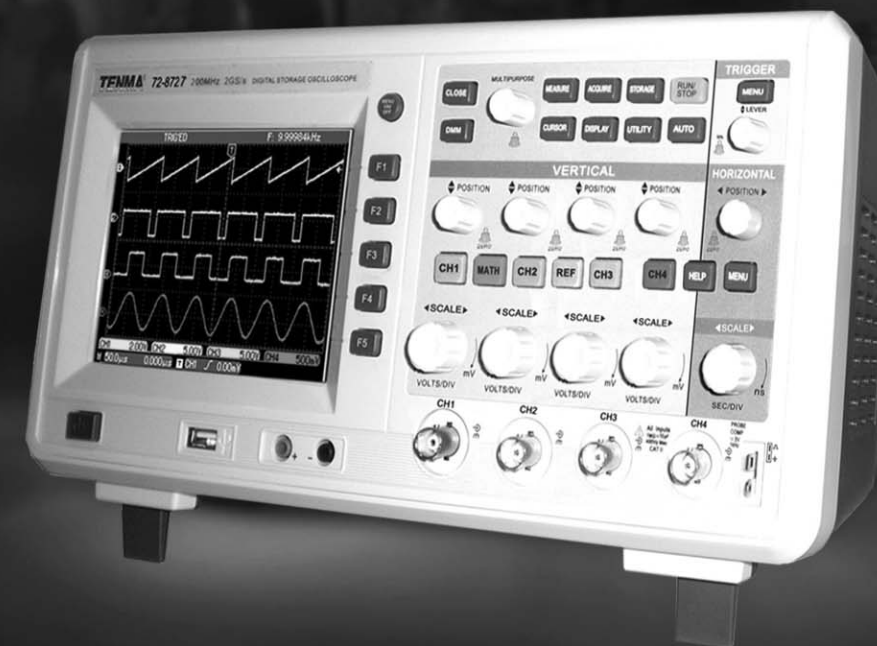


**TENMA®**



# **TENMA DSO**

## **Four-channel**

### **OPERATING**

### **MANUAL**

**Digital Storage**  
**Oscilloscope**

## **Introduction**

Dear valued customer,

Thank you for purchasing a Tenma instrument. To use your new product correctly, make sure you read this User Manual carefully and completely before operation and pay particular attention to the “Safety Instructions” section.

Please keep this User Manual in a safe place after reading it carefully. For easy reference during future operation, we recommend putting it alongside your Tenma product or in an easily accessible place.



Tenma DSO Four-channel User Manual

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Information contained in this manual supercedes all information in previously published versions.

**TENMA** is the registered trademark of Premier Farnell plc and its subsidiaries .



If this product is sold or assigned by the original purchaser to a third party within three years of purchase, the new owner should note that warranty is available for a period of three years from the day the original purchaser acquired the product from TENMA or an authorized dealer. The probe, other accessories and fuses are not covered by warranty.

If any genuine defect is found during the valid warranty period, TENMA has the option to repair the defective product without any charge for parts or labor, or replace it with another product (at the discretion of TENMA). TENMA may use parts, modules and replacement products that are brand new or repaired to a good-as-new standard. All old parts, modules and products that are removed during replacement become properties of TENMA.

In this User Manual, "customer" means an individual or entity vested with the rights hereunder. To enjoy the warranty service, the "customer" must report any defect to TENMA during the valid warranty period and make appropriate arrangement to allow servicing. The

customer should pack the defective product in a container and deliver it to a maintenance centre specified by TENMA. The customer should also prepay all freight cost and provide a copy of the original sales receipt issued to the original purchaser. If the product is to be delivered to an address within the country where the maintenance centre operates, TENMA shall pay the cost of returning the product to the destination, all freight, custom duty, tax and other costs will be paid by the customer.

This warranty does not apply to any defect, malfunction or damage caused by accident, normal wear and tear of mechanical parts, any form of application other than the stated ones, improper use, improper maintenance or poor maintenance. Under the warranty terms and conditions, TENMA has no obligation to provide the following services :

- a) Repairing any damage arising from installation, repair or maintenance carried out by a non TENMA service representative;
- b) Repairing any damage arising from improper use or connection to incompatible equipment;



## Tenma DSO Four-channel User Manual

- c) Repairing any damage or malfunction arising from using a power source not provided by TENMA;
- d) Servicing a product that has been modified or integrated with other products (such modification or integration makes repair more time consuming and difficult).

This warranty is made available to this product specifically and supercedes all other previous warranties, whether express or implied. TENMA and its dealers will not make any implied guarantee on the salability or suitability of this product for any specific purpose. In the event of breach of warranty terms and conditions, repair or replacement of defective product shall be the only and all remedial measure offered by TENMA. Notwithstanding any prior notification of potential damage that is indirect, special, consequential or inevitable, TENMA and its dealers shall bear no liability for any such damage.

### **Safety Instructions**

This unit is designed and manufactured strictly in accordance with IEC61010-1 safety standards. It fully meets CAT II 600V insulation and overvoltage requirements and Grade II anti-pollution safety standards. To prevent personal injuries and damage of this unit or any other devices connected to it, please take note of the following safety precautions. To avoid potential hazards, use this unit strictly as instructed by this User Manual.

**Maintenance should only be carried out by a trained professional.**

**To avoid fire and personal injury ,**

**Use a correct power cable :** Use only the specified power cable which is authorized in the country of use.

**Remove the plug correctly** : Do not remove the probe or testing cable when they are connected to power.

**Ensure good grounding** : This unit is grounded by the ground wire of the power cable. To avoid electric shock, the grounding conductor must touch the ground. Before connecting the input or output terminal, ensure the unit is properly grounded.

**Connect the probe of the digital storage oscilloscope** : The probe ground cable is the same as ground potential. Do not connect the ground cable to non ground voltage or high voltage.

**Check the rated values of all terminals** : To prevent fire and excessive current shock, please check all rated values and label data. Read the manual carefully and check the rated values before connecting the unit.

**Do not operate the unit with the chassis cover open** : Do not operate this unit when the outer cover or front panel is open.

**Use suitable fuses** : Only use specified fuse types and rated specifications.

**Avoid exposing circuitry** : When power is on, never make contact with exposed adaptor or components.

**When fault is suspected, stop operation** : If you suspect a fault, ask a qualified maintenance professional to carry out inspection.

**Maintain good ventilation.**


**Do not operate in humid condition.**


**Do not operate in combustible and explosive conditions.**

**Keep the product surface clean and dry.**

### **Safety Messages and Symbols**

Safety terminology used in this manual. The following messages may appear in this manual :

 **Warning** : *Warning statements identify conditions or practices that could result in injury or loss of life.*

 **Caution** : *Caution statements identify conditions or practices that could result in damage to this unit or other properties*

**Messages on the product** : The following messages may appear on the product :

"**Danger**" means potential damage that is immediate.

"**Warning**" means potential damage that is not immediate.

"**Caution**" means possible damage to this product or other properties.

**Icons on the product** : The following icons may

appear on the product :



High voltage



Caution!  
Refer to manual



Protective  
ground terminal



Ground terminal  
for chassis



Ground terminal  
for testing



## **Preface**

This manual provides information on the operation of the Tenma DSO four-channel digital storage oscilloscope.

Guidance is given in several chapters as follows :

**Chapter 1 User Guide:** Simple guide to oscilloscope functions and installation.

**Chapter 2 Instrument Setups:** Guide to operation of the Tenma DSO four channel digital storage oscilloscope.

**Chapter 3 Practical Illustrations:** Example illustrations are provided to solve various testing problems.

**Chapter 4 System Prompts and Trouble-shooting**

**Chapter 5 Servicing and Support**

**Chapter 6 Appendixes**

**Appendix A : Technical Indicators**

**Appendix B : Accessories for Tenma DSO Four-channel Digital Storage Oscilloscope**

**Appendix C : Maintenance and Cleaning**

**Appendix D : Factory Setup**





## Tenma DSO Four-channel User Manual

### The Tenma DSO Four-channel Digital Storage Oscilloscope

Tenma DSO four-channel digital storage oscilloscopes offer user-friendliness, outstanding technical indicators and a host of advanced features. They are your perfect tools to complete testing tasks swiftly and efficiently.

This manual is a user guide for the Tenma DSO digital storage oscilloscope :

| Model   | Bandwidth | Single-channel Sampling Rate | Dual-channel Sampling Rate | Equivalent Sampling Rate |
|---------|-----------|------------------------------|----------------------------|--------------------------|
| 72-8725 | 100MHz    | 2GS/s                        | 1GS/s                      | 25GS/s                   |
| 72-8727 | 200MHz    | 2GS/s                        | 1GS/s                      | 50GS/s                   |

Tenma DSO four-channel digital storage oscilloscope offer a user-friendly front panel with clear indications to allow access to all basic functions for easy operation. The scaling and position buttons for all channels are optimally arranged for intuitive operation. As design is based on the familiar practices of traditional instruments, users can use the new units without spending considerable time in learning and familiarizing with operation. For faster adjustment to ease testing, there is an **[AUTO]** key to instantly display the appropriate waveform and range position.

The performance features listed below will explain why the Tenma DSO Four-channel can fully satisfy your testing and measurement requirements :

- 2GS/s real-time sampling rate and 50GS/s equivalent sampling rate
- Dual time base function; unrivaled waveform detail observation and analysis capabilities
- 24k storage depth; 60M equivalent storage depth; 1024k recording length
- Unique envelop sampling feature with direct visual display of carrier wave details after amplitude modulation
- Scroll display in scan mode for continuous monitoring of signal variations
- Unique XY mode that displays the waveform and Lissajous figure concurrently
- USB drive system software upgrade
- Supports plug-and-play USB storage device. Communication with computer through the USB device
- Storage of waveforms, setups and bit maps; waveforms and setups reproduction
- Built-in FFT
- Multiple waveform mathematics functions (including add, subtract, multiply and divide)



## Tenma DSO Four-channel User Manual

- Edge, video, pulse, slope and alternate trigger functions
- Automatic measurement of 24 waveform parameters; parameters testing and customization
- Multiple **AUTO** setups for extra flexibility
- Visual system help messages
- 2x multimeter test lead; 2x current-to-voltage converter module: UT-M03/UT-M04

### Tenma DSO Four-channel accessories :

- 4 x 1.2m, 1:1/10:1 probe. For details refer to the probe instructions. These accessories conform with EN61010-031: 2008 standards
- Power line conforming to international standards applicable in the country of use
- User Manual
- USB connecting cable : UT-D06
- Tenma DSO four-channel oscilloscope communication control software (USB-device)

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## Chapter 1 UserGuide

Your Tenma DSO Four-channel digital storage oscilloscope is a small and compact benchtop device. The user-friendly front panel enables easy operation. This chapter will guide you through basic testing steps.

This chapter provides notes on the following :

- General inspection
- Functional check
- Probe compensation
- Automatic setups for waveform display
- Getting to know the vertical system
- Getting to know the horizontal system
- Getting to know the trigger system

When beginning to use your Tenma DSO Four-channel oscilloscope, first familiarize yourself with the operation front panel. This chapter briefly describes the operation and functions of the front panel, so you

can get started with your Tenma DSO four-channel digital storage oscilloscope as quickly as possible.

Your Tenma DSO Four-channel oscilloscope comes with a front panel with at-a-glance functions for easy operation. There are knobs and function keys on the front panel. The functions of knobs are similar to other oscilloscopes. On the right you will find 5 menu operation keys (designated as [F1] to [F5] from top down). With these keys you can set up different options of the current menu. The other keys are function keys. You can use them to enter different function menus or access particular functions directly.



Figure 1-1 Tenma DSO Four-cha Digital Storage Oscilloscope



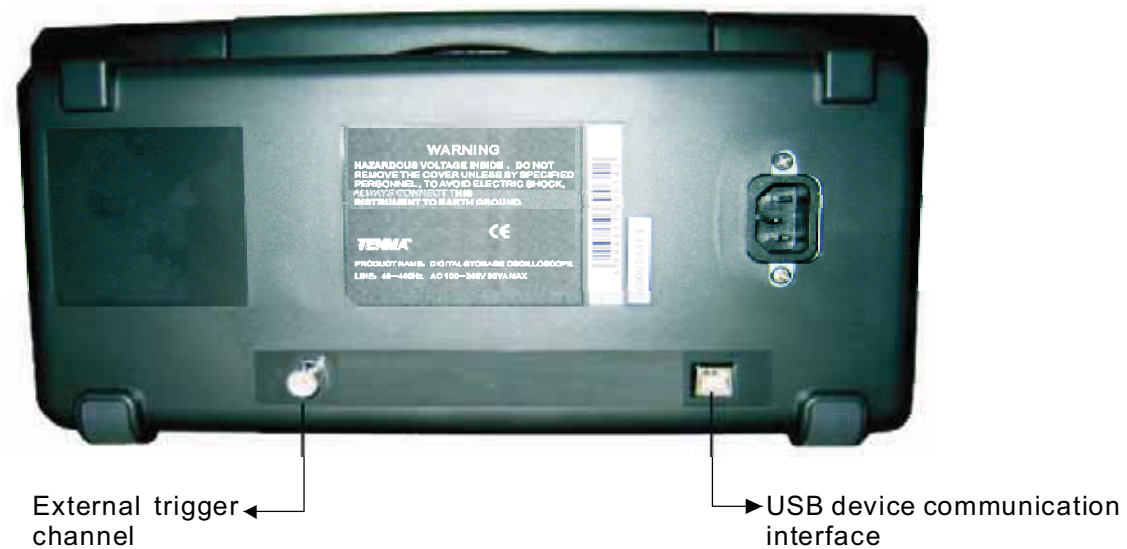


Figure 1-2 Back cover of Tenma DSO four-channel digital storage oscilloscope

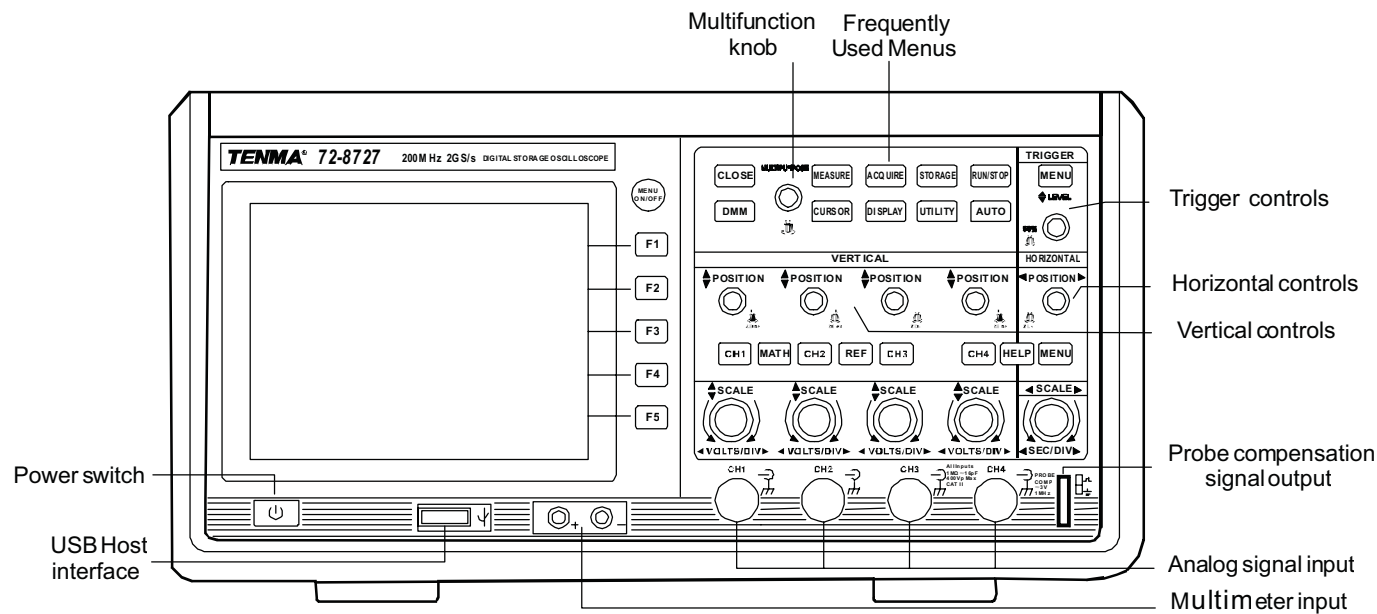


Figure 1-3 Tenma DSO Four-cha Digital Storage Oscilloscope Front Panel

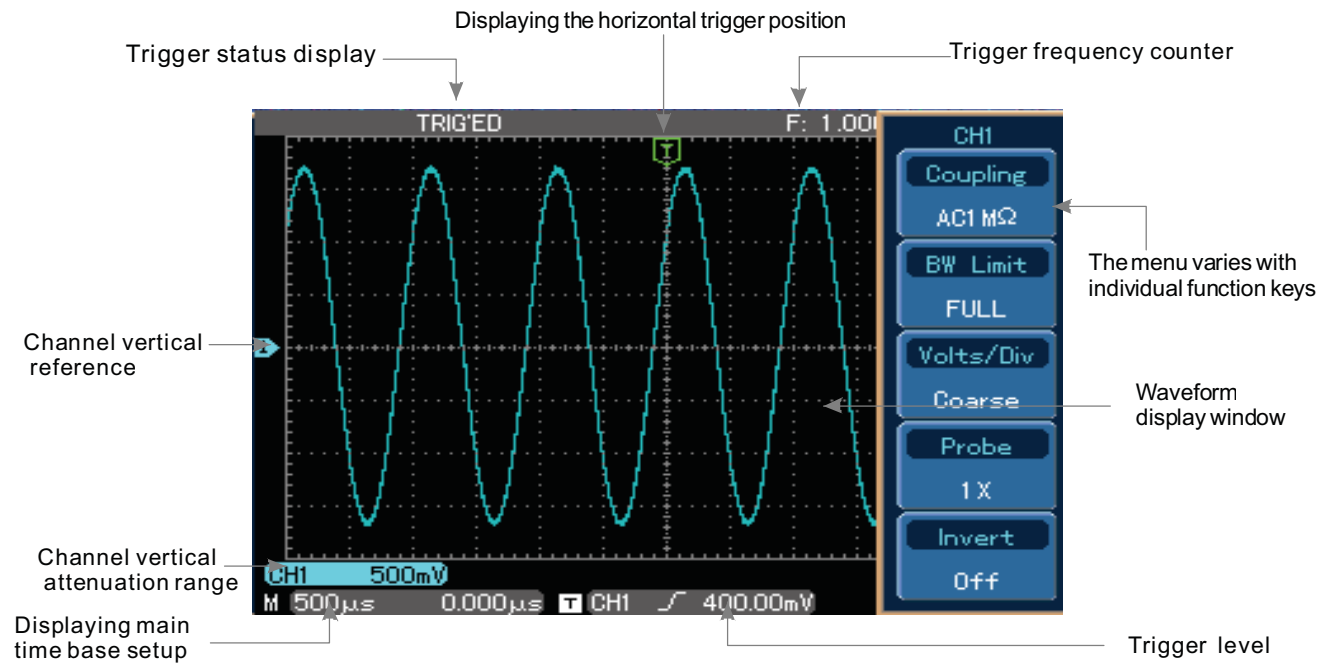


Figure 1-4 Schematic diagram of the display interface



## **General Inspection**

We suggest checking your new Tenma DSO Four-channel oscilloscope in the following steps.

### **1. Check the unit for possible shipping damages**

If the package carton or foam plastic protective lining is seriously damaged, please arrange for exchange immediately.

### **2. Check the accessories**

A checklist of accessories that come with your Four-channel oscilloscope is provided in the section "Accessories for Tenma DSO Four-channel Digital Storage Oscilloscope" of this user manual. Please check any missing items against this list. If any item is missing or damaged, please contact your TENMA dealer or our local office.

### **3. Thorough inspection of the entire unit**

If the exterior of the unit is damaged, or it is not operating normally, or it fails to pass the performance

test, please contact your TENMA dealer or our local office.

In the event of any shipping damages, please retain the packaging and notify our shipping department or your TENMA dealer. We will be glad to arrange maintenance or repair.

## **Functional Check**

Carry out a quick functional check in the following steps to make sure your oscilloscope is operating normally.

### 1. Power on the unit

Power on the unit. AC power supply voltage range is 100V to 240V, frequency 45Hz-440Hz. After connecting to power, start the self calibration process on the optimal oscilloscope signal path at greatest measurement accuracy. Press the **[UTILITY]** button and **[F1]** twice, then press the **MULTIPURPOSE** control knob to perform the function. Press **[UTILITY]** and **[F1]**, then press **[F5]** to go to the next page. There, press **[F1]** then the **MULTIPURPOSE** control knob. To recall default setup, see

Figure 1-5.

At the end of the above process, press **[CH1]** to enter the CH1 menu..



Figure 1-5

**Warning :** *To avoid danger, ensure the digital storage oscilloscope is safely grounded.*

## 2. Accessing signals

Your Tenma DSO Four-channel digital storage oscilloscope has four input channels and an external trigger input channel, as shown in Figure 1-6. Please access signals in the following steps :



Figure 1-6 Four-channel input and external trigger channel

- ① Connect the probe of the digital storage oscilloscope to the CH1 input terminal, and set the attenuation switch of the probe to 10X (Figure 1-7).

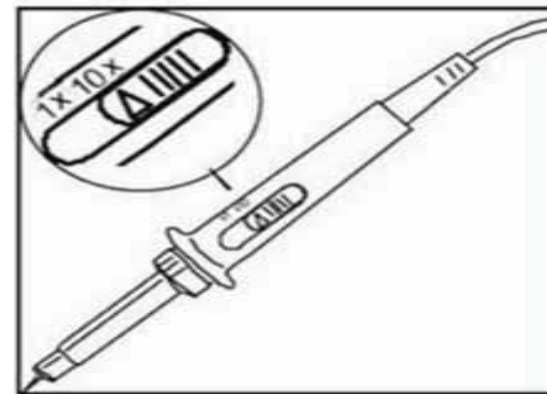


Figure 1-7 Setting the attenuation switch of the oscilloscope probe

## Tenma DSO Four-channel User Manual

② You have to set the probe attenuation factor of the oscilloscope. This factor changes the vertical range multiple to ensure the measurement result correctly reflects the amplitude of the signal being tested. Set the attenuation factor of the probe as follows : Press [**F4**] then [**F2**] to show 10X on the menu.

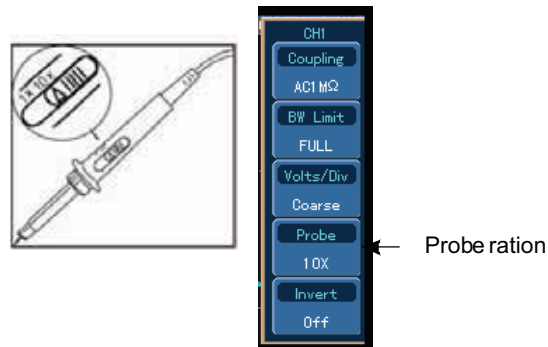


Figure 1-8 Setting the deflection factor of the oscilloscope probe

③ Connect the probe tip and ground clamp to the connection terminal for the probe compensation signal. Press [**AUTO**] and you will see a square wave in the display (1kHz, approximately 3V, peak-to-peak value) in a few seconds, as shown in Figure 1-9.

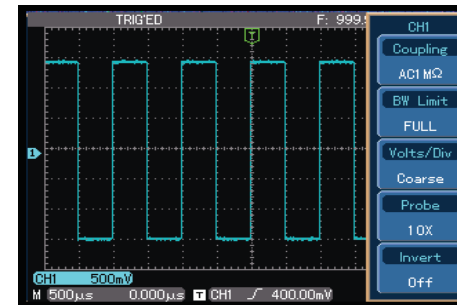


Figure 1-9 Probe compensation signal

④ Press [**CH1**] twice to close CH1, then press [**CH2**] to activate CH2 and repeat steps 2 and 3. Use the same method for CH3 and CH4.

### Probe Compensation

When connecting the probe to any input channel for the first time, perform this adjustment to match the probe to the channel. Skipping the compensation calibration step will result in measurement error or fault. Please adjust probe compensation as follows :

1. Set the probe attenuation factor to 10X. Move the switch on the probe to 10X and connect the probe to CH1. When using a hook-tip, ensure it is well connected to the probe. Connect the probe tip to the output terminal of the probe compensator's signal connector, and the ground clamp to the ground cable connector of the probe compensator. Activate CH1 then press **[AUTO]**.

2. Observe the displayed waveform.



Overcompensation    Correct Compensation    Undercompensation

Figure 1-10 Probe compensation calibration

3. If you see an “Undercompensation” or “Overcompensation” waveform display, adjust the adjustable capacitance tab of the probe with a screwdriver with non-metal handle, until a “Correct Compensation” waveform shown in the above figure is displayed.

**Warning :** *To avoid electric shock when measuring high voltage with the probe, ensure the probe's insulation lead is in good condition. Do not touch the metal part of the probe when connected to HV power.*



### Automatic Setup for Waveform Display

Your Tenma DSO Four-channel digital storage oscilloscope features an auto setup function. It can automatically adjust the vertical gratitude factor, scanning time base and trigger mode based on the input signal, until the most appropriate waveform is displayed. The auto setup function can only be operated when the signal to be measured is 50Hz or above and the duty ratio is larger than 1%.

#### Using the Auto Setup Function :

1. Connect the signal to be tested to the signal input channel.
2. Press **[AUTO]**. The oscilloscope will automatically set the vertical gratitude factor, scanning time base and trigger mode. Should you require to make more detailed check, you can adjust manually after the auto setup process until you get the optimal waveform display.

### Getting to Know the Vertical System

As shown in the figure below, there are a group of buttons and knobs in the vertical control zone. The following exercise will guide you through vertical setup.



Figure 1-11 Vertical control zone on the front panel

The **POSITION** knob can move the waveform vertically. Press this knob to quickly return to the centre point.

Press the [CH1], [CH2], [CH3], [CH4], [REF] and [MATH] keys for the vertical channel operation menu, or to open or close the waveform display channel.

Use the [VOLTS/DIV](CH1, CH2, CH3, CH4) key to set the vertical gratitude factor.

Displacement and vertical gratitude factor adjustments of [REF], [MATH] channels by **MULTIPURPOSE** control knob.

1. Press the vertical **POSITION** knob to display the waveform signal in the centre of the window. The vertical **POSITION** knob controls the vertical display position of the signal. When you turn the vertical **POSITION** knob, the reference sign indicating the channel [GROUND] level will move up and down with the waveform.

### Measurement Tips :

If the channel coupling is DC, you can measure the signal's DC component quickly by checking the distance between the waveform and signal ground level.

In the case of AC coupling, the DC component of the signal will be blocked. With this coupling mode you can display the AC component of the signal with higher sensitivity.

2. Change the vertical setup and observe changes of status information. You can identify changes of any vertical range by reading the status display column at the lower corner of the waveform window. Turn the vertical **VOLTS/DIV** knob to change the vertical **VOLT/DIV** range. You will find that the range in the current status column has changed accordingly. Press [CH1], [CH2], [CH3], [CH4], [REF] or [MATH] and the screen will show the corresponding operation menu, sign, waveform and range status information.

## Getting to Know the Horizontal System

As shown in the figure below, there are one button and two knobs in the horizontal control zone. The following steps will get you familiar with horizontal time base setup.



Figure 1-12 Horizontal control zone on the front panel

The **POSITION** knob can move all channels, MATH waveforms and REF waveforms horizontally. Press this knob to quickly return to the centre point. Press the **[MENU]** horizontal menu, to display **Window Dual Xbase Holdoff**.

Use the **SEC/DIV** knob to set the SEC/DIV graduation factor for horizontal scan. If the window is expanded, you can adjust graduation of the window there.

1. Use the horizontal **SEC/DIV** knob to change the horizontal time base setup and check any changes in status information. Turn the horizontal **SEC/DIV** knob to change the **SEC/DIV** time base range. You will find that the time base range in the current status column has changed accordingly. Range of horizontal scanning rate is 5ns/div~50s/div, in steps of 1-2-5.

\* **Note** : Horizontal scanning time base range of the Tenma DSO Four-channel varies from model to model.

2. Use the horizontal **POSITION** knob to adjust the horizontal position of the waveform window. When the horizontal **POSITION** knob is turned, you can see that the waveform moves horizontally with the knob.
3. Press **[MENU]** to activate the display window and dual time base menu. In this menu press **[F1]** to activate window expansion. Then press **[F1]** again to quit window expansion and return to the main display screen. For dual time base setup, press **[F3]**. You can also set the holdoff time with this menu by turning the **MULTIPURPOSE** control knob.

### Shortcut key for resetting the trigger point to horizontal zero :

When the trigger point has shifted significantly away from the horizontal centre point, use the **[POSITION]** knob to quickly reset the trigger point to the horizontal centre point. You can also use the horizontal **POSITION** knob for adjustments.

### Definition

**Trigger point** means the actual trigger point relative to the centre point of the storage device. By turning the horizontal **POSITION** knob, you can move the trigger point horizontally.

**Holdoff** means the interval time before another trigger to be accepted. Turn the **MULTIPURPOSE** control knob to set the holdoff time. By adjusting holdoff time, you can observe complex or complicated signals.

## Getting to Know the Trigger System

As shown in Figure 1-13, there are one knob and one button in the trigger menu control zone. The following steps will get you familiar with trigger setup.



Figure 1-13 Trigger menu on the front panel



Figure 1-14 Trigger Menu

Trigger **LEVEL** knob :

When operating edge, pulse width and slew rate triggers, set the amplitude to be crossed by the waveform upon signal occurrence by turning the trigger **LEVEL** knob. To quickly set the trigger level as the vertical centre point of the trigger signal, press the trigger **LEVEL** knob.

[ **MENU** ] To display trigger menu contents

1. Use the trigger **LEVEL** knob to change the trigger level. You will see a trigger sign on the screen that indicates the trigger level. The sign will move up and down with the knob. While you move the trigger level, you will find the trigger level value on the screen changing accordingly.

2. Open the trigger [ **MENU** ] key (see the figure 1-14) to change trigger setup.

Press [ **F1** ] twice and select **EDGE** for [ **TYPE** ] .

Press [F2] and select **CH1** for [SIGNAL SOURCE] (Turn the **MULTIPURPOSE** control knob to select and then press that key to confirm).

Press [F3] then [F1]. Set **DC** for [COUPLING].

Press [F4] then [F1]. Set **AUTO** for [MODE].

Press [F5] then [F2]. Set **RISE** for [SLOPE].

### Notes :



Icon utility function of the **POSITION** knob. Press this key to quickly return to the centre point.



Icon utility function of the trigger **LEVEL** knob. Press this key to quickly return to horizontal ground level, i.e. trigger zero level.



Icon utility function of the **MULTIPURPOSE** knob. Press this key to confirm selection.

## Chapter 2 Instrument Setups

You should be familiar with basic operation of the vertical controls, horizontal controls and trigger system menu of your Tenma DSO Four-channel oscilloscope by now. After reading the last chapter, you should be able to use the menus to set up your digital storage oscilloscope. If you are still unfamiliar with these basic operation steps and methods, please read Chapter 1.

This chapter will guide you through the following :

- Setting up the vertical system ([CH1], [CH2],[CH3], [CH4], [MATH], [REF], POSITION, VOLTS/DIV)
- Setting up the horizontal system ([MENU], POSITION, SEC/DIV)
- Setting up the Trigger system (TRIGGER MENU, LEVEL)
- Setting up the sampling method ([ACQUIRE])

- Setting up the display mode ( [ **DISPLAY** ] )
- Storage and recall ([**STORAGE**])
- Setting up the help system ([**UTILITY**])
- Automatic measurement ([**MEASURE**])
- Cursor measurement ([**CURSOR**])
- Auto setup, run/stop key ([**AUTO**], [**RUN/STOP**])
- Multimeter ([**DMM**])
- Multipurpose control knob (**MULTIPURPOSE**)

It is recommended that you read this chapter carefully to understand the various measurement functions and system operation steps of your Tenma DSO four-channel digital storage oscilloscope.

## Setting the Vertical System

### CH1, CH2, CH3, CH4 and setups

Each channel has its own vertical menu. You should set up each item for each channel individually. Press the [CH1], [CH2], [CH3] or [CH4] function button and the system will display the operation menu for CH1, CH2, CH3 or CH4. For explanatory notes please see Table 2- 1 below :

Table 2-1 : Explanatory notes for channel menu

| Function Menu | Setup                      | Explanatory Note  |
|---------------|----------------------------|---|
| Coupling      | DC 1MΩ<br>AC 1MΩ<br>GND    | Pass AC and DC quantities of input signal. Intercept DC quantities of the input signal.<br>Display reference ground level (without disconnecting the input signal).                             |
| BW Limit      | Full<br>20MHz              | Full band width.<br>Limit bandwidth to 20MHz to reduce noise display  |
| VOLTS/DIV     | Coarse<br>Fine             | Coarse tune in steps of 1-2-5 to set up the vertical grating factor of the vertical system. Fine tune means further tuning within the coarse tune setup range to raise the vertical resolution. |
| Probe         | 1X<br>10X<br>100X<br>1000X | Select either one value based on the probe attenuation factor to keep the vertical deflection factor reading correct. There are four values : 1X, 10X, 100X and 1000X.                          |
| Invert        | On<br>Off                  | Waveform is inverted.<br>Normal waveform display.   |



### 1. Setting up channel coupling :

Take an example of applying a signal to CH1. The signal being tested is a sine signal that contains DC%. Press [F1] to select AC then press [F2] to select AC 1MΩ. It is now set up as AC coupling. DC quantities of the signal being tested will be intercepted. The waveform display is as follows :

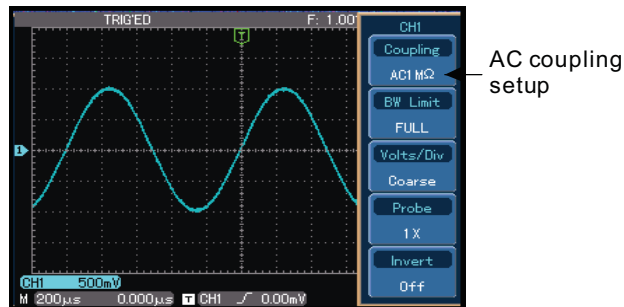


Figure 2-1 DC quantities of the signal are intercepted

Press [F1] twice to select DC 1MΩ. Both DC and AC quantities of the testing signal being inputted to CH1 can pass through. The waveform display is as follows :

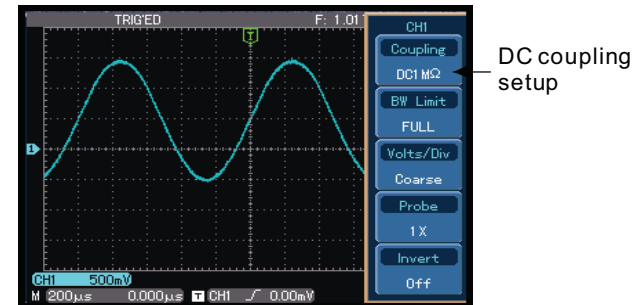


Figure 2-2 Both DC and AC quantities of the signal are displayed

Press [F1] then [F3] to select ground. It is now set up as ground. The waveform display is as follows :

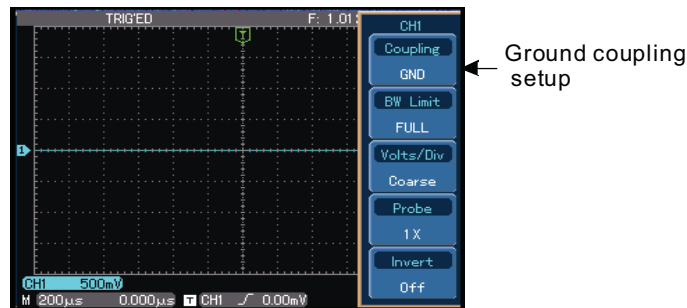


Figure 2-3 Channel is set to ground mode

\* **Note :** In this mode, although waveform is not displayed, the signal remains connected to the channel circuit.

## 2. Setting the channel bandwidth limit

Take applying a signal to Ch1 as an example, the signal to be tested contains high frequency quantities.

Press [CH1] to turn CH1 on, then press [F2] and [F1]. Bandwidth is now set to full bandwidth. The signal being measured can pass through even if it contains high frequency quantities. The waveform display is as follows :

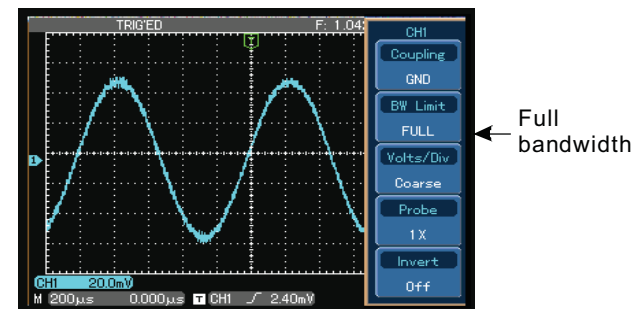
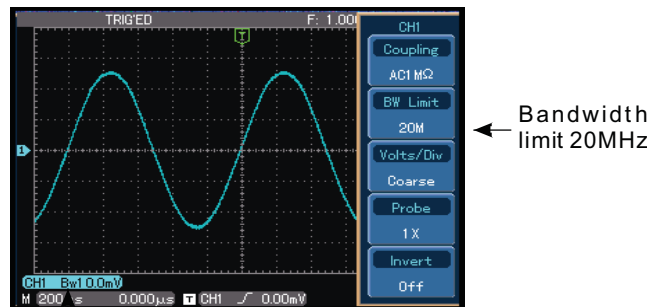


Figure 2-4 Waveform display at full bandwidth displayed

## Tenma DSO Four-channel User Manual

Press [F2] then [F3]. The noise and high frequency quantities over 20MHz of the signal being tested are now restricted. Waveform display is as follows.



The "BW" bandwidth limit icon

Figure 2-5 Waveform display when bandwidth limit is on

### 3. Setting up the probe rate

To match the probe attenuation factor setup, it is necessary to set up the probe attenuation factor in the channel operation menu accordingly. For example, when the probe attenuation factor is 10:1, set the probe attenuation factor at 10X in the channel menu. Apply this principle to other values to ensure the voltage reading is correct. The figure below shows the setup and vertical range display when the probe is set at 10:1.

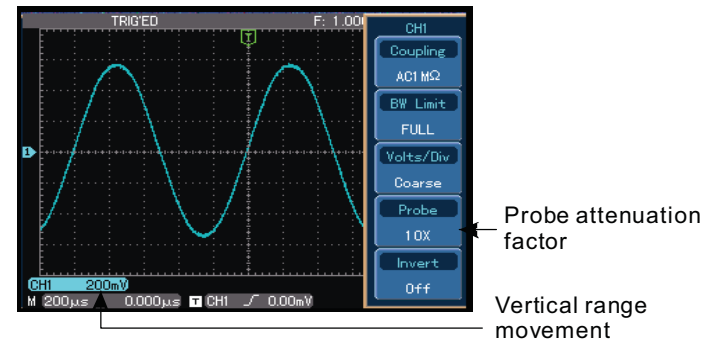
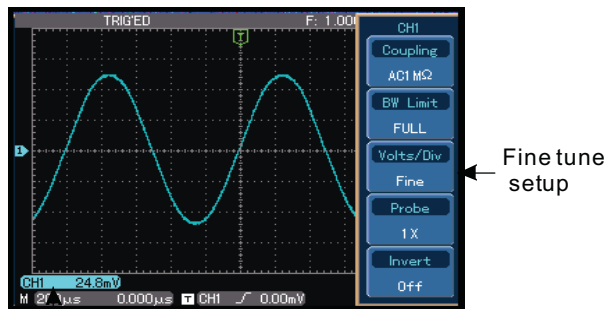


Figure 2-6 Setting the probe attenuation factor in the channel menu

## 4. Vertical VOLTS/DIV adjustment setup

You can adjust the VOLTS/DIV range of the vertical deflection factor either in the coarse tune mode or fine tune mode. In coarse tune mode, the VOLTS/DIV range is 2mV/div~5V/div. Tuning is in steps of 1-2-5. In fine tune mode, you can change the deflection factor in even smaller steps within the current vertical range, so as to continuously adjust the vertical deflection factor within the range of 2mV/div~5V/div without interruption.



Vertical deflection factor VOLTS/DIV movement

Figure 2-7 Coarse tuning and fine tuning the vertical deflection factor

## 5. Waveform inversion setup

Waveform inversion : The displayed signal is inverted 180 degrees. Figure 2-8 shows the non-inverted waveform. Figure 2-9 shows the inverted waveform.

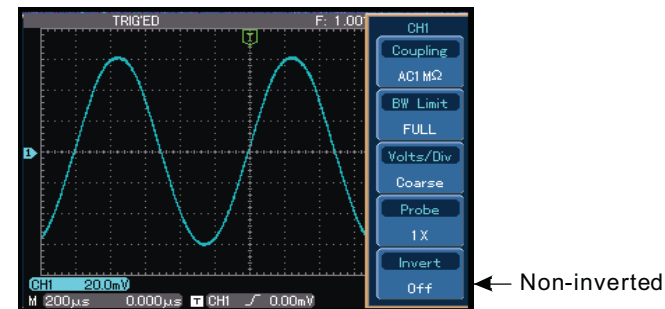


Figure 2-8 Inversion setup for vertical channel (non-inverted) deflection factor

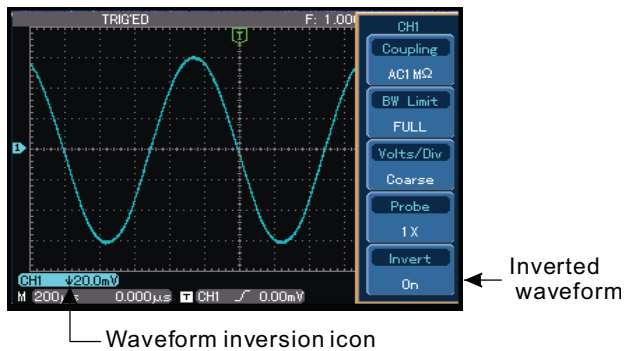


Figure 2-9 Inversion setup for vertical channel (inverted)

## Operating Math Functions

Math functions are displays of  $+$ ,  $-$ ,  $\times$ ,  $\div$  and FFT mathematical results of waveform channels CH1, CH2, CH3 and CH4, and the digitally filtered waveform.

The menu is as follows :

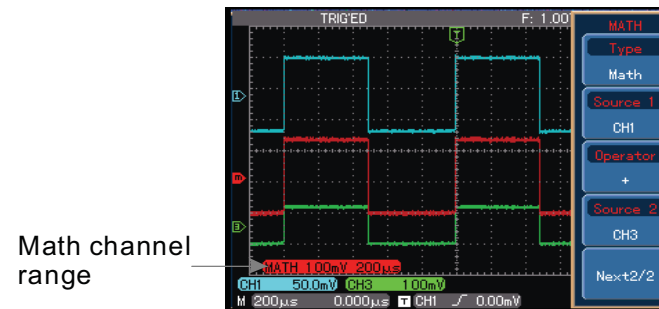


Figure 2-10 Math functions

Table 2-2a Explanatory notes for the Math menu (1)

| Function Menu | Setup                            | Explanatory Note   |
|---------------|----------------------------------|--|
| Type          | Math                             | To carry out $+$ , $-$ , $\times$ , $\div$ , functions   |
| Source 1      | CH1<br>CH2<br>CH3<br>CH4         | Set Source 1 as CH1 waveform<br>Set Source 1 as CH2 waveform<br>Set Source 1 as CH3 waveform<br>Set Source 1 as CH4 waveform |
| Operator      | $+$<br>$-$<br>$\times$<br>$\div$ | Source 1 $+$ Source 2<br>Source 1 $-$ Source 2<br>Source 1 $\times$ Source 2<br>Source 1 $\div$ Source 2                     |
| Source 2      | CH1<br>CH2<br>CH3<br>CH4         | Set Source 2 as CH1 waveform<br>Set Source 2 as CH2 waveform<br>Set Source 2 as CH3 waveform<br>Set Source 2 as CH4 waveform |
| Next page 2/2 | ----                             | Go to next page  |

Table 2-2b Explanatory notes for the Math menu (2)

| Function Menu | Setup                          | Explanatory Note   |
|---------------|--------------------------------|--|
| Compress      | 1/1<br>1/10<br>1/100<br>1/1000 | Scale the waveform by ratio. There are four ratios to choose from : 1/1, 1/10, 1/100, 1/1000 |
| Y Offset      | ----                           | Use the <b>MULTIPURPOSE</b> control knob to move the waveform vertically                     |
| Y Level       | ----                           | Use the <b>MULTIPURPOSE</b> control knob to adjust the vertical scale factor                 |
| Pre 1/2       | ----                           | Return to previous page  |

## FFT spectrum analysis

By using the FFT (Fast Fourier Transform) algorithm, you can convert time domain signals (YT) into frequency domain signals. With FFT, you can conveniently observe the following types of signals :

- Measure the harmonic wave composition and distortion of the system
- Demonstrate the noise characteristics of the DC power
- Analyse oscillation

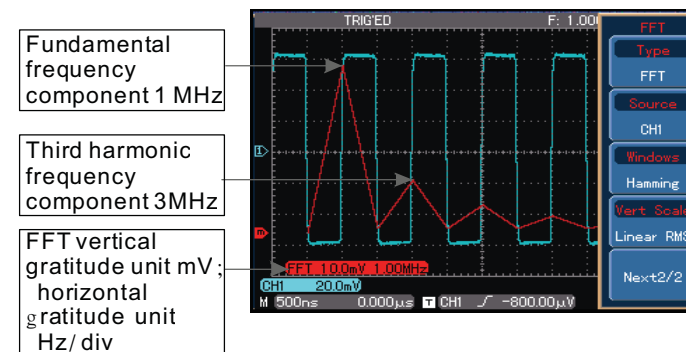


Figure 2-11 FFT Frequency



Table 2-3a Explanatory notes for the FFT menu (1)

| Function Menu       | Setup                                       | Explanatory Note  |
|---------------------|---|---|
| Type                | FFT   | To carry out FFT algorithm functions  |
| Source              | CH1<br>CH2<br>CH3<br>CH4                    | Set CH1 as math waveform<br>Set CH2 as math waveform<br>Set CH3 as math waveform<br>Set CH4 as math waveform                |
| Window              | Hamming<br>Blackman<br>Rectangle<br>Hanning | Set Hamming window function<br>Set Blackman window function<br>Set Rectangle window function<br>Set Hanning window function |
| Vertical coordinate | Linear<br>V dB                              | Set the vertical coordinate unit to linear or V dB  |
| Next 2/2            | ----  | Go to next page   |

Table 2-3b Explanatory notes for the FFT menu (2)

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| Y Offset      | ----  | Use the <b>MULTIPURPOSE</b> control knob to move the waveform vertically         |
| Y Level       | ----  | Use the <b>MULTIPURPOSE</b> control knob to adjust the vertical gratitude factor |
| ----          | ----  | ----   |
| ----          | ----  | ----   |
| Pre 1/2       | ----  | Return to previous page  |

### How to use FFT functions

Signals with DC quantities or DC offset will cause error or offset of FFT waveform quantities. To reduce DC quantities, select AC coupling. To reduce random noise and frequency aliasing resulted by repeated or single pulse event, set the acquiring mode of your oscilloscope to average acquisition.

waveform by one window function to set the value to 0 for start and finish compulsively. For application of the window function, please see the table below :

### Select the FFT Window

Assuming the YT waveform is constantly repeating itself, the oscilloscope will carry out FFT conversion of time record of a limited length. When this cycle is a whole number, the YT waveform will have the same amplitude at the start and finish. There is no waveform interruption. However, if the YT waveform cycle is not a whole number, there will be different amplitudes at the start and finish, resulting in transient interruption of high frequency at the connection point. In frequency domain, this is known as leakage. To avoid leakage, multiply the original

Table 2-4

| FFT Window | Feature  | Most Suitable Measurement Item  |
|------------|--|---|
| Rectangle  | The best frequency recognition rate , the worst amplitude recognition rate . Basically similar to a status without adding window . | Temporary or fast pulse. Signal level is generally the same before and after. Equal sine wave of very similar frequency. There is broad-band random noise with slow moving wave spectrum. |
| Hanning    | Frequency recognition rate is better than the rectangle window, but amplitude recognition rate is poorer.                          | Sine, cyclical and narrow-band random noise .   |
| Hamming    | Frequency recognition rate is marginally better than Hanning window.   | Temporary or fast pulse. Signal level varies greatly before and after.  |
| Blackman   | The best amplitude recognition rate and the poorest frequency recognition rate.  | Mainly for single-frequency signals to search for higher-order harmonic wave.   |

**Definition :**

**FFT recognition rate** means the quotient of the sampling and math points . When math point value is fixed , the sampling rate should be as low as possible relative to the FFT recognition rate.

**Nyquist frequency** : To rebuild the original waveform, at least  $2f$  sampling rate should be used for waveform with a maximum frequency of  $f$ . This is known as Nyquist stability criterion , where  $f$  is the Nyquist frequency and  $2f$  is the Nyquist sampling rate.

## Digital Filtering Function

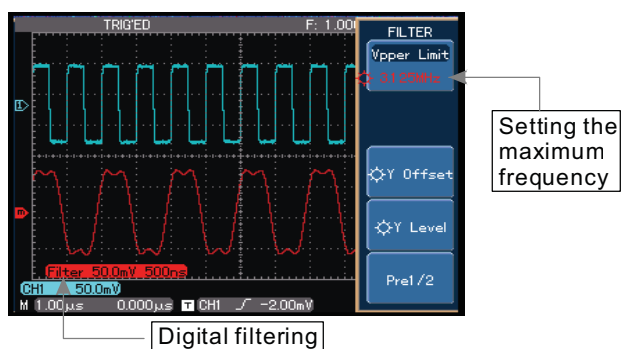


Figure 2-12 Digital filtering

Table 2-5a Explanatory notes for the digital filtering menu (1)

| Function Menu | Setup                              | Explanatory Note   |
|---------------|------------------------------------|--|
| Type          | Filter                             | Digital filtering  |
| Source        | CH1<br>CH2<br>CH3<br>CH4           | Set CH1 as filter target<br>Set CH2 as filter target<br>Set CH3 as filter target<br>Set CH4 as filter target           |
| Filter Type   | Low-pass<br>High-pass<br>Band-pass | Set the filter to low-pass filtering<br>Set the filter to high-pass filtering<br>Set the filter to band-pass filtering |
| Next 2/2      | ----                               | Go to next page  |

Table 2-5b Explanatory notes for the digital filtering menu (2)

| Function Menu | Setup | Explanatory Note  |
|---------------|-------|---|
| Upper Limit   | ----  | Effective only during low-pass filtering or band-pass filtering. Use the <b>MULTIPURPOSE</b> control knob to set the maximum frequency  |
| Lower Limit   | ----  | Effective only during high-pass filtering or band-pass filtering. Use the <b>MULTIPURPOSE</b> control knob to set the minimum frequency |
| Y Offset      | ----  | Use the <b>MULTIPURPOSE</b> control knob to move the waveform vertically  |
| Y Level       | ----  | Use the <b>MULTIPURPOSE</b> control knob to adjust the vertical gratitude factor  |
| Pre 1 / 2     | ----  | Return to previous page   |

### Reference Waveform

Display of the saved reference waveforms can be set on or off in the REF menu. The waveforms are saved in the non volatile memory of the oscilloscope or an external USB device and are identified with the following names : RefA, RefB. To display (Load) or hide (off) the reference waveforms, take the following steps :

1. Press the **[REF]** key.
2. Press **[F2]** for "Load" and select the signal source by turning the **MULTIPURPOSE** control knob. You can choose from 1 to 10. After selecting a numeral for saved waveform, e.g. 1, press the **MULTIPURPOSE** control knob to confirm and the waveform originally stored in that position can be recalled. For instructions on storing or recalling reference waveforms on the USB device, read "Storage and Recall".
3. Press **[F1]** for "RefB" to select the second signal source for the math function by repeating

step 2.

4. To close the reference waveform, press **[OFF]**. In actual application, when using your Tenma DSO Four-channel to measure and observe such waveforms, you can compare the current waveform with the reference waveform for analysis. Press **[REF]** to display the reference waveform menu. For setup please refer to Table 2-6.

\* **Note** : When **[AUTO]** is pressed after a waveform is recalled or imported, that waveform will remain.

Table 2-6a Explanatory notes for the REF menu (1)

| Function Menu | Setup          | Explanatory Note  |
|---------------|----------------|---|
| Ref Wave      | REF A<br>REF B | Select <b>REF A</b> as the reference waveform<br>Select <b>REF B</b> as the reference waveform  |
| Load          |                | Recall waveforms stored in 10 positions then select one with the <b>MULTIPURPOSE</b> control knob. Press the control knob to confirm. |
| ----          |                | To display the amplitude and time base contents of the current waveform   |
| Next 2/2      |                | Go to next page   |

Table 2-6b Explanatory notes for the REF menu (2)

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| Y Offset      |       | Use the <b>MULTIPURPOSE</b> control knob to move the waveform vertically                   |
| Y level       |       | Use the <b>MULTIPURPOSE</b> control knob to adjust the vertical graticule factor           |
| OFF           |       | Close the reference waveform   |
| Import        | USB   | Enter the USB menu (see Table 2-7), recall the reference waveform stored on the USB device |
| Pre 1 /2      |       | Return to previous page  |

Table 2-7 Explanatory notes for the USB menu

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| File name     |       | Use the <b>MULTIPURPOSE</b> control knob and [F1] key to set the document name to be imported from the USB device. For specific operation instruction see note 2 |
| OK            |       | After confirming, go back to the REF menu. If there is such a document on the USB device, it will be imported. Otherwise a "I/O failure" message will appear     |

**Note 1 :** To select an internal storage position, choose between 1 and 10. In the case of external storage device, plug in the USB device. A message saying "USB installation complete" appears. Press [F4] on the next page for the "import" menu, and then enter the USB menu.

**Note 2 :** In the USB menu, use the [F1] key and **MULTIPURPOSE** control knob to set the document name. Press [F1] to select the character positions that need to be changed. Use the

**MULTIPURPOSE** control knob to change the selected characters or numerals.

**Note 3 :** "Y Offset", "Y level", "OFF" [REF] are operative only after the reference waveform has been recalled or imported.



## Setting the Horizontal System

### Horizontal Control

You can use the horizontal control knobs to change the horizontal gratitude (time base) and trigger the horizontal position of the memory (triggering position). Changing the horizontal gratitude will cause the waveform to increase or decrease in size relative to the screen centre. When the horizontal position changes, the position with respect to the waveform triggering point is also changed.

Horizontal position : Adjust the horizontal positions of channel waveforms (including math waveforms). Resolution of this control button changes with the time base.

Horizontal scaling : Adjust the main time base, i.e SEC/DIV. When time base extension is on, you can use the horizontal scaling knob to change the delay scanning time base and change the window width.

Two horizontal control knobs : Use the **SEC/DIV** knob

to change horizontal time base gratitude, and use the horizontal **POSITION** knob to change the relative position if the triggering point on the screen. For instructions on how to display the horizontal menu [ **MENU** ], see Table 2-8.

Horizontal controls menu : Horizontal menu display (see the table below).

Table 2-8 Explanatory notes for the horizontal menu

| Function Menu | Setup               | Explanatory Note  |
|---------------|---------------------|---|
| Window        | ----                | Press [F1] to switch between the “main screen” and “expanded window”. |
| Dual Xbase    |                     | Enter the dual time base menu. See Table 2-9                          |
| Holdoff       | 96.0000ns~ 1.50000s | Use the <b>MULTIPURPOSE</b> control knob to adjust holdoff time .     |

### Horizontal parameter interface definitions :

- ① Represents the signal frequency currently selected as trigger source.
- ② Represents the triggering point position of the current waveform.
- ③ Represents the trigger level of the current waveform.
- ④ Distance between the triggering position and the horizontal centre point.
- ⑤ The time base value of main time base M1, i.e SEC/DIV.

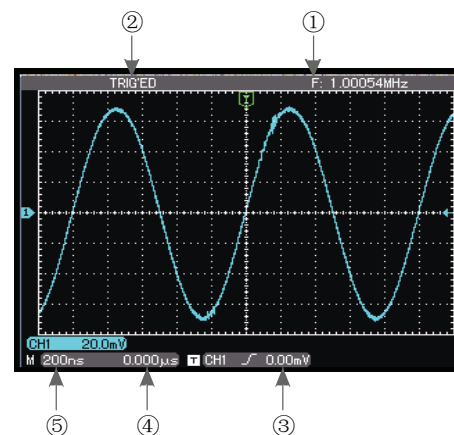


Figure 2-13 Horizontal parameter interface

## Window Expansion

Window expansion can be used to zoom in a band of waveform to check image details. Please refer to Figure 2-14.

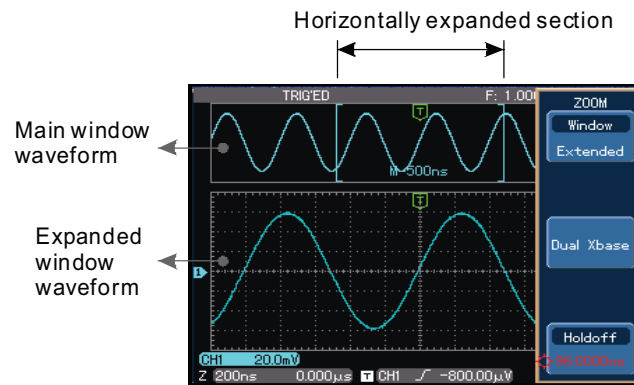


Figure 2-14 Expanded screen display

The window expansion setting cannot be slower than the main time base setting. Maximum magnification multiple is 100x.

In the window extension mode, the display is divided into two zones as shown above. The upper part displays the original waveform. You can move this zone left and right by turning the horizontal **POSITION** knob, or increase and decrease the selected zone in size by turning the horizontal **SEC/DIV** knob. The lower part is the horizontally expanded waveform. Please note that the recognition rate of expanded time base relative to the main time base is now higher (as shown in the above figure). Since the waveform shown in the entire lower part corresponds to the selected zone in the upper part, you can increase the extended time base by turning the horizontal **SEC/DIV** knob to decrease the size of the selected zone. In other words, you can increase the multiple of waveform expansion.

### Dual Time Base Function

The dual time base function is similar to window extension but there is a fundamental difference. In the window extension mode you can magnify the waveform 100 times, whereas in the dual time base mode you can magnify details of the waveform being observed by thousands of times. In effect, the main time base storage depth is increased by thousands of times.

The dual time base menu and its operation are as follows :

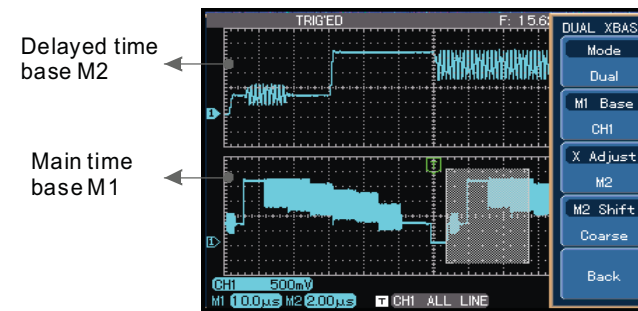


Figure 2-15 Dual time base

\* **Note** : The Math function is disabled in the dual time base mode.

Table 2-9 Explanatory notes for the dual time base menu

| Function Menu | Setup                 | Explanatory Note   |
|---------------|-----------------------|--|
| Mode          | Main<br>Dual          | Switching between main time base and dual time base .<br>For dual time base mode instructions see Figure 2-15  |
| M1 Base       | CH1, CH2,<br>CH3, CH4 | Switch to the waveform displayed on a different channel. Only one channel can be displayed in the dual time base mode  |
| X Adjust      | M1<br><br>M2          | When M1 is the main time base, use the horizontal <b>POSITION</b> and <b>SEC/DIV</b> knobs to adjust into main time base parameters<br>When M2 is the main time base, use the horizontal <b>POSITION</b> and <b>SEC/DIV</b> knobs to adjust into main time base parameters |
| M2 Shift      | Coarse<br>Fine        | Set delayed time base M2 to move horizontally in escalating scale<br>Set delayed time base M2 to move horizontally in de-escalating scale  |
| BACK          |                       | Return to the horizontal menu  |

## Setting the Trigger System

Triggering decides when the oscilloscope collects data and display waveforms. Once the trigger is correctly set up, it can transform unstable displays into meaningful waveforms. When beginning to acquire data, the digital storage oscilloscope first collects sufficient data required for drawing a waveform on the left side of the trigger point. When trigger is detected, it continuously acquires sufficient data to draw a waveform on the right side of the trigger point.

The trigger control zone on the operation panel of your oscilloscope comprises a trigger **LEVEL** knob and a trigger [ **MENU** ] button.

### Trigger Control

**Trigger modes** : Edge, Pulse , Video and Slope rate.

**Edge trigger** : Trigger is set to occur when the signal is at the rising or falling edge. You can use the trigger

**LEVEL** knob to change the trigger point's vertical position on the trigger edge, i.e. the intersection point of the trigger level line and the signal edge on the screen.

**Pulse width trigger** : When the pulse width of the trigger signal reaches a preset trigger condition, trigger occurs.

**Video trigger**: Carry out field or line trigger to standard video signals.

**Slope trigger**: Trigger condition is the signal rising or falling rate.

Below are notes for various trigger menus.

### Edge Trigger

For edge trigger menu setups please see Table 2-10.

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Table 2-10 Edge trigger

| Function Menu | Setup  | Explanatory Note  |
|---------------|--|---|
| Type          | Edge   |   |
| Source        | CH1, CH2, CH3, CH4<br>EXT, EXT/5<br>LINE<br>CH1 & CH2<br>CH1 & CH3<br>CH1 & CH4<br>CH2 & CH3<br>CH2 & CH4<br>CH3 & CH4 | Set CH1, CH2, CH3 or CH4 as the signal source trigger signal<br>Set to external trigger or divide the external trigger source by 5<br>Set to AC power trigger<br>CH1 and CH2 trigger their respective signals alternately<br>CH1 and CH3 trigger their respective signals alternately<br>CH1 and CH4 trigger their respective signals alternately<br>CH2 and CH3 trigger their respective signals alternately<br>CH2 and CH4 trigger their respective signals alternately<br>CH3 and CH4 trigger their respective signals alternately |
| Coupling      | DC<br>AC<br>L/F Reject<br>H/F Reject   | Allow AC and DC quantities of the input signal to pass<br>Intercept DC quantities of the input signal<br>Reject low frequency quantities below 80kHz of the signal<br>Reject high frequency quantities above 80kHz of the signal  |
| Mode          | Auto<br><br>Normal<br><br>Single   | The system automatically acquires waveform data when there is no trigger signal . The scan baseline is shown on the display. When the trigger signal is generated, it automatically turns to trigger scan<br>The system stops acquiring data when there is no trigger signal. When the trigger signal is generated, trigger scan occurs<br>One trigger will occur when there is an input trigger signal. Then trigger will stop   |

Continued table

Table 2-10 Edge trigger(Connected to the table)

| Function Menu | Setup     | Explanatory Note  |
|---------------|-----------|---|
| Slope         | Rise      | Set to trigger at the signal's rising edge              |
|               | Fall      | Set to trigger at the signal's falling edge             |
|               | Rise-Fall | Set to trigger at the signal's rising and falling edges |

### Pulse Trigger

Pulse trigger means determining the triggering time based on the pulse width. You can acquire abnormal pulse by setting the pulse width condition.

Table 2-11 Pulse width Trigger

| Function Menu | Setup               | Explanatory Note   |
|---------------|---------------------|--|
| Type          | Pulse width Trigger |  |
| Source        | CH1, CH2, CH3, CH4  | Set CH1, CH2, CH3 or CH4 as the signal source trigger signal       |
|               | EXT, EXT/5          | Set to external trigger or divide the external trigger source by 5 |
|               | LINE                | Set to AC power trigger  |
|               | CH1 & CH2           | CH1 and CH2 trigger their respective signals alternately           |
|               | CH1 & CH3           | CH1 and CH3 trigger their respective signals alternately           |
|               | CH1 & CH4           | CH1 and CH4 trigger their respective signals alternately           |
|               | CH2 & CH3           | CH2 and CH3 trigger their respective signals alternately           |
|               | CH2 & CH4           | CH2 and CH4 trigger their respective signals alternately           |
|               | CH3 & CH4           | CH3 and CH4 trigger their respective signals alternately           |



Table 2-11 Pulse width Trigger

| Function Menu | Setup          | Explanatory Note   |
|---------------|----------------|--|
| Mode          | Auto           | The system automatically acquires waveform data when there is no trigger signal. The scan baseline is shown on the display. When the trigger signal is generated, it automatically turns to trigger scan |
|               | Normal         | The system stops acquiring data when there is no trigger signal. When the trigger signal is generated, trigger scan occurs   |
|               | Single         | One trigger will occur when there is an input trigger signal. Then trigger will stop   |
| Pulse setup   | See Table 2-12 | Set the pulse width  |

Table 2-12 Pulse setup

| Function Menu | Setup    | Explanatory Note  |
|---------------|----------|---|
| Type          | Pulse    |   |
| Polarity      | Positive | Set the positive pulse width as the trigger signal                                    |
|               | Negative | Set the negative pulse width as the trigger signal                                    |
| When          | <        | Trigger occurs when pulse width of the input signal is smaller than the setting value |
|               | >        | Trigger occurs when pulse width of the input signal is larger than the setting value  |
|               | =        | Trigger occurs when pulse width of the input signal equals to the setting value       |

Table 2-12 Pulse width setup

| Function Menu | Setup       | Explanatory Note  |
|---------------|-------------|---|
| Type          | Pulse width |   |
| Setting       |             | Set pulse width trigger to 20.0ns-10s with the <b>MULTIPURPOSE</b> control knob |
| Back          | ----        | Return to the pulse width trigger menu  |

## Video Trigger

By selecting video trigger, you can carry out field or line trigger with NTSC or PAL standard video signals.

See Table 2-13 for the trigger menu :

Table 2-13 Video trigger

| Function Menu | Setup  | Explanatory Note  |
|---------------|--|---|
| Type          | Video  |   |
| Source        | CH1, CH2, CH3, CH4<br>EXT, EXT/5<br>LINE<br>CH1 & CH2<br>CH1 & CH3<br>CH1 & CH4<br>CH2 & CH3<br>CH2 & CH4<br>CH3 & CH4 | Set CH1, CH2, CH3 or CH4 as the signal source trigger signal<br>Set to external trigger or divide the external trigger source by 5<br>Set to AC power trigger<br>CH1 and CH2 trigger their respective signals alternately<br>CH1 and CH3 trigger their respective signals alternately<br>CH1 and CH4 trigger their respective signals alternately<br>CH2 and CH3 trigger their respective signals alternately<br>CH2 and CH4 trigger their respective signals alternately<br>CH3 and CH4 trigger their respective signals alternately |
| Video setup   | See Table 2-14   | Enter the video setup   |

Table 2-14 Video Setup

| Function Menu | Setup  | Explanatory Note   |
|---------------|--|--|
| Standard      | PAL<br>NTSC                                      | Suitable for PAL video signals<br>Suitable for NTSC video signals  |
| Sync          | Odd Field<br>Even Field<br>All lines<br>Line Num | Set the video odd field to synchronized trigger<br>Set the video even field to synchronized trigger<br>Set the line signal to synchronize with trigger<br>Set synchronized trigger on the specified line and adjust by turning the <b>MULTIPURPOSE</b> control knob : 625 lines for PAL ; 525 lines for NTSC |
| Back          |  | Return to video trigger menu   |

When PAL is selected for video and synchronization mode is line, you will see a screen display as shown in Figure 2-16. When synchronization mode is field, you will see a screen display as shown in Figure 2-17.



Figure 2-16 Video trigger : Line synchronization

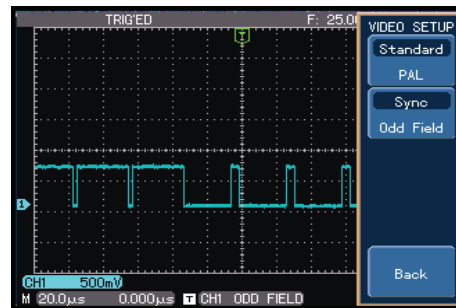


Figure 2-17 Video trigger : Field synchronization

## Slope trigger

If slope trigger is selected, trigger occurs when the signal's rising or falling rate meets the set condition. For the trigger menu see Table 2-15 below.

Table 2-15 Slope trigger

| Function Menu | Setup  | Explanatory Note  |
|---------------|--|---|
| Type          | Slew rate  |   |
| Source        | CH1, CH2, CH3, CH4<br>EXT, EXT/5<br>LINE<br>CH1 & CH2<br>CH1 & CH3<br>CH1 & CH4<br>CH2 & CH3<br>CH2 & CH4<br>CH3 & CH4 | Set CH1, CH2, CH3 or CH4 as the signal source trigger signal<br>Set to external trigger or divide the external trigger source by 5<br>Set to AC power trigger<br>CH1 and CH2 trigger their respective signals alternately<br>CH1 and CH3 trigger their respective signals alternately<br>CH1 and CH4 trigger their respective signals alternately<br>CH2 and CH3 trigger their respective signals alternately<br>CH2 and CH4 trigger their respective signals alternately<br>CH3 and CH4 trigger their respective signals alternately |
| Coupling      | DC<br>AC<br>L/F Reject<br>H/F Reject   | Allow AC and DC quantities of the input signal to pass<br>Intercept DC quantities of the input signal<br>Reject low frequency quantities below 80kHz of the signal<br>Reject high frequency quantities above 80kHz of the signal  |
| Mode          | Auto<br><br>Normal<br><br>Single   | The system automatically acquires waveform data when there is no trigger signal. The scan baseline is shown on the display. When the trigger signal is generated, it automatically turns to trigger scan<br>The system stops acquiring data when there is no trigger signal. When the trigger signal is generated, trigger scan occurs<br>One trigger will occur when there is an input trigger signal. Then trigger will stop  |
| Slope Setup   | See Table 2-16   | Enter slope setup   |

Table 2-16 Slew rate setup

| Function Menu | Setup                     | Explanatory Note  |
|---------------|---------------------------|---|
| Polarity      | Rise<br>Fall              | Select the rising edge within the threshold for trigger<br>Select the falling edge within the threshold for trigger   |
| When          | <<br>><br>=               | Trigger occurs when the signal slew rate within the threshold is greater than the set slew rate<br>Trigger occurs when the signal slew rate within the threshold is smaller than the set slew rate<br>Trigger occurs when the signal slew rate within the threshold equals to the set slew rate |
| Slew rate     |                           | Set the slew rate value with the <b>MULTIPURPOSE</b> control knob   |
| Threshold     | Low<br>High<br>High & Low | Change the low level value with the <b>MULTIPURPOSE</b> control knob<br>Change the high level value with the <b>MULTIPURPOSE</b> control knob<br>Change the high and low level value with the <b>MULTIPURPOSE</b> control knob  |
| Back          |                           | Return to the slew rate trigger menu  |

#### Alternate Trigger

When alternate trigger is selected, the trigger signal will be present in two vertical channels. This triggering mode is suitable for observing two signals of unrelated signal frequencies. Alternate trigger can also be used to compare pulse widths.

### Adjusting the Holdoff Time

You can adjust the holdoff time to observe complicated waveforms (e.g. pulse string series). Holdoff time means the waiting time for the trigger circuit to be ready for use again when the oscilloscope is restarted. During this time the oscilloscope will not trigger until the holdoff is complete. For example, if you wish to trigger one group of pulse series at the first pulse, set the holdoff time to the pulse string width as shown in Figure 2-18.

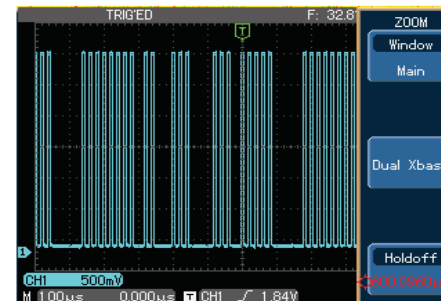


Figure 2-18 Use the holdoff function to synchronize complicated signals

Table 2-17 Trigger holdoff menu

| Function Menu | Setup               | Explanatory Note  |
|---------------|---------------------|---|
| Window        | ----                | Press [F1] to switch between the “Main” and “Extended”.           |
|               |                     |   |
| Dual Xbase    |                     | Enter the dual time base menu. See Table 2-9                      |
|               |                     |   |
| Holdoff       | 96.0000ns~ 1.50000s | Use the <b>MULTIPURPOSE</b> control knob to adjust holdoff time . |

### Operation

1. Follow the normal signal synchronization procedure and select the edge and trigger source in trigger **[MENU]**. Adjust the trigger level to make the waveform display as stable as possible.
2. Press the horizontal **[MENU]** key to display the horizontal menu.
3. Adjust the **MULTIPURPOSE** control knob in the upper front panel. The holdoff time will change accordingly until the waveform display is stable.

**Operation tip** : Holdoff time is usually slightly shorter than the "Large cycle". When observing a RS-232 communication signal waveform, it is easier to observe if holdoff time is slightly longer than the starting edge time of every data frame.

### Definitions

1. **Trigger source** : The signal used for trigger. The signal for trigger can be obtained from various sources : input channel (CH1, CH2, CH3, CH4), external trigger (EXT, EXT/5) and LINE, etc.
  - **Input Channel** : The most common trigger source is to select one of the four input channels. The channel selected as trigger source can operate normally whether the input waveform is displayed or not.
  - **External Trigger** : This trigger signal can be input directly through the external trigger input terminal. For example, you can use an external clock or the signal from a circuit to be tested as the trigger source. The **EXT** trigger source uses the **EXT TRIG** input terminal to access external trigger signals. **EXT** setup is enabled when signal trigger level range is  $-0.8\text{V}$  to  $+0.8\text{V}$ . To allow input of larger signal through external trigger, the trigger signal is divided by 5 in the EXT/5 mode, so that the trigger level range is extended to  $-4\text{V}$  to  $+4\text{V}$ .



- **LINE** : means the AC power source. This trigger mode is suitable for observing signals related to the AC power e.g. the correlation between lighting equipment and power source equipment to achieve stable synchronization.
  - 2. **Trigger mode** : Determine the action of your oscilloscope at trigger. This oscilloscope offers three trigger modes for selection : auto, normal and single.
    - **Auto Trigger** : The system will acquire and display waveform data automatically when there is no trigger signal input. When the trigger signal is generated, it automatically turns to trigger scan for signal synchronization.
- \***Note** : Time base of the scan range can be set to 50ms/div or slower to generate a roll waveform.
- **Normal Trigger** : In this mode, your oscilloscope samples waveforms only when triggering conditions are met. The system stops acquiring data and waits when there is no trigger signal. When the trigger signal is generated, trigger scan occurs.
  - **Single Trigger** : In this mode, you only have to press the [RUN] button once and the oscilloscope will wait for trigger. One sampling will occur and the acquired waveform will be displayed when the digital storage oscilloscope detects a trigger. Then trigger will stop.
  - 3. **Trigger coupling** : Trigger coupling determines which quantities of the signal are transmitted to the trigger circuit. Coupling modes are DC, AC, low frequency suppression and high frequency suppression.
    - **DC** :Allowing all quantities to pass .
    - **AC** :Intercepting DC quantities and attenuating signals under 10Hz .
    - **LF Reject**:Intercepting DC quantities and attenuating low frequency quantities under 80kHz .
    - **HF Reject**:Attenuating high frequency quantities over 80kHz .

4. **Pretrigger/Delayed Trigger** : Data sampled before/after triggering.

The trigger position is typically set at the horizontal center of the screen. In this case, you are able to view 6 divisions of pretrigger and delay information. Adjusting the horizontal displacement of the waveform with the **POSITION** knob allows you to see more pretrigger information. By observing pretrigger data, you can see the waveform before trigger occurs. For example, you can detect the glitch that occurs when the circuitry starts. Observation and analysis of trigger data can help you identify the cause of glitch.

### Setting the Sampling System

As shown below, [ACQUIRE] button in the control zone is the function key for the sampling system.



Figure 2-19 Function key for the sampling

Press the [ACQUIRE] key to pop out the sampling setup menu. You can use this menu to adjust the sampling mode.

Table 2-18 Sampling menu

| Function Menu                                 | Setup                                    | Explanatory Note  |
|---|--|---|
| Acquisition                                   | Normal<br>Peak<br>Average<br><br>Envelop | Ordinary sampling mode<br>Peak detect mode<br>Set to average sampling with display of the average number of times<br>Envelop sampling   |
| Average number of times (In the Average mode) | 2~256                                    | Set the average number of times in multiples of 2, i.e. 2, 4, 8, 16, 32, 64, 128, 256. To change the average number of times, use the <b>MULTIPURPOSE</b> control knob shown on the left in Figure 2-19 |
| Equivalent                                    | ON/OFF                                   | Turn the equivalent sampling mode on or off. In this mode, selecting alternate trigger (e.g. CH1 and CH2) as the trigger source is disallowed   |
| ----  |  |   |

By changing the acquisition setup, you can observe the consequent changes in waveform display. If the signal contains considerable noise, you will see the following displays when average sampling is not selected and when 32-time average sampling is selected. For sampling waveform display please see Figure 2-20 and Figure 2-21.

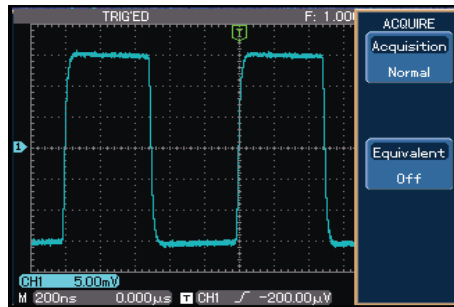


Figure 2-20 Waveform without average

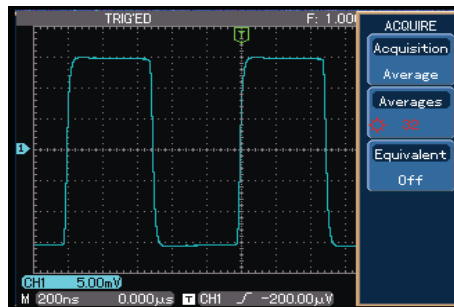


Figure 2-21 Waveform when 32-time

### Notes :

1. Use Real time sampling to observe single signals.
2. Use Equivalent sampling to observe high frequency cyclical signals.
3. To avoid mixed envelop when observing a signal, select Peak Detect. To reduce random noise of the displayed signal, select average sampling and increase the average number of times in multiples of 2, i.e selecting from 2 to 256.

**Definitions :**

**Real time sampling:** Acquiring the data required in one go. Maximum sampling rate is 2GS/s.

**Equivalent sampling:** This is a repeated sampling mode that allows detailed observation of repeated cyclical signals. In the equivalent sampling mode, the horizontal pixel aspect ratio is 20ps higher than the real time mode, i.e. 50GS/s equivalent.

**Normal mode:** Your oscilloscope acquires signal samples at equal time intervals to reconstruct waveform.

**Peak detect mode:** In this acquisition mode, the oscilloscope identifies the biggest and smallest values of the input signals at each sampling interval and use these values to display the waveform. In effect, the oscilloscope can acquire and display narrow pulse which would otherwise be omitted in the sampling mode. Noise seems to be more significant in this mode.

**Average mode :** The oscilloscope acquires several waveforms and take the average value to display the final waveform. You can use this mode to reduce random noise.

**Envelop Mode :** The oscilloscope acquires multi-amplitude waveforms and calculate all sampling points that synchronize with the triggering point. The maximum and minimum values are then displayed.

## Setting the Display System

As shown below, the **[DISPLAY]** key in the control zone is the function key for the display system.

Press the **[DISPLAY]** button to pop out the setup menu shown below. You can use this menu to adjust the display mode.



Figure 2-22 Function key for the sampling

Table 2-19 Display menu

| Function Menu | Setup             | Explanatory Note   |
|---------------|-------------------|--|
| Format        | YT<br>XY          | Voltage relative to time (horizontal gratitude) is displayed<br>There are two groups in X-Y display mode. The first group is CH1 for X input and CH2 for Y input. The second group is CH3 for X input and CH4 for Y input. |
| Type          | Vectors<br>Points | Sampling points are linked for display<br>Sampling points are directly displayed   |

Table 2-19 Display menu

| Function Menu | Setup                               | Explanatory Note   |
|---------------|-------------------------------------|--|
| gratitude     | Full<br>Grid<br>Cross Hair<br>Frame | Set the grid display mode of the waveform zone to full, grid, Cross Hair or frame  |
| Persist       | Auto<br>1s<br>2s<br>5s<br>Infinite  | Waveform on the screen is refreshed at normal rate<br>Waveform on the screen is maintained for 1 second and then refreshed<br>Waveform on the screen is maintained for 2 seconds and then refreshed<br>Waveform on the screen is maintained for 5 seconds and then refreshed<br>Waveform on the screen remains on display. New data will be added continuously until this function is disabled |
| Intensity     | 1~32                                | In “Fast ACQ” mode, intensity of the waveform can be adjusted with the <b>MULTIPURPOSE</b> control knob  |

## X-Y Mode

This mode offers two separate displays. The first group is CH1 and CH2, i.e. CH1 signal input on the horizontal axis (X axis) and CH2 signal input on the vertical axis (Y axis). The other group is CH3 and CH4, i.e. CH3 signal input on the horizontal axis (X axis) and CH4 signal input on the vertical axis (Y axis), as shown in Figure 2-23.

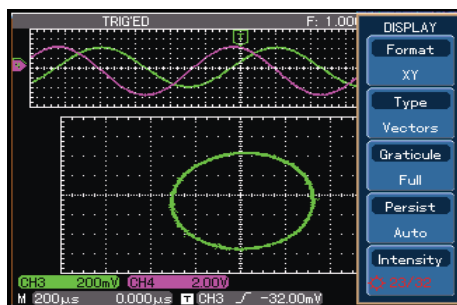


Figure 2-23 Waveform display in X-Y

## Caution :

In the normal **X-Y** mode, you can move **XY** figures horizontally with the CH1 or CH3 **POSITION** knob, and move **XY** figures vertically with the CH2 or CH4 **POSITION** knob. Adjust the dimension and shape of XY figures with **VOLTS/DIV** of the four channels, and turn the **SEC/DIV** knob to improve the display quality of the lissajous figure.

Thanks to the unique **X-Y** display feature, your oscilloscope can display channel waveform and lissajous figure concurrently. The Tenma DSO Four-channel also offers the following functions :

- Automatic measurement mode
- Cursor measurement mode
- Reference or math waveform

The following functions are disabled under X-Y mode:

- Dual time base
- Horizontal **POSITION** knob



### Key points :

**Display Type** : Vector display fills the space between adjacent sampling points in display. The dot mode displays only the sampling points.

**Refresh Rate** : Refresh rate is the number of times the digital storage oscilloscope refreshes the waveform display per second. The refreshing speed affects the capability to observe signal movements speedily.

### Storage and Recall

As shown below, the [**STORAGE**] button in the control zone is the function key for the storage system.



Figure 2-24 Function key for the sampling system (storage)

Press the [**STORAGE**] button to display the storage setup menu. You can use this menu to save waveforms or setup status of the oscilloscope in the internal memory or the USB device, and recall any stored waveform through RefA (or RefB), or press [**STORAGE**] to recall the setup status. When the USB device is inserted, you can store the oscilloscope's waveform display in bitmap format on the USB device.

## Instructions :

Press [**STORAGE**] to go to the type menu. There are three types to choose from : Setting, Wave, Bitmap.

1. Select Wave to go to the waveform storage menu shown below (see Table 2-20). A stored reference waveform can be recalled with the REF menu (reference waveform, P 32). For specific steps see the REF instructions.

Table 2-20 Storage Menu

| Function Menu | Setup                    | Explanatory Note  |
|---------------|--------------------------|---|
| Type          | Wave                     | Select a signal source waveform displayed on the screen   |
| Source        | CH1<br>CH2<br>CH3<br>CH4 | Select waveform from CH1<br>Select waveform from CH2<br>Select waveform from CH3<br>Select waveform from CH4  |
| Save          | 1~10                     | To save the reference waveform on the internal memory of the oscilloscope, turn the <b>MULTIPURPOSE</b> control knob to select the storage position and press the <b>MULTIPURPOSE</b> control knob to confirm |
|               | ----                     |   |
| Export        | See Table 2-21           | Go to the USB menu  |

## Note :

About “Internal” and “CSV” formats : When exporting a “reference waveform” to the USB device, you can select internal or CSV. “Internal” waveforms can only be imported to the oscilloscope in REF mode and cannot be displayed on any other interface. “CSV” waveforms can be opened in EXCEL on a PC. It is a group of voltage and time correlation 2D data.

Table 2-21 USB menu

| Function Menu | Setup         | Explanatory Note  |
|---------------|---------------|---|
| Filename      |               | Set the document name to be imported from the USB device with the <b>MULTIPURPOSE</b> control knob and [ <b>F1</b> ] key. For specific steps see note 2 (P34)                     |
| Format        | CSV, Internal | See note  |
| OK            | ----          | After confirming, go back to the reference waveform storage menu. If there is a USB drive it will be exported to the USB, otherwise the prompt “I/O operation failed” will appear |

2. Select setup to enter the save setting menu.

See Table 2-22.

Table 2-22 Save setup menu

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| Type          | Setup | Save the current front panel setup status  |
| Save          | 1~10  | To save on the internal memory of the oscilloscope, select a save position with the <b>MULTIPURPOSE</b> control knob and press the <b>MULTIPURPOSE</b> control knob to confirm |

Table 2-22 Save setup menu

| Function Menu | Setup          | Explanatory Note  |
|---------------|----------------|---|
| Load          | 1~10           | Recall 10 internal save positions and select one of them with the <b>MULTIPURPOSE</b> control knob. Press the <b>MULTIPURPOSE</b> control knob to confirm |
| Import        | See Table 2-23 | Enter the USB menu  |
| Export        | See Table 2-23 | Enter the USB menu  |

Table 2-23 USB menu

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| Filename      |       | Enter the document name to be imported from the USB device with the <b>MULTIPURPOSE</b> control knob and [F1] key. For specific steps see note 2 (P46)   |
|               |       |  |
|               |       |  |
| OK            | ----  | After confirming, go back to the save setup menu. If there is a USB drive it will be exported to the USB, otherwise the prompt "I/O failure" will appear (when exporting a waveform)<br>After confirming, go back to the save setup menu. If the document exists on the USB it will be imported, otherwise the prompt "I/O operation failed" will appear (when importing a waveform) |

3. Select bitmap to enter the bitmap export menu.

See Table 2-24.

**Note** : A bitmap can only be exported to a USB device.

Table 2-24 Bitmap export menu

| Function Menu | Setup          | Explanatory Note  |
|---------------|----------------|---|
| Bitmap        |                | Export the display waveform to the USB device in bmp format |
| ----          |                |   |
| Export        | See Table 2-25 | Enter the USB menu  |
| ----          |                |   |
| ----          |                |   |

Table 2-25 USB menu

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| Filename      |       | Enter the document name to be imported from the USB device with the <b>MULTIPURPOSE</b> control knob and [F1] key. For specific steps see note 2 (P46). Default is TENMA0000.bmp |
|               |       |  |
|               |       |  |
| OK            |       | After confirming, go back to the save setup menu. If there is a USB drive it will be exported to the USB, otherwise the prompt "I/O operation failed" will appear                |

## Utility Function Setup

As shown below, the [UTILITY] key in the control zone is the function key for utility functions.



Figure 2-25 Function key for the sampling system (function)

Press the [UTILITY] key to pop out the setup menu for utility functions.

Table 2-26 Utility menu ( 1 )

| Function Menu | Setup                                       | Explanatory Note   |
|---------------|---|--|
| Configure     | Self Cal<br>Version                         | Run auto system calibration<br>Display information like oscilloscope model, version and serial number  |
|               | Erase<br>RTC Setup<br>Next 2/2              | Clear all saved reference waveforms and setups<br>Enter date and time setup. See Table 2-29  |
|               | Default Set<br>Auto setup<br>Pre1/2<br>Back | Restore factory setup. See Appendix D<br>Set the auto function. See Table 2-30<br>Return to the Utility menu   |
|               | Language                                    | Select your desired languages with the <b>MULTIPURPOSE</b> control knob and then press the <b>MULTIPURPOSE</b> control knob to confirm                 |
| Preference    | Skin<br>Menu Display                        | Classical, Traditional, Modern<br>Set the waiting time for automatic menu shutoff 5s, 10s, 20s and manual. Manual means automatic shutoff is disabled. |
|               | Brightness                                  | Press [ <b>MENU ON/OFF</b> ] to turn it on or off<br>Adjust the brightness of the display grid with the <b>MULTIPURPOSE</b> control knob               |
|               | Back  | Return to the Utility menu   |
| ----          |   |  |
| Record        | See Table 2-28                              | Set waveform recording operation   |
| Next 2/2      | Setup                                       | Go to the next page  |

Table 2-27 Utility menu (2)

| Function Menu | Setup  | Explanatory Note   |
|---------------|--------|--|
| Cymometer     | ON/OFF | Displayed at the top right corner of the screen when turned on.<br>See note  |
| Interface     |        | Set GPIB and LAN for communication. Applicable for optional accessory UT-M06 |
| ----          |        |  |
| ----          |        |  |
| Pre 2/2       |        | Return to the previous page<br>Go to the next page                           |

**Note :**

The Cymometer counts the frequency of trigger events of the trigger channel. It works on edge or pulse trigger but not alternate trigger. The Cymometer is also disabled for video trigger.



Table 2-28 Waveform record menu

| Function Menu | Setup | Explanatory Note  |
|---------------|-------|---|
| ■F(1)         |       | Stop recording  |
| ▶F(2)         |       | Playback button<br>1. When you press this button the system plays back and displays the number of screens to be played back. By turning the <u>MULTIPURPOSE</u> control knob, you can suspend playback. Turn the knob to select display of waveforms in random screen numbering<br>2. If you wish to continue full playback, press [F1] to stop and then press [F2] |
| ●F(3)         |       | Record button. Press this button then the [MENU ON/OFF] key to record. The number of screens recorded is displayed. You can record up to 100 screens of data. Recorded data will be lost when the oscilloscope is powered off. This function is disabled in dual time base, roll, average and envelop modes.  |

Table 2-29 RTC setup (Real Time Clock)

| Function Menu | Setup  | Explanatory Note   |
|---------------|--------|--|
| Display       | On/Off | Turn on the time display. Time display is disabled when the frequency counter is in use    |
| Min&Hour      |        | Press [F2] to select minute or hour, then adjust with the <b>MULTIPURPOSE</b> control knob |
| Day&Mon       |        | Press [F3] to select date or month, then adjust with the <b>MULTIPURPOSE</b> control knob  |
| Year          |        | Press [F4] to select and adjust with the <b>MULTIPURPOSE</b> control knob                  |
| OK            |        | Confirm your setting and return to the Utility menu  |

Table 2-30 Auto setup menu

| Function Menu | Setup         | Explanatory Note  |
|---------------|---------------|---|
| Channel       | Locked/Unlock | In the unlock mode, default status is restored. The default status is as follows :<br>Bandwidth limit : full bandwidth; VOLTS/DIV: coarse tune; Inversion: Off                        |
| Acq set       | Locked/Unlock | In the unlock mode, default status is restored. The default status is as follows :<br>Sampling mode : normal sampling; equivalent sampling : Off                                      |
| Trigger       | Locked/Unlock | In the unlock mode, default status is restored. The default status is as follows :<br>Type : edge; signal source: adjusted, see note; trigger coupling: DC;<br>slew rate type: rising |
| Signal        | Locked/Unlock | Unlock : Channel is open/closed depending on the presence of input signal<br>Locked : Channel is maintained open or closed  |
| Back          |               | Return to the Utility menu  |

**Unlock** : In Auto mode the setup will go back to default for auto setup.

**Locked** : In Auto mode the current status is locked for auto setup.

For unlock or locked status see the table below 2-30.

**Notes :**

The adjustment basis for the trigger signal source in Auto mode :

1. If there is input signal in only one channel, that channel will be the trigger source.
2. When more than one channels have input signal, the system will search for trigger signal from CH1. The first channel where signal is detected will be the trigger source.
3. If no signal is detected in any channel, CH1 will be the trigger source.

**Important Points :**

**Auto Calibration** : You can correct measurement errors caused by environmental changes with the auto calibration function. This process can be run selectively when necessary. To make calibration more accurate, power on your oscilloscope and allow 20 minutes to warm up. Then press the [UTILITY] button (help function) and follow on-screen instructions.

## Automatic Measurement

As shown below, the **[MEASURE]** key is the function key for auto measurement. Read the following instructions to familiarize with all the powerful automatic measurement functions of your Tenma DSO Four-channel digital storage oscilloscope.



Figure 2-26 Function key for the sampling system (auto measurement)

## Measurement menu

Operation : Press **[MEASURE]** to display 4 function options, as shown in Table 2-31 .

Table 2-31 Measurement menu (1)

| Function Menu | Setup | Explanatory Note   |
|---------------|-------|--|
| All           |       | Display all parameters. To quit all parameters press any key or knob   |
| Custom        |       | Press <b>[F2]</b> then use the <b>MULTIPURPOSE</b> control knob to select the desired parameter. Press the <b>MULTIPURPOSE</b> control knob to confirm. Up to 4 parameters can be displayed on screen simultaneously, i.e. parameter 1 to parameter 4 from left to right |
| Indicators    |       | Visual indication of the measurement value 's physical properties by lines. Turn on the indicator and select between parameters 1 and 4  |
| Clear         |       | Clear all customized parameters  |
| Next 2/2      |       | Enter the next page  |

Table 2-32 Measurement menu (2)

| Function Menu | Setup       | Explanatory Note   |
|---------------|-------------|--|
| ADV           | Delay Phase | The rising edge or falling edge time interval of a random channel waveform. See Table 2-33 |
| ----          |             |  |
| ----          |             |  |
| ----          |             |  |
| Pre 2/2       |             | Confirm your setting and return to the Utility menu  |

Table 2-33 Delay menu

| Function Menu | Setup              | Explanatory Note  |
|---------------|--------------------|---|
| From          | CH1, CH2, CH3, CH4 | Select one channel waveform as the delayed reference waveform   |
| From edge     | Rise, fall         | Take the centre point of 10%-90% of the waveform rising or falling edge   |
| To            | CH1, CH2, CH3, CH4 | Select one channel waveform as the delayed measurement waveform   |
| To edge       | Rise, falle        | Take the centre point of 10%-90% of the waveform rising or falling edge   |
| OK            |                    | Selection of the measurement point of delayed measurement waveform is complete . Return to the measurement menu |

### Note:

Customised parameters are for quick parameter measurement. The measurement menu of your oscilloscope is capable of measuring 26 waveform parameters. Two of them (delay and phase for advance measurement) are generally used when you do not require to measure all parameters but only a few. You can set these as customized parameters. Customized parameters are displayed on the screen.



Figure 2-27 Measurement parameters

### Automatic measurement of voltage parameters

Your Tenma DSO Four-channel Oscilloscope can automatically measure the following voltage parameters:

Peak-to-peak value (Vpp) : The voltage value from the highest point to lowest point of the waveform.

Maximum value (Vmax) : The voltage value from the highest point to ground (GND) of the waveform.

Minimum value (Vmin) : The voltage value from the lowest point to ground (GND) of the waveform.

Amplitude value (Vamp) : The voltage value from top to base of the waveform.

Mean (Vmid) : Half of the amplitude value.

Top value (Vtop) : The voltage value from the level top to ground (GND) of the waveform.

Base value (Vbase) : The voltage value from the level base to ground (GND) of the waveform.

Overshoot : The ratio value of the difference between maximum value and top value to the amplitude value.

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**Preshoot** : The ratio value of the difference between minimum value and base value to the amplitude value.

**Average** : Average amplitude of signals within 1 cycle.

**Root mean square value (Vrms)** : The effective value. Energy generated by AC signal conversion during 1 cycle with respect to the DC voltage that produces equivalent energy, i.e. root mean square value.

### **Automatic measurement of time parameters**

Your Tenma DSO Four-channel Oscilloscope can automatically measure the frequency, cycle, rising time, falling time, positive pulse width, negative pulse width, delay, positive duty ratio, negative duty ratio and 9 time parameters. Definitions of these parameters are as follows :

**RiseTime** : The time taken by the waveform amplitude to rise from 10% to 90%.

**FallTime** : The time taken by the waveform amplitude to fall from 90% to 10%.

**Positive Pulse Width (+Width)** : The pulse width when positive pulse is at 50% amplitude.

**Negative Pulse Width (-Width)** : The pulse width when negative pulse is at 50% amplitude.

**Delay (Rising or falling edge)** : Delayed time from waveform to waveform (during advance measurement).

**Positive duty ratio (+Duty)** : Ratio of positive pulse width to cycle.

**Negative duty ratio (-Duty)** : Ratio of negative pulse width to cycle.

### Cursor Measurement

Press [CURSOR] to display the measurement cursor and cursor menu, then adjust the cursor position by turning the **MULTIPURPOSE** control knob. As shown in the figure below, [CURSOR] in the control zone is the function key for cursor measurement.

You can move the cursor to carry out measurement in the [CURSOR] mode. There are two modes to choose from : voltage and time. When measuring voltage, select voltage for type and adjust the positions of the two cursors with the **MULTIPURPOSE** control knob to measure V. Likewise, by selecting time, you can measure T. The [CURSOR] menu has two other modes : independent and tracking. In the independent mode, you can adjust the positions of the two cursors independently. In the tracking mode, you press the **MULTIPURPOSE** control knob to move two cursors simultaneously.



Figure 2-27 Function key for the sampling system (cursor)

#### Notes :

1. In the independent or tracking mode, select one of the cursors with the **MULTIPURPOSE** control knob. The selected cursor is a solid line. Adjust its position with the **MULTIPURPOSE** control knob.
2. There are two percentage options. The current status is 100%. The value between the two cursors is set to 100%, i.e. one cursor is 0% and the other is 100%. When 100% is set to 6 DIV, the  $\pm 3\text{DIV}$  area on the screen is 100%.
3. When the cursor function is enabled, measurement value is automatically displayed in the top left corner. @ is the selected cursor value.



Table 2-34 Time cursor measurement menu

| Function Menu | Setup       | Explanatory Note  |
|---------------|-------------|---|
| Type          | Time        | Measure time with the cursor                                |
| Mode          | Independent | Move any one of the two cursors                             |
|               | Tracking    | Move two cursors simultaneously without changing $\Delta T$ |
| V Units       | Second      | Select time as the measurement parameter                    |
|               | Hertz       | Select frequency as the measurement parameter               |
|               | Percent     | Select percent as the measurement parameter                 |
|               | Degree      | Select degree as the measurement parameter                  |
|               |             |   |

Table 2-35 Voltage cursor measurement menu

| Function Menu | Setup       | Explanatory Note  |
|---------------|-------------|---|
| Type          | Amplitude   | Measure voltage with the cursor                             |
| Mode          | Independent | Move any one of the two cursors                             |
|               | Tracking    | Move two cursors simultaneously without changing $\Delta V$ |
| H Units       | Base        | Select voltage as the measurement parameter                 |
|               | Percent     | Select percent as the measurement parameter                 |

### Using the Run Button

There is a button on the top right corner on the front panel : **[RUN/STOP]**. When this button is pressed and a green indicator lights up, your oscilloscope is in a running status. If a red light comes on after pressing this key, it indicates the unit has stopped operation.



Figure 2-28 RUN/STOP key

### RUN/STOP :

Acquire waveform continuously or stop acquisition.

If you want the oscilloscope to acquire waveform continuously, press **[RUN/STOP]** once. Press the button again to stop acquisition. You can use this button to switch between acquiring and stop acquiring waveform. In the Run mode, a green light comes on and AUTO appears on the screen. In the STOP mode, a red light comes on and STOP appears on the screen.

**Auto Setup :**

As shown above, Auto Setup can simplify operation. Press **[AUTO]** and the oscilloscope can automatically adjust the vertical gratitude factor and horizontal time

base range according to the amplitude and frequency of the waveform, and ensure stable display of the waveform. When the oscilloscope is in auto setup mode, the system setup is as follows :

Table 2-36 Auto setup

| Function Menu       | Setup   |
|---------------------|---|
| Acquire             | Normal  |
| Display format      | YT  |
| Horizontal position | Automatically adjusted                                      |
| SEC/DIV             | Adjust according to signal frequency                        |
| Trigger coupling    | DC  |
| Holdoff             | Minimum value   |
| Trigger level       | Set at 50%  |
| Trigger mode        | Auto  |
| Trigger source      | Automatically adjusted. See notes to Table 2-30 for details |
| Trigger slope       | Rising  |
| Trigger type        | Edge  |
| BW Limit            | Full  |
| VOLT/DIV            | Adjust according to amplitude of the signal                 |

### Menu Display ON/OFF :

To display or hide the current menu

With the “menu ON/OFF” key, you can display or hide the menu currently on screen, but help messages are not displayed.

### Multimeter Measurement

Operation instructions : Open the multimeter function menu by pressing the [DMM] (Digital Multimeter) button.

#### Notes :

If it is necessary to test electric current, follow these steps :

Insert the current/voltage converter module that comes with the oscilloscope into the digital multimeter port, and move the switch of the current/voltage converter so that it is consistent with the selected DMM current. Proceed with testing.

#### Cautions :

1. Please select a suitable current/voltage converter module that fits the measurement range, and

select an appropriate range. If you are not certain about the current being tested, make an estimation, use the which has the largest range, then select a suitable module range to suit the data.

2. The current-voltage converter module of the multimeter cannot be used to measure AC current.
3. When measuring large current with the module, to ensure precision, carry out power on measurement every 15 minutes. Do not power on for more than 15 seconds each time .

### Help System

The oscilloscope has a Help system with topics that cover all the features of the oscilloscope. The oscilloscope displays information about the last menu displayed on the screen when you push the HELP .Information about specific menus and controls, such as the **Vertical Position Control**.

**Note:** Push [ **HELP** ] button to display or exit help information .

Table 2-37 DMM Menu

| Function Menu | Setup      | Explanatory Note  |
|---------------|------------|---|
| Funtion       | ON/OFF     | DMM functions on/off  |
| Mode          | Voltage    | Activate the voltage measurement function. Maximum measurement value for DC voltage is 400V. Maximum measurement value for AC voltage is 400V |
|               | Resistance | Activate the resistance measurement function. Maximum measurement value for resistance is 40MΩ  |
|               | ON/OFF     | Activate the on/off measurement function. When on/off measuring is lower than 70, the beeper will sound                                       |
|               | Diode      | Activate the diode measurement function. Connect the positive pole to the red test lead, and the negative pole to the black test lead         |
|               | DC current | Current range : 4mA, 40mA, 400mA, 4A  |
| Win shift     |            | Set the horizontal shift or vertical shift of the window with the <b>MULTIPURPOSE</b> control knob  |

## Chapter 3 Practical Example Illustrations

### Illustration 1 : Measuring simple signals

To observe and measure an unknown signal, and to quickly display and measure the signal's frequency and peak-to-peak value.

#### 1. To quickly display this signal, follow the steps below :

- ① In the probe menu, set the attenuation factor to 10X and set the switch on the probe to 10X.
- ② Connect the CH3 probe to the circuitry point to be measured.
- ③ Press **[AUTO]**.  
The oscilloscope will carry out auto setup to optimise waveform display. In this status, you can further adjust the vertical and horizontal range until you get the desired waveform display.

#### 2. Voltage and time parameters for automatic measurement

Your oscilloscope can automatically measure most display signals. To measure signal frequency and peak-to-peak value, follow the steps below :

- ① Press **[MEASURE]** to display the automatic measurement menu.
- ② Press **[F2]** to enter the measurement type selection menu.
- ③ Use the **MULTIPURPOSE** control knob to select peak-to-peak value, then press it down to confirm. Next use the **MULTIPURPOSE** control knob to select frequency then press it down to confirm.
- ④ Press **[MENU ON/OFF]** to exit the selection menu.

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Peak-to-peak and frequency measurements will now appear at the bottom of the screen, as shown in Figure 3-1.

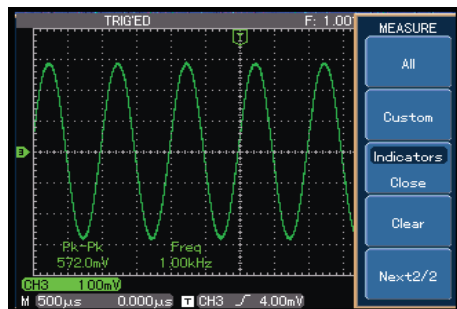


Figure 3-1 Automatic measurement

### Illustration 2 : Observing the delay caused by a sine wave signal passes through the circuit

As in the previous scenario, set the probe attenuation factor of the probe and oscilloscope channel to 10X. Connect the CH1 to the circuit signal input terminal. Connect CH2 to the output terminal.

#### Steps :

##### 1. To display CH1 and CH2 signals :

- ① Press [AUTO].
- ② Continue to adjust the horizontal and vertical range until you get the desired waveform display.
- ③ Press [CH1] to select CH1. Adjust vertical position of the CH1 waveform by turning the vertical position control knob.
- ④ Press [CH2] to select CH2. In the same way described above, adjust vertical position of the CH2 waveform so that the waveforms of CH1 and CH2 do not overlap. This will make observation easier.

**2. Observing the delay caused by a sine wave signal passes through the circuit and observing waveform changes.**

- ① When measuring channel delay automatically : Press [MEASURE] to display the automatic measurement menu. Press [F5] to enter next measurement menu. Press [F1] for advance measurement, then [F1] for delayed measurement.
- ② In the delayed measurement menu, set measurement from CH1, i.e. from waveform edge "rising", to Ch2, i.e. to waveform edge "rising". Press OK to confirm.
- ③ "Delay" appears on the screen.

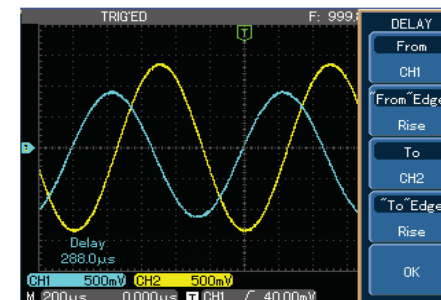


Figure 3-2 Waveform delay



**Illustration 3 : Acquiring single signals**

The advantages and special features of your digital storage oscilloscope lie in its ability to acquire non cyclical signals like pulse and glitch. To acquire a single signal, you must have prior knowledge of that signal to set the trigger level and trigger edge. For example, if the pulse is a logical signal of TTL level, the trigger level should be set at about 2V and the trigger edge should be set to rising edge trigger. If you are not certain about the signal, you can observe it by automatic or normal trigger to determine the trigger level and trigger edge.

Steps :

1. As in the previous illustration, set the attenuation factor of the probe and CH1.
2. Carry out trigger setup.
  - ① Press [**MENU**] in the trigger control zone to display the trigger setup menu.
  - ② In this menu, use F1~F5 menus to set the trigger type to edge, set trigger source to Ch1, set trigger coupling to DC, set trigger mode to

single and set slew rate type to rising.

- ③ Adjust horizontal time base and vertical range to an appropriate range.
- ④ Turn the **LEVEL** knob to get the desired level.
- ⑤ Press [**RUN/STOP**] and wait for a signal that meets the trigger condition. If any signal reaches the set trigger level, the system will sample once and display it on the screen. By using this function you can easily acquire any occasional event. For example, when a sudden glitch of relatively big amplitude is acquired : set the trigger level to just higher than the normal signal level. Press [**RUN/STOP**] and begin waiting. When a glitch occurs, the machine will automatically trigger and record the waveform immediately before and after triggering. By turning the horizontal **POSITION** knob in the horizontal control zone on the front panel, you can change the trigger position horizontally to achieve negative delay trigger of various lengths for easy observation of waveform occurring before the glitch.

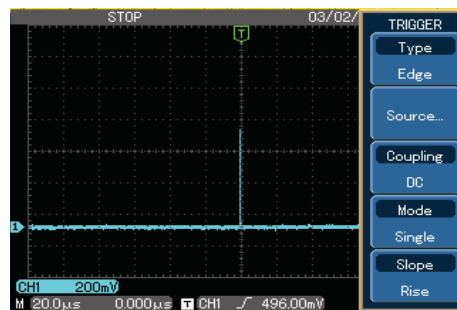


Figure 3-3 Single signal

## Illustration 4 : Reducing random noise of signals

If the signal being measured is stacked with random noise, you can adjust the setups of your oscilloscope to filter or reduce the noise, so it will not cause interference to the signal during measurement. (Waveform is shown below)

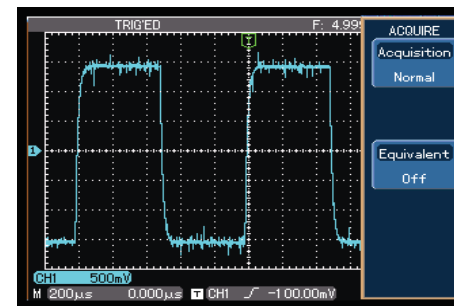


Figure 3-4 Reducing random noise of signals

**Steps :**

1. **As in the previous illustration, set the attenuation factor of the probe and Ch1.**
2. **Connect the signal to ensure stable display of waveform.** See the previous illustration for operation instruction. See the previous chapter for guidance on adjusting the horizontal time base and vertical range.
3. **Improving trigger by setting trigger coupling .**
  - ① Press **[MENU]** in the trigger zone to display the trigger setup menu.
  - ② Set trigger coupling to low frequency suppression or high frequency suppression. By selecting low frequency suppression a high-pass filter is set up. It filters low frequency signal quantities under 80kHz and allows high frequency signal quantities to pass through. If you select high frequency suppression a low-pass filter is set up. It filters high frequency signal quantities higher than 80kHz and allows low frequency signal quantities

to pass through. By setting low frequency suppression or high frequency suppression, you can suppress low frequency or high frequency noise respectively and achieve a stable trigger.

4. **Reducing display noise by setting the sampling mode.**

If the signal being measured is stacked with random noise and the waveform is too coarse as a result, you can use the average sampling mode to eliminate random noise display and reduce the size of waveform for easy observation and measurement. After getting the mean, random noise is reduced and details of the signal are clearer. Follow the steps below :

Press **[ACQUIRE]** in the menu zone of the front panel to display the sampling setup menu. Press menu operation key **[F1]** then **[F3]** to set sampling mode to AVERAGE, then press the **MULTIPURPOSE** control knob to adjust the average number of times in multiples of 2,

i.e. 2 to 256, until you get the desired waveform display that meets observation and measurement requirements. (See the figure below)

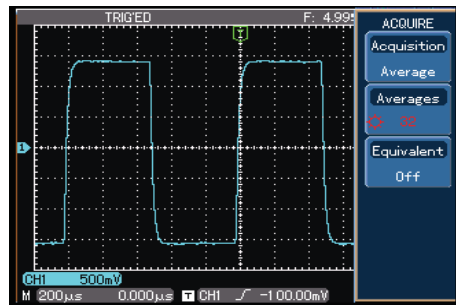


Figure 3-5 Signal noise suppressed

**Caution :** In the average sampling mode the waveform display will update at a slower rate. This is normal.

### Illustration 5 : Using the cursors for measurement

Your oscilloscope can measure 28 waveform parameters automatically. All auto parameters can be measured with the cursors. By using the cursors, you can quickly measure the time and voltage of a waveform.

#### I. Measuring the frequency of a Sinc peak

To measure the peak frequency of a Sinc signal, follow the steps below :

1. Press [**CURSOR**] to display the cursor measurement menu.
2. Press [**F1**] to activate the cursor measurement function.
3. Press [**F1**] again to set cursor type to time .
4. Press [**F3**] to set the vertical cursor unit to Hz .
5. Turn the **MULTIPURPOSE** control knob to set cursor 1 at the Sinc first peak .

6. Press the **MULTIPURPOSE** control knob to select cursor 2, then turn the **MULTIPURPOSE** control knob again to set cursor 2 at the Sinc second peak. See the figure below.

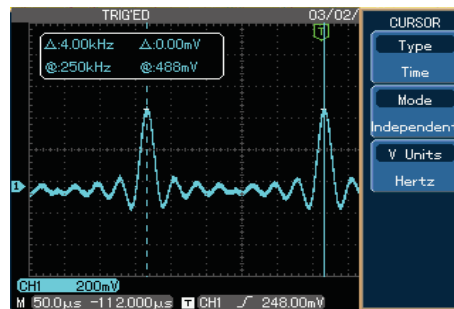


Figure 3-6 Using the cursors to test signal frequency

**Note :** When using the cursor to measure voltage, follow step 2 only and set the cursor type to voltage.

### II. Measuring the negative duty ratio of a pulse signal

1. Press [**CURSOR**] to display the cursor measurement menu.
2. Press [**F1**] to activate the cursor measurement function.
3. Press [**F1**] again to set cursor type to time.
4. Press [**F3**] to set the vertical cursor unit to ratio.
5. Turn the **MULTIPURPOSE** control knob to set cursor 1 at the first rising edge peak of the pulse.
6. Press the **MULTIPURPOSE** control knob to select cursor 2, then turn the **MULTIPURPOSE** control knob again to set cursor 2 at the second rising edge peak of the pulse.
7. Press [**F4**]. Current position is 100%. Set the current  $\Delta$  value between cursor 1 and cursor 2 to 100%.

8. Use the **MULTIPURPOSE** control knob to set cursor 1 at the first falling edge of the pulse. This  $\Delta$  value is the negative duty ratio. See the figure below.

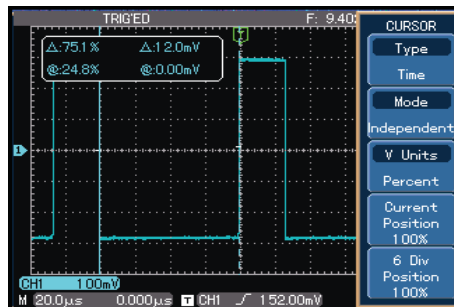


Figure 3-7 Using the cursors to test pulse negative duty ratio

### III. Measuring the phase difference between two signals

Measure the phase difference that occurs when a sine signal passes through the circuit. Connect CH1 to the input signal of the circuit and connect CH2 to the output signal of the circuit. To make testing easier, CH1 and CH2 displacements are set in the centre point, as shown in Figure 3-8. Follow the steps below :

1. Press [**CURSOR**] to display the cursor measurement menu.
2. Press [**F1**] to activate the cursor measurement function.
3. Press [**F1**] again to set cursor type to time.
4. Press [**F3**] to set the vertical cursor unit to Degree.
5. Turn the **MULTIPURPOSE** control knob to set cursor 1 at the center point of the first sine rising edge (where is crosses with channel ground line).

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6. Press the **MULTIPURPOSE** control knob to select cursor 2, then turn the **MULTIPURPOSE** control knob again to set cursor 2 at the center point of the second rising edge.
7. Press [**F4**]. Current position is 100%. Set the current  $\Delta$  value between cursor 1 and cursor 2 to 100%.
8. Press [**CH2**], then [**CURSOR**] to set the cursor at the CH2 signal being tested. Keep cursor 1 stationary and move cursor 2.
9. Use the **MULTIPURPOSE** control knob to set cursor 2 at the center point of the first rising edge of the CH2 signal. This  $\Delta$  value is the phase difference between the two signals.

See the figure below.

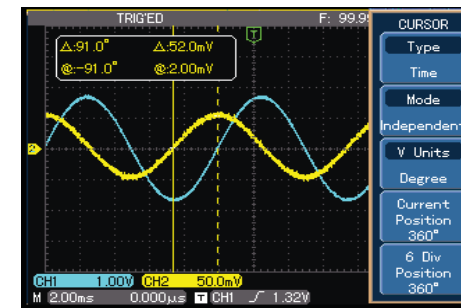


Figure 3-8 Using the cursors to test the phase difference between two signals

### Illustration 6 : Using the X-Y function

To check the phase difference between two channels.  
Example : To measure the phase variation when a signal passes through the circuit, connect your oscilloscope to the circuit and monitor the input and output signals. To check the circuit's input and output in the X-Y coordinate mode, follow the steps below :

1. Set the attenuation factor of the probe to 10X. Set the switch of the probe to 10X.
2. Connect the CH1 probe to the input terminal of the network. Connect the CH2 probe to the output terminal of the network.
3. If the channel is not displayed, press the [CH1] and [CH2] menu button to enable the two channels.
4. Press [AUTO].
5. Adjust the vertical **SCALE** knob to make the displayed amplitude of the two channels to about equal.
6. Press the [DISPLAY] menu key to recall the

display menu.

7. Press [F1] to select X-Y. The oscilloscope will display the circuit's input and output characteristics in a Lissajous figure.
8. Adjust the vertical scale and vertical position knob to achieve the best result of waveform.
9. Using the elliptic oscilloscope display graph to observe, measure and calculate the phase difference.

(see the figure below)

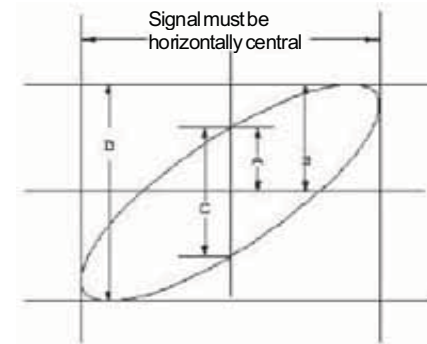


Figure 3-9



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If  $\sin\theta = \frac{A}{B}$  or  $\frac{C}{D}$  ,

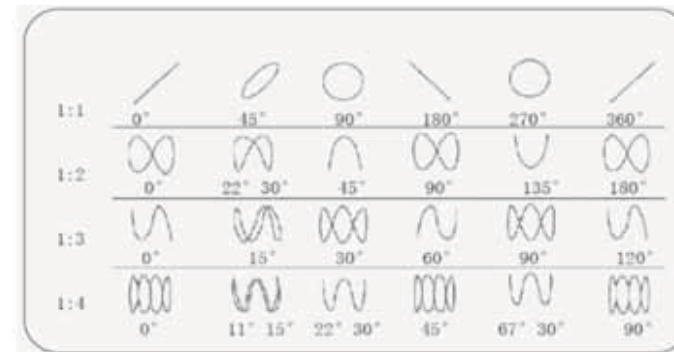
$\theta$  is the angle of disparity between the channels. For definitions of A, B, C, D see the above figure. Calculating with this formula, the angle of disparity is

$\theta = \pm \arcsin(\frac{A}{B})$  or  $\theta = \pm \arcsin(\frac{C}{D})$

If the elliptic main axis is within quadrants I and III, the angle of disparity should be within quadrants I and IV, i.e. inside  $(0 \sim \frac{\pi}{2})$  or  $(\frac{3\pi}{2} \sim 2\pi)$  .

If the main axis is within quadrants II and IV, the angle of disparity should be within quadrants II and III, i.e. inside  $(\frac{\pi}{2} \sim \pi)$  or  $(\pi \sim \frac{3\pi}{2})$  .

### 10. X-Y Phase difference table :



### Illustration 7 : Video signal triggering

To observe an individual video circuit, use the video trigger function to obtain a stable display of video output signal.

#### Video field triggering

To trigger in the video field, follow the steps below :

1. Press **[MENU]** in the trigger control zone to display the trigger menu.
2. Press **[F2]** then **[F3]** to set the type to video.
3. Press **[F2]** then turn the **MULTIPURPOSE** control knob to set trigger source to CH1. Next press the **MULTIPURPOSE** control knob to confirm.
4. Press **[F5]** to enter the video setup screen then press **[F1]** to select PAL as video format.
5. Press **[F2]** to select odd field or even field synchronization.
6. Turn the **SEC/DIV** knob in the horizontal control zone to adjust horizontal time base for a clear waveform display.

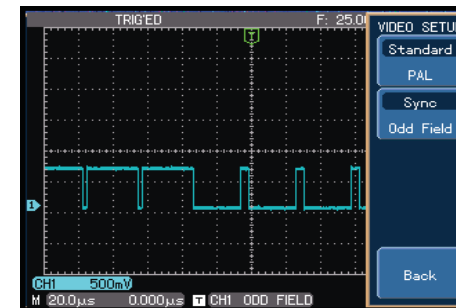


Figure 3-11 Video field triggering

### Video line triggering

To trigger on the video field, follow the steps below :

1. Press [**MENU**] button in the trigger control zone to display the trigger menu.
2. Press [**F2**] then [**F3**] to set the type to video.
3. Press [**F2**] then turn the **MULTIPURPOSE** control knob to set trigger source to CH1. Next press the **MULTIPURPOSE** control knob to confirm.
4. Press [**F5**] to enter the video setup screen then press [**F1**] to select PAL as video format.
5. Press [**F2**] then [**F4**] to select line synchronization.
6. Use the **MULTIPURPOSE** control knob to select any line.
7. Turn the horizontal **SEC/DIV** knob in the horizontal control zone to adjust horizontal time base for a clear waveform display.



Figure 3-11 Video line triggering

### Illustration 8 : Using the dual time base function

In the dual time base mode, you can enjoy unrivaled detailed observation of a waveform. For example, you can observe the colour Burst signal of the video signal (clear observation is impossible with ordinary oscilloscopes).

1. To access video signal in CH1, follow the “Video line trigger” instructions in “Illustration 7 : Video signal triggering”.
2. Press [MENU] in the horizontal control zone to display the time base setup menu.
3. Press [F3] to enter dual time base setup.
4. Press [F1] to select dual time base, then press [F2] to select CH1. Press [F3] to set time base magnitude to M1. Adjust the M1 time base range with the **SEC/DIV** knob as shown in Figure 3-13. Then press [F3] to select M2 and adjust the M2 time base range with the **SEC/DIV** knob as shown in Figure 3-13.

5. Shift the M2 time base with the **MULTIPURPOSE** control knob to show the parts you require to observe in detail. When shifting M2, press [F5] to choose coarse or fine tune to shift in greater or smaller steps. .

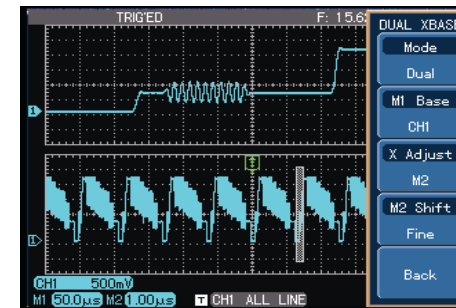


Figure 3-13 Dual time base function

### Illustration 9 : Using the multimeter

The multimeter of this digital storage oscilloscope can measure 5 parameters : voltage, resistance, on/off, diode and DC current. The following example shows the steps for DC current measurement :

1. Assuming the size of the current to be measured is unknown, a current-voltage converter module of 4A range should be used. Connect it to the multimeter port of the oscilloscope then connect the test lead.
2. Press the [DMM] key and [F1] to open the multimeter function table. Press [F2] then [F5] to select measurement parameter "DC current". Press [F5] then [F4] to set current range to "4A".
3. Connect the test lead to the circuit being tested.
4. If the current being tested is relatively small, follow step 2 to select an appropriate current range and use a suitable current-voltage converter module. Adjust the current range of the current-voltage converter module so it is consistent with that of the oscilloscope. Next follow step 3 to measure.

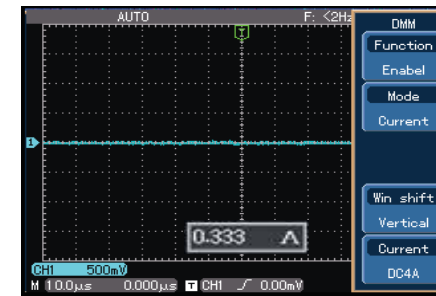


Figure 3-14 Selecting a large range for measurement

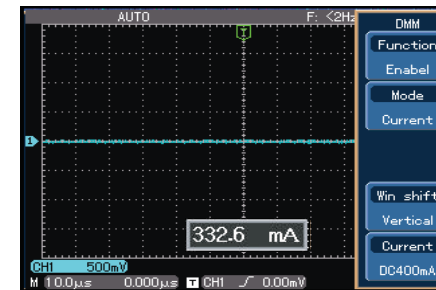


Figure 3-15 Selecting a suitable range for measurement

## Chapter 4 System Prompts and Trouble-shooting

### Definitions of System Prompts

**Adjustment at Ultimate Limit** : This informs you that the multifunction control knob has reached its adjustment limit in the current status. No further adjust is possible. When the vertical gratitude factor switch, time base switch, horizontal shift, vertical shift and trigger level adjustment have reached their ultimate limits, this prompt will appear.

**USB Device Installed** : After a USB device is plugged into the oscilloscope, this prompt appears when the connection is valid.

**USB Device Unplugged** : After a USB key is unplugged from the oscilloscope, this prompt appears.

**Saving** : When the oscilloscope is saving a waveform, this prompt is shown on the screen. A progress bar

appears at the bottom.

**Waiting** : This prompt appears on the screen during auto calibration. A progress bar appears at the bottom.

**I/O Failure** : When USB communication fails or no document meeting specific requirements is found on the USB device, this prompt appears.

**Function Disabled** : When [MATH] key is pressed in the dual time base mode, this prompt appears.

### Troubleshooting

1. If the screen of your oscilloscope remains black without any display after powering on, follow the steps below to find the cause :
  - ① Check the power cable connection and check if there is normal power supply.
  - ② Check if the power switch is properly pressed.
  - ③ Restart the unit after performing the above checks

2. If no waveform is displayed after you have acquired a signal, follow the steps below to find the cause :
  - ① Check whether the probe is properly connected to the signal lead.
  - ② Check whether the signal lead is properly connected to the BNC (channel adaptor).
  - ③ Check whether the probe is connected properly to the object to be measured.
  - ④ Check whether the object for measurement is generating signals (connect the channel with signals to the questionable channel to find the cause).
  - ⑤ Restart the acquisition process.
3. The measurement voltage amplitude value is 10 times larger or smaller than the actual value :

Check if the channel attenuation factor corresponds with the probe attenuation you have chosen.
4. There is waveform display but it is not stable :
  - ① Check the trigger source setup in the trigger menu. See whether it is the same as the actual signal input channel.
  - ② Check the trigger type : Use edge trigger for ordinary signals. Stable waveform display is achieved only when the correct trigger mode is selected.
  - ③ Try changing the coupling display to high frequency suppression or low frequency suppression to filter any high or low frequency noise that is interfering with triggering.
5. No display after pressing **[RUN/STOP]** :
  - ① Check if the trigger mode is set to normal or single in the menu, and whether the level exceeds the waveform range. If so, move the level to the centre or set trigger mode to AUTO.
  - ② Press **[AUTO]** to complete the setup.

6. Display speed is slow after average sampling time is enabled :

- ① If average sampling is carried out for more than 32 times, the display speed will drop. This is normal.
- ② You can reduce the intervals of average sampling.

7. Trapezoidal waveform display :

- ① This is normal. The reason is possibly horizontal time base range is too low. You can improve horizontal resolution and enhance the display quality by increasing the horizontal time base.
- ② If the display type is vector, the connection between sampling dots may cause a trapezoidal waveform. Set the display type to dot to solve this problem.

## Chapter 5 Using the USB update program

The USB upgrade program makes upgrade easier and more flexible. To use this function follow the steps below :

1. Check the model name, software and hardware versions of your oscilloscope in Table 2-26.
2. Download the highest version of the update program document that matches your model, software and hardware versions online, and store it on the USB device (preferably a USB device recommended by us).
3. Power off the oscilloscope then insert the USB device. Then power on the oscilloscope again. The prompt “Please press [F5] to continue or [F1] to cancel” appears on the screen, as shown in the figure on the right.





Figure 5-1 USB update confirmation

After pressing **[F5]**, the screen will prompt you to select the update program, as shown in the following figure. You can now select the required update program with the multifunction control knob then press **[F5]** to move to the next step (If there is only one program on the USB device, the following screen will not appear. The system will move straight to the next step).

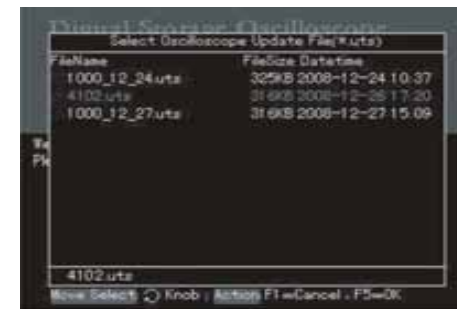


Figure 5-2 Selection of the USB upgrade document

- When **[F5]** is pressed as shown in Figure 5-2, the prompt on the right will appear : “Are you sure you wish to update? If yes, press **[F5]**, otherwise press **[F1]** to cancel upgrade”.



Figure 5-3 Confirming the USB update document

5. When the USB document is confirmed the following prompt will appear : "System upgrade is in progress. Please wait ". (This process may take 3 to 5 minutes)

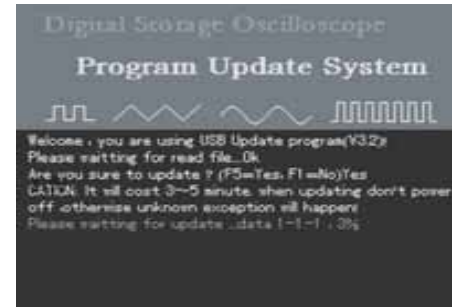


Figure 5-4 USB upgrade in progress

6. When update is complete, a successful update prompt will appear : "Upgrade is successfully complete. Please remove USB device, then power off your oscilloscope and power it back on again to complete the process." The oscilloscope program is now updated and system upgrade is complete. In the event of update failure, follow the steps below .



Figure 5-5 Successful USB update

**Caution :** If upgrade fails due to power interruption, power off the oscilloscope and repeat all the USB update steps.

Below are some common causes for update failure :

1. No update document.

If there is no document with the suffix “uts”, the following message will appear when [F5] is pressed after powering on : “Can't find the valid update file! Please ensure there is update file on the USB device then restart the operation.”



Figure 5-6 No valid update document

### 2. The user cancels the update process.

- ① When the oscilloscope is restarted with the USB device plugged in, you can cancel upgrade by pressing [**F1**]. To cancel upgrade and operate your oscilloscope normally, follow the on-screen instructions : “Remove the USB device and reboot.”



Figure 5-7 Cancel update (1)

- ② During the update process, you can cancel update by pressing [**F1**]. To cancel upgrade and operate your oscilloscope normally, follow the on-screen instructions : “ Remove the USB device and reboot.”

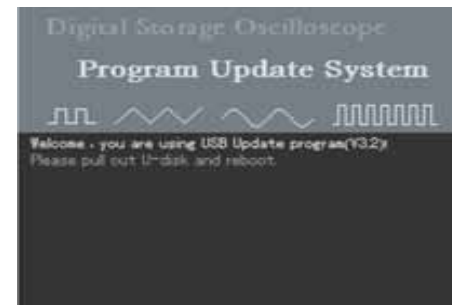


Figure 5-8 Cancel update (2)

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- ③ You can still cancel update when the oscilloscope is ready for the process. Simply press **[F1]** to return to normal operation. Please follow the on-screen instructions : “Remove the USB device and reboot.”
3. The USB device is removed before update begins  
If the USB device is removed when the update document is being read before commencement of update, the following prompt will appear : “USB device has been removed! Please reboot.” To resume normal operation, power on the oscilloscope with the USB device unplugged.



Figure 5-9 Cancel upgrade (3)



Figure 5-10 USB device is removed before update

#### 4. Incorrect update document

If the version of the update document on the USB device is incorrect, update will fail upon selecting the upgrade document by pressing [F5] (Figure 3-18). You will see the prompt : “Incorrect upgrade document” . Save a correct document on the USB device and repeat the previous steps for upgrade.”



Figure 5-11 Incorrect update document version

#### 5. Failure in reading update document

After selecting the update document, press [F5] to read.

If the document cannot be read, you will see the prompt : “Sorry, upgrade has failed. Please contact our after-sales service department”. It may be that our oscilloscope does not support your USB device , or document reading is unsuccessful due to other reasons. You can retry and see if the problem can be solved, or use a USB device we recommend. If the problem persists, contact our after-sales service department. To resume normal operation, power off your oscilloscope and then reboot.



Figure 5-12 Reading failure

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### 6. Low software version

If the version of USB document is lower than that of the oscilloscope, update will fail. You will be prompted that, "Software version too low. Please read the user manual for further instructions." This indicates that the software version you have saved on to the USB device is lower than the existing one on the oscilloscope. You should acquire the correct version either online or through our after-sales service department. To see version information, press **[UTILITY]** **[SYSTEM CONFIGURATION]** **[SYSTEM INFORMATION]**. Please download the suitable update document.



Figure 5-13 Low software version

### 7. Software document incompatible with product model

If the USB update document is incompatible with the oscilloscope model, update will fail. You will be prompted that, "Software and product model incompatible. Please read the user manual for further instructions." You should download an update document which corresponds with your oscilloscope model, e.g. Tenma DSO then repeat the USB update steps.



Figure 5-14 Incompatible software document and product model

## Chapter 6 Appendixes

### Appendix A: Technical Indicators

Unless otherwise specified, all technical specifications apply to probes with attenuation setting of 10X and the Tenma DSO Four-channel Digital Oscilloscope. To verify that your oscilloscope meets specifications, it must first meet the following conditions :

- The oscilloscope must have been operating continuously for thirty minutes at the specified operating temperature.
- If the operating temperature changes by more than 5°C, you must perform the "Self Cal" operation, accessible through the system functions menu. All specifications are guaranteed unless noted "Typical" .



**Technical Indicators**

| <b>Sampling</b>   |  |            |
|-------------------|--|------------|
| Sampling modes    | Real-time  | Equivalent |
| Acquisition rates | CH1, CH2 : single channel 2GS/s, two channels 1GS/s<br>CH3, CH4 : single channel 2GS/s, two channels 1GS/s       | 50GS/s     |
| Average           | When all channels have made N acquisitions simultaneously, N is selectable from 2, 4, 8, 16, 32, 64, 128 to 256. |            |

| <b>Input</b>                          |   |
|---------------------------------------|---|
| Input coupling                        | DC, AC, GND                               |
| Input impedance                       | 1±2% MΩ in parallel with 16±3pF           |
| Probe attenuation                     | 1X, 10X, 100X, 1000X                      |
| Maximum input voltage                 | 400V (DC + AC Peak, 1 MΩ input impedance) |
| Time delay between channels (Typical) | 150ps                                     |

| <b>Horizontal</b>   |   |
|---|---|
| Waveform interpolation  | $\sin(x)/x$   |
| Recording length  | 1024k   |
| Storage depth   | 24k (Max)   |
| Equivalent storage depth<br>(dual time base)                          | 60M   |
| Scanning range (s/div)  | 5ns/div~50s/div (100MHz)<br>At 1-2-5 increment  |
| Accuracy of sampling rate and delay<br>time                           | $\pm 50\text{ppm}$ (any time interval $\geq 1\text{ms}$ )   |
| Time interval ( $\Delta T$ )<br>Measurement accuracy (full bandwidth) | Single : $\pm (1 \text{ sampling time interval} + 50\text{ppm} \times \text{reading} + 0.6\text{ns})$<br>> 16 average values : $\pm (1 \text{ sampling time interval} + 50\text{ppm} \times \text{reading} + 0.4\text{ns})$ |

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| <b>Vertical</b>   |   |         |  |
|---|---|---------|--|
| Model   | 72-8727   | 72-8725 |  |
| A/D converter   | 8-bit resolution  |         |  |
| Deflection gratitude factor V/div Range   | 2mV/div ~ 5V/div at input BNC   |         |  |
| Displacement range  | ± 5 div   |         |  |
| Analog bandwidth  | 200MHz  | 100MHz  |  |
| Single bandwidth  | 100MHz  | 100MHz  |  |
| Selectable analog bandwidth limit (Typical)   | 20MHz   |         |  |
| Low frequency response (AC coupling, -3dB)  | ≤10Hz at BNC  |         |  |
| Rise time   | ≤1.8ns  | ≤3.5ns  |  |
| DC gain accuracy  | When vertical sensitivity is 2mV/div : ± 4% (sampling or average acquisition mode)<br>When vertical sensitivity is 5mV/div~5V/div : ±3% (sampling or average acquisition mode)  |         |  |
| DC measurement accuracy<br>(average acquisition mode)                                   | When vertical position is zero and $N \geq 16$ :<br>± (5% x reading + 0.1 div + 1mV) and 2mV/div is selected<br>± (3% x reading + 0.1 div + 1mV) and 5mV/div~5V/div is selected<br>When vertical position is not zero and $N \geq 16$ :<br>± [3% x (reading + vertical shift reading) + (1% x vertical shift reading)] + 0.2div). Set from 5mV/div to 200mV/div plus 2mV<br>Setup value > 200mV/div to 5V/div plus 50mV |         |  |
| Voltage difference ( $\Delta V$ )<br>measurement accuracy<br>(average acquisition mode) | Under identical setup and environmental conditions, the voltage difference ( $\Delta V$ ) between two points of the waveform after the average of $\geq 16$ waveforms acquired waveforms is taken : ± (3% x reading + 0.05div)  |         |  |

|  |  |  |
|--|--|--|
| Trigger  |  |  |
| Trigger sensitivity  | Internal trigger : 1 div; external trigger: 100mV  |  |
| Trigger level range  | Internal   | ± 8 div from the centre of the screen                            |
|  | EXT  | ±800mV   |
|  | EXT/5  | ±4.0V  |
| Trigger level accuracy (Typical) applied on signals of ≥20ns rise or fall time | Internal   | ± (0.3div x V/div) (within ± 4div from the center of the screen) |
|  | EXT  | ±(6% default value + 40mV)                                       |
|  | EXT/5  | ±(6% default value + 200mV)                                      |
| Pretrigger capability  | Normal mode/scanning mode, pretrigger/delayed trigger. Pretrigger depth is adjustable                                      |  |
| Holdoff range  | 96.0000ns~1.5s   |  |
| Set level to 50% (Typical)   | Input signal frequency ≥50Hz   |  |
| Edge Trigger   |  |  |
| Edge type  | Rise, Fall, Rise&Fall  |  |
| Pulse Trigger  |  |  |
| Trigger mode   | ( Smaller than, greater than, or equalling to) positive pulse<br>( Smaller than, greater than, or equal to) negative pulse |  |
| Pulse width  | 20ns~10s   |  |

|  |  |       |
|--|--|-------|
| <b>Slew Rate Trigger</b>                     |  |       |
| Slew rate condition                          | < (Smaller than) , > (greater than) , = (equalling to)                         |       |
| Slew rate range                              | 40pV/s~1.6kV/s   |       |
| <b>Video Trigger</b>                         |  |       |
| Trigger sensitivity (video trigger, Typical) | Internal   | 2 div |
|  | EXT  | 400mV |
|  | EXT/5  | 2V    |
| Video format                                 | Supporting standard NTSC and PAL. Line ranges are 1~525 (NTSC) and 1~625 (PAL) |       |

|                                  |                                       |
|----------------------------------|---------------------------------------|
| <b>Trigger frequency counter</b> |                                       |
| Reading resolution               | 6 bit                                 |
| Precision                        | ±51ppm                                |
| Frequency range                  | 10Hz to full bandwidth at AC coupling |
| Trigger type                     | Pulse or edge                         |

| Measurement           |   |   |
|-----------------------|---|---|
| Cursor                | Manual mode   | Voltage difference ( $\Delta V$ ) between cursors; time difference ( $\Delta T$ ) between cursors; time difference ( $\Delta T$ ) countdown (Hz) ( $1/\Delta T$ ) |
|                       | Automatic mode  | Cursor display is enabled during automatic measurement  |
| Automatic measurement | Amplitude, maximum, minimum, top, bottom, mean, peak-to-peak, amplitude, average, root mean square, cycle root mean square, area, cycle area, frequency, cycle, rising edge, falling edge, positive pulse, negative pulse, burst pulse, overshoot, preshoot, duty ratio, negative duty ratio, positive duty ratio, delay (advance measurement), phase (advance measurement) |   |
| Math functions        | + , - , × , ÷   |   |
| Saving waveforms      | 10 groups of waveforms and 10 setups  |   |
| FFT                   | Windows   | Hanning, Hamming, Blackman, Rectangle   |
|                       | Sampling points   | 1024 points   |
| Lissajous figure      | Phase difference  | $\pm 3$ degrees   |

| <b>Digital Multimeter</b>                             |  |
|---|--|
| DC voltage  | Range : 400mV, 4V, 40V, 400V<br>Precision : $\pm$ ( 1% + 5 quantization words)   |
| AC voltage ( 40Hz ~ 400Hz )                           | Range : 400mV, 4V, 40V, 400V<br>Precision : $\pm$ ( 1.2% + 5 quantization words)   |
| Resistance  | Range : 400 $\Omega$ , 4k $\Omega$ , 400k $\Omega$ , 4M $\Omega$ , 40M $\Omega$<br>Precision : $\pm$ ( 1.5% + 5 quantization words)          |
| On/Off test   | <70 . 0 $\Omega$   |
| Diode measurement                                     | Forward voltage drop 0.5V~ 0.8V  |
| DC current(external current-voltage converter module) | Range : 4mA, 40mA, 400mA<br>Precision : $\pm$ ( 1% + 5 quantization words)<br>Range : 4A<br>Precision : $\pm$ ( 1.5% + 5 quantization words) |

| <b>Display</b>                 |  |
|--------------------------------|--|
| Display type                   | 145mm diagonal line (5.7") LCD panel               |
| Display resolution ( display ) | 320 horizontal x RGB x 240 vertical pixels (color) |
| Display Colour                 | Color  |
| Backlight Intensity            | 300 nit.   |
| Display Languages              | Simplified Chinese, Traditional Chinese, English   |

| Probe Compensator Output |   |
|--------------------------|---|
| Output Voltage (Typical) | About 3V into peak-to-peak ( $\geq 1\text{M}\Omega$ ) |
| Frequency (Typical)      | 1 kHz   |

| Interface Functions |  |
|---------------------|--|
| Standard setup      | 1 x USB device/1 x USB host/Multimeter interface |
| Optional            | GPIB and LAN                                     |

| Power Source      |   |
|-------------------|---|
| Source Voltage    | 100~240VAC <sub>RMS</sub> , 45~440Hz, CAT II                |
| Power Consumption | 50VA~60VA   |
| Fuse              | F1.6AL 250V      Located on the power board inside the unit |

Please note:

The product come with the power source 220V (for UK/Europe) or 110V (for USA);

| Environment    |                                |
|----------------|--------------------------------|
| Temperature    | Operating : 0 °C~+40 °C        |
|                | Non-operating : -20 °C~+60 °C  |
| Cooling Method | Natural cooling                |
| Humidity       | < +35 °C : $\leq 90\%$ RH      |
|                | +35 °C~+40 °C : $\leq 60\%$ RH |
| Altitude       | Operating : 3,000m             |
|                | Non-operating : 15,000m        |



| Mechanical Specifications |   |       |
|---------------------------|---|-------|
| Dimension                 | Width                                   | 336mm |
|                           | Height                                  | 117mm |
|                           | Depth                                   | 174mm |
| Weight (net)              | Without packaging                       | 3.8kg |
|                           | With packaging                          | 6.5kg |
| IP Protection IP2X        |   |       |
| Adjustment interval       | Calibration every 1 year is recommended |       |

## Appendix B : Accessories for Tenma DSO Four-channel Digital Storage Oscilloscope

### Standard Accessories :

- Four 1.2m, 1:1 (10:1) passive voltage probes. For details please read the probe manual. EN61010-031: 2008 standard .  
Rating is 150V CAT II when the switch is in the 1X position ;  
Rating is 300V CAT II when the switch is in the 10X position
- One international standard power cord
- One User Manual
- Tenma DSO Four-channel Digital Storage Oscilloscope communication & control software (USB-device)
- USB connection cable
- Two multimeter test lead and current-voltage converter module

### Optional Accessory

- LAN & GPIB module

### Appendix C : Maintenance and Cleaning

#### General Care

Do not store or leave the oscilloscope where the LCD display will be exposed to direct sunlight for long periods of time.

**Caution :** To avoid damage to the oscilloscope or probes, do not expose them to sprays, liquids, or solvents.

#### Cleaning

Inspect the oscilloscope and probes as often as operating conditions require. To clean the exterior surface, follow these steps :

1. Remove dust on the outside of the oscilloscope and probes with a soft cloth. When cleaning the LCD, use care to avoid scratching the clear protection film of the LCD.
2. Use a dampened but not dripping soft cloth to clean the oscilloscope. Remember to

disconnect power. Use a mild cleaner or water. To avoid damaging the product or probe, do not use abrasive chemical cleaner.

**Warning :** *To avoid short circuit or personal injury due to the presence of moisture, please ensure the product is completely dry before reconnecting power for operation.*

### Appendix D : Factory Setups

When you press [UTILITY] Factory Setup , the selected option will be changed . Please refer to the table below .

| System            | Function                | Factory Setup           |
|-------------------|-------------------------|-------------------------|
| Vertical system   | CH1                     | 5V/DIV                  |
|                   | POSITION                | Vertical centre point   |
|                   | CH2\CH3\CH4             | Off                     |
|                   | MATH, REF               | Off                     |
| Horizontal system | Dual time base          | Off                     |
|                   | Window expansion        | Off                     |
|                   | Horizontal time base    | 1.0ms/div               |
|                   | Horizontal displacement | Horizontal centre point |
| Trigger system    | Holdoff time            | Minimum 96.0000ns       |
|                   | Trigger type            | Edge                    |
|                   | Signal source           | CH1                     |
|                   | Coupling mode           | AC                      |
|                   | Trigger mode            | Auto                    |
|                   | Slope                   | Rise                    |

| System       | Function          | Factory Setup                 |
|--------------|-------------------|-------------------------------|
| Acquisition  | Sampling mode     | Normal sampling               |
|              | Equivalent mode   | Off                           |
| Other system | Save type         | Setup                         |
|              | Measurement       | Off<br>Clear all measurements |
|              | Cursor            | Off                           |
|              | Frequency counter | On                            |
|              | Display format    | YT                            |
|              | Display type      | Vector                        |
|              |                   |                               |
|              |                   |                               |
|              |                   |                               |
|              |                   |                               |



## Tenma DSO Four-channel User Manual

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