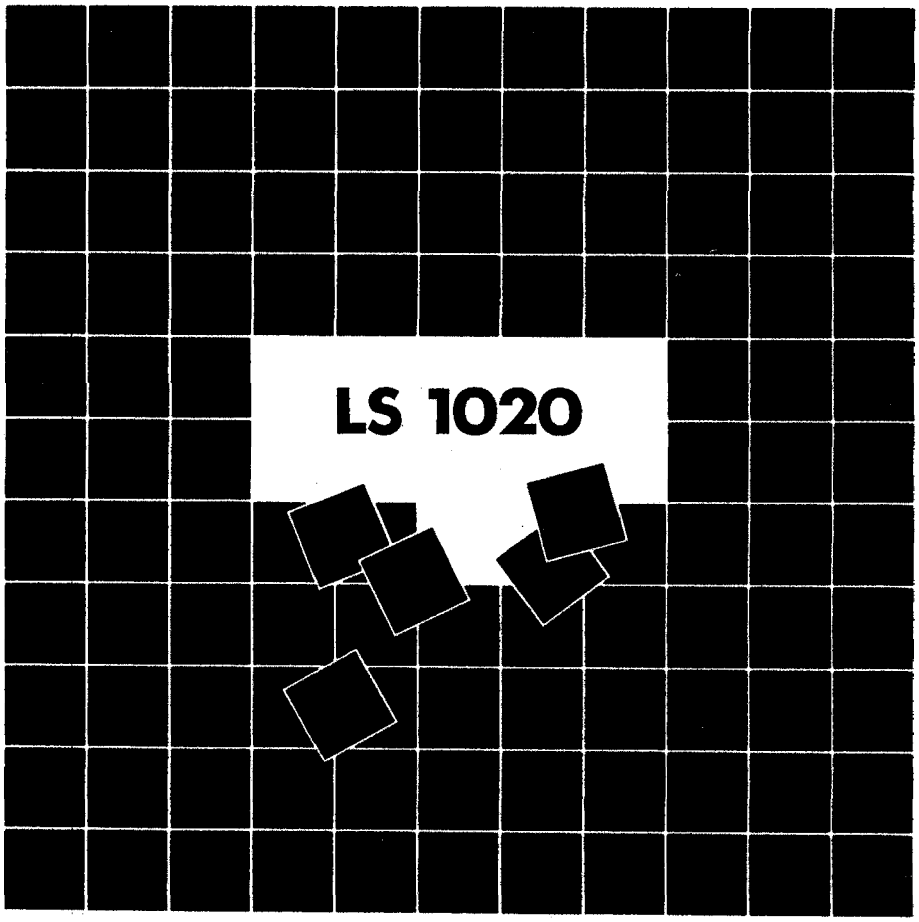
LEADER

20 MHz OSCILLOSCOPE

INSTRUCTION MANUAL



取扱説明書

LEADER ELECTRONICS CORP.

OSCILLOSCOPE
LS 1020

INSTRUCTION MANUAL

TABLE OF CONTENTS

1. INTRODUCTION

Thank you for purchasing our product. Please read the instruction manual carefully before operating this instrument.

1.1 For Safety's Sake

Explanation of the Terms

WARNING ... The WARNING sign calls attention to abnormal conditions or dangerous practices that could result in personal injury or death.

[CAUTION] ... The CAUTION sign calls attention to abnormal conditions or dangerous practices that could result in damage to the instrument or other property.

Cautions on operation appear in the instruction manual. Read the manual carefully to ensure correct operation.

WARNING

- Do not remove any cases or covers.
  The high-voltage section inside this instrument can cause electrical shock.
- Do not operate this instrument and connected units in a volatile or flammable atmosphere.
  An explosive can result.
- Do not insert metal objects (e.g., wire, pin) into the vents.
  Otherwise, you may damage the instrument or suffer electrical shock.
- Connect this instrument to the rated power line voltage.
  Excessive voltage can cause fire.
- Do not touch the high-voltage section with hand directly when measuring it.
  You may suffer electrical shock.
- Do not connect this instrument to equipment whose chassis has electrical potential to ground (i.e., transformerless equipment).
  Otherwise, you may damage the instrument or suffer electrical shock.

1.2 Operating Precautions

1.2.1 Line Voltage and Fuse [CAUTION]

Confirm that the power line voltage is correct before connecting the power cord.
The voltage range and fuse rating are indicated on the rear panel.
The instrument must be connected to the rated line voltage and line frequency of 50 Hz or 60 Hz.

When replacing the fuse, turn the power switch off and disconnect the power cord from the mains. Use specified fuse only.

Rated Voltage	Voltage Range	Fuse	
		Rating	Leader Parts Number
100 V 120 V	90 to 110 V 108 to 132 V	1 A, time-lag	4363765006
220 V	198 to 242 V	0.5 A, time-lag	4363750006

1.2.2 Maximum Allowable Input Voltage [CAUTION]

The maximum allowable input voltage to the input connectors and probe is shown in Table below.
Do not apply excessive voltage to prevent damage the instrument.

Input Connector	Maximum Allowable Input Voltage
CH1 OR X IN	400 V peak (DC + AC peak)
CH2 OR Y IN	400 V peak (DC + AC peak)
EXT TRIG IN	400 V peak (DC + AC peak)
Probe	600 V peak (DC + AC peak)

The maximum allowable input voltage reduces when 1 kHz or higher frequency is applied.
The maximum input voltage of "400 V peak (DC + AC peak)" is as shown in Figure 1-1.

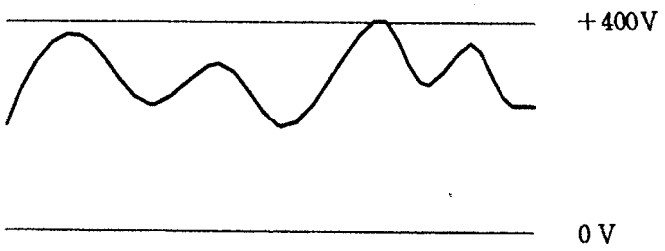


Figure 1-1

1.2.3 Installation [CAUTION]

Do not use the instrument in the following environments.

- High temperature environments
  Do not place the instrument under direct sunlight or near a heater (e.g., stove). Do not move the instrument from cold to warm environment abruptly, it may cause condensation.
  Operating temperature range: 0 to 40°C

- High humidity environments
  Do not place the instrument in the high humidity environment (e.g., bathroom, near a humidor).
  Operating humidity range: 10 to 85 % RH

- Dusty environments

- Excessive magnetic fields
  Do not place the instrument by the strong magnetic field (e.g., high-power transformer). Waveform distortion or tilt may occur.

1.2.4 CRT Intensity [CAUTION]

Do not leave the instrument with high intensity or displaying sharp spot. The CRT screen may be burned-in or its life may reduce.

2. SPECIFICATIONS

2.1 Description

The Model LS 1020 Dual-Trace Portable Oscilloscope with 6-inch rectangular, internal graticule CRT features a bandwidth of DC to 20 MHz, maximum deflection factor of 0.5 mV/div (5MHz), and maximum sweep speed of 50 ns/div. Various functions (e.g., TV sync separator, variable holdoff, X-Y display mode) allow this oscilloscope for educational use as well as production line and service applications of TVs, VTRs, and audio products.

2.2 Features

- High-sensitivity of 0.5 mV/div
  Enables measurement of low level signals (e.g., power supply ripple, noise components).

- TV-V, TV-H trigger
  Allows TV video signal observation. Stable display can be obtained by selecting the vertical or horizontal sync signal of the video signal regardless of the TIME/DIV switch setting.

- Variable holdoff
  The variable holdoff time (from the sweep end to sweep start) can display complex waveform stably.

- ALT trigger
  Displays asynchronous waveforms stably.

- X-Y display
  Offers X-Y oscilloscope capability: CH1 for X axis, CH2 for Y axis.

- Scale illumination
  Permits operating the oscilloscope in dark locations, or photographing the screen.

- CH1 OUTPUT connector
  Outputs buffered signal applied to the CH1 input connector. Therefore, the oscilloscope can be used as a wideband, high-sensitivity amplifier.

2.3 Specifications

2.3.1 LS 1020 Oscilloscope

CRT	
Type	150 mm, rectangular, internal graticule
Accelerating Potential	2 kV, regulated
Effective Display Area	8 x 10 divisions (1 div = 10 mm)
Beam rotator	Adjustment on the front panel
Scale Illumination	3 steps
Intensity Modulation	Positive TTL level reduces brightness
Vertical Axis (CH1, CH2)	
Deflection Factor	5 mV/div to 5 V/div 0.5 mV/div to 2 mV/div (X10 MAG on) 1-2-5 sequence, 10 ranges, continuous variable between ranges
Accuracy	±3 % ±5 % (X10 MAG on)
Bandwidth	
DC Coupled	DC to 20 MHz (8 div ref), -3 dB DC to 5 MHz (8 div ref), -3 dB (X10 MAG on)
AC Coupled	Lower cutoff frequency: 10 Hz, -3 dB
Rise Time	17.5 ns 70 ns (X10 MAG on)
Input Impedance	1 MΩ ±1.5 % 30 pF ±5 pF (deviation: ±2 pF)
Input Coupling	AC, GND, DC
Maximum Input Voltage	400 V peak
Operation Mode	CH1, CH2, CHOP, ALT, ADD
Polarity	CH2 only
CH1 OUT	Approx. 50 mV/div (into 50 Ω) DC to 20 MHz, -3 dB
Horizontal Axis	
Sweep Mode	Triggered sweep, automatic sweep
Sweep Time	0.1 µs/div to 0.2 s/div 1-2-5 sequence, 20 ranges, continuous variable between ranges
Accuracy	±3 %
Magnifier	10 times ±5% (0.1 and 0.2 µs/div ranges are not calibrated.)
Maximum Sweep Speed	50 ns/div (X10 MAG on)

Triggering

Holdoff Variable Range	One sweep or longer
Signal Source	ALT, CH1, CH2, LINE, EXT
Coupling	AC, HF-REJ, DC, TV-V, TV-H
Trigger Slope	+, -
Sensitivity	

	Frequency Range	Internal	External
NORM	30 Hz to 10 MHz	0.5 div	0.2 Vp-p
	2 Hz to 20 MHz	1.5 div	0.6 Vp-p
AUTO	30 Hz to 10 MHz	0.5 div	0.2 Vp-p
	30 Hz to 20 MHz	1.5 div	0.6 Vp-p

TV triggering: Triggered by sync signal of composite video signal. To select the trigger polarity to match the signal polarity, use SLOPE switch.

X-Y Mode

Input Connector	CH1: X axis, CH2: Y axis
Deflection Factor	Same as the vertical axes
X Axis Bandwidth	DC or 10 Hz to 1 MHz (8 div ref), -3 dB
X-Y Phase Accuracy	≤3° at 100 kHz

Calibrator

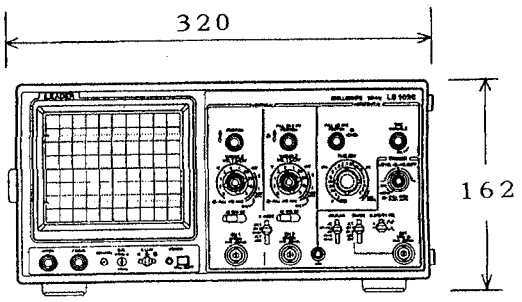
Output Voltage	0.5 Vp-p ±2 %
Frequency	Approx. 1 kHz, square wave

Environmental Conditions

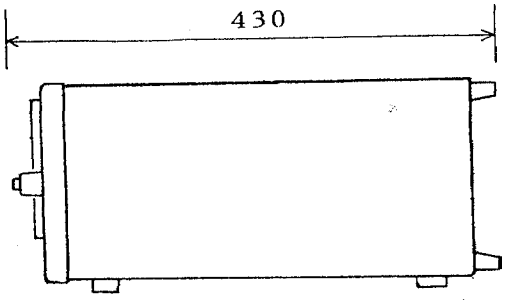
Operating	Temperature: 0 to 40°C
	Humidity: 10 to 85 % RH
Spec-Guaranteed	Temperature: 10 to 35°C
	Humidity: 10 to 85 % RH

Others

Power Requirements	100 V, 120 V, 220 V ±10 % 50/60 Hz
Power Consumption	50 VA
Size and Weight	310 (W) x 150 (H) x 375 (D) mm, 8.5 kg



Front View



Rear view

Accessories

LP-051 Low Capacitance Probe (X10, X1 selectable)	2
Fuse	1
Instruction Manual	1

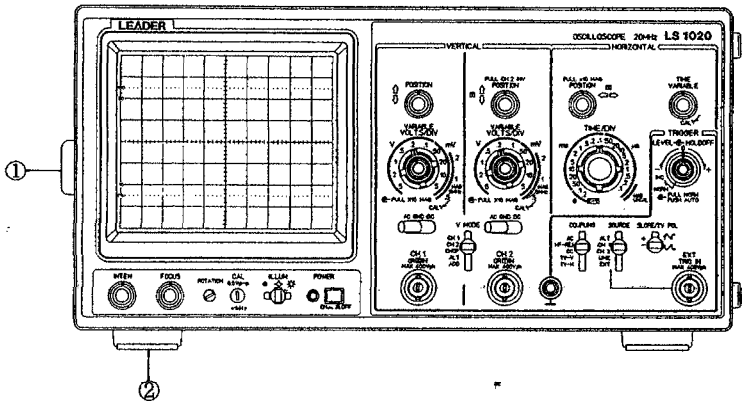
2.3.2 LP-051 Low Capacitance Probe

Applicable Oscilloscope Input Resistance: 1 MΩ, ±2 %
Input Capacitance: 20 to 35 pF

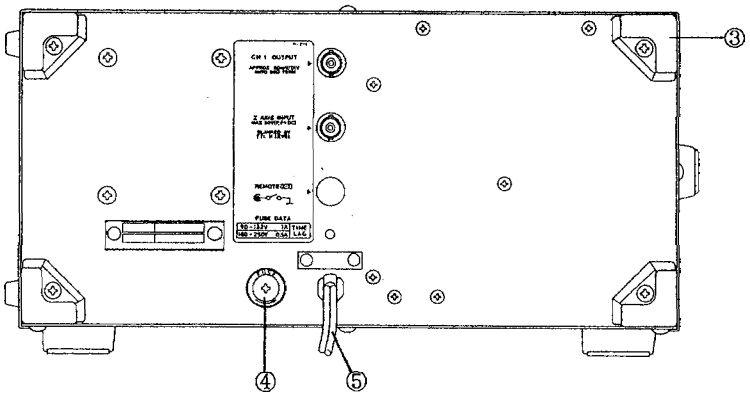
	X10	X1
Attenuation	1/10, ±2 %	1/1
Bandwidth	DC to 50 MHz	DC to 6 MHz
Input Resistance	10 MΩ	1 MΩ
Input Capacitance	Approx. 20 pF	Approx. 200 pF
Maximum Input Voltage	600 VDC	

3. PANEL DESCRIPTION

3.1 Exterior



Front panel



Rear panel

① Handle

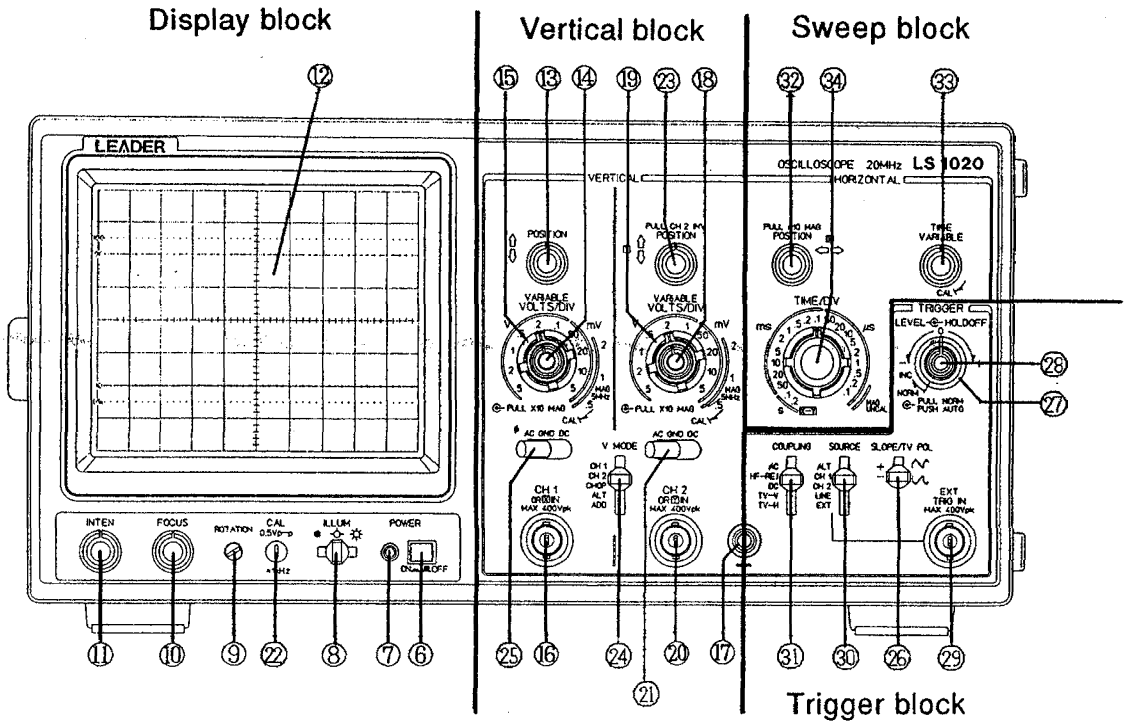
② Bottom feet
Tilt stand angles the oscilloscope for bench top operation.

③ Legs
Provides a winding the power cord, and supports the oscilloscope for vertical operation.

④ Fuse
To remove fuse, rotate the cap counterclockwise using a Pillips screwdriver. The fuse can be removed with the cap.
When replacing the fuse, confirm that the type and rating indicated on the rear panel.

⑤ Power cord
Connect the power cord to the rated power line voltage.

3.2 Front Panel



3.2.1 Display Block

⑥ POWER ON/OFF switch
Push the switch in to turn power on. The pilot lamp lights.
Release the switch to turn power off.

⑦ Pilot lamp
Indicates the oscilloscope is powered on.

⑧ ILLUM switch
Controls brightness of the scale illuminator. Three positions (i.e., off, mid, high) are provided.

⑨ ROTATION adjustment
Compensates slight tilting of the trace due to terrestrial magnetism when the oscilloscope is relocated. Adjust the trace with respect to the horizontal graticule line.

⑩ FOCUS control
Adjusts trace sharpness.

⑪ INTEN control
Controls brightness of the displayed waveform.
Clockwise rotation increases brightness; counterclockwise rotation decreases brightness.

⑫ Graticule

The graticule is inscribed on the CRT inner surface for parallax-free measurements. Display area is 8 x 10 divisions (1 div = 10 mm). Sub-scales at interval of 0.2 division are provided on the vertical and horizontal center lines.

The vertical deflection factor and horizontal sweep time is calibrated with respect to this graticule.

The supplemental scales (0, 10, 90, and 100 %) are provided for measuring the rise and fall times of pulse.

3.2.2 Vertical Block

⑬ ⇕ CH1 POSITION control

Clockwise rotation moves the waveform up.

⑭ VARIABLE control, PULL X10 MAG switch (CH1 or X)

This knob has following two functions.

VARIABLE: Provides continuously variable between the setting of the CH1 VOLTS/DIV switch. Counterclockwise rotation decreases sensitivity.
Set this control to the CAL position for voltage measurements.

PULL X10 MAG: Pulling this switch out increases the CH1 vertical deflection factor 10 times. By this setting, bandwidth reduces to 5 MHz (-3 dB). Noise caused by an amplifier may be increased. Normally, push this knob in.

⑮ VOLTS/DIV switch (CH1 or X)

Selects the deflection factor of the input signal applied to the CH1 OR X IN connector.

The 10 ranges, 5 mV/div to 5 V/div, are provided.

In the X-Y display mode, this switch selects the X axis deflection factor.

⑯ CH1 OR X IN connector

For applying an input signal to the CH1 vertical amplifier, or X-axis amplifier during X-Y operation.

[CAUTION] Do not apply excessive voltage to the connector. The maximum allowable input voltage is 400 V peak.

⑰ Ground terminal

⑱ VARIABLE control, PULL X10 MAG switch (CH2 or Y)

This knob has following two functions.

VARIABLE: Provides continuously variable between the setting of the CH2 VOLTS/DIV switch. Counterclockwise rotation decreases sensitivity.
Set this control to the CAL position for voltage measurements.

PULL X10 MAG: Pulling this switch out increases the CH2 vertical deflection factor 10 times. By this setting, bandwidth reduces to 5 MHz (-3 dB). Noise caused by an amplifier may be increased. Normally, push this knob in.

⑲ VOLTS/DIV switch (CH2 or Y)

Selects the deflection factor of the input signal applied to the CH2 OR Y IN connector.
The 10 ranges, 5 mV/div to 5 V/div, are provided.
In the X-Y display mode, this switch selects the Y axis deflection factor.

⑳ CH2 OR Y IN connector

For applying an input signal to the CH2 vertical amplifier, or Y-axis amplifier during X-Y operation.

[CAUTION] Do not apply excessive voltage to the connector. The maximum allowable input voltage is 400 V peak.

㉑ AC-GND-DC switch (CH2 or Y)

Selects the method of coupling the input signal applied to the CH2 OR Y IN connector.

DC: DC coupled.
AC: AC coupled. A capacitor block the DC component.
GND: The amplifier input is grounded, and the CH2 OR Y IN connector is opened.

㉒ CAL 0.5 Vp-p Terminal

Outputs probe calibration signal. The frequency is about 1 kHz.

㉓ ⇕ CH2 POSITION control, PULL CH2 INV

Clockwise rotation moves the waveform up.
By pulling this knob, the CH2 waveform is inverted; top of the waveform for negative, bottom of the waveform for positive. Normally, push this knob in for normal polarity operation.

㉔ V MODE switch

Display mode selector for vertical axis.

CH1: Displays CH1 input signal only.
To trigger with internal source, set the TRIG SOURCE switch to CH1.

CH2: Displays CH2 input signal only.
To trigger with internal source, set the TRIG SOURCE switch to CH2.

CHOP: Switches and displays CH1 and CH2 input signals about 250 kHz rate regardless of the TIME/DIV switch setting. Use this mode for the TIME/DIV setting of 0.5 ms/div or lower.

ALT: Displays CH1 and CH2 input signals alternately every sweep. Use this mode for the TIME/DIV setting of 0.5 ms/div or higher.

ADD: Algebraically adds and displays CH1 and CH2 input signals. When the CH2 POSITION control is pulled out (INV), the subtracted signal is displayed.

㉕ AC-GND-DC switch (CH1 or X)

Selects the method of coupling the input signal applied to the CH1 OR X IN connector.

DC: DC coupled.

AC: AC coupled. A capacitor block the DC component.

GND: The amplifier input is grounded, and the CH1 OR X IN connector is opened.

3.2.3 Trigger Block

㉖ SLOPE +/-, TV POL switch

Selects the positive or negative of the trigger signal for starting sweep.

㉗ LEVEL control

Sets the trigger point on the waveform at which the sweep is triggered. Counterclockwise rotation towards the trigger point negative; clockwise rotation towards the trigger point positive.

㉘ HOLDOFF control, PULL NORM/PUSH AUTO switch

This knob has following two functions.

HOLDOFF: Adjusts holdoff time (i.e., from the sweep end to sweep start). Rotating clockwise increases the holdoff time. Normally, set the knob fully counterclockwise for NORM position.

NORM/AUTO: Selects the sweep mode.
When the AUTO (knob is pushed in) is selected with no trigger signal presents, the sweep free runs and trace is displayed.
When the NORM (knob is pulled out) is selected, trace is only displayed when trigger signal presents.

㉙ EXT TRIG INPUT connector

To apply external trigger source.

[CAUTION] Do not apply excessive voltage to the connector. The maximum allowable input voltage is 400 V peak.

㉚ SOURCE switch

Selects source of trigger signal.
The trigger signal is automatically selected by setting the V MODE switch.

V MODE	Trigger Source
CH1	CH1
CH2	CH2
CHOP	CHOP signal
ALT	CH1, CH2 respectively
ADD	CH2

CH1: Selects the CH1 signal for triggering.
CH2: Selects the CH2 signal for triggering.
LINE: Selects the power line signal for triggering.
EXT: Selects the signal applied to the EXT TRIG INPUT connector for triggering.

㉛ COUPLING switch

Selects coupling of trigger signal.

AC: Accepts signal for triggering above 10 Hz. Normally, set the coupling to AC.

HF-REJ: Rejects signal above about 100 kHz. This coupling is useful to observe low frequency signal with high-frequency components since it is rejected.

DC: Accepts all trigger signals including DC component. This coupling is useful to observe below 10 Hz signal.

TV-V: Accepts vertical sync signal of TV video signal.

TV-H: Accepts horizontal sync signal of TV video signal.

3.2.4 Sweep Block

㉜ ⇦⇨ H POSITION control, PULL X10 MAG switch

This knob has following two functions.

H POSITION: Clockwise rotation moves the waveform to the right. In the X-Y display mode, this knob moves the waveform horizontally.

X10 MAG: Pulling this switch out magnifies the displayed waveform 10 times horizontally.

㉝ TIME VARIABLE control

Provides continuously variable between the setting of the TIME/DIV switch. Counterclockwise rotation reduces sweep speed.

When making time measurements, set this control to the CAL.

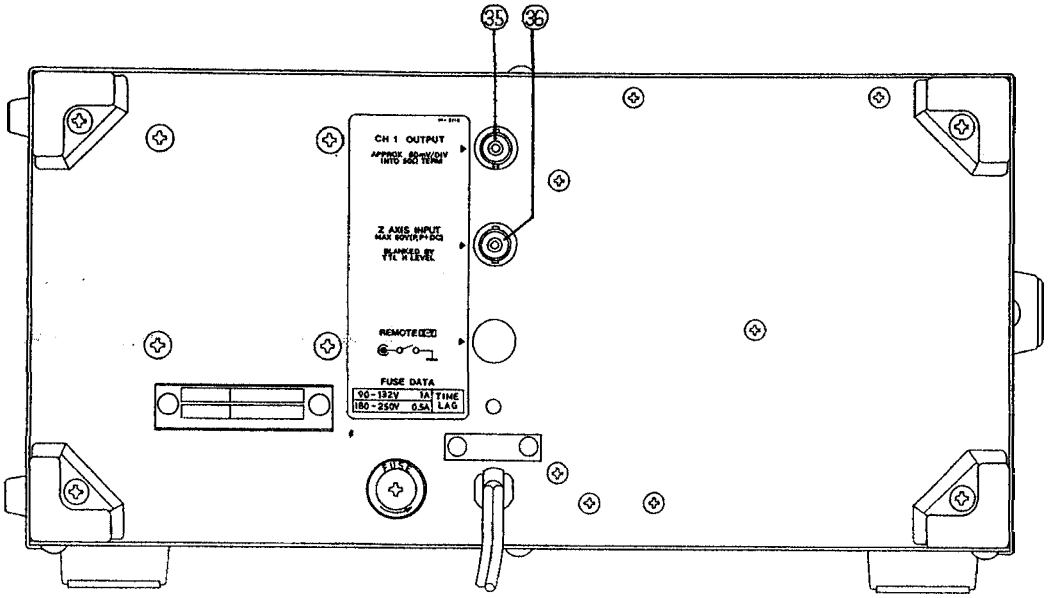
㉞ TIME/DIV switch

Selects the sweep time.

The sweep time is calibrated with respect to the graticule per division.

By selecting the X-Y position, this oscilloscope can be used as a X-Y oscilloscope (CH1 for X axis, CH2 for Y axis).

3.3 Rear Panel



㉟ CH1 OUTPUT connector
Outputs the signal applied to the CH1 OR X IN connector.

㊱ Z AXIS INPUT connector
Used for intensity modulation.
Positive TTL level reduces display brightness.

4. BASIC OPERATING PROCEDURES

This section describes a basic operating procedure.

4.1 Displaying Trace

This section describes a display procedure of the CAL signal. These settings can also be used for performance check.

- **Procedure**

(1) Set the controls as follows.

Display block	
ILLUM switch	As desired
ROTATION adjustment	Center
FOCUS control	Center
INTEN control	Center
Vertical block	
V MODE switch	ALT
CH1, CH2 VOLTS/DIV switches	0.1 V
CH1, CH2 V VARIABLE controls	CAL, pushed in
CH1, CH2 V POSITION controls	Center, pushed in
CH1, CH2 AC-GND-DC switches	AC
CH1 OR X IN connector	Apply CAL signal through the X1 probe
Sweep block	
TIME/DIV switch	0.5 ms
TIME VARIABLE control	CAL
H POSITION control	Center, pushed in
Trigger block	
TRIG SLOPE switch	+
TRIG LEVEL control	Center
HOLDOFF control	NORM, pushed in
TRIG SOURCE switch	CH1
TRIG COUPLING switch	AC

(2) Connect the power cord to the rated power line voltage.

(3) Press the POWER switch. The pilot lamp lights. The square wave and CH2 trace are displayed about 10 seconds after as shown in Figure 4-1.

(4) Adjust the FOCUS control for optimum trace sharpness.

(5) If the trace is tilted, adjust ROTATION adjustment using a flat-head screwdriver so that the trace is paralleled to a horizontal graticule line.

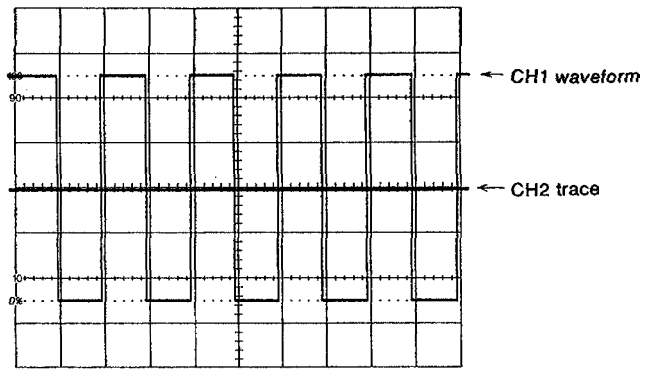


Figure 4-1

4.2 Using the Low Capacitance Probe

The low capacitance probe with selectable impedance of X1 and X10 is provided as an accessory.

4.2.1 Appearance and Name

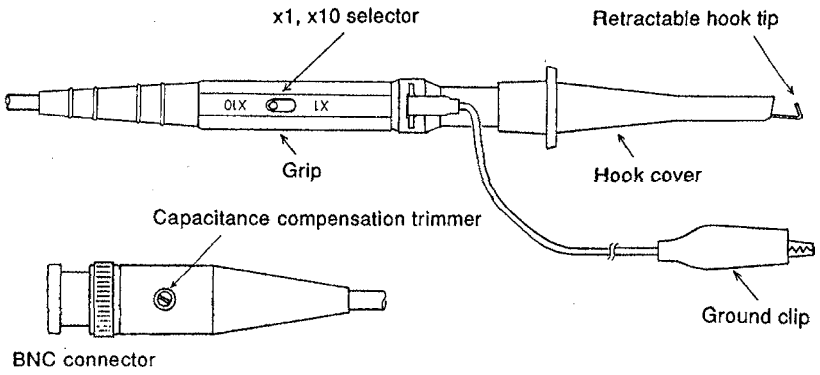


Figure 4-2

4.2.2 Probe Adjustment

- **Procedure**

(1) Set the switch to X10 position.

(2) Refer to Section "4.1 Displaying Trace" and set the controls. Set the CH1 and CH2 VOLTS/DIV switches to 10 mV.

(3) Connect the probe to the CH1 OR X IN connector, and connect the probe tip to the CAL terminal.

(4) Adjust the trimmer for a best flat-top square wave.

(5) Connect the other probe to the CH2 OR Y IN connector.
Set the TRIG SOURCE switch to CH2.
Adjust the trimmer for a best flat-top square wave.

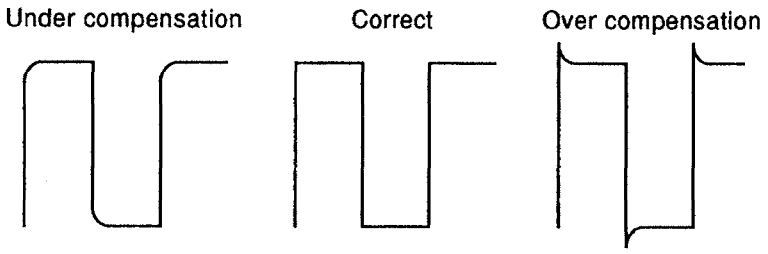


Figure 4-3

4.3 Connecting Signal

There are two methods for connecting a signal to the oscilloscope: direct connection using a conventional cable (e.g., coaxial cable, wire lead), and low capacitance probe.

4.3.1 Direct Connection

When using a coaxial cable or wire lead to apply a signal, consider that the following conditions.

(1) Using a Lead Wire
A wire lead may be used in the following conditions:
signal level is high,
signal frequency is low (<100 kHz), or
source impedance is low.

Using the wire lead under the conditions other than mentioned above may result improper waveform display since it picks up noise or hum components. Use shielded cable (e.g., coaxial cable) or low capacitance probe in this case.
When connecting the wire lead to the oscilloscope, use the LC-1585 BNC Adapter (optional accessory).

(2) Using a Coaxial Cable
When a signal source has a coaxial connector, a coaxial cable with connectors can be used.
When the source impedance is high or signal frequency is above 100 kHz, waveform distortion or amplitude reduction may occur due to the loading error.
Use the low capacitance probe in this case.

4.3.2 Using the Low Capacitance Probe

Use the low capacitance probe with X10 setting to reduce influence by noise or loading error. The probe is convenient to connect a device under test without connector.

The probe has two impedance positions, X1 and X10.

(1) Selecting X1 or X10
Slide the switch on the probe to X1 or X10.

(2) Using X10 setting
In the X10 setting, the signal is divided by 10 before being applied to the oscilloscope. Multiply the displayed amplitude 10 times to obtain correct value.
Since the probe input capacitance is 20 pF, it greatly reduce a loading error.

(3) Using X1 setting
In the X1 setting, the probe input capacitance is approximately 200 pF. Therefore, the loading error may result when measuring high impedance source or signal frequency of 100 kHz or higher.

Connect the ground clip close to the measurement point.

4.4 Single-Trace Operation

This section describes the single-trace operation mode. In general, CH1 is used in this case.

- **Procedure**

(1) Set the controls as follows.
Refer to Section "4.1 Displaying Trace" and set other controls.

Vertical block	
V MODE switch	CH1
CH1 VARIABLE control	CAL, pushed in
CH1 VOLTS/DIV switch	5 V
CH1 AC-GND-DC switch	AC (for AC voltage measurement) DC (for DC voltage measurement)
Sweep block	
TIME VARIABLE control	CAL
TIME/DIV switch	1 *ms*
Trigger block	
TRIG SLOPE switch	+
TRIG LEVEL control	Center
HOLDOFF control	NORM, pushed in
TRIG SOURCE switch	CH1
TRIG COUPLING switch	AC

(2) Position the trace to the horizontal center graticule line by using the V POSITION control.

(3) Connect the signal to the CH1 OR X IN connector by using the probe or cable.

(4) Set the CH1 VOLTS/DIV switch to obtain suitable waveform amplitude.

(5) Set TIME/DIV switch to obtain several cycles of waveforms.
Adjust the TRIG LEVEL control as required to display a stable waveform.

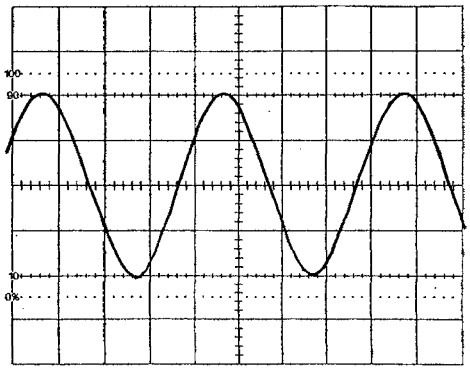


Figure 4-4

4.5 Dual-Trace Operation

The CH1 and CH2 input signals are electrically switched and displayed. This mode is used to observe amplitude or time relationship between signals. This section describes the dual-trace operation mode.

- **Procedure**

(1) Set the controls as follows.
Refer to Section "4.1 Displaying Trace" and set other controls.

Vertical block	
V MODE switch	Select ALT for higher frequency Select CHOP for lower frequency
CH1, CH2 VARIABLE controls	CAL, pushed in
CH1, CH2 VOLTS/DIV switches	5 V
CH1, CH2 AC-GND-DC switches	AC (for AC voltage measurement) DC (for DC voltage measurement)
Sweep block	
TIME VARIABLE control	CAL
TIME/DIV switch	1 ms
Trigger block	
TRIG SLOPE switch	+
TRIG LEVEL control	Center
HOLDOFF control	NORM, pushed in
TRIG SOURCE switch	CH1
TRIG COUPLING switch	AC

(2) When the DC signals are input, position the two traces to the graticule center by using the CH1 and CH2 V POSITION controls.
When the AC signals are input, position the CH1 waveform 2 divisions above the graticule center by using CH1 V POSITION control; CH2 waveform 2 division below the graticule center by using CH2 V POSITION control.

(3) Apply the reference signal to the CH1 OR X IN connector, and signal to be measured to the CH2 OR Y IN connector.

(4) Set the CH1 and CH2 VOLTS/DIV and TIME/DIV switches to obtain suitable waveform amplitude.

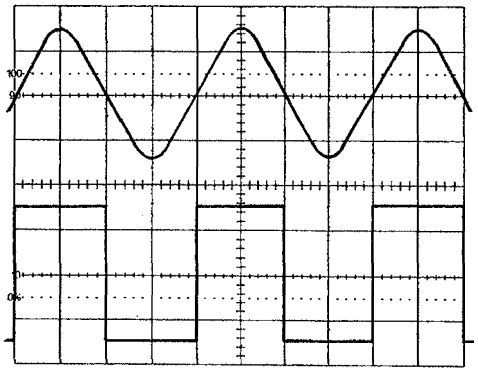


Figure 4-5

4.6 Triggering for Stable Display

When observing a waveform, triggering is really important to obtain a stable display. This section describes a triggering procedure to display stable waveform. Table 4-1 lists the triggering procedure. Refer to Sections "4.6.1 Trigger Mode Selection" through "4.6.4 Trigger Point Setting" for detail.

Table 4-1

Procedure	Switch/Control	Setting
Trigger Mode Selection (Section 4.6.1)	PULL NORM/PUSH AUTO (HOLDOFF control)	AUTO NORM
Trigger Source Selection (Section 4.6.2)	SOURCE switch	ALT (Internal) CH1 (Internal) CH2 (Internal) LINE (Line) EXT (External)
Trigger Coupling Selection (Section 4.6.3)	COUPLING switch	AC HF-REJ DC TV-V TV-H
Trigger Point Setting (Section 4.6.4)		
Trigger Point	LEVEL control	LEVEL
Trigger Slope	SLOPE switch	+, −
Holdoff Time	HOLDOFF control	HOLDOFF

The following control settings can be used to display a simple waveform.

PULL NORM/PUSH AUTO:	AUTO
SOURCE:	CH1 or CH2
COUPLING:	AC
LEVEL:	Center

4.6.1 Trigger Mode Selection

(1) AUTO

Push the HOLDOFF knob in.
This mode is used for displaying above 30 Hz.
The sweep free runs in the following conditions:
no signal is applied,
signal frequency is below 30 Hz, or
incorrect trigger setting is made.

(2) NORM

Pull the HOLDOFF knob out.
The sweep occurs when a signal is input, and proper trigger setting is made.

4.6.2 Trigger Source Selection

Use the SOURCE switch to select source of trigger signal.

(1) Internal Trigger Source (ALT, CH1, CH2)
Normally, select the internal source for triggering.

Single-trace mode:
Select the CH1 or CH2 corresponding to the vertical input channel.
ALT selects the CH1 or CH2 automatically according to the V MODE switch setting.

Dual-trace mode:
Select the CH1 or CH2 corresponding to the vertical input channel used as a reference.
When synchronous signals (e.g., input and output of a frequency divider) are applied to the CH1 and CH2 input connectors, select the lower frequency signal as a reference.
When asynchronous signals are applied to the CH1 and CH2 input connectors, selected channel signal is only triggered. To trigger both signals, set the V MODE and SOURCE switches to ALT.

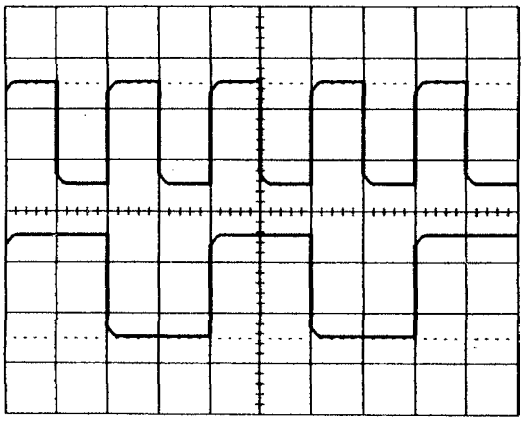


Figure 4-6

(2) External Trigger Source (EXT)
When using a signal other than internal or line source for triggering, apply the signal to the EXT TRIG IN connector.

(3) Power Line Trigger (LINE)
This triggering is useful for observing the signal related to a power line frequency.

4.6.3 Trigger Coupling Selection

Use COUPLING switch to select coupling of trigger signal.

(1) Conventional Waveform Observation
Select the AC.
Since AC component of the trigger signal is blocked by a capacitor, above 10 Hz signal is triggered. The proper triggering can be made even DC component on the signal drifts.
Select the DC to observe below 10 Hz signal.

(2) Displaying Noisy Signal
If displayed waveform is unstable due to noise components on the trigger signal, select the HF-REJ for a stable display.
Since the trigger signal is low-pass filtered to reject above 100 kHz components, a stable display can be obtained.

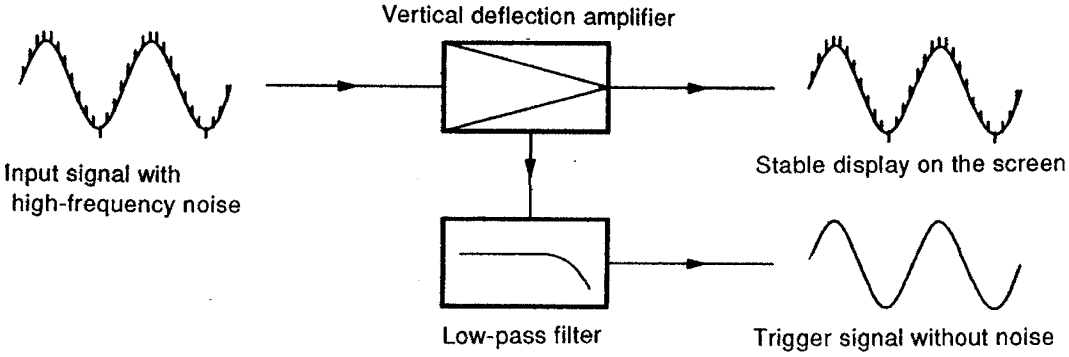


Figure 4-7

(3) Displaying TV Video Composite Signal
Since the video signal contains both horizontal and vertical sync signals, triggering is relatively difficult.
In this mode, the horizontal or vertical sync signal is picked up from the video signal and applied to the trigger circuit for a stable triggering.
Set the COUPLING switch to TV-V for observing the vertical component, or set the COUPLING switch to TV-H for observing the horizontal component.
Set the SLOPE switch as shown in Figure 4-8.

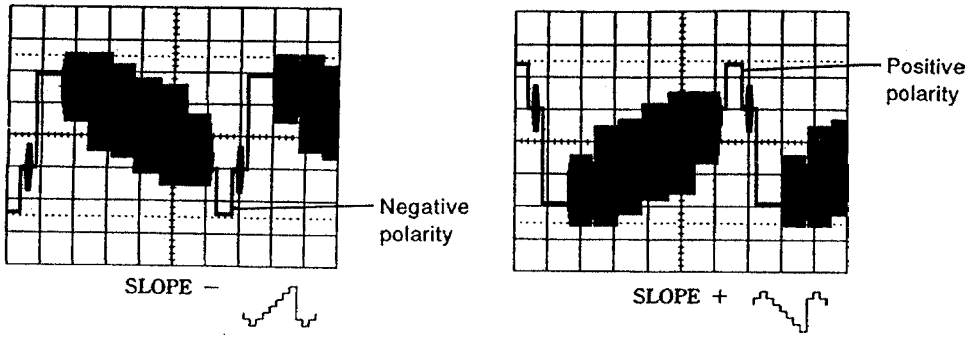


Figure 4-8

4.6.4 Trigger Point Setting

Setting the trigger point and holdoff time is useful for a stable display.

(1) Trigger Point Setting
Position the trigger point to the stable portion on the waveform by using the LEVEL control as shown in Figure 4-9.

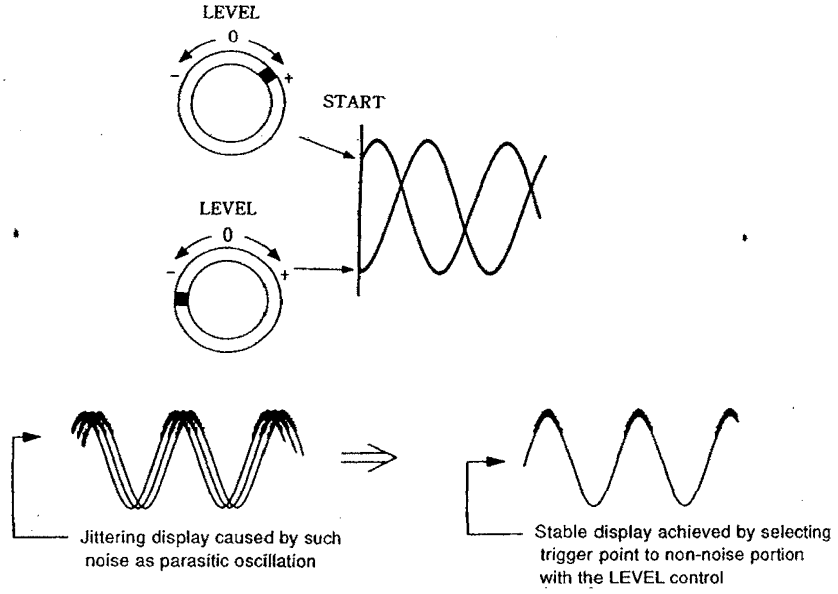


Figure 4-9

(2) Slope Selection (SLOPE)
When the SLOPE switch is set to "-", triggering is made at the negative slope of waveform.
When the SLOPE switch is set to "+", triggering is made at the positive slope of waveform.
For example, if a square wave has jitter on the trailing edge, set the SLOPE switch to "+" to obtain a stable display.

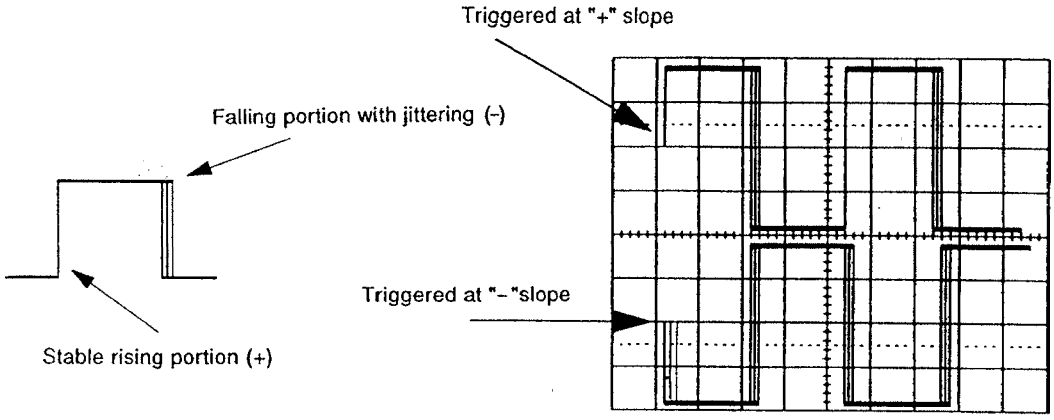


Figure 4-10

(3) Triggering Intermittent Pulse (HOLDOFF)
When observing an intermittent pulse train, the display is triggered in appearance, however sometimes, the waveform is not triggered. Adjust the holdoff time (from the sweep end to sweep start) for proper triggering.

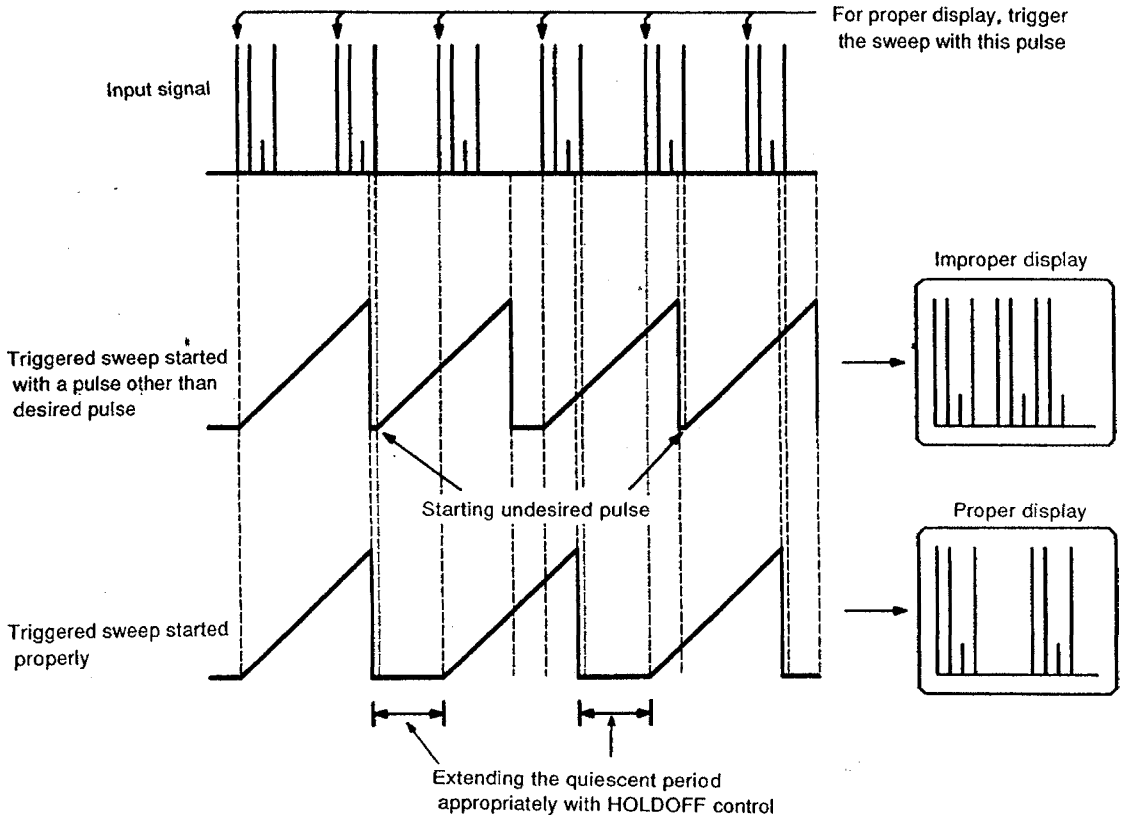


Figure 4-11

4.7 Horizontal Magnification

When the TIME/DIV switch is used to magnify a part of waveform to be measured, off-screen display may result. In this case, use the horizontal X10 MAG mode to magnify the waveform.

- **Procedure**

(1) Position the part of waveform to be magnified to the graticule center by using the H POSITION control.

(2) Pull the H POSITION control out for X10 MAG mode. Thus, the waveform is magnified 10 times in the horizontal direction with the measurement point centered.

Note: Normally, set the X10 MAG to off since brightness is reduced.

5. MEASUREMENT APPLICATIONS

5.1 DC Voltage Measurements

- **Procedure**

(1) Refer to Section "4.4 Single-Trace Operation" and set the controls. The V VARIABLE control should be set to the CAL.
(2) Set the AC-GND-DC switch to GND. Position the trace to the horizontal center graticule line by using the V POSITION control.
(3) Set the AC-GND-DC switch to DC. Read the trace displacement from the center graticule line.
(4) Moving direction of the trace indicates the voltage polarity: upward for positive and downward for negative. The voltage can be obtained as follows.
   a. When using the cable or probe (X1 setting)
      Voltage = VOLTS/DIV setting [V/div] x displacement [div]
   b. When using the probe with X10 setting
      Voltage = VOLTS/DIV setting [V/div] x displacement [div] x 10

In the X10 MAG setting (V VARIABLE control is pulled out), divide the voltage by 10 to obtain correct value.

Example:
See Figure 5-1. The displacement is +3.0 divisions.
In the following conditions, the voltage is as follows.
VOLTS/DIV switch: 0.2 V
Probe switch: X10

Voltage = 0.2 [V/div] x (+3.0) [div] x 10
= +6.0 [V]

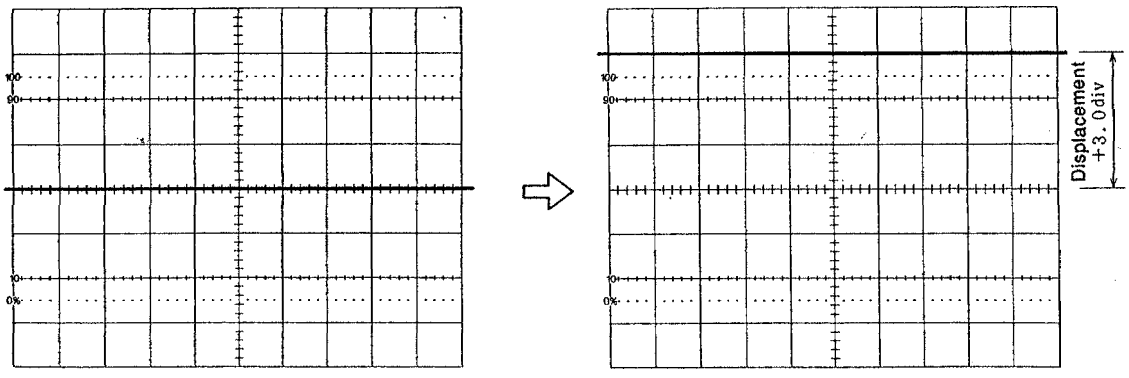


Figure 5-1

5.2 AC Voltage Measurements

- **Procedure**

(1) Refer to Section "4.4 Single-Trace Operation" and set the controls. The V VARIABLE control should be set to the CAL.
(2) Set the AC-GND-DC switch to AC. Position the waveform trough to the bottommost graticule line by using the V POSITION control.
(3) Position the waveform peak to the vertical center graticule line by using the H POSITION control.
(4) Read the vertical distance, from the peak to trough.
(5) The peak-to-peak voltage can be obtained as follows.
   a. When using the cable or probe (X1 setting)
      Peak-to-peak voltage = VOLTS/DIV setting [V/div] x vertical distance [div]
   b. When using the probe with X10 setting
      Peak-to-peak voltage = VOLTS/DIV setting [V/div] x vertical distance [div] x 10

In the X10 MAG setting (V VARIABLE control is pulled out), divide the voltage by 10 to obtain correct value.
When the input signal is a sine wave, the root-mean-square [rms] voltage can be obtained as follows.

$$\text{Root-mean-square voltage} = \frac{\text{peak-to-peak voltage}}{2.83}$$

Example:
See Figure 5-2. The vertical distance is 5.0 divisions.
In the following conditions, the voltage is as follows.
VOLTS/DIV switch: 50 mV
Probe switch: X10

$$\text{Peak-to-peak voltage} = 50\ [\text{mV/div}] \times 5.0\ [\text{div}] \times 10 = 2.5\ [\text{Vp-p}]$$

$$\text{Root-mean-square voltage} = \frac{2.5\ [\text{Vp-p}]}{2.83} = 0.883\ [\text{Vrms}]$$

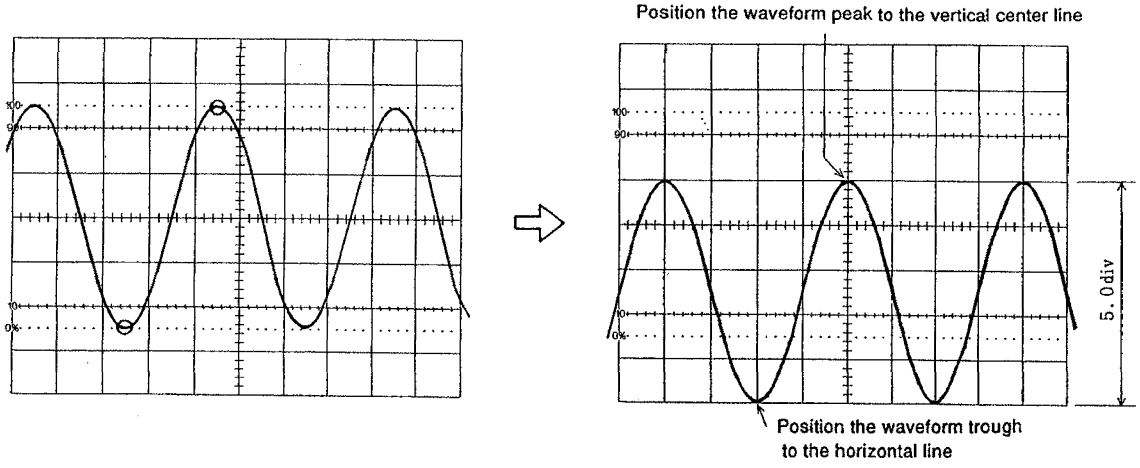


Figure 5-2

5.3 Time Interval Measurements

- ***Procedure***

(1) Refer to Section "4.4 Single-Trace Operation" and set the controls. The TIME VARIABLE control should be set to the CAL.
(2) Display the two measurement points on the waveform as large as possible in the horizontal direction by using the TIME/DIV switch.
(3) Position the left-end point on the waveform to the leftmost vertical graticule line by using the H POSITION control.
(4) Position the right-end point on the waveform to the horizontal center graticule line by using the V POSITION control.
(5) Read the horizontal distance between the two points.
(6) The time interval can be obtained as follows.

Time interval = TIME/DIV setting [s/div] x horizontal distance [div]

In the X10 MAG setting (H POSITION control is pulled out), divide the time by 10 to obtain correct value.

Example:
See Figure 5-3. The horizontal distance is 4.5 divisions.
When the TIME/DIV switch is set to the 0.5 ms, the time interval is as follows.

Time interval = 0.5 [ms/div] x 4.5 [div]
= 2.25 [ms]

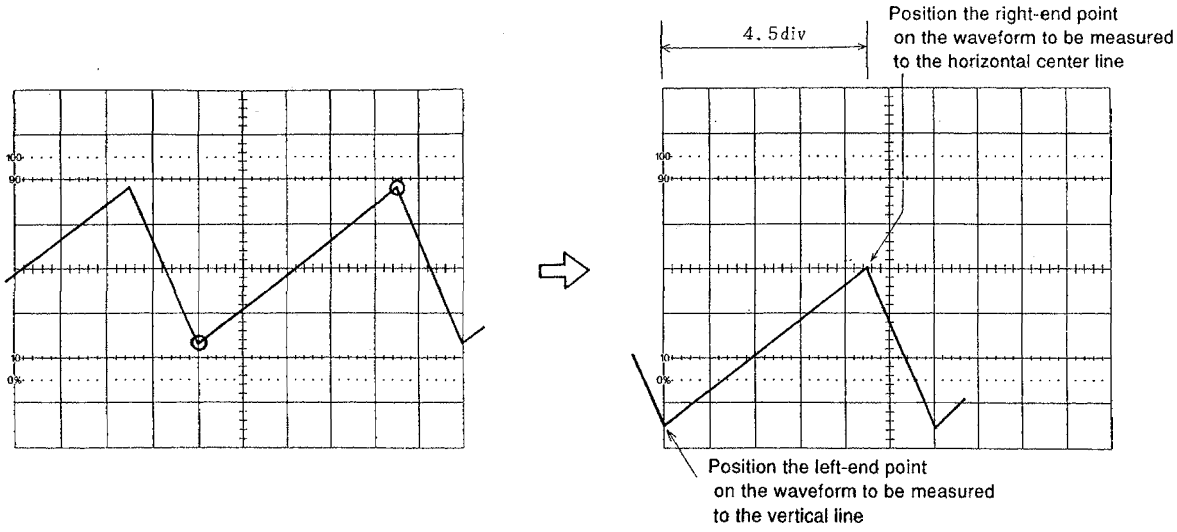


Figure 5-3

5.4 Frequency Measurements

The frequency is the reciprocal of the period (one complete cycle of repeating signal).

- **Procedure**

(1) Refer to Section "5.3 Time Interval Measurements" and read the period.
(2) The frequency can be obtained as follows.

$$\text{Frequency} = \frac{1}{\text{period}}$$

Example:
See Figure 5-4. The period is 4.0 divisions.
If the TIME/DIV switch is set to the 0.5 ms/div, the period is as follows.

$$\text{Period} = 0.5\ [\text{ms/div}] \times +4.0\ [\text{div}]$$
$$= 2.0\ [\text{ms}]$$

The frequency is as follows.

$$\text{Frequency} = \frac{1}{2.0\ [\text{ms}]} = \frac{1}{2.0 \times 10^{-3}\ [\text{s}]}$$
$$= 500\ [\text{Hz}]$$

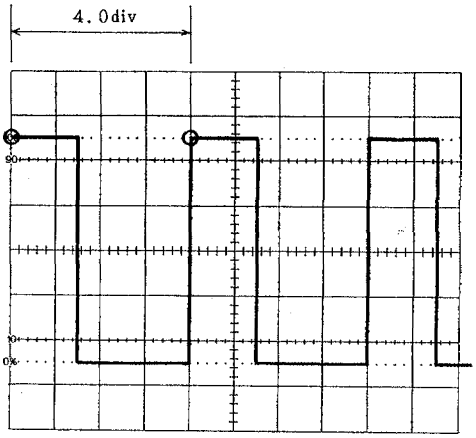


Figure 5-4

5.5 Pulse Rise Time Measurements

The rise time (fall time) can be obtained by measuring the time interval between 10 % and 90 % of the total pulse amplitude. The 0, 10, 90, and 100 % graticule lines are provided for measuring the rise time.

- **Procedure**

(1) Refer to Section "4.4 Single-Trace Operation" and set the controls.
The TIME VARIABLE control should be set to the CAL.
(2) Adjust the pulse amplitude for 5 divisions by using the VOLTS/DIV switch and V VARIABLE control.
(3) Position the bottom of pulse to the 0 % graticule line by using the V POSITION control. The top of pulse should be positioned at the 100 % line.
(4) Magnify the leading edge by using the TIME/DIV switch.
When the leading edge is displayed off-screen, pull the H POSITION control for X10 MAG setting.
(5) Use the H POSITION control so that the leading edge is positioned at the intersection of 10 % and vertical graticule lines.
Read the horizontal distance between the 10 % and 90 % points.
Refer to Section "5.3 Time Interval Measurements" to obtain the time interval. The time interval represents the rise time.

Example:
See Figure 5-5. The horizontal distance between the 10 % and 90 % points is 2.9 divisions.
In the following conditions, the rise time is as follows.

TIME/DIV switch: 2 µs/div
X10 MAG: ON

Rise time = 2 [µs/div] x 2.9 [div] x 0.1
= 0.58 [µs]

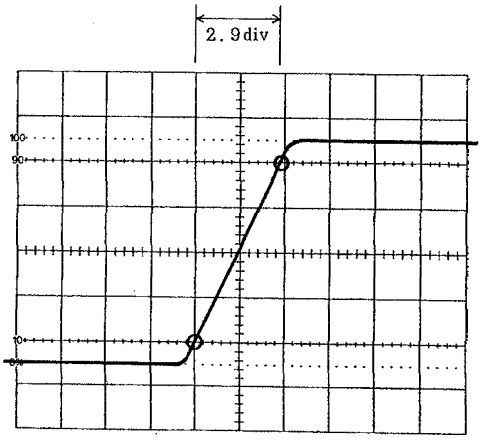


Figure 5-5

When the rise time of a device under test is 50 ns or faster, measurement error increases caused by the rise time of this oscilloscope.
Calculate the rise time of the device under test using the following formula.

$$\text{Rise time of device under test} = \sqrt{Ta^2 - Tr^2}$$

where Ta: Rise time displayed
Tr: Rise time of this oscilloscope (17.5 ns)

When the rise time of a device under test is 50 ns or slower, the measurement error will be 3 % or less.

5.6 Observing Composite Video Signal

Since the composite video signal contains both horizontal and vertical components, the conventional triggering is difficult to obtain a stable display. This oscilloscope can easily be triggered to the video signal due to the sync signal pick-off circuit is provided.

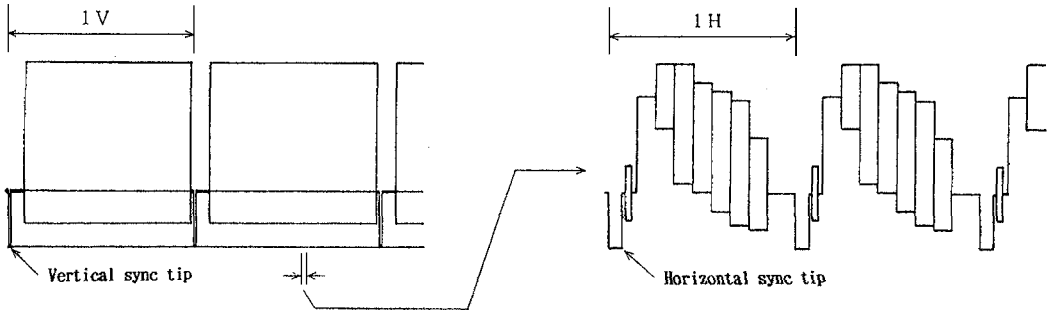


Figure 5-6

- **Procedure**

(1) Refer to Section "4.4 Single-Trace Operation" and set the controls.
(2) Refer to Table below for setting the TIME/DIV and TRIG COUPLING switches. Set the SLOPE switch according to the sync signal polarity.

Video Signal	Sync Polarity	TIME/DIV	COUPLING	SLOPE
Vertical Component	Negative	2 ms	TV-V	–
	Positive	2 ms	TV-V	+
Horizontal Component	Negative	10 µs	TV-H	–
	Positive	10 µs	TV-H	+

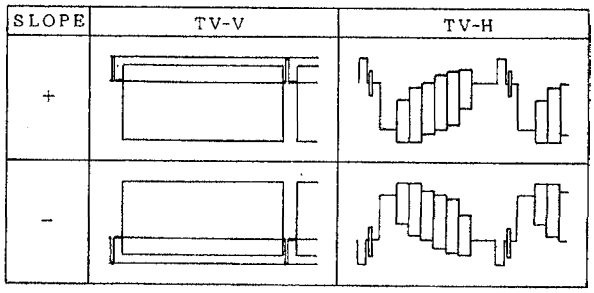


Figure 5-7

5.7 Phase Difference Measurements

The phase difference between two signals can be measured by using the dual-trace or X-Y display method as described below.

5.7.1 Dual-Trace Method

- **Procedure**

(1) Refer to Section "4.5 Dual-Trace Operation" and set the controls.
(2) Apply the reference signal to the CH1 OR X IN connector, and signal to be measured to the CH2 OR Y IN connector.
Adjust the waveform amplitude for 4 divisions by using the CH1 and CH2 VOLTS/DIV switches and V VARIABLE controls.
(3) Adjust the one cycle of waveform for 8 divisions display by using the TIME/DIV switch and TIME VARIABLE control.
By this setting, horizontal 1 division represents a phase of 45°.
(4) Position the waveform to the graticule center by using the CH1 and CH2 V POSITION controls.
(5) Read the horizontal distance between the corresponding points on the horizontal center graticule line. When the distance is short, pull the H POSITION control for X10 MAG setting.
(6) The phase difference can be obtained as follows.

Phase difference = 45 [°/div] x horizontal distance [div]

In the X10 MAG setting (H POSITION control is pulled out), divide the phase difference by 10 to obtain correct value.

Example:
See Figure 5-8. The horizontal distance is 0.7 division.
The phase difference is as follows.

Phase difference = 45 [°/div] x 0.7 [div]
= 31.5 [°]

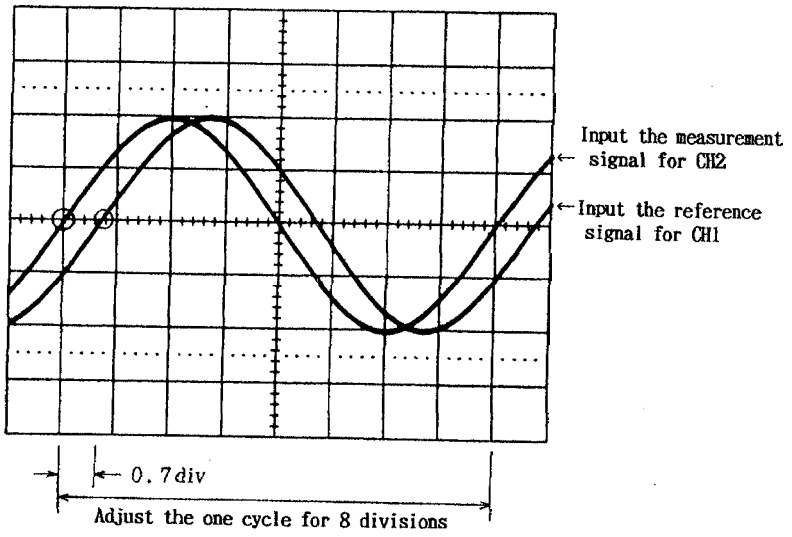


Figure 5-8

5.7.2 X-Y Display Method

- **Procedure**

(1) Refer to Section "4.5 Dual-Trace Operation" and set the controls.
(2) Set the TIME/DIV switch X-Y.
(3) Apply the reference signal to the CH1 OR X IN connector, and signal to be measured to the CH2 OR Y IN connector.
Set the CH1 AC-GND-DC switch to AC.
Set the CH2 AC-GND-DC switch to GND.
Adjust the CH1 VOLTS/DIV switch and VARIABLE control for a horizontal display of 6 divisions.
Position the trace to the horizontal center graticule line by using the H POSITION control.
(4) Set the CH2 AC-GND-DC switch to AC.
Set the CH1 AC-GND-DC switch to GND.
Adjust the CH2 VOLTS/DIV switch and VARIABLE control for a vertical display of 6 divisions.
Position the trace to the vertical center graticule line by using the H POSITION control.
(5) Set the CH1 AC-GND-DC switch to AC. The lissajous pattern is displayed.
(6) Read the vertical distance between the intersections of the lissajous pattern and the vertical center graticule line.
The phase difference can be obtained as follows.

$$\text{Phase difference} = \sin^{-1}\frac{\text{vertical distance (div)}}{\text{6 (div)}}$$

Example:
See Figure 5-9. The vertical distance is 4 division.
The phase difference is as follows.

$$\text{Phase difference} = \sin^{-1}\frac{4\ [\text{div}]}{6\ [\text{div}]}$$
$$= 41.8^{\circ}$$

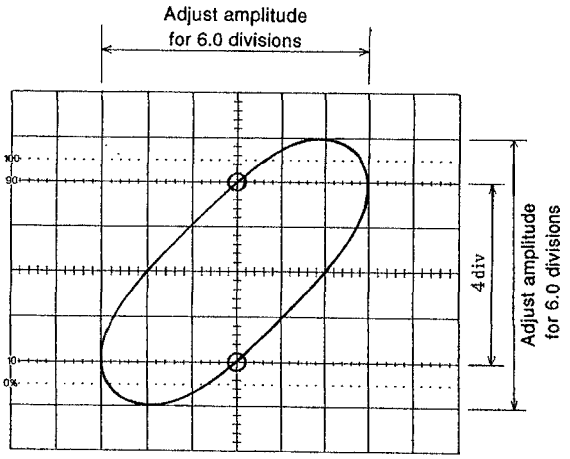


Figure 5-9

6. MAINTENANCE

6.1 Cleaning

If the CRT surface becomes dirty, remove the filter before cleaning the surface. To remove the filter, proceed as follows.

See Figure 6-1. Stick a cellophane tape on the filter and slide it downward. Filter top is came off from the frame, then pull it out.
To install the filter, insert the bottom of filter into the frame and press it in place.

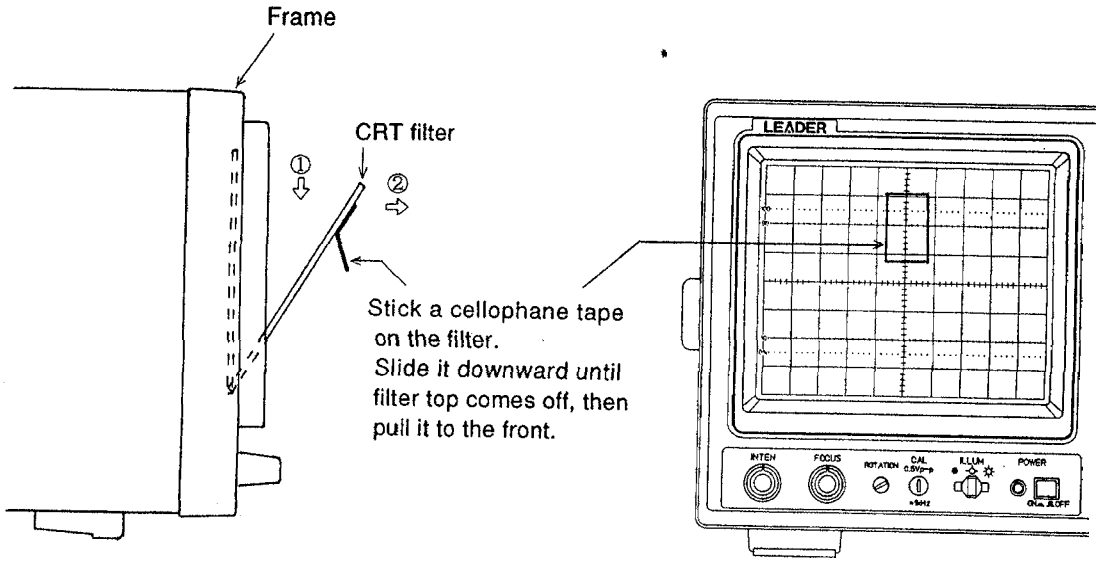


Figure 6-1

If the oscilloscope becomes dirty, wipe it off using a cloth damped with diluted neutral detergent, then clean the oscilloscope with a dry cloth.

[CAUTION] Avoid the use of solvents (e.g., benzol, thinner) which may damage the panels or cabinet surface.

6.2 Periodical Calibration

To maintain the performance of the oscilloscope, yearly calibration is recommended. Contact your local Leader agent for periodical calibration.