NATIONAL POLYTECHNIC INSTITUTE

ACADEMIC DEPARTMENT OF ELECTRICAL ENGINEERING
ACADEMY OF ELECTRICAL ENGINEERING

USER MANUAL

DIGITAL STORAGE OSCILLOSCOPE
FROM THE TDS 1002 SERIES

071-1068-00

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Content

Preface

This document is part of the manual and contains operating information. for the TDS 1012 series digital storage oscilloscope. It includes the following chapters:

. The chapter on initial procedures briefly describes the characteristics from the oscilloscope and provide installation instructions.

. The chapter Description of oscilloscope functions, describes the operation and Basic functions of the oscilloscope. Oscilloscope setup, triggers, data acquisition, scaling, and positioning of waveforms measurement form.

. The chapter Fundamentals of Use covers the operational principles of oscilloscope.

. The chapter Application Examples includes examples of a wide diversity of measures that will help solve their own problems of measure.

. The chapter References describes the selections or the range of values. available by option.

Help System

The oscilloscope features a help system with topics that cover all the characteristics of the oscilloscope.

General information about the knowledge and use of the oscilloscope, such as use of the menu system.

Information about specific menus and controls such as the control of vertical position.

•Advice on problems you may face when using a oscilloscope. Like noise reduction.

There are three ways to search for information: Context-sensitive help, hyperlinks and an index.

Context-sensitive help

The oscilloscope displays information about the last menu on the screen when pressed HELP. The move LED help located under the COMMAND POSITION HORIZONTAL lights up to indicate the alternative function of the remote control. If the theme use more than one page, turn the control SHIFT HELP to move from one page to another on the topic.

Hyperlinks

Most Help topics contain phrases marked with parentheses. angular, such as <Autoconfiguration>. It corresponds to links with other topics. Turn the MOVE HELP control to move the result of a link to another. Press the radio button Show topic to observe the topic corresponding to the highlighted link. Press the Back button to return to the previous topic.

Index

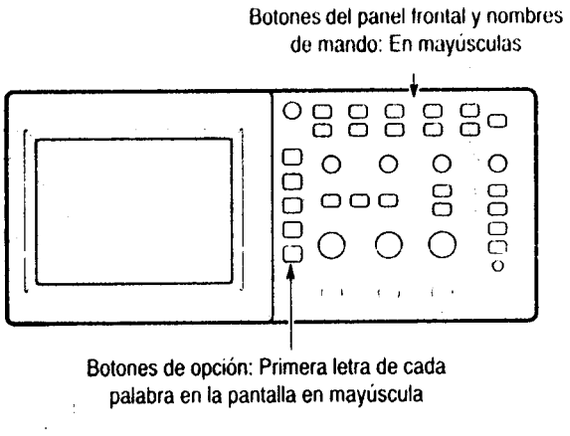
Press the HELP button on the front panel and then the button for the option index. Press the Previous page or Next page option buttons until find the page of the topic you are interested in consulting. Turn the joystick to scroll help even highlight a help topic, press the Show topic option button.

Note. Press the Exit option button or any menu button to remove the help text from the screen and return to the waveforms that are they present.

Conventions

The buttons on the front panel, controls, and connectors appear in uppercase. For example HELP, PRINT.

The menu options appear with the first letter of each word in Uppercase. For example: Det. Peak. Expand Window



Note. The option buttons are also called screen buttons. side menu buttons, bezel buttons or programmable keys.

The delimiter□Separate a series of button presses. For example. UTILITIES□ Options□ RS - 232 means that you have to press first the UTILITIES button, then the Options button and finally the option button RS -232.

Initial procedures

The TDS 1000 series digital storage oscilloscopes is a lightweight and small work surface package that can be used for take measurements with reference to the ground.

The following tasks can also be performed:

Install the product

Carry out a functionality test

•Perform a probe check and compensate probes

Equalize the probe attenuation factor

Use the self-calibration routine

Note. You can select a language when turning on the oscilloscope. In any
At the moment you can press the UTILITIES button and then the button for
language option to select the desired one.

General characteristics

Model	Channels	Bandwidth Speed of sampling	Screen
TDS 1002	2	60 MHz	1.0 GS/s	Monochromatic

Context-sensitive help system

Monochrome LCD screen

20 MHz bandwidth selection

Recording length of 2500 points per channel

Self-Configuration Menu

Probe Verification Assistant

Cursor with readings

Shot frequency reading

Once automatic measures

Averaged waveform and peak detection

Double time base

Fast Fourier Transform (FFT)

Pulse width firing capacity

Video shooting capability with line selection shooting

External shot

Configuration and storage of waveforms

Variable persistence presentation

RS–232, GPIB, and Centronics ports with the expansion module for TDS2CMA communications optional

User interface in ten selectable languages

Installation

Power cable

Use power cables designed for the oscilloscope. Use a power source. power supply that delivers 90 to 264 $VAC_{rms,}$ from 45 to 66 Hz.

Functionality test

Perform this quick test to verify that the oscilloscope works. correctly.

1. Turn on the oscilloscope.
   Wait for the screen to show that all tests have been passed.
   Turn-on. Press the CONFIG button. PRESET. The attenuation value
   The default for the Probe option is 10X.

2. Set the P2200 probe switch to 10X and connect the probe to channel 1 of the oscilloscope. To do this, align the slot of the probe connector with the BNC key of CH 1. Press until connected and turn to the right to secure the probe in its place.
   Connect the tip of the probe and the reference cable to the connectors. COMP SONDA.

3. Press the AUTOCONFIGURE button. In a few minutes you should see on the screen a square wave of approximately 5 V peak to peak at 1 KHz.

   Press the MENU CH 1 button twice to delete channel 1, press the button CH 2, to show channel 2.

Probe security

The protection around the probe body protects the fingers from electric shocks. electric

WARNING. To avoid electric shocks when using the probe, keep the fingers behind the probe body protection.

To avoid electric shocks while using the probe, avoid touching the metal parts. from the head of the probe while it is connected to a voltage source.
Connect the ground terminal of the oscilloscope probe to ground before I started to take measures.

Probe check assistant

You can use the probe check assistant to quickly verify that the probe operates correctly. The assistant also helps to adjust the probe compensation (which is generally adjusted with a screw located at the sonde body), and to set the probe attenuation factor in the menu.

vertical channel menu (for example, the menu that appears when pressing the MENU button CH1).

You must perform this check every time you connect a probe to a channel.
as an appetizer.

To use the probe check assistant, press the CHECK button
SONDA. If the probe has connected and compensated correctly, and the input
the vertical menu probe of the oscilloscope has been set to match
the probe. The oscilloscope will display an "OK" message at the bottom of the screen. Otherwise, the oscilloscope will display instructions on the screen.
help to guide you in solving these problems.

NOTE. The probe check is useful for probes 1X, 10X, and 100X;
it does not work with the BNC of the front panel DISP. EXT.

To compensate for a probe connected to the BNC of the front panel DISP EXT. Follow these steps:

1.Connect the probe to a BNC connector of the channel, such as CH1.

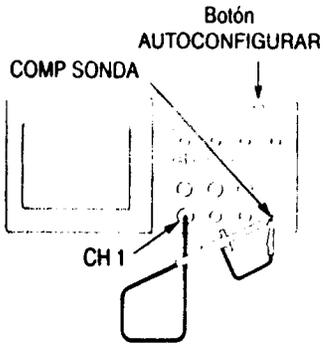
2. Press the CHECK PROBE button and follow the instructions indicated in screen.
3. After verifying that the probe is functioning correctly, connect the probe. to BNC of EXT. DISP.

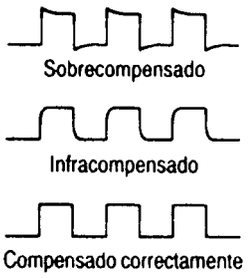
Manual probe compensation

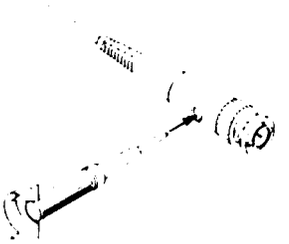
As an alternative method to probe checking, this can be done
manual adjustment to match the probe with the input channel.

1. Set the menu probe attenuation option for the menu of channels at 10X. Set the P2200 probe switch to 10X and connect the probe to channel 1 of the oscilloscope. If you use the hook tip of the probe, ensure a proper connection by firmly inserting the tip in the probe.
2. Connect the tip of the probe to the 5V connector of COMP SONDA and the reference cable to the ground connector. Show the channel and press the AUTOCONFIGURE button.
3. Check the appearance of the waveform.
4. If necessary, adjust the probe.

Repeat as many times as necessary.







Sonde attenuation value

There are probes with different attenuation factors that affect the scale. vertical of the signal. The probe check function verifies that the option the probe attenuation matches the probe attenuation.

As an alternative method to checking the probe, you can press a button. from the vertical menu (like the MENU CH 1 button) and select the Probe option that match the attenuation factor of the probe.

NOTE. The default value for the Probe option is 10X.

Make sure that the attenuation switch of the P2200 probe matches the oscilloscope probe option. The switch values are 1X and 10X.

NOTE. When the attenuation switch is set to 1X, the probe
P2200 limits the oscilloscope bandwidth to 6 MHz. To use the width of
complete bandwidth of the oscilloscope, make sure to set the switch to 10

Autocalibration

The self-calibration routine allows for quick improvement of the signal path. from the oscilloscope to achieve maximum precision in measurements. It can execute the routine at any time, but you must do it whenever the ambient temperature changes 5º C or more.

To compensate for the path of a signal, disconnect the probes or the cables from the input connectors of the front panel. Surely, press the button UTILITIES, select the Auto-calibrate option and follow the given instructions in screen.

Description of the functions of the oscilloscope

It includes information about what is necessary to know before using a oscilloscope effectively. You should know the following functions of it.

Oscilloscope configuration

Shot

Acquisition of signals (waveforms)

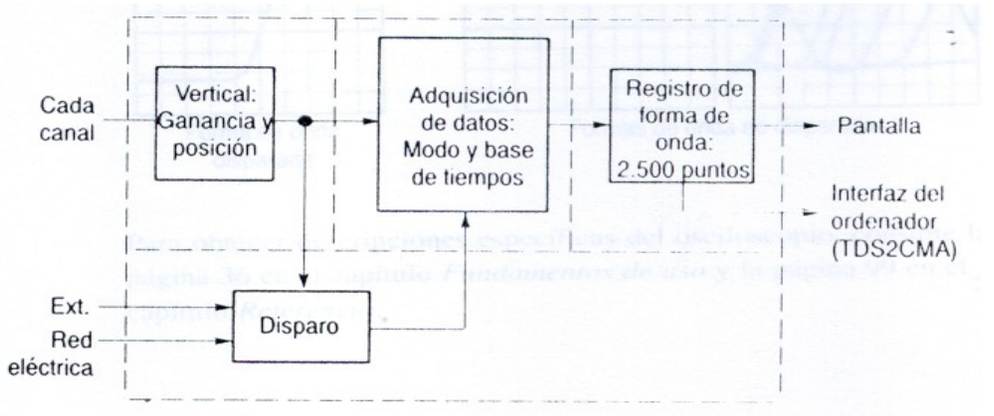
Scaling and positioning of waveforms

Waveform measurement

The following figure shows a block diagram of the different functions of the oscilloscope and the relationship between them.

Oscilloscope configuration

You should have relatives with three functions that you may need to use. Strange when working with the oscilloscope: Auto-configuration, saving of a configuration and recovery of a configuration.



Use of Autoconfiguration

With the Autoconfiguration feature, you achieve a stable presentation of shape. of wave. This function automatically adjusts the vertical scale values, horizontal scale and shooting. It also shows several automatic measurements in the grid area, depending on the type of signal.

Saving a configuration

The oscilloscope saves the current configuration if you wait five minutes to turn off the oscilloscope once the last change has been made. The next time you turn it on, the oscilloscope automatically recovers that configuration.

You can analyze the ALM./REC menu. To permanently save up to ten different configurations.

Recovery of a configuration

The oscilloscope can retrieve the last saved configuration before turn it off. Any of the saved settings or the configuration predetermined.

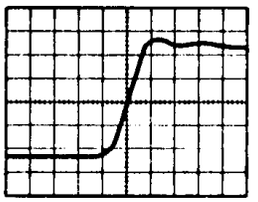
Default configuration

The oscilloscope is set up for normal operation when sent from the factory. This is the default setting. To retrieve this

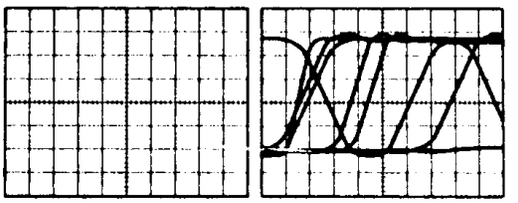
settings, press the CONFIG button. DEFAULT. To see the values default settings refer to Appendix D. Default Configuration.

Shot

The trigger determines the moment when the oscilloscope starts to collect data. and present a waveform. When the trigger is properly set up, the oscilloscope turns unstable presentations or blank screens into descriptive waveforms.



Forma de onda disparada



Formas de onda no disparadas

To obtain specific descriptions of the oscilloscope, refer to the chapter Fundamentals of use.

By pressing the ACTIVATE/STOP or SINGLE SEC buttons to start an acquisition. Follow these steps.

1. Acquire sufficient data to fill in the registration form wave to the left of the shooting point. This is also referred to as predischarge.
2. continues to acquire data while waiting for the condition to occur of shooting.
3. Detect the trigger condition.
4. Continue acquiring data until the waveform record is complete.
5. Show the newly acquired waveform.

NOTE. In the case of flank and pulse shots, the oscilloscope records the speed at which trigger events occur to determine the firing frequency, which is shown in the bottom right corner of the screen.

Source

You can use the trigger source options to select the signal that the The oscilloscope will use as a trigger. The source can be any connected signal. to a channel BNC, to the external BNC DISP. or to the AC power line (available only in flank shots).

Types

The oscilloscope offers three types of triggering: edge, video, and width. pulse.

Modes

You can use a shooting mode to define how the oscilloscope acquires the data when it does not detect a trigger condition. The modes are automatic and normal.

To perform a single sequence acquisition, press the SINGLE SEC. button. front panel.

Coupling

You can use the trigger coupling options to filter the signal going out. to go to the firing circuit. This may help to achieve a presentation stable waveform.

To use the trigger coupling, press the MENU TRIGGER button. Select a flank or pulse shot and a coupling option.

NOTE. The firing coupling only affects the signal sent to the system. shot. It does not affect the bandwidth limit nor the coupling of the signal shown in the screen.

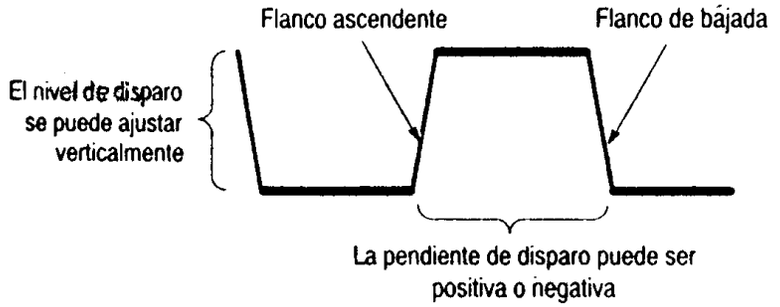
To see the conditioned signal that is sent to the trigger circuit, press and press and hold the VIEW TRIGGER SIGNAL button.

Position

The horizontal position control sets the time in which the shot takes place. and the central line of the screen. Check scales and horizontal position: predisposition information on page 12 for more information about the use of this control to set the shooting position.

Slope and level

The Incline and Level controls help define the shot. The incline option (only in the side shot type) determines if the oscilloscope seeks the point of shooting on the upward or downward flank of a signal. The LEVEL control DISPARO controls the flank location where the firing point occurs.



Signal acquisition

When a signal is acquired, the oscilloscope converts it into a digital form and presents a waveform. The acquisition mode defines how the digital signal is digitized and in which time base adjustment it affects the margin of time and the level of detail of the acquisition.

Modes of acquisition

There are three modes of acquisition: sampling, peak detection and averaged.

Sampling. In this acquisition mode, the oscilloscope performs samplings of the signal at regular intervals to generate the waveform. This mode represents the signal with the greatest accuracy most of the time.

However, this mode does not capture the rapid signal variations that they can produce between samplings. This may result in false representations and cause the loss of narrow pulses. In such cases, the peak detection mode must be used to acquire data.

Peak detection. In this acquisition mode, the oscilloscope searches for the highest and lowest values of the input signal in each interval sampling, and use those values to present narrow pulses, which could getting lost in the sampling mode. The noise could be higher in this mode.

Averaged. In this acquisition mode, the oscilloscope acquires various waveforms, averages them and presents the resulting waveform. It can be use this mode to reduce random noise.

Time base.

The oscilloscope digitizes waveforms by acquiring the value of a signal of entry at different points. The time base allows controlling the frequency with what are the values digitized.

To adjust the time base on a horizontal scale to fit your purpose, use the SEC/DIV control.

Wave scaling and positioning

You can change the presentation of the waveforms by adjusting their scale and Position. By changing the scale, the size of the presentation increases or decreases. of the waveform. By changing the position, the waveform shifts towards up, down, to the right or to the left.

The channel reference indicator (located to the left of the grid) identifies each waveform in the presentation. The indicator shows the ground level of waveform recording.

Scale and vertical position.

You can change the vertical position of the waveform by moving it upwards. up or down on the screen. To compare data, you can align a shape of wave with another or several waveforms on top of each other.

You can change the vertical scale of a waveform. The waveform display the wave contracts or expands with respect to the ground level.

Scale and horizontal position: pre-preparation information

You can adjust the HORIZONTAL POSITION control to view data in shape of wave before the shot, after the shot or part and part. When the change occurs the horizontal position of a waveform actually changes the time elapsed between the shot and the center line of the screen (what seems shift the waveform to the right or left on the screen.

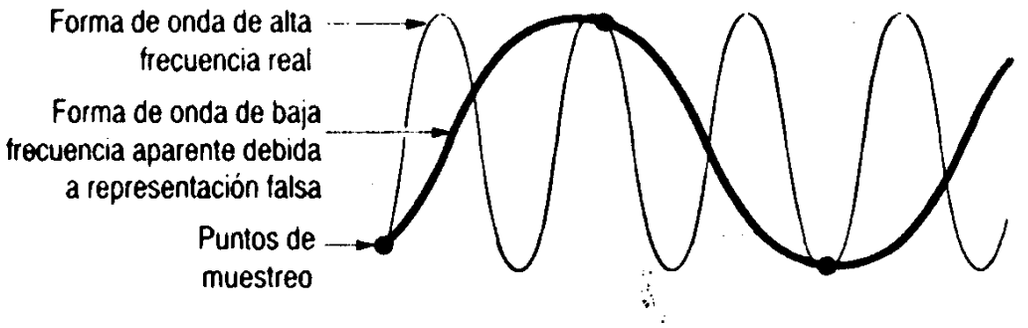
For example, if you want to find the cause of a spurious signal in the test circuit, you must shoot at the imposter and increase the pre-fire period to capture data before the shot. You can then analyze the data from I pre-fire and, perhaps, seek the cause of the spurious.

The horizontal scale of all the waveforms is changed by turning the knob. SEC/DIV. For example, you may want to see a single waveform cycle to measure the overshoot on the rising edge.

The oscilloscope samples the horizontal scale as time per division in the reading. of the scale. Since all active waveforms use the same base of times., the oscilloscope shows only one value for all active channels, except when using Define Window.

False presentations in the domain of time.

A false representation (aliasing) occurs when the oscilloscope does not perform sampling of the area quickly enough to generate a record of exact waveform. When this happens, the oscilloscope displays a waveform of lower frequency wave than the actual input waveform, or it triggers and presents an unstable waveform.



The oscilloscope represents signals accurately, but this is limited by the bandwidth of the oscilloscope and the sampling rate. To avoid false representations, the oscilloscope must sample the signal at a speed greater than double that of the highest frequency component of the signal.

The highest frequency than the sampling speed of the oscilloscope can theoretically represent that corresponding to the Nyquist frequency. The speed The sampling is called Nyquist rate and is equivalent to double the Nyquist frequency.

Oscilloscope models with bandwidths of 60 MHz or 100 MHz sampling is conducted at speeds of up to one gigasample per second (GS/s). Models with bandwidths of 200 MHz sample at speeds up to 2 GS/s. In both cases, the maximum sampling speeds are equivalent at least ten times the bandwidth. The high sampling rates allow reducing the possibility of false representations.

There are several ways to verify the existence of a false representation:

Turn the SEC/DIV knob to change the horizontal scale. If the shape of the the wave changes drastically, there may be a representation false.

Select the peak detection acquisition mode. This mode performs samples of the highest and lowest values for the oscilloscope it can detect the fastest signals. If the waveform changes drastically, a false representation may occur.

If the firing frequency is faster than the screen information, it may have a false representation or a waveform that crosses the firing level several times. The waveform examination must allow to identify if the shape of the signal will allow for only one trigger crossing cycle. If the firing frequency continues to be faster than what it indicates the presentation may have a false representation.

If the firing frequency is slower, the test is not useful.

If the signal you observe is also the trigger source, use the reticle or the cursors to calculate the frequency of the waveform that show. Compare it with the shot frequency reading that appears in the bottom right corner of the screen. If they differ greatly, it may be a false representation has occurred.

Taking measurements

The oscilloscope displays comparative graphs of voltage and time that can help to measure the presented waveform.

There are several ways to take measurements. You can use the grid, the cursors. or an automated measure.

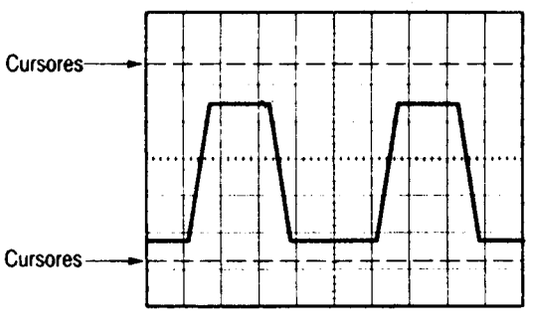
Reticle

This method allows for a quick visual calculation. For example, I could look at the amplitude of the waveform and determine that it is slightly above 100 mV.

You can take simple measurements by counting the major and minor divisions. included in the grid and multiplying the result by the scale factor.

For example, five major vertical divisions have been counted among the values. minimums and maximums of a waveform, and knows that the scaling factor is 100 mV/division, you can calculate the peak to peak voltage in the following way:

5 divisions x 100 mV/division = 500 mV



Cursors

This method allows for taking measurements by moving the cursors. that always appear in pairs and see their numerical values in the readings of screen. There are two types of cursors: voltage and time.

When using cursors, make sure to set the source of the shape of the wave in the presentation that you want to measure.

To use the cursors, press the CURSORS button.

Voltage cursor. The voltage cursors appear as horizontal lines in the presentation and measure the vertical parameters.

Time cursors. Time cursors appear as vertical lines in
the presentation and measure the horizontal parameters.

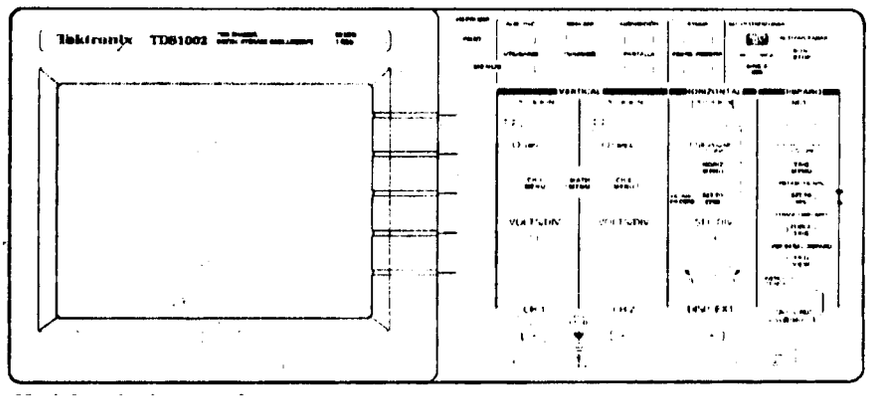
Automatics.

The menu MEASURES can take up to five automatic measurements. When automatic measures are taken, the oscilloscope performs all the calculations. Since These measures use the waveform's registration points, they are more accurate. that the grid or cursor measurements.

Automatic measures use readings to show the results of the measurement. The readings are updated periodically as the oscilloscope acquire new data.

Fundamentals of use

The front panel is divided into areas of easy-to-use functions. The application of the controls and the information displayed on the screen. The figure the following shows the front panel.



Two-channel model.

Presentation area

In addition to displaying waveforms, the screen is filled with details about the control values of the waveform and the oscilloscope.

Icons that show the mode of acquisition.

Sampling method

Peak detection mode

Averaged mode.

2. Trigger state that indicates the following:

Armed. The oscilloscope acquires pre-trigger data. In this state disregard all shots.

Prepared. All pre-preparation data has been acquired and the oscilloscope is ready to accept a trigger.

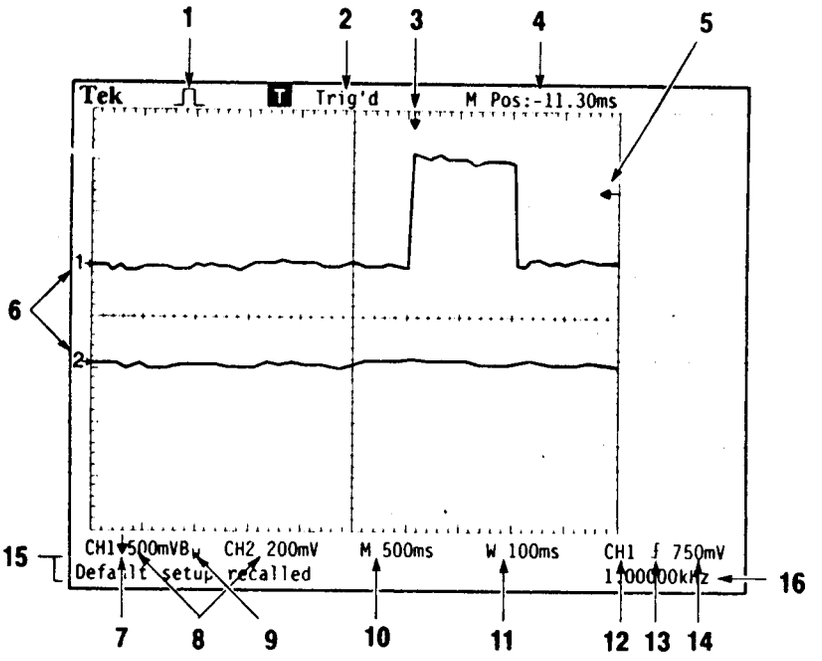
Shot. The oscilloscope has sent a shot and is acquiring the post-shot data.

Stop. The oscilloscope has interrupted the data acquisition of the waveform.

Acquisition. Complete. The oscilloscope has completed a acquisition of unique sequence.

Autom. The oscilloscope is in trigger mode and acquires waveforms in the absence of triggering.

Explore. The oscilloscope acquires and displays waveform data. continuously in exploration mode.



1. Icono que muestra el modo de adquisición.

Modo de muestreo

Modo de detección de picos

Modo promediado

3. Indicator that shows the horizontal shooting position. Turn the knob. HORIZONTAL POSITION, until adjusting the position of the marker.

4.Reading that shows the time in the center line of the grid. The time of shooting equals zero.

5. Marker that shows the shooting level by flank, or by pulse width.
6. Screen markers that display the ground reference points of the waveforms shown. If there is no marker, it is not displayed.
   canal.

An arrow icon indicates that the waveform is inverted.

8. Readings that show the vertical scale factors of the channels.
9. An icon B_w indicates that the channel has a bandwidth.
10. Reading that shows the adjustment of the main time base.
11. Reading that shows the adjustment of the window time base if used.
12. Reading that shows the source used for the shot.
13. Icon that shows the selected shooting type as follows.

 ▪ Disparo por flanco para el flanco ascendente

 ▪ Disparo por flanco para flanco de bajada.

 ▪ Disparo por video para sincronismo de línea.

 ▪ Disparo por video para sincronismo de campo.

 ▪ Disparo por ancho de pulso, polaridad positiva.

 ▪ Disparo por ancho de pulso, polaridad negativa.

14. Reading that shows the numerical value of the edge trigger level.
15. The presentation area shows helpful messages: some are only displayed on screen for only three seconds.

    If a saved waveform is retrieved, the reading shows information about the reference waveform as ref. A 1.00 V 500µs.

16. Reading that shows the firing frequency.

Message areas

The oscilloscope shows a message area (point 15 above) at the part lower part of the screen that transmits the following types of information:

Instructions to access another menu, like when the button is pressed. SHOOTING MENU.

For TRIGGER RETENTION, go to the HORIZONTAL menu.

Suggestion of what I could do next, like when you press the MEASUREMENTS button.

Press the screen button to change the measurement.

Information about the action that the oscilloscope has performed, such as when press the CONFIG. PREDETER button:

The factory default settings have been restored.

Information about the waveform, such as when the button is pressed AUTOCONFIGURE:

Square pulse detected on CH1.

Use of system menu

The user interface of the TDS 1000 series oscilloscopes has been designed to simplify access to specialized functions through the structure of menus.

When a button on the front panel is pressed, the oscilloscope displays the menu corresponding on the far right of the screen. The menu displays the options that are available when directly pressing the option buttons without identify from the right side of the screen (it may be part of the documentation refers to these buttons as screen buttons, buttons of side menus, bezel buttons or programmable keys.

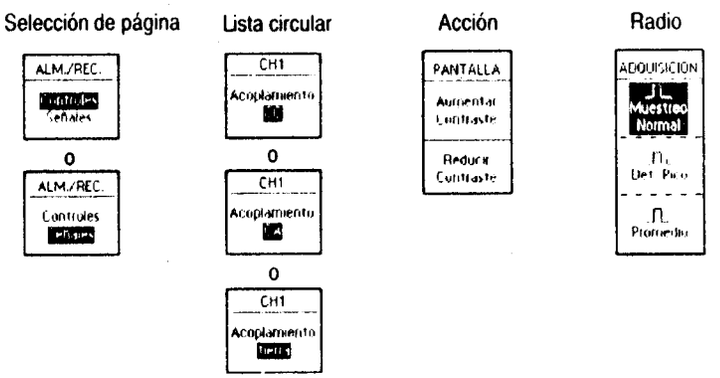
The oscilloscope shows four methods to display menu options:

•Page selection (submenus): In some menus, you can use the button of the top option to choose two or three submenus. Each time when the top button is pressed, the options change: For example, by pressing the top button in the ALM/REC. menu, the oscilloscope sweeps through the submenus Controls and Signals.

Circular list: The oscilloscope sets the parameter of another value each once the option button is pressed. For example, you can press the button MENU CH 1 and then, the top option button to navigate the vertical coupling options (channel).

Action: The oscilloscope shows the type of action that will occur. immediately upon pressing an action button. For example, when press the SCREEN menu button and then the option button Increase Contrast, the oscilloscope immediately changes the contrast.

The oscilloscope uses a different button for each option. The option currently selected is highlighted. For example, when pressing the button FROM THE ACQUISITION MENU. The oscilloscope displays the different options of modo de adquisición para seleccionar una opción pulse el botón corresponding.



Vertical controls

POSITION of CURSOR 1 AND CURSOR 2 FOR CH 1 AND CH 2. Place vertically the waveform. When showing and using cursors, an LED lights up. what the alternative function of the controls to move the cursors indicates.

MENU CH1 AND CH2. Shows the selections of the vertical menu, and activates and deactivate the waveform display of the channel.

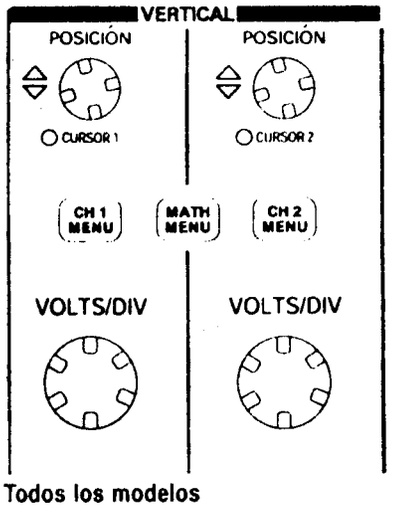
VOLTS/DIV (CH1, CH2). Select calibrated scale factors.

MATEM Menu. Display the menu of waveform mathematical operations and
It can also be used to activate and deactivate the mathematical waveform.

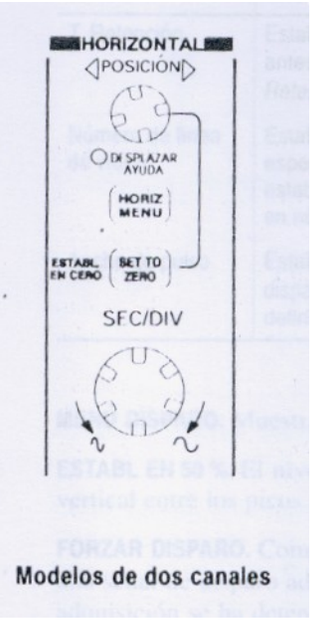
POSITION. Adjust the horizontal position of all waveforms.
mathematics and channel. The resolution of this control varies depending on the adjustment from the time base.

NOTE. To make a large horizontal adjustment, turn the
I command SEC/DIV to a higher value, change the horizontal position and return.
turn the SEC/DIV knob back to the previous value.

When consulting Help topics, you can use this remote to navigate through
vehicles or index entries.



Todos los modelos



Modelos de dos canales

HORIZONTAL MENU. Display the horizontal menu.

SET TO ZERO. Establishes the position at zero.

SEC/DIV. Select the time/division horizontal adjustment (scale factor) of the main time base or window. If Define Window is activated, the
I think from the window area when changing the time base of the window.

Trigger controls

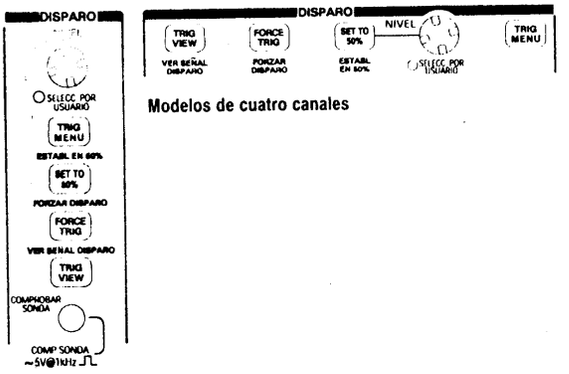
LEVEL AND SELECTION BY USER. When a flank shot is used, the
The main function of the NIVEL command is to establish the amplitude level that the signal must cross to provoke an acquisition. This remote control can also be used.
to run alternative options of SELECT. BY USER. LED lights up
located underneath the control to indicate an alternative function.

SHOOTING MENU. Display the Shooting menu.

SET AT 50%. The trigger level is set at the vertical midpoint between the peaks of the trigger signal.

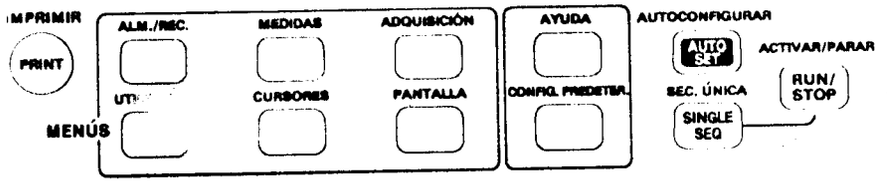
FORCE SHOT. Complete an acquisition regardless of a signal.
of appropriate trigger. This button has no effect if the acquisition has been stopped yes.

SHOW TRIGGER SIGNAL. Displays the trigger waveform instead of the channel waveform while the SIGNAL button is pressed
SHOOTING. You can use this button to see how the values of firing affects the firing signal, like a firing coupling.



SELECT BY USER Description	
T. Retention	Set the amount of time that should to pass before being able to accept a trigger event.
Video line number	Set the oscilloscope to a number of specific line when the type option of shot is set in video and the option of firing synchronization in number of line.
Pulse width	Set the pulse width when the the shooting type option is set to pulse and select the definition option pulse width.

Control and menu buttons



ALM/REC. Show the Alm/Rec menu. For configurations and waveforms.
MEASURES. Show the automatic measures menu.
ACQUISITION. Displays the Acquisition menu.
SCREEN. Displays the Screen menu.
CURSORS. Shows the Cursors menu. The vertical position controls adjust the position of the cursor while the Cursor menu is displayed and the cursors are activated. The cursors remain on screen (unless it has been set the type option to No) after exiting the Cursor menu, but does not they can adjust.

UTILITIES. Show the utilities menu.
HELP.Show the Help menu.
CONFIG. PREDETER. Recovers factory settings.

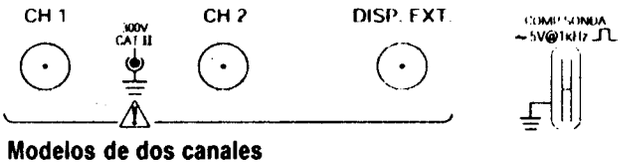
AUTOCONFIGURE. Automatically sets the oscilloscope controls
to generate a useful presentation of the input signals.

SEC.UNICA. Acquires a single waveform and stops.

ACTIVATE/STOP. Continuously acquires waveforms or stops the acquisition.

PRINT. Starts printing operations. A module is required. expansion with a Centronics port, RS - 232 or GPIB.

Connectors.



Modelos de dos canales

COMP SONDA. Compensation of output voltage and ground of the probe. Use
this button to electrically equalize the probe to the input circuit of oscilloscope. The shielded BNC connectors and probe ground compensation they are grounded and are considered ground terminals.

CAUTION. If you connect a voltage source to the ground terminal, it may
cause damage to the oscilloscope or the circuit being tested. To avoid this, do not connect a voltage source to the ground terminals.

CH 1, CH2 Input connectors for waveform presentation.

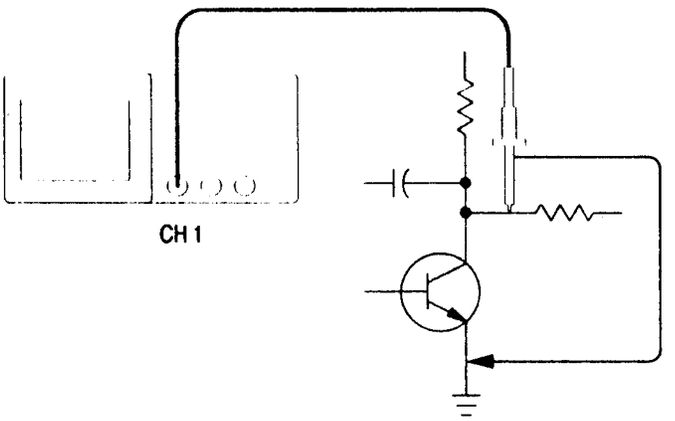
DIAP. EXT. Input connector for an external trigger source. Use the shooting menu to select the shooting source Ext. 0 or Ext/5.

APPLICATION EXAMPLES.

This section presents a series of application examples. These examples simplified highlight the features of the oscilloscope and provide ideas to use it, to solve their own testing problems.

Taking simple measurements

You need to see a signal in a circuit but do not know the amplitude or frequency of it. the signal. It wants to quickly display the signal and measure the frequency, the period and the peak-to-peak amplitude.



Use of Autoconfiguration

To quickly display a signal, follow these steps:

1. Press the MENU CH1 button and set the attenuation of the Probe option. en10X.
2. Set the P2200 probe switch to 10X.
3. Connect the channel 1 probe to the signal.
4. Press the AUTOCONFIGURE button.

The oscilloscope automatically sets the vertical controls. horizontal and shooting. If you want to improve the presentation of the form of wave. You can manually adjust those controls.

NOTE. The oscilloscope displays the relevant automatic measurements in the area of the waveform on the screen as a function of the type of signal detected.

Automatic measurements taking

The oscilloscope can take automatic measurements of most of signals presented. To measure the frequency, the period, and the peak amplitude to peak, in rising time and the positive pulse width of the signal, follow this steps:

Press the MEASURES button to see the measures menu.

2. Press the top option button; the Measures 1 menu appears.
3. Press the radio button Type and select Frequency.

The reading presents the measure and updates it.

NOTE. If a closing question mark (?) appears in the reading value, turn the VOLUME/DIV knob of the corresponding channel to increase the sensitivity or change the SEC/DIV value,

4. Press the Back button.

5. Press the second option button from the top, the menu appears. **Measures 2.**
6. Press the option button Type and select Period. The reading value presents the measure and updates it.
7. Press the Back option button.
8. Press the middle option button; the Measures 3 menu appears.

Press the option button and select peak-to-peak.

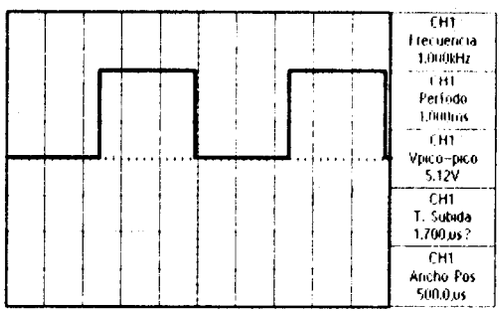
The readingValue presents the measurement and updates it.

10. Press the Back option button.
11. Press the second option button from the bottom; the appears the menu Measures 4.
12. Press the option button Type and select T. Upload. The reading Value presents the measure and updates it.

Press the back option button.

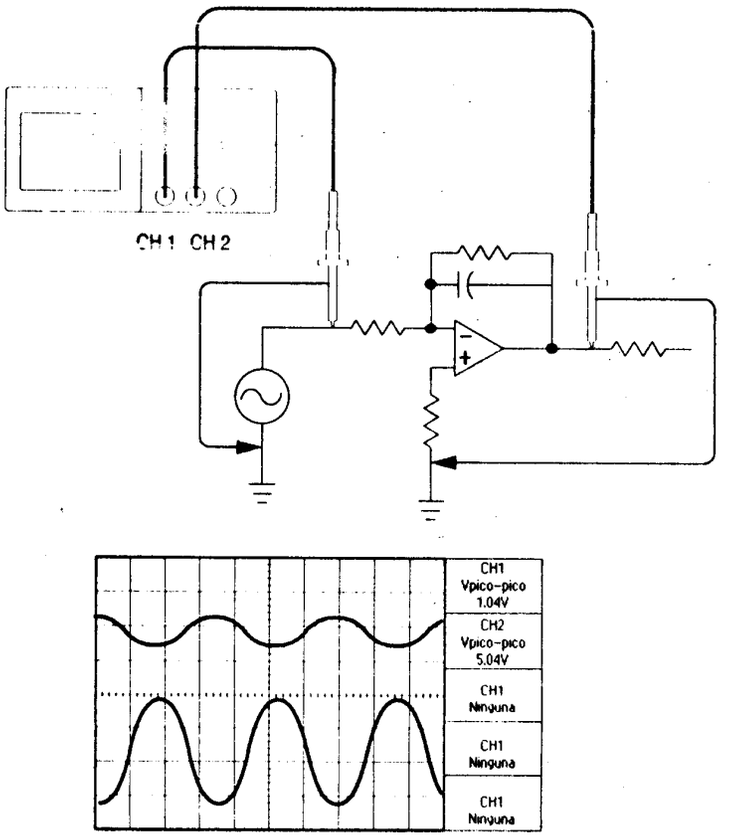
14. Press the lower option button; the Media 5 menu appears.
15. Press the option button Type and select Width Pos. The reading Value presents the measure and updates it.

16. Press the Back option button.



Measurement of two signals

Imagine you are testing a piece of equipment and need to measure the sound amplifier gain. It has a generator that can apply a test signal to the input of the amplifier. Connect two channels of the amplifier at the input and output of the amplifier, as shown. Measure both signal levels and use the measurements to calculate the gain.



To activate and present the signals connected to channel 1 and channel 2, follow these steps:

1. If the channels are not showing, press the buttons MENU CH1 and MENU **CH2.**
2. Press the AUTO CONFIGURE button.

To select the channel dimensions, follow these steps:

1.Press the MEASUREMENTS button to see the measurements menu.

2. Press the top option button: the Measures menu appears 1.
3. Press the option button Type and select CH 1.
4. Press the option button and select peak-to-peak.
5. Press the optionsBack button.

Press the second option button from the top; the menu appears. Measurements 2.

7. Press the option button Type and select CH 2.
8. Press the option button Type and select peak-peak.

Press the Back options button.

10. To calculate the voltage gain of the amplifier, use the following equations:

$$\text{[illegible]} = \frac{\text{[illegible]}}{\text{[illegible]}}$$

10

Taking measurements with the cursor

You can take the cursors to quickly take time and voltage readings in a waveform.

Measurement of the oscillation frequency

To measure the oscillation frequency of the rising edge of a signal, follow these steps:

1.Press the CURSORS menu to see the Cursors menu.

Press the option button Type and select Time.

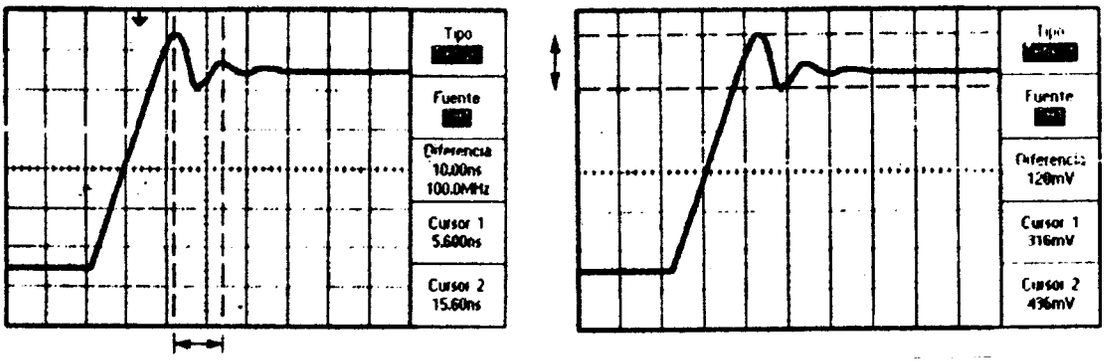
3. Press the source option button and select CH1.

4. Turn the CONTROL CURSOR 1 to place a cursor on the first peak of the oscillation.

5. Turn the CURSOR 2 control to place a cursor on the second peak of the oscillation.

You can see the time and frequency difference (the oscillation frequency measure) in the Cursor menu.

Measurement of oscillation amplitude



In the previous example, the oscillation frequency has been measured. Now you want to measure the amplitude of the oscillation. To measure the amplitude, follow these steps.

1.Press the CURSORS menu to view the Cursors menu.

2. Press the option button Type and select Voltages.

3. Press the option button Source and select CH1.

4. Turn the CURSOR 1 control to place a cursor on the highest peak of the oscillation.

5. Turn the CURSOR 2 knob to place a cursor at the lowest peak of the oscillation.

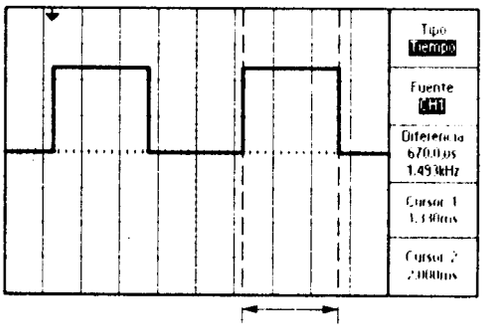
You can see the following measurements in the cursor menu:

. The voltage difference (peak-to-peak voltage of the oscillation)

. The voltage of cursor 1

. The voltage of cursor 2

Pulse width measurement



Suppose you are analyzing a pulsating wave and want to know the width of the pulse. To measure the pulse width using the time cursors, follow these steps:

1. Press the CURSORS menu to see the Cursors menu.

   The LEDs located under the VERTICAL POSITION controls light up to indicate the alternative functions CURSOR 1 and CURSOR 2.

2. Press the option button Source and select CH1.
3. Press the radio button Type and select Time.
4. Turn the CONTROL 1 to place a cursor on the rising edge of the pulse.
5. Turn the CURSOR 2 knob to place a cursor on the falling edge of the pulse.

You can see the following measurements in the Cursor menu:

. The time of cursor 1 relative to the shot.

. The cursor time 2 relative to the shot.

. The time difference, which corresponds to the measure of the width of pulse.

NOTE: The measure of positive pulse width is available as a measure. automatic in the Measures menu.

This measure is also shown when selecting the Single Cycle Square option. from the AUTOCONFIGURE menu.

Acquisition

Press the ACQUISITION button to set the acquisition parameters.

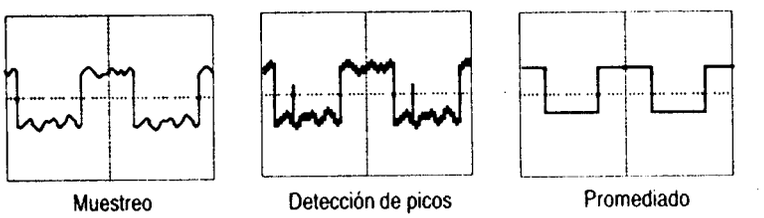
Options	Values	Comments

Sampling		Use this option to acquire and show accurately the majority of the waveforms: it is the mode default.
Peak detection		Use this option to detect spurious and reduce the possibility of false representations.
Averaged		Use this option to reduce the random or unrelated noise from the presentation of the signal. It can select the number of averages.
Averaged	4, 16, 64, 128	Select the number of averages.

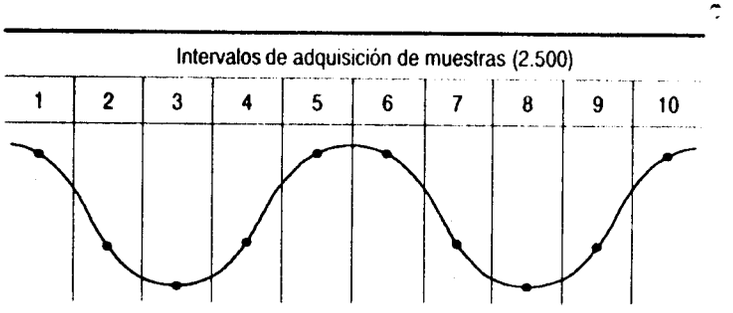
Key points

If they are from a square wave signal

If they are a square wave signal containing intermittent spurious signals and narrow. The waveform shown will vary depending on the acquisition mode. chosen.



Sampling. Use the sampling acquisition mode to acquire 2500 points and show them in the SEC/DIV value. The sampling mode is the default.



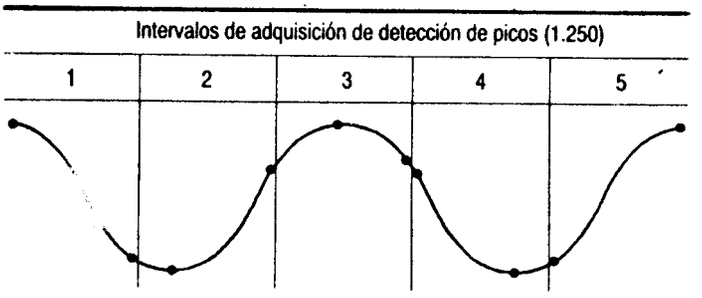
• Puntos de muestra

El modo de muestreo adquiere un punto de muestra en cada intervalo.

The maximum sampling speed is one gigasample per
seconds (GS/s), in oscilloscope models with a bandwidth of 60 MHz or
100 MHz, y dos gigamuestras por segundo en los modelos de 200 MHz. A valores
At 100 nS and faster, this sampling speed does not acquire 2500 points.
In this case, a digital signal processor interpolates points between the points
sampled and create a complete record of the waveform of 2500 points.

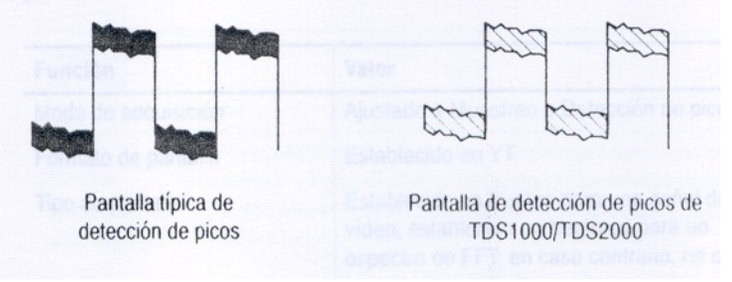
Peak detection. Use the peak detection mode to detect
spurious as narrow as 10 ns and limit the possibility of representations
false. This mode is effective when operating with the SEC/DIV value of 5µs/div or
slower.

NOTE. If you set SEC/DIV to 2.5µs/div or faster, the acquisition mode
it goes to sampling because the sampling rate is fast enough and not
It is necessary to use peak detection. The oscilloscope does not display a message.
that indicates that the mode has changed to sampling.



El modo de detección de picos muestra el voltaje máximo y mínimo adquirido en cada intervalo.

When there is enough noise in the waveform, a typical screen of
peak detection shows large areas in black. The oscilloscopes of the series
TDS 1000 shows this area with diagonal lines to improve performance
of the screen.



Pantalla típica de detección de picos

Pantalla de detección de picos de TDS1000/TDS2000

Averaged. Use the Averaged acquisition mode to reduce noise.
random or unrelated in the signal you want to display. The data is

they are acquired in sampling mode and then averaged in several ways wave.

Select the number of acquisitions (4, 16, 64, 128) to be averaged. for the waveform.

START/STOP button. Press the START/STOP button when you want the oscilloscope continuously acquires waveforms. Press the button again to stop the acquisition.

SEC. UNIQUE button. Press the SEC. UNIQUE button when you want the oscilloscope acquires a single waveform and stops. Every time you press the SEC. UNIQUE button makes the oscilloscope start acquiring another waveform. When it detects a shot, it completes the acquisition and stops.

Exploration mode screen. You can use the acquisition mode. horizontal exploration (also known as roll mode) for supervision continuously signals that change slowly. The oscilloscope shows from left to right on the screen, the waveform updates and erases the previous points as it shows the new points. A section of the screen, of a division, empty and mobile, separates the new waveform from the previous.

The oscilloscope switches to the scan acquisition mode when the knob is turned. set SEC/DIV to 100 ms/div or slower, and select the mode option automatic of the SHOOTING menu.

To deactivate exploration mode, press the SHOOT MENU button and set the mode option to Normal.

Acquisition detection. While the acquisition is running, the way to waveform presentation is active. When acquisition is stopped (when it press the ACTIVATE/STOP button, the presentation stops. In any of The modes, the waveform display can be scaled with the controls. verticals and horizontals.

Autoconfigure

By pressing the AUTOCONFIGURE button, the oscilloscope identifies the type of waveform Wave and adjust the controls to generate a useful presentation of the wave signal.

Function	Value
Acquisition mode	Adjusted to Sampling or Peak Detection
Screen format	Established in YT
Type of screen	Established in Points for a video signal, established in Vectors by a FFT spectrum, in otherwise, it doesn't change
Horizontal position	Adjusted
SEC/DIV	Adjusted
Firing coupling	Adjusted to CC, noise filter or AF Rejection F
Shooting retention	Minimum
Shooting level	Set at 50%

Shooting mode	Car
Shooting source	Adjusted; Auto-configuration cannot be used at the signal of DISP. EXT.
Pending shot	Adjusted
Type of shot	Flanco or Videl
Video synchronization of the shot Adjustment	
Video shooting standard	Adjusted
Vertical bandwidth	Complete
VOLTS/DIV	Adjusted
Vertical coupling	CC (if EARTH has been selected previously) CA for a video signal; otherwise not change.

The Auto-configuration functions scan all channels for signals.
and show the corresponding waveforms.

The self-configuration determines the origin of the trigger based on the following conditions:

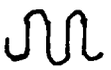
If several channels have signals, the channel with the lowest frequency signal shown when invoking the self-configuration function

If no signals have been found, the channel with the lowest number is displayed.

No signals have been found and channels are not displayed, the oscilloscope show and use channel 1.

Sine wave.

When the auto-configuration function is used and the oscilloscope determines that the signal is similar to a sinusoidal wave, it presents the following options:

Opción de onda sinusoidal	Detalles
 Sinusoidal de ciclo múltiple	Presenta distintos ciclos con el correspondiente escalado vertical y horizontal, el osciloscopio presenta las medidas automáticas de valor RMS del ciclo, frecuencia, período y pico a pico.
 Sinusoidal de ciclo único	Establece la escala horizontal para que muestre aproximadamente un ciclo de la forma de onda; el osciloscopio presenta las medidas automáticas de valor medio y pico a pico.
 FET	Convierte la señal de dominio de tiempo de entrada en sus componentes de frecuencia y muestra los resultados en forma de gráfico comparativo de frecuencia y amplitud (espectro).
Deshacer configuración	Hace que el osciloscopio recupere la configuración anterior.

Cursors

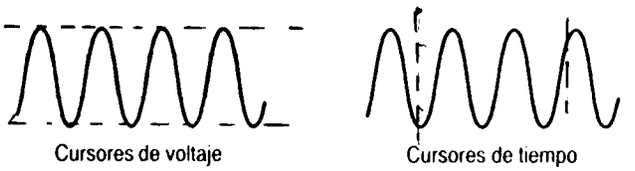
Press the CURSORS button to display the measurement cursors and the menu cursors.

Options		
Type	Voltage	Select and display the measurement cursors; Voltage measures amplitude and Time measures time and the frequency.
Source	CH1 CH2 MAT	Choose the waveform in which the ... cursor measures The readings show the measures
Difference		Show the difference (delta) between the cursors
Cursor 1		Show the cursor location 1 (time makes reference to the shooting position, the voltage makes earth reference).
Cursor 2		Show the location of the cursor 2 (the time makes reference to the shooting position, the voltage makes ground reference).

NOTE. The oscilloscope must display a waveform for the cursors and the cursor readings appear.

Key points

Cursor displacement. Use the CURSOR 1 and CURSOR 2 controls to move cursors 1 and 2. Cursors can only be moved when displayed the Cursor menu.



A level and difference readings. The vertical sensitivity of the waveforms
used in mathematical operations must match. If they do not match and are used the cursors to measure the waveform result of an operation mathematics, it shows a U that represents an unknown value.

Default configuration

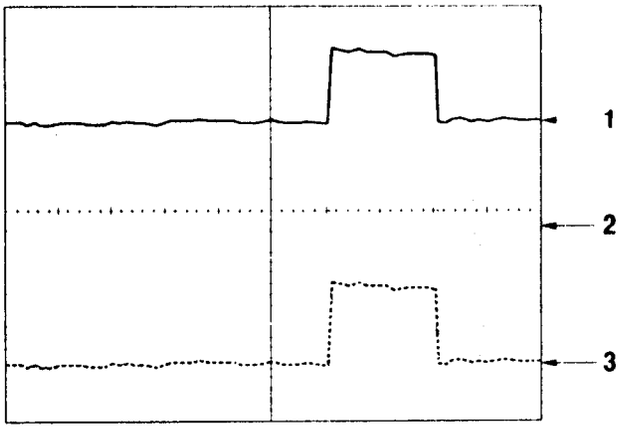
Press the CONFIG. PRESET button to retrieve most of the values of control and factory option, but not all.

Screen

Press the SCREEN button to choose how the shapes are presented. wave and change the overall appearance of the presentation.

Options	Values	Comments
Type	Vectors Points	Vectors fill the space between sample points adjacent on the screen Sample points show only the sample points
Persistence	NO 1 2 5, infinite	Set the amount of time for each point of the display remains on screen.
Format	YT XY	The TY format displays the vertical voltage in relation to time (horizontal scale) The XY format shows a point every time it Acquire a sample in channel 1 and in channel 2. The voltage of channel 1 determines the X coordinate of point (horizontal) and the voltage of channel 2 determines the Y coordinate (vertical)
Increase contrast		It darkens the screen, facilitating the perception of a waveform.
Reduce contrast		Illuminate the screen.

According to the type, the waveforms are shown in three distinct styles: solid, attenuated and discontinuous.



A solid waveform indicates a waveform presentation
(active) channel. The waveform remains solid when the acquisition
It stops if controls that ensure accuracy have not been changed.
uncertain screen.

Vertical and horizontal controls can be changed in acquisitions
detained.

2. In the TDS 1000 series (monochrome monitor), a waveform
attenuated, indicates reference waveform shapes or waveforms to which
persistence has been applied.

A dotted line indicates that the waveform presentation has already us
matches the controls. This occurs when you stop the acquisition and
the value of a control that the oscilloscope cannot apply to the
waveform shown. For example, change the trigger controls in
a stopped acquisition causes a wave of discontinuous line

Key points

Persistence. The TDS1000 series oscilloscopes use 'dfm' at a
reduced intensity for persistence.

When persistence is set to infinity, the checkpoint points s accumulate.
until a control is changed.

XY format. Use the XY screen format to analyze differences between
phases, like those represented by the figures of Lissajous. This format traces the
voltage of channel 1 and the voltage of channel 2, where channel 1 corresponds to the axis
horizontal and channel 2 to the vertical axis. The oscilloscope uses the acquisition mode
Sample not fired and shows the data in the form of points. The speed
The sampling is set at one megasample per second (MS/s).

NOTE. The oscilloscope can capture a waveform in normal YT mode and at
any sampling speed. You can see the same waveform in XY mode.
To do this, stop the acquisition and change the screen format to XY.

The controls operate as follows.

The VOLTS/DIV controls and VERTICAL POSITION of channel 1 establish the horizontal scale and the position.

The VOLTS/DIV controls and VERTICAL POSITION of channel 2, continue establishing the horizontal scale and position.

The following functions do not operate in XY screen format:

Mathematical or reference waveforms

Cursors

•Autoconfiguration (reset YT screen format)

Time base controls

Trigger controls

Help

Press the HELP button to display the Help menu. The topics cover all the options and controls of the oscilloscope menu.

Horizontal

You can use the horizontal controls to change the scale and position. horizontal waveform display. The horizontal position reading shows the time represented by the central line from the screen, with the shooting time set to zero. When changing the Horizontal scale, the waveform expands it contracts around the central line of the screen.

Options	Values	Comments
Principal		The value of the main horizontal time base is used to show the waveform
Expand window		Two cursors define a window area Adjust the window area using the controls Horizontal SEC/DIV position.
window		Change the presentation to show the segment of waveform (expanded to the screen width) inside the window area.
Mando Shot	Level * T. Retention	Select whether the Fire Level control adjusts the level of shot (volts) or the retention time (seconds) The retention value is shown.

For video shooting with synchronization on a line number, the SELEC remote control. BY USER (function alternatively) switch between the line number value and the trigger level.

Note. You can click the horizontal option buttons to switch between a entire waveform presentation and an expanded and more detailed part of she.

The axis of the vertical scale is the ground level. A reading located at the top top right the screen shows the current horizontal position in

seconds. An M indicates the main time base and a W indicates the base of window times. The Oscilloscope also shows the horizontal position through an arrow icon at the top of the grid.

Controls and buttons

Horizontal POSITION control. Use this control to adjust the position.
of the shot in relation to the center line of the screen.

SET BUTTON TO ZERO. Use this button to set the horizontal position.
in zero.

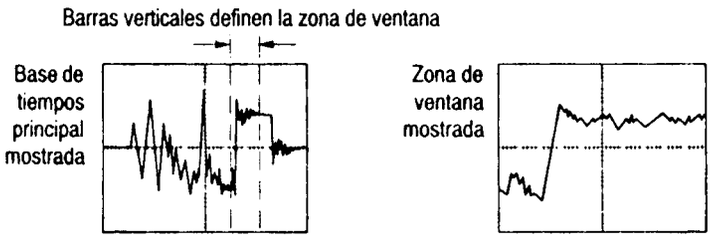
SEC/DIV control (horizontal scale). Use this button to change the scale of tiempo horizontal y ampliar o comprimir la forma de onda.

Key points

SEC/DIV. If the waveform acquisition stops (with the button ACTIVATE/STOP or SINGLE SEC), the SEC/DIV control expands or compresses the waveform.

Exploration mode screen (roll mode). When the SEC/DIV control is
set to 100 ms/div or slower, and the shooting mode is set to Auto, the oscilloscope introduces the scanning acquisition mode. In this mode the The waveform shows updates from left to right. There is no control. neither of shooting nor of horizontal wave position during the mode of exploration.

Expand window. Use the Expand Window option to define a segment of waveform and see more details. The base value of window times does not it can be slower than the main base time value.



Window. Expand the window area to cover the entire screen.

NOTE. When switching between the main views, window area, or window, the oscilloscope erases any waveform saved on the screen by persistence.

Retention. Retention can help stabilize the presentation of shape periodic waves.

Mathematical functions

Valor Operations		Comments
(remaining)	CH1 – CH2 CH2 - CH1	The waveform of channel 2 remains the waveform of channel 1 remains the waveform of channel 1 of the waveform of channel 2
(sum)	CH1 + CH2	Sum of channels 1 and 2

Key points

VOLTS/DIV. Use the VOLTS/DIV control to scale the waveforms of the channels. The waveform of addition or mathematical subtraction corresponds to the subtraction or visual sum of the channel waveforms.

MEASURES

Press the MEASURES button to access the automatic measurements. There are eleven. types of measurements available. It can display up to five measurements at the same time time.

Press the upper option button to display the Measures I menu. You can choose the channel where to take a measurement in the Source option. You can choose the type of measure to take in the Option Type. Press the Back option button to return to the menu MEASURES and display the selected measures.

Key points

Measurement taking. It can show up to five automatic measurements at once. a single waveform (or divided into waveforms). The waveform channel of The wave must be activated (shown) to take a measurement.

Automatic measurements cannot be represented in mathematical waveforms or in reference, nor while using exploration mode or XY. The measurements are they update approximately twice per second.

Type of measure	
Frequency	Calculate the frequency of the waveform by measuring the first cycle.
Period	Calculate the time of the first cycle
Medium	Calculate the arithmetic measure of the voltage over the entire record.
Pico - pico	Calculate the absolute difference between the maximum and minimum peaks of the entire waveform.
RMS cycle	Calculate a real RMS average of the first complete cycle of the waveform.
Min.	Examine the waveform of 2,500 points and display the value. minimum.
Max.	Examine the waveform of 2,500 points and show the value maximum.
Upload time	Measure the time that passes between 10% and 90% of the first. ascending flank of the waveform.
Descent time	Measure the time that elapses between 10% and 90% of the first. falling edge of the waveform.
Wide Position	Measures the time that elapses between the first ascending flank. and the following downward slope to the 50% level of the shape of wave
Narrow Black	Measure the time that elapses between the first descending flank. and the next ascending flank of the 50% level of the shape of wave
None	Does not take any measures.

Probe check

You can use the probe check assistant to quickly verify which probe works correctly.

To use the probe check assistant, press the CHECK button. PROBE. If the probe has been connected and compensated correctly, and the input the vertical menu probe of the oscilloscope has been set to match with the probe, the oscilloscope will display a message 'OK' at the bottom of the screen. Otherwise, the oscilloscope will display instructions on the screen. to help guide you in solving these problems.

Alm./Rec.

Press the button ALM/REC to save or retrieve configurations of the oscilloscope or waveform.

Controls

Options	Values	
Controls	From 1 to 10	Highlighting controls displays the menus for storage or retrieval of configurations of the oscilloscope.
No. memory configuration		Specify the memory location in which it is they keep or from which they recover the values current oscilloscope settings.
Store		Complete the save action
Recover		Retrieve the values from the oscilloscope saved at the chosen location in the field No. Memory Configuration.

Key points

Saving and retrieving configurations. The complete configuration is stores in non-volatile memory. When it retrieves the configuration, the the oscilloscope will remain in the mode it has been saved in.

The oscilloscope saves the current configuration if you wait 3 seconds to turn off the oscilloscope after making the last change. The next time you turn on, the oscilloscope automatically retrieves that configuration.

Restoring default settings. You can press the button CONFIG. PREDETER to start the oscilloscope in a known configuration. To see the option and control values that the oscilloscope retrieves when pressed. this button.

Waveforms

Opciones		
Ways of wave		Highlighting Memory Signals displays the menu for the storage or retrieval of waveforms
Source	CH1 CH2	Choose the waveform presentation that will store
Ref	A B	Choose the reference location for storage or recovery of a waveform
Store		Store the source waveform in the location of the chosen reference.
Ref(x)	Yes No	Show or remove the reference waveform in the screen.

The waveform must be displayed in order to save it as a waveform. for reference.

Save-Recover waveforms. The oscilloscope must display the waveform that you want to save. Two-channel oscilloscopes can store two reference waveforms in non-volatile memory.

The oscilloscope can display the reference waveforms and the channel waveform acquisitions. The reference waveforms do not they can adjust, but the oscilloscope does show the horizontal and vertical scales in the bottom of the screen.

Utilities

Press the UTILITIES button to see the Utilities menu. The utilities menu It changes when an expansion module TDS2CMA is added.

Options		
State of system		Show summaries of the oscilloscope values
Options	Style screen	Display the data on a black screen. white or in white on a black background.
	Configure printer	Show printer settings
Autocalibrated		Perform self-calibration
Error in registration		Show a list of the recorded errors The list is useful when connected to a center of Tektronix service seeking help.
Language	English Spanish.	Select the screen language of the operating system

Key points

Autocalibration. The autocalibration routine improves the accuracy of oscilloscope at room temperature. To achieve the same accuracy, run an automatic calibration when the ambient temperature changes by 5 ºC or more. Follow the on-screen instructions.

System status.

When selecting System Status from the Utilities menu, the menus are displayed. available for obtaining a control value list by group of oscilloscope controls

Press one of the menu buttons on the front panel to clear the screen state.

Options	**Comments**
Horizontal	List the horizontal parameters of the channels
Vertical	List the vertical parameters of the channels
Shot	List the shooting parameters
Miscellaneous	oscilloscope model

Vertical

You can use the vertical controls to display waveforms, adjust the position and vertical scale, and set input parameters.

Vertical channel menus

There is an independent vertical menu for each channel. Each option is set. individually for each channel.

Options		
DC Coupling	CA EARTH	CC passes the components of both types. AC and DC, of the input signal CA blocks the CC components of the signal of input and attenuate signals below 10 Hz EARTH disconnects the input signal
Limit Width of Band	20 MHz NO	Limit the bandwidth to reduce the noise of the presentation; filters the signal to reduce noise and others high frequency components.
Profit Variable	Thick Fine	Select the VOLTS/DIV setting Thick defines a sequence 1,2,5. Fine changes the resolution to smaller steps between the values of the thick.
Probe	1X 10X 100X 1000X	It is set to match the type of probe used to ensure correct vertical readings.
Investment	YES NO	Invert the waveform

NOTE. The vertical response of the oscilloscope occurs slowly above. of the bandwidth (60 MHz, 100 MHz or 200 MHz, depending on the model, at 20 MHz when the bandwidth limit option is set to NO

Mandos

Controls VERTICAL POSITIONUse the controlsVERTICAL POSITIONto move the waveforms up and down on the screen.

VOLTS/DIV controls. Use the VOLT/DIV controls to manage the way in which the oscilloscope amplifies or attenuates the source waveform signal of the channel. When the VOLTS/DIV knob on the oscilloscope is turned, it increases or decreases the vertical size of the waveform of the screen with respect to the axis.

Key points

Ground coupling. Use the GROUND coupling to show a zero volts waveform. Internally, the channel input is connected to a reference level of zero volts.

Fine resolution. The vertical scale reading shows the actual value of Gain.
Variable when it is at the fine resolution value. When changing the value to
The thick one does not change the vertical scale unit as long as it is not adjusted.
control.VOLTS/DIV.

In level readings and difference. The vertical sensitivity of the forms of
waves used in mathematical operations must match. If they do not match and they use cursors to measure the waveform result of an operation
Mathematics shows a U that represents units or scales.
unknown.

Removal of a waveform. To remove a waveform from the screen, press the channel menu button to display its vertical menu. I put again to eliminate the waveform.

NOTE. It is not necessary to display a channel waveform to use it as source of fire in mathematical operations.

Wave configuration in the time domain

Before using the FFT mode, you need to set up the waveform in the time domain (Y,T). To do this, follow these steps:

1.PulseAUTOCONFIGURE to display a YT waveform.

2. Turn the control VERTICAL POSITION of the waveform YT for center it vertically (zero divisions).

In this way, it is guaranteed that the FFT will show a true CC value.

3. Turn the control HORIZONTAL POSITION until the part of the shape is positioned.
of waveYTthat wishes to analyze in the eight central divisions of the screen.

The oscilloscope calculates the FFT spectrum using the 2018 central points. of the waveform in the time domain.

4. Turn the VOLTS/DIV knob to ensure that the entire waveform remains on screen. If the waveform does not fully visible, the oscilloscope may show erroneous results. the addition of frequency components.

5. Turn the SEC/DIV knob to provide the desired resolution in the FFT spectrum.

6. If possible, set the oscilloscope to display several cycles. of signals.

If you turn the SEC/DIV knob to select a faster value (less cycles), the FFT spectrum shows a wider range of frequencies and reduce the possibility of false representations of FFT.

To set up the FFT presentation, follow these steps:

1. Press the button menuMATH.

2.Set the source option to FFT.

3. Select the source channel in FFT mathematics.

In many cases, the oscilloscope can produce a useful FFT spectrum. even if the waveform YT is not triggered. This is fulfilled especially when the signal is periodic or random (with noise).

NOTE. The transient or burst waveforms must be triggered and positioned.
as close as possible to the center line of the screen.

Nyquist frequency

The maximum frequency that any real-time digitizing oscilloscope can be measured without errors corresponds to half of the sampling rate. This frequency is referred to as Nyquist frequency. The frequency information Above Nyquist frequency is shown poorly.
(undersampling), which translates into false representations of FFT.

The mathematical function transforms the 2048 central points of the shape of wave in the time domain in a FFT spectrum. The FFT spectrum resultant contains 1024 points that span from CC (0 Hz), up to the Nyquist frequency.

Experiment 1: Series RLC Circuit Sinusoidal Response

Introduction

Since inductive and capacitive reactances are a function of frequency, the The sinusoidal response of a series RLC circuit will vary with the applied frequency. Inductive reactance is directly proportional to the frequency, and the capacitive reactance is inversely proportional to frequency. There is a frequency, fo, where the reactances cancel out ($X_L X_C = 0$) and the circuit becomes resistive ($Z = R + j(X_L X_C$This phenomenon is called resonance. Below the 'resonant' frequency. the impedance is inductive. Above the resonant frequency the impedance is inductive. In this laboratory experiment, the measured response of the RLC Circuit will be compared to analysis and simulation.

The series resonant circuit has two important parameters, resonant frequency, fo, and bandwidth, BW. The bandwidth is the difference between the two frequencies where the current in the circuit is 0.707 of its maximum value. These two parameters are related to the parameters of the circuit's 'step' response. One The objective of this lab exercise is to become more familiar with the response of "oscillatory" circuits. Oscillation is a common natural phenomenon, and in electrical circuits it may be desired or undesired. For example, we don't want digital signals to oscillate when the voltage level changes, but oscillation may occur because of inductance in wires and capacitance between wires and within logic gates. Understanding resonance is important for engineers in general. Resonance can destroy mechanical systems, or be desired, as in a musical instrument.

Equipment Required

Function Generator and Oscilloscope.

100mH

(Use the components whose values you determined in experiment 1, measure R)

Procedure Part 1: Resonant Frequency and Bandwidth

1. Connect C, L, and R directly together, with no wires in between. Connect the function generator and oscilloscope leads directly to the components.

2. Connect channel 1 of the oscilloscope to measure Vs, the output of the function generator and connect channel 2 of the oscilloscope to measure the voltage, Vo, across R. Set the oscilloscope to trigger on channel 1.

4. Set the function generator to produce a 5 volt, peak to peak, 1600 Hertz sine. wave, with no offset (this is Vs). Fine-tune the function generator to get the maximum voltage, Vo. This will occur at the circuit's resonant frequency, fo.

5. Measure and record the peak to peak magnitude of the voltage, Vo, and the frequency, fo (make sure that Vs is still 5 volts peak to peak). Also measure and record the phase angle, θ_0, of Vo with respect to Vs. 6

6. Tune the function generator to a frequency below fo where the voltage, Vo, is 0.707

   of its maximum value. Make sure that Vs is still 5 volts peak to peak. Measure the phase angle of Vo with respect to Vs. Record the frequency as f1, and the phase angle as θ_1.

7. Tune the function generator to a frequency above fo where the voltage, Vo, is 0.707 of its maximum value. Again, make sure that the function generator Voltage is still 5 volts peak to peak. Measure the phase angle of Vo with respect to Vs. Record the frequency as f2, and the phase angle as θ_2.

   Organize your data into a table such as the one below:

	Frequency	In Magnitude	Phase angle
fo, Resonant frequency			θ_0=
f1, Lower frequency			θ_1=
f2, Upper frequency			θ_2=

Procedure Part 2: Frequency Response Plot

This procedure requires a function generator capable of generating a frequency sweep and an oscilloscope connected to a computer. The procedure in this part uses an Agilent 33120A function generator, a Tektronix TDS1002 oscilloscope, a PC with Microsoft Excel, and Tek Open Choice software.

1. Use the same setup as in part 1 (repeat part 1, steps 1 and 2).

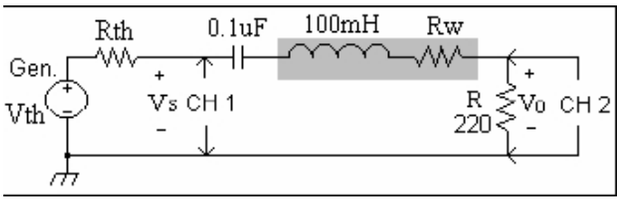
2. Open Excel. You should see the TekXL tool bar as shown on the right. Click on connection

3. Select an instrument, usually the first one, and click on 'identify'. instrument ID should appear at the bottom of the window, in this case, TDS1002

Click 'OK'. If there is a problem with this part of the procedure, you may need to ask the instructor or lab assistant for help. Also, you may click on the Help in the TekXL tool bar.

4. Click on 'Measurements' in the TekXL tool bar. Click the 'Selection' tab and select both channels 1 and 2. Select the measurements: FREQUENCY and ROOT MEAN SQUARE, as shown below. Click on the “Timing” tab.

5. The timing settings depend on the capability of the function generator and oscilloscope interface. The example frequency response plot shown on the next page was done using an Agilent 33120A function generator set to logarithmic sweep from 100Hz to 10KHz in 400 seconds. If you need help Setting the function generator, ask the lab instructor or assistant for help. You can also refer to the function generator's user manual.



The sampling interval was set to 2 seconds so one would expect 200 measurements in 400 seconds. However, only 95 measurements were actually made in that time, due to a slow serial interface. So the record length was set to 100.

6. The oscilloscope time base needs to be set so that one cycle is displayed at the lowest frequency, in this case, 1mS/Div. At the highest frequency there will be 100 cycles displayed. Since the oscilloscope takes 2500 samples per screen, one cycle of 100Hz would consist of 2500 samples and one cycle of 10KHz would consist of 25 samples.

7. Set the function generator to produce a 1 volt rms sine wave. Set both vertical channels of the oscilloscope to 500mV/Div. You should now be ready to start the sweep.

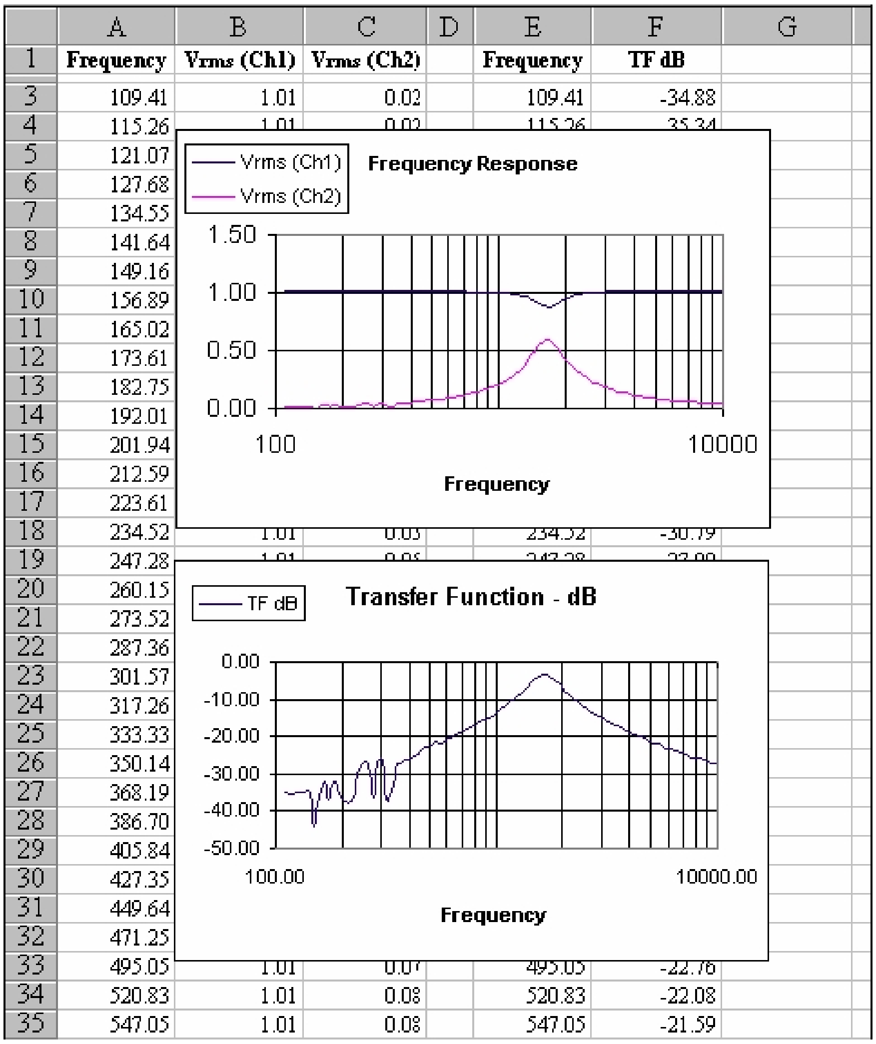
8. The Agilent function generator starts the sweep when the 'Single/TRIG' button is pressed. TekXL Measurement starts when the start button is clicked. Click the start button and immediately after push the “Single/TRIG” button on the function generator.

You should observe the frequency increase on the oscilloscope screen and in Excel. Channel 2 frequency will be way off most of the time due to the low amplitude of the channel 2 signal. Stop the acquisition at 10KHz. You can delete the channel 2 frequency column and format the columns for better readability. See the sample result on the next page.

Sample Acquisition

The first 35 of 95 rows of the acquired measurements are shown below. columns and graphs have been formatted. Note the dip in the function generator output at the resonant frequency in the first graph. This is due to the generator’s 50-ohm internal resistance. This internal resistance would need to be included in calculating the Q and bandwidth for the response curve in the top graph.
The second graph was generated by plotting the actual 'Transfer Function' of the filter. The ratio of the filter's output to its input is plotted. The internal resistance

of the function generator would not be included in calculating the Q and bandwidth for the response curve in the bottom graph. Cell F3 has the equation: =20*LOG10(C3/B3). A linear plot could be generated by writing in cell F3: =(C3/B3).



Analysis, Part 1

1. Calculate the theoretical resonant frequency of your RLC circuit. What is the percent difference between the measured and the calculated resonant frequency?
2. Calculate the theoretical bandwidth of your RLC circuit from your data in part 1 Does the internal resistance of the function Should the generator be included in the calculations? Why or why not? What is the percent difference between the measured and the calculated bandwidth?

3. Simulate the RLC circuit with PSpice. Use 'AC Sweep' analysis to plot the magnitude and phase response of the circuit from 100 Hertz to 10,000 Hertz. See below. Be sure to use your measured component values. 10 o, f1 and f2 on the PSpice plot. Note the circuit and simulation. Compare your simulation results Record your measured resonant results for fo = _____ BW = _____ R = _____ Rw L
4. Use the cursors in PSpice to locate f
5. results on the right and the simulation settings below.
6. with your calculations. They should be in close agreement.
7. frequency and measured bandwidth. Save these for the next experiment. (Also save the parts and measured values for the next set of experiments.