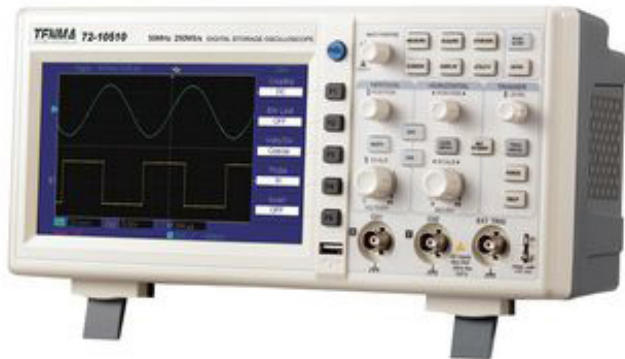


# TENMA®



## Digital Storage Oscilloscope

Model No. 72-2650, 72-8705A, 72-8710A  
72-8225A & 72-10510

**When using electrical appliances, basic safety precautions should always be followed to reduce the risk of fire, electric shock and injury to persons or property.**

**Read all instructions before using the appliance and retain for future reference.**

- This meter is designed to meet IEC61010-1, 61010-2-032, and 61010-2-033 in Pollution Degree 2, Measurement Category (CAT II 150V when switched to 1X and 300V CAT II when switched to 10X) and double Insulation.
- Check that the voltage indicated on the rating plate corresponds with that of the local network before connecting the product to the mains power supply.
- Do not operate this product with a damaged plug or cord, after a malfunction or after being dropped or damaged in any way.
- Check the product before use for any damage. Should you notice any damage on the cable or casing, do not use.
- This product contains no user-serviceable parts. All repairs should only be carried out by a qualified engineer. Improper repairs may place the user at risk of harm.
- Take caution when voltages are above 60V DC and 30V ACrms.
- The earth probe must only be used to connect to ground, never connect to a voltage source.
- This product must be earthed using the mains power cord ground connection.
- Do not disconnect from the mains supply and its ground connection when any item is connected to this product for measurement.
- Children should be supervised to ensure that they do not play with the product.
- Always disconnect from the mains when the product is not in use or before cleaning.
- Do not use the product for any purpose other than that for which it is designed.
- Do not operate or store in an environment of high humidity or where moisture may enter the product as this can reduce insulation and lead to electric shock.

## **PRODUCT OVERVIEW**

### **Main Features**

- Dual analogue channels with HD colour LCD display
- Automatic waveform and status configuration
- Multi-waveform mathematical operation function
- Automatic measurement of 28 waveform parameters
- Edge, video, pulse width and alternate trigger functions
- Supports plug and play USB storage devices and communication with PC
- Built-in FFT software function
- Unique waveform recording and replay function

## **WHAT'S INCLUDED**

- Digital Oscilloscope Unit
- Mains power lead
- User Manual
- Communications software CD
- USB lead
- 2 x selectable 1:1/10:1 passive voltage probes

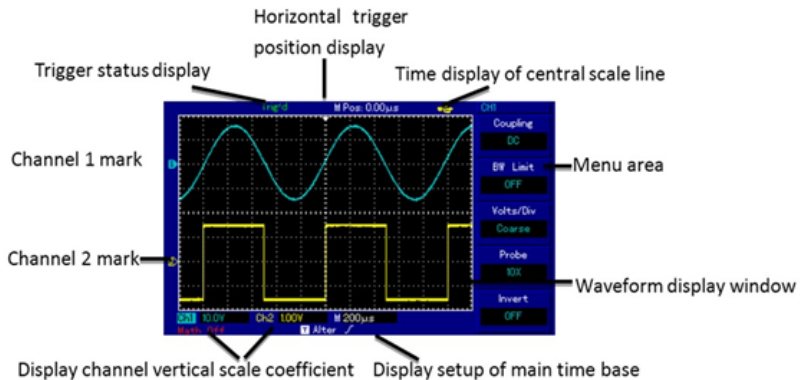
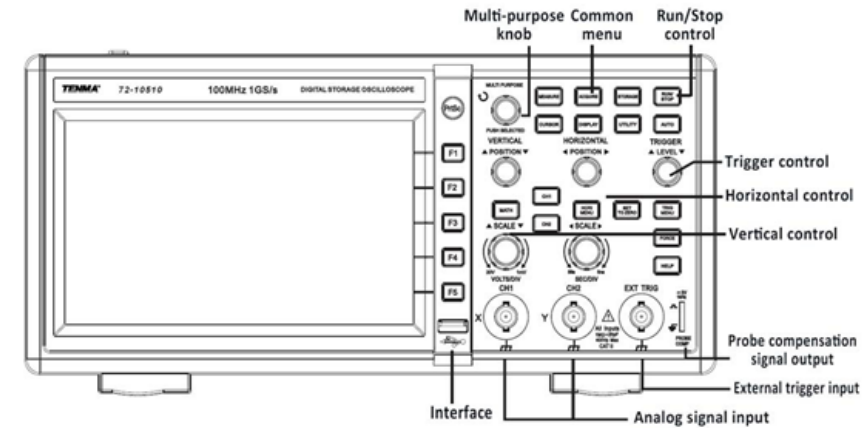
### **Optional accessories**

- LAN port module

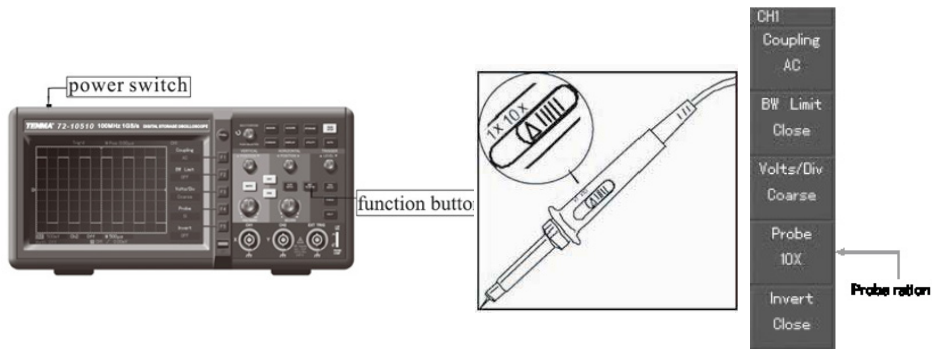
## OPERATING PARAMETERS

- The oscilloscope also has high performance index and powerful functions required for faster measurements. Faster signals can be observed with the oscilloscope via 500MS/s (or 1GS/s) real-time sampling and 25GS/s (or 50GS/s) equivalent sampling.
- Powerful trigger and analysis ability make it easier to capture and analyse waveforms.
- Clear LCD and mathematical operating functions make it easy to use to observe and analyse signal problems in a faster and clearer way.

## CONTROLS AND CONNECTIONS



## OPERATION



### Accessing signals

- Power on the unit then allow the self test to complete.
- Press UTILITY button then F1 and the screen will display DEFAULT SETUP.

**Note:** The meter has dual input channels plus one external trigger input channel.

- Press CH1 to enter channel 1 menu.
- Connect the probe to the Ch1 input.
- Set the probe attenuation switch to 10X position.

**Note:** The oscilloscope attenuation has to be set as well.

- Press F4 until 10X displays. This changes the vertical range multiple to ensure the measurement result correctly reflects the amplitude of the measured signal.
- Connect both probe and ground clamp to the corresponding signal terminals.
- Press AUTO and a square wave of about 3V at 1kHz is displayed for a moment.
- Press OFF then CH2 and repeat for channel 2.

### Probe compensation

- Perform this adjustment when connecting the probes to any input channel for the first time or errors in the measurement may result.
- Connect the probe tip to the probe compensator's signal output connector and connect the ground clamp to the earth wire of the probe compensator.
- Enable CH1 and press AUTO.
- Observe the shape of the displayed waveform.



**Overcompensation    Correct Compensation    Undercompensation**

- Adjust the variable capacitor on the probe with an insulated screwdriver until a correct waveform is achieved.

### AUTOSET WAVEFORM DISPLAY

- The oscilloscope features an AUTOSET function which automatically adjusts the vertical deflection factor, scanning time base and trigger mode based on the input signal until the most appropriate waveform is displayed.
- This function only operates when the signal to be measured is 50Hz or above and the duty ratio is larger than 1%.

## Using the AUTOSET function

- Connect the signal to be measured to the signal input channel.
- Press AUTO and the oscilloscope will scan the time base and trigger mode and set the vertical deflection factor. You can manually adjust further after this process to get the optimum display.

## DISPLAY SETTING CONTROLS

### Vertical control panel

- Vertical position control centres the waveform display.
- As you adjust the position the GROUND channel indicator moves in line with the waveform.
- Pressing SET TO ZERO resets the display to the centre point.
- Adjusting the vertical scale control adjusts the VOLT/DIV range. The current status display changes accordingly.
- Press CH1, CH2, MATH or REFERENCE and the screen shows the corresponding operation menu, sign, waveform and range status information.
- Press OFF to disable the selected channel (72-2650).



### Horizontal control panel

- Horizontal position control adjusts the position of the waveform window by adjusting the trigger shift of the signal.
- The horizontal scale adjustment changes the SEC/DIV time base range and the current status indicator will change accordingly.
- The horizontal scanning rate range is 5ns - 50ns in steps of 1-2-5-10.

**Note:** the horizontal scanning time base range varies between models - see table in specification section.

- Pressing SET TO ZERO resets the display to the centre point.



### Zoom display option

- Press MENU to display the ZOOM options.
- Press F3 to display further options including WINDOW EXPANSION and HOLDOFF.
- Rotate the MULTI FUNCTION rotary control to make adjustments.
- Press F1 to quit the option and return to MAIN TIME BASE.

### Trigger system

- The trigger level rotary control adjusts the trigger level. The display value changes on the display as you make adjustment.
- Press MENU to select the trigger options.
- Press F1 and set EDGE TRIGGER
- Press F2 and set TRIGGER SOURCE to CH1
- Press F3 and set EDGE TYPE as RISING
- Press F4 and set TRIGGER MODE as AUTO
- Press F5 and set TRIGGER COUPLING as DC
- Press 50% to set trigger level at the range amplitude centre point (trigger zero - highest sensitivity setting)
- Press COMPULSORY to generate a compulsory trigger signal mainly used in normal and single trigger modes.



## INSTRUMENT SETUP

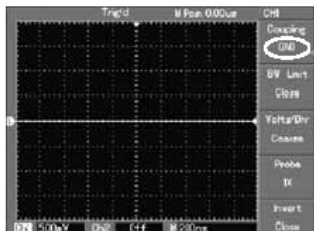
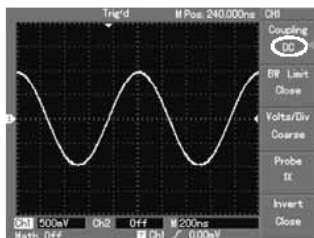
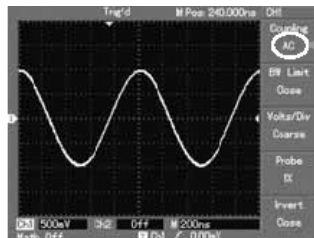
### Vertical system setup

- Each channel CH1 or CH2 has it's own vertical menu. Each channel should be set up individually.
- Press CH1 or CH2 and the system will display the operation menu for that channel.

Functions Menu	Setup	Notes
Coupling	AC	Intercepts the DC quantities of the input signal.
	DC	Pass AC and DC quantities of input signal
	GROUND	Disconnect input signal
Bandwidth Limit	On	Limit bandwidth to 20MHz to reduce noise display.
	Off	Full bandwidth
Volts / DIV	Coarse tune	Coarse tune in steps of 1-2-5 to set up the deflection factor of the vertical system.
	Fine tune	Fine tune is further tuning within the coarse tune set up to improve the vertical resolution.
Probe	1X, 10X, 100X and 1000X	Select either value based on the probe attenuation factor to keep the vertical deflection factor reading correct.
Invert	On	Waveform invert function on.
	Off	Normal waveform display.

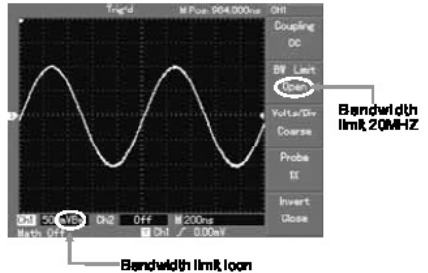
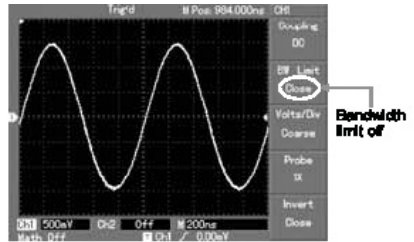
### Channel coupling setup

- If for example a signal is applied to CH1 which has a sine signal that contains DC quantities.
- Press F1 to select AC and set up as AC coupling. Any DC quantities in the signal are now intercepted.
- Press F1 to select DC.
- Both AC and DC quantities of the signal being measured can now pass through.
- The waveform displays both AC and DC quantities of the signal.
- Press F1 to select GROUND.
- Both AC and DC quantities of the signal being measured are now intercepted.
- The waveform is not displayed in this mode but the signal remains connected to the channel circuit.



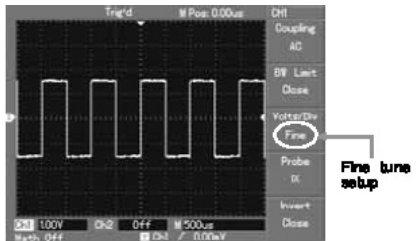
### Channel bandwidth setup

- If for example a signal is applied to CH1 which is a pulse signal that contains high frequency oscillation.
- Press CH1 to select Channel1.
- Press F2 to set the BANDWIDTH LIMIT OFF so it is set up as full bandwidth.
- The signal being measured can now pass through even if it contains high frequency quantities.
- Press F2 to set BANDWIDTH LIMIT ON so that frequency quantities higher than 20MHz in the signal being measured will be limited.



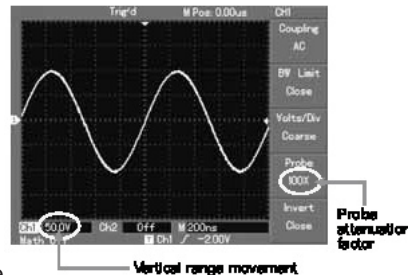
### Vertical Volts/Div adjustment setup

- The VOLTS/DIV range of the vertical deflection factor can be adjusted either in coarse or fine tune mode.
- In COARSE TUNE the VOLTS/DIV range is 2mV/div~5V/div. Tuning is in steps of 1-2-5.
- In FINE TUNE mode the deflection factor can be adjusted in smaller steps allowing continuous adjustment within the range 2mV/div~5V/div without interruption.



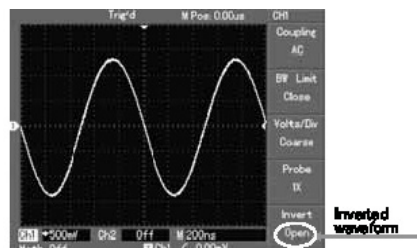
### Probe rate setup

- 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 menu. This principle applies to other values to ensure the voltage reading is correct.



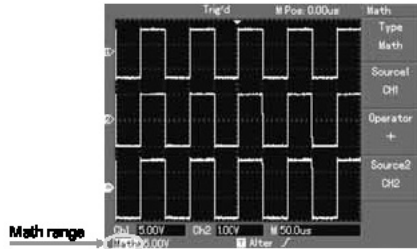
### Waveform inversion setup

- The displayed signal is inverted 180 degrees with respect to the ground level.



### Operating Math functions

- Math functions are displays of +, -, x, ÷ and FFT mathematical results of CH1 and CH2. The menu options are:-



Functions Menu	Setup	Notes
Type	Math	To carry out +, -, x, ÷ functions
Signal source 1	Ch1 Ch2	Set signal source 1 as CH1 waveform Set signal source 1 as CH2 waveform
Operator	+ - x ÷	Signal source 1+ Signal source 2 Signal source 1- Signal source 2 Signal source 1x Signal source 1 Signal source 1÷ Signal source 2
Signal source 2	Ch1 Ch2	Set signal source 2 as CH1 waveform Set signal source 2 as CH2 waveform

### FFT spectrum analysis

- Using FFT algorithm you can convert the domain signals (YT) into frequency domain signals.
- With FFT you can 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.
- Signals with DC quantities or DC offset will cause error or offset FFT waveform quantities. To reduce DC quantities select AC coupling.
- To reduce random noise and frequency aliasing as a result of repeated or single pulse event, set the acquired mode of the oscilloscope to average acquisition.

Functions Menu	Setup	Notes
Type	FFT	To carry out FFT algorithm functions
Signal source	Ch1 Ch2	Set CH1 as math waveform Set CH2 as math waveform
Window	Hanning Hamming Blackman Rectangle	Set Hanning window function Set Hamming window function Set Blackman window function Set Rectangle window function



**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.
- 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 waveform by one window function to set the value at 0 for start and finish compulsively. See the following table:

FFT Window	Feature	Most suitable measurement item
Rectangle	The best frequency resolution, the worst amplitude resolution. 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 resolution is better than the rectangle window but amplitude resolution is poorer.	Sine, cyclical and narrow-band random noise.
Hamming	Frequency resolution is marginally better than Hanning window.	Temporary or fast pulse. Signal level varies greatly before and after.
Blackman	The best amplitude resolution and the poorest frequency resolution.	Mainly for single frequency signals to search for higher-order harmonic wave.

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

- 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.

**Reference waveform**

- Displays of the saved reference waveforms can be set on or off in the REF menu.
- The waveforms are saved in non-volatile memory and identified with the following names: Ref A, Ref B.
- To display (recall) or hide the reference waveforms use the following method:
  1. Press REF menu button on the front panel
  2. Press REF A (reference option)
  3. Select the signal source and the position of the signal source 1~10 by use of the multi-function rotary control.
  4. Press RECALL to display the waveform stored in that location.

**Note:** If the stored waveform is on external disk press F2 to select between DSO and USB and select USB having inserted the drive into the USB port.

5. The recalled waveform will be displayed on the screen.
6. Press CANCEL to go back to the previous menu.

7. Press REF B and select the second signal source for the math function repeating step 3

**Note:** To measure and observe such waveforms you can compare the current waveform with the reference waveform for analysis.

8. Press REF to display the reference waveform menu. See following table:

Functions Menu	Setup	Notes
Signal source selection	1~10	1~10 stands for positions of 10 groups of waveforms respectively
Disk	DSO USB	Select an internal storage location select an external storage position (U disk must be connected)
Close	--	Close the recalled waveform
Recall	--	Recall the selected waveform
Cancel	--	Go back to the previous menu

- To store to a selected location choose between 1 and 10. To use external USB, plug in the U disk and press F2 to select the USB memory.
- To save a waveform press SAVE menu.

### Horizontal system setup

- The horizontal rotary control is used to change the graticule (time base) and trigger the horizontal position of the memory (triggering position).
- The vertical centre point above the horizontal orientation of the screen is the time reference point of the waveform. Changing the graticule will cause the waveform to increase or decrease in size relative to screen centre. When the horizontal position changes, the position in respect to the waveform triggering point is also changed.

### Horizontal position

- Adjust the horizontal positions of the channel waveforms (including math waveforms). Resolution of this control changes with the time base.

### Horizontal scaling

- Adjusting the main time base i.e. sec/div. When time base extension is on you can use the horizontal scaling control to change the delay scanning time base and change the window width.



Functions Menu	Setup	Notes
Main time base	--	1 - enable main time base 2 - if window extension is enabled, press main time base to disable window extension
Window extension	--	Enable time base
Holdoff	--	Adjust Holdoff time

### Icon definitions

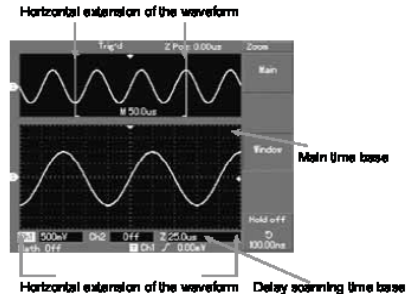
1. Represents the memory position of the current waveform.
2. Represents the memory position of the triggering point.
3. Represents the position of the triggering point in the current waveform window.
4. Horizontal time base (main time base) ie: sec/div.
5. Horizontal distance between the triggering position and the window centre point.

### Definitions

- **YT Mode:** in this mode the y axis indicates voltage and the x axis indicates time.
- **X-Y Mode:** in this mode the X axis indicates CH1 voltage and the Y axis indicates the CH2 voltage.
- **Slow Scanning Mode:** When the horizontal time base control is set at 50ms/div or slower, the unit will operate in the slow scan sampling mode. When observing low frequency signals in slow scanning mode, it is advised to set the channel coupling as DC.
- **Sec/Div:** a horizontal scaling (time base) unit. If waveform sampling is stopped (by pressing the RUN/STOP button) time base control can expand or compress the waveform.

### Window Extension

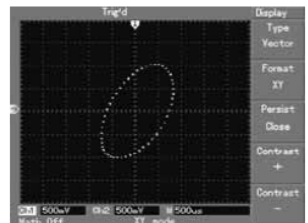
- Window extension can be use to zoom in or zoom out a band of waveform to check image details. The window extension setting must not be slower than that of the main time base.
- In the time base extension mode, the display is divided into two zones as shown.
- The upper part displays the original waveform. You can move this zone left or right by turning the horizontal POSITION control, or increase and decrease the selected zone in size by turning the horizontal SCALE control.
- The lower part is the horizontally extended waveform zone.
- Please note that the resolution of extended time base relative to the main time base is now higher as shown.
- 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 SCALE control to decrease the size of the selected zone (increase the multiple of waveform extension).



### XY Mode

- This mode is suitable for CH1 and CH2 only. After selecting the X-Y display mode, the horizontal axis will display CH1 voltage, while the vertical axis will display CH2 voltage.

**Note:** in the normal X-Y mode the oscilloscope can cause the random sampling rate to acquire waveforms. To adjust sampling rate and channel vertical range in the X-Y mode, the omitted sampling rate is 100MS/s.



- Generally adjusting the time base lower will result in appropriately Lissajous figures of better display quality.
- The following functions have no effect in the X-Y display mode:-
  1. Auto measurement mode
  2. Cursor measurement mode
  3. Reference or math waveform
  4. Vector display type
  5. Horizontal position control
  6. Trigger control

### Setting up the Trigger system

- Triggering decides when the oscilloscope collects data and displays waveforms. Once the trigger is correctly set up, it can convert unstable display into significant waveforms.
- When beginning to collect data the oscilloscope first collects sufficient data to draw a waveform on the left of the triggering point.
- While waiting for the triggering condition to occur it will continuously collect data. When sufficient data to draw a waveform on the right of the triggering point.
- The trigger control zone on the operation panel comprises a trigger level adjustment control, a trigger MENU button, 50% button for setting up the trigger level at the vertical centre point of the signal, and a COMPULSORY trigger button.
- Trigger level sets the signal voltage with respect to the triggering point.
- 50% sets the trigger level at the vertical centre point of the trigger signal amplitude.
- Compulsory used to generate a compulsory trigger signal, mainly used in the trigger mode and normal and single modes.
- Menu button enables the trigger set up modes.

### Trigger Control

- Trigger modes: Edge, Pulse, Video and Alternate.

### Edge Trigger:

- When selecting edge trigger, you are triggering at the rising and falling edges of the input signal.

Functions Menu	Setup	Notes
Type	Edge	
Signal source selection	CH1 CH2 EXT EXT/5	Set Ch1 as the signal source trigger signal Set CH2 as the signal source trigger signal Set the external trigger input channel as the signal source trigger signal Set the external trigger source divided by 5 to extend the external trigger level range
	Grid Alternate	Set up as grid trigger Ch1, CH2 trigger their own signals alternatively
Inclination	Rising Falling	Set to trigger on the signals rising edge Set to trigger on the signals falling edge
Trigger Mode	Auto Normal Single	Set to sample waveform only if no trigger condition is detected Set to sample waveform only if trigger condition is satisfied Set to sample waveform once when detecting one trigger and then stop

Functions Menu	Setup	Notes
Type	Edge	
Trigger coupling	DC	Intercept DC quantities of the input signal
	AC	Allow AC and DC quantities of the input signal to pass
	H/F reject	Reject high frequency quantities above 80kHz of the signal
	L/F reject	Reject low frequency quantities below 80kHz of the signal

### 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.
- Adjust the pulse width from 20ns~10s by turning the control on the upper front panel.

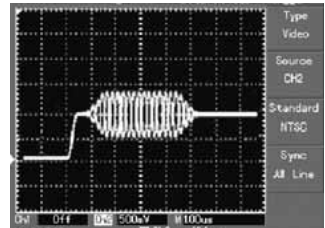
Functions Menu	Setup	Notes
Type	Pulse	
Trigger source	CH1 CH2 EXT	Set Ch1 as the signal source trigger signal Set CH2 as the signal source trigger signal Set the external trigger input channel as the signal source trigger signal
	Grid Alternate	Set up as grid trigger Ch1, CH2 trigger their own signals alternately
Pulse width condition	Larger	Trigger when pulse width is larger than default value
	Smaller	Trigger when pulse width is smaller than default value
	Equal	Trigger when pulse width equals to default value
Trigger polarity	Pos pulse width	Set positive pulse as the trigger signal
	Neg pulse width	Set negative pulse width as the trigger signal
Trigger mode	Auto	The system automatically samples waveform data when there is no trigger signal input. 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.

### Video Trigger

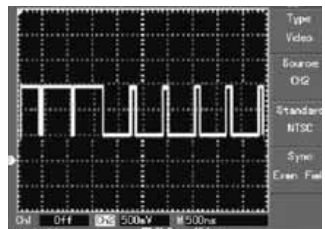
- By selecting video trigger you can carry out field or line trigger with NTSC or PAL standard video signals. Default trigger coupling is DC.

Functions Menu	Setup	Notes
Type	Video	
Trigger source	CH1 CH2 EXT EXT/5  AC Line	Set Ch1 as the trigger signal Set CH2 as the trigger signal Set the external trigger input channel as the trigger signal Attenuate the external trigger source 5 times as the trigger signal  Set AC power line as trigger signal
Standard	PAL NTSC	Suitable for video signals of low black level Suitable for video signals of high black level
Synchronisation	All lines Specified lines Odd field Even field	Set the TV line to synchronise with trigger Set synchronised trigger on the specified line and adjust by turning the control on the front panel Set video odd field to synchronised trigger Set video even field to synchronised trigger

- When PAL is selected for STANDARD format and SYNCHRONISATION mode is LINE you will see a screen display similar to this:-

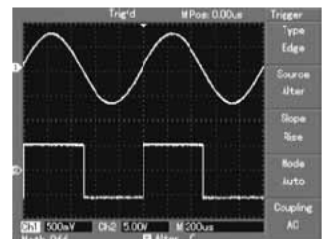


- When SYNCHRONISATION mode is FIELD you will see a screen display similar to this:-



### 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.



Functions Menu	Setup	Notes
Type	Edge	Set trigger mode to EDGE
Trigger source	Alternate	Set CH1 and Ch2 to alternate trigger
Inclination	Rising	Set trigger inclination as rising edge
Trigger mode	Auto	Set trigger mode to automatic
Trigger coupling	AC	Set trigger coupling mode to AC

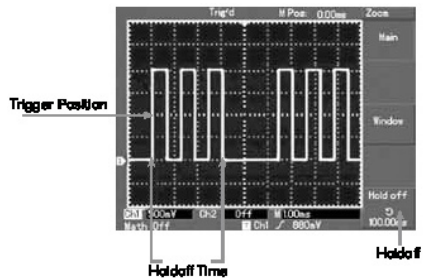
### Set up for Trigger Coupling mode

- Enter the trigger setup menu to set up the trigger coupling mode and achieve the most stable synchronisation.

Functions Menu	Setup	Notes
Type	Edge	Set trigger mode to EDGE
Trigger source	Alternate	Set CH1 and Ch2 to alternate trigger
Inclination	Rising	Set trigger inclination as rising edge
Trigger mode	Auto	Set trigger mode to automatic
Coupling	DC	Intercept DC quantities.
	AC	Allow all quantities to pass.
	H/F reject	Intercept high frequency quantities of the signal only allow low frequency quantities to pass.
	L/F reject	Intercept low frequency quantities of the signal only allow high frequency quantities to pass.

### Adjusting the Holdoff time

- You can adjust the Holdoff time to observe complicated waveforms. Holdoff time means the waiting time for the trigger to be ready for use again. During this time the oscilloscope will not trigger until the Holdoff is complete.
- Follow the normal signal synchronisation procedure and select the edge, trigger source and inclination in the trigger menu.
- Adjust the trigger level to make the waveform display as stable as possible.
- Press the key in the horizontal MENU to display the horizontal menu.
- Adjust the multi-function control in the upper front panel. The hold-off time will change accordingly until the waveform display is stable.



## OPERATION

**Trigger Source** - Trigger can be obtained from various sources: Input channel (CH1 or CH2), external trigger (EXT, EXT/5) or grid.

1. **Input channel** - the most common trigger source is input channel. The selected trigger source can operate normally whether the input is displayed or not.
2. **External trigger** - this type of trigger source can trigger in a third channel while acquiring data in two other channels. Both EXT and EXT/5 trigger sources use external trigger signals from the EXT TRIG jack. EXT can use the signals directly. You can use EXT within the trigger level range of -3V and +3V. EXT/5 divides the trigger by 5. As a result trigger range is extended to -15V to +15V enabling the oscilloscope to trigger at a large signal.
3. **Grid** - this trigger mode is suitable for observing signals related to the grid power source eg: the correlation between lighting equipment and power source equipment to achieve stable synchronisation.

**Trigger Mode** - determines the action of the oscilloscope when there is no trigger. There are three trigger modes - auto, normal and single.

1. **Auto Trigger** - samples the waveform data when there is no trigger signal input. The scan base is shown on the display. When the trigger signal is generated it automatically turns to trigger scan for signal synchronisation.

**Note:** when the time base of the scan waveform is set to 50ms/div or slower, the auto mode allows no trigger signal.

2. **Normal Trigger** - In this mode waveforms are only sampled when triggering conditions are met. The system stops acquiring data and waits when there is no trigger signal. When a trigger is generated, trigger scan occurs.
3. **Single Trigger** - In this mode press RUN button once and the oscilloscope will wait for trigger. When one trigger is detected, it will sample and display the acquired waveform, then stop.

**Trigger coupling** - determines which quantities of the signal are transmitted to the trigger circuit. Coupling modes are DC, AC, low frequency reject and high frequency reject.

1. **DC** - allowing all quantities to pass.
2. **AC** - intercepting DC quantities and attenuating signals under 10Hz.
3. **Low Frequency Reject** - Intercepting DC quantities and attenuating low frequency quantities under 80kHz.
4. **High Frequency Reject** - Attenuating high frequency quantities over 80kHz.

**Pre-Trigger/Delayed Trigger** - data sampled before/after triggering. The trigger position is typically set at the horizontal centre of the screen. You are able to view five divisions of pre-trigger and delayed trigger information. Use the horizontal position control to adjust the horizontal shift of the waveform to see more pre-trigger information. By observing pre-trigger data you can see the waveform before trigger occurs. You can detect the glitch that occurs when the circuitry starts. Observing this data can help identify the cause of this glitch.

### Setting up the Sampling System

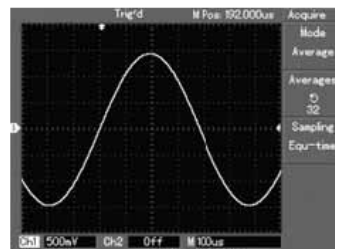
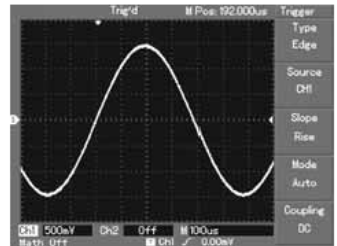
- The ACQUIRE button on the control panel is the function key for the sampling system.





Functions Menu	Setup	Notes
Acquisition Mode	Sample Peak detect Average	Turn on the ordinary sampling mode Turn on the peak detect mode Set the average sampling and display the average number of times
Average number of times	2-256	Set the average number of times in multiples of 2 ie: 2, 4, 8, 16, 32, 64, 128, 256 To change the average number of times use the multi-function control on the front panel.
Sampling mode	Real time Equivalent	Set sampling to real time Set sampling to equivalent at a time base range of 5ns~100ns/div.

- By changing acquisition setup you can observe the consequent changes in waveform display. If the signal contains considerable noise, you will see this waveform displays when average sampling is not selected.
- When 32 time average sampling is selected you will see this.



**Note:** Use **Real Time Sampling** to observe single signals. In this mode the system makes full acquisition to fill the memory. Maximum sampling rate is 500MS/s. At a setting of 50ns or faster, the oscilloscope will automatically carry out interpolation ie: inserting a sampling point between other sampling points.

Use **Equivalent Sampling** to observe high frequency cyclical signals. This is a repeated sampling mode that allows detailed observation of repeated cyclical signals. In the equivalent sampling mode, the horizontal resolution is 40ps higher than the real time mode ie: 25GS/s equivalent.

**Sampling Mode** is when the oscilloscope reconstructs the waveform by sampling signals at regular intervals.

To avoid mixed envelope, select **Peak Detect**. In this mode the oscilloscope identifies the maximum and minimum 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** is when the oscilloscope acquires several waveforms and take the average value to display the final waveform. You can use this mode to reduce random noise. To reduce random noise of the displayed signal, select average sampling and increase the average number of times in multiples of 2 ie: selecting from 2 to 256.

## Setting up the Display System

- The DISPLAY button on the control panel is the function key for the display system.



Functions Menu	Setup	Notes
Display type	Vector Dots	Sampling points are linked for display Sampling points are directly displayed
Format	YT XY	Operating mode of the oscilloscope X-Y is the display mode CH1 is X input CH2 is Y input.
Persist	Off Infinite	The waveform on the screen is refreshed at higher speed The original waveform on the screen remains on display. New data will be added continuously until this function is disabled.
Contrast	+, -	Setting the waveform contrast

**Display Type:** Vector display fills the spaces between adjacent sample points. Dots display only the sample points.

**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.

**Save and Recall:** pressing the STORAGE button displays the setup menu from where you can save or recall waveforms and setup documents stored in memory both internal and in USB storage devices.

## Operating procedure

- Press STORAGE to go to the type menu. There are three types to select from:
  - WAVEFORM to go to the waveform save menu.
  - SETUP to enter the setup save menu.
  - BITMAP to enter the position save menu



Note: this feature can only be recalled after connecting USB ram.

Functions Menu	Setup	Notes
Type	Waveform	Select the waveform save and recall menu
Signal source	CH1 CH2	Select the waveform from CH1 Select the waveform from CH2
Save position	1~10	Set and select the position in which the waveform is saved in the internal memory. Adjust using the multi-function control
Save	--	Save the waveform
Disk	DSO USB	Select the internal memory Select external USB memory
Depth	Normal Lengthy	Set normal saving depth of 250 dots Set lengthy saving of 2.5k

Functions Menu	Setup	Notes
Setup		Select the front panel setup menu
Setup (save position)	1~10	Maximum 10 front panel setups can be saved. Select with the multi-function control on front panel
Save	--	Save the setting
Recall	--	Recall the setting

Functions Menu	Setup	Notes
Bitmap		Select the bitmap menu
Save position	1~10	Maximum 10 position data can be saved. Select with the multi-function control on front panel
Recall		Save graphic data

### Setting up Alternative Functions

- The UTILITY button on the control panel is the function key for alternative functions.



Functions Menu	Setup	Notes
Auto calibration	Run Cancel	Run auto calibration Cancel calibration and return to previous menu
Recording waveform	SEE TABLE BELOW	Setup for recording waveform
Language	S Chinese T Chinese English	Select the language interface
Factory setup	--	Setting up factory setup recall
Interface design	Design1 Design2 Design3 Design4	Setting up the interface design (colour display) Two designs (mono display)

Functions Menu	Setup	Notes
Record	CH1 CH2	Select CH1 as the recording signal source Select CH2 as the recording signal source
Cancel		Quit the current record menu and return to previous menu
■ (F3)		Stop recording
▶ (F4)		Playback button - the system plays back and displays the position reference in the lower RH corner. Use the multi-function control to select the waveform to be displayed repeatedly.
● (F5)		Record button - use to record. The position reference is displayed in the bottom of the screen

**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 the oscilloscope and allow 20 minutes to warm up then press UTILITY button and follow the on screen instructions.

**Choose your language:** The Oscilloscope can be operated in several languages, press UTILITY button and choose the desired language.

### Setting up Auto Measurement

- The MEASURE button on the control panel is the function key for auto measurement.



The oscilloscope is capable of measuring 20 waveform parameters.

- Press MEASURE to enter the parameter measurement display menu which has five zones for simultaneous display of measurement values assigned to function keys F1 to F5 respectively. When selecting the measurement type of any zone, press the corresponding function key to enter the type option menu.
- The measurement type option menu lets you choose voltage or time. You can enter the voltage or time measurement by pressing F1~F5 for the corresponding type and then return to the measurement display menu.
- Pressing F5 and select ALL PARAMETERS to show all measured parameters of both voltage and time. Press F2 to select the channel (has to be enabled to take measurements).
- Press F1 to return to the parameter measurement menu.

### Automatic measurement of voltage parameters

- The DSO series oscilloscope can automatically measure the following voltage parameters.
- Peak to peak value ( $V_{pp}$ ) - the voltage value from the highest point to lowest point of the waveform.
- Maximum value ( $V_{max}$ ) - the voltage value from the highest point to ground of the waveform.
- Minimum value ( $V_{min}$ ) - the voltage value from the highest point to ground of the waveform.
- Amplitude value ( $V_{amp}$ ) - the voltage value from top to base of the waveform.
- Top value ( $V_{top}$ ) - the voltage value from the level top to ground of the waveform.
- Base value ( $V_{base}$ ) - the voltage value from the level base to ground of the waveform.
- Overshoot - the ratio value of the difference between maximum value and top value of the waveform to the amplitude value.
- Pre-shoot - the ratio value of the difference between minimum value and base value of the waveform to the amplitude value.
- Average value - average amplitude of signals within 1 cycle.
- RMS value - the effective value. Energy generated by AC signal conversion during one cycle with respect to the DC voltage that produces equivalent energy.

**Automatic measurement of time parameters**

- The DSO series oscilloscope can automatically measure the following parameters.
- Rise time - the time taken by the waveform to rise from 10% to 90%.
- Fall time - the time taken for the waveform to fall from 90% to 10%.
- Positive pulse (+width) - pulse width of positive pulse at 50% amplitude.
- Negative pulse (-width) - pulse width of negative pulse at 50% amplitude.
- Delay 1→2 (Rising Edge) - delayed time of the rising edge of CH1, Ch2.
- Delay 1→2 (Falling Edge) - delayed time of the falling edge of CH1, Ch2.
- Positive duty ratio (+Duty) - ratio of positive pulse width to cycle.
- Negative duty ratio (-Duty) - ratio of negative pulse width to cycle.

Functions Menu	Setup	Notes
Return		Return to the parameter measurement display menu
Signal source	CH1	Select the channel for parameter measurement
	CH2	Select the channel for parameter measurement
Voltage type		Enter the voltage type parameter menu
Time type		Enter the time type parameter menu
All parameters		Display/close all parameters

Functions/Measurement	Notes
Return	Return to the previous menu
Pre-shoot	Select to return to the parameter measurement display menu and replace the original parameter in that position
Amplitude	
Overshoot	
Average value	
Peak to Peak value	
RMS value	
Top value	
Base Value	
Mean value	
Maximum value	
Minimum value	
Frequency	
Amplitude	
Rise time	
Fall time	
Positive pulse width	
Negative pulse width	
Delay	
Positive duty ratio	
Negative duty ratio	

### Cursor Measurement

- The CURSOR button on the control panel is the function key for cursor measurement.
- Adjust the cursor position by turning the multi-function control.



Functions Menu	Setup	Notes
Channel	CH1/CH2/ MATH	Select the measurement channel
Channel	CH1/CH2/ MATH	Select the reference channel
Confirm		Select to return to the parameter measurement display menu and replace the original parameter in that position

- You can move the cursor to carry out measurement in CURSOR mode.
- There are three types to select from:
  1. VOLTAGE - press SELECT and COARSE TUNE on the front panel. The two cursor positions can be adjusted with the multi-function control to measure  $\Delta V$ . Choose which cursor to adjust with the SELECT button. The displayed reading is the voltage value between the two cursors.
  2. TIME - press SELECT and TIME on the front panel. The two cursor positions can be adjusted with the multi-function control to measure  $\Delta T$ . Choose which cursor to adjust with the SELECT button. The displayed reading is the time value between the two cursors.
  3. TRACKING - press SELECT and TRACK and when the waveform display is on the cursor is shown tracking the changing signal automatically. Horizontal and vertical cursors overlap to form a cross shaped cursor. It positions itself on the waveform automatically. You can adjust the horizontal position of the cursor using the multi-function control. The co-ordinates are displayed on screen. The measurement value is displayed in the upper right corner of the screen.

### Using the RUN button

- The RUN/STOP button indicates the status of the oscilloscope. If a green indicator illuminates the status is 'running' and the oscilloscope is acquiring waveform, if the status is 'stopped' then it lights red and the oscilloscope is not acquiring waveform and STOP appears on the screen.



### Auto Setup

- Auto setup simplifies the operation. Press AUTO and the oscilloscope can automatically adjust the vertical deflection factor and horizontal time base range according to the amplitude and frequency of the waveform, and also ensure a stable display of the waveform.
- When the oscilloscope is in auto mode the setup is as follows:

Functions Menu	Setup
Acquisition mode	Adjust to 'Sampling' or 'Peak Measurement'
Cursor	Disabled
Display format	Set to YT
Display type	Vector
Horizontal position	Adjusted
SEC/DIV	Adjust according to signal frequency
Trigger coupling	AC
Trigger Holdoff	Minimum value
Trigger level	Set at 50%
Trigger mode	Auto
Trigger source	Set to CH1 but if there is no signal in CH1 and CH2 applies a signal, it will be set to CH2
Trigger inclination	Rising
Trigger type	Edge
Vertical bandwidth	Full
VOLT/DIV	Adjust according to amplitude of the signal
Vertical coupling	DC

### System prompts

- **Adjustment at ultimate limit** - this informs you that the control adjustment has reached its limit in the current status. No further adjustment is possible. When the vertical deflection factor ON/OFF, time base ON/OFF, X shift, vertical shift and trigger level adjustments have reached their ultimate limits, this prompt will appear.
- **USB Drive Connected** - after a USB drive is plugged in this prompt appears when the connection is valid.
- **USB Drive Disconnected** - after a USB drive is unplugged from the oscilloscope this prompt appears.
- **Saving** - when the oscilloscope is saving a waveform, this prompt will show on screen. A progress bar appears at the bottom.
- **Loading** - when recalling a waveform, this prompt shows on screen. A progress bar appears at the bottom.

### Troubleshooting

- If the screen remains black after switching on check the power supply and mains lead are connected and check the main supply is switched on.
- If no waveform is displayed after acquiring a signal, check the probe and signal lead is properly connected to the BNC. Check that the object being measured is generating signals.
- If the voltage amplitude value is 10 times larger than actual value, check the channel attenuation factor corresponds with the probe attenuation.
- Unstable waveform displayed - check the trigger type (use edge for normal signals) and also check the trigger source is the same as the signal input channel. Also check trigger mode is set to normal or single and try changing the coupling display to high or low frequency suppression.

- If the display speed is slower after average sampling time is enabled - this is normal if average sampling is carried out more than 32 times. You can reduce the intervals of average sampling.
- Waveform display in ladder shape - this is normal. The reason may be the horizontal time base range is too low. If the display type is vector, the connection between sampling dots may produce a ladder waveform. Set the display type to dot to solve this issue.

## SPECIFICATION

<b>Sampling</b>			
Sampling modes	Real time	Real time	Equivalent
Sampling rates	72-2650	1GS/s	50GS/s
	72-8710A	1GS/s	50GS/s
	72-8705A	1GS/s	50GS/s
	72-8225A	500MS/s	25GS/s
	72-10510	250MS/s	----
Average value	When all channels have made N samplings simultaneously, N is selectable from 2, 4, 8, 16, 32, 64, 128 and 256		
<b>Input</b>			
Input coupling	DC, AC, GND		
Input impedance	72-2650	1±2%MΩ with 21pF±3pF	
	72-10510 72-8225A 72- 8705A 72-8710A	1±2%MΩ with 24pF±3pF	
Probe attenuation	1X, 10X, 100X, 1000X		
Maximum input voltage	400V(DC+AC peak, 1MΩ input impedance)		
Time delay between channels (typical)	150ps		
<b>Horizontal</b>			
Waveform interpolation	Sin (x) / x		
Record length	2 x 512k sampling point		
Scanning range (s/div)	72-8705A 72-8710A	2ns/div-50s/div	
	72-8225A	5ns/div-50s/div	
	72-10510	10ns/div-50s/div	
Accuracy of sampling rate and delay time	±50ppm (any time interval ≥1m)		
Time interval (ΔT) measurement accuracy (full bandwidth)	Single: ±(1 sampling time interval + 50ppm X reading + 0.6ns) >16 average values: ±(1 sampling time interval + 50ppm x reading + 0.4ns)		



<b>Vertical</b>			
A/D converter	8-bit resolution, two channels sampled simultaneously		
Deflection factor VOLTS/DIV Range at input BNC	72-2650	2mV/div~5V/div	
	72-10510 72-8225A 72-8705A 72-8710A	1mV/div~20V/div	
Position range	±10div (72-10510)		
Selectable bandwidth limit (Typical)	20MHz		
Low frequency response (AC coupling, -3dB)	≤10Hz at BNC		
DC gain accuracy	72-2650 ± 4% When vertical sensitivity is 2mV/div, 5V/div ± 3% When vertical sensitivity is 10mV/div, 5mV/div		
	72-10510 72-8225A 72-8705A 72-8710A ±5% When vertical sensitivity is 1mV/div or 2mV/div ± 4% When vertical sensitivity is 5mV/div ± 3% When vertical sensitivity is 10mV/div, 20mV/div		
DC measurement accuracy (average sampling mode)	72-2650 When vertical position is 0 and N≥16: ±(4%x reading+0.1div+1mV) and 2mV/div~5mV/div. ±(3%x reading+0.1div+1mV) and 10mV/div~5mV/div. When vertical position is not 0 and N≥16: ±(3%x(reading+vertical shift reading) +(1%xvertical shift reading) + 0.2div) Set from 2mV/div to 200mV/div plus 2mV. Setup value >200mV/div to 5V/div plus 50mV.		
	72-10510 72-8225A 72-8705A 72-8710A When vertical position is 0 and N≥16: ±(5%x reading+0.1div+1mV) and 1mV/div or 2mV/div. ±(4%x reading+0.1div+1mV) and 5mV/div. ±(3%x reading+0.1div+1mV) and 10mV/div~20mV/div. When vertical position is not 0 and N≥16: ±(3%x(reading+vertical shift reading) +(1%xvertical shift reading)+ 0.2div) Set from 5mV/div to 200mV/div plus 2mV; Setup value >200mV/div to 5V/div plus 50mV.		
Voltage difference (ΔV) measurement accuracy (average sampling mode)	Under identical setup and environmental conditions, the voltage difference (ΔV) between two points of the waveform after the average of ≥16 waveforms acquired waveforms is taken: ±(3% x reading + 0.05 div)		
<b>NOTE:</b> The range of deflection factor for 72-10510 is 2mV/div~10V/div (in the place of BNC).			
<b>Bandwidth for each model</b>			
Model	Analogue	Real Time	Rise Time
72-2650	200MHz	100MHz	1.8ns
72-8710A	100MHz	100MHz	3.5ns
72-8705A	50MHz	50MHz	7ns
72-8225A	50MHz	50Mhz	7ns
72-10510	25MHz	25MHz	14ns

<b>Trigger</b>		
Trigger sensitivity	≤1 div	
Trigger level range	Internal	±5 div from the centre of the screen
	EXT	±3V
	EXT/5	±15V
Trigger level accuracy (Typical) applied on signals of ≥20ns rise or fall time	Internal	± (0.3 div x V/div) within ± 4 div from the centre of the screen)
	EXT	± (6% default value + 40mV)
	EXT/5	± (6% default value + 200mV)
Trigger capability	Normal mode/scanning mode, pre-trigger/delayed trigger Pre-trigger depth is adjustable	
Holdoff range	80ns - 1.5s	
Set level to 50% (Typical)	Input signal frequency ≥50Hz	
<b>Edge Trigger</b>		
Edge type	Rise, Fall, Rise & Fall	
<b>Pulse Trigger</b>		
Trigger mode	(Less than, greater than or equal) positive pulse; (Less than, greater than or equal) negative pulse	
Pulse width	20ns - 10ns	
<b>Video Trigger</b>		
Trigger sensitivity (Video trigger, Typical)	Internal	2 div peak to peak
	EXT	400mV
	EXT/5	2V
Signal format and line/field frequency (video trigger type)	Supports standard NTSC and PAL Line range: 1-525 (NTSC) and 1-625 (PAL)	
<b>Alternate Trigger</b>		
CH1 trigger	Edge, pulse, video	
CH2 trigger	Edge, pulse, video	
<b>NOTE:</b> EXT/5 function is only for 72-2650 and video trigger function for 72-2650 and 72-10510		
<b>Measurement</b>		
Cursor	Manual Mode	Voltage difference ( $\Delta V$ ) between cursors, time difference ( $\Delta T$ ) between cursors, $\Delta T$ countdown (Hz) ( $1/\Delta T$ )
	Tracking mode	Voltage or time value of waveform dots
	Auto measurement mode	Allows cursor or display during auto measurement

Auto measurement	Measuring peak to peak, amplitude, maximum, minimum, top, base, middle, average, root mean square value, overshoot, pre-shoot, frequency, cycle, rise time, fall time, positive pulse, negative pulse, positive duty ratio, negative duty ratio, delay 1->2f and delay 1->2f		
Math functions	+, -, x, ÷		
Saving waveforms	20 groups and 20 setups		
FFT	Window	Hanning, Hamming, Blackman, Rectangle	
	Sampling points	1024 points	
Lissajous figure	Phase difference	±3 degrees	
Reading resolution	6 bits		
Trigger sensitivity	≤30Vrms		
Accuracy (typical)	±51ppm (+1 character)		
<b>Display</b>			
	72-2650	72-10510 72-8225A	72-8705A 72-8710A
Display type	LCD 145mm (5.7")	LCD 178mm (7")	LCD 178mm (7")
Display resolution	320 x240 RGB	400x240 RGB	800x480 RGB
Display	Colour		
Contrast (Typical)	Adjustable (colour)		
Backlit intensity (Typical)	300nit		
Display languages	Simplified Chinese, Traditional Chinese, English		
<b>Interface Function</b>			
	72-2650	1 x USB device, 1 USB host	
Standard Configuration	71-10510 72-8225A 72-8705A 72 8710A	1 USB OTG	
Optional component	LAN communication port for 72-2650		

<b>Power Source</b>	
Mains voltage	100-240V AC rms 45-440Hz, CAT II
Power consumption	Less than 30VA
Fuse	F1.6AL 250V
<b>Environmental</b>	
Temperature	Operating: 0°C - 40°C (32°F - 104°F) Storage -20°C - 60°C (4°F - 140°F)
Cooling	Forced fan cooling
Humidity	<35°C: ≤90%RH (<95°F ≤90%RH) +35°C~40°C: ≤60%RH (<95°F~104°F ≤60%RH)
Altitude	Operating: under 3000m Non-operating: under 15,000m

Dimensions			
		72-2650	72-10510 72-8225A 72-8705A 72-8710A
Size	WIDTH	320mm	306mm
	HEIGHT	150mm	147mm
	DEPTH	130mm	122mm
Weight	Exc Packaging	2.5kg	2.2kg
	Inc Packaging	4.0kg	3.3kg
IP rating		IP20	
Adjustment interval		Recommended calibration interval is one year	

## MAINTENANCE

### Cleaning

- Periodically wipe the case with damp cloth and mild detergent. Do not use abrasives or solvents for cleaning. Disconnect from the mains first.
- Clean the measurement probe tips occasionally, as dirt on the probes can affect reading accuracy.
- Take care to avoid scratching the glass display when cleaning the LCD.
- Do not leave the oscilloscope where the LCD screen will be exposed to strong direct sunlight for long periods.



### INFORMATION ON WASTE DISPOSAL FOR CONSUMERS OF ELECTRICAL & ELECTRONIC EQUIPMENT.

When this product has reached the end of its life it must be treated as Waste Electrical & Electronic Equipment (WEEE). Any WEEE marked products must not be mixed with general household waste, but kept separate for the treatment, recovery and recycling of the materials used. Contact your local authority for details of recycling schemes in your area.



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