OWON®

MSO Series

Portable Mixed Signal Digital Storage Oscilloscope

User Manual

■ **MSO5022S**

■ **MSO7102T**

WWW.OWON.COM.CN

Xiamen Lilliput Technology Co.,Ltd.: the 5th floor, B Area, Chuangxin Mansion, Software Park,ZhenZhuWan, Huandao RD, Xiamen,Fujian,China

Fujian Lilliput Optoelectronics Technology Co.,Ltd.: The mansion of optoelectronics hengsan road, Lantian industrial zone ,Zhangzhou,Fujian,China

Tel:+86-592-2575666

Fax:+86-592-2575669

Mail:sales@owon.com.cn

General Warranty

The Lilliput warrants that the product will be free from defects in materials and workmanship for a period of three years from the date of purchase of the product by the original purchaser from the Lilliput company. And the warranty period of accessories such as probe, battery, adapter is one year. This warranty only applies to the original purchaser and is not transferable to the third party. If the product proves defective during the warranty period, Lilliput either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Lilliput for warranty work may be new or reconditioned to like new performance.All replaced parts, modules and products become the property of Lilliput.

In order to obtain service under this warranty, Customer must notify Lilliput of the defect before the expiration of the warranty period. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Lilliput, and with a copy of customer proof of purchase.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Lilliput shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Lilliput representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Lilliput supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

Please contact the nearest Lilliput's Sales and Service Offices for services or a complete copy of the warranty statement.

Excepting the after-sales services provided in this summary or the applicable warranty statements, Lilliput will not offer any guarantee for maintenance definitely declared or hinted, including but not limited to the implied guarantee for marketability and special-purpose acceptability. Lilliput should not take any responsibilities for any indirect, special or consequent damages.

Table of Contents

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.

Prevent the Fire or Bodily 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 the proper power line. Only use the power cord specially provided for this product or that has been approved to be used in this user state.

Connect or Disconnect Correctly. When the probe or testing wire is connected to the power lead, please do not connect and disconnect the probe or testing wire at random.

Product Grounded. This product is grounded through the power lead grounding conductor. In order to prevent any electric shocking, the grounding conductor must be connected to the ground. It requires guarantee that this product has been already grounded correctly before any connection with its input or output terminal.

Pay attention to the nominal values of all terminals. In order to prevent any fire or electric shock risks, please pay attention to all the nominal values and marks of this product. Before implement any connections for this product, please read the user's manual of this product to understand the information about the rated values further.

Do not make any operations without the instrument cover installed. If the cover or panel has already been removed, please don't operate this product.

Use the proper fuse. Only the fuse complying with the specified type and nominal value for this product can be used.

Avoid touching any exposed circuit. When the product is on power, please don't touch the uncovered contacts and parts.

Please don't make any operations while there is an uncertain fault emerged. If suspecting damage to this product, please contact the qualified maintenance personnel for check.

Keep a good ventilation condition. Please consult the detailed installation instruction in the user's manual so that this product can be erected correctly, keeping it under a good ventilation condition.

Please do not make any operations in a moist environment.

Please do not make any operates in an explosive environment.

Keep the products surface clean and dry.

Safety Terms and Symbols

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

⚠ **Warning.** A warning statement indicates the conditions and actions which may endanger the life safety.

⚠ **Note.** A note statement indicates the conditions and actions which may cause damage to this product or other property.

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

Danger: It indicates that there may be an immediate injury to you when you encounter this mark.

Warning: It indicates that there may not be an immediate injury to you when you encounter this mark.

Note: It indicates that there may be damage to this product or other property.

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

| High Voltage | Please Consult the Manual. | Protective Ground End | Earth End on the Shell | Grounding End for Measurement |

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

⚠ Warning:

When use BC(battery charge) as power supply, to avoid fire or electrical shock if a test tool input is connected to more 42V peak (30Vrms) or on circuits of more than 4800VA:

- **Only use accessory insulated voltage probes, test lead**
- **Before use, inspect oscilloscope probes, accessories for mechanical damage and replace when damage.**
- **Remove all probes, test leads and accessories that are not in use.**
- **Remove computer data line**
- **Do not apply input voltages above the rating of the instrument Use caution when using 1:1 test leads because the probe tip voltage will be directly transmitted to the oscilloscope.**
- **Do not use exposed metal BNC or banana plug connectors**
- **Do not insert metal objects into connectors.**

General Characteristics of the MSO Series Oscilloscope

Digital Storage Oscilloscope

- Bandwidth available from 25MHz to 100MHz;

- Sample Rate available from 100MS/s to 1GS/s；

- Record length of 6,000 points for each channel;

- 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 and alternate triggering function;

- RS232 or USB communication ports;

- Different continuous displaying time;

- Multiple Language User Interface.

Logic Analyzer

- Bandwidth available from 33MHz to 66MHz:
- Sample Rate available from 10S/s to 400MS/s;
- 16 input channel;
- Max sampling rates for each channel;
- 4M max Storage for each channel;
- Plenty of trigger Mode;
- Convenient data measurement & data search;
- Freely setting of all kinds of threshold level.

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

Introduction to the Front Panel and the User's Interface of the MSO series Oscilloscope

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
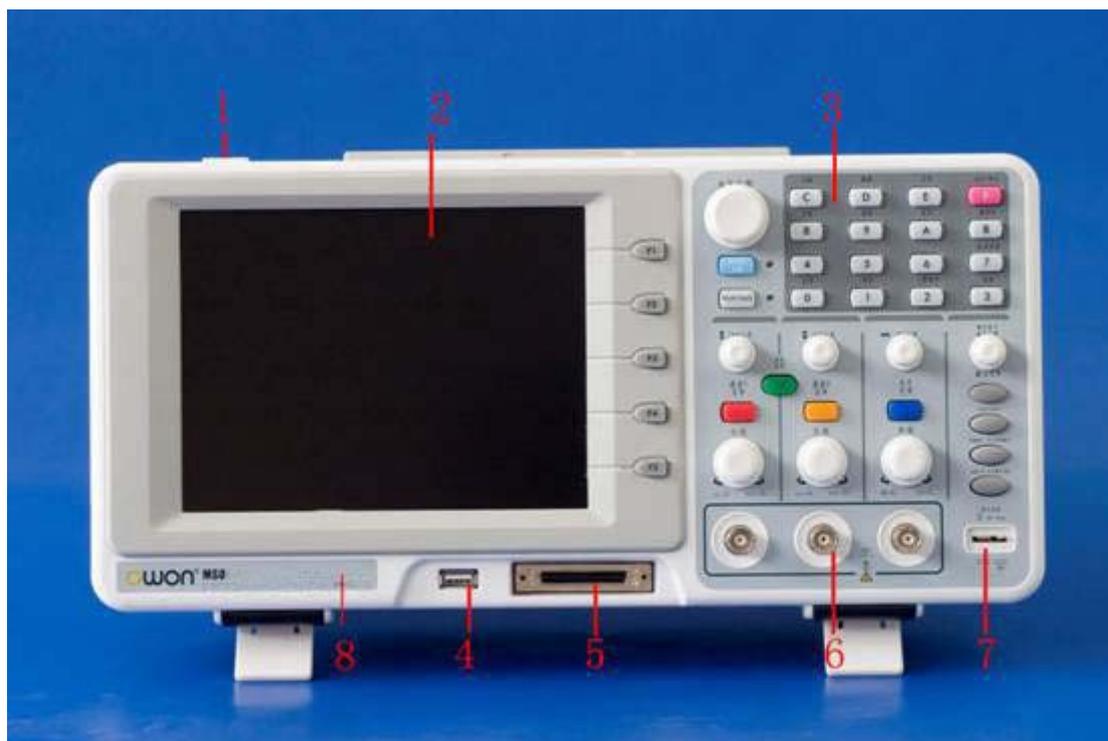
Fig. 1: Front panel overview

    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 indicate AC supply and battery full charged; yellow light indicate under charging
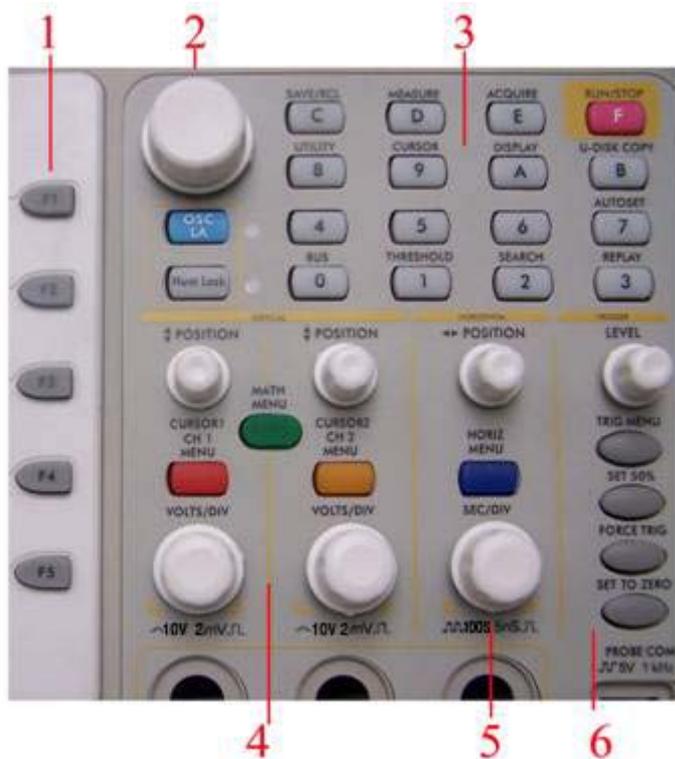
Fig. 2: Keys Overview

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 minificating 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" knob control the vertical position of CH1. CH2, and two "Volts/Div" knob control voltage scale of CH1, CH2.

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.

Digital Storage Oscilloscope

User interface introduction
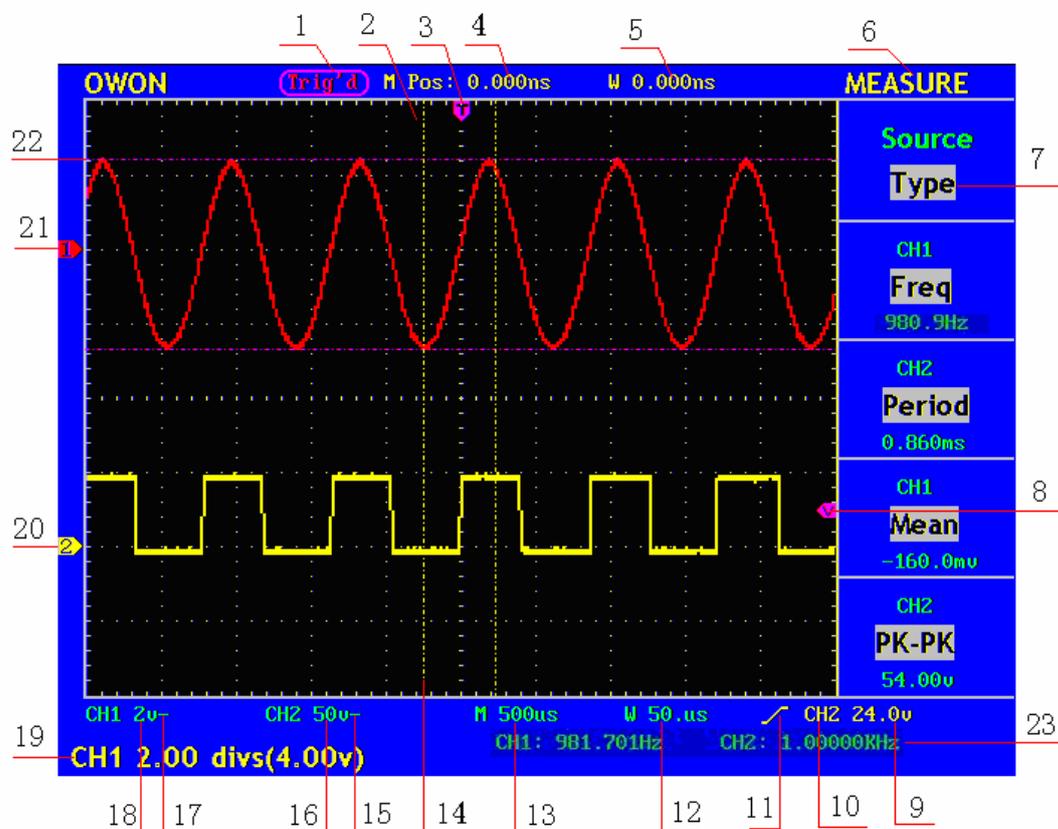
Fig. 3 Illustrative Drawing of Display Interfaces

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 reading shows the time deviation between the horizontal trigger position and

the screen centre line, which equals 0 in the screen center.

5. This reading shows the time deviation between the horizontal trigger position and the window centre 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

    " ⏚ " 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 " ⏚ " 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 frequence 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 tiggering channel. When the triggering mode is alternating triggering,it is a two channel cymometer and it can measure the frequency of two channels.(Note:the model of MSO5022S donot support the function.)

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 B** "Accessories" 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 LILLIPUT responsible for this service or the LILLIPUT'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 LILLIPUT's distributor responsible for this business or the LILLIPUT's local offices. If there is damage to the instrument caused by the transportation, please keep the package. With the transportation department or the LILLIPUT's distributor responsible for this business informed about it, a repairing or replacement of the instrument will be arranged by the LILLIPUT.

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).
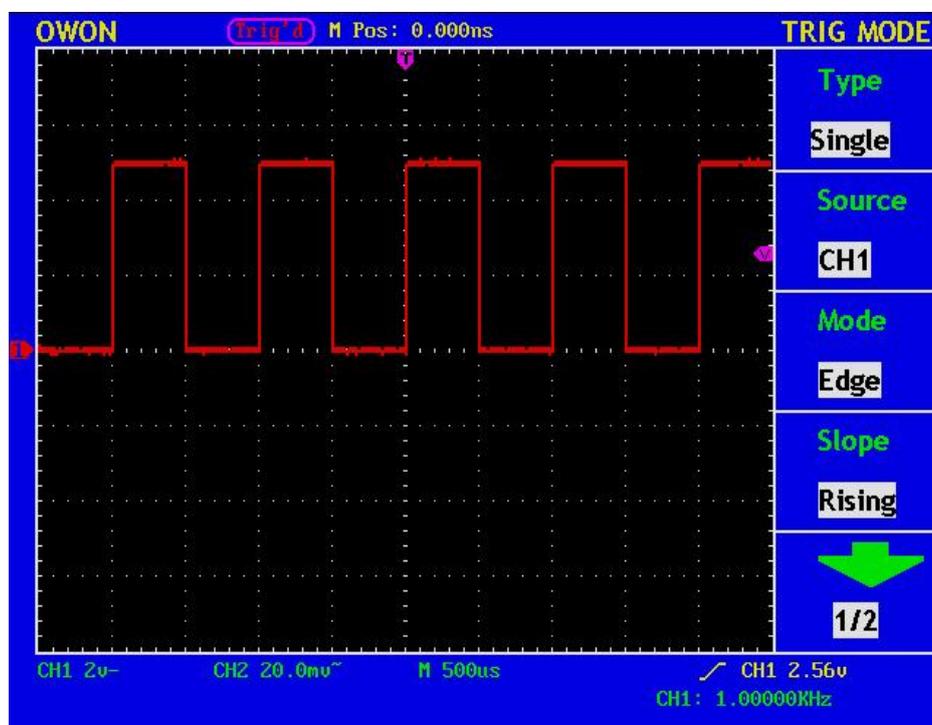
Fig.4 Auto set

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.5 and Fig.6).

Overcompensated　　　Compensated correctly　　　Under compensated

Fig. 5 Displayed Wave Forms of the Probe Compensation

3. Repeat the steps mentioned if necessary.
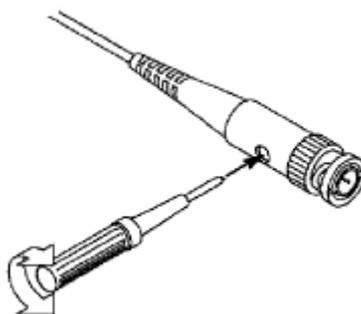
Fig. 6 Adjust Probe

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. 7).
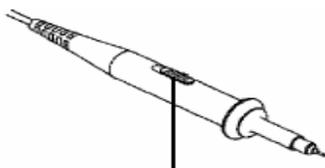
Fig. 7 Attenuation Switch

⚠ **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. 8.
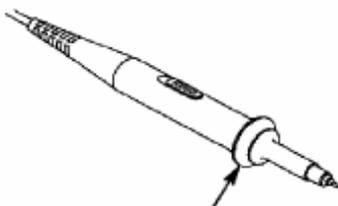
Fig. 8 Finger Guard

⚠ **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℃, 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.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.
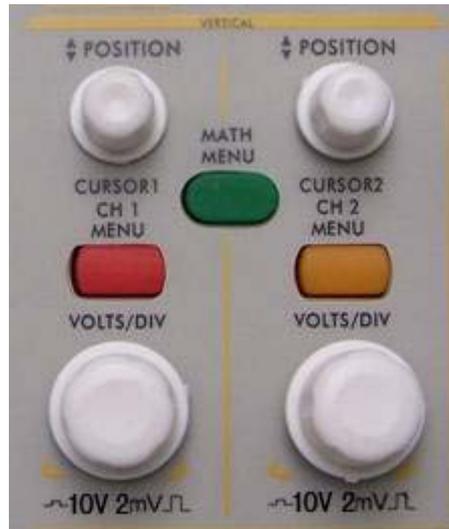
Fig. 9 Vertical Control Zone

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.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. 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

    5ns up to 100s in the sequence of 1-2.5-5-----MSO5022S;

    2 ns up to 100s in the sequence of 1-2-5 -----MSO7102T.

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.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. 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 mid point 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.

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 singal and ready for measurement

User interface introduction
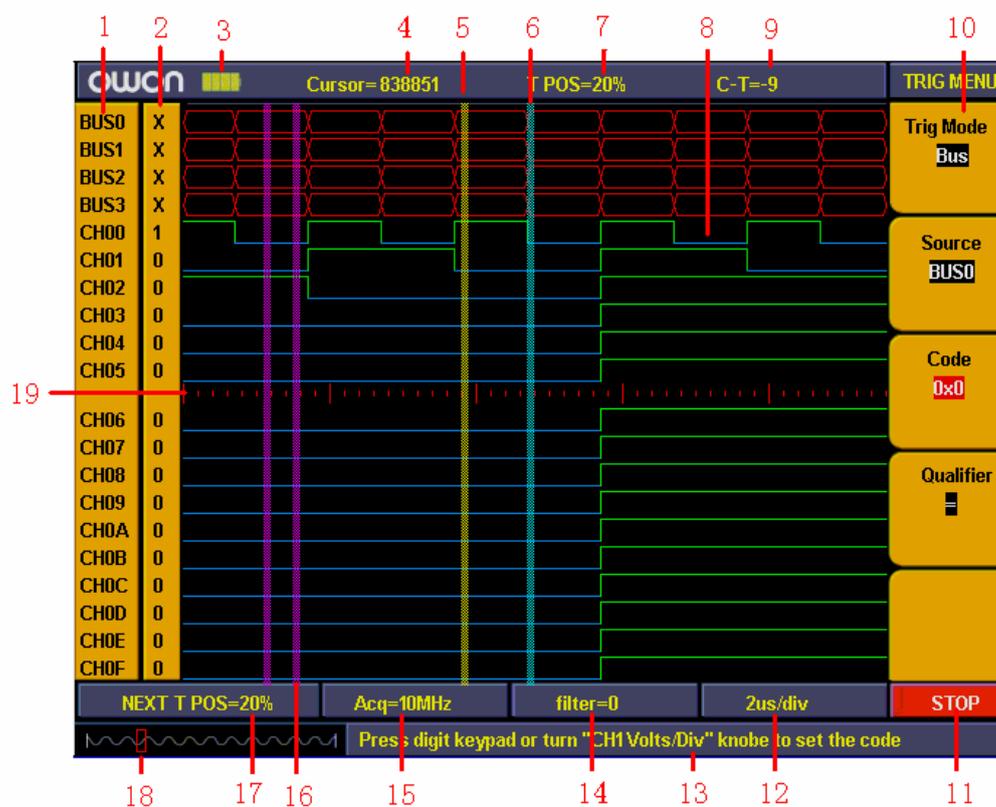
Fig.12：User interface of logic analyzer

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 dashed line indicates current cursor。

6、Blue dashed 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 operation 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 signal 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-CHOF as "**OFF**". Refer to Fig.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.14

Now display panel only show CH00、CH01、CH02 and others channel and bus are all off. Ref to Fig.13
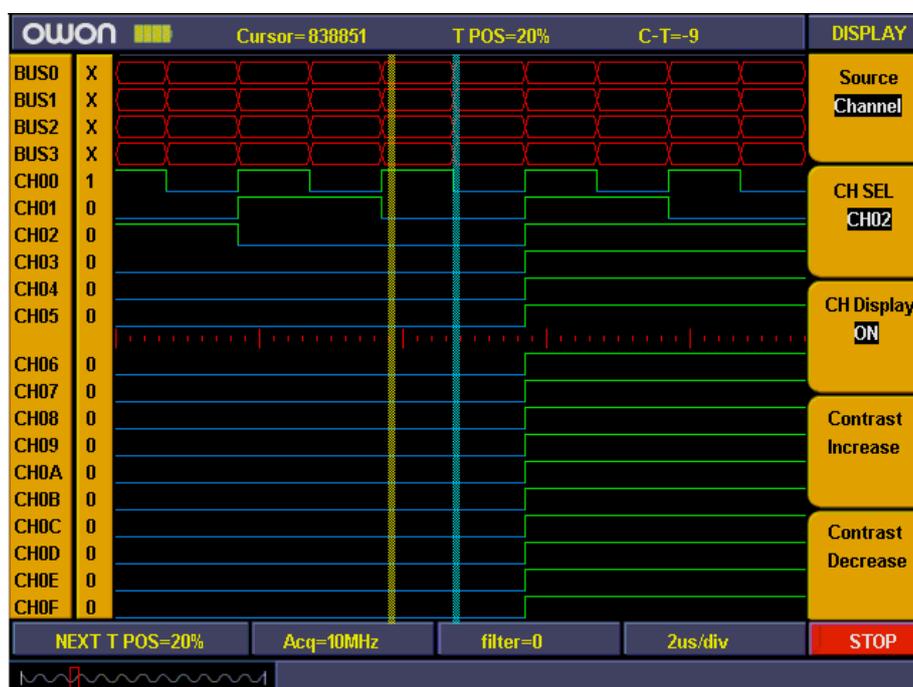

Fig.13
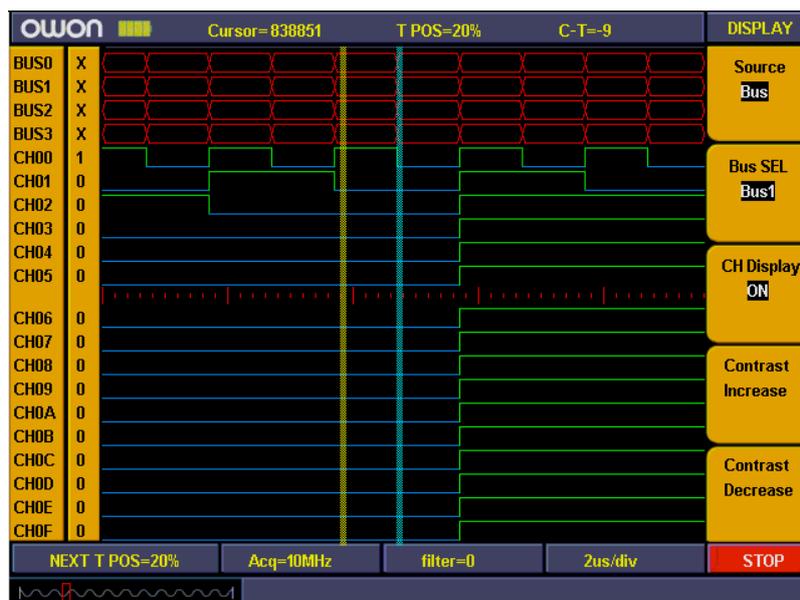
Fig.14
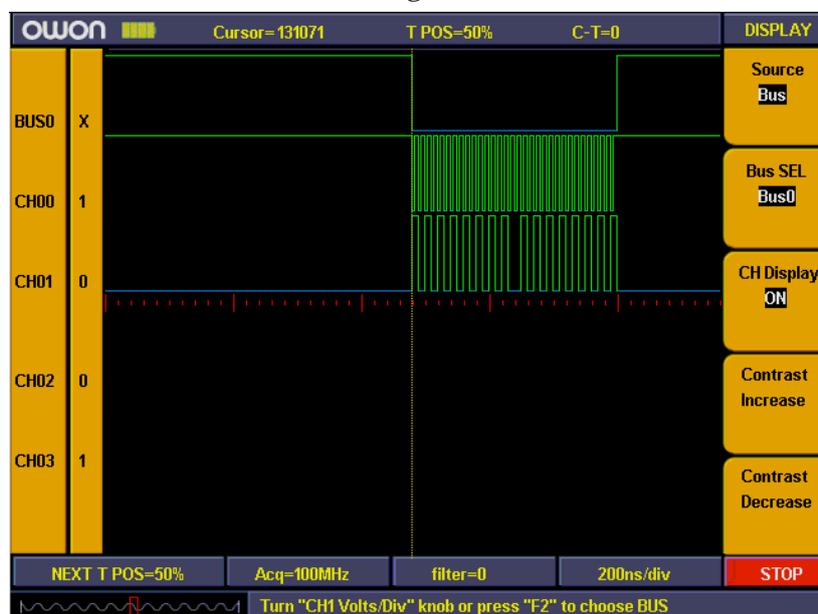
Fig. 15

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 adjus**t" knob or press "**SET 50%"**till "**NEXT T POS**" window display as "**50%**"

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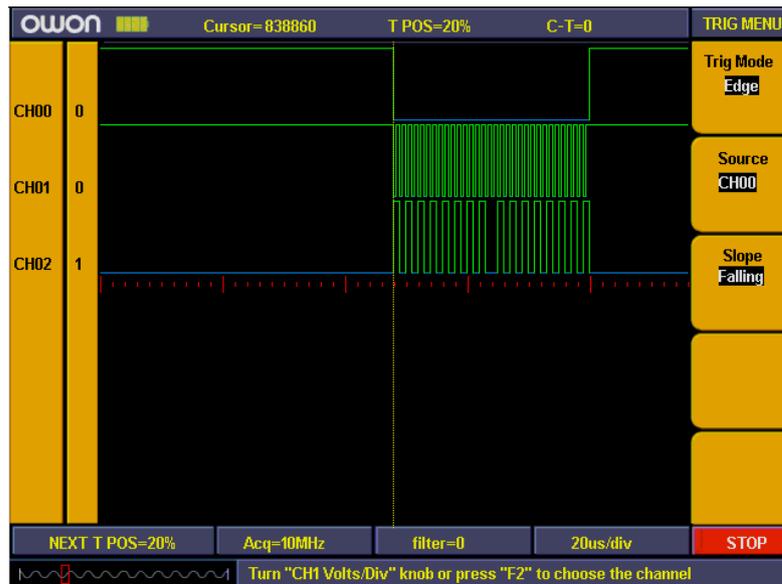
Fig. 16

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, LVMOS etc. And you can set any trigger voltage using custom setting.

The signal voltage is 3.3V and we set threshold voltage as "LVCMO3.3/1.7V" 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 "**LVCMOS3.3/1.7V**".

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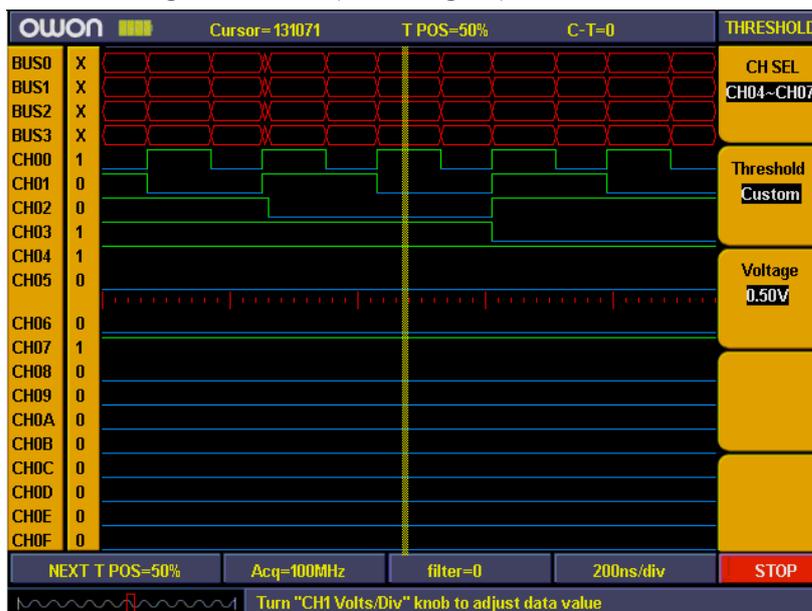
Fig. 17

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.
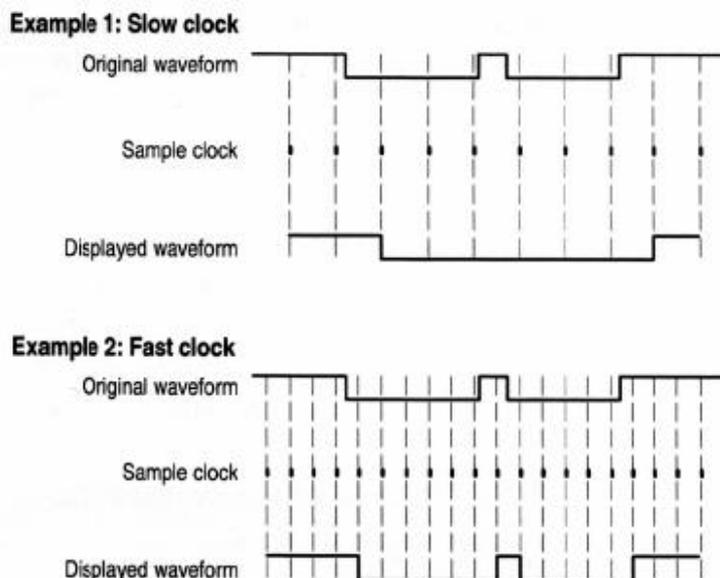

Fig.18

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, sample rate are quicker then 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. 19 when sampling finished.
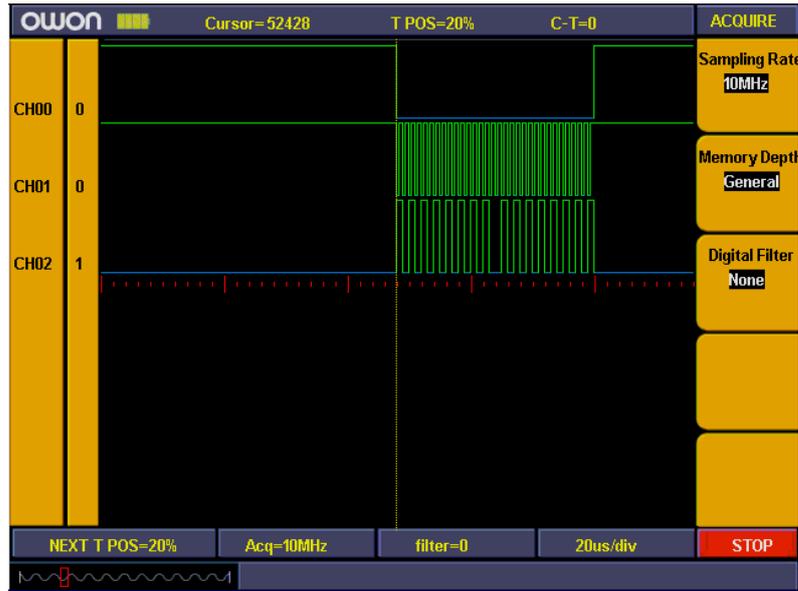
Fig. 19

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.

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 **VERTICA 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. 20).

Fig. 20 Channel Setting Menu

The description of the Channel Menu is shown as the following list:

| Function Menu	Setting	Description
Coupling	AC	Block the DC component in the input signal.
	DC	Unblock the AC and DC components in the input signal.
	GROUND	The Input signal is interrupted.
Band Limit	OFF 100MHz	Get full bandwidth.
	ON 20MHz	Limits the channel bandwidth to 20MHz to reduce display noise.
	Note:This function is not supported by MSO5022S	
Channel	OFF	Close the measurement channel.
	ON	Open the measuring channel.
Probe	1X	Choose one according to the probe attenuation factor to make the vertical scale reading accurate.
	10X	
	100X	
	1000X	
Inverted	OFF	The wave form is displayed normally.
	ON	Initiate the wave form inverted function.

1. **Setting Channel Coupling**

Taking the Channel 1 for example, the measured signal is a square wave signal containing the direct current bias. The operation steps are shown as below:
(1). Press the **CH1 MENU** button and call out the **CH1 SETUP** menu.
(2). Press the **F1** menu selection button and select the Coupling item as "AC" to set the channel coupling as ac mode, under which the direct current component in the signal will be blocked.

Then, press the **F1** menu selection button again and select the Coupling item as "DC", setting the channel coupling as dc mode, under which both dc and ac components in the signal will be unblocked.

The wave forms are shown as Fig.21 and Fig.22.

29
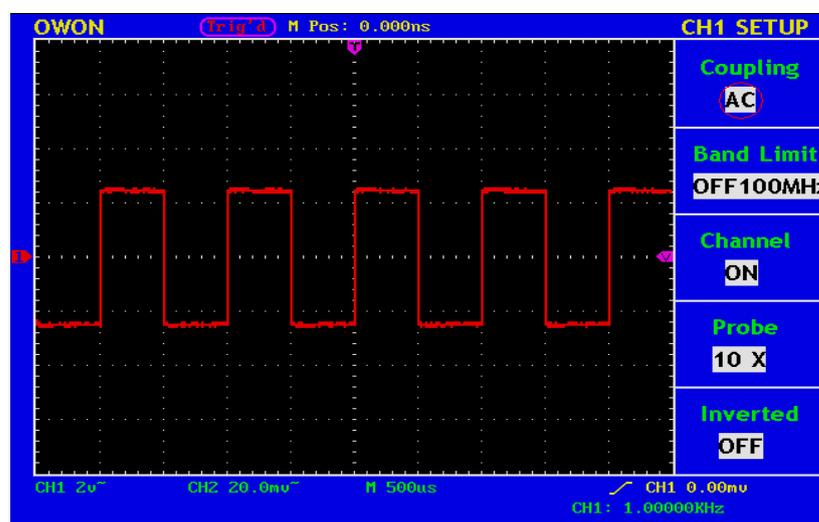
Fig. 21 AC Coupling Oscillogram
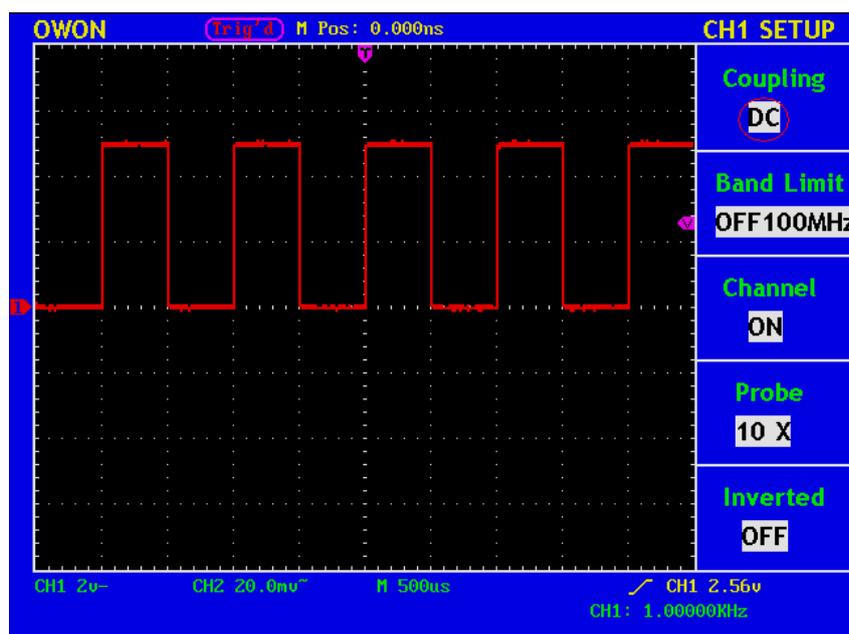
Fig. 22 DC Coupling Oscillogram

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. 22 and Fig.23.
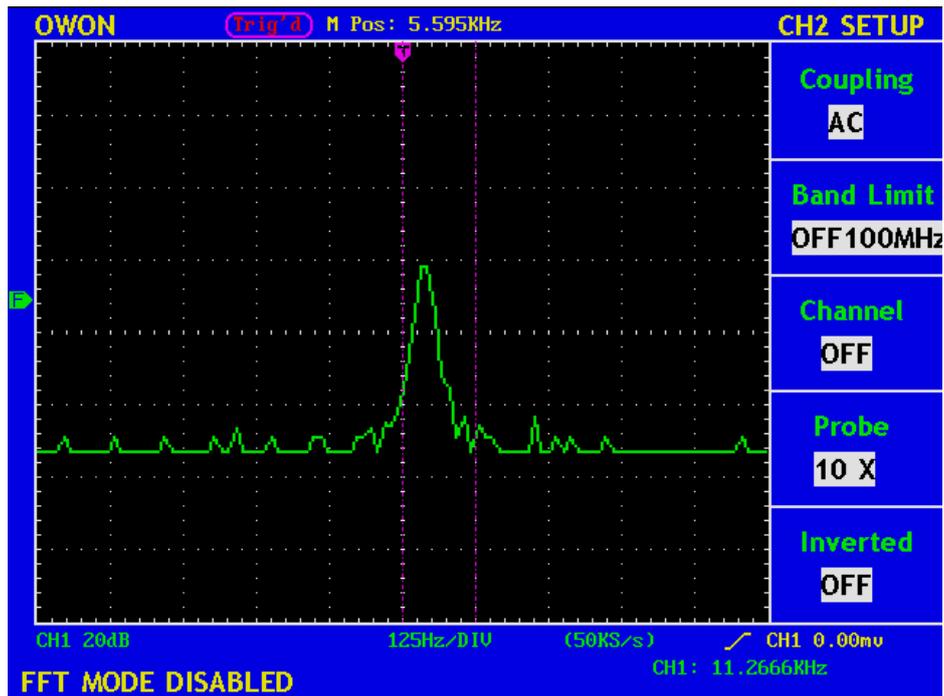
Fig. 22 Channel CH1 is diable under FFT mode
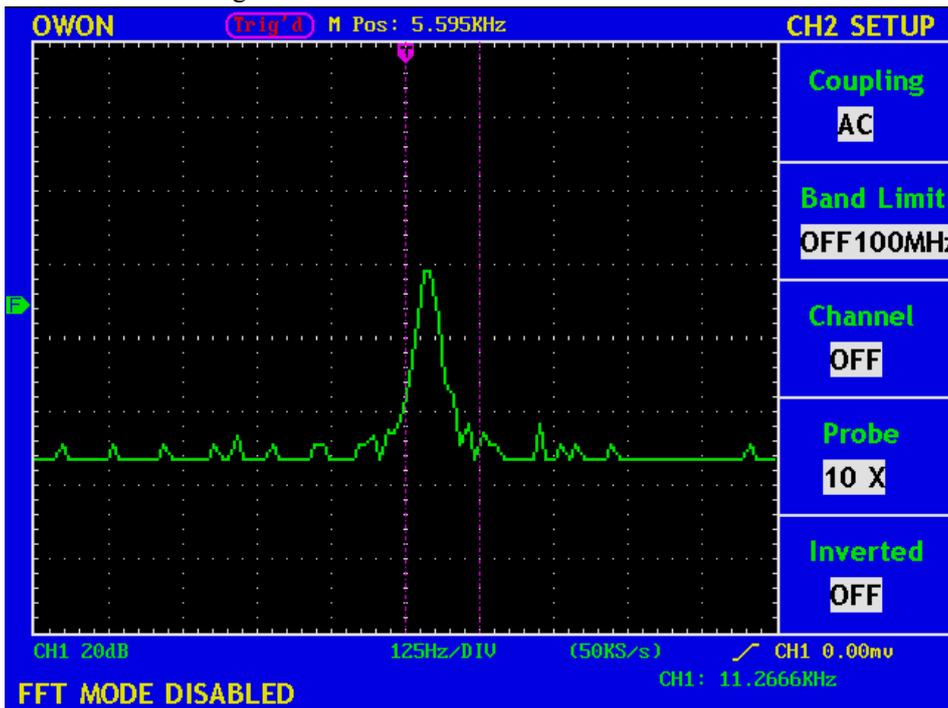
Fig. 23 Channel CH2 is diable under FFT mode

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.23 illustrates the setting and the vertical scale factor when the probe of the attenuation coefficient of 10:1.is used.
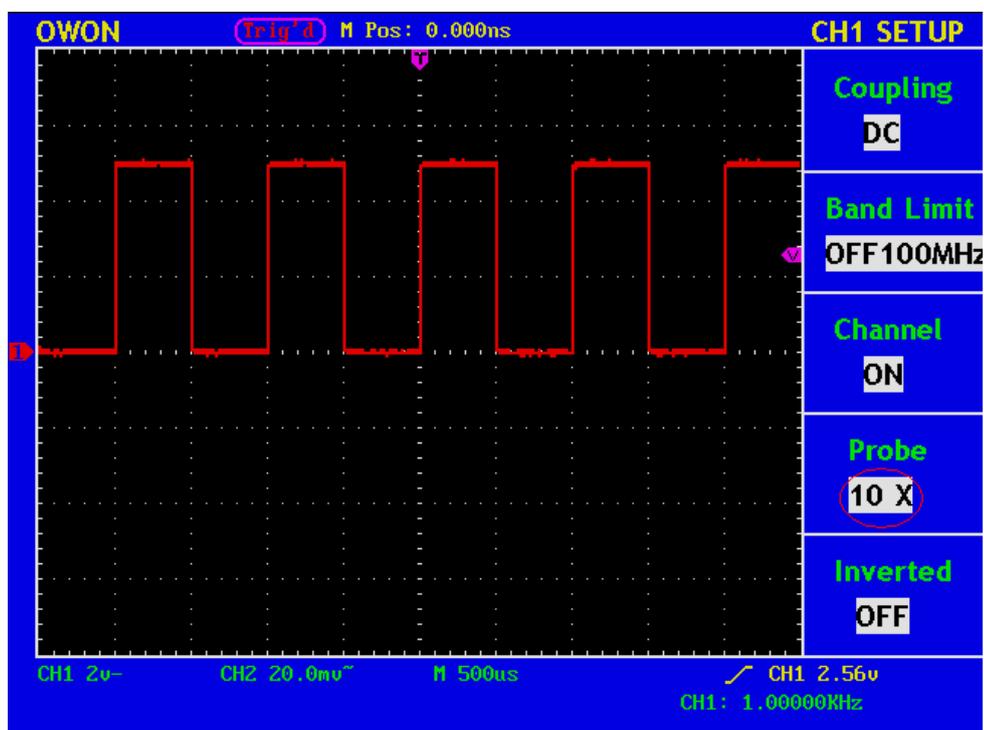
Fig. 24 Regulation of the Attenuation Ratio of the Probe

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. 25 and Fig. 26.
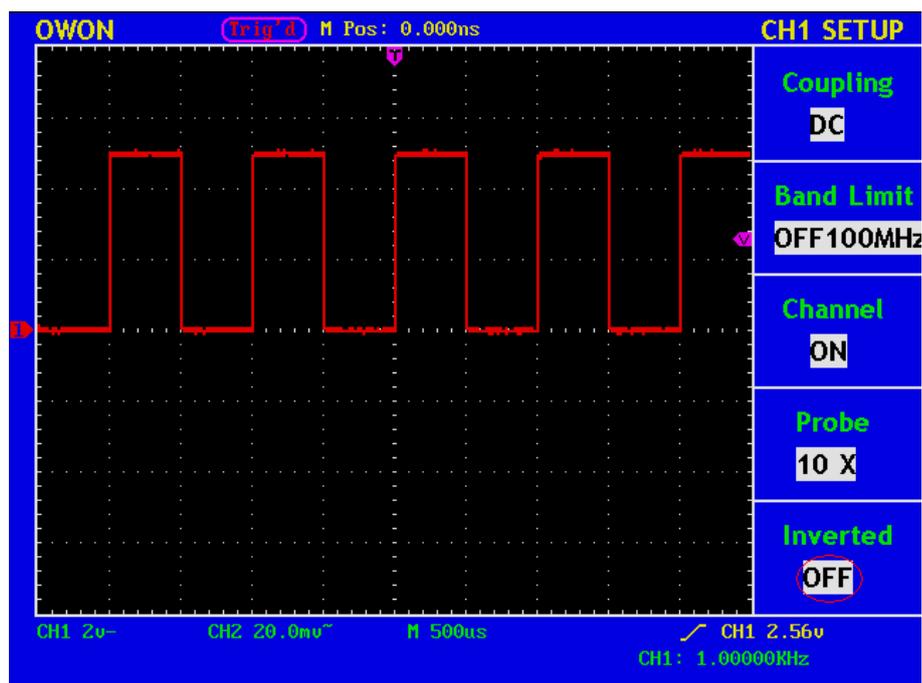
**Fig. 25** Wave Form not inverted
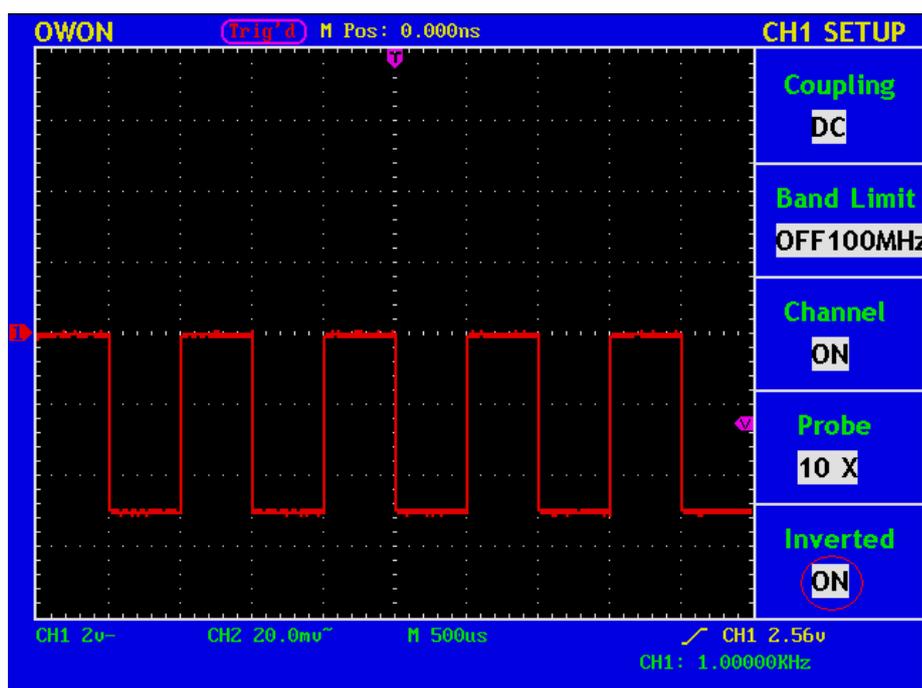
Fig. 26 Wave Form Inverted

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.27).
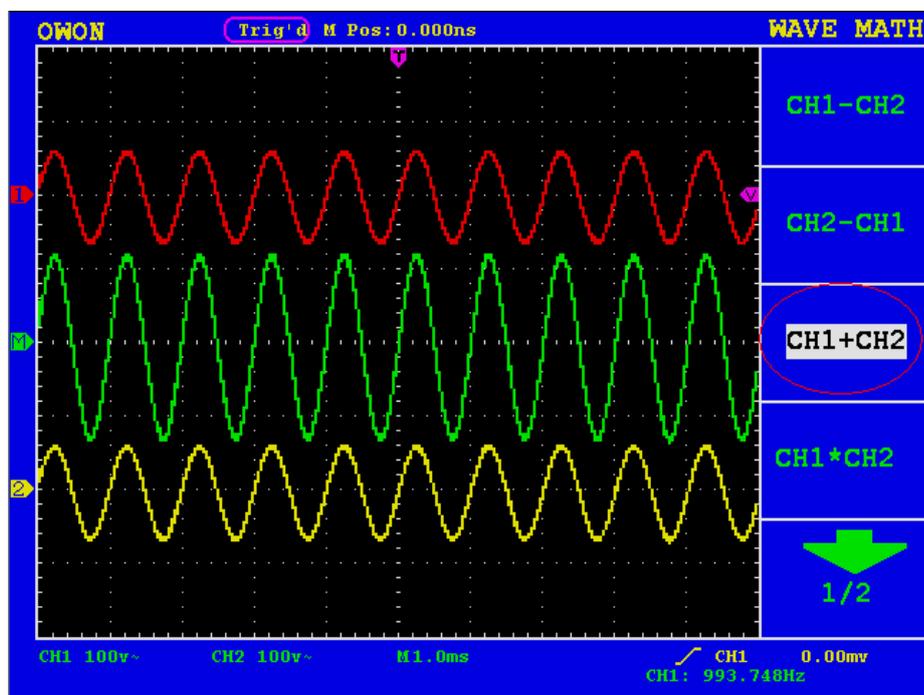
Fig. 27 Wave Form resulted from CH1 +CH2 Mathematical Manipulation

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:

Function Menu	Setting	Instruction
FFT	ON	Turn on FFT function.
	OFF	Turn off FFT function.
Source	CH1	Select CH1 as FFT source.
	CH2	Select CH2 as FFT source.
Window	Rectangle	Select window for FFT.
	Blackman	
	Hanning	
	Hamming	
Format	dB	Select dB for Format.
	Vrms	Select Vrms for Format.
Zoom	*1	Set multiple *1.
	*2	Set multiple *2.
	*5	Set multiple *5.
	*10	Set multiple *10.

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

1. Press the **MATH MENU** button and call out the WAVE MATH menu.

2. Press the **F5** selection button to turn to Page2 , Press **F3** to choose FFT.

3. Press F1 to turn on/off FFT after entering FFT menu, and please note that FFT is prohibited in Window setting mode. The green waveform F is shown in the screen after calculation.

4. Press **F2** selection button to switch over source channel CH1 and CH2.

5. Press **F3** button to select WINDOW,including Rectangle、 Hamming、 Hanning and Blackman.

6. Press **F4** to choose the Format as dB or Vrms.

7. Press F5 to zoom in or out the wave of the multiple including *1, *2, *5, *10.

8. 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.

9. Turn off FFT and then press **math menu** button to go back to the second page of wave math.

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	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 nonrepetitive signals and measuring frequency components near DC. 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.	
Hamming	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. 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.	
Hanning	This is a very good window for measuring amplitude accuracy but less so for resolving frequencies. 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.	
Blackman	This is the best window for measuring the amplitude of frequencies but worst at resolving frequencies. Use Blackman-Harris for measuring predominantly single frequency waveforms to look for higher order harmonics.	

Fig.28,29,30,31 show four kinds of window function referring to sine wave of 1KHz.
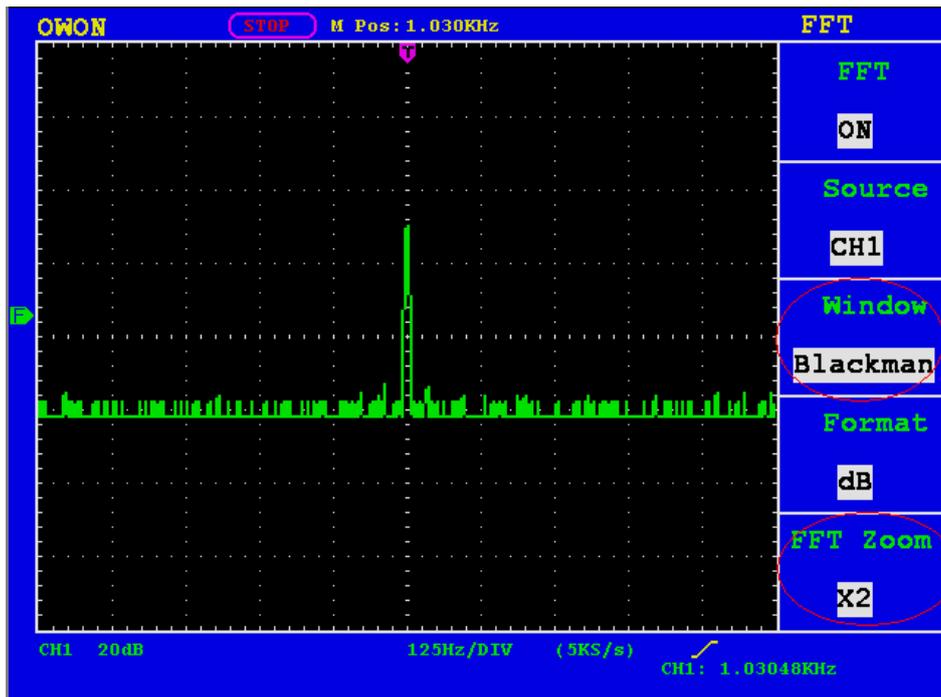
Fig.28. Blackman window
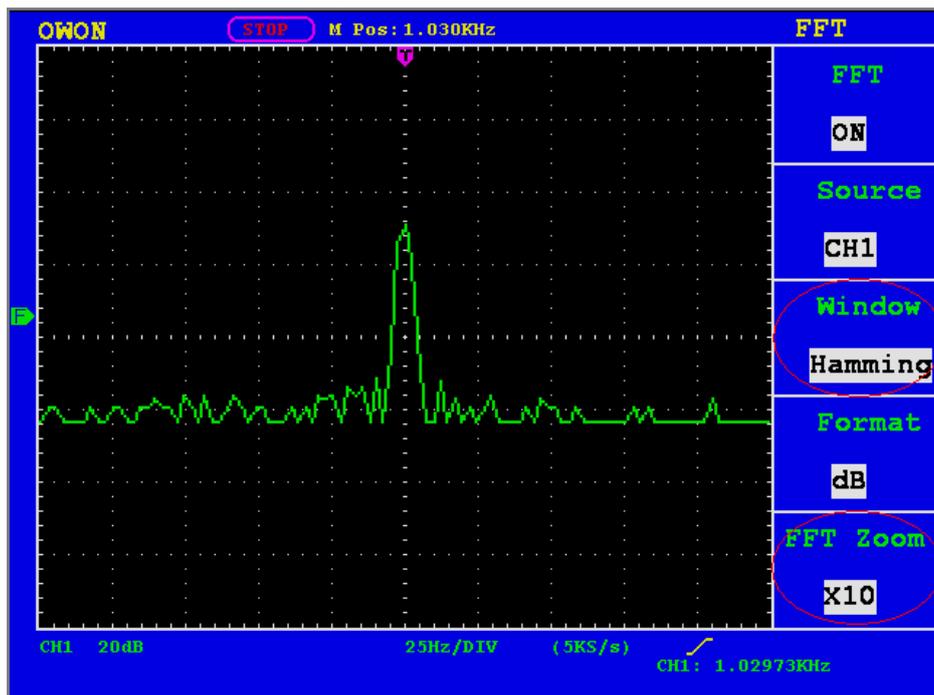
Fig.29 . Hamming window
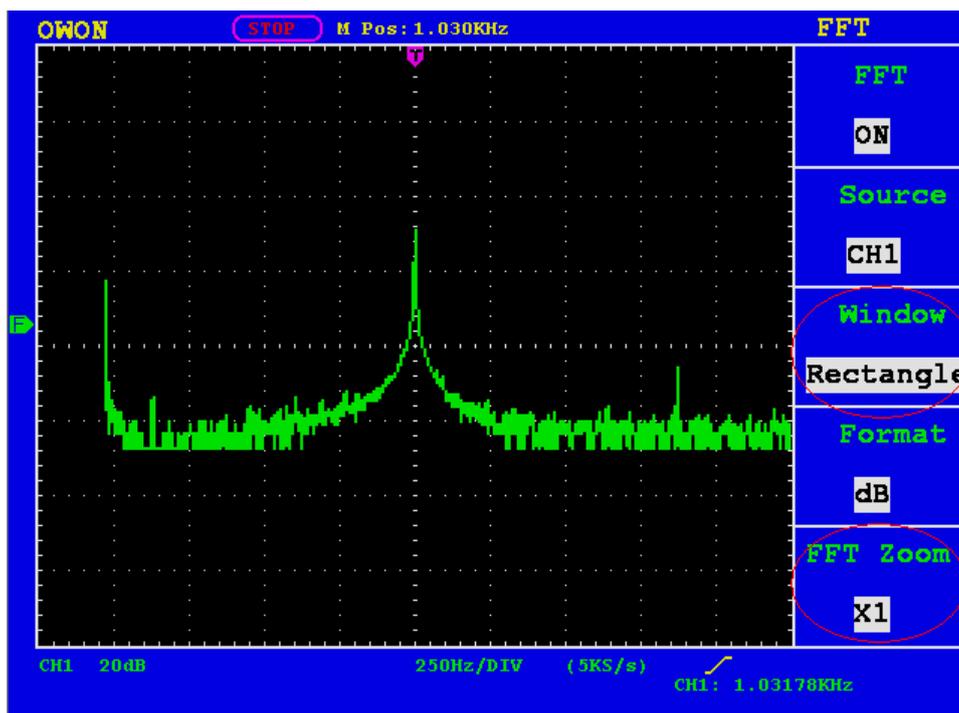
Fig.30. Rectangle window
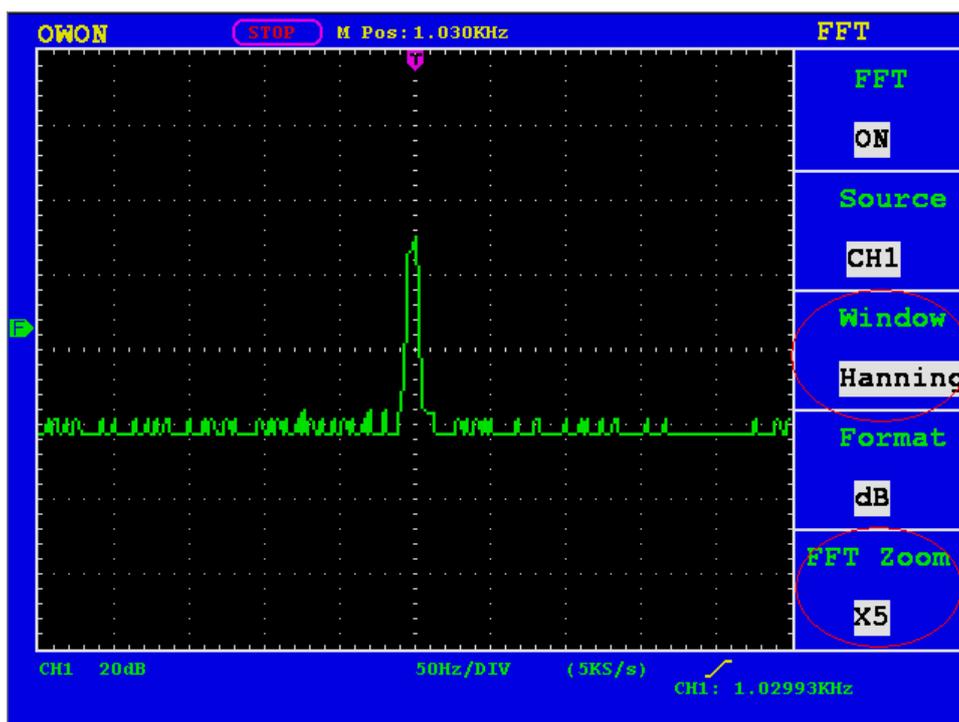
Fig.31 . Hanning window

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：

In FFT mode, the following settings are prohibited:

1) Window set;

2) change source channel (in CH1 Setup or CH2 Setup menu);

3) XY Format in DISPLAY SET;

4) "SET 50%" (the triggering level at the vertical point of signal amplitude) in Trigger setting;

5) Autoscale;

6) Measure 1 and Measure 2.

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.32).
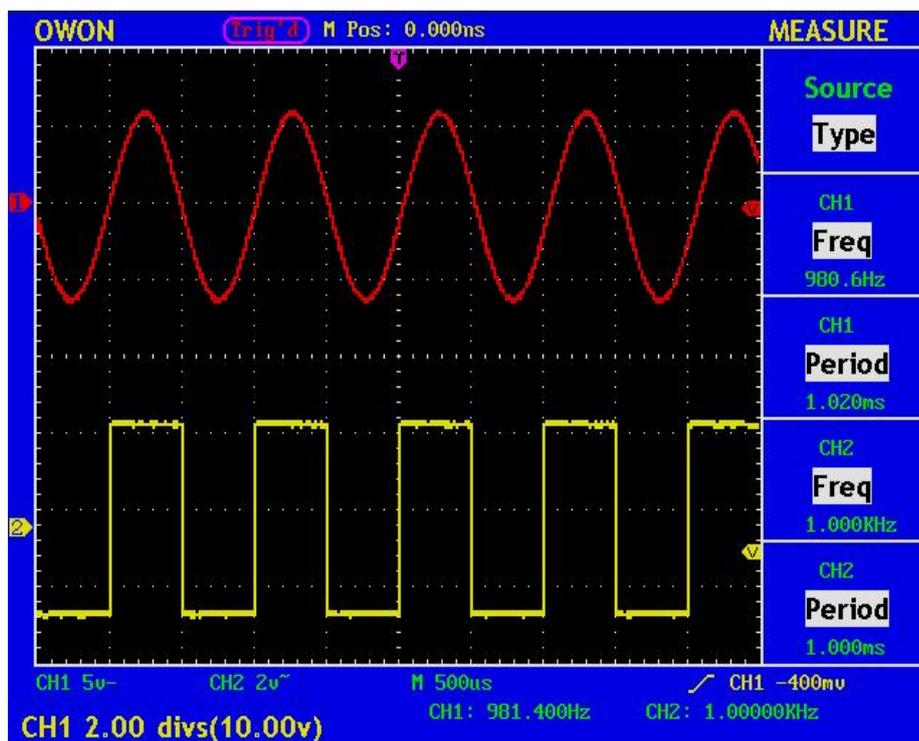
Fig. 32 Information about Vertical Position

How to Set the Horizontal system

The **HORIZONTAL CONTROLS** includes the **HORIZONTAL NENU** 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: with this button pushed down, the screen shows the operating menu (see Fig. 33).
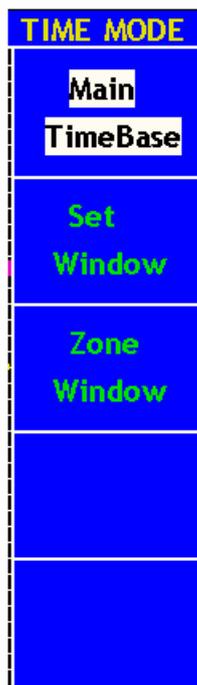
Fig. 33 Time Base Mode Menu

The description of the **Horizontal Menu** is as follows:

Function Menu	Setting	Description
Main Time Base		The setting of the horizontal main time base is used to display the wave form.
Set Window		A window area is defined by two cursors.This function is forbidden at the FFT mode disable
Zone Window		The defined window area for display is expanded to the full screen.

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.34.
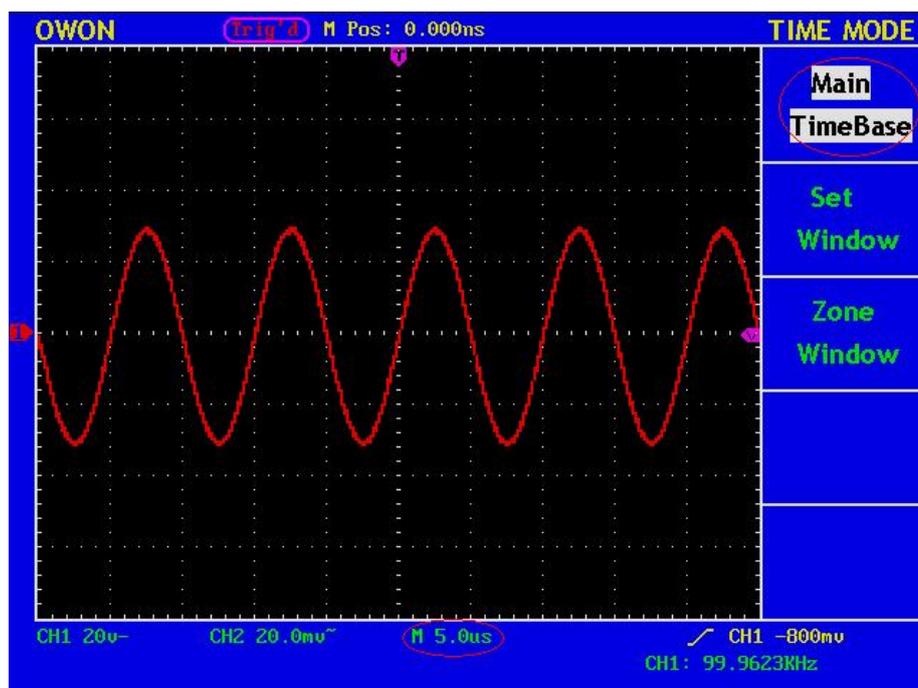
Fig. 34 Main Time Base

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 (see Fig. 30(a)). Press F2 menu button under the FFT mode ,it will notice "FFT mode disable".see Fig.35.
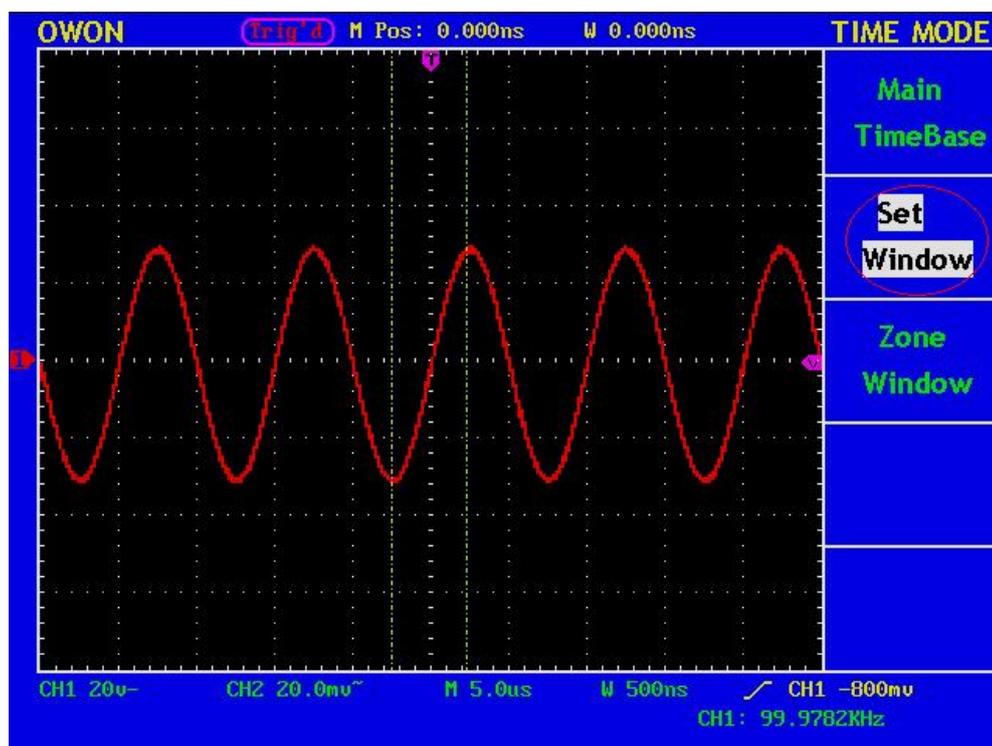

**Fig. 35** Window Setting
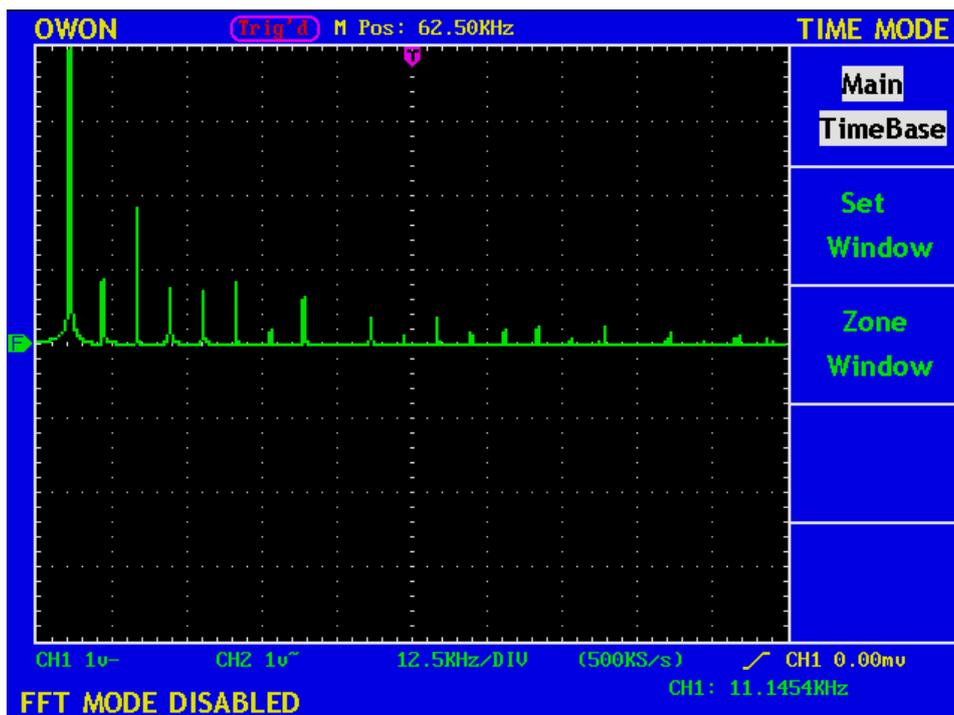
Fig.36 FFT mode disable

Window Expansion

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. 37).
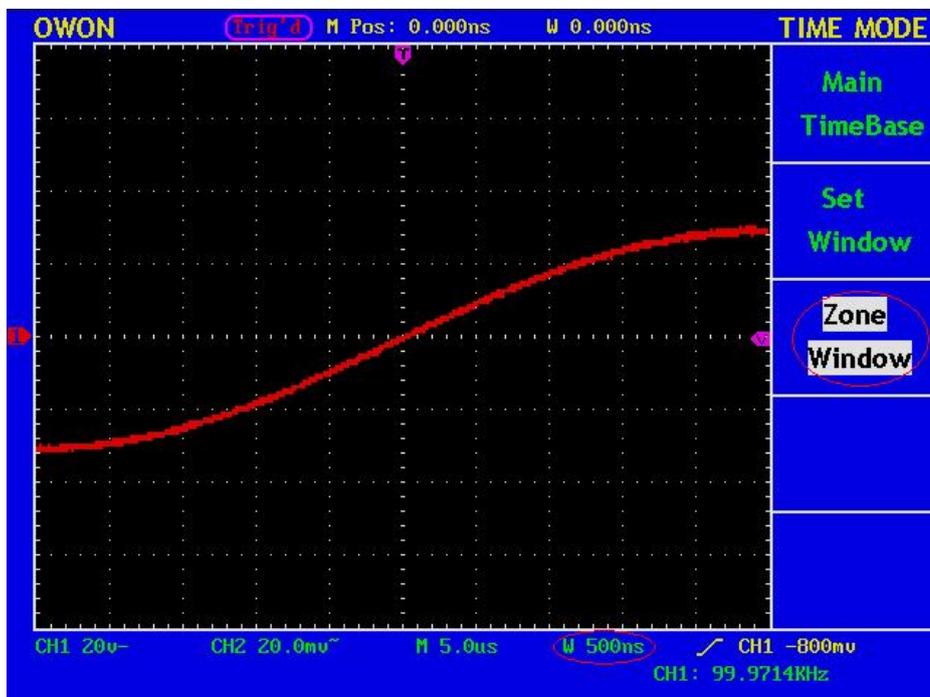

Fig. 37 Zone Window

How to set trigger system

Trigger is to determine when DSO starts to acquire data and waveform display. Once trigger to be set correctly then it will convert the unstable display to meaning waveform.

When DSO start to acquire data it will acquire enough data to form waveform on left of trigger point. DSO continues to acquire data when it waits for trigger condition happen. Once it detect out the trigger it will acquire enough data continuously to form the waveform on right of trigger point.

Trigger control area include 1 knob and 4 menu keys.

Trigger level: trigger level knob to set signal voltage correspond to trigger point.

SET 50%: set trigger level in middle vertical point of trigger signal voltage range, this setting is disable at the FFT mode.

FORCE TRIG: Force to a trigger signal and mainly to use in "Normal" and "Single" mode.

SET TO ZERO: Trigger horizontal position set to Zero.

Trig MENU: Press this key and panel display menu.

Trigger Control

The trigger control of MSO5022S

Edge trigger, Video trigger and alternate trigger. Press F1 to switch among different triggers.

Edge: when trigger input follow up certain direction to specify level then edge trigger happen.

Video: Take field/line trigger to video signal.

Alternate: Stabilize trigger un-synchronous signal.

Edge

Edge trigger is to trigger in the trigger voltage value of input signal edge. When choose "Edge" trigger in rising or falling of input signal.

Edge menu refer to Fig.33

Fig. 38 Edge trigger menu

Edge menu list:

MENU	SETTING	INSTRUCTION
Slop	Rising	Trigger in signal rising edge
	Falling	Trigger in signal falling edge
Source	CH1	Select CH1 as the trigger source.
	CH2	Select CH2 as the trigger source.
	EXT	Ext-trigger
	EXT/5	Ext-trigger divide to 5 and extend trigger level range.
	AC LINE	AC Line as resource trigger signal.
Trigger mode	Auto	Acquire waveform whatever detect trigger condition or not
	Normal	Only acquire waveform when match trigger condition
	Single	Only acquire waveform for single time when detect trigger condition then stop
⬇ 1/2		to Next menu
⬆ 2/2		Back to previous menu
Coupling	AC	Not allow DC portion to pass
	DC	Allow all portion pass
	HF	Not allow high frequency of signal pass and only low frequency portion pass.
	LF	Not allow low frequency of signal pass and only high frequency portion pass
Sensitivity	0.2～1.0div	Sensitivity from 0.2~1.0 Div.
Holdoff	100ns～10s	Turn "TRIG LEVEL" knob to set time slot before another trigger event
Holdoff Reset		Reset hold time to 100ns
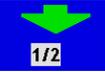
Follow up below step to set CH1 as rising slope edge trigger and trigger mode is auto, coupling is DC, trigger sensitivity is 0.5 Div.

1、Press "Trig menu"

2、Press "F1" to choose "Edge"

3、Press "F2" to choose slope as "Rising"

4、Press "F3" to choose source as "CH1"

5、Press "F4" to choose trigger mode as "Auto". Display as Fig.39

6、Press "F5" to choose "Next menu"

7、Press "F2" to choose coupling as "DC"

8、Press "F3" till "Sensitivity" display as 0.5div.

9、Press "F4" menu button to select Holdoff ,use trig level knob to ajust Holdoff.
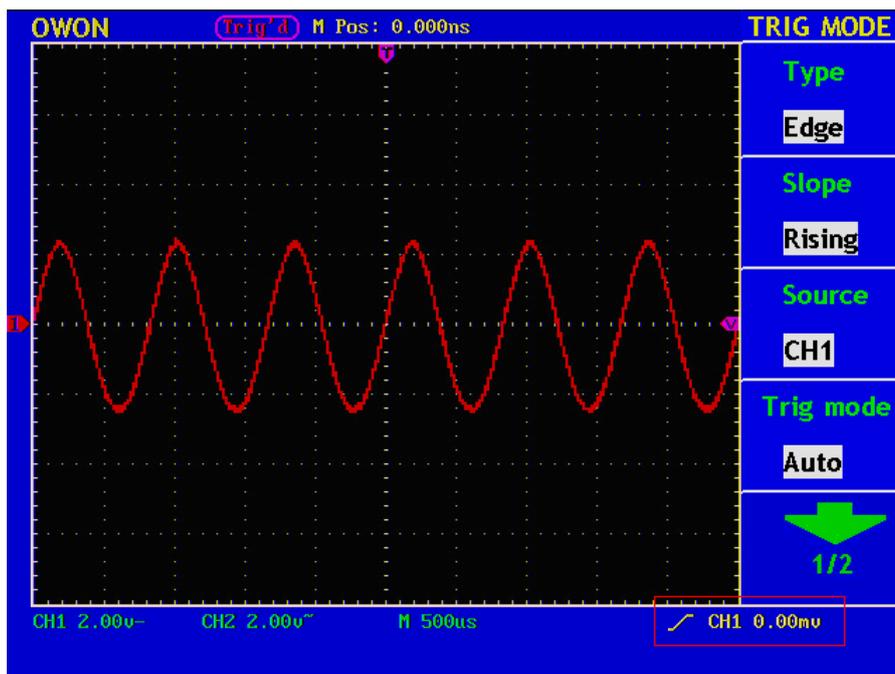
Fig. 39 Edge trigger (Rising Wave)

Video

    Choose "Video" and trigger in field/line of NTSC, PAL standard video signal
Trig menu refer to Fig.40
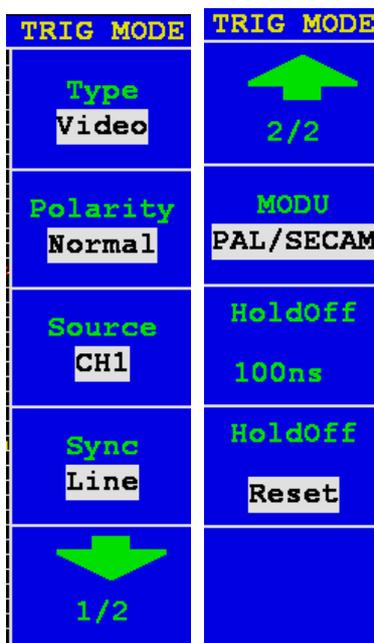
Fig.40 Video trigger menu

    Video trigger menu

MENU	SETTING	INSTRUCTION
Polarity	Normal	For low video signal of black voltage level
	Reverse	For high video signal of black voltage level
Source	CH1	Select CH1 as the trigger source.
	CH2	Select CH2 as the trigger source.
	EXT	Ext-trigger

	EXT/5	Ext-trigger divide to 5 to extend trigger level range
Sync	Line	Synchronic trigger in video line.
	Field	Synchronic trigger in video field.
	Odd Field	Synchronic trigger in video odd filed
	EvenField	Synchronic trigger in video even field
	Designed Line	Synchronic trigger in designed video line
⬇ 1/2		to Next menu
⬆ 2/2		Back to previous menu
MODU	NTSC PAL/SECAM	Video format setting
Holdoff	100ns～10s	Turn "TRIG LEVEL" knob to set time slot before another trigger event
Holdoff Reset		Reset hold time to 100ns

Follow up below steps to set CH1 as video trigger

1、Press "Trig menu"

2、Press F1 to choose mode as "Video"

3、Press "F2" to choose slope as "Normal".

4、Press "F3" to choose source as "CH1"

5、Press F4 to choose synchronization as "Field" (refer to Fig.41)

6、Press F5 to Next menu

7、Press F2 to chose modulation as "NTSC" .

8、Press F3 menu button to select Holdoff ,use trig level knob to ajust Holdoff.
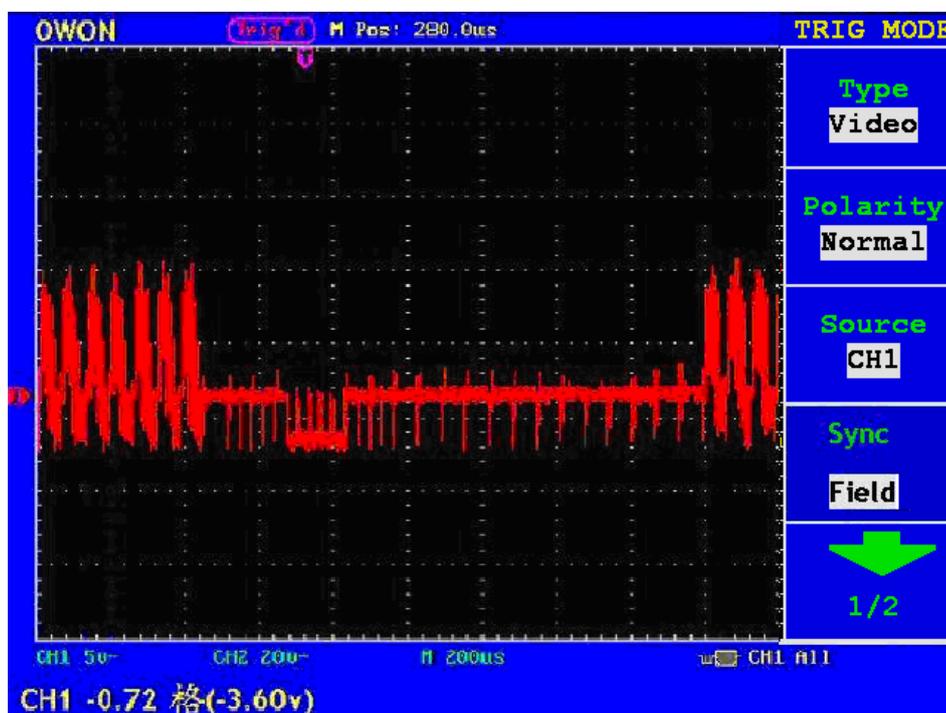
Fig. 41 Video field trigger Oscillogram

47

Alternate trigger

Trigger signal come from two vertical channels with alternate trigger. This mode is to observe two unrelated signals. It is able to set different trigger mode (edge or video) for different channels in the menu. Two trigger vertical position indexes (red for CH1 and yellow for CH2) will displayed in alternate trigger.
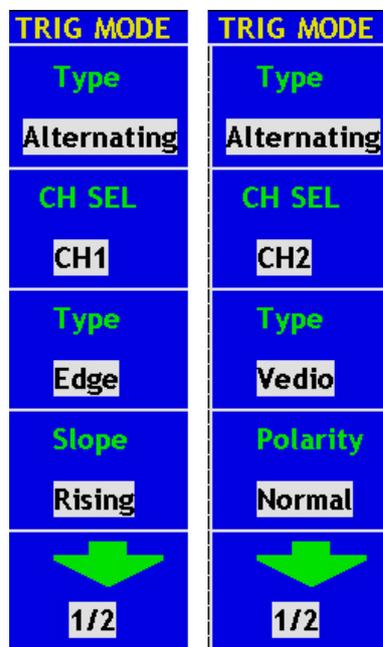
Fig. 42 Alternate trigger menu

When trigger mode as slope setting is same as edge. When trigger mode as video setting same as video.

CH1 to measure a square wave of 10K Hz and CH2 to measure a video signal. The alternate setting as below:

1、Press "Trig menu"

2、Press "F1" and choose type as "Alternate"

3、Press "F2" and choose source as "CH1"

4、Press "F3" to choose type as "Edge"

5、Press "F4" to choose slope as "Rising"

6、Press "F5" to choose "Next menu"

7、Press "F2" to choose coupling as "DC"

8、Press "F3" till sensitivity display as 0.5 div. CH1 trigger setting finished.

9、Press "F1" to choose "Previous menu"

10、Press "F2" to choose source as "CH2"

11、Press "F3" to choose type as "Video"

12、Press "F4" to choose polarity as "Normal"

13、Press "F5" to choose "Next menu"

14、Press "F2" and choose synchronization as "Line". CH2 trigger setting finished.

Acquired waveform refer to Fig.43
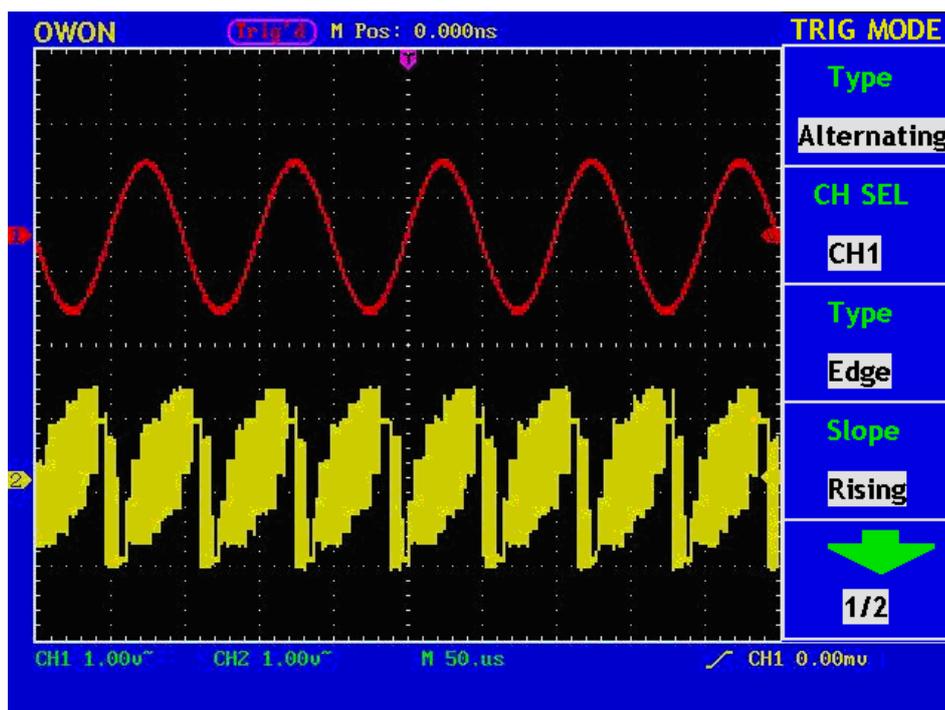
Fig. 43 Alternate trigger Oscillogram

The trigger control of MSO7102T

There are two trigger modes: single trigger and alternate trigger.

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

Alternate trigger: Trigger nsynchronous signals steadily. The two channels could acquire the waveforms when the CH1 and CH2 are inputting two different frequency signals.

Single trigger

Single trigger mode have edge trigger and video trigger, you can see different trigger type for two vertical channels in this menu.

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

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

The Edge and Video Trigger menus are described respectively as below:

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.44.

Fig. 44 Edge trigger menu

Edge menu list:

MENU	SETTING	INSTRUCTION
Source	CH1	Select CH1 as the trigger source.
	CH2	Select CH2 as the trigger source.
	EXT	Ext-trigger
	EXT/5	Ext-trigger divide to 5 and extend trigger level range.
	AC LINE	AC Line as resource trigger signal.
Mode	Edge	Set vertical channel trigger type for edge trigger.
Slop	Rising	Trigger in signal rising edge
	Falling	Trigger in signal falling edge
		to Next menu
		Back to previous menu
Trigger mode	Auto	Acquire waveform whatever detect trigger condition or not
	Normal	Only acquire waveform when match trigger condition
	Single	Only acquire waveform for single time when detect trigger condition then stop
Coupling	AC	Not allow DC portion to pass.
	DC	Allow all portion pass.
	HF	Not allow high frequency of signal pass and only low frequency portion pass.
	LF	Not allow low frequency of signal pass and only high frequency portion pass
Holdoff	100ns～ 10s	Turn "TRIG LEVEL" knob to set time slot before another trigger event.
Holdoff Reset		Reset hold time to 100ns

Follow up below step to set CH1 as rising slope edge trigger and trigger mode is auto,

coupling is DC.

1、Press "Trig menu"

2、Press "F1" to choose type as"Single"

3、Press "F2" to choose source as "CH1"

4、Press "F3" to choose mode as "Edge"

5、Press "F4" to choose slope as "Rising". Display as Fig.45

6、Press "F5" to choose "Next menu"

7、Press "F2" to choose trigger mode as "Auto"

8、Press "F3" to choose coupling as "DC".

9、Press"F4" menu button to select Holdoff ,use trig level knob to ajust Holdoff.
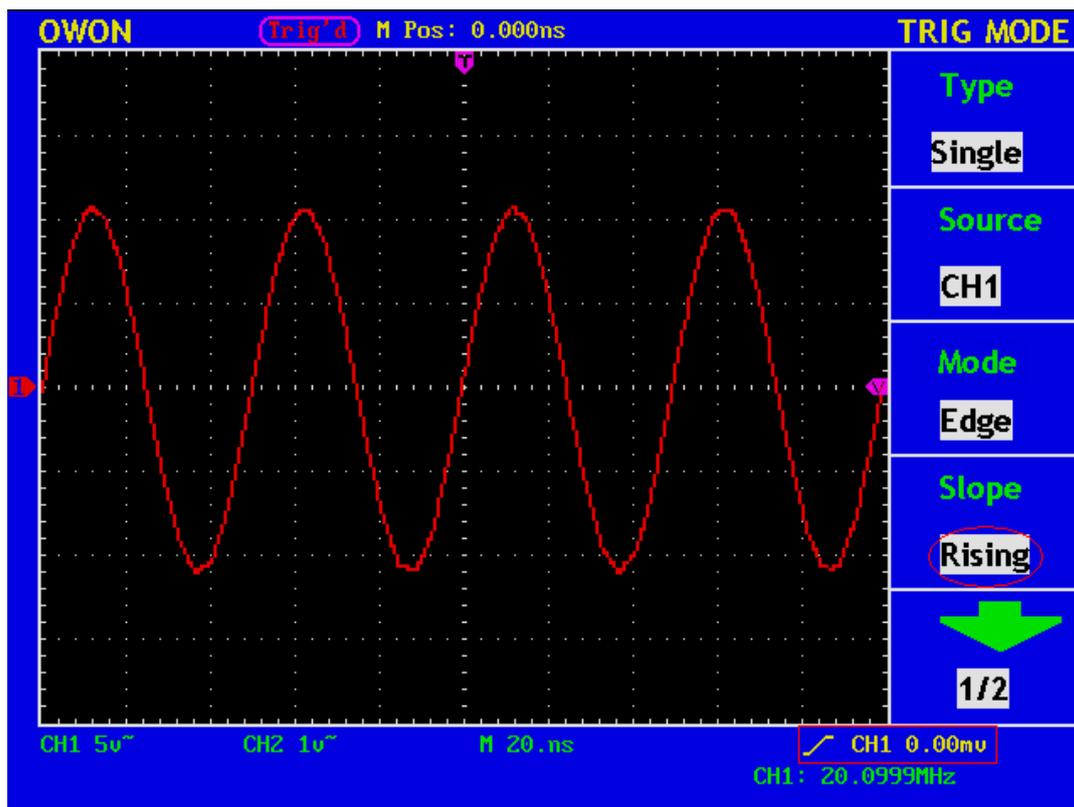
Fig. 45   Edge trigger (Rising Wave,the first menu)
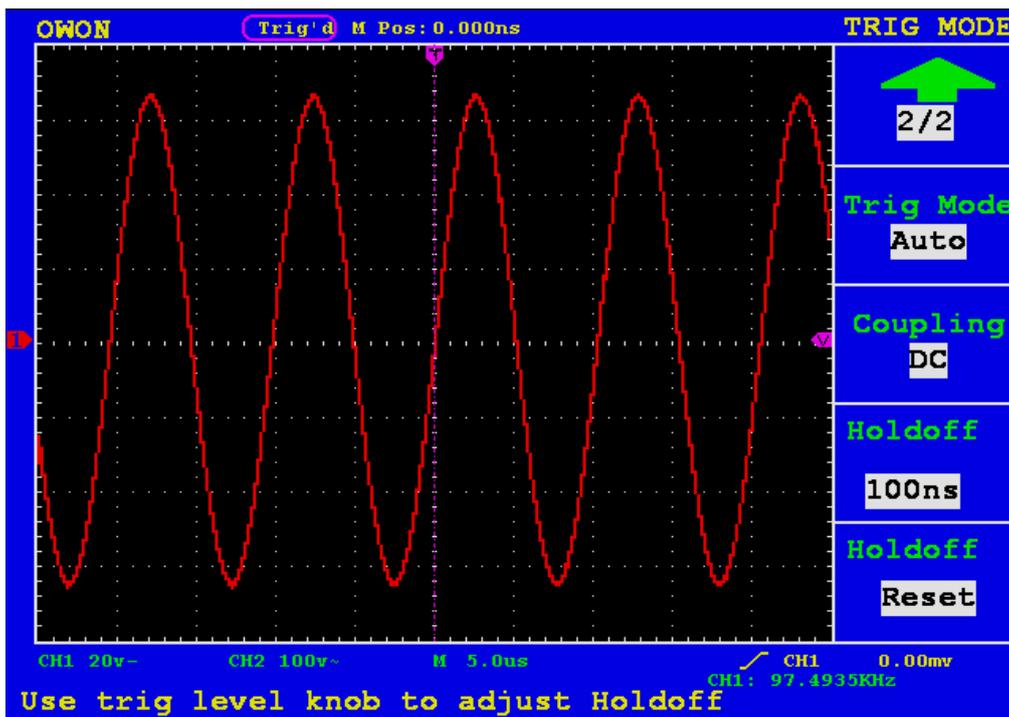
Fig. 46 Edge trigger (Rising Wave, the second menu)

Video

Choose "Video" and trigger in field/line of NTSC, PAL standard video signal

Trig menu refer to Fig.47

Fig. 47 Video trigger menu

Video trigger menu

MENU	SETTING	INSTRUCTION
Source	CH1	Select CH1 as the trigger source.
	CH2	Select CH2 as the trigger source.
	EXT	Ext-trigger
	EXT/5	Ext-trigger divide to 5 to extend trigger level range

Mode	Video	
Sync	Line	Synchronic trigger in video line.
	Field	Synchronic trigger in video field.
	Odd Field	Synchronic trigger in video odd filed
	EvenField	Synchronic trigger in video even field
	Designed Line	Synchronic trigger in designed video line
		to Next menu
		Back to previous menu
Modulation	NTSC PAL/SECAM	Video modulation setting
Holdoff	100ns～10s	Turn "TRIG LEVEL" knob to set time slot before another trigger event
Holdoff Reset		Reset hold time to 100ns

Follow up below steps to set CH1 as video trigger

1、Press "Trig menu"

2、Press F1 to choose type as "Single"

3、Press F2 to choose source as "CH1".

4、Press F3 to choose mode as "Video".

5、Press F4 to choose synchronization as"Line" (refer to Fig.48)

6、Press F5 to Next menu.

7、Press F2 to chose modulation as "NTSC".
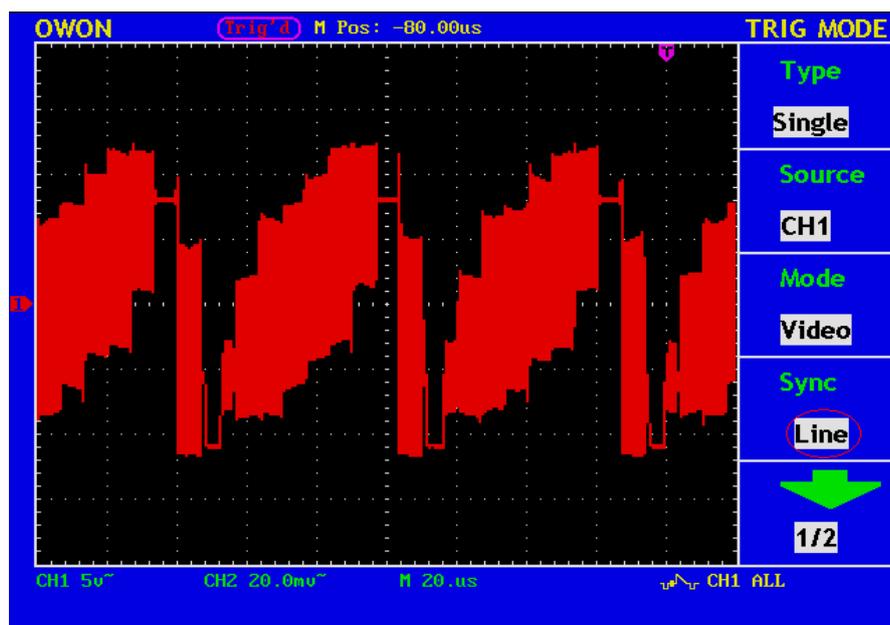
Fig. 48 Video field trigger Oscillogram

Alternate trigger

Trigger signal come from two vertical channels with alternate trigger. This mode is to observe two unrelated signals. It is able to set different trigger mode (edge or video) for different channels in the menu. Two trigger vertical position indexes (red for CH1 and yellow for CH2) will displayed in alternate trigger.

Fig.49：Alternate edge trigger menu   Fig.50：Alternate video trigger menu

When trigger mode as slope setting is same as edge. When trigger mode as video setting same as video.

CH1 to measure a square wave of 10K Hz and CH2 to measure a video signal. The alternate setting as below:

1、   Press "Trig menu"；
2、   Press "F1" and choose type as "Alternate";
3、   Press "F2" and choose source as "CH1";
4、   Press "F3" to choose mode as "Edge";
5、   Press "F4" to choose slope as "Rising";
6、   Press "F5" to choose "Next menu";
7、   Press "F2" to choose trigger mode as "Auto";
8、   Press "F3" to choose coupling as "DC". CH1 trigger setting finished;
9、   Press "F1" to choose "Previous menu";
10、   Press "F2" to choose source as "CH2";
11、   Press "F3" to choose mode as "Video"
12、   Press "F4" to choose sync as "Line"；
13、   Press "F5" to choose "Next menu";
14、   Press "F2" and choose modulation as "NTSC". CH2 trigger setting finished.
   Acquired waveform refer to Fig.51;
15、   Press"F4" menu button to select Holdoff ,use trig level knob to ajust Holdoff.
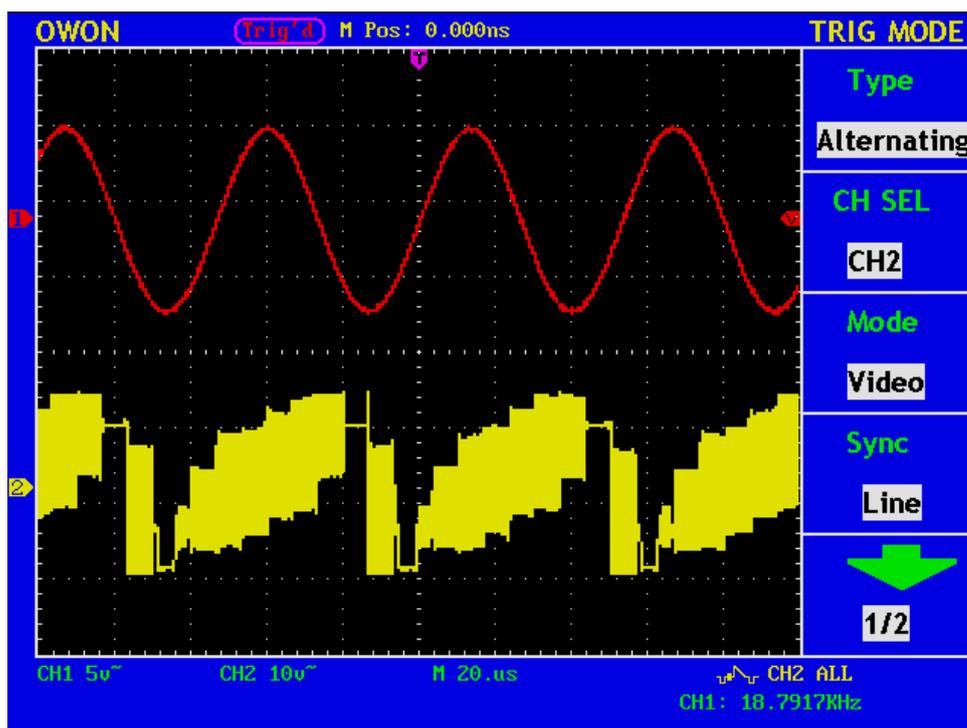
Fig. 51 Alternate trigger Oscillogram

Term interpretation

Holdoff:A time interval before the oscilloscope responses to next trigger signal.During this Holdoff period,the trigger system becomes "blind " to grigger 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. 52.
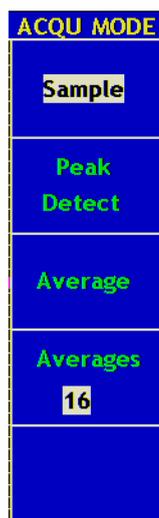
Fig. 52 ACQU MODE Menu

The description of the **Sampling Setup Menu** is shown as follows:

Function Menu	Setting	Description
Sample		General sampling mode.
Peak Detect		It is used for the detection of the jamming burr and the possibility of reducing the confusion.
Average		It is used to reduce the random and don't-care noises, with the optional number of averages.
Averages	4, 16, 64, 128	Choose the number of averages.

Change the **ACQU Mode** settings and observe the consequent variation of the wave form displayed.
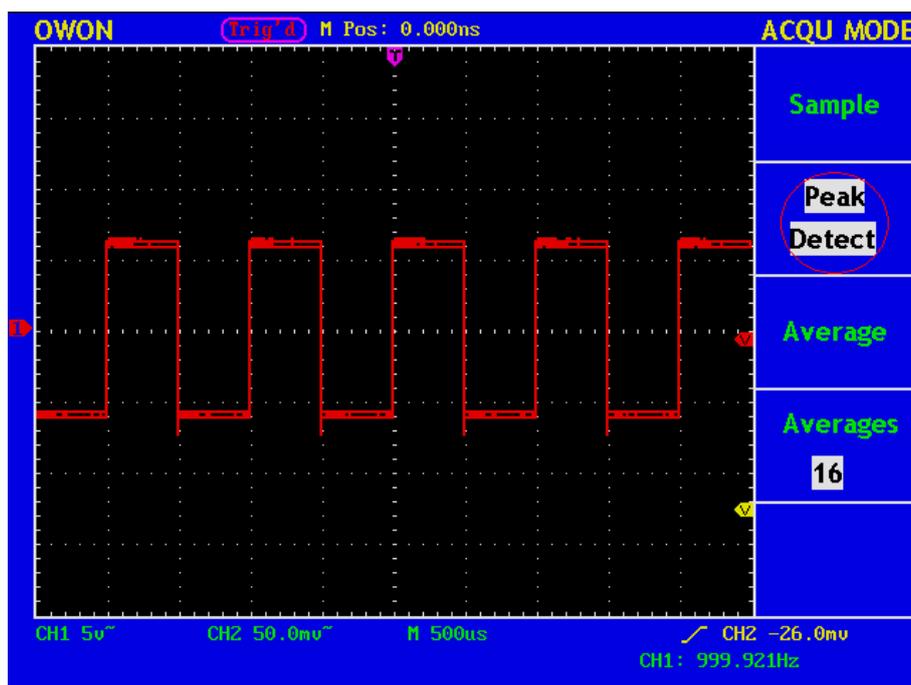
Fig. 53 Peak Detect mode, under which the burrs on the falling edge of the square wave, can be detected and the noise is heavy.
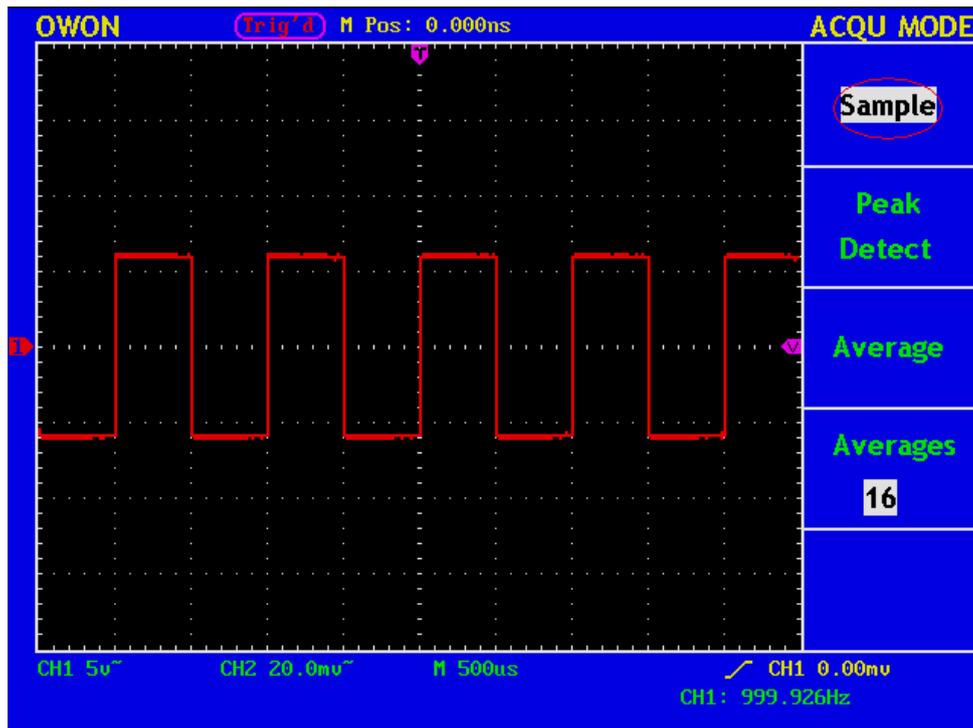
Fig. 54 Common **ACQU Mode** display, in which no burr can be detected.
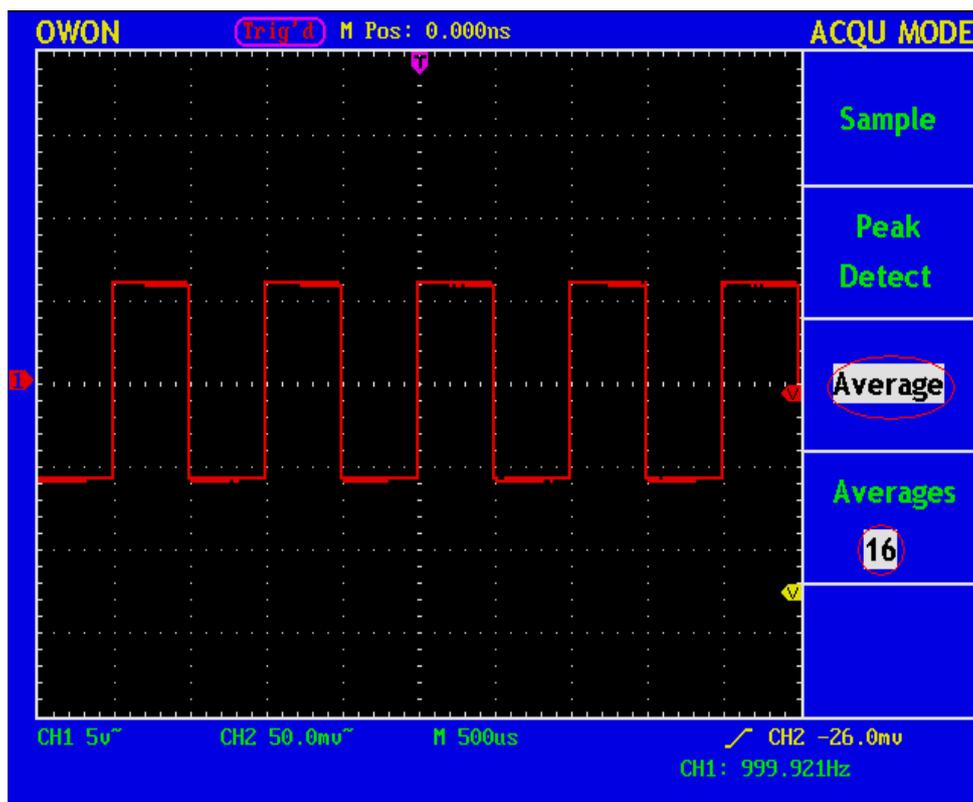
Fig. 55 The displayed wave form after the noise is removed under the Average Mode,

in which the average number of 16 is set.

How to Set the Display System

Push down the **DISPLAY** button and the menu displayed in the screen is shown as Fig. 56.
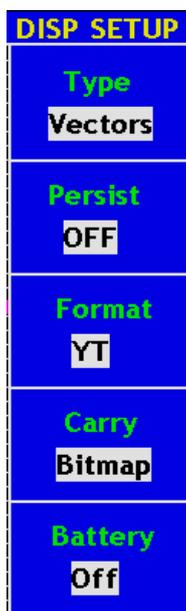
Fig. 56 Display Set Menu

The description of the **Display Set Menu** is shown as follows:

Function Menu	Setting	Description
Type	Vectors	The space between the adjacent sampling points in the display is filled with the vector form.
	Dots	Only the sampling points are displayed.
Persist	OFF 1sec 2sec 5sec Infinite	Set the persistence time for each sampling point.
Format	YT	Show the relative relation between the vertical voltage and the horizontal time.
	XY	Channel 1 is displayed on the horizontal axis and Channel 2 on the vertical axis. FFT mode disable.
Carry	Bitmap	The data transmitted in communication are in the bitmap form.
	Vectors	The data transmitted in communication are in the vector form.
Battery	On	Battery power content symbol on
	Off	Battery power content symbol off
Contrast Increase *		Increase panel display contrast
Contrast Decrease *		Decrease panel display contrast

＊only the MS05022S model has the the two menu options.

Display Type: With the **F1** menu selection button pushed down, you can shift between **Vectors** and **Dots** types**.** The differences between the two display types can be observed through the comparison between Fig.57 and Fig.58.
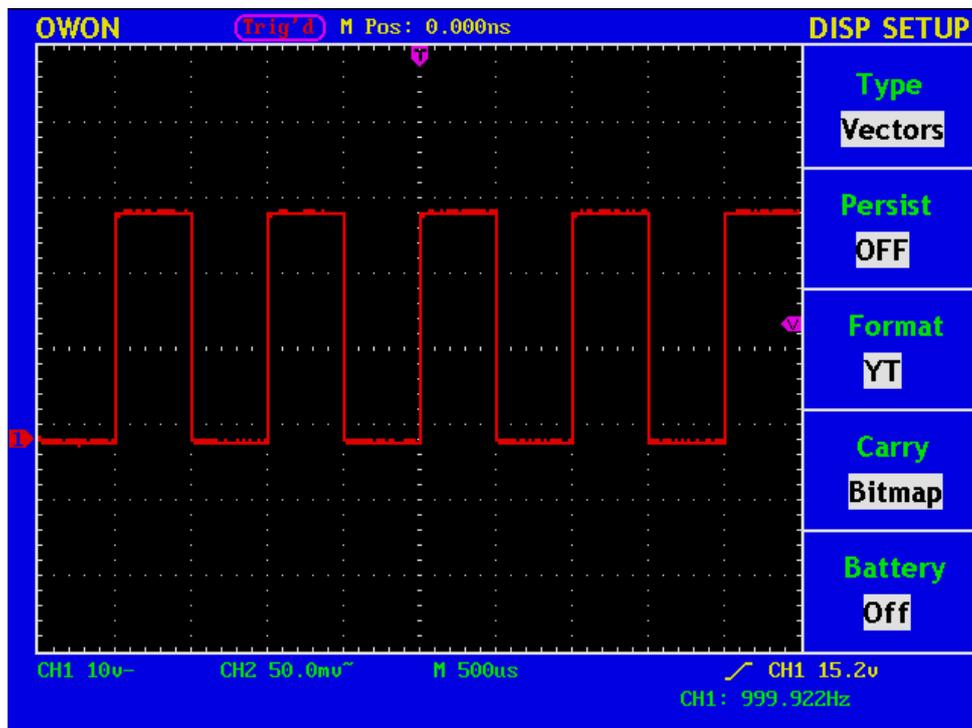
Fig. 57 Display in the Vector Form
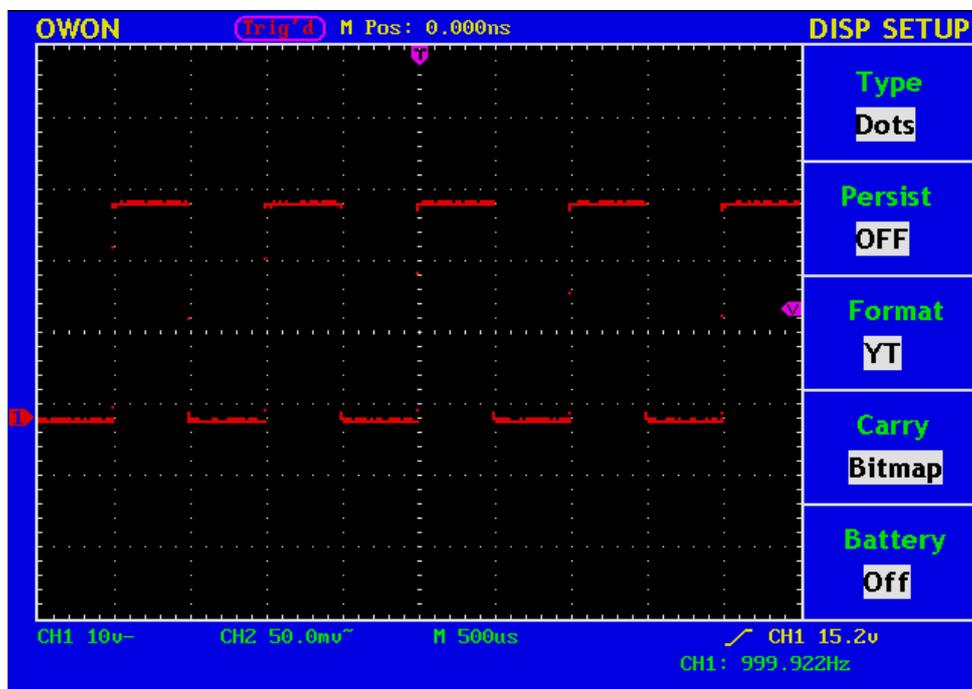
Fig. 58 Display in Dots form

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.59).
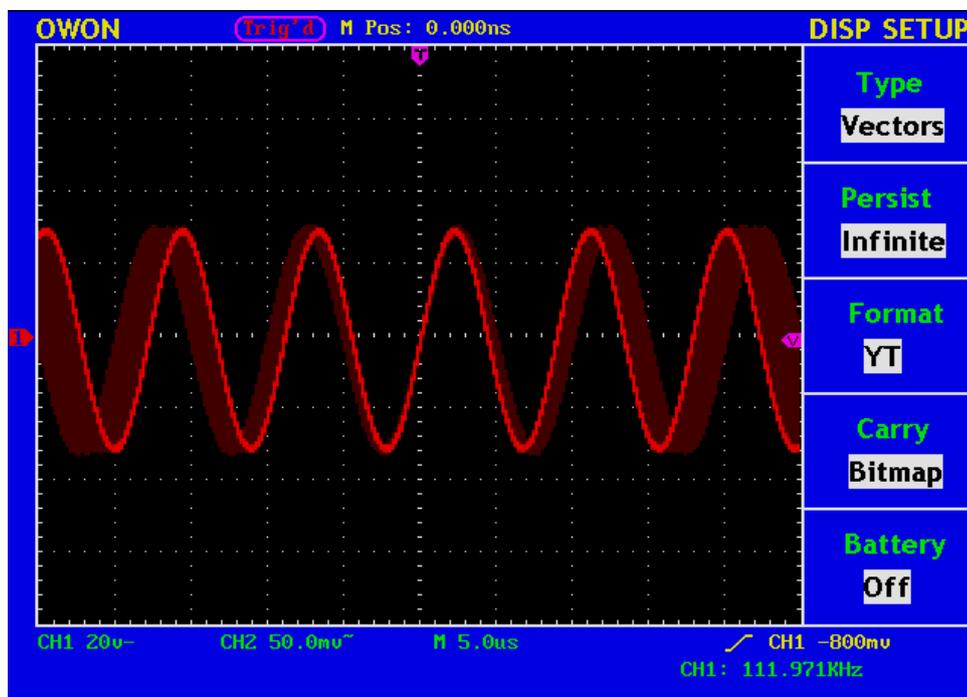
Fig. 59 Infinite Persistence Display

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 1are 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.

 The following functions can not work in the XY Format:

■ Reference or digital wave form

■ Cursor

■ Time base control

■ Trigger control

Operation steps:

1. Press the **DISPLAY** button and call out the **Display Set** Menu.

2. Press the **F3** menu selection button and choose the form as XY. The display format is changed to be XY mode (see Fig.60).
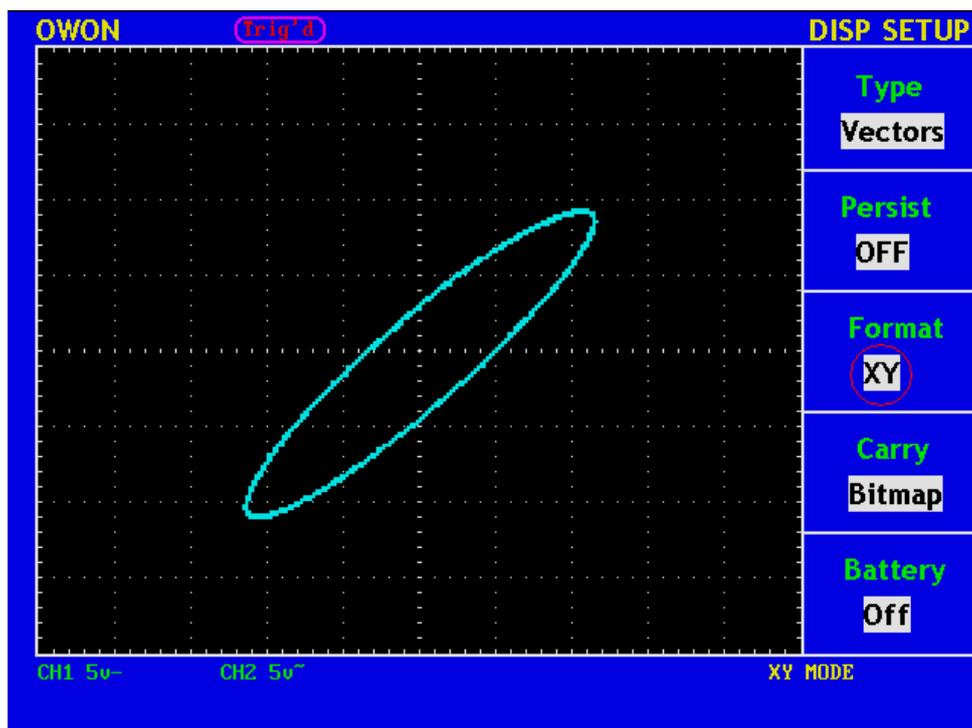
Fig. 60 XY Display Mode

At the mode of FFT,if switching YT to XY, "FFT MODE is unavailable" prompts as Fig.61
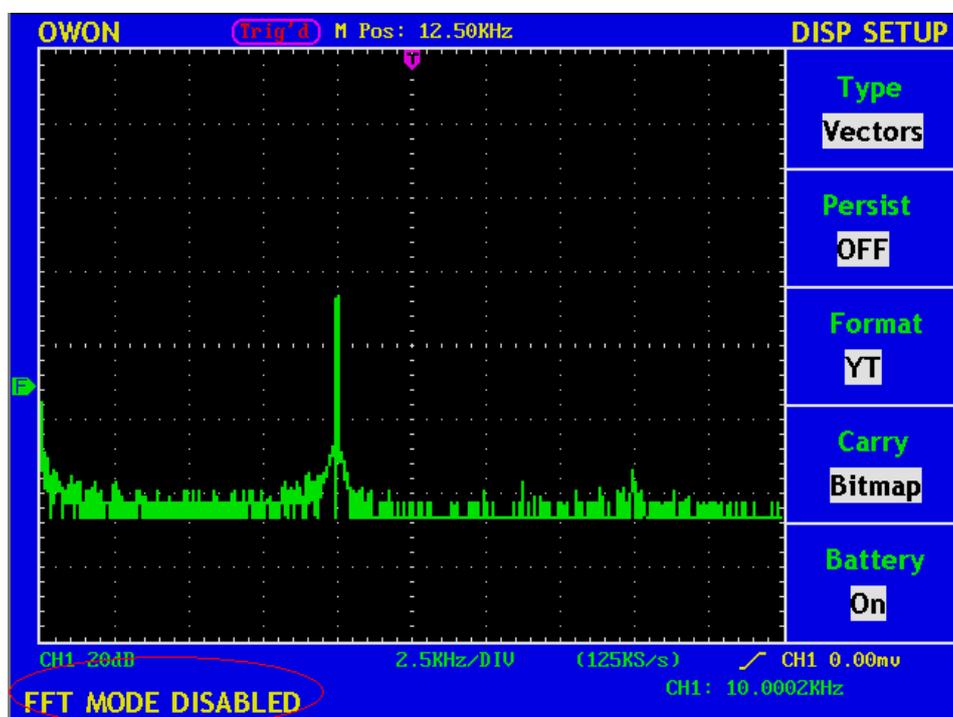
Fig.61 FFT mode XY Format Disable

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.62.

Fig. 62 Wave Form Save Menu

The description of the **Wave Form Save Menu** is shown as the following table:

Function Menu	Setting	Description
Source	CH1 CH2 MATH OFF	Choose the wave form to be saved.
WAVE	A , B C , D	Choose the address in or from which the waveform is saved or can be get access to.
Save		Save the wave form of the source in the selected address.
CHA	OFF ON	Switch on or off the display of the stored waveform.

Save and Recall the Wave Form

The MSO series oscilloscope can store four waveforms, which can be displayed with the current waveform at the same time. The stored waveform called out can not be adjusted.

In order to save the waveform of the channel CH1 into the address A, the operation steps should be followed:

1. Press the **F1** menu selection button and choose CH1 for Source.

2. Press the **F2** menu selection button and choose A as save address.

3. Press the **F3** menu selection button and save the waveform.

4.   Press the **F4** menu selection button and choose **ON** for CH A. The stored wave form A will be displayed in the screen. The voltage level and time base level will also be shown at the upper left corner of the display area at the same time (see Fig.63).
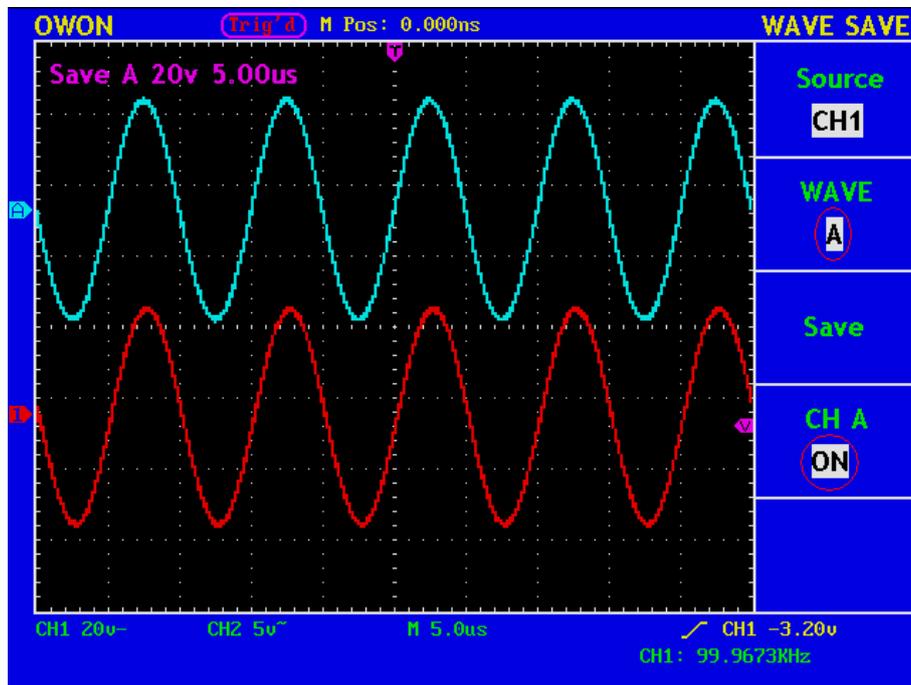
Fig. 63 Wave Saving
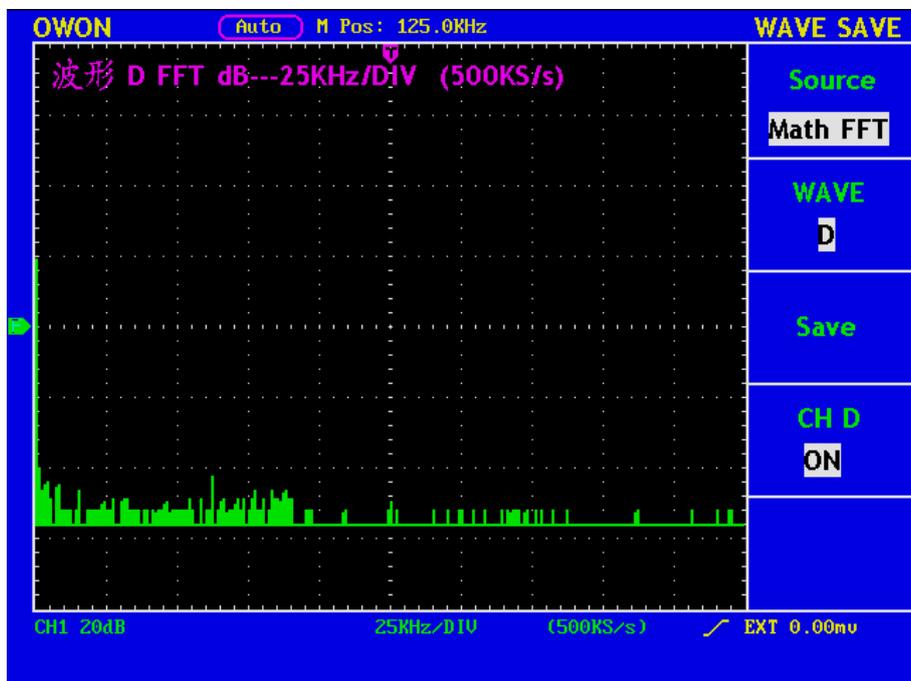
Fig.64   FFT wave Saving

How to Implement the Auxiliary System Function Setting

Press the **UNTILITY** button and the menu is displayed in the screen as Fig.65.
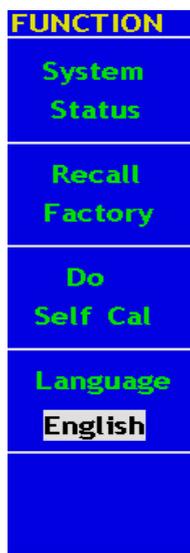
Fig. 65 Function Menu

The description of the **Auxiliary Function Menu** is shown as the following table.

Function Menu	Setting	Description
System Status		Display the system function menu.
Recall Factory		Call out the factory settings.
Do Self Cal		Carry out the self-calibration procedure.
Language	Chinese English	Choose the display language of the operating system.

Do Self Cal (Self-Calibration)

The self-calibration procedure can improve the accuracy of the oscilloscope under the ambient temperature to the greatest extent. If the change of the ambient temperature is up to or exceeds 5℃, the self-calibration procedure should be executed to obtain the highest level of accuracy.

Before executing the self-calibration procedure, disconnect the probe or wire and the input connector. Then，press the **F3** menu selection button and choose "**Do Self Cal**". After confirming it is all set, push down **F3** button and choose "**Do Self Cal**", entering the self-calibration procedure of the instrument.

SYS STAT (System State)

Press the **F1** menu selection button and choose "**SYS STAT**" item. The menu pops up in the screen as Fi**g. 66.**

Fig. 66 SYS STAT Menu

The "**SYS STAT**" menu is described as the following table:

Function Menu	Setting	Description
Horizontal		Show the horizontal parameter of the channel.
Vertical		Show the vertical parameter of the channel.
Trigger		Show the parameters of the trigger system.
Misc		Show the serial number and edition number.

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. 67).
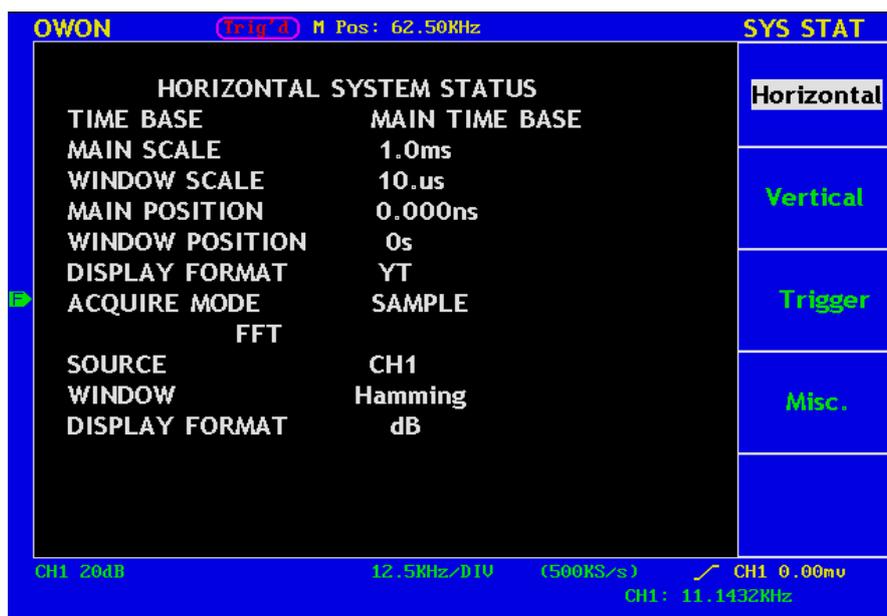
Fig. 67 Horizontal System State

How to Implement the Automatic Measurement

With the **Measure** button pressed down, an automatic measurement can be implemented. There are 20 types of measurements and 4 measurement results can be displayed simultaneously.

Term interpretation：

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 (Vmax-Vtop)/Vamp, useful for square and pulse waveforms.

Preshoot: Defined as (Vmin-Vbase)/Vamp, useful for square and pulse waveforms.

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.

Press the **F1** menu selection button to choose **Source** or **Type** menu. You can choose the channel to be measured from the **Source** menu and choose the measurement **Type** (Freq, Period, Mean, PK–PK, and Cyc RMS). The menu is displayed as Fig.68.
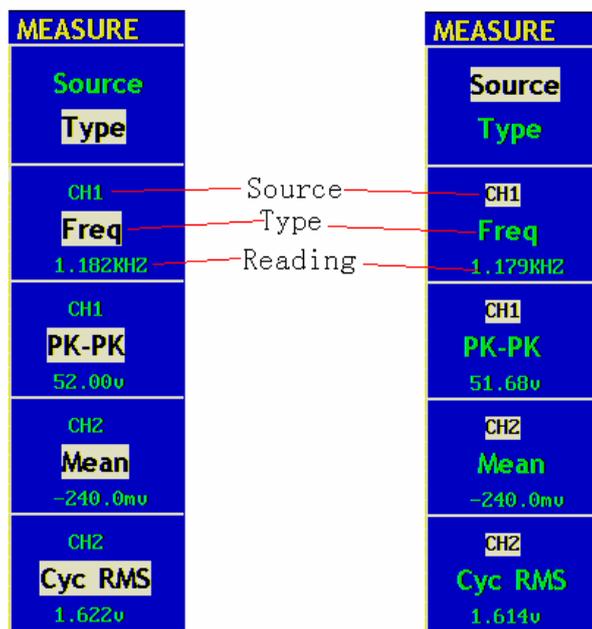
Fig. 68 Measure Menu

Measure

Four automatic measured values can be detected on each channel simultaneously. Only if the waveform channel is in the ON state can the measurement be carried out. No automatic measurement can be made in the following situation: 1) on the saved waveform. 2) on the mathematical waveform. 3) on the XY format. 4) on the Scan format.

Measure the frequency, the peak-to-peak value of the Channel CH1 and the mean, the RMS of the Channel CH2, following below steps:

1. Press the F1 menu selection button and choose Source.

2. Press the **F2** menu selection button and choose **CH1**.

3. Press the **F3** menu selection button and choose **CH1**.

4. Press the **F4** menu selection button and choose **CH2**.

5. Press the **F5** menu selection button and choose **CH2**.

6. Press the **F1** menu selection button and choose **Type**.

7. Press the **F2** menu selection button and choose **Freq**.

8. Press the **F3** menu selection button and choose **Pk-Pk**.

9. Press the **F4** menu selection button and choose **Mean**.

10. Press the **F5** menu selection button and choose **Cyc RMS**.

The measured value will be displayed in the reading window automatically (see Fig. 69).
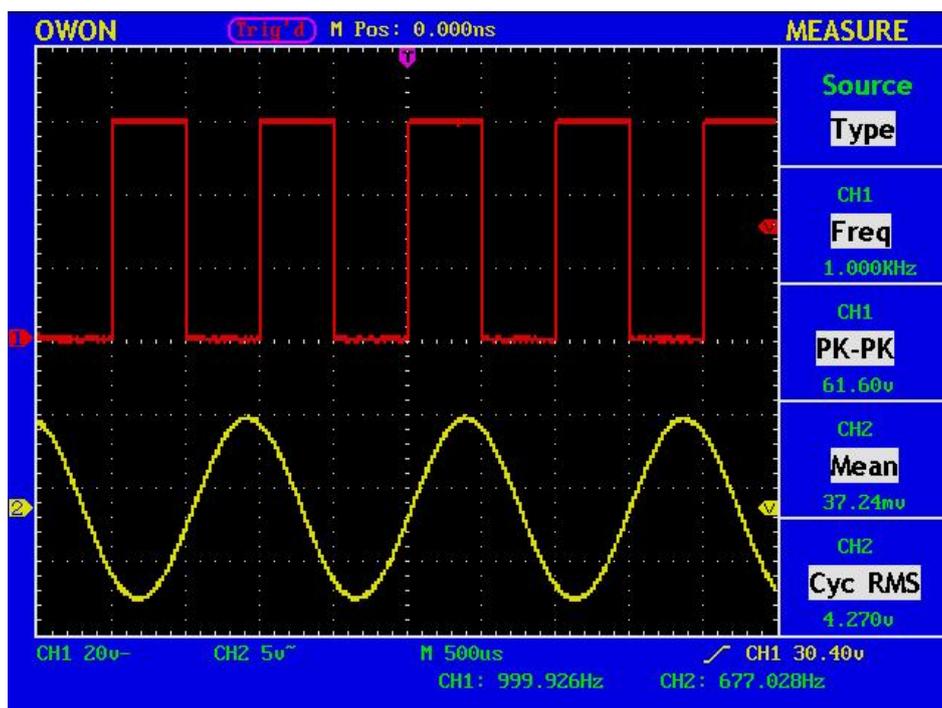
Fig. 69 Automatic Measurement

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.70.
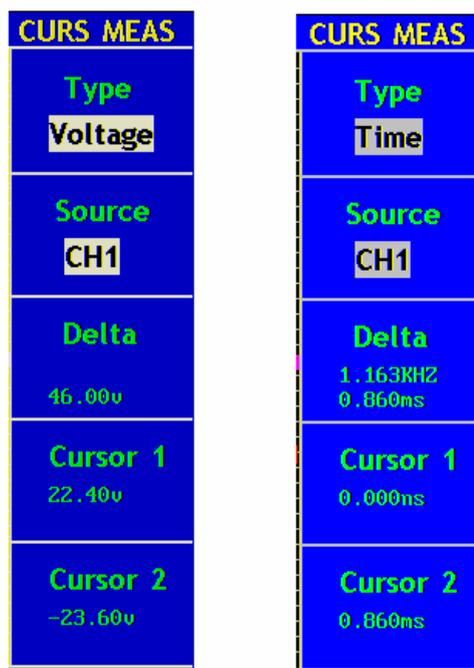
Fig.70   CURS MEAS Menu

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

Function Menu	Setting	Description
Type	OFF	Switch off the cursor measurement.
	Voltage	Display the voltage measurement cursor and menu.
	Time	Display the time measurement cursor and menu.
Source	CH1 CH2	Display the channel generating the waveform to which the cursor measurement will be applied.
Delta		Read the difference between cursors.
Cursor 1		Read the position of Cursor 1 (the Freq is read with reference to the horizontal trigger position and the Vamp is to the ground point).
Cursor 2		Read the position of Cursor 2 (the Freq is read with reference to the horizontal trigger position and the Vamp is to the ground point).

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 voltage cursor measurement of the channel CH1:

1. Press **CURSOR** and recall the **CURS MEAS** menu.

2. Press the **F1** menu selection button to choose **Voltage** for Type, with two purple dotted lines displayed along the horizontal direction of the screen, which

69

indicating **CURSOR1** and **CURSOR2**.

3. Press the **F2** menu selection button and choose **CH1** for **Source**.

4. Adjust the positions of **CURSOR1** and **CURSOR2** according to the measured waveform, with the absolute value of the voltage 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.71).
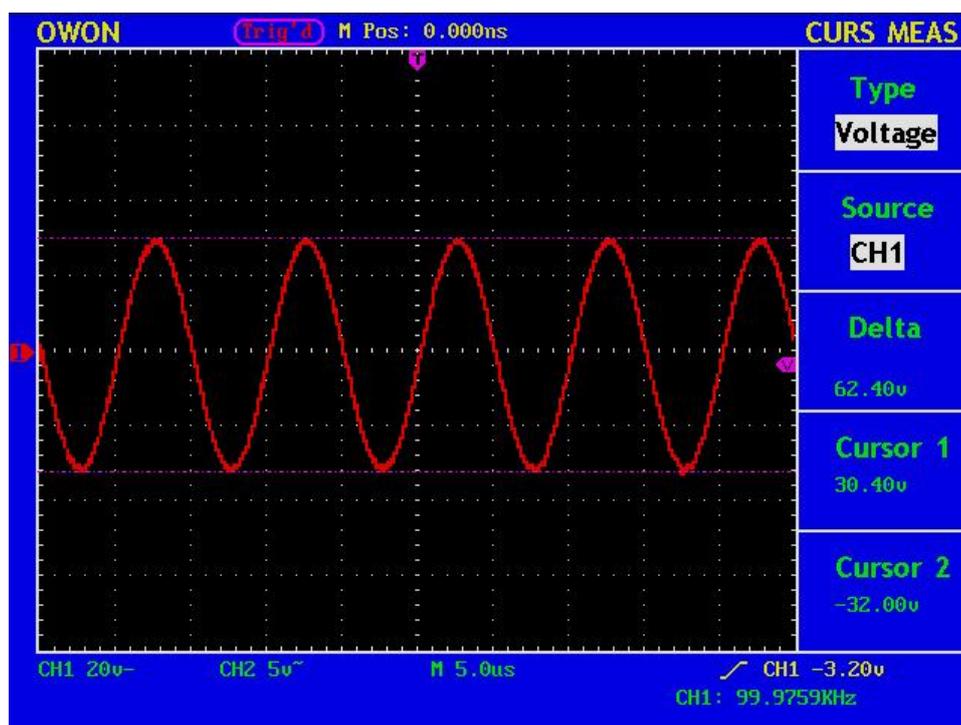
Fig. 71 Waveform of Voltage Cursor Measurement

Carry out the following operation steps for the time cursor measurement of the channel CH1:

1. Press "**CURSOR**" and recall the CURS MEAS menu.

2. Press the **F1** menu selection button and choose **Time** for **Type**, with two purple dotted lines displayed along the vertical direction of the screen, which indicating Cursor 1 and Cursor 2.

3. Press the **F2** menu selection button and choose **CH1** for **Source**.

4. 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. 72).
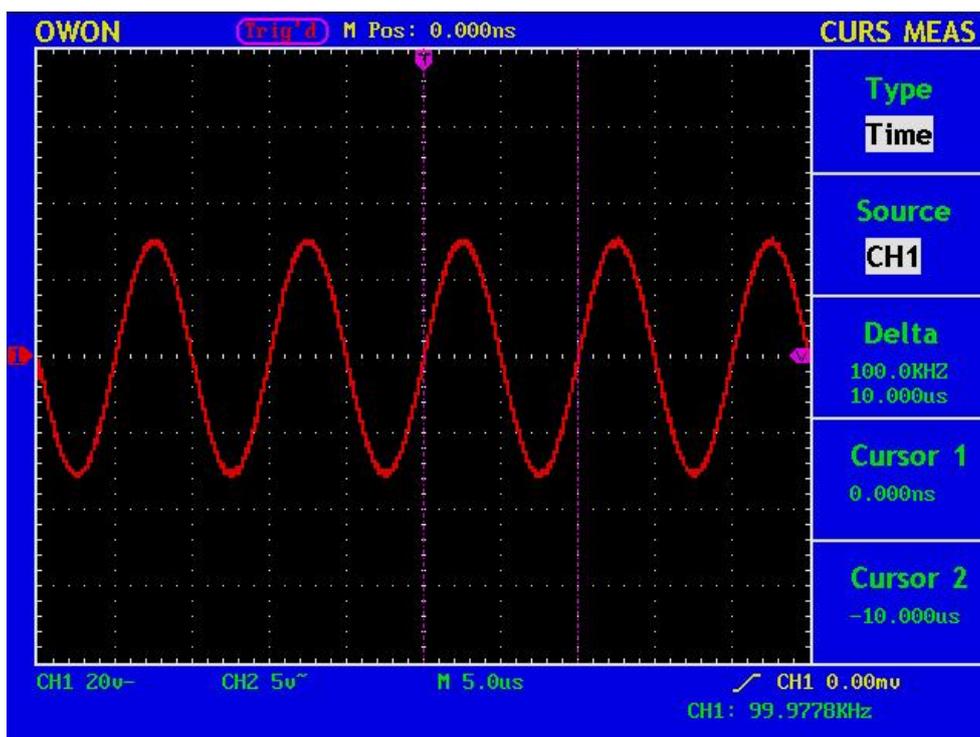
Fig. 72 Wave Form of Cursor Measurement

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.73.
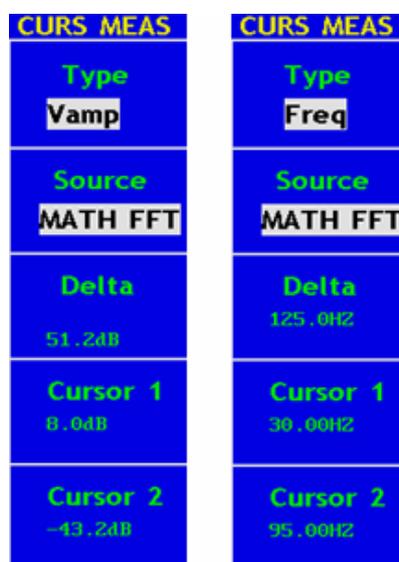
Fig.73   CURS MEAS Menu

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

| Function Menu	Setting	Description
Type	OFF	Switch off the cursor measurement.
	Vamp	Display the Vamp measurement cursor and menu.
	Freq	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.74).
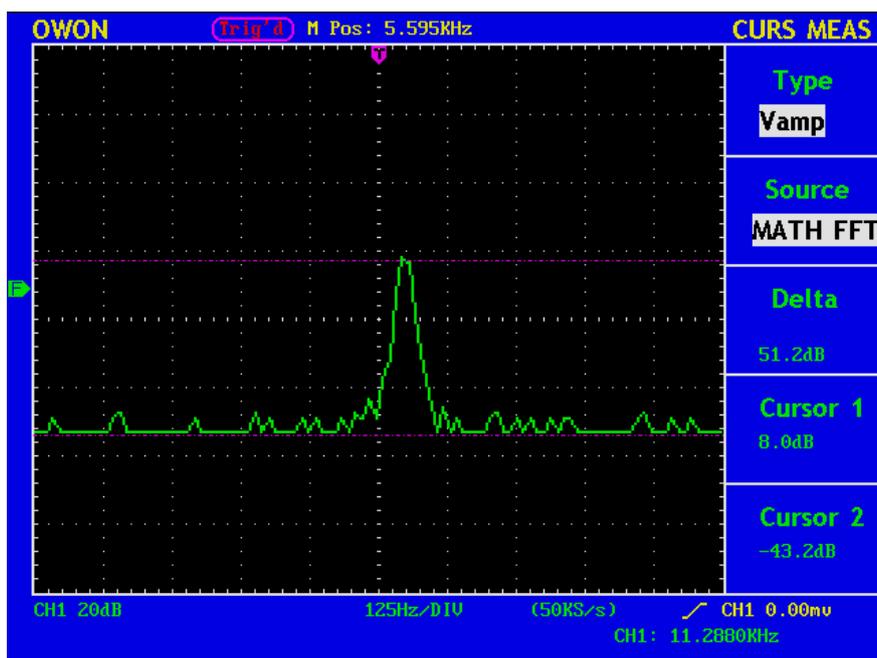
Fig.74 wave of Vamp cursor measurement

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 corrersponding 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.75).
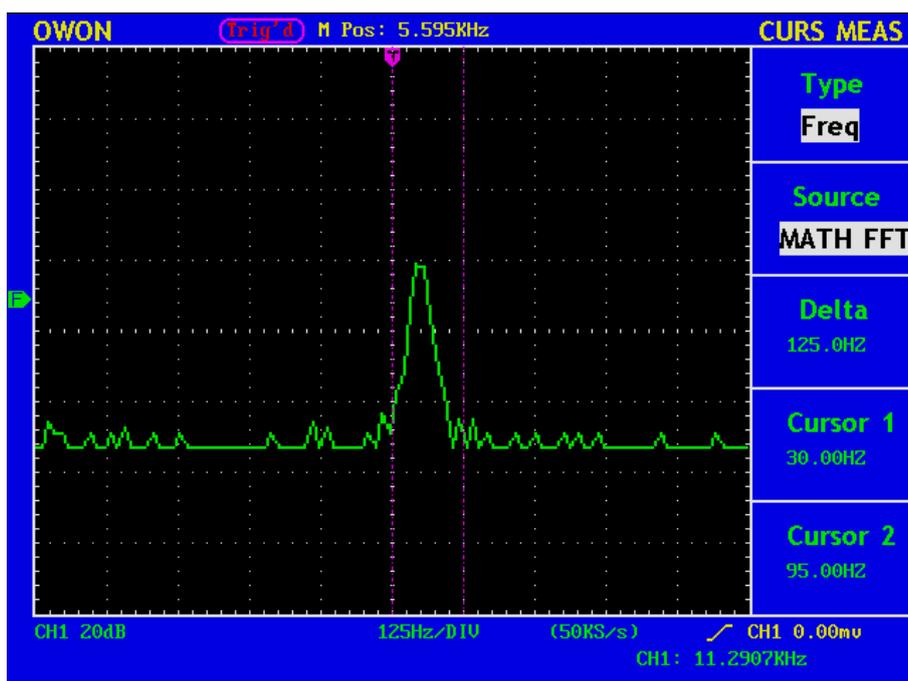

Fig.75 wave of Freq cursor measurement

73

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	Follow-up and adjust vertical scale without changing horizontal setting.
	Horizontal	Follow-up and adjust horizontal scale without changing vertical setting.
	HORI—VERT	Follow-up and adjust the vertical and horizontal settings.
Wave		Only show one or two periods.
		Show Multi-period waveforms.
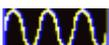
If you want to measure the two-channel signal, you can do as the follows:

1. Press **Autoscale**, the function menu will appear on the right of the screen.
2. Press **F1** and choose **ON.**
3. Press **F2** and choose Horizontal- Vertical for **Mode** item.
4. Press **F3** and choose for **Wave** item.
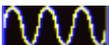
Then the wave is displayed in the screen,showon as Fig.76.
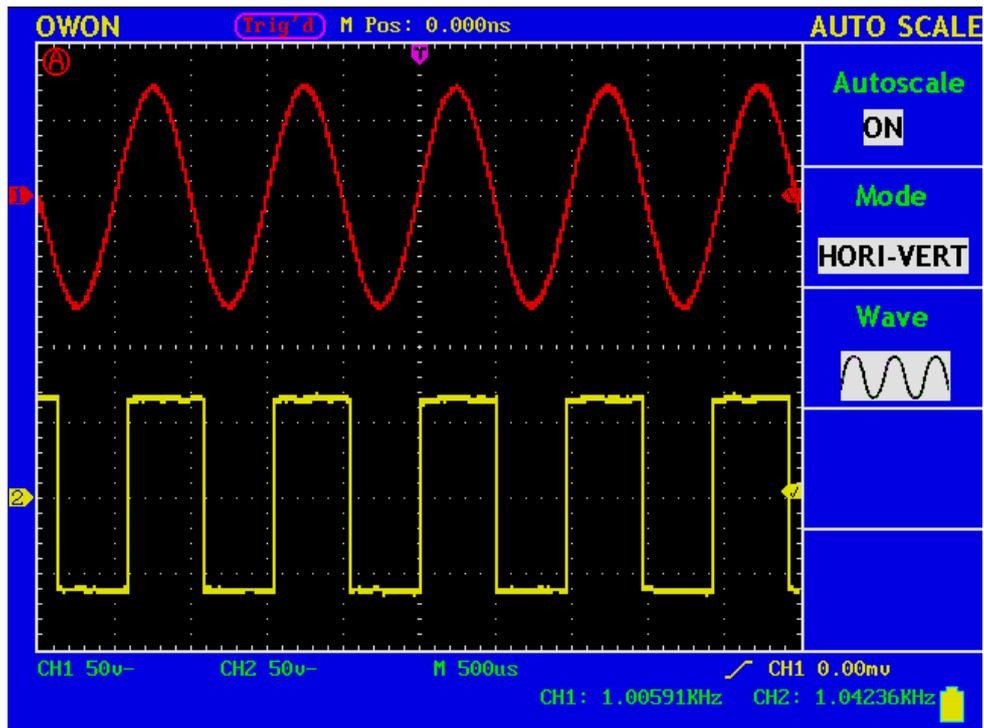
Fig.76: Autoscale Horizontal- Vertical multi-period waveforms
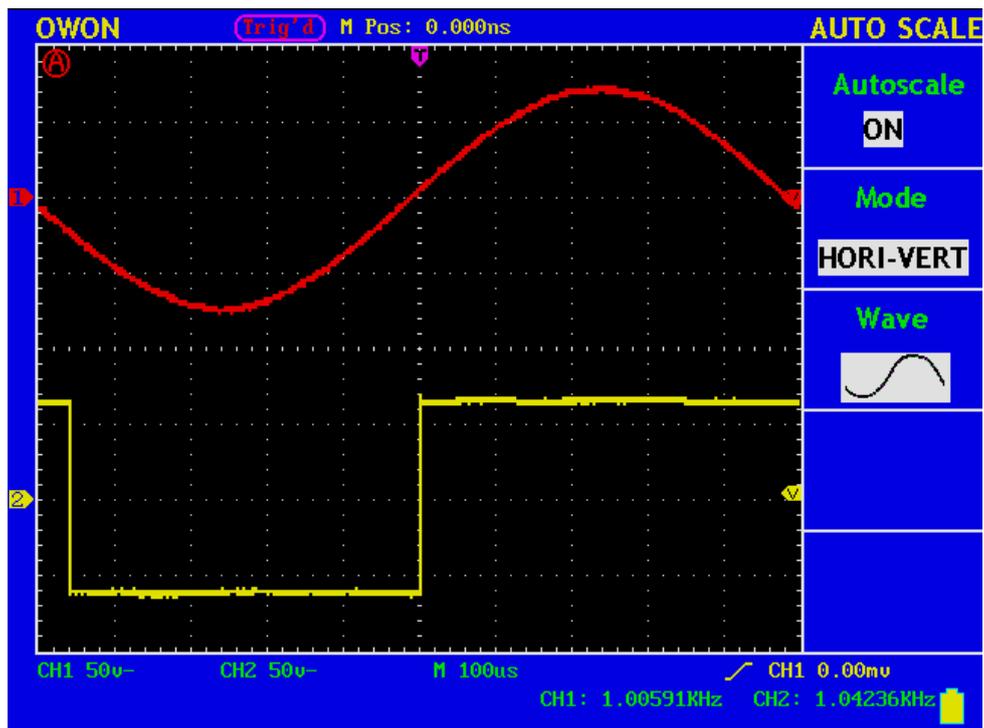
Fig.77: Autoscale Horizontal- Vertical mono-period waveform

Note:

1. Entering into Autoscale function and 🅐 flicker will be on the top left corner. (flicker every 0.5 second)

2. At the mode of Autoscale, the oscilloscope can self-estimate "Trigger Type" (Edge,

Video, and Alternate) and "mode" (Edge, Video). If now, you press "Trigger mode" or "Type", the forbidden information will display on the screen.

3. At the mode of XY and STOP status, pressing **AUTO SET** to enter into Autoscale, DSO switches to YT mode and AUTO status.

4. At the mode of Autoscale, DSO is always in the state of DC coupling and AUTO triggering. In this case, the forbidden information will be showing when making Triggering or Coupling settings.

5. At the mode of Autoscale, if adjust the vertical position, voltage division, trigger level or time scale of CH1 or CH2, the oscilloscope will turn off Autoscale function and if press **AUTOSET** again, the oscilloscope will enter into Autoscale.

6. Turn off the submenu at the Autoscale menu, the Autoscale is off and turn on the submenu still enters into the function.

7. 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.

8. While the Autoscale is working,below settings will be made forcibly:

    (1) The unit will switch from non-main time base to main time base status.

    (2) The unit will siwtch to Peak detection menu while in the state of Average sampling mode.

How to Use Executive Buttons
AUTOSET

This button is used for the automatic setting of all control values of the instrument to generate the waveform suitable for observation. Press the **AUTOSET** button and the oscilloscope will perform the fast automatic measurement of the signal.

The function items of **AUTOSET** are shown as the following table:

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 the waveform sampling.

Notice: Under the **Stop** state, the vertical division and the horizontal time base of the waveform can be adjusted within a certain range, in other words, the signal can be expanded in the horizontal or vertical direction.

When the horizontal time base equal to or is less than 50ms, the horizontal time base can be expanded for 4 divisions downwards.

U-DISK COPY

Insert U disk into USB port, then press "COPY" 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.

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.78:

Fig.78：Sampling menu

Sample menu function list:

Function	Setting	Instruction
Sample rate	According to the model *	
Storage depth	Low memory	Storage depth of 16K
	General	Storage depth of 256K
	Deep memory	Storage depth of 4M
Digital Filter	None	Filter closed
	1	Filter one pulse of sample width
	2	Filter two pulse of sample width

```
* Sample rate:
In sequence of 1-2-5 from 20Hz to 100MHz----MSO5022S
In sequence of 1-2-5 from 20Hz to 400MHz----MSO7102T
```

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

Sample rate	Storage depth	Continuance time	Sample rate	Storage depth	Continuance time
400MHz	Low memory	40us	50kHz	Low memory General Deep memory	320 ms 5.12 s 80 s
200MHz	Low memory General Deep memory	80 us 1.280 ms 20 ms	20kHz	Low memory General Deep memory	800 ms 12.8 s 200 s
100MHz	Low memory General Deep memory	160 us 2.560 ms 40 ms	10kHz	Low memory General Deep memory	1.6 s 25.6 s 400 s
50MHz	Low memory General Deep memory	320 us 5.12 ms 80 ms	5kHz	Low memory General Deep memory	3.2 s 51.2 s 800 s
20MHz	Low memory General Deep memory	800 us 12.8 ms 200 ms	2kHz	Low memory General Deep memory	8 s 128 s 2000 s
10MHz	Low memory General Deep memory	1.6 ms 25.6 ms 400 ms	1kHz	Low memory General Deep memory	16 s 256 s 4000 s
5MHz	Low memory General Deep memory	3.2 ms 51.2 ms 800 ms	500Hz	Low memory General Deep memory	32 s 512 s 8000 s
2MHz	Low memory General Deep memory	8 ms 128 ms 2 s	200Hz	Low memory General Deep memory	80 s 1280 s 20000 s
1MHz	Low memory General Deep memory	16 ms 256 ms 4 s	100Hz	Low memory General Deep memory	160 s 2560 s 40000 s
500kHz	Low memory General Deep memory	32 ms 512 ms 8 s	50Hz	Low memory General Deep memory	320 s 5120 s 80000 s
200kHz	Low memory General Deep memory	80 ms 1.28 s 20 s	20Hz	Low memory General Deep memory	800 s 12800 s 200000 s
100kHz	Low memory General Deep memory	160 ms 2.56 s 40 s			

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

Sample rate: 100M Storage depth: 4M

Filter: none

Setting steps as below:

1. Press "**E(ACQUIRE)**" and sample menu appears.

2. Press "**F1**"repeatly or turn "**CH1 Volts/div**" knob till sample rate set as "100M"

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.79).
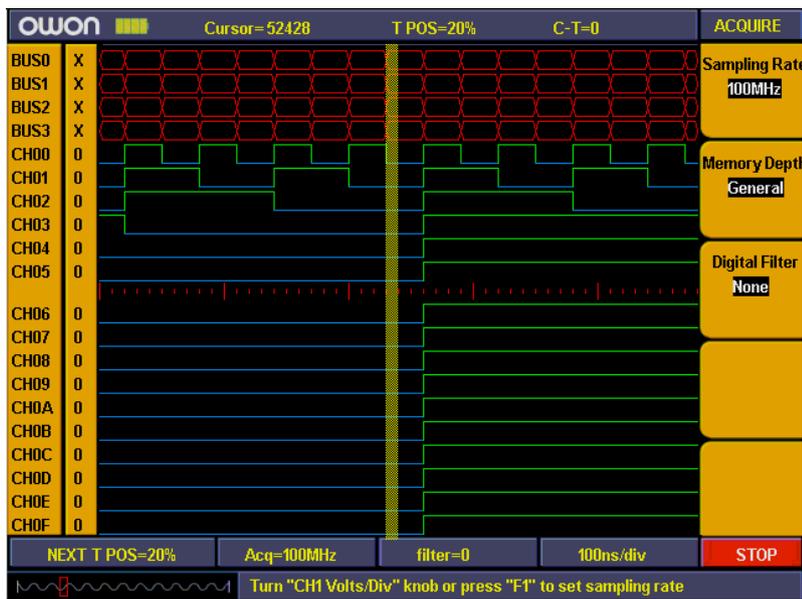
Fig 79: Sampling setting

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.80.

Fig.80: Edge trigger menu

80

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.81) and ready for data acquisition.
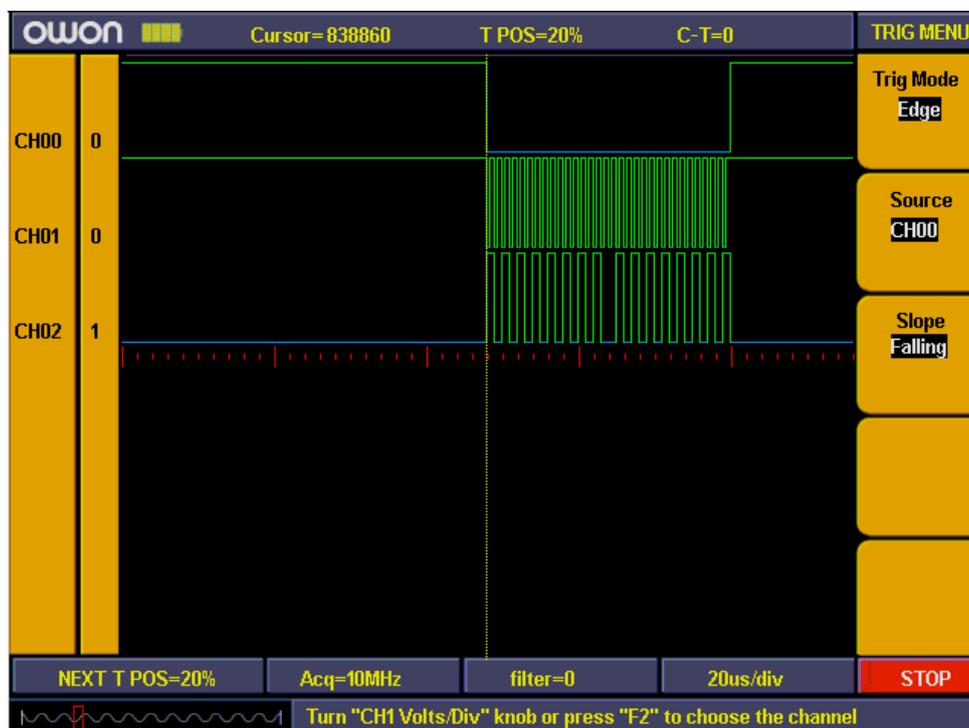
Fig.81：Edge trigger setting

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.82

Fig.82：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.83).
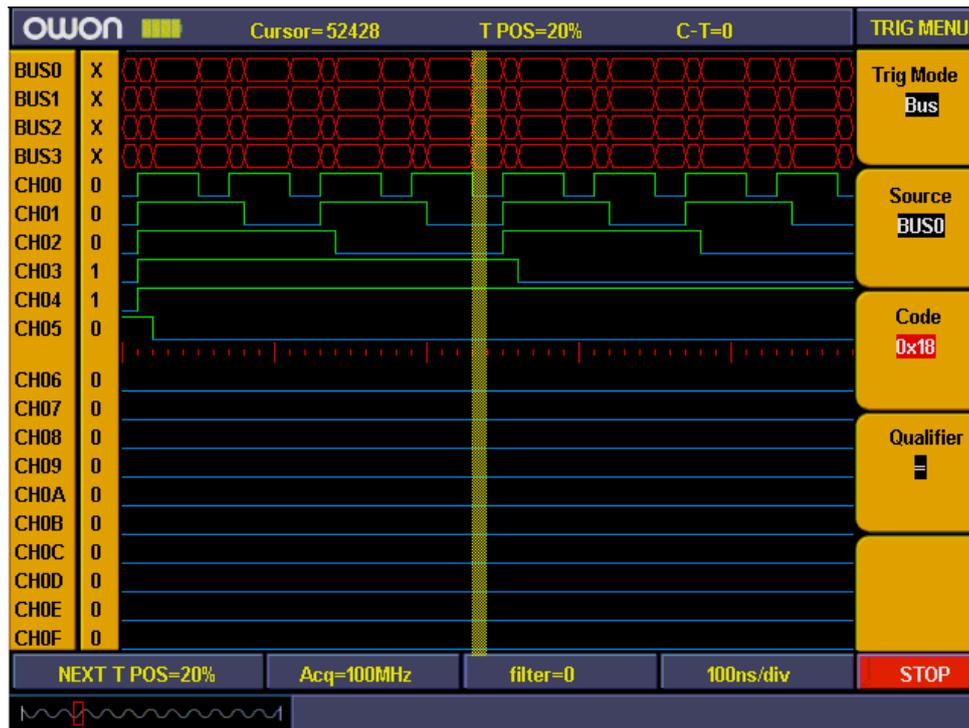
Fig.83：Bus trigger

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.84).

Fig.84：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 occur. Trigger occur when signal on the low level Trigger occur 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.85) and ready for data acquisition.
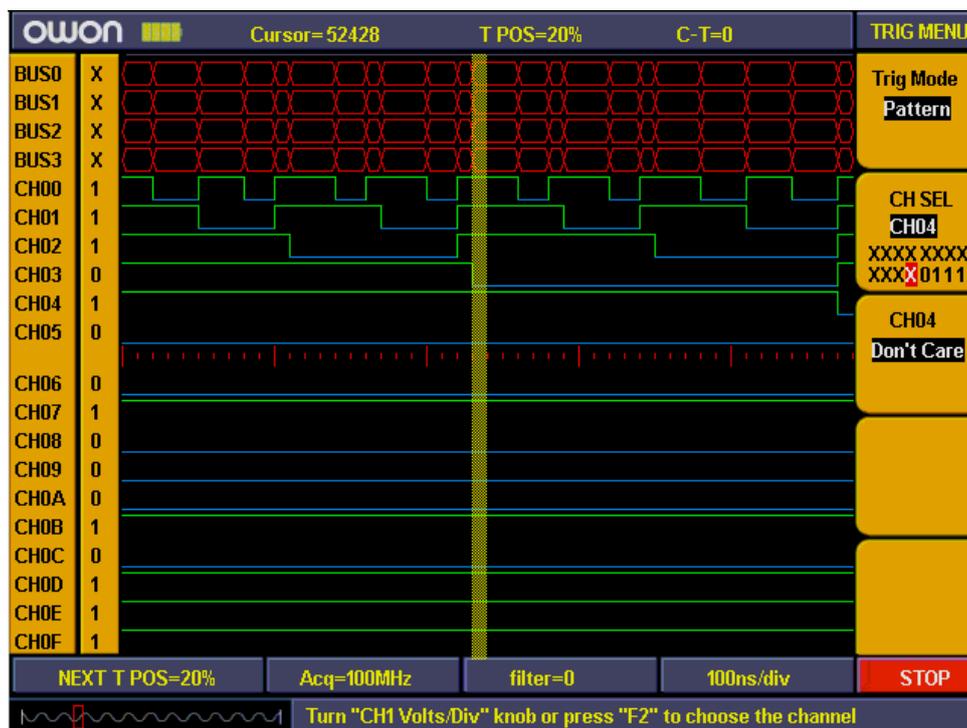
Fig.85：Pattern trigger

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. 86)

Fig. 86：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. 87) and data ready for acquisition.
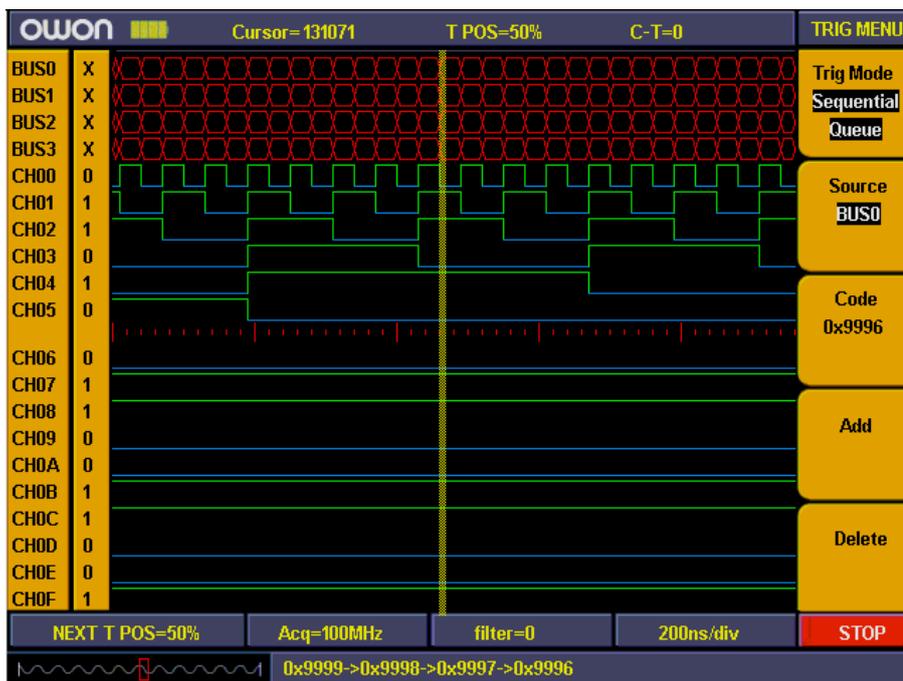

Fig. 87：Sequential queue trigger

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.88

Fig. 88：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 （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

Setting operation are same as sequential trigger setting.
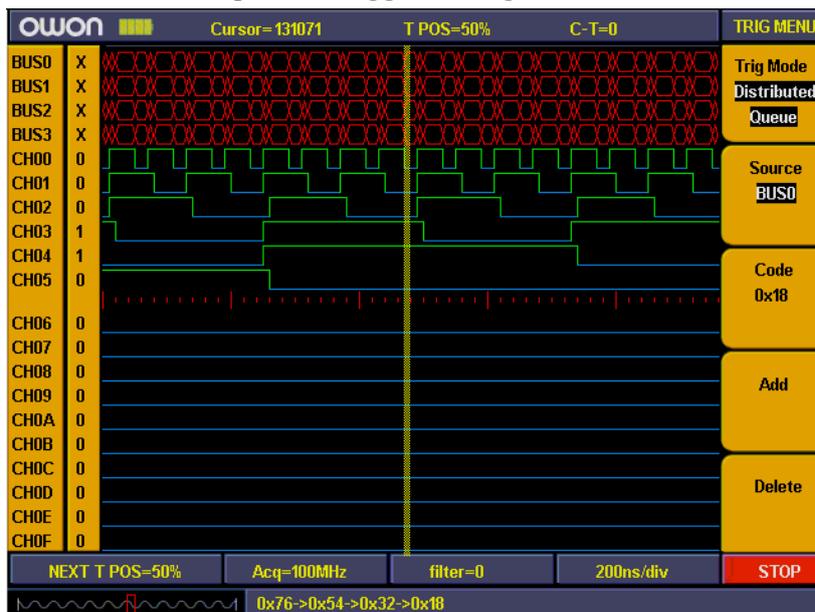
Fig.89：Distributed queue trigger

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.90：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.
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. 91) and ready for data acquisition.
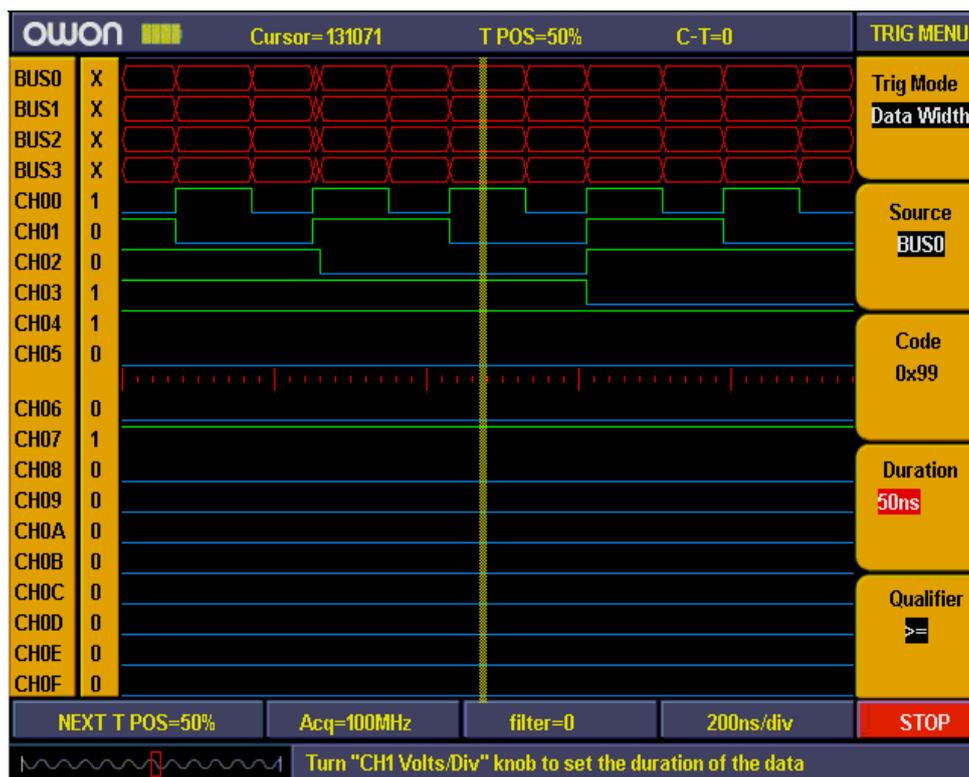
Fig. 91：Data width trigger

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.92
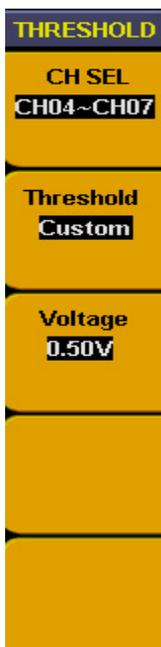
Fig. 86: Threshold setting menu

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)	CMOS level and set threshold voltage as 2.5V
	LVCMOS3.3/(1.7V)	LVCMOS3.3V level and set threshold voltage as 1.7V
	LVCMOS2.5/(1.3V)	LVCMOS2.5V level and set threshold voltage as 1.3V
	LVCMOS1.8/(0.9V)	LVCMOS1.8V level and set threshold voltage as 0.9V
	Custom	Level can be set discretionarily.
Voltage	0～4.09V(forward by 0.01V pace)	In custom, the voltage can be set from 0V to 4.09V with the pace of 0.01V.

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.93).
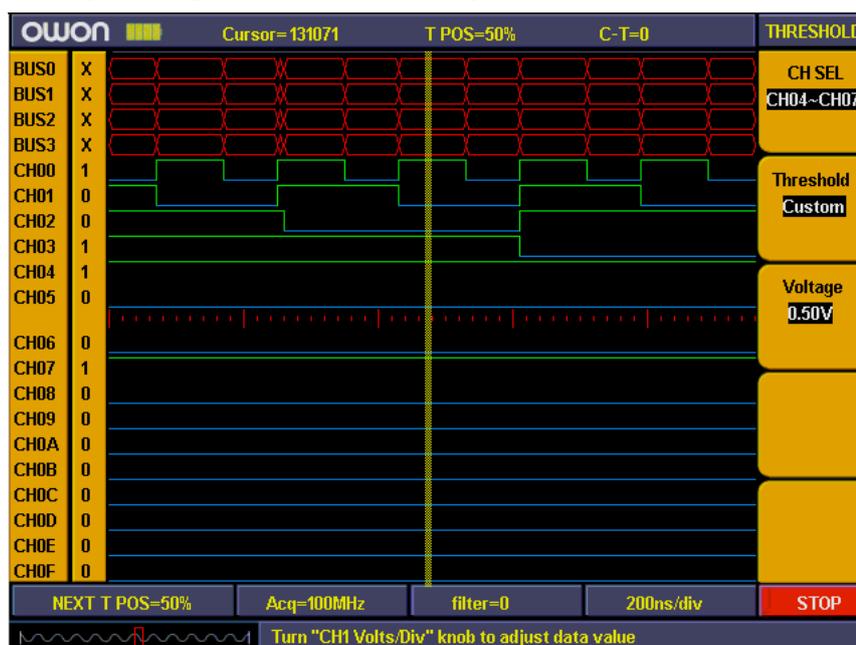
Fig. 93：Threshold custom setting

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.94
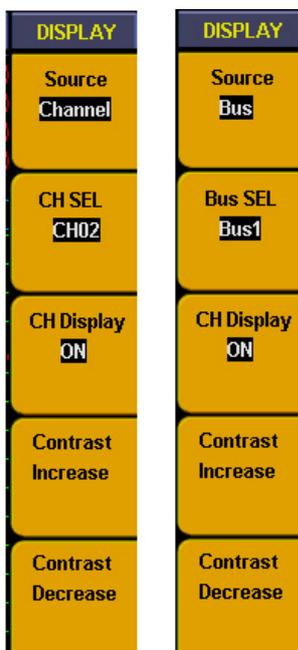
Fig. 94：Display menu

Display function menu as below;

Function	Setting	Instruction
Source	BUS	Choose resource as BUS
	Channel	Choose resource as channel
BUS SEL. CH SEL	BUS0～BUS3	Among BUS0~BUS3
	CH00～CH0F	Among CH00~CH0F
display	ON	BUS or Channel on
	OFF	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.95)
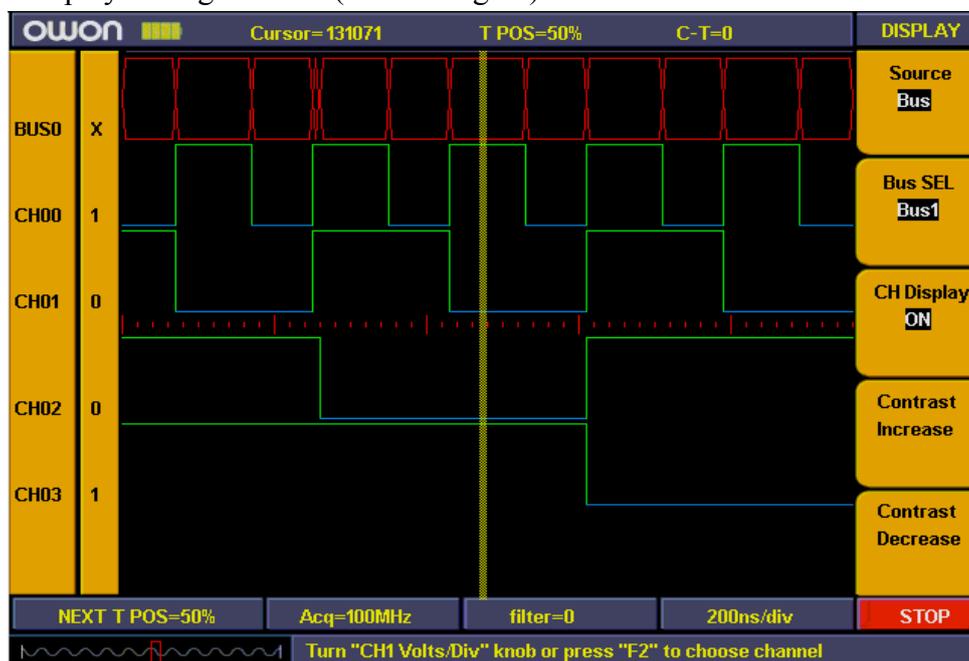
Fig. 95：Display setting

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. 96

Fig.96：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.97).
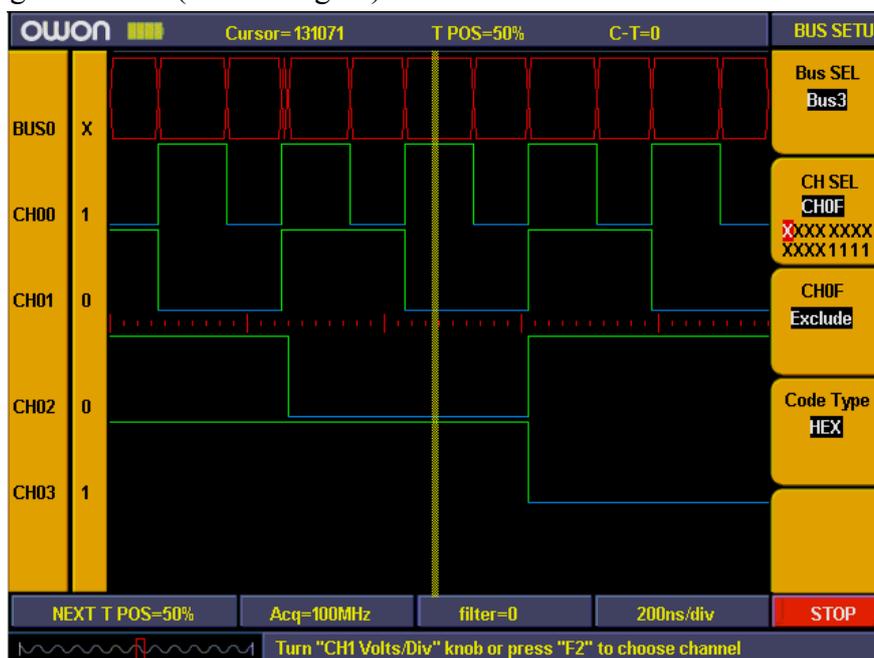
Fig. 97：Bus setting

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.98
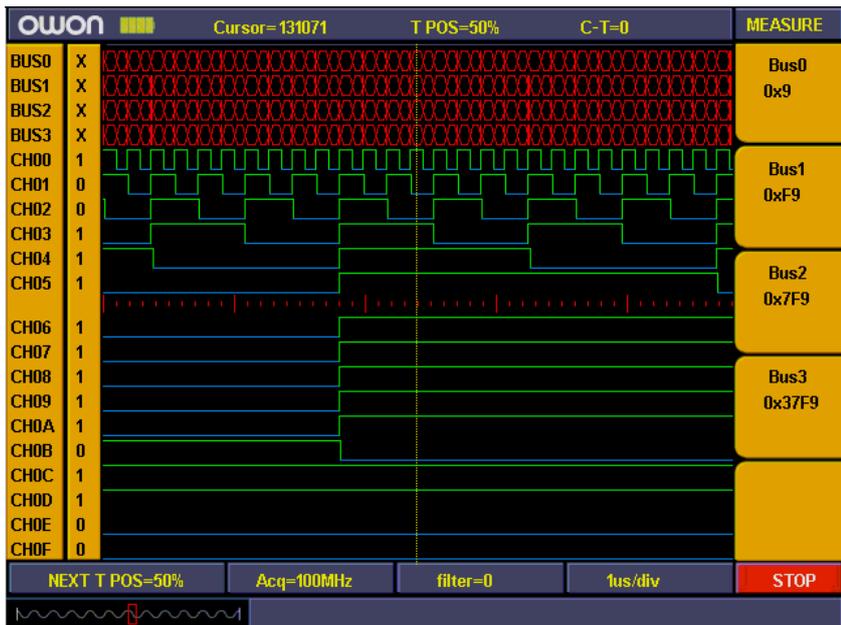
Fig.98：Bus measurement

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. 99.
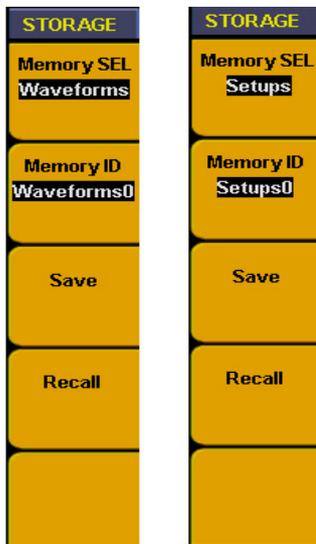
Fig. 99：Storage menu

Storage menu instruction as below:

Function	Setting	Instruction
Memory SEL	Waveform	Waveform for storage or recall
	Setups	Setups for storage or recall
Memory ID	Wavefor～Waveform3	Storage 4 groups of waveform
	Setups 0～Setups 9	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.100)
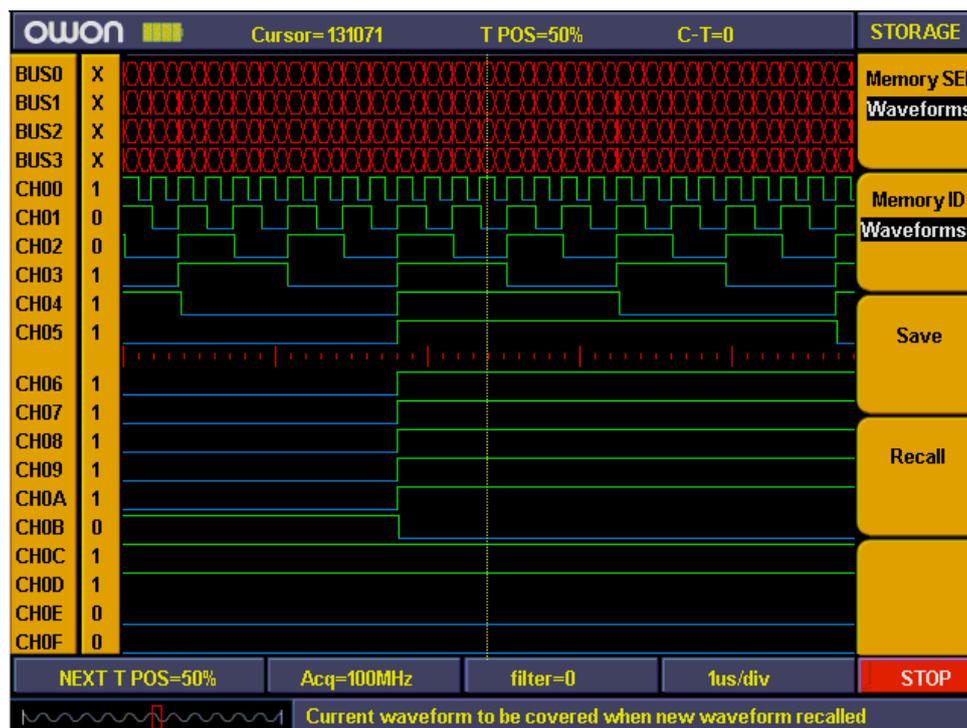
Fig.100：Waveform saving

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
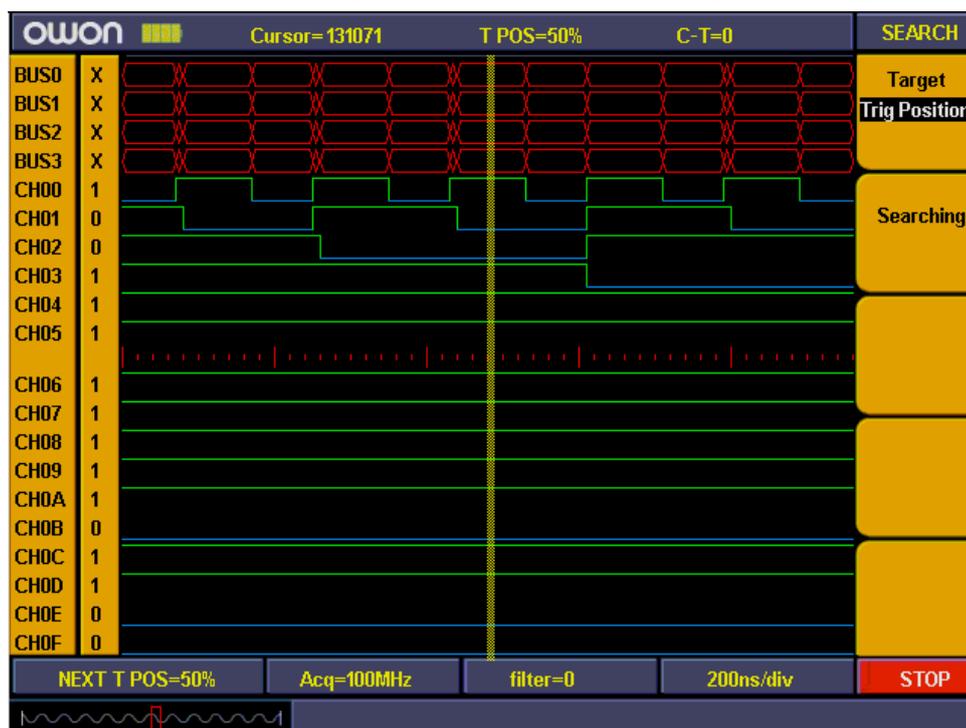
Fig.101：Search trigger position

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.102：Search Bus

3. **Searching target is pattern**: pattern refers to the complex of different channel according to high/low voltage or irrelated 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.
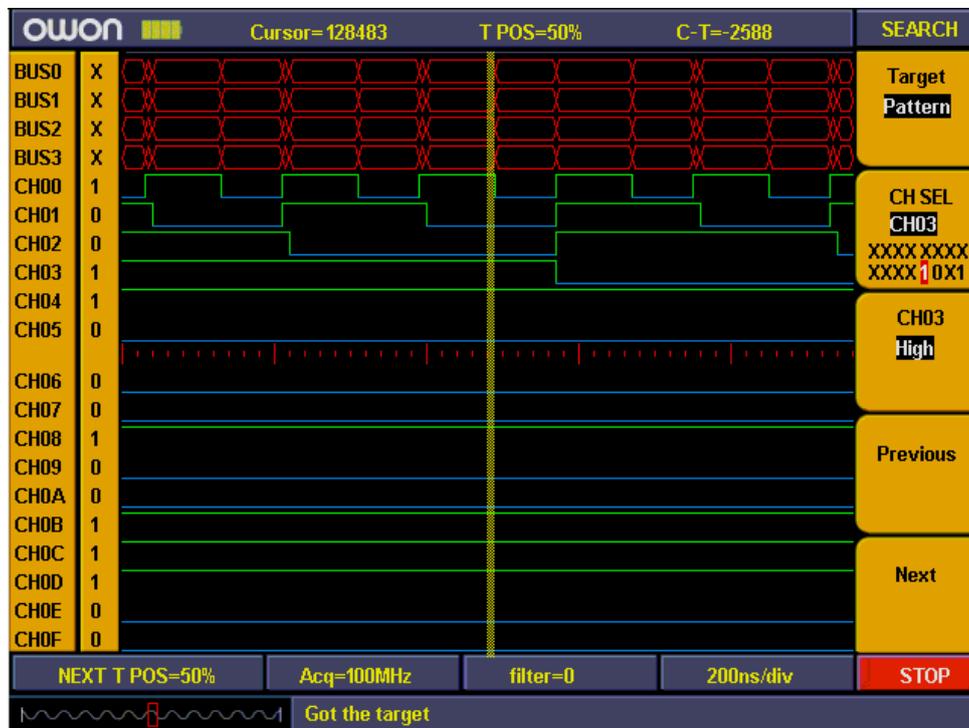
Fig.103：Search Code type

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.104：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.
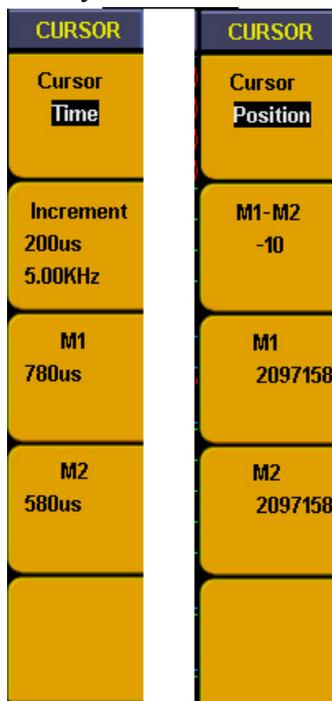
Fig.105：Cursor measurement menu

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 purples 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".
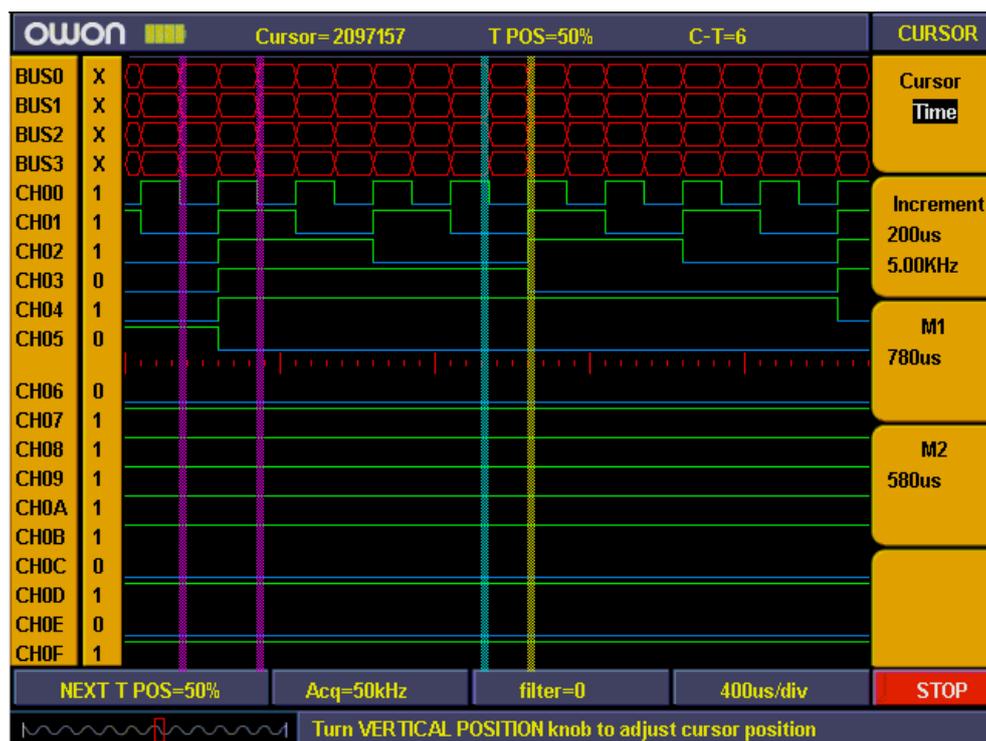
Fig. 106：Cursor time measurement

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 purples 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**".
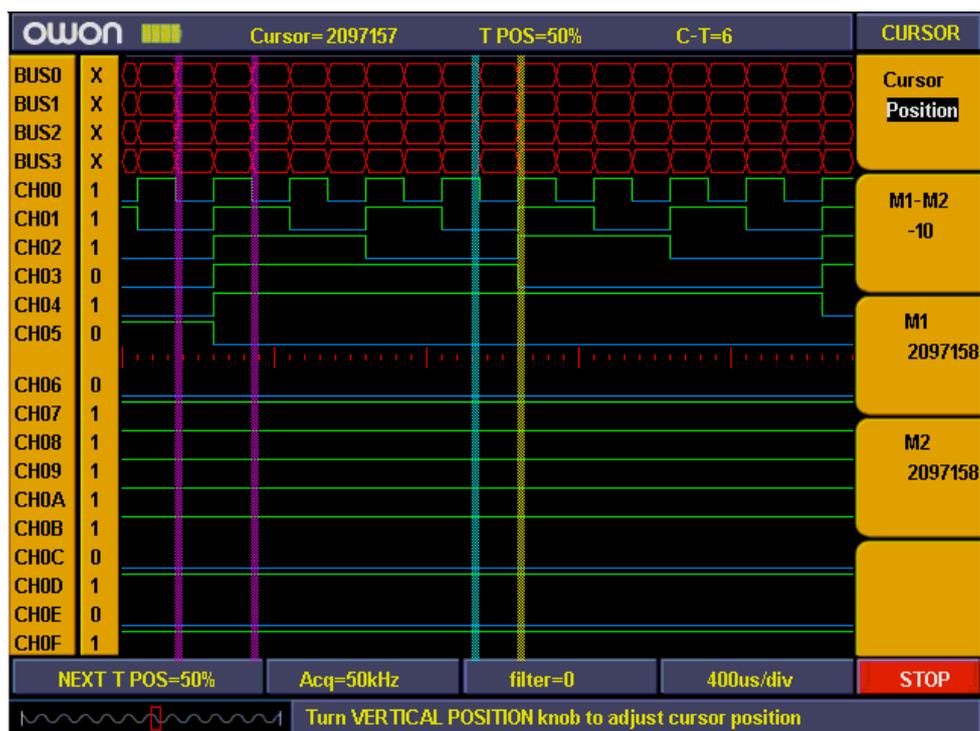
Fig.107：Cursor position measurement

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	Default to be Chinese
	English	Default to be English
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.

Demonstration

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

Example 1: Measurement of Simple Signals

Observe an unknown signal in the circuit, and display and measure rapidly the frequency and peak-to-peak value of the signal.

1.   Carry out the following operation steps for the rapid display of this signal:

1.   Set the probe menu attenuation coefficient as **10X** and that of the switch in the probe switch as **10X**.

2.   Connect the probe of **Channel 1** to the measured point of the circuit.

3.   Push down the **AUTOSET** button.

The oscilloscope will implement the **AUTOSET** to make the wave form optimized, based on which, you can further regulate the vertical and horizontal divisions till the waveform meets your requirement.

2.   Perform Automatic Measurement

The oscilloscope can measure most displayed signals automatically. Complete the following operations for the measurement of frequency, cycle, mean and peak-to-peak value:

1.   Press the **MEASURE** button to show the automatic measurement function menu.

2.   Press the **F1** menu selection button and choose **Source**, with the **Source** menu displayed.

3.   Press the **F2, F3, F4** and **F5** menu selection buttons and choose **CH1**.

4.   Press the **F1** menu selection button again and choose **Type,** with the **Type** menu displayed.

5.   Press the **F2** menu selection button and choose **Freq**.

6.   Press the **F3** menu selection button and choose **Period**.

7.   Press the **F4** menu selection button and choose **Mean**.

8.   Press the **F5** menu selection button and choose **Pk-Pk**.

Then, the frequency, cycle, mean and peak-to-peak value will present in the menu and change periodically (see Fig. 108).
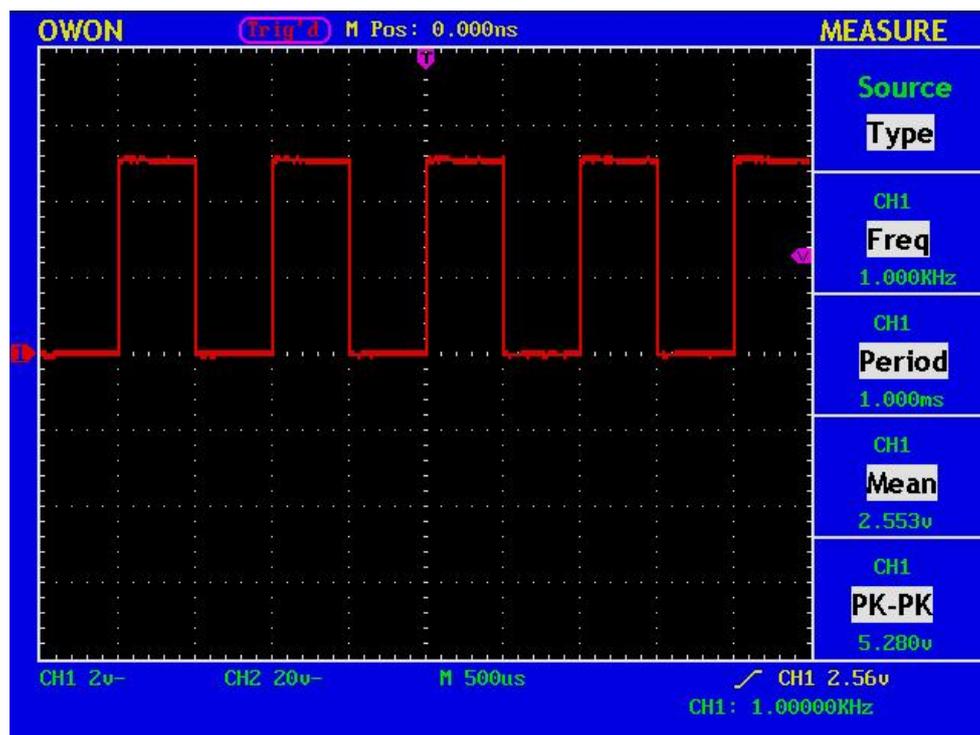
Fig. 108 Waveform of Automation Measurement

Example 2: Gain of the Amplifier in the Metering Circuit

Set the probe menu attenuation coefficient as **10X** and that of the switch in the probe as **10X**.

Connect the oscilloscope CH1 channel with the circuit signal input end and the CH2 channel to the output end.

Operation Steps

1. Push down the **AUTOSET** button and the oscilloscope will automatically adjust the waveforms of the two channels into the proper display state.

2. Push down the **MEASURE** button to show the MEASURE menu.

3. Press the **F1** menu selection button and choose **Source**.

4. Press the **F2** menu selection button and choose **CH1**.

5. Press the **F3** menu selection button and choose **CH2**.

6. Press the **F1** menu selection button again and choose **Type**.

7. Press the **F2** menu selection button and choose **Pk-Pk**.

8. Press the **F3** menu selection button and choose **Pk-Pk**.

10. Read the peak-to-peak values of Channel 1 and Channel 2 from the displayed

menu (see Fig. 109).

11.   Calculate the amplifier gain with the following formulas.

Gain = Output Signal / Input signal

Gain (db) = 20×log (gain)
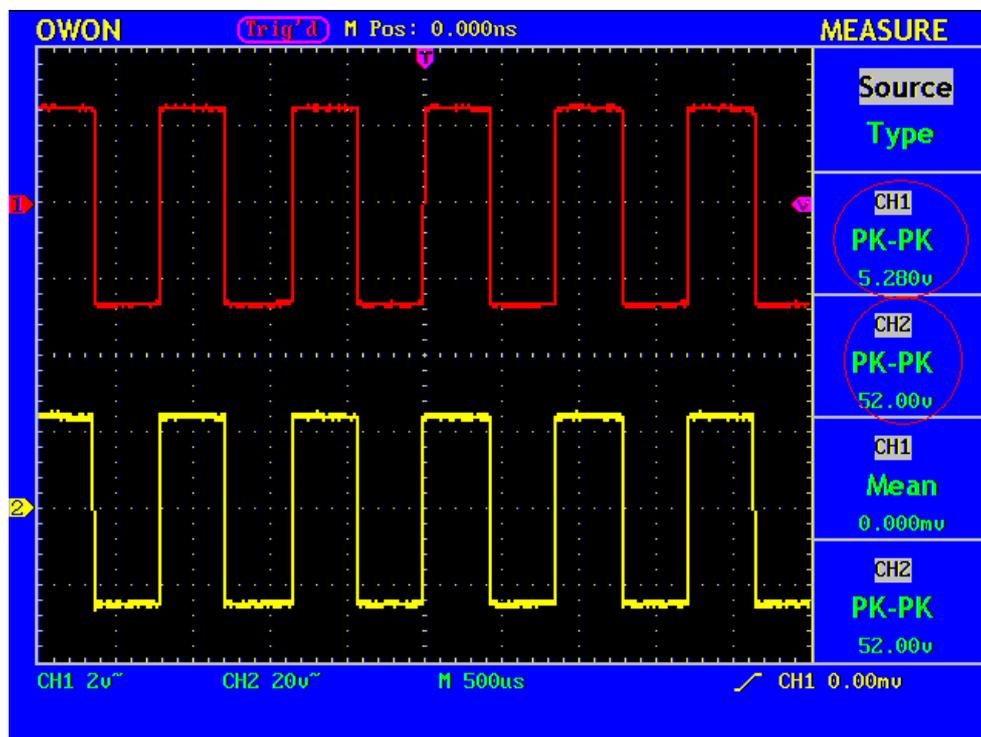
Fig. 109 Wave Form of Gain Measurement

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. 110).
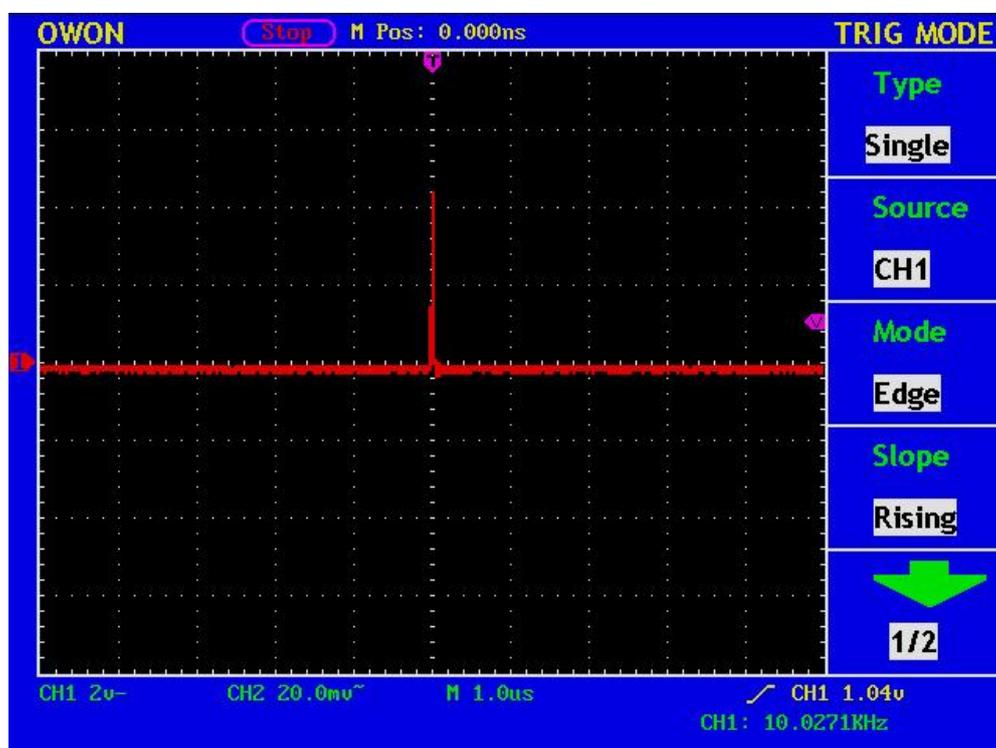
Fig. 110 Capture the Single Signal

Example 4: Analyze the Details of a Signal

Observe the Signal Containing Noises

If the signal is interfered by the noise, the noise may cause a failure in the circuit. For the analyzing of the noise in detail, please operate the instrument according to the following steps:

1. Press the **ACQUIRE** button to display the **ACQU MODE** menu.

2. Press the **F2** menu selection button and choose **Peak Detect**.

In this case, the screen display contains the wave form of a random noise. Especially when the time base is set as Low Speed, then noise peak and burr contained in the signal can be observed with the peak detection (See Fig. 111).
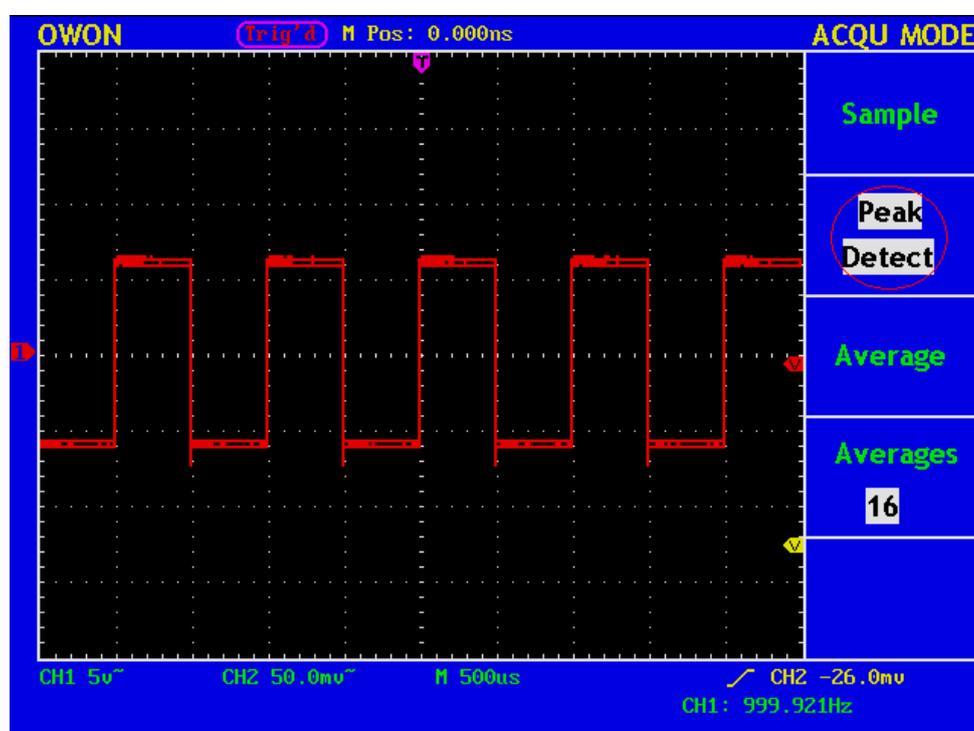
Fig. 111 Wave Form of the Signal Containing Noises

Separate Noises from the Signal

When analyze the wave form of a signal, you should remove the noise contained in it. For the reduction of the random noise in the oscilloscope display, please operate the instrument according to the following step:

1. Press the **ACQUIRE** button to show the **ACQU MODE** menu.

2. Press the **F3** menu selection button and choose **Average**.

3. Press the **F4** menu selection button and observe the wave form obtained from averaging the wave forms of different average number.

After the averaging, the random noise is reduced and the detail of the signal is easier to be observed. Shown as follows, after the noise is removed, the burrs on the rising

and falling edges appear (see Fig. 112).
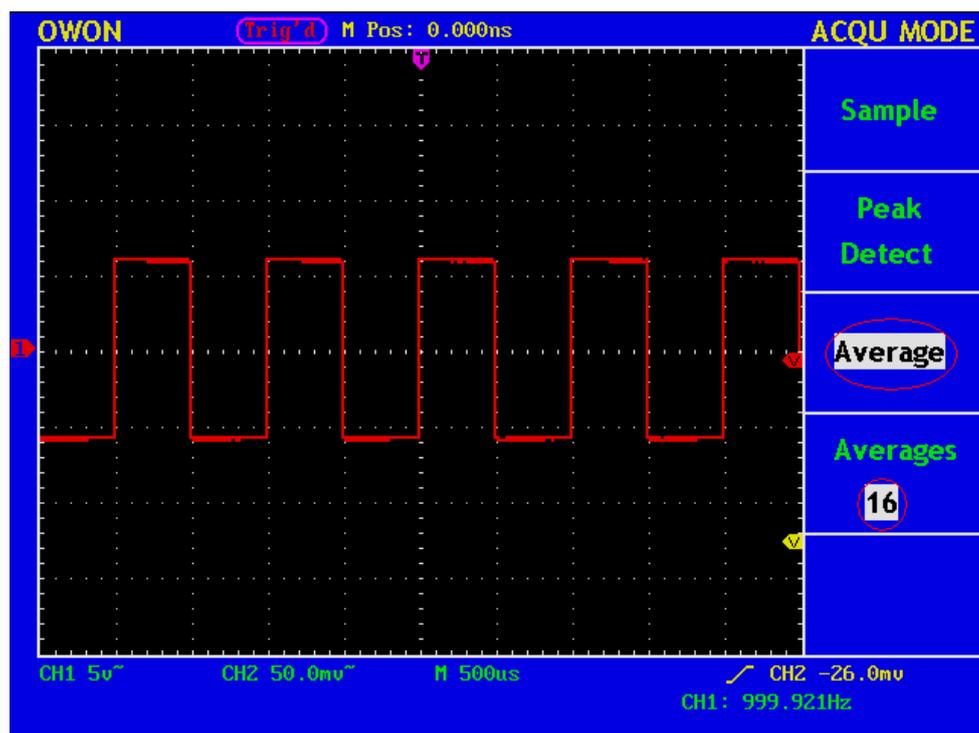
Fig. 112 Wave Form of the Noise-Removed Signal

Example 5: Application of X-Y Function

Examine the Phase Difference between Signals of two Channels

Example: Test the phase change of the signal after it passes through a circuit network.

Connect the oscilloscope with the circuit and monitor the input and output signals of the circuit.

For the examination of the input and output of the circuit in the form of X-Y coordinate graph, please operate according to the following steps:

1. Set the probe menu attenuation coefficient for **10X** and that of the switch in the probe for **10X**.

2. Connect the probe of channel 1 to the input of the network and that of Channel 2 to the output of the network.

3. Push down the **AUTOSET** button, with the oscilloscope turning on the signals of the two channels and displaying them in the screen.

5. Adjust the **VOLTS/DIV** knob, making the amplitudes of two signals equal in the rough.

6. Push down the **DISPLAY** button and recall the **DISP SET** menu.

7. Press the F3 menu selection button and choose XY for Format.
    The oscilloscope will display the input and terminal characteristics of the network

in the **Lissajous** graph form.

8. Adjust the **VOLTS/DIV** and **VERTICAL POSITION** knobs, optimizing the wave form.

9. With the elliptical oscillogram method adopted, observe and calculate the phase difference (see Fig. 113).
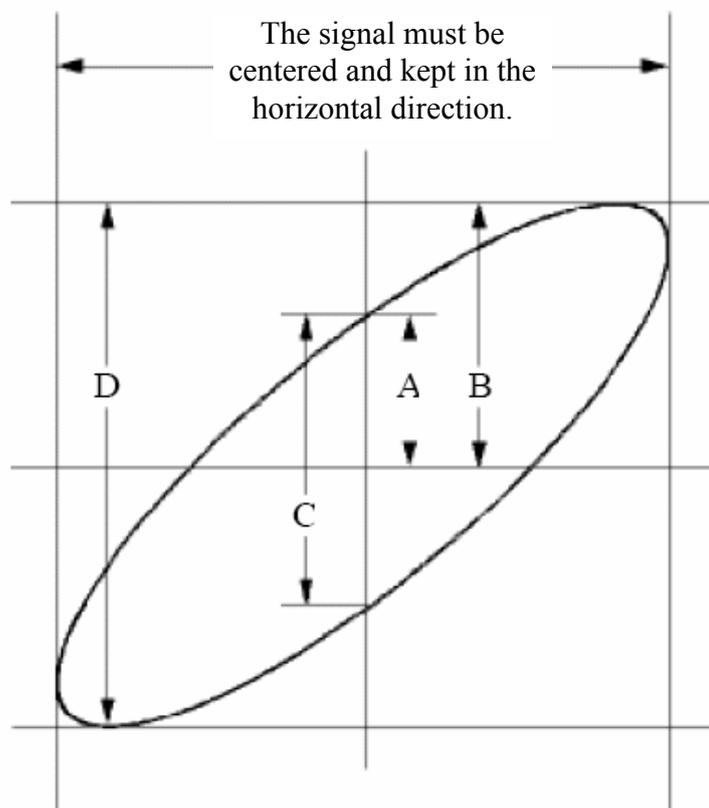
Fig. 113 Lissajous Graph

Based on the expression **sin =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 =± arcsin (A/B) or ± arcsin (C/D)**. If the principal axis of the ellipse is in the I and III quadrants, the determined phase difference angel should be in the I and IV quadrants, that is, in the range of (0- π /2) or (3π / 2- 2π). 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 (π / 2 - π) or (π- 3π /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.114).
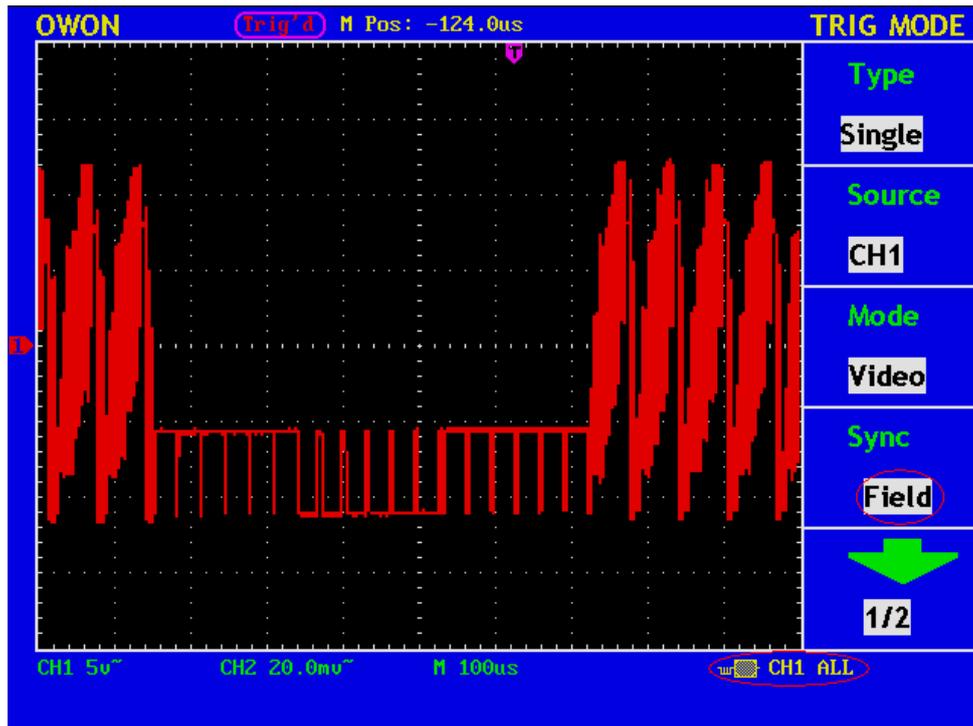
Fig. 114 Wave Form Obtained from Video Field Trigger

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 complete the checks above.
   ● If this product still can not work normally, please get in touch with Lilliput 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.

Appendix A: 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℃, 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		● 25MHz----MSO5022S ● 100MHz----MSO7102T
Channel		2 + 1 (External)
Acquisition：	Mode	Normal, Peak detect, Averaging
	Sample rate (real time)	● 100MS/s---- MSO5022S ● 1GS/s half channel*，500MS/s each channel----MSO7102T
Input：	Input coupling	DC，AC，Ground
	Input impedance	1MΩ±2%，in parallel with 20pF±5pF
	Probe attenuation factor	1X，10X，100X，1000X
	Max. input voltage	● 300V (PK-PK) （DC + AC PK-PK） ----MSO5022S ● 400V (PK-PK) （DC + AC PK-PK） ----MSO7102T
	Bandwidth limit	● 20MHz、100MHz ----MSO7102T
	Channel isolation	50Hz: 100 : 1 10MHz: 40 : 1
	Time delay between channel(typical)	150ps

Horizontal System	Sampling rate range	● 10 S/s~100MS/s---- MSO5022S
		
		● 1S/s~1GS/s half channel*,
		
		   1S/s~500MS/s each channel
		
		                    ----MSO7102T

	Interpolation	（sin x）/x
	Record length	6K points on each channel

	Scanning speed（S/div）	● 5ns/div～100s/div,
		
		   step by 1～2.5～5 ---- MSO5022S
		
		● 2ns/div～100s/div, step by 1～2～5
		
		                    ----MSO7102T

	Sampling rate / relay time accuracy	±100ppm
	Interval（△T）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	● 5mV/div～5V/div（at BNC）
		
		                    ---- MSO5022S
		
		● 2mV/div～10V/div（at BNC）
		
		                    ----MSO7102T

	Displacement	● ±10div(5mV～5V) ---- MSO5022S
		
		● ±1V(2mV～50mV), ±10V(100mV～
		
		   1V), ±100V(2V～10V)
		
		                    ----MSO7102T

	Analog bandwidth	● 25MHz----MSO5022S ● 100MHz----MSO7102T
	Single bandwidth	Full bandwidth
	Low Frequency	≥5Hz (at input, AC coupling, -3dB)

	Rise time		● ≤14ns---- MSO5022S ● ≤3.5 ns (at input, Typical) ----MSO7102T
	DC accuracy		±3%
	DC accuracy (average)		Average > 16: ±(3% rdg + 0.05 div) for △V
Trigger	Type	Edge	Rising、Falling
		Video	Line synchronization, Field synchronization，Odd field, Even field, Any line
	Edge trigger	Sensitivity	● 0.2~1.0div ----MSO5022S ● 0.3div ----MSO7102T
	Source		CH1、CH2、EXT、EXT/5、AC LINE
	Coupling		DC, AC, LF Rjc, HF Rjc
	Trigger level range	Internal	±6 div from the screen center
		EXT	±600mV
		EXT/5	±3V
	Trigger level Accuracy (typical) :	Internal	±0.3div
		EXT	±(40mV + 6% of Set Value)
		EXT/5	±(200mV +6% of Set Value)

	Trigger displacement		● Pre-trigger : 1300 div
			  Post-trigger : 4 div ----MSO5022S
			● Pre-trigger : 655 div
			  Post-trigger : 4 div
			                    ----MSO7102T

	Trigger Holdoff range		100ns~10s
	50% level setting(typical)		Input signal frequency ≥50Hz
	Trigger sensitivity	Internal	Peak-peak value of 2div
		EXT	400mV

	(Video trigger, typical)	EXT/5	2V
	Signal system		NTSC, PAL, SECAM (any frequency)
	Alternate trigger	CH1 trigger	Edge, Video
		CH2 trigger	Edge, Video
Measurement	Cursor		$\triangle$V and $\triangle$T between cursors
	Automatic		Vpp, Vmax, Vmin, Vtop, Vbase, Vamp, Vavg, Vrms, Overshoot, Preshoot, Freq, Period, Rise Time,Fall Time, DelayA→B⌐, DelayA→B⌐, +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	USB1.1 or RS-232, USB for file storage		

＊ Half channel is when only one of channel pair 1 or 2 is turned on.

Logic analyzer

Sampling rate	● 20 S/s ～ 100MS/s Step as 1～2 ~5 ----MSO5022S ● 20 S/s ～ 400MS/s Step as 1～2～5 ----MSO7102T
Input channel	16
Max Storage	4M/Channel,16K(when only sampling rate is 400MS/s)
Measurement bandwidth	● 33MHz----MSO5022S ● 66MHz----MSO7102T

Input impedance	1MΩ±2%
Threshold level	-10V～10V
Input signal range	-15V～15V
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
Data System	Binary system, Decimal system, Hex
Digital Filter	0/1/2 optional
Setting storage	Support
USB storage	Support

General Technical Specifications

Display

Model	MSO5022S	MSO7102T
Display Type	7.8" Colored LCD (Liquid Crystal Display)	8" Colored LCD (Liquid Crystal Display)
Display Resolution	640 (Horizontal) × 480 (Vertical) Pixels	
Display Colors	256 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	● ＜ 15W----MSO5022S ● ＜ 18W----MSO7102T
Fuse	1A, T grade, 250V

Environment

Temperature	Working temperature: 0 ℃～ 40 ℃ Storage temperature: -20 ℃～ +60 ℃
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.

Appendix B: 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 C: 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 form the moisture.

Appendix D: Battery Using Guide
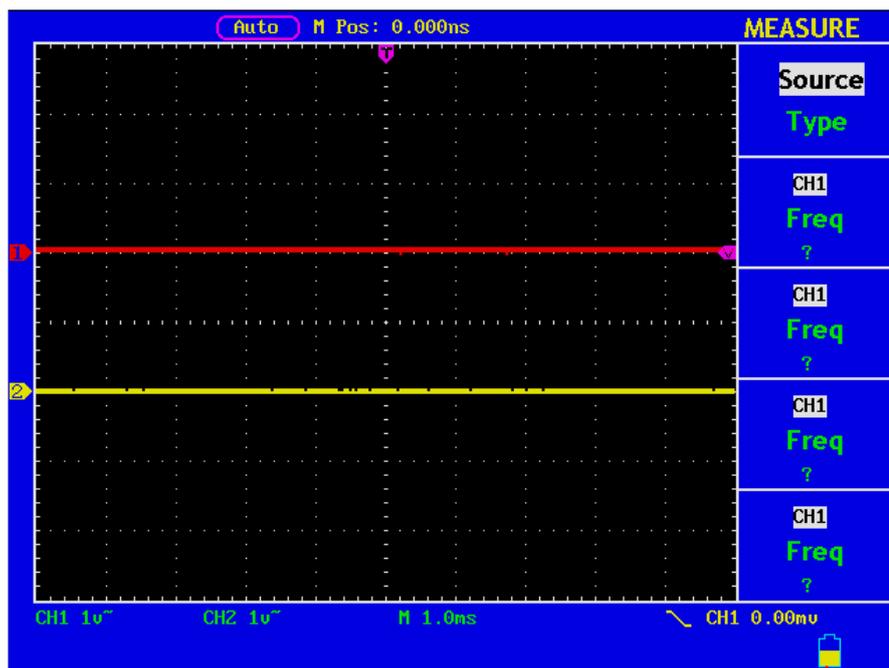
Battery electric quantity indicating symbols including: ▮, ▮, ▯ and ⬚

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 (the oscilloscope should be turned on during charging) 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.