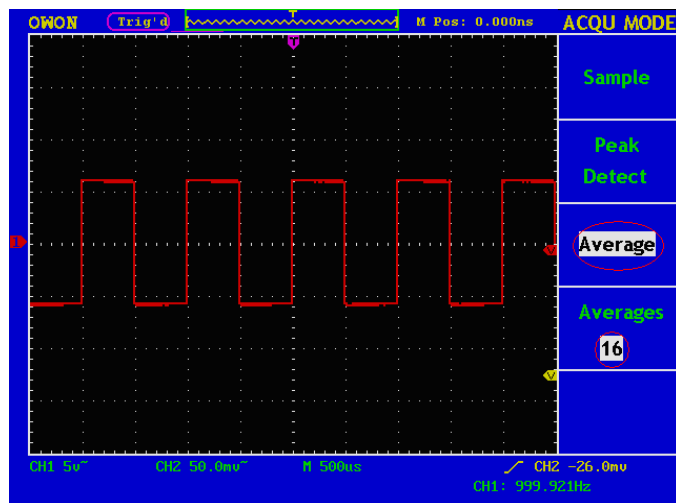


Fig.6-5 Wave Form of the Noise-Removed Signal

Example 5: Examine the Phase shift between two related signals

X-Y mode is a very useful when examining the Phase shift of two related signals. This example takes you step by step to check out the phase change of the signal after it passes a specified circuit. Input signal to the circuit and output signal from circuit are used as sources signals.

1. Set up attenuation coefficient to **10X** through Probe menu for both CH1 and CH2. Switch Probes to **10X**. For source signals, CH1 takes in input signal to the circuit and CH2 takes in output signal from circuit.
2. Press **AUTOSET**, adjust **VOLTS/DIV** for both CH1 and CH2 to the same amplitude level to get an ellipse.
3. Press **DISPLAY** to activate **DISP SET** menu, then F3 to select XY mode. Now the waveform is displayed as **Lissajou's curve**, adjust **VOLTS/DIV** and **VERTICAL POSITION** to get the best possible display, work out the phase shift as in Fig.6-6.

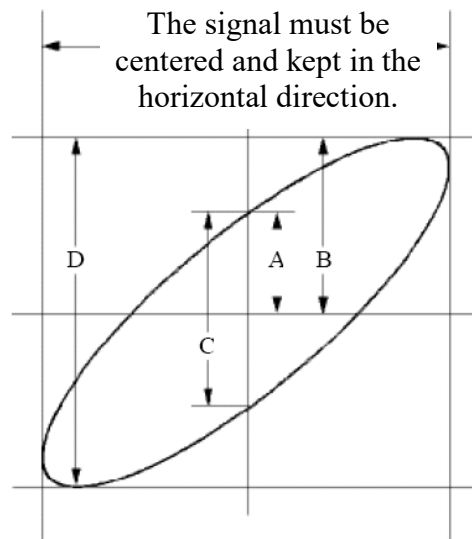


Fig.6-6 Lissajous Graph

Based on the expression $\sin q = A/B$ or C/D , where, q is the phase difference angle, and the definitions of A, B, C, and D are shown as the graph above. As a result, the phase difference angle can be obtained, namely, $q = \pm \arcsin (A/B)$ or $\pm \arcsin (C/D)$. If the principal axis of the ellipse is in the I and III quadrants, the determined phase difference angle should be in the I and IV quadrants, that is, in the range of $(0 - \pi/2)$ or $(3\pi/2 - 2\pi)$. If the principal axis of the ellipse is in the II and IV quadrants, the determined phase difference angle is in the II and III quadrants, that is, within the range of $(\pi/2 - \pi)$ or $(\pi - 3\pi/2)$.

Example 6: Video Signal Trigger

Observe the video circuit of a television, apply the video trigger and obtain the stable video output signal display.

Video Field Trigger

For the trigger in the video field, carry out operations according to the following steps:

1. Press the **TRIG MENU** button to display the trigger menu.
2. Press the **F1** menu selection button and choose **Single** for Type.
3. Press the **F2** menu selection button and choose **CH1** for Source.
4. Press the **F3** menu selection button and choose **Video** for type.
5. Press the **F4** menu selection button and choose **Field** for Sync.
6. Adjust the **VOLTS/DIV**, **VERTICAL POSITION** and **SEC/DIV** knobs to obtain a proper wave form display (see Fig.6-7).

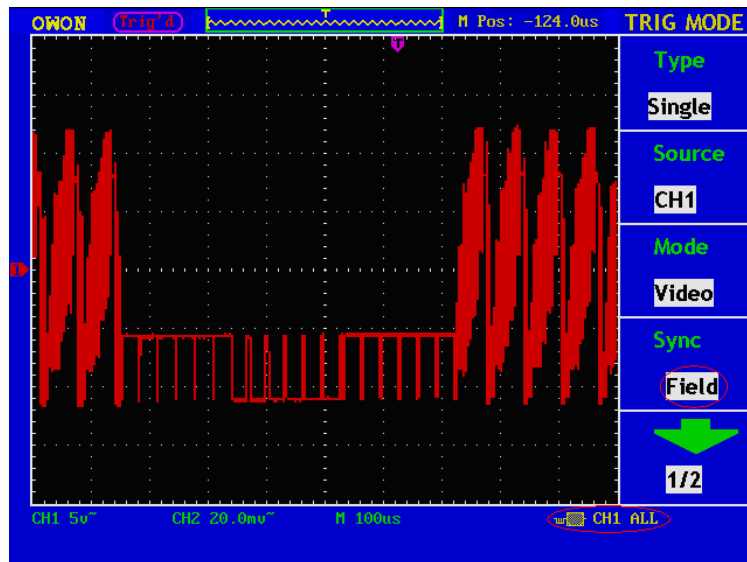


Fig.6-7 Wave Form Obtained from Video Field Trigger

7. F.A.Q

1. **In the case of that the oscilloscope is still in the black-screen state without any display after the power is switch on, implement the following fault treatment procedure.**

- Check whether the power connection is connected properly.
- Check whether the power switch is pushed down to the designated position.
- Restart the instrument after completing the checks above.
- If this product still can not work normally, please get in touch with OWON and we will be under your service.

2. **After acquiring the signal, carry out the following operations if the wave form of the signal is not displayed in the screen.**

- Check whether the probe is properly connected to the signal connecting wire.
- Check whether the signal connecting wire is correctly connected to the BNC (namely, the channel connector).
- Check whether the probe is properly connected with the object to be measured.
- Check whether there is any signal generated from the object to be measured (the trouble can be shot by the connection of the channel from which there is a signal generated with the channel in fault).
- Make the signal acquisition operation again.

3. **The measured voltage amplitude value is 10 times greater or smaller than the actual value.**

Check whether the channel attenuation coefficient and the attenuation ration of the probe used in practical application is match.

4. **There is wave form displayed, but it is not stable.**

- Check whether the **Source** item in the **TRIG MODE** menu is in conformity with the signal channel used in the practical application.
- Check on the trigger **Type** item: The common signal chooses the **Edge** trigger mode for **Type** and the video signal the **Video**. Only if a proper trigger mode is applied, the wave form can be displayed steadily.
- Try to change the trigger coupling into the high frequency suppress and the low frequency suppress to smooth the high frequency or low frequency noise triggered by the interference.

5. **No Display Responses to the Push-down of RUN/STOP.**

Check whether Normal or Signal is chosen for Polarity in the TRIG MODE menu and the trigger level exceeds the wave form range.

If it is, make the trigger level is centered in the screen or set the trigger mode as Auto. In addition, with the **AUTOSET** button pressed, the setting above can be completed automatically.

6. **After the AVERAGE value sampling is set in the ACQU MODE or the longer duration is set in the DISP MODE, the display rate is slowed down.**

It is a normal phenomenon.

8. Technical Specifications

Unless otherwise specified, the technical specifications applied are applicable to the probe with the attenuation switch setting 10X and the MSO series digital oscilloscope. Only if the oscilloscope fulfill the following two conditions at first, can these specification standards be reached.

- This instrument should run for more than 30 minutes continuously under the specified operating temperature.
- If the change range of the operating temperature is up to or exceeds 5°C, open the system function menu and execute the "Auto-calibration" procedure.

All specification standards can be fulfilled, except one(s) marked with the word "Typical".

Digital Storage Oscilloscope

Performance Characteristics		Instruction
Bandwidth		<ul style="list-style-type: none"> ● 60MHz----MSO7062TD ● 100MHz----MSO7102TD,MSO8102T ● 200MHz----MSO8202T
Channel		2 + 1 (External)
Acquisition:	Mode	Normal, Peak detect, Averaging
	Sample rate (real time)	<ul style="list-style-type: none"> ● 1GS/s half channel*, 500MS/s each channel----MSO7062TD, 7102TD ● 2GS/s half channel*, 1GS/s each channel----MSO8102T, 8202T
Input:	Input coupling	DC, AC, Ground
	Input impedance	1MΩ±2%, in parallel with 15pF±5pF
	Probe attenuation factor	1X, 10X, 100X, 1000X
	Max. input voltage	400V (PK-PK) (DC + AC PK-PK)
	Bandwidth limit	20MHz、100MHz
	Channel isolation	50Hz: 100 : 1 10MHz: 40 : 1
	Time delay between channel(typical)	150ps

8. Technical Specifications

Horizontal System	Sampling rate range	<ul style="list-style-type: none"> ● 1S/s~1GS/s half channel*, 1S/s~500MS/s each channel ---- MSO7062TD, 7102TD ● 1S/s~2GS/s half channel*, 1S/s~1G S/s each channel ----MSO8102T, 8202T
	Interpolation	(sin x) /x
	Record length	2M points on each channel
	Scanning speed (S/div)	<ul style="list-style-type: none"> ● 2ns/div~100s/div, step by 1~2~5 ----MSO7062TD, 7102TD, 8102T ● 1ns/div~100s/div, step by 1~2~5 ---- MSO8202T
	Sampling rate / relay time accuracy	±100ppm
	Interval (ΔT) accuracy (DC~100MHz)	Single: ±(1 interval time +100ppm×reading+0.6ns); Average>16: ±(1 interval time +100ppm×reading+0.4ns)
Vertical system	A/D converter	8 bits resolution (2 Channels simultaneously)
	Sensitivity	2mV/div~10V/div (at BNC)
	Displacement	±1V(2mV - 100mV), ±10V(200mV - 1V), ±100V(2V - 10V)
	Analog bandwidth	<ul style="list-style-type: none"> ● 60MHz----MSO7062TD ● 100MHz----MSO7102TD,MSO8102T ● 200MHz----MSO8202T
	Single bandwidth	Full bandwidth
	Low Frequency	≥10Hz (at input, AC coupling, -3dB)

8. Technical Specifications

	Rise time	<ul style="list-style-type: none"> ● ≤ 5.8 ns (at input, Typical) ----MSO7062TD ● ≤ 3.5 ns (at input, Typical) ----MSO7102TD, 8102T ● ≤ 1.75 ns (at input, Typical) ----MSO8202T 	
	DC accuracy	$\pm 3\%$	
	DC accuracy (average)	Average > 16: $\pm(3\% \text{ rdg} + 0.05 \text{ div})$ for ΔV	
Measurement	Cursor	ΔV and ΔT between cursors	
	Automatic	Vpp, Vmax, Vmin, Vtop, Vbase, Vamp, Vavg, Vrms, Overshoot, Preshoot, Freq, Period, Rise Time, Fall Time, Delay A→B Φ , Delay A→B Ψ , +Width, -Width, +Duty, -Duty	
	Waveform Math	+, -, *, / ,FFT	
	Waveform storage	4 waveforms	
	Lissajou's figure	Bandwidth	Full bandwidth
		Phase difference	± 3 degrees
	Frequency (typical)	1KHz square wave	
Communication port	USB2.0, USB for file storage; RS-232 or VGA port (optional)		

* Half channel is when only one input channel is available.

Trigger:

Trigger level range	Internal	± 6 div from the screen center
	EXT	$\pm 600\text{mV}$
	EXT/5	$\pm 3\text{V}$
Trigger level Accuracy (typical)	Internal	$\pm 0.3\text{div}$
	EXT	$\pm(40\text{mV} + 6\% \text{ of Set Value})$
	EXT/5	$\pm(200\text{mV} + 6\% \text{ of Set Value})$
Trigger	Pre-trigger: 655 div, Post-trigger: 4 div	

8. Technical Specifications

displacement		
Trigger Holdoff range	100ns~10s	
50% level setting(typical)	Input signal frequency $\geq 50\text{Hz}$	
Edge trigger	slope	Rising、 Falling
	Sensitivity	0.3div
Pulse trigger	Trigger condition	Positive pulse: >、 <、 = negative pulse: >、 <、 =
	Pulse Width range	24ns~10s
Video Trigger	Modulation	Support standard NTSC、 PAL and SECAM broadcast systems
	Line number range	1-525 (NTSC) and 1-625 (PAL/SECAM)
Slope Trigger	Trigger condition	Positive pulse: >、 <、 = negative pulse: >、 <、 =
	Time setting	24ns~10s
Alternate Trigger	Trigger on CH1	Edge, Pulse, Video, Slope
	Trigger on CH2	Edge, Pulse, Video, Slope

Logic analyzer

Sampling rate	20 S/s ~ 1GS/s
Input channel	16
Max Storage	4M/Channel,16K(when only sampling rate is 250MS/s, 500 MS/s, 1GS/s)
Measurement bandwidth	100MHz---- MSO7062TD,MSO7102TD,MSO8102T 200MHz---- MSO8202T
Input impedance	660K Ω $\pm 5\%$ // 15 $\pm 5\text{pF}$
Threshold level	-6V~6V
Input signal range	-30V~30V
Trigger position setting	Pre-trigger, mid-trigger, re-trigger
Trigger Mode	Edge trigger, Bus trigger, Pattern trigger, Sequential queue data ,Distributed queue trigger, Data width queue trigger
Data Search	Support

8. Technical Specifications

Data System	Binary system, Decimal system, Hex
Digital Filter	0/1/2 optional
Setting storage	Support
USB storage	Support

General Technical Specifications

Display

Display Type	8" Colored LCD (Liquid Crystal Display)
Display Resolution	640 (Horizontal) × 480 (Vertical) Pixels
Display Colors	65536 colors, TFT screen

Output of the Probe Compensator

Output Voltage (Typical)	About 5V, with the Peak-to-Peak value equal to or greater than 1MΩ of load.
Frequency (Typical)	Square wave of 1KHz

Power

Mains Voltage	100~240 VAC RMS, 50/60Hz, CAT II
Power Consumption	< 18W
Fuse	2A, T grade, 250V

Environment

Temperature	Working temperature: 0°C ~ 40°C Storage temperature: -20°C ~ +60°C
Relative Humidity	≤ 90%
Height	Operating: 3,000 m Non-operating: 15,000 m
Cooling Method	Natural convection

Mechanical Specifications

Dimension	370mm× 180mm×120mm
Weight	2.2 kilogram

Interval Period of Adjustment:

One year is recommended for the calibration interval period.

9. Appendix

Appendix A: Enclosure

Standard Accessories:

- Passive probe: 2, 1.2 m, 1:1 (10:1)
- OL-16 LA measurement module
- CD: x 1 (PC link application software)
- RS232 data line or USB data line
- Power line: one, up to the standards of the country in which it is used.
- User Manual: One

Options:

- Battery

Appendix B: Maintenance, Cleaning and Repairing

General Maintenance

Please don't store or put the instrument in the place where the liquid crystal display will be directly exposed to the sunlight for a long time.

Caution: The instrument or probe should not be stained with the spraying agent, liquid and solvent to avoid any damage to it.

Cleaning /

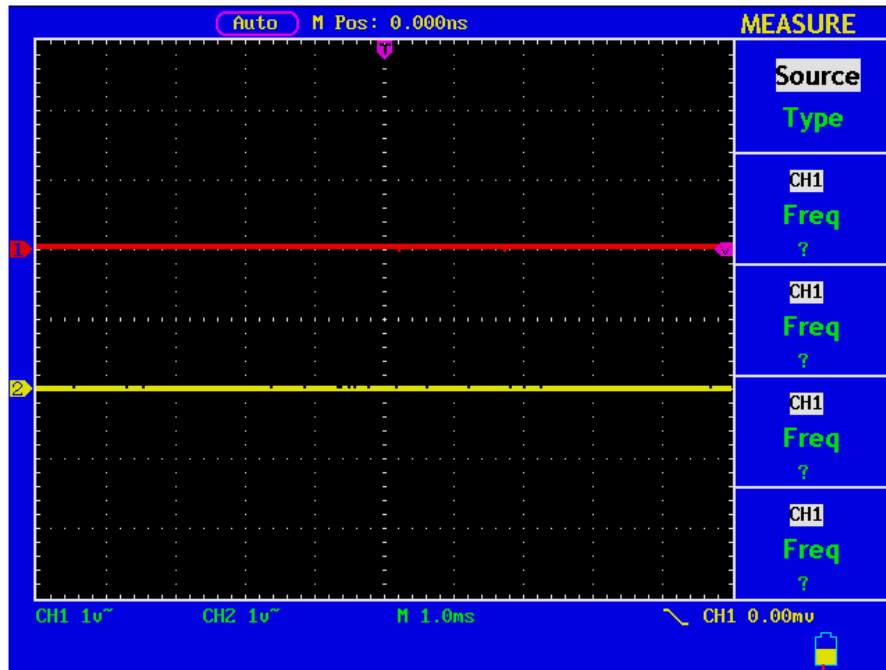
Check the probe and instrument regularly according to their operating state. Clean the external surface of the instrument following the steps shown below:

1. Please wipe the dust from the instrument and probe surface with a soft cloth. Do not make any scuffing on the transparent LCD protection screen when clean the LCD screen.
2. Clean the instrument with a wet soft cloth not dripping water, during the period of which please pay attention to the disconnection of power. It is recommended to scrub with soft detergent or fresh water. Please don't apply any corrosive chemical cleaning agent to prevent the instrument or probe from damage.



Warn: Before power on again for operation, it is required to confirm that the instrument has already been dried completely, avoiding any electrical short circuit or bodily injury resulting from the moisture.

Appendix C: Battery Using Guide



Battery electric quantity indicating symbols including: and

Charging the oscilloscope

The lithium battery maybe not be charged when delivery. Please charge the battery for 12 hours to make sure enough power to supply to oscilloscope. The battery can supply power for 4 hours after being charged completely.

There will have battery power indication show on the top of panel when oscilloscope power supplied by the battery. and imply for different power consumption and when shows it means the power can only supply for 5 minutes maximum.

Note:

To avoid superheat of battery during charging, the environment temperature is not allowed to exceed the permissible value given in technical specification.

Replacing the Lithium Battery Unit

It is usually not required to replace the battery unit. But when it is required to replace it, only qualified personnel can carry out this operation, and only use the same specification lithium battery.