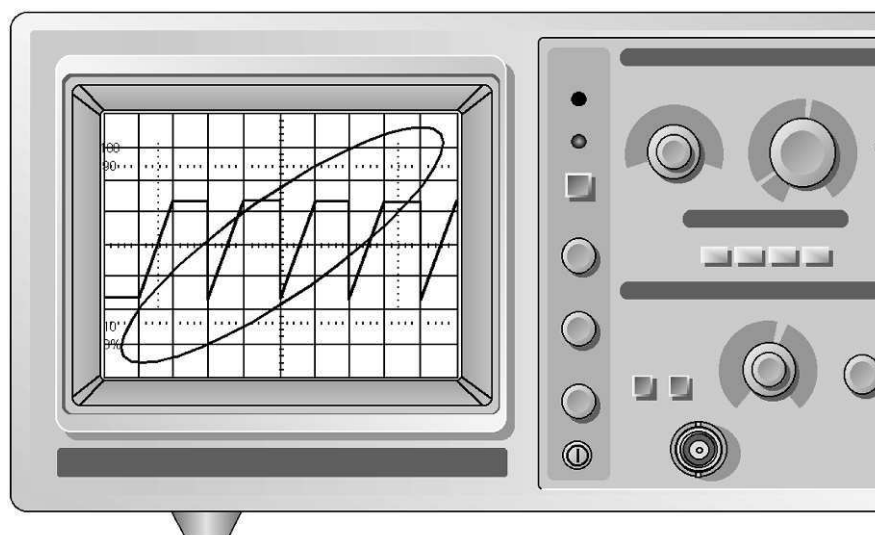




Oscilloscope

OS-5100

Analog Oscilloscope
Operation Manual



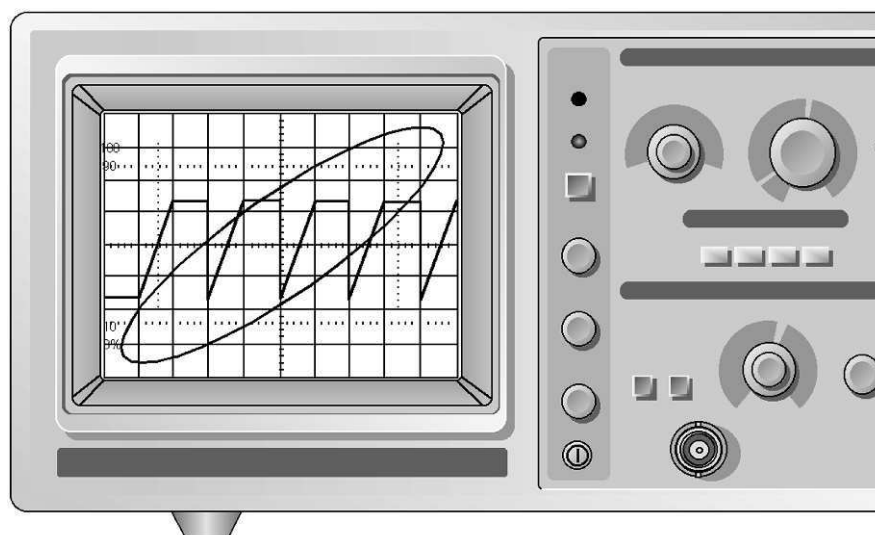
 **EZ Digital Co., Ltd.**



Oscilloscope

OS-5100

Analog Oscilloscope
Operation Manual



 **EZ Digital Co., Ltd.**

Safety Summary

Introduction

Thank you for purchasing a EZ product. Electronic measuring instruments produced by EZ digital are high technology products made under strict quality control. We guarantee their exceptional and utmost reliability. For proper use of the product please read this manual carefully.

Instructions

1. To maintain the precision and reliability of the product use it in the standard conditions(temperature 10

Warranty

Warranty service covers a period of one year from the date of original purchase.

In case of technical failure within a year, repair service will be provided by our service center or sales outlet free of charge.

We charge for repairs after the one-year warranty period expires.

When the failure is a result of user=s neglect, natural disaster or accident, we charge for repairs regardless of the warranty period.

For more professional repair service, be sure to contact our service center or sales outlet.

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1. PRODUCT DESCRIPTIONS

1-1. INTRODUCTION

OS-5100 is the 100MHz, 2 channels, 2 traces which has excellent functions including wide band width, high sensitivity, two timebase generator, delay sweep and divided TV trigger Signal, It reduces the measurement error, and uses 6" squared type CRT with internal fluorescent scale which enables to take the photograph of observed waveform.

1-2. SPECIFICATIONS

1-3. PRECAUTIONS

1-3. PRECAUTION

Before you operate this instrument, follow the following procedure to ensure safe operation and to prevent any damage to the instrument.

1-3-1. Line voltage selection

This instrument must be operated with the correct. Line Voltage Selection switch setting and the correct line fuse for the line voltage selected to prevent damage. The instrument operates from either a 90 to 132 volts or a 198 to 250 volts line voltage source. Before line voltage is applied to the instruments.

To change the line voltage selection :

1. Make sure the instrument is disconnected from the power source.
2. Pull out the Line Fuse Holder containing the fuse for overload protection. Replace the fuse in the holder with the correct fuse from Table 1-1 slide the arrow mark to the desired position and plug it in.

Table 1-1 Line Voltage Selection and Fuse Ratings

Voltage	Arrow	Fuse (250V)	
		UL198G	IEC127
90 to 110volts	100	2A	F2A
108 to 132volts	120		
198 to 242volts	220	1A	F1A
207 to 250volts	230		

<Caution> This product has the ground chassis (3 wire power cord is used). Check whether any other equipment connecting with this product requires the transformer before use. If so, do not connect the DC/AC or the hot chassis equipment if no transformer is available.

Do not directly connect it to the AC power nor to the circuit directly connected to the AC power. Otherwise serious personal injury or damage to this product for a long time without trouble.

1-3-2. Installation and handling precautions

When placing the OS-5100 in service at your workplace, observe the following precautions for best instrument performance and longest service life.

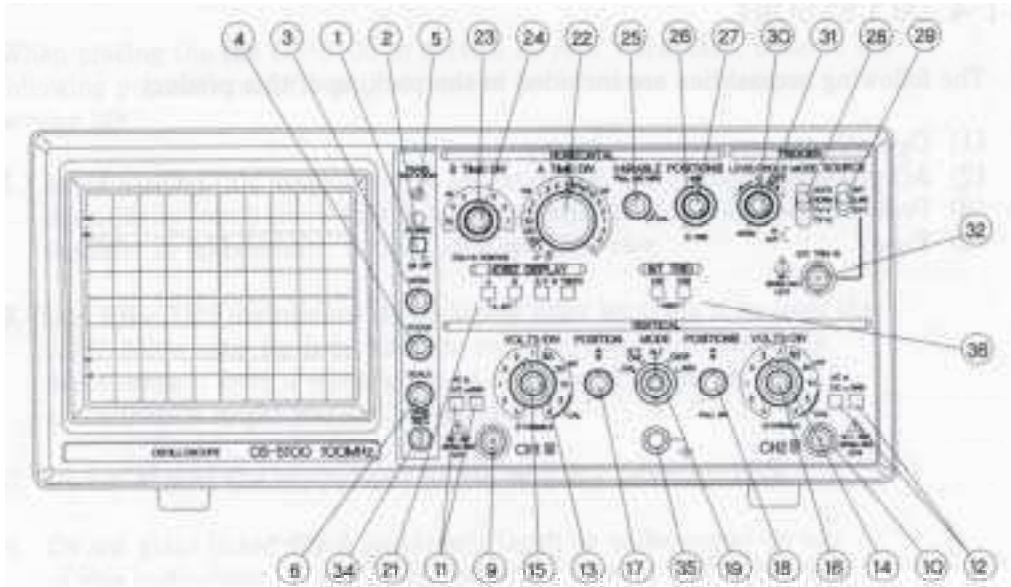
1. Avoid placing this instrument in an extremely hot or cold place. Specifically, don't leave this instrument in a close car, exposed to sunlight in midsummer, or next to a space heater.
2. Don't use this instrument immediately after bringing it in from the cold. Allow time for it to warm to room temperature. Similarly, don't move it from a warm place to a very cold place, as condensation might impair its operation.
3. Do not expose the instrument to wet or dusty environments.
4. Do not place liquid-filled containers (such as coffee cups) on top of this instrument. A spill could seriously damage the instrument.
5. Do not use this instrument where it is subject to severe vibration, or strong blow.
6. Do not place heavy object on the case, or otherwise block the ventilation holes.
7. Do not use this oscilloscope in strong magnetic fields, such as near motors.
8. Do not insert wires, tools, etc. through the ventilation holes.
9. Do not leave a hot soldering iron near the instrument.
10. Do not place this scope face down on the ground, or damage to the knobs may result.
11. Do not use this instrument upright while BNC cables are attached to the rear-panel connectors. This will damage the cable.
12. Do not apply voltages in excess of the maximum ratings to the input connectors probes.

1-1. ACCESSORY

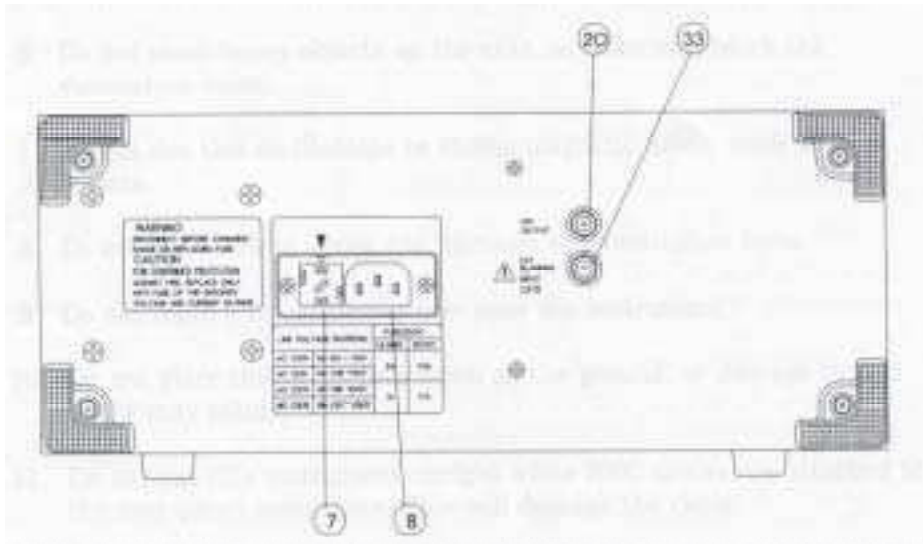
The following accessories are included in the packing of this product :

- (1) Operating manual : 1copy
- (2) AC power code : 1EA
- (3) Probe (Option : 2 EA
- (4) Fuse : 1EA

2. OPERATING INSTURCTIONS



(a) FRONT-PANEL ITEMS



(b) REAR-PANEL ITEMS

Fig. 2-1. PANEL ITEMS

This section contains the information needed to operate the OS-5100 and utilize it in a variety of basic and advanced measurement procedures. Included are the identification and function of controls, connectors, and indicators, startup procedures, basic operating routines, and selected measurement procedures.

2-1. FUNCTION OF CONTROLS, CONNECTORS, AND INDICATORS

Before turning this instrument on, familiarize yourself with the controls, connectors, indicators, and other features described in this section. The following descriptions are keyed to the items called out in Figures 2-1.

2-1-1. Display and power blocks

- | | |
|------------------|--------------------------------------------------------------------------------------|
| [1] POWER SWITCH | : Push in to turn instrument power on and off. |
| [2] POWER LAMP | : Green lights when power is on |
| [3] INTENSITY | : Adjust the brightness of the CRT display. Clockwise rotation increases brightness. |
| [4] FOCUS | : To obtain maximum trace sharpness |

[10] CH2 or Y IN connector : For applying an input signal to vertical amplifier channel 2, or to the Y-axis (vertical) amplifier during X-Y operation

[19] V MODE

: To select the vertical-amplifier display mode.

CH1 : CH1 position displays only the channel 1 input signal on the CRT screen.

CH2 : CH2 position displays only the channel 2 input signal on the CRT screen.

ALT : The waveform appears alternatively at each sweep end.
This function is useful to measure at the speed faster than 50

B TRIG'D : The delay seep is triggered by the first trigger pulse.

[22] A TIME/DIV : To select either the calibrated sweep rate of the main (A) timebase, the delay-time range or delayed-sweep operation

[23] B TIME/DIV : To select the calibrated sweep rate of the delayed (B) timebase

[24] DLY'SD POSITION : To determine the exact starting point within the A timebase delay range at which the B timebase will begin sweeping

[25] A VARIABLE : Continuously changes the A sweep time to the calibrated position.

PULL X 10MAG : Pulling switch extends the seep time ten times. In this case, sweep time becomes one tenth the TIME/DIV value. Pulling the X 10 MAG switch when the zone to be magnified is aligned with the center scale of vertical axis by adjusting the horizontal axis, the magnified waveform appears in symmetry. In this case, sweep time becomes one tenth the TIME/DIV value.

[26] HORIZONTAL POSITION : To adjust the horizontal position of the traces displayed on CRT. Clockwise rotation moves the traces to the right, counterclockwise rotation moves the traces to the left.

[27] FINE : It is used to make fine adjustment of horizontal position

[28] TRIGGER MODE : To select sweep triggering mode.

AUTO : AUTO position selects free-running sweep where a baseline is displayed in the absence of a signal. This condition automatically, reverts to triggered sweep when a trigger signal of 25Hz or higher is received and other trigger controls are properly set.

NORM : NORM position produces sweep only when a trigger signal is received and other controls are properly set. No trace is visible if any trigger requirement is missing. This mode must be used when the signal frequency is 25Hz or lower.

TV-V : TV-V position is used for observing a composite video signal at the frame rate.

TV-H : TV-H position is used for observing a composite video signal at the line rate.

[29] TRIGGER SOURCE : To conveniently select the trigger source.

INT : CH1 (CH2) position selects the channel 1 (channel 2) signal as the trigger source.

LINE : LINE position selects a trigger derived from the AC power line. This permits the scope to stabilize display line-related components of a signal even if they are very small compared to other components of the signal.

EXT : The signal applied to the input terminal of EXT is used as trigger signal. When small internal signal or any unexpected signal prevents the trigger, the outside trigger signal source can be entered to stabilize the measurement of waveform.

[30] HOLD OFF : Allows trigger on certain complex signals by changing the holdoff (dead) time of the main (A) sweep. This avoids triggering on intermediate trigger points within the repetition cycle of the desired display. The holdoff time increase with clockwise rotation.

[31] TRIG LEVEL : To select the trigger signal amplitude at which triggering occurs. When rotated clockwise, the trigger point moves toward the positive peak of the trigger signal. When this control is rotated counterclockwise, the trigger point moves toward the negative peak of the trigger signal.

TIGGER SLOPE : To select the positive or negative slope of the trigger signal for initialing sweep. Pushed in, the switch selects the positive (+) slope. When pulled, this switch selects the negative (-) slope.

[32] EXT TRIG IN : For applying external trigger signal to the trigger circuits.

<CAUTION> To avoid damage to the oscilloscope, do not apply more than 250V (DC + peak, AC) between “EXT Trig In” terminal and ground.

2-1-4. Miscellaneous Features Connector

[33] EXT BLANKING INPUT : For applying signal to intensity modulate the CRT. Trace brightness is reduced with a positive signal, and increased with a negative signal.

[34] PROBE ADJUST : Outputs square wave (0.5V, P-P, 1KHz) to calibrate probe and vertical amplifier.

[35] GROUND CONNECTOR : Provides an attachment point for a separate ground lead.

[36] VERT MODE : Selects mode of operation for vertical amplifier system
CH1 : Channel 1 is displayed on the CRT
CH2 : Channel 2 is displayed on the CRT

2-2. BASIC OPERATING PROCEDURES

2-2-1. Signal Connections

There are three methods of connecting an oscilloscope to the signal you wish to observe. They are a simple wire lead, coaxial cable, and scope probes.

1. A simple lead wire
2. Coaxial cable
3. Scope probes

1. A simple lead wire

A simple lead wire may be sufficient when the signal level is high and the source impedance low (such as TTL circuitry), but is not often used. Unshielded wire picks up hum and noise ; this distorts the observed signal when the signal level is low.

Also, there is the problem of making secure mechanical connection to the input connection to the input connectors. A binding post-to BNC adapter is advisable in this case.

2. Coaxial cable

Coaxial cable is the most popular method of connecting an oscilloscope to signal sources and equipment having output connectors. The outer conductor of the cable shields the central signal conductor from hum and noise pickup. These cables are usually fitted with BNC connectors on each end, and specialized cable and adaptors are readily available for mating with other kind of connectors.

3. Scope probes

Scope probes are the most popular method of connecting the oscilloscope to circuitry. These probes are available with 1 X attenuation (direct connection) and 10 X attenuation. The 10 X attenuator probes increase the effective input impedance of the probe/scope combination to 10 megohms shunted by a few picofarads. The reduction in input capacitance is the most important reason for using attenuator probes at high frequencies, where capacitance is the major factor in loading down a circuit and distorting the signal. When 10 X attenuator probes are used, the scale factor (VOLTS DIV switch setting) must be multiplied by ten.

Despite their high input impedance, scope probes do not pickup appreciable hum or noise. As was the case with coaxial cable, the outer conductor of the probe cable shields the central signal conductor. Scope probes are also quite convenient from a mechanical standpoint.

To determine if a direct connection with shielded cable is permissible, you must know the source impedance of the circuit you are connecting to, the highest frequencies involved, and the capacitance of the cable. If any of these factors are unknown, use a 10 X low capacitance probe.

2-2-2. Preliminary control settings and adjustments

Before placing the instrument in use, set up and check the instrument as follows ;

1. Set the following controls as indicated

Power source part

POWER SWITCH [1]	: OFF (coming up)
INTEN [3]	: Fully counterclockwise
FOCUS [4]	: Center

Vertical Part

AC-DC, GND [11, 12]	: AC
VOLT/DIV [13, 14]	: 10Mv
VERTICAL POSITION [17, 18]	: Locates at center while being pressed
VARIABLE [15, 16]	: Fully clockwise while being pressed
V. MODE [19]	: CH1

Horizontal part

TIME/DIV [22]	: 0.5ms
TIME VARIABLE [25]	: Fully clockwise while being pressed
HORIZONTAL POSITION [26]	: Center
FINE POSITION [27]	: Center

Trigger part

TRIGGER MODE [28]	: AUTO
TRIGGER SOURCE [29]	: INT
HOLD OFF [30]	: NORM (Max. counterclockwise)
TRIGGER LEVE [31]	: Center
SLOPE [31]	: + (pressed)

2. Connect the AC Power Cord to the Power Connector [8], then plug the cord into a convenient AC outlet.

3. Press in the Power switch [1], The POWER lamp [2] should light immediately. About 30 seconds later, rotate the INTEN control clockwise until the trace appears on the CRT screen. Adjust brightness to you liking.

< Note> A burn-resistant material is used in the CRT. However if the CRT is left with an extremely bright dot or trace for a very long time, the screen may be damaged. Therefore, if a measurement requires high brightness, be certain to turn down the INTEN control immediately afterward. Also, get in the habit of turning the brightness way down if the scope is left unattended for any period of time.

4. Turn the FOCUS control [4] for a sharp trace.

5. Turn the CH1 Vertical POSITION CONTROL [17] to move the CH1 trace to the center horizontal graticule line.

6. Turn the Horizontal POSITION control [26] to align the left edge of the trace with the left-most graticule line.

2-2-3. Probe adjustment

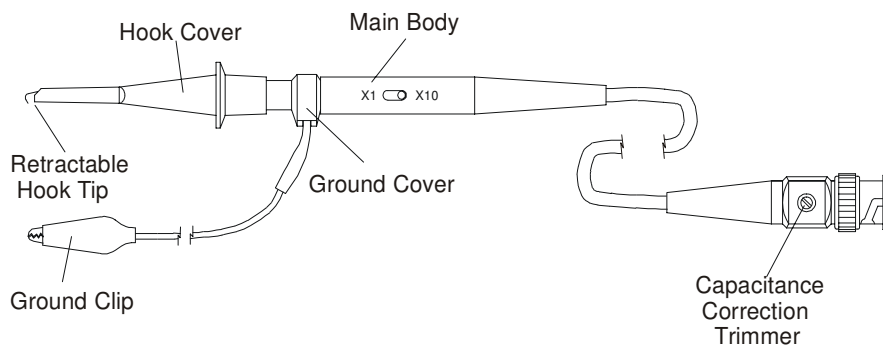
When applying the external signal to be measure using oscilloscope, use probe. The applied waveform is displayed on the CRT of oscilloscope. This product has two points.

1 X (direct connection) and 10 X (attenuation). At 10 X point, the input impedance of oscilloscope increases, which attenuates the input signal by 1/10. Therefore, it is necessary to multiply 10 to the measurement unit (volts/div.)

The damping probe is used for high frequency measurement because of the reduction of input capacity which distorts signal and reduces the load.

Using any incorrectly calibrated probe may cause error in the measurement. So adjust the probe as follows :

1. Connect probe to CH1 X IN [9]. With CH1 input coupling set to DC, connect tip to PROBE ADJUST [34].
In this case, set the probe damping position to 10 X and set VOLT/DIV [13] to 10mV.
2. Adjust Trigger Level to stabilize screen.
When the top or a part of spherical wave is slanted or has any tooth, adjust the probe adjustment trimmer as shown in Fig. 2-2(b) using small screw driver.



(a) PROBE

2-2-4. Single-trace operation

Single-trace operation with single timebase and internal triggering is the most elementary mode of the OS-5100. Use this mode when you wish to observe only a single signal, and not be disturbed by other traces on the CRT. Since this is fundamentally a two-channel instrument, you have a choice for your single channel. Channel 1 has an output terminal [20] use channel 1 if you also want to measure frequency with a counter while observing the waveform. Channel 2 has a INVERT [18] to convert the polarity.

CH1 Signal display

1. Set the initial screen as described in paragraph 1. 2-2-2.
2. Set the CH1 input coupling [11] to AC.
3. Connect the signal to CH1 connector [9].
<Note> Do not apply power voltage (DC + PEAK AC) higher than 250V.
4. Adjust CH1 VOLT/DIV switch [13] and vertical POSITION (17) terminal to place the signal in the measurable area.
5. Adjust TRIGGER LEVEL [31] to display a stable waveform.
6. Adjust a TIME/DIV switch [22] and horizontal POSITION [26] to place the waveform in the measurable area.
When it is difficult to measure high frequency signal with A TIME/DIV switch [22] set to 10ns at these have to many cycle, pull VARIABLE [25] to pull X 10 MAG..
Then retry to measure.
7. When measuring any damped or distorted low frequency signal, set the vertical input coupling to DC.

CH2 Signal display

Except for the following step, the method to display CH2 signal is same as that of CH1.

1. Set V MODE [19] switch to CH2,. And TRIGGER SOURCE switch [29] to INT.

2. Set CH2 input coupling [12] to AC, and connect signal to CH2 input connector.
3. Adjust CH2 VOLTS/DIV switch [14] and vertical position terminal [18] to place signal in the measurable area.

TRIGGER signal display

When signal is applied to TRIGGER generator, signal is displayed on the CRT.

1. Set the initial screen as described in paragraph 1, 2-2-2.
2. Set CH1, CH2 input coupling [11] and [12] to AC.
3. Set V mode switch (19) to ALT or CHOP.
4. When TRIGGER SOURCE switch [29] is set to INT, the output from CH1 input amplifier is displayed on CRT.
5. When TRIGGER SOURCE switch [29] is set to INT, the output from CH2 input amplifier is displayed on CRT.
6. When TRIGGER SOURCE switch [29] is set EXT, the signal is fed to TRIGGER generator and displayed on CRT.

2-2-5. Dual-trace operation

For dual-trace measurement, two waveforms out of CH1. CH2 may be displayed in ALT or CHOP mode.

1. When selecting the desirous channel, the CH1 and CH2 bright line are selectively displayed on the CRT.
2. Select the ALT for the related high frequency signal (sweep rate is higher than 50

INT and the channel to which waveform with steeper slope is applied.

As for other signal, if the frequency is of multiple number, set TRIGGER SOURCE switch [29] to the channel to which low frequency is applied.

Remember that no trigger is possible on the screen if the currently used channel is not adjusted using TRIGGER SOURCE [29]

5. If non-synchronized signal with different frequency is displayed, please set TRIGGER SOURCE SWITCH (29) to "INT" and set "Vert" of the INT SWITCH (36).

Remember that vert trigger is possible on the screen only when VERTICAL MODE SWITCH (19) is selected to "ALT"

2-2-6. Trigger options

Triggering is often the most difficult operation to perform on an oscilloscope because of the many options available and the exacting requirements of certain signals.

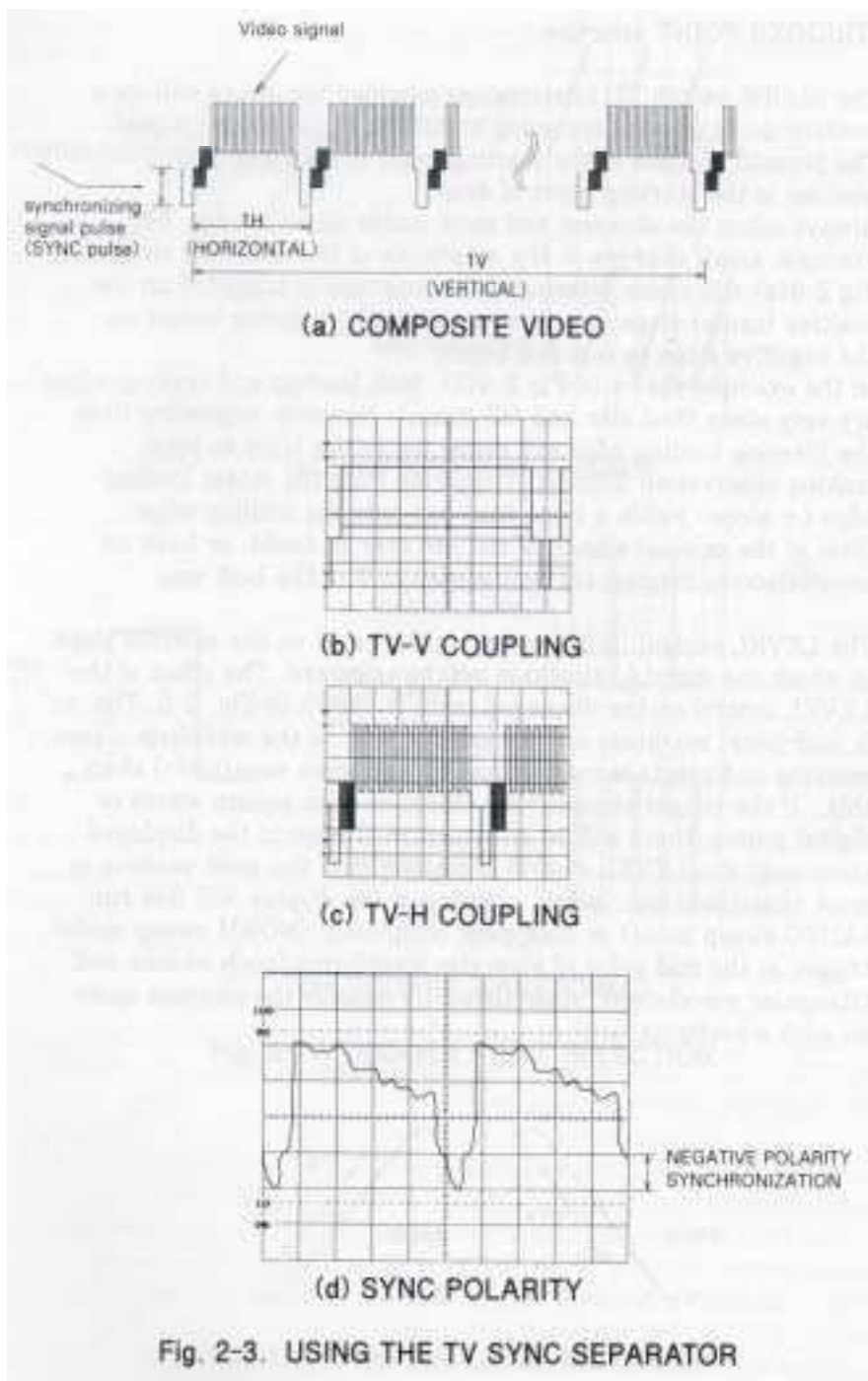
(1) TRIGGER MODE [28] selection

AUTO, NORM TRIGGER MODE

When the NORM trigger mode is selected, the CRT beam is not swept horizontally across the face of the CRT until a sample of the signal being observed, or another signal harmonically related to it, triggers the timebase. However, this trigger mode is inconvenient because no base line appears on the CRT screen in the absence of a signal, or if the trigger controls are improperly set. Since an absence of trace can also be due to an improperly set Vertical POSITION control or VOLTS/DIV switch, much time can be wasted in determining the cause. The AUTO trigger mode solves this problem by causing the timebase to automatically free run when not triggered. This yields a single horizontal line with no signal, and a vertically-deflected but non-synchronized display when vertical signal is present but the trigger controls are improperly set. This immediately indicates what is wrong. The only hitch with AUTO operation is that signals below 25Hz cannot, and complex signals of any frequency may not, reliably trigger the timebase. Therefore, the usual practice is to leave the TRIGGER MODE switch [28] set to AUTO, but reset it to NORM if any signal (particularly one below 25Hz) fails to produce a stable display.

TV-V, TV-H TRIGGER MODE

The TV-V and TV-H positions of the Trigger MODE switch insert a TV sync separator into the trigger chain, so a clean trigger signal at either the vertical-or horizontal-repetition rates can be removed from a composite video signal (Fig 2-3 (b)), set the TRIGGER MODE switch to TV-V. To trigger the scope at the horizontal (line) rate (Fig 2-3(c)), set the TRIGGER MODE switch to TV-H. For best results, the TV sync polarity should be negative (Fig 2-3 (d)) when the sync separator is used.



(2) TRIGGER POINT selection

The SLOPE switch [31] determines whether the sweep will be on a positive-going or negative-going transition of the trigger signal. The pressed position is the starting point of rise, and pulled position is the starting point of drop.

Always select the steepest and most stable slope or edge. For example, small changes in the amplitude of the sawtooth shown in Fig 2-4 (a) will cause jittering if the timebase is triggered on the positive (ramp) slope, but have no effect if triggering occurs on the negative slope (a fast-fall edge).

In the example shown in Fig 2-4(b), both leading and trailing edges are very steep (fast rise and fall times). However, triggering from the jittering trailing edge will cause the entire trace to jitter, making observation difficult. Triggering from the stable leading edge (+ slope) yields a trace that has only the trailing-edge jitter of the original signal. If you are ever in doubt, or have an unsatisfactory display, try both slopes to find the best way.

The LEVEL control [31] determines the point on the selected slope at which the main (A) timebase will be triggered. The effect of the LEVEL control on the displayed trace is shown in Fig. 2-5. The +, 0, and - panel markings for this control refer to the waveform's zero crossing and points more positive (+) and more negative (-) than this. If the trigger slope is very steep, as with square waves or digital pulses, there will be no apparent change in the displayed trace until the LEVEL control is rotated past the most positive or most negative trigger point, whereupon the display will free run (AUTO sweep mode) or disappear completely (NORM sweep mode), trigger at the mid point of slow-rise waveforms (such as sine and triangular waveforms), since these are usually the cleanest spots on such waveforms.

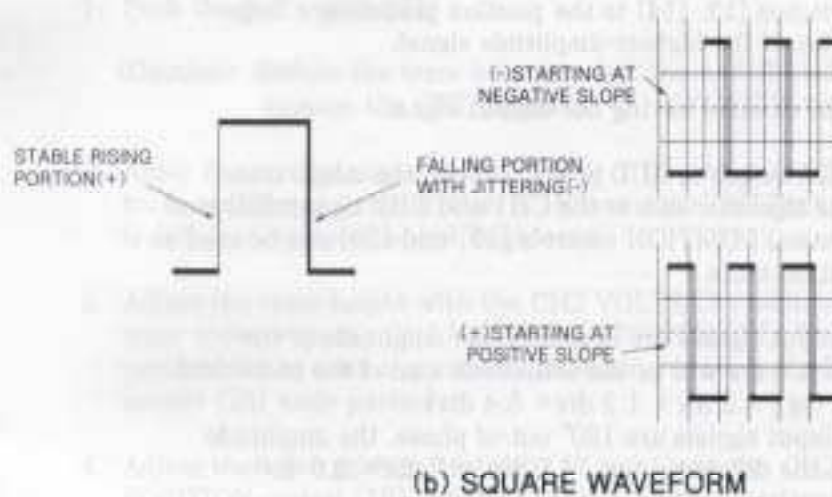
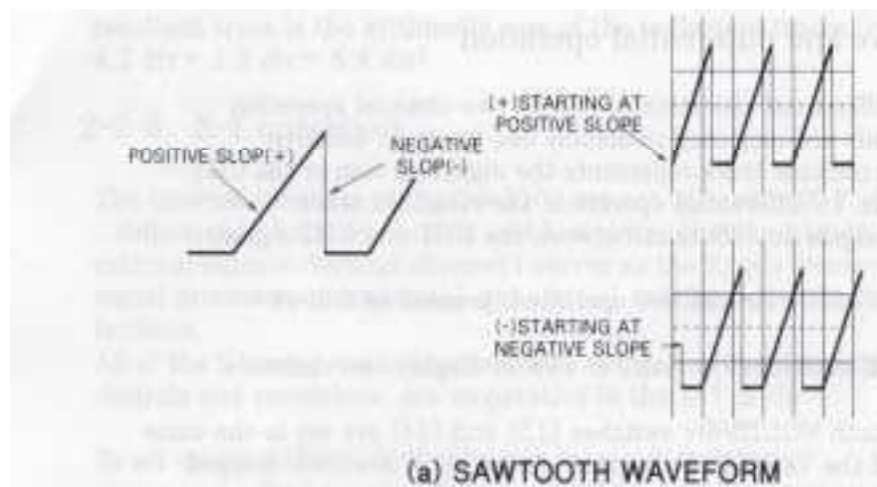


Fig. 2-4. TRIGGER POINT SELECTION

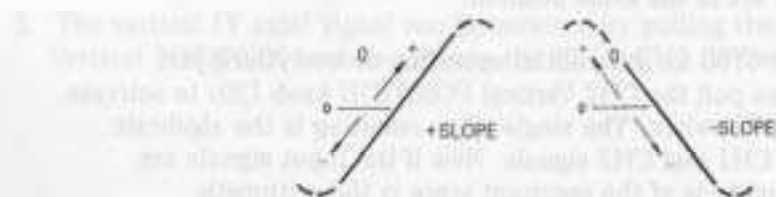


Fig. 2-5. TRIGGER LEVEL SELECTION

2-2-7. Additive and differential operation

Additive and differential operation are forms two-channel operation where two signals are combined to display one trace. In additive operation, the resultant trace represents the algebraic sum of the CH1 and CH2 signals. In differential operation, the resultant trace represents the algebraic difference between the CH1 and CH2 signals.

To set up the OS-5100 for additive operation, proceed as follows :

1. Set V MODE switch [19] to ALT or CHOP, display two channels.
2. Make sure both VOLTS/div switches [13] and [14] are set to the same position and the VARIABLE control [15] and [16] are click-stopped fully clockwise. If the signal levels are very different, set both VOLTS/div switches [13]. [14] to the position producing a large on-screen display of the highest-amplitude signal.
3. Trigger from the channel having the biggest signal.
4. Set the V MODE switch ADD position. Then the single trace resulting is the algebraic sum of the CH1 and CH2 signal. Either of both of the Vertical POSITION controls [19] and [20] can be used to shift the resultant trace.

<Note> If the input signals are in-phase, the amplitude of the resultant trace will be the arithmetic sum of the individual traces (eg., 4.2 div + 1.2 div = 5.4 div)
If the input signals are 180

2-2-8. X-Y operation

The internal timebase of the OS-5100 are not utilized in X-Y operation; deflection in both the vertical and horizontal directions is via external signals. Vertical channel I serves as the X-axis (horizontal) signal processor, so horizontal and vertical axis have identical control facilities.

All of the V mode, and trigger switches, as well as their associated controls and connectors, are inoperative in the X-Y mode.

To set up OS-5100 for X-Y operation, proceed as follows :

1. Push the X-Y switch [21]

<Caution> Reduce the trace intensity, lest the undeflected spot damage the CRT phosphor.

2. Apply the vertical signal to the CH2 or Y IN connector [10], and the horizontal signal to the CH1 or X IN connector [9]. Once the trace is deflected, restore normal brightness.
3. Adjust the trace height with the CH2 VOLTS/DIV switch [14], and the trace width with the CH1 VOLTS/DIV SWITCH [13]. The VARIABLE controls can be used if greater is necessary, so leave the TIME VARIABLE control [25] knob pushed in.
4. Adjust the trace position vertically (Y axis) with the CH2 Vertical POSITION control [18]. Adjust the trace position horizontally (X axis) with the Horizontal POSITION control [26] ; the CH1 Vertical POSITION control has no effect during X-Y operation.
5. The vertical (Y axis) signal can be inverted by pulling the CH2 Vertical POSITION knob to activate the PULL CH2 INV switch [18].

2-2-9. Delayed-time base operation

The OS-5100 contains two timebase, arranged so one (the A timebase) may provide a delay between a trigger event and the beginning of sweep by the second (B) timebase. This allows any selected portion of a waveform, or one pulse of a pulse train, to be spread over the entire CRT screen. Delayed sweep can be used with either single-trace or dual-trace operation. The procedure is the same regardless of the number of trace displayed.

Delay timebase (B SWEEP) display

1. Set the required vertical mode.
2. Set **HORIZ DISPLAY SWITCH [21]** to **A INT.** (Press **A** and **B** buttons simultaneously) A part of waveform is displayed more brightly than other part.
This magnified waveform is delay sweep.
The waveform having emphasized sector is in A sweep, whereas waveform having delay sweep is in B sweep.
The starting point of part of the emphasized B sweep is adjustable using **DLY'D POSITION** adjustor [24].
In order to prevent the trembling of B sweep waveform, press **B TRIG'D** button on **HORIZ DISPLAY** switch [21] (if stable waveform is required) and adjust **TRIGGER LEVE** [31].
Then decide the delay using **DLY'D POSITION** [24] and **A TIME/DIV** [22]. After this, B sweep is triggered by first **TRIGGER SIGNAL**.
3. Pressing **B** button on the **HORIZ DISPLAY** [21] (**B TRIG'D** button out) displays one waveform by B sweep on the CRT.
This mode is used to measure B **TRIG'D**.

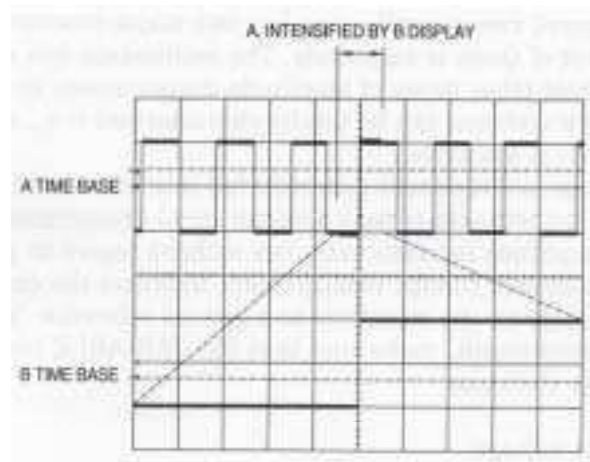


Fig. 2-6 SWEEP MAGNIFICATION BY THE B TIMEBASE

2-3. MEASUREMENT APPLICATIONS

This section contains instructions for using your OS-5100 for specific measurement procedures. However, this is but a small sampling of the many applications possible for this oscilloscope. These particular applications were selected to demonstrate certain controls and features not fully covered in BASIC OPERATING PROCEDURES, to clarify certain operations by example, or for their importance and universality.

2-3-1. Amplitude measurements

The modern triggered sweep oscilloscope has two major measurement functions. The first of these is amplitude. The oscilloscope has an advantage over most other forms of amplitude measurement in that complex as well as simply waveforms can be totally characterized (i.e., complete voltage information is available).

Oscilloscope voltage measurement generally fall into one of two types ; peak-to-peak or instantaneous peak-to-peak (p-p) measurement simply notes the total amplitude between extremes without regard to polarity reference. Instantaneous voltage measurement indicates the exact voltage from each every point on the waveform to a ground reference. When marking either type of measurement, make sure that the VARIABLE controls are click-stopped fully clockwise.

(1) Peak-to-peak voltage

1. Set up the scope for the vertical mode desired per the instruction in 2-3 BASIC OPERATING PROCEDURES.
2. Adjust the TIME/DIV switch (22) for two or three cycles of waveform, and set the VOLTS/DIV switch [13] and [14] for the largest-possible totally-on-screen display.
3. Use the appropriate vertical POSITION control [17] or [18] to position the negative signal peaks on the nearest horizontal graticule line below the signal peak, per Fig 2-7.
4. Use the Horizontal POSITION control [26] to position one of the positive peaks on the central vertical graticule line. This line has additional calibration marks equal to 0.2 major division each.
5. Count the number of division from the graticule line touching the negative signal peaks to the intersection of the positive signal peak with the central vertical graticule line. Multiply this number by the VOLTS/DIV switch setting to get the peak-to-peak voltage of the waveform. For example, if the VOLTS/DIV switch was set to 2v, the waveforms shown in Fig 2-7 would be 8.0Vp-p. ($4.0\text{div} \times 2\text{V} = 8.0\text{V}$)

6. If 10 X attenuator probes are used, multiply the voltage by 10.
 7. If measuring a sine wave below 100Hz, or a rectangular wave 1000Hzm flip the AC-DC, GND switch to DC.
- <Note> With the waveform to which high voltage is applied, it is impossible to measure as described above. In this case, set AC-DC, GND switch to AC prior to measurement. (When it is necessary to measure AC component)

(2) Instantaneous voltages

1. Set up the scope for the vertical mode desired per the instructions in 2-2 BASIC OPERATING PROCEDURES.
2. Adjust the TIME/DIV switch [22] or [23] for one complete cycle of waveform and set the VOLTS/DIV switch for a trace amplitude of 4 to 6 divisions (see Fig 2-8).
3. Flip the AC-DC,GND switch [11] or [12] to GND.
4. Use the appropriate Vertical POSITION control [17] or [18] to set the baseline on the central horizontal graticule line. However, if you know the signal voltage is wholly positive, use the bottommost graticule line. If you know the signal voltage is wholly negative, use the uppermost graticule line.

<Note> The vertical POSITON controls must not be touched again until the measurement is completed.

5. Flip the AC-DC, GND switch to DC. The polarity of all points above the ground-reference line is positive ; all points below the ground-reference line are negative.

<Caution> Make certain the waveform is not riding on a high-amplitude DC voltage before flipping the AC-DC, GND switch.

6. Use the Horizontal POSITION control [26] to position any point of interest on the central vertical graticule line. This line has additional calibration marks equal to 0.2 major division each. The voltage relative to ground at any point selected is equal to the number of division from that point to the ground-reference line multiplied by the VOLTS/DIV setting. In the example used for Figure 2-8 the voltage for a 0.5V/divscale is 2.5V (5.0div X 0.5V = 2.5V)
7. If 10 X attenuator probes are used, multiply the voltage by 10.

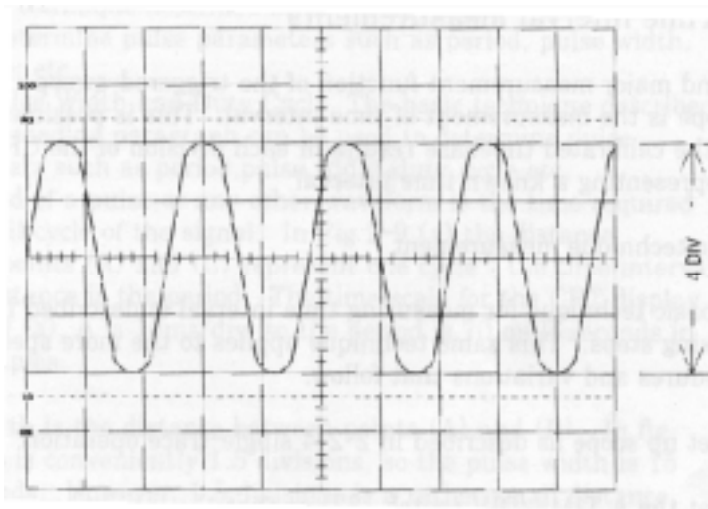


Fig. 2-7 PEAK-TOPEAK VOLTAGE MEASUREMENT

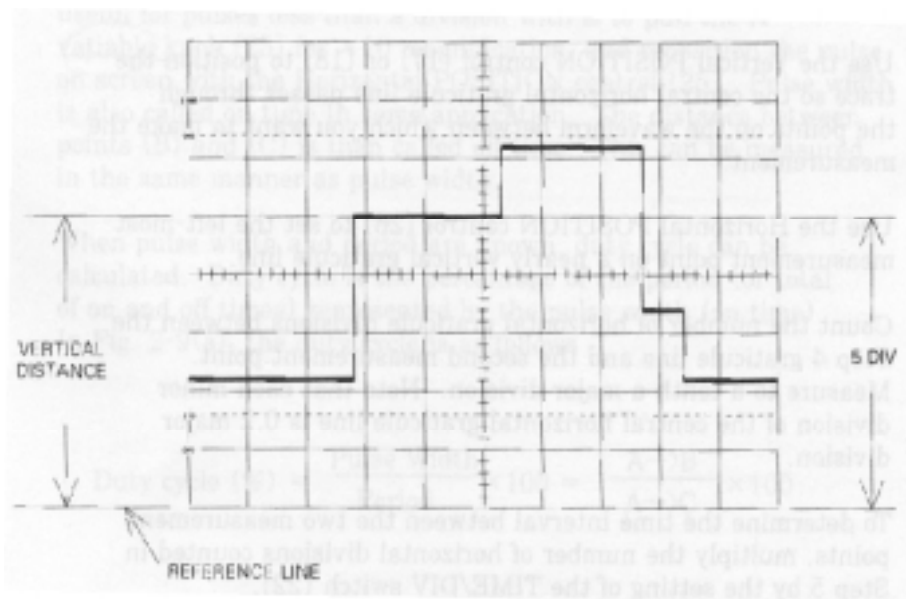


Fig. 2-8. INSTANTANEOUS VOLTAGE MEASUREMENTS

2-3-2. Time interval measurements

The second major measurement function of the triggered-sweep oscilloscope is the measurement of time interval. This is possible because the calibrated timebase results in each division of the CRT screen representing a known time interval.

(1) Basic technique measurement

The basic technique for measuring time interval is described in the following steps. This same techniques applies to the more specific procedures and variations that follow.

1. Set up scope as described in 2-2-4 single-trace operation.
2. Set the A TIME/DIV switch [22] to that the interval you wish to measure is totally on screen and as big as possible. Make certain the A VARIABLE control [25] is click-stopped fully clockwise. If not, any time interval measurements made under this condition will be inaccurate.
3. Use the Vertical POSITION control [17] or [18] to position the trace so the central horizontal graticule line passes through the points on the waveform between which you want to make the measurement.
4. Use the Horizontal POSITION control [26] to set the left-most measurement point on a nearly vertical graticule line.
5. Count the number of horizontal graticule divisions between the Step 4 graticule line and the second measurement point. Measure to a tenth a major division. Note that each minor division of the central horizontal graticule line is 0.2 major division.
6. To determine the time interval between the two measurement points, multiply the number of horizontal divisions counted in Step 5 by the setting of the TIME/DIV switch [22].
If the TIME VARIABLE knob [25] is pulled (X 10 magnification), be certain to divide the TIME/DIV switch setting by 10.

(2) Period, pulse width, and duty cycle measurement

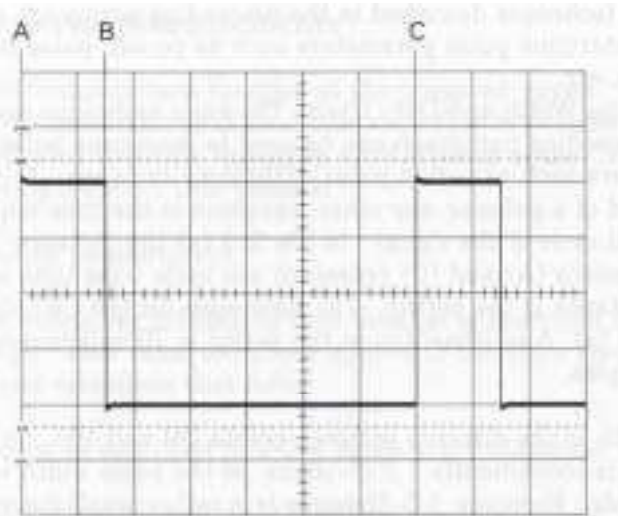
The basic technique described in the preceding paragraph can be used to determine pulse parameters such as period, pulse width, duty cycle, etc.

Period, Pulse Width, and Duty Cycle. The basic technique described in the preceding paragraph can be used to determine pulse parameters such as period, pulse width, duty cycle, etc.

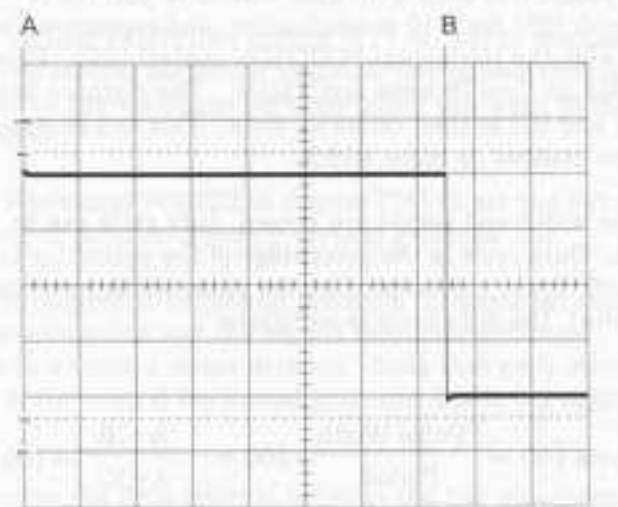
The Period of pulse or any other waveform is the time required for one full cycle of the signal. In Fig 2-9 (a) the distance between points (A) and (C) represent one cycle ; the time interval of this distance is the period. The time scale for the CRT display of Fig 2-9 (a). A is 10ms/div, so the period is 70 milli-seconds in this examples.

Pulse width is the distance between points (A) and (B). In fig. 2-9 (a) it is conveniently 1.5 divisions, so the pulse width is 15 milliseconds. However, 1.5 divisions is a rather small distance for accurate measurements, so it is advisable to use a faster sweep speed for this particular measurement. Increasing the seep speed to 2ms/div as in Fig 2-9 (b). B gives a large display, allowing more accurate measurement. An alternative technique useful for pulses less than a division with is to pull the A variable knob [25] for X 10 magnification, and reposition the pulse on screen with the Horizontal POSITION control [25]. Pulse width is also called on time in some application. The distance between points (B) and (C) is then called off time. This can be measured in the same manner as pulse width.

When pulse width and period are known, duty cycle can be calculated. Duty cycle is the percentage of the period (or total of on and off times) represented by the pulse width (on time). In Fig. 2-9 (a), the duty cycle is as follows. :



(a) 10ms INTERVAL



(b) 2ms INTERVAL

Fig. 2-9. TIME INTERVAL MEASUREMENT

2-3-3. Frequency measurement

When a precise determination of frequency is needed, a frequency counter is obviously the first choice. A counter can be connected to the CH1 OUTPUT connector [20] for convenience when both scope and counter are used. However, an oscilloscope alone can be used to measure frequency when a counter is not available, or modulation AND/or noise makes a counter unusable.

Frequency is the reciprocal of period. Simply measure the period “t” of the unknown signal as instructed in 2-3-2 Time Interval Measurements, and calculate the frequency “f” using the formula $f=1/t$. If a calculator is available, simply enter the period and press the 1/x key. Period in seconds (s) yields frequency in Hertz (Hz) : period in millisecond (ms) yields frequency in kilohertz (kHz) : period in microseconds (

3. Center the stable (trigger source) trace with its Vertical POSITION control, and adjust its amplitude to exactly 6 vertical divisions by means of its VOLTS/DIV switch and VARIABLE control.
4. Use the Trigger LEVEL control [31] to ensure that the trace crossing the central horizontal graticule line at or near the beginning of the sweep. See Fig 2-10.
5. Use the A TIME/DIV switch [22], TIME VARIABLE [25], AND THE Horizontal POSITION [26] TO display one cycle of trace over 7.2 divisions. When this is done, each major horizontal division represents 50

2. Make sure the CH2 POSITION [18] / PULL X 10 MAG knob [25] is pushed in.
3. Connect one signal to the CH1 or X IN connector [9], and the other signal to the CH2 or Y IN connect [10].
4. Center the trace vertically with the CH2 vertical POSITION control [18]. And adjust the CH2 VOLTS/div switch [14] and VARIABLE control [16] for a trace height of exactly 6 divisions (the 100% and % graticule lines tangent to the trace).
5. Adjust the CH1 VOLTS/div switch [13] and VARIABLE for the horizontal 6 divisions shown in step 4.
6. Precisely center the trace horizontally with the Horizontal POSITION control [26].
7. Count the number of divisions along the central vertical graticule line. You can now shift the trace vertically with CH2 POSITION control to a major division line for easier counting
8. The phase difference (angle) between the two signals is equal to the arc sine of dimension A B (the Step 7 number divided by 6). For example, in the Step 7 value of the Fig 2-11 (a), pattern is 2.0. Dividing this by 6 yields 0.3334, whose arcsine is 19.5

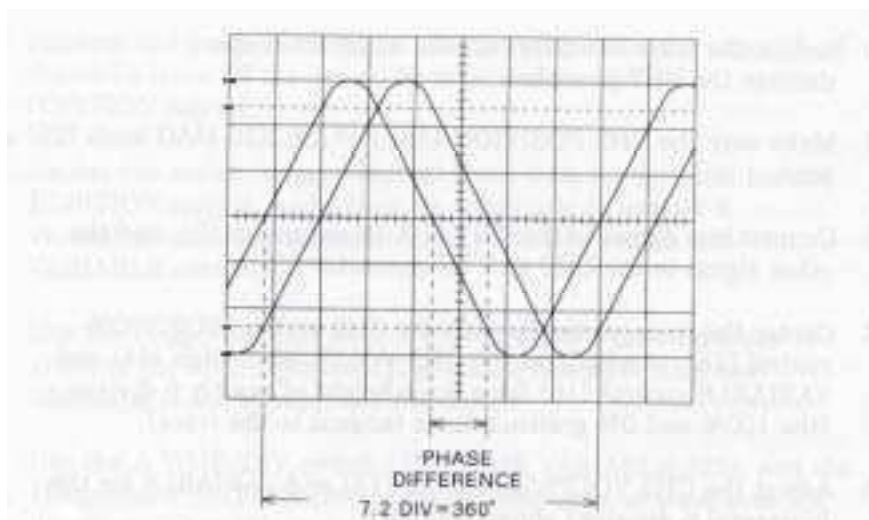


Fig. 2-10. DUAL-TRACE METHOD OF PHASE MEASUREMENT

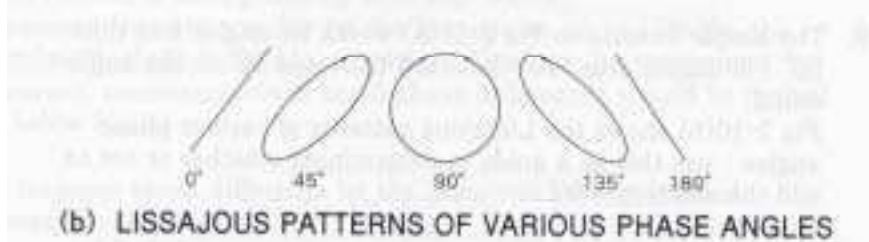
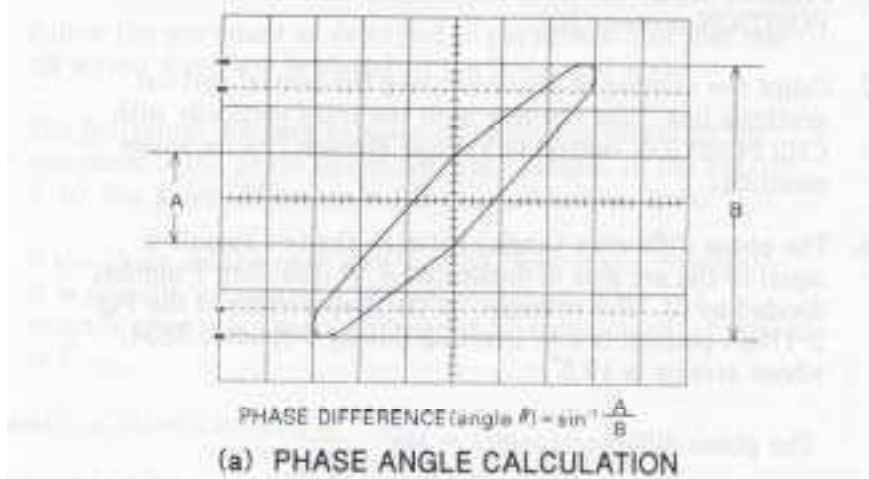


Fig. 2-11. LISSAJOUS METHOD OF PHASE MEASUREMENT

2-3-5. Risetime measurement

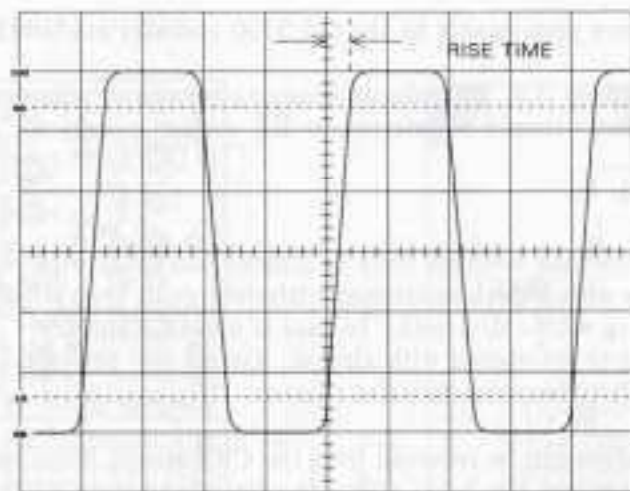
Risetime is the time required for the leading edge of a pulse to rise from 10% to 90% of the total pulse amplitude.

Falltime is the time required for the trailing edge of a pulse to drop from 90% of total pulse amplitude to 10%. Risetime and falltime, which may be collectively called transition time, are measured essentially in the same manner.

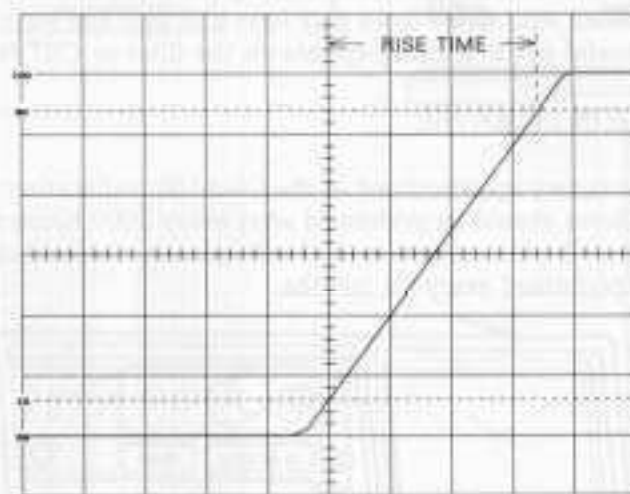
To measure rise and fall time, proceed as follows :

1. Connect the pulse to be measured to CH1 IN connector [9], and set the AC-Dc, GND switch [11] to AC.
2. Adjust the A TIME/DIV switch [22] to display about 2 cycles of the pulse. Make certain the A VARIABLE control [25] is rotated fully clockwise and pushed in.
3. Center the pulse vertically with the channel 1 Vertical Position control [17].
4. Adjust the channel VOLTS/DIV switch [13] to make the positive pulse peak exceed the 100% graticule line, and the negative pulse peak exceed the 0% line, then rotate the VARIABLE control [15] counterclockwise until the positive and negative pulse peaks rest exactly on the 100% and 0% graticule line. (See Fig 2-12(a)).
5. Use the Horizontal POSITION control [26] to shift the trace so the leading edge passes through the intersection of the 10% and central vertical graticule lines.
6. If the risetime is slow as compared to the period, no further control manipulations are necessary. If the risetime is fast (leading edge almost vertical), pull the A VARIABLE/PULL x 10 MAG control [25] and reposition the trace as in Step 5. (See Fig 2-12(b)).
7. Count the number of horizontal divisions between the central vertical line (10% point) and the intersection of the trace with the 90% line.

8. Multiply the number of divisions counted in step 7 by the setting of the TIME/DIV switch to find the measured risetime. If 10 X magnification was used, divide the TIME/DIV setting by 10. For example, if the A timebase setting in Fig 2-12 (a) was 1s/div (1000ns), the risetime would be 360 nanoseconds (1000ns)



(a) BASIC DISPLAY



(b) WITH HORIZONTAL MAGNIFICATION

Fig. 2-12. RISE TIME MEASUREMENT

3. USER MAINTENANCE GUIDE

Maintenance routines performable by the OS-5100 operator are listed in this section. More advance routines (i.e., procedures involving repairs or adjustments within the instrument) should be referred to EZ service personnel.

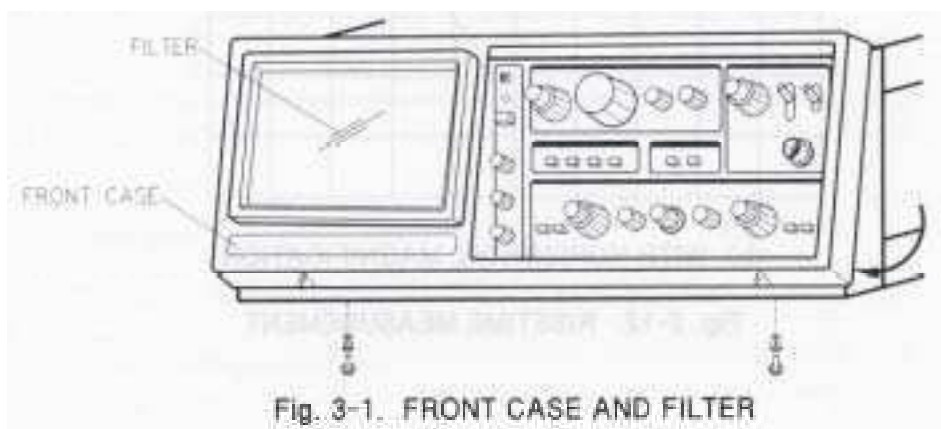
3-1. CLEANING

If the outside of the case becomes dirty or stained, carefully wipe out the soiled surface with a cloth moistened with detergent, then wipe out the cleaned surface with a dry cloth. In case of severe stain, try cleaning with a cloth moistened with alcohol. Do not use powerful hydrocarbons such as benzene or paint thinner.

Dust and/or smudges can be removed from the CRT screen. First remove the front case and filter (see Fig 3-1). Clean the filter (and the CRT face, if necessary) by wiping out carefully with a soft cloth or commercial wiping tissue moistened with a mild cleaning agent. Take care not to scratch them. Do not use abrasive cleanser or strong solvents. Let the cleaned parts dried thoroughly before reinstalling the filter and front case. If it is installed wet, water dews may form and blur the waveforms. Be particularly careful not to get fingerprints on the filter or CRT face.

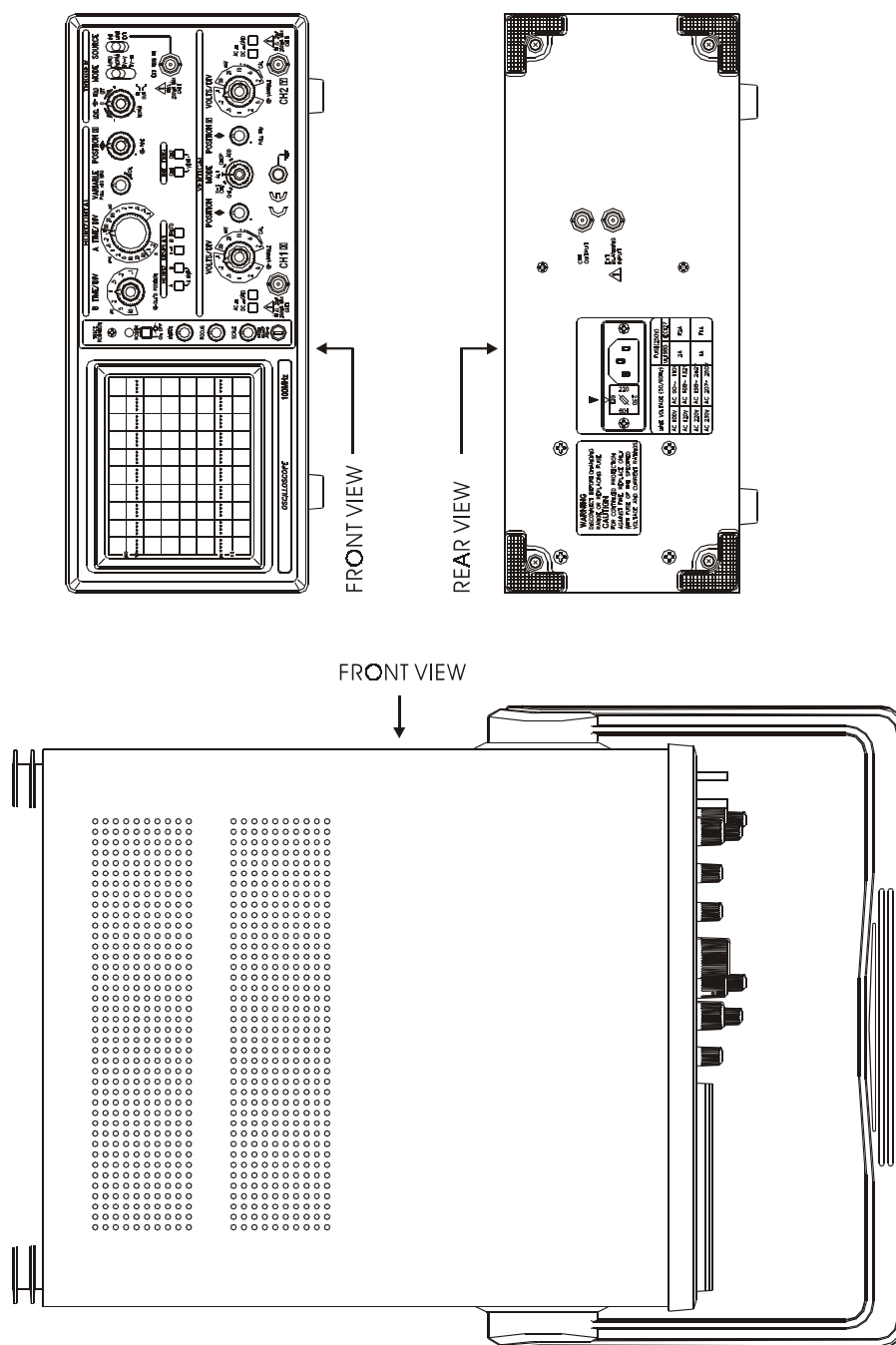
3-2. CALIBRATION INTERVAL

To maintain the accuracy specifications of the OS-5100, calibration checks and procedures should be preformed after every 1000 hours of service. However, if the instrument is used infrequently, the calibration checks should be performed every six months.



4. DIAGRAMS

4-1. EXTERNAL VIEWS



4-2. BLOCK DIAGRAM

