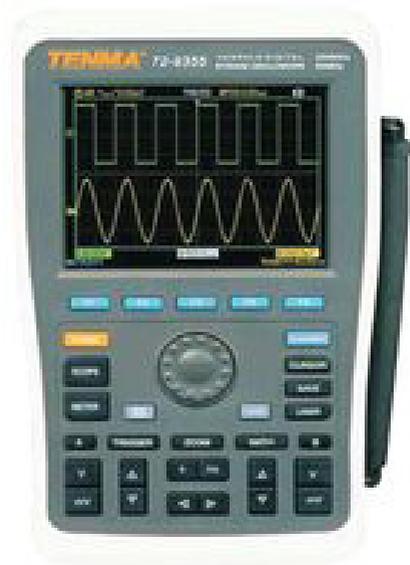# Digital Storage Oscilloscope

Model No. 72-9355, 72-9360 & 72-9365

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 600V 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 it's 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 channels; vertical deflection width range : 5mV/div – 50V/div.
- Automatic waveform and status configuration.
- Storage of waveforms, setups and interfaces.
- Screen copy function.
- Fine window extension; precise analysis of waveform details and overview.
- Automatic measurement of 27 waveform parameters.
- Cursor measurement function.
- Unique waveform recording, storage and replay function.
- USB interface that supports USB2.0.
- Bright colour/mono 5.7 inch LCD panel at 320 x 240 pixel aspect ratio.
- Built-in FFT.
- Multiple waveform math functions (including add, subtract, multiply and divide).
- Edge, video, pulse width, and alternate trigger functions.
- Multimeter function.
- USB drive system software upgrade.
- Multilingual menu displays.

WHAT'S INCLUDED

- 2 x 1.2m, 1:1/10:1 probe (conforms with EN 61010-031:2002+A1:2008)
- Power cable
- User Manual
- 2 x current-to-voltage converter module
- Multimeter pen
- DC adaptor

OPERATING PARAMETERS

- User-friendly front panel with clear labelling to enable access to all basic functions for easy operation.
- 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.

Model	Bandwidth	Sampling Rate	Display
72-9355	60MHz	250MS/s	Colour
72-9360	100MHz	500MS/s	Colour
72-9365	200MHz	1GS/s	Colour

CONTROLS AND CONNECTIONS

- The oscilloscope comes with a front panel with at-a-glance functions for easy operation.
- There are function keys and a special function jog dial on the front panel.
- The row of 5 keys at the bottom of the display panel are menu operation keys (designated as [F1] to [F5] from left to right). With these 5 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.

- Apart from the waveform display zone, the display panel also features other details about the waveform and the unit's control setup. These are explained by their sequence numbers in the above figure:

1. Trigger source status display is as follows:
   A. Select signals of Channel A as the trigger signal source.
   B. Select signals of Channel B as the trigger signal source.
   AB. Select signals of Channels A and B as the alternate trigger signal source
2. Trigger coupling mode display is as follows:
   ~ AC trigger coupling mode, i.e. only AC quantities larger than 10Hz of the trigger signals can pass the coupling capacitor. The DC% will be intercepted. This is a general trigger coupling mode.

Power on the unit

• You can select from two power supply methods : internal battery power or external DC adaptor power. Power supply voltage of the DC adaptor is grid voltage. After connecting to power, start the self calibration process by pressing the [USER] button then [F3]. This will ensure optimal performance.

Accessing signals

• Press UTILITY button then F1 and the screen will display DEFAULT SETUP.
• Connect the probe to the ChA input.
• Set the probe attenuation switch to 10X position.

Note 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: Select other menu in Channel A then set probe ratio to 10X with the jog dial.

• Return
• K-return
• Normal
• Invert
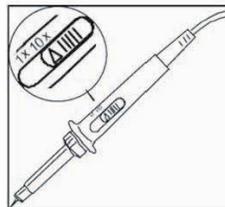
• Connect the probe tip and ground clamp to the output terminal of the function signal generator. Select a square wave of 1kHz output frequency and 3Vpp amplitude. Press [AUTO] and you will see a 1kHZ/3Vpp square wave in the display in a few seconds, as shown in Figure 1-5. Repeat steps 2 and 3 to check Channel B.
• Input A : On
  Coupling : DC
  Bandwidth limit ; Full bandwidth
  Bias Voltage : Others

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
- Pressing the $\boxed{\frac{V}{mV}}$ key to adjust the vertical range (V/div) of the oscilloscope, you can adjust the signal to a size best suited to screen.
- Pressing the key adjusts the position of the reference waveform so you can adjust the position on the screen display.

Horizontal control
- Pressing the $\boxed{S \ nS}$ key to change the horizontal time base range setup. Range of horizontal scanning rate is 5ns-50s/div (72-9360) in steps of 1-2-5.
- Pressing the key adjusts the position of the reference waveform so you can adjust the position on the screen display. You can observe more pre-trigger information.

The Trigger System :
- Press [TRIGGER] to adjust the trigger setup of the waveform.

INSTRUMENT SETUP

Resetting the Instrument
- To use factory setup, follow the steps below :
- After connecting to power press [POWER] to turn the oscilloscope on. When the power-on screen appears, press and hold the [CLEAR/MENU] key to select factory setup. When setup is done, this screen will appear.

Using the Jog Dial Function
- The jog dial is a multifunction control that enables easy operation and control of various menus. The example below illustrates the use of this dial.

Making menu selection with the jog dial

- Press [SCOPE]. The menu in the figure below appears at the bottom of the screen.
  - Parameter measurement
  - Frequency counter
  - Off
- Press F3 to select the display menu.
- With the jog dial, select the display type. The selected menu will appear bold. Turn the jog dial to make a selection, then press the jog dial once to confirm. The screen will then enter the next menu. If you wish to change the format repeat the above steps. Otherwise press the jog dial to close this menu.
- Press F5 to return to a previous selection option and reset that page.
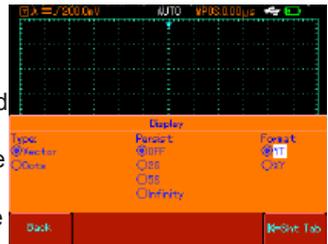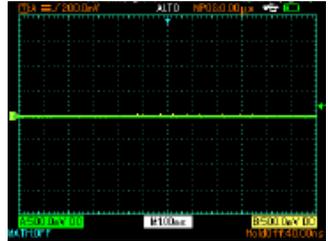
Vertical system setup
Channel A, Channel B and shifting signals vertically
- Each channel has its own menu. Set up each item for each channel individually. Press the [A] or [B] function key and the system will display the operation menu for Channel A or Channel B.

Input A	On Off	Channel A on Channel A off
Coupling	DC AC Ground	AC and DC quantities of input signal is allowed to pass. This mode is for observing DC or exchange signals with DC quantities. DC quantities of the input signal are intercepted. This mode is for observing exchange signals with DC quantities intercepted. DC level of the channel input terminal upon equivalent grounding is displayed.
Bandwidth Limit	Full Bandwidth 20MHz	The oscilloscope's frequency bandwidth is full bandwidth. Limit bandwidth to 20MHz to reduce display noise.
Bias Voltage	Voltage Reset to zero Return	Adjust the channel bias voltage with the jog dial. When the DC quantities of the signal being tested are much larger than the amplitude of the AC signal, you can offset the DC quantities with bias voltage. In this condition, you can observe the amplified AC signal. Reset the bias voltage to zero. Go back to the Channel A menu

| Others	Probe ratio	1X 10X 100X 1000X	Select one of the values based on the probe attenuation factor to keep the reading of the signal being measured correct.
	Polarity	Normal Invert	Normal waveform display Waveform is inverted

Setting channel coupling
- To apply a signal to Channel A. The signal being tested is a sine signal that contains DC quantities.
- Press [A] to select Channel A. Then press [F1] to set A input to "ON".
- Next press [F2] to select DC coupling. Both DC and AC quantities of the signal being tested and input to Channel A can pass through.

- Press [F2] to select AC coupling. DC quantities of the signal being tested and input to Channel A will be intercepted. Only AC quantities can pass through.

- Press [F2] to select ground coupling. The channel input is now set to equivalent ground. The channel input level appears on screen.
Note: In this mode, although waveform is not displayed, the input signal remains connected to the channel circuit.
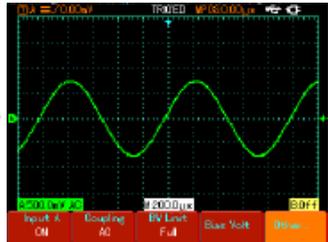
Setting the channel bandwidth limit
- Applying a signal to Channel B. The signal being tested is a signal stacked with high frequency quantities.
- Press [B] to turn Channel B on. Next press [F3] to set channel bandwidth to full bandwidth. The signal being measured can pass through even if it contains high frequency quantities.

- Press [F3] to set bandwidth limit to 20MHz. All high frequency quantities higher than 20MHz in the signal being tested will be limited.

7
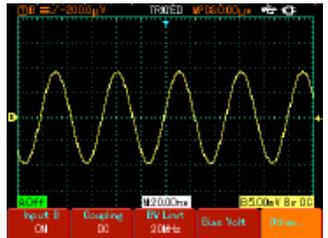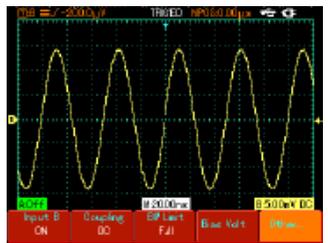
Setting bias voltage
- Bias voltage is suitable for observing the following signals:
- The input signal is made up of relatively high DC quantities and relatively low AC quantities.
- The input AC signal is very low in frequency and contains DC quantities. AC mode is unsuitable.
- Duty ratio of the signal is too small. Waveform details are hard to observe even in AC mode.

Setting 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 menu.
- Apply this principle to other values to ensure the voltage reading is correct.
- Press [A] to turn Channel A on, then press [F5]. Select "Others" and select 10X probe ratio with the jog dial, as shown.
- Next press the jog dial once to confirm, then press the jog dial again to close the menu.

  The screen shows the setup and vertical range display when the probe is set at 10:1.
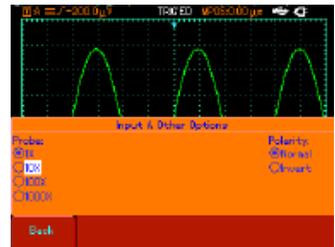
Setting the waveform polarity
- Inverted waveform : This indicates the signal is 180° inverted in relation to the channel ground level. The example below shows the setup for signal inversion and the display for inverted signal.
- Press [A] to turn Channel A on.
- Press [F5]. Select "Others" and select inverted polarity, as shown in Figure 2-13.
- Press the jog dial once to confirm, then press the jog dial again to close the menu.

- The screen shows the channel polarity inverted.

Changing the signal time base and horizontal shift
- Accelerate or decelerate the oscilloscope's scanning rate by pressing [S | nS] from 5ns/div~50s/div (72-9360).

Note: Minimum horizontal time base range of the 72-93xx Series varies from model to model.

Trigger System Setup
- 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.
- While waiting for the triggering condition, the oscilloscope will continue acquiring sufficient data to draw a waveform on the right side of the trigger point. You can set trigger functions with the trigger function key [TRIGGER].

Trigger : Key for the trigger function setup menu.
Trigger level : Trigger level is set to a signal voltage that matches the trigger point (by turning the jog dial).
Trigger types : Edge, Video, Pulse.
Edge trigger : Trigger is set to occur when the signal is at the rising or falling edge. You can set the trigger level 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.

| Function	Setup		Explanation
Trigger	Edge		Set edge as the trigger type
Trigger source	A B Alternate		Set Channel A as the signal source trigger signal. Set Channel B as the signal source trigger signal. A and B trigger their individual signals alternately
Trigger Setup	Trigger Mode	Auto Normal Single	Waveform is acquired even when no trigger condition is detected. Acquisition takes place only when trigger condition is met. One waveform is acquired when one trigger is detected. Acquisition then stops.
	Trigger Coupling	AC DC H/F Suppression L/F Suppression	Allow AC and DC quantities of the input signal to pass. Intercept DC quantities of the input signal. Reject low frequency quantities below 80kHz of the signal. Reject high frequency quantities above 80kHz of the signal
Slew Rate	Rise Fall		Set to trigger at the signal's rising edge. Set to trigger at the signal's falling edge.
Holdoff	40ns – 1.5s		Adjust holdoff time.

Adjusting Hold-off Time
- You can adjust the hold-off time to observe complicated waveforms (e.g. pulse string series). Hold-off time means adjusting the data acquisition cycle of the digital storage oscilloscope. It is an exact multiple of the cycle of the complicated waveform being tested, thus synchronization is possible.

For example: if the signals being tested are a group of wave signals, apply them to Channel A then press [TRIGGER] to select edge trigger mode. Next press [F5] to activate hold-off adjustment and adjust hold-off time with the jog dial. Hold-off time will change accordingly until waveform display is stable, as shown.

Note: Hold-off time is usually slightly shorter than the "large cycle" time. When observing the RS-232 communication signal, it is easier to achieve stable synchronization of hold-off time is slightly shorter than the starting edge time of every set of data.
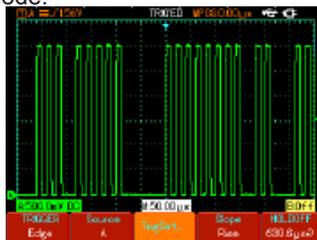
Pulse Trigger
- When the pulse width of the trigger signal reaches a preset trigger condition, trigger occurs.
- Pulse trigger means determining the triggering time based on the pulse width. You can acquire abnormal pulse by setting the pulse width condition.

Function	Setup		Explanation
Trigger	Pulse		Set edge as the trigger type.
Trigger source	A B Alternate		Set Channel A as the signal source trigger signal. Set Channel B as the signal source trigger signal. A and B trigger their individual signals alternately.
Trigger setup	Trigger mode	Auto Normal Single	Set to acquire waveform only if no trigger is detected. Set to acquire waveform only if trigger condition is satisfied. Set to acquire one waveform when one trigger is detected, then stop.
	Trigger coupling	AC DC H/F Reject L/F Reject	Intercept AC and DC quantities of the input signal. Intercept DC quantities of the input signal. Suppress low frequency quantities below 80kHz of the signal. Suppress high frequency quantities above 80kHz of the signal.
Pulse width	40ns – 6.40s		Set pulse width with the jog dial.
Pulse width setup	Pulse width condition	= < >	Trigger occurs when pulse width equals to the set value. Trigger occurs when pulse width is smaller than the set value. Trigger occurs when pulse width is larger than the set value.
	Pulse width polarity	Positive Negative	Set the positive pulse width as the trigger signal. Set the negative pulse width as the trigger signal.

Video trigger : Carry out field or line trigger with NTSC or PAL standard video signals.

Functions Menu	Setup	Notes
Trigger	Video	Set video trigger as trigger type.
Trigger source	A B Alternate	Set A as the signal source trigger signal. Set B as the signal source trigger signal. A and B trigger their individual signals respectively.
Standard trigger	PAL NTSC	Suitable for PAL video signals. Suitable for NTSC video signals
Synchronisation	All lines Specified lines Odd field Even field	Set the TV line to synchronize with trigger. Set synchronized trigger on the specified line and adjust with the jog dial. Set the video odd field to synchronized trigger. Set the video even field to synchronized trigger.

- When PAL is selected for standard format and synchronization mode is "specified line", you will see a screen display as shown.
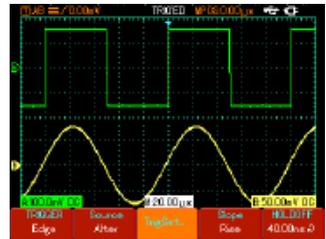
- When synchronization mode is "odd field", you will see a screen display as shown.

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

Definitions
1. **Trigger source**: Trigger can be obtained from various sources : Input channel (A or B) and alternate.
- Input Channel : The most common trigger source is input channel (choose A or B). The channel selected as trigger source can operate normally only when the corresponding input channel is on.
2. **Trigger mode**: Determine the action of your oscilloscope at trigger by selecting the mode. This oscilloscope offers three trigger modes for selection: auto, normal and single.
- Auto Trigger: The system will acquire waveform data automatically 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 for signal synchronization. Note: When time base of the scan range is set to 50ms/div or slower, the oscilloscope will enter the "Scan" mode.
- 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 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.
- Low Frequency Suppression: Intercepting DC quantities and attenuating low frequency quantities under 80kHz.
- High Frequency Suppression: Attenuating high frequency quantities over 80kHz.

4. **Pre-trigger/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 pre-trigger and delayed information. Adjusting the horizontal position of the waveform allows you to see more pre-trigger information. By observing pre-trigger 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.

Acquisition Modes, Display and Automatic Measurement
• Press [SCOPE] to access frequently used function options, as shown in the table.

Functions Menu	Setup	Notes
(Press F1) Acquisition mode See Note A	Sampling Peak detect Average	Set to standard sampling mode. Set to peak detect mode. Set to average sampling and display the average number of times.
Average number of times (when average sampling is selected)	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 jog dial.
Sampling mode	Real time Equivalent	Set sampling to real time. Set sampling to equivalent at a time base range of 5ns~100ns/div.
(Press F3) Display type See Note B	Vector Dot	Sampling points are linked for display. Sampling points are directly displayed.
Duration	Off 2s 5s Infinite	Waveform on the screen is refreshed at normal rate. Waveform on the screen is maintained for 2 seconds and then refreshed. Waveform on the screen is maintained for 5 seconds and then refreshed. Waveform on the screen remains on display. New data will be added continuously.
Format	YT XT	Operating mode of the oscilloscope. X-Y is the display mode; A input signal is X signal, B input signal is Y signal.
(Press F2) Parameter Measurement	Customised All parameters OFF	The screen displays only user-defined parameters. All 27 parameters are displayed. Close the automatic measurement function.
Customised parameters	Parameter 1 Parameter 2 Parameter 3	Up to 3 parameters can be displayed simultaneously on screen.
No. of parameters	Total 27	Select with the jog dial
Channel	A B OFF	Display measurement value of Channel A. Display measurement value of Channel B. Close the automatic measurement display.
Indicator	Parameter 1 Parameter 2 Parameter 3	This function offers visual indication of the parameter being tested.
Frequency Counter	ON OFF	Turning the frequency counter on/off

Note A
- Use Real time sampling to observe single signals.
- Use Equivalent sampling to observe high frequency cyclical signals.
- To avoid mixed envelop, 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 :
1. **Normal sampling mode** : The digital storage oscilloscope acquires signal sample at equal and regular intervals to reconstruct the waveform.
2. **Peak detect mode** : In this acquisition mode, the digital storage oscilloscope identifies the biggest and smallest values of the input signals at each sampling interval and uses these values to display the waveform. In effect, it can acquire and display narrow pulse which would otherwise be omitted in the sampling mode. Noise seems to be more significant in this mode.
3. **Average mode** : The digital storage oscilloscope acquires several waveforms and takes the average value to display the final waveform. You can use this mode to reduce random noise.

Note B
Definitions :
1. **Display Type** : Vector display fills the space between adjacent sample points in the display. Dot display shows only the sampling points.
2. **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.
3. **X-Y Mode**
   This mode can be activated only when Channel A and Channel B are both on. After selecting the X-Y display mode, the horizontal axis will display the A signal, while the vertical axis will display the B signal.

Caution: In the normal X-Y mode, you can adjust waveform amplitude with VOLTS/DIV of the two channels. Adjusting the s/DIV time base will result in a lissajous figure of better display quality. The following functions are disabled in the X-Y display mode:
- Automatic measurement mode
- Cursor measurement mode
- Reference or function waveform
- Vector display type
- Trigger control

4. **Y-T Mode**: In this mode the Y axis indicates voltage and the X axis indicates time.
5. **X-Y Mode**: In this mode the X axis indicates Channel A voltage and the Y axis indicates Channel B voltage.
6. **Slow Scanning Mode**: When 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 channel coupling to DC.
7. **S/ns** : 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.

To display the measurement peak-to-peak value of Channel A
- Press [A] to turn on Channel A.
- Press [SCOPE] to enter the frequently used function menu.
- Press [F2] to enter the parameter measurement options.
- Press [F1] to select customized parameter for parameter measurement.
- Press [F2] to select parameter 1 as the customized parameter.
- Press [F3] then turn the jog dial to select peak-to-peak value, then press the jog dial once to confirm and exit from the current menu.
- Press [F4] to select Channel A.
- Press [F5] to set indicator to parameter 1.
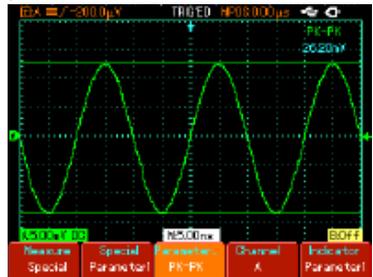
Note : Customized parameters are for quick parameter measurement. This device has 27 measurement parameters. In general use, the user is not required to measure all parameters. Only a few have to be tested. In this case, set the parameters you require as customized parameters. All such parameters will be displayed on the screen.

Automatic measurement of parameters
Your oscilloscope can automatically measure the following voltage parameters of the waveform :
- Maximum value (Vmax): The voltage value from the highest point to ground (GND).
- Minimum value (Vmin): The voltage value from the lowest point to ground (GND).
- Top value (Vtop): The voltage value from top to ground (GND).
- Base value (Vbase): The voltage value from base to ground (GND).
- Middle value (Vmid): Half of the amplitude value.
- Peak-to-peak value (Vpp): The voltage value from the highest point to lowest point.
- Amplitude value (Vamp): The voltage value from top to base.
- Overshoot: The ratio value of the difference between maximum value and top value to the amplitude value.
- Preshoot: The ratio value of the difference between minimum value and top value to the amplitude value.
- Average value: 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.

Your oscilloscope can automatically measure the following time parameters:
- Rise Time: The time taken by the waveform to rise from 10% to 90%.
- Fall Time: The time taken by the waveform 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.
- Rising delay (Rise): Delayed time of the rising edge from A to B.
- Falling delay (Fall): Delayed time of the falling edge from A to B.
- Positive duty ratio (+Duty): Ratio of positive pulse width to cycle.
- Negative duty ratio (-Duty): Ratio of negative pulse width to cycle.

To display all measurement values of Channel A
- Press [A] to turn on Channel A.
- Press [SCOPE] to enter the frequently used function menu.
- Press [F2] to enter the parameter measurement options.
- Press [F1] to select customized parameter for parameter measurement.
- All measurement parameters will be shown on screen.

Storage Setups and Screen Copy
- Press [SAVE] to access the storage menu.
- You can save and recall waveforms and setup documents on the oscilloscope's internal memory and any USB device. You can also save and recall waveform documents and setup documents on a USB device.

Functions Menu	Setup	Notes
Save	Setup Waveform A Waveform B	Save the current setups of all menus. Save the Channel A waveform. Save the Channel B waveform.
Medium	Internal USB	Save the setup and waveform documents internally. Save the waveform document on the USB device.
Position	1~10	Set and select the storage position with the jog dial.
Run		Run the previously selected operation.
Return		Go back to previous menu.

Screen copy
- With this function, you can save the display interface on the USB device.
- Press [A] to turn on Channel A.
- Insert the USB device into the USB jack.
- Press and hold the [SAVE] button for 4 to 5 seconds and then release. The "Saving......." progress bar will appear. The display interface is successfully saved on the USB device when that progress bar disappears.
- You can see the saved USB image on your computer. It is saved in the root directory of the USB device.

Recall
- In the storage menu press [F2] to select the recall function:

Functions Menu	Setup	Notes
Save	Setup Reference waveform	Recall a saved setup. Recall and display a saved waveform.
Source	Internal USB	
Position	1~10	Set and select the storage position with the jog dial.
Run		Run the previously selected operation.
Return		Go back to previous menu.

To request recalling a recorded waveform document saved on the USB device
•   Insert the USB device and press [SAVE] to access the storage menu. Press [F3] to
    select the recording function.
•   Press [F3] to select "import", then press [F2] to
    activate the "USB document" option. Select "3" with
    the jog dial and press [F4]. The playback waveform
    will appear on screen when the "Loading......."
    progress bar disappears.
•   If [F3] is pressed again, all recorded waveform
    screens will be displayed. Press [F3] to stop
    playback, then select playback of a certain screen of
    waveform with the jog dial.
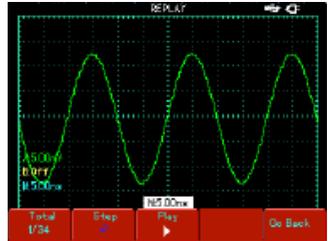
Record
•   Press [SAVE] to access the storage menu, then press [F3] to select the record
    function.
•   Press [F1] to activate the waveform recording function. The system enters the
    recording mode. The number of screens being recorded is shown in the top right
    corner.
•   When all specified screens are recorded, press [F1] to close the recording function.
    All recorded waveforms will be saved internally.
•   Insert the USB device and press [F4] to access the record and save menu. Press
    [F2] to activate the "USB document" option, then select "3" with the jog dial.
•   Press [F4]. The waveform is successfully recorded on the USB device when the
    "Saving......." progress bar disappears.

Functions Menu	Setup	Notes
Waveform record	ON OFF	Recall a saved setup. Recall and display a saved waveform.
Playback	Screen Single screen Playback Return	The number of screens being played and total number of screens Select single screen playback with the jog dial. Play and pause a recorded waveform document. Go back to the previous menu.
Import	USB document (1-10)	Import the recorded waveform document on the USB device to the oscilloscope.
Save	USB document (1-10)	Save the recorded waveform on the USB device.
Return		Go back to previous menu.

Note: Your 72-93xx Series Digital Storage Oscilloscope can record up to 1,000 screens
of waveform data. If any of the following operations is activated during recording, the
oscilloscope will restart recording from screen 1 again :
•   Changing vertical range of the signal
•   Changing horizontal time base of the signal
•   Changing horizontal position of the signal
•   Changing vertical position of the signal

Cursor Measurement
- Press [CURSOR] to display the cursor measurement menu, and then press [F1] to activate the cursor.
- The [CURSOR] menu offers two cursor measurement modes: voltage and time.
- When measuring voltage, press [F2] on the front panel and the jog dial to adjust the positions of the two cursors for ΔV measurement. Likewise, by selecting time, you can measure Δt.

Voltage/time measurement modes: Positions of cursor 1 and cursor 2 can be adjusted with the jog dial and [F2] key.
- Press [F2] to make the cursor move in solid line, and then adjust it with the jog dial to a desired position. If you require to move two cursors simultaneously, press [F4] to turn the "Co-Movement" function ON.
- The cursor measurement value is displayed in the top left corner.

Utility Function Setup
- Press [USER] to pop up the utility system setup menu.

Functions Menu	Setup		Notes
Option	Energy save mode	OFF 5 min 10 min 15 min 20 min	When operating with battery, the device will power off at the set interval to save battery power if the unit remains idle. If DC power adaptor is connected, this energy-save mode is disabled.
	Language	Simplified Chinese Traditional Chinese English	Select the interface language
	Interface design	Classic Traditional Modern	Set the interface design
Help	ON OFF		Turn the help function on/off.
Auto calibration	Cancel OK		Cancel auto system calibration. Run auto system calibration.
System info			Display the software and hardware version information
Contrast			Adjust the display brightness

Setting the energy-save mode
- The initial auto power-off time is 10 minutes. To adjust this follow the steps below:
- Press [USER] for the utility menu.
- Press [F1] to access the user option menu.
- Select the energy-save off time with the jog dial.
- Press the jog dial to confirm until the current menu is closed.

Auto Calibration :
- You can correct measurement errors caused by environmental changes with the auto calibration function. This process can be run when necessary.
- To make calibration more accurate, power on your oscilloscope and allow 20 minutes to warm up.
- Then press the [USER] button, then [F3] and follow the on-screen prompts.

Operating Math Functions
- Math functions are displays of +, -, ×, ÷ and FFT mathematical results of Channel A and Channel B.
- Press [MATH] then [F1] to select FFT, +, -, ×, ÷ or OFF as the math type.

Functions Menu	Setup	Notes
Math	+ - x ÷ OFF	Signal source 1 + Signal source 2. Signal source 1 - Signal source 2. Signal source 1 x Signal source 2. Signal source 1 ÷ Signal source 2. Close the math function.
Signal source 1	A B	Set signal source 1 as Channel A waveform. Set signal source 1 as Channel B waveform.
Signal source 2	A B	Set signal source 2 as Channel A waveform. Set signal source 2 as Channel B waveform.
Vertical range	5mV-50V	Display the current math range and adjust with the jog dial.
Shift	--	You can shift the math waveform with the jog dial.

- Press [MATH] then [F1] select FFT as the math type.

Functions Menu	Setup	Notes
FFT	Hanning Hamming Blackman Rectangle	Set Hanning window function. Set Hamming window function. Set Blackman window function. Set Rectangle window function.
Signal source	A B	Set A as the math waveform. Set B as the math waveform.
Horizontal range	305.1 MHz-244.1MHz	Display the frequency per division (f/div) of the current horizontal axis.
Vertical range	5mV-50V	Display the current FFT range and adjust with the jog dial.
Shift	--	You can shift the math waveform with the jog dial.

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
- Analyze oscillation

How to operate FFT functions
- Signals with DC quantities or offset signals 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.

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

| FFT Window	Feature	Most suitable measurement item
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.
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.

Definitions:
FFT recognition rate: It means the quotient of the sampling and math points. When math point value is fixed, the sampling rate should be as low as possible.
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.

Window Extension

- Window extension can be used to zoom in a band of waveform to check image details. The window extension setting must not be slower than that of the main time base as shown.
- In the window extension mode, the display is divided into two zones as shown in Figure 2-28. The upper part displays the original waveform. You can move the horizontally extended part of this zone left and right with the ◁ ▷ button, or enlarge and reduce the selected zone with the S nS button.
- The lower part is the horizontally extended waveform of the selected original waveform zone. Please note that the recognition rate of extended 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 pressing the S nS button to decrease the size of the selected zone. In other words, you can increase the multiple of waveform extension.
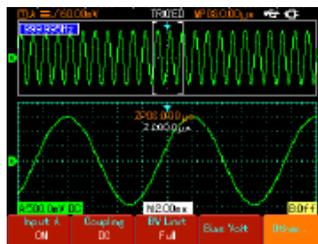
Hiding the Menus
- Use the [CLEAR/MENU] key to hide the current menu. To display a menu, press any menu key.

Using the Run button
- There is a [RUN/STOP] button on the front panel. When this button is pressed your oscilloscope stops acquiring data. To restart data acquisition, press it again.

Auto Setup:
- Auto Setup can simplify 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, so as to ensure stable waveform display.
- When the oscilloscope is in auto setup mode, the system setup is as in the table below.

Function	Setup
Acquisition mode	Sampling
Display format	YT
SEC/DIV	Adjusted according to signal frequency
VOLT/DIV	Adjusted according to signal amplitude
Trigger mode	Edge
Trigger level	Mid point of the signal
Trigger coupling	AC
Trigger source	Set to A but if there is no signal in A and a signal is applied to B it will be set to B
Trigger slew rate	Rising
Trigger type	Auto

Multimeter Measurement
- Operation instructions: Open the multimeter function menu by pressing [METER].

Functions Menu	Setup	Notes
Type	DC voltage AC voltage Resistance ON/OFF Diode Capacitance DC current AC current	Select the DC voltage measurement mode. Select the AC voltage measurement mode. Select the resistance measurement mode. Select the ON/OFF measurement mode. Select the diode measurement mode. Select the capacitance measurement mode. Select the DC current measurement mode. Select the AC current measurement mode.
Range mode	Auto Manual	The multimeter automatically selects an appropriate range for measurement. The user manually selects an appropriate range for measurement.
Range		Display the current measurement range.
Trend plot	ON/OFF	Turn the trend plot function on/off. This function records the moving trends of voltage, current, resistance within a specified period.
Zero line value		When trend plot is on, the zero line value enhances the trend plot resolution.

Definitions of System Prompts
1. **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 deflection factor switch, time base switch, X shift, vertical shift and trigger level adjustments have reached their ultimate limits, this prompt will appear.
2. **USB Device Installed:** After a USB device is plugged into the oscilloscope, this prompt appears when the connection is valid.
3. **USB Device Unplugged:** After a USB key is unplugged from the oscilloscope, this prompt appears:
4. **Saving...... :** When the oscilloscope is saving a waveform, this prompt is shown on the screen. A progress bar appears at the bottom.
5. **Loading...... :** During waveform recall, this prompt is shown on the screen. A progress bar appears at the bottom.
6. **Function Disabled:** This prompt appears when [ZOOM] is pressed at 5ns-100ns time base.

TROUBLESHOOTING

1. If the screen of your oscilloscope remains black without any display after powering on, follow the steps below to find the cause:
   • Check if the power switch is properly pressed.
   • Plug in the DC power adaptor and check if the battery is out.
   • Check the power cable connection.
   • Restart the unit after performing the above checks.
   • If the unit still fails to power on, contact UNI-T to request service.
2. If no waveform is displayed after you have acquired a signal, follow the steps below to find the cause:
   • Check whether the probe is properly connected to the signal lead.
   • Check whether the signal lead is properly connected to the BNC (channel adaptor).
   • Check whether the probe is connected properly to the object to be measured.
   • Check whether the object for measurement is generating signals (connect the channel with signals to the questionable channel to find the cause).
   • 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:
   • Check the trigger source setup in the trigger menu. See whether it is the same as the actual signal input channel.
   • Check the trigger type: Use edge trigger for ordinary signals and video trigger for video signals. Stable waveform display is achieved only when the correct trigger mode is selected.
   • 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]
    • 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.
    • Press [AUTO] to complete the setup.
6. Display speed is slow after average sampling time is enabled:
    • If average sampling is carried out for more than 32 times, the display speed will drop. This is normal.
    • You can reduce the intervals of average sampling.
7. Trapezoidal waveform display:
    • This is normal. The reason is possibly horizontal time base range is too low. You can improve horizontal pixel aspect ratio and enhance the display quality by increasing the horizontal time base.
    • 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.

UPGRADE

Product program upgrade
• You can obtain the program upgrade pack from our marketing department or download it online from our website. Use the built-in program upgrade system of the oscilloscope to upgrade the program so that it is the latest version released by Tenma and UniTrend.
• You have to own a compatible oscilloscope manufactured by Tenma. To check the model, hardware version and software version of the unit, go to the system information sub-menu under the user menu.
• The software upgrade pack that corresponds with the model and hardware version of the oscilloscope requiring upgrade is available online from our website or from our marketing department. The software version should be higher than the one currently installed.
• Prepare a USB device (disk format FAT). After decompressing the program upgrade pack, save it in the USB root directory. The program upgrade document has the suffix "uts".
• The FLASH type of the program upgrade pack must be the same as the oscilloscope to be upgraded.

Upgrade procedure
• 1. Power off the oscilloscope then insert the USB device with the program upgrade document into the USB HOST jack.
• 2. Press [POWER] to power on the oscilloscope and enter the program upgrade system welcome screen. The following message be appear, "Welcome to the USB program upgrade system. Please press [F5] to start upgrade or [F1] to cancel".
• Follow the on-screen prompts to select the file and upgrade the program.
Caution: If power is disconnected or the unit is turned off during this stage of program upgrade, the oscilloscope will fail to function normally. In that case you have to re-insert the USB device and complete the upgrade step by step as prompted before normal operation can be resumed.
When you restart the oscilloscope after successful upgrade, the system will initialise itself. It will take 30 seconds to 1 minute for the operation screen to appear.

SPECIFICATION

• Unless otherwise specified, all technical specifications apply to probes with 10X attenuation setting, and the oscilloscope has been powered on for 30 minutes at the specified ambient temperatures.

Sampling		
Sampling modes	Real time	Equivalent
Sampling rates	250MS/s (72-9355) 500MS/s (72-9360) 1GS/s (72-9365)	25GS/s
Sampling	Sampling, peak detect, average	
Average value	When all channels have made N samplings simultaneously, N is selectable from 2, 4, 8, 16, 32, 64, 128 and 256	
Input		
Input coupling	DC, AC, GND	
Input impedance	1MΩ±2% in parallel with 21F±3pF	
Probe attenuation	1X, 10X, 100X, 1000X	
Maximum input voltage	400V(DC+AC peak)	
Time delay between channels (typical)	50ps	
Horizontal		
Waveform interpolation	Linear	
Record length	2 x 512K sampling point	
Storage depth	7.5k	
Scanning range (s/div) At 1-2-5 increment.	2ns/div-50s/div (200MHz); 5ns/div-50s/div (100MHz, 60MHz);	
Accuracy of sampling rate and delay time	±50ppm (any time interval ≥1ms)	
Time interval ($\triangle$T) 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)	

Vertical			
Model	**72-9365**	**72-9360**	**72-9355**
Analogue bandwidth	200MHz	100MHz	60MHz
Single bandwidth	200MHz	100MHz	60MHz
Rise time	1.8ns, ≤2.3ns, ≤3.5ns, ≤4.3ns, ≤5.8ns, ≤8.7ns, ≤14ns		
A/D converter	8-bit resolution		
Deflection gratitude factor VOLTS/DIV Range	5mV/div ~ 50 V/div at input BNC		
Displacement range	±10div		
Selectable bandwidth limit (Typical)	20MHz		

Low frequency response (AC coupling, -3dB)	≤10Hz at BNC
DC gain accuracy	When vertical sensitivity is 5mV/div ±4% (sample or average sampling mode) When vertical sensitivity is 10mV/div~5V/div ± 3% (sample or average sampling mode)
DC measurement accuracy (average sampling mode)	When vertical shift is zero and N ≥16 : ± (4% x reading + 0.1 div + 1mV) and 5mV/div is selected; ± (3% x reading + 0.1 div + 1mV) and 10mV/div~50V/div is selected; When vertical shift is not zero and N ≥16 : ± (3% x (reading + vertical shift reading) + (1% x vertical shift reading)) + 0.2 div). Set from 5mV/div to 200mV/div plus 2mV; Setup value > 200mV/div to 50V/div plus 50mV.
Voltage difference (△V) measurement accuracy (average sampling mode)	Under identical setup and environmental conditions, the voltage difference (△V) between two points of the waveform after the average of ≥16 waveforms acquired waveforms is taken: ±(3% x reading + 0.05 div)
Trigger	
Trigger sensitivity	≤ 1 div
Trigger level range	±5 div from the centre of the screen
Trigger level accuracy (Typical) applied on signals of ≥20ns rise or fall time	± (0.3 div x V/div) within ± 4 div (from the centre of the screen)
Pre-trigger capability	Normal mode/scanning mode, pre-trigger/delayed trigger Pre-trigger depth is adjustable
Hold-off range	40ns – 1.5s
Set level to 50% (Typical)	Input signal frequency ≥50Hz
Edge Trigger	
Edge type	Rise, Fall
Pulse Trigger	
Trigger mode	(Less than, greater than or equal) positive pulse; (Less than, greater than or equal) negative pulse
Pulse width	40ns – 6.4s
Video Trigger	
Trigger sensitivity (video trigger, Typical)	2 div peak-to-peak
2 div peak-to-peak signal format and line/field frequency (video trigger type)	Supports standard NTSC and PAL Line range : 1-525 (NTSC) and 1-625 (PAL)
Alternate Trigger	
A Trigger	Edge, pulse, video
B Trigger	Edge, pulse, video

Measurement		
Cursor	Manual Mode	Voltage difference (△V) between cursors, time difference (△T) between cursors, △T countdown (Hz)(1/△T)
Auto measurement	Cursor display is allowed during auto measurement. Total 27 measurements : peak-to-peak, amplitude, maximum, minimum, top, bottom, mean, average, root mean square, overshoot, pre-shoot, frequency, cycle, rising time, falling time, positive pulse, negative pulse, positive duty ratio, negative duty ratio, rise delay, fall delay.	
Customized parameter measurement	3 types	
Math functions	+, −, x, ÷ Internal : 10 groups of waveforms and 10 setups.	
Saving waveforms	10 groups and 10 setups	
FFT	Window	Hanning, Hamming, Blackman-Harris, Rectangle
	Sampling points	1024 points
Lissajous figure	Phase difference	±3 degrees
Display		
Display type	145mm (5.7") diagonal liquid crystal	
Display resolution	320 horizontal by 240 vertical pixels	
Waveform display zone	Lateral 12 div, 25 dot/div Longitudinal 8 div, 25 dot/div	
Display	Adjustable	
Backlit intensity (Typical)	300nit	
Display languages	Simplified Chinese, Traditional Chinese, English	
Interface Functions		
Standard setup	1xUSB Host	
Optional		
Digital Multimeter		
DC voltage	Range : 600mV, 6V, 60V, 600V, 1000V Precision : ± (1% + 5 quantization words)	
AC voltage	Range : 600mV, 6V, 60V, 750V Precision : ± (1.2% + 5 quantization words)	
Resistance	Range : 600Ω, 6kΩ, 60kΩ, 600kΩ, 6MΩ, 60MΩ Precision : 60MΩ ± (1.5% + 3 quantization words) Others : ± (1.2% + 3 quantization words)	
On/Off test	Yes	
Diode measurement	Yes	
DC current external current voltage converter module	Range : 6mA, 60mA, 600mA, 6A, 10A Precision : 6mA-600mA ± (1% + 5 quantization words) 6A, 10A ± (1.2% + 5 quantization words)	

AC current measurement (external module)	Range : 6mA, 60mA, 600mA, 6A, 10A Precision : ± (2% + 5 quantization words)
Capacitance measurement	Range : 6nF, 60nF, 600nF, 6uF, 60uF, 600uF, 6mF Precision : 6nF ± (4% + 10 quantization words) 6mF ± (5% + 10 quantization words) Others : ± (4% + 10 quantization words)
Measurement modes	Auto/manual (Only manual mode is available for current measurement)
Maximum display number	5999
Power Source	
Mains voltage	100-240V AC rms 45-440Hz, CAT II
Power consumption	Less than 20VA.
DC power supply	72-9355 / 72-9360 : 3h / 72-9365 : 2h
Environmental	
Temperature	Operating: 0°C - 40°C (32°F - 104°F) Storage -20°C - 60°C (4°F - 140°F)
Cooling method	Natural 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	
Width	168mm
Height	268mm
Depth	60mm
Weight	1.8kg unit only, 4.5kg total
IP rating	IP2X
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.

Made in China. PR2 9PP
Man Rev 1.0