4. PANEL ILLUSTRATIONS

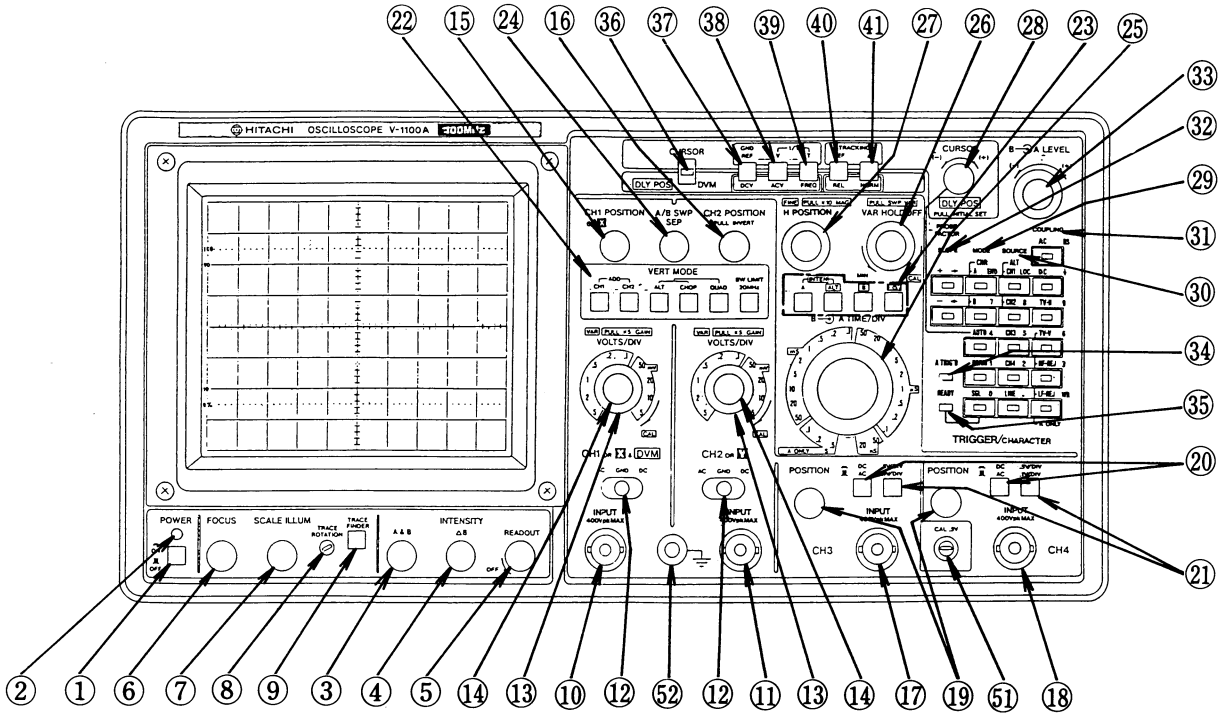


Fig. 4-1 Front View (A)

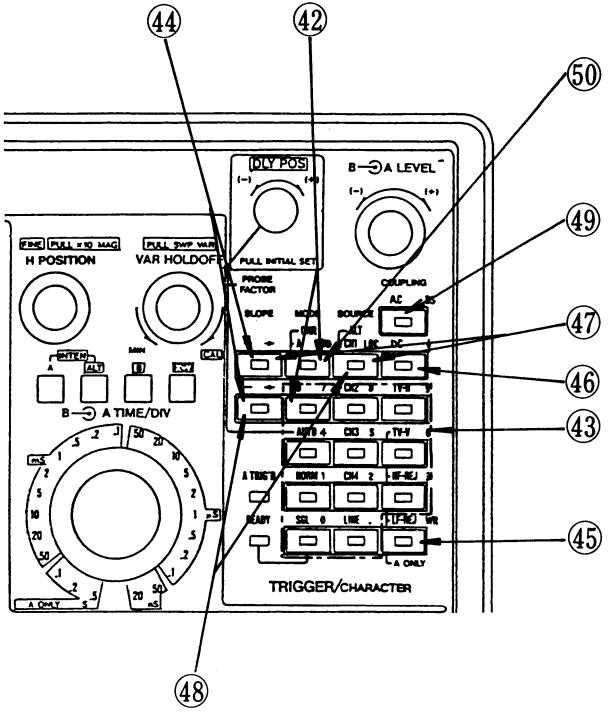


Fig. 4-2 Front View (B)

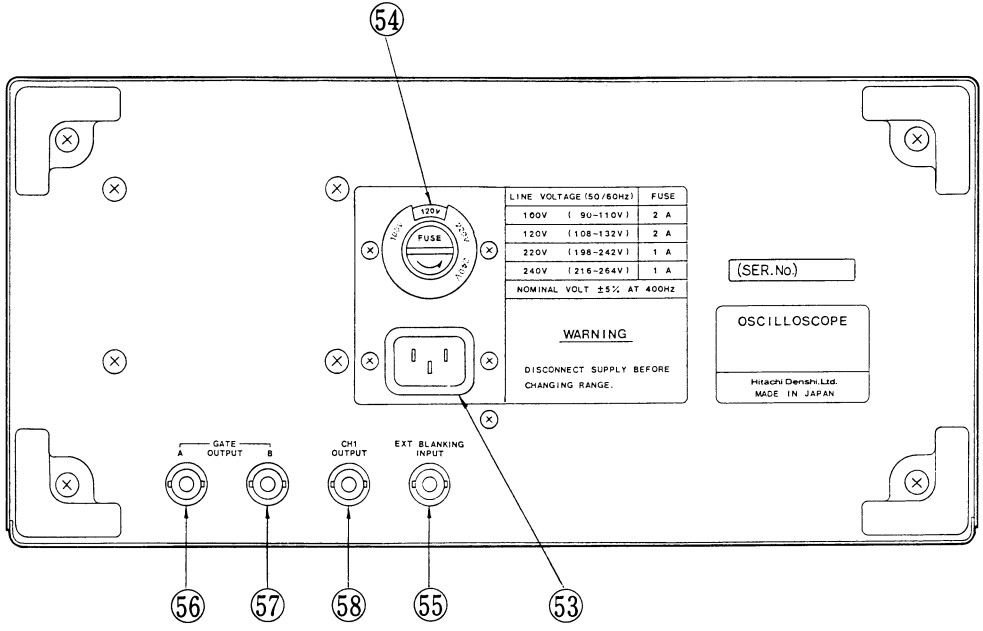


Fig. 4-3 Rear View

5. PANEL DESCRIPTION

(1) Power and CRT

① POWER switch

Power is ON in the depressed mode (⊓), and OFF in the released mode (⊔).

② POWER lamp

Lights up in red with POWER ON.

INTENSITY controls

③ A & B

Adjusts the intensity of the main sweep (A) and the delayed sweep (B). Clockwise adjustment increaes intensity.

④ △ B

Adjusts the intensity of the delayed sweep (B). Clockwise adjustment increases intensity.

⑤ READOUT

Adjusts the intensity of characters displayed on the CRT. Fully counterclockwise rotation disables characters display.

⑥ FOCUS control

After obtaining an appropriate brightness by operating the INTENSITY control, adjust the FOCUS control until the trace has best definition. Although the FOCUS is corrected automatically when the INTENSITY control is rotated, the focus can be slightly shifted. In this case, adjustment is required.

⑦ SCALE ILLUM control

Controls graticule illumination. Useful when photographing or viewing waveforms in a dark area.

⑧ TRACE ROTATION control

Corrects a slight tilting of trace caused by external magnetic fields. Align the trace with the horizontal graticule line by rotating the control.

⑨ TRACE FINDER switch

Compresses the display within the graticule area, when the trace is located off-screen.

(2) Vertical deflection system

⑩ CH1 or X INPUT and DVM connector

This BNC connector provides external signal to Channel 1 and DVM.

The applied signal is supplied to the horizontal deflection system in X-Y operation.

⑪ CH2 or Y INPUT connector

This BNC connector provides external signal to Channel 2. The applied signal is supplied to the vertical deflection in X-Y operation.

⑫ AC-GND-DC switches

Select the method of coupling the input signal to the vertical deflection system.

AC: Input signal is capacitively coupled to the vertical attenuattor. The DC component of the input signal is blocked.

GND: The input of the vertical amplifier is grounded to provide a ground reference. This provides ground free run function in NORM of the trigger mode.

DC: All frequency components of the input signal are coupled to the vertical attenuator.

⑬ VOLTS/DIV switches (CH1 and CH2)

Selects the sensitivity level of the input signal to Channels 1 and 2 in 10 steps from 5mV/DIV to 5V/DIV.
The deflection factor set by these switches is shown on the lower left side of the CRT. In the case of a 10:1 probe, multiply the displayed value by 10 times.
The deflection factor corresponding to probes can be displayed by following the procedure of Item 8-(1)-(b).

⑭ VAR PULL x5 GAIN controls

* Provides a continuous variable deflection factor. Attenuation of less than 1/2.5 is obtained by counter-clockwise rotation.
* This control is used when comparing two waveforms or when measuring the rise time of a square wave.
* To measure a voltage by the use of the deflection factor indicated by VOLTS/DIV, turn the VAR control clockwise fully to the CAL position.
* △ cursor measurement is available by turning the VAR control on with V button ㊵ depressed in the CURSOR mode ㊳ . (Refer to item 8-(5)-(a).)
* When the control is pulled, the vertical deflection factor at each range of VOLTS/DIV is magnified to 5 times.
  The maximum deflection factor is obtained at 1 mV/DIV.

NOTE:

1. When the control is pulled, the S/N ratio and frequency bandwidth of instrument will be reduced.
2. Observation of signals in the high-sensitivity range of 1 mV to 2 mV/DIV and in the CHOP mode, it is sometimes difficult to obtain a stable trigger.

a. Put a high level synchronization signal into the vacant channel as trigger signal source.
b. For observing low frequency signals under 50 kHz, select the HF-REJ by the COUPLING switch in the A trigger mode.

⑮ CH1 POSITION control

Sets vertical position of the Channel 1 signal display. Clockwise rotation moves the associated trace upward while counterclockwise rotation moves it downward.

⑯ CH2 POSITION PULL INVERT control

* Sets vertical position of the Channel 2 signal display. Clockwise rotation moves the associated trace upward while counterclockwise rotation moves it downward.
* When the control is pulled out, the signal polarity of Channel 2 is inverted.
  Useful for the comparison of two signals of opposite polarities and for the observation of the difference between Channels 1 and 2 in the ADD mode.

⑰ CH3 INPUT connector

The BNC connector provides external signal to Channel 3.

⑱ CH4 INPUT connector

The BNC connector provides external signal to Channel 4.

⑲ POSITION controls

Set vertical positions of Channel 3 and Channel 4 signal displays.

⑳ DC/AC switches (CH3 and CH4)

Sets input coupling to Channels 3 and 4. AC coupling is accomplished with the function switch out (⊓), while DC coupling is with the function switch in (⊓).

㉑ .5V/DIV–.1V/DIV switch

Set the deflection factor of Channel 3 or 4 to .5V/DIV, function switch in (⊓) or .1V/DIV, function switch out (⊓).

㉒ VERT MODE switches:

CH1 switch Displays the Channel 1 signal.

CH2 switch Displays the Channel 2 signal.

ADD switch Displays the algebraic sum of Channels 1 and 2, when the both CH1 and CH2 buttons are latched in.

ALT switch Chennel 1 and 2 signals are alternately displayed at each sweep.
Used for the dual trace observation of flicker free waveforms in the sweep time ranging from 0.5 ms/DIV to 20 ns/DIV.

CHOP switch Channel 1 and 2 signals are switched at about 250 kHz rate regardless of the sweep and they are simultaneously displayed on the CRT.
This is used for dual trace observation of waveforms in the low sweep time ranging from 1 ms/DIV to 0.5 s/DIV. To prevent triggering from noise occured at chop switching, select the COUPLING switch to the HF REJ or set the A trigger LEVEL control to the optimum level.

QUAD switch Quad signals of Channels 1 to 4 are all displayed by pressing the QUAD button, with the ALT or CHOP buttons depressed.

BW LIMIT-20 MHz switch Reduces interference from undesired high-frequency signals when viewing low-frequency signals.
Reduces the bandwidth of Channels 1 and 4 to approximately 20 MHz.

(3) Horizontal deflection system

㉓ Horizontal display switches:

Provides for selecting the operation mode of the horizontal deflection.

A switch Main sweep (A) appears on the CRT.
This setting is used in normal cases.

ALT switch Both main sweep (A) and delayed sweep (B) are displayed alternately.

INTEN switches Intensifies the main sweep (A) for the duration of the delayed sweep (B) by pressing both the A and ALT switches.

B switch Magnifies the intensified portion of the main sweep (A) over the full screen. The sweep time is controled by the B time base.

X-Y switch Used for an X-Y operation. Signals applied to Channels 1 and 2 become signals of X axis and Y axis respectively.
The vertical deflection factor is read on CH2 VOLTS/DIV and horizontal deflection factor on CH1 VOLTS/DIV.
CH1 POSITION control sets horizontal position of the waveform and CH2 POSITION control sets vertical position in the X-Y mode.

㉔ A/B SWP SEP control

Adjusts the vertical position of the delayed sweep (B) in the ALT sweep mode.

㉕ **A TIME/DIV switch (outer)**

Sets the sweep speed of the main sweep (A) in 23 steps from 20 ns/DIV to 0.5 s/DIV.

㉕ **B TIME/DIV switch (inner)**

Sets the sweep speed of the delayed sweep (B) in 20 steps from 20 ns/DIV to 50 ms/DIV.

The scale factors of the A and B TIME/DIV switches are displayed on the lower right side of the CRT.

The independent setting is available by the two knobs.

㉖ **PULL SWP VAR control (inner)**

Continuously varies the sweep speed of the main sweep (A) when the control is pulled out.

The sweep is delayed by 2.5 times or more at the fully counterclockwise position.

Normally, the knob is left depressed.

By turning PULL SWP VAR on, ΔT% cursor measurement (refer to item 8-(10)) is available with T button ㊴ depressed in the CURSOR mode ㊱ , and PHASE cursor measurement (refer to item 8-(8)) with V 40 and T ㊴ buttons depressed in the CURSOR mode ㊱ .

㉖ **VAR HOLDOFF control (outer)**

Increases the holdoff time to trigger and aids triggering on complex displays such as high-frequency signal, irregular signal and digital words.

Rotate the VAR HOLDOFF control to obtain stable triggering. Normally, set this control to MIN.

㉗ **POSITION control (outer)**

Used to adjust the horizontal position. Display is moved to right side when the control is rotated clockwise and to left side with counterclockeise rotation. The outer shaft is for coarse adjustment.

㉗ **FINE PULL x10 MAG control (inner)**

The inner shaft for fine adjustment is described below. A and B sweeps are magnified to 10 times by pulling out FINE knob (inner shaft) of horizontal POSITION control ㉗ . In this case the sweep time is 1/10 the value indicated by TIME/DIV. Bring the portion of the waveform to be magnified to the center of the scale by the horizontal POSITION control ㉗ . Then pull the x10 MAG switch and the waveform placed at the center is magnified.

By controlling the PULL x10 MAG, sweep speed becomes 10 times the sweep set by the TIME/DIV control and the sweep rate displayed on the CRT becomes 1/10 the sweep time set at initial time.

㉘ DLY POS control

Used to set the delay time of the delayed sweep (B) starting point with respect to the main sweep (A) starting point. The delay time is displayed on the upper left side of the CRT.
The CURSOR/DVM select lever must be set downward. In this state, DLY POS operation is available.
Depress and turn this control to move cursor fast.

NOTE:
This control moves the cursor when the CURSOR/DVM select lever is set upward (CURSOR).

(4) Trigger system

The SLOPE, MODE, SOURCE or COUPLING selection is performed by pressing the buttons arranged vertically. The LED selected button lights up. The black characters on the TRIGGER/CHARACTER section buttons indicate the setting of TRIGGER system, and the blue characters indicate that of CHARACTER (Comment display) system. In the comment display mode, the all LEDs indicating TRIGGER system go off.

㉙ MODE buttons

A The MODE A or MODE B LED lights up to indicate the selected mode.

B When the A button of ㉓ horizontal display buttons is selected, MODE is automatically set to A.
When the ALT, INTEN, or B button of ㉓ horizontal display buttons is pressed, push either MODE A or MODE B to select the trigger mode.

AUTO The instrument will automatically display a sweep without an input signal being applied or out of trigger.
Normal trigger will be established by setting trigger level when a signal is applied to the input. This setting is convenient in most cases.

NORM No sweep will appear, unless a signal is present or out of trigger. Use this MODE when effecting synchronization to a very low frequency signal (30 Hz or less).
Sweep free runs in the NORM mode when the input coupling, whose channel is set for a trigger source, is GND.
In ADD VERT MODE ㉒, sweep free runs by setting the input coupling of CH1 and CH2 to GND.

SGL Displays a single sweep by A trigger source. Used for photography.

NOTE:
Characters are not displayed on the CRT when the SGL button is pressed and the READY LED lights up. When signal is supplied, single sweep is executed and characters are momentarily displayed. Press the SGL button again for one more single sweep. When the SGL button is pressed and the X-Y switch of ㉓ horizontal display switches is pressed, characters are continuously displayed.

㉚ SOURCE buttons

Selects the triggering signal source – CH1, CH2, CH3, CH4, or LINE.

CH1 The signal applied to CH1 is selected for the source.

CH2 The signal applied to CH2 is selected.

CH3 The signal applied to CH3 is selected.

CH4 The signal applied to CH4 is selected.

LINE The frequency of the mains (AC power) is selected.
Functions only in the A trigger mode.

NOTES: When LINE is selected in the A trigger mode, B trigger is automatically set to the AUTO mode.

ALT (**CH1** / **CH2**) When the ALT button is pressed in the A trigger mode, press the buttons CH1 and CH2 at the same time for alternate trigger mode.
CH1 and CH2 signals can be triggered even if the two signals have no relationship of synchronization. COUPLING is automatically set to DC.

㉛ COUPLING

Selects coupling method for the triggering signal.

AC Blocks DC and cuts off the very low frequency components.

DC Directly connects the triggering signal to the trigger circuit.
Used when triggering by a very low frequency signal.

TV-H Used when observing the entire horizontal video signal.

TV-V Used when observing the entire vertical video signal.

NOTE: When TV-V is selected in the A trigger mode, TV-H is automatically established in the B trigger mode.

HF-REJ Among the AC component for triggering, the high frequency components of more than 50 kHz will be attenuated.
A stabilize trigger will be unaffected by noise of more than 50 kHz, can be obtained.

LF-REJ Among the AC component for triggering,

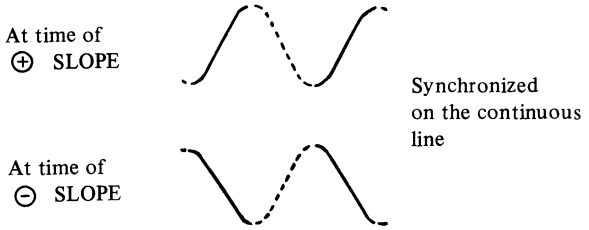
the low frequency components of less than 50 kHz will be attenuated.
A stabilized triggering will be unaffected by noise of less than 50 kHz, can be obtained.

(HF-REJ, LF-REJ, and TV-V function only in the A trigger mode.)

㉜ SLOPE buttons

Selects the triggering polarity of (+) or (-). The (+) or (-) LED lights up to indicate the selected polarity.

Explanation of trigger polarity SLOPE



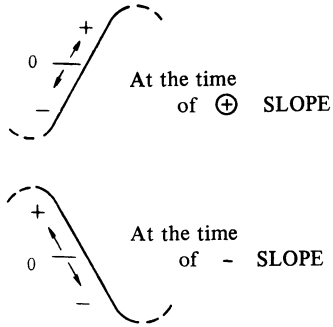
㉝ A LEVEL control (outer)

Sets the triggering level of the main sweep (A).

B LEVEL control (inner)

Sets the triggering level of the delayed sweep (B).
By controlling the trigger level, the sweep start point of the waveform is set.

Explanation of trigger LEVEL



㉞ A TRIG'D indicator

Lights up when the main sweep (A) is triggered.

㉟ /READY indicator

Lights up to indicate that the oscilloscope is ready for single sweep.
Goes off when single sweep is started.

(5) Functions of CURSOR and DVM

㊱ CURSOR/DVM lever switch

Selects the function of CURSOR or DVM.
Set the lever to the up position for CURSOR function,

and the five functions ㊲ , ㊳ , ㊴ , ㊵ and ㊶ can be operated, related to the top five legends.

Set the level to down position for the DVM function, and the lower five functions can be operated.

In adition, DLY POS operation is available in the down position.

(a) CURSOR function (When CURSOR/DVM lever switch is set to the up position.)

㊲ GND REF button

When the GND REF button is latched in, the GND reference cursor is displayed on the CRT. The GND reference cursor moves corresponding to the vertical POSITION control.

Channels 1 and 2 can display the GND REFerence cursor, the alternate long and short dash lines are for CH1, the dotted line for CH2.

NOTE:

Channels 3 and 4 do not display the GND reference cursor. In the QUAD or the ADD of VERT MODE and in the ALT of the horizontal display mode, the GND reference cursor is not displayed.

㊳ V button

Two horizontal cursors appear by pressing this button. The voltage between the two cursors are displayed with cursor menu on the upper side of the CRT. It corresponds to the setting of VOLTS/DIV.

㊴ T button

Two vertical cursors appear by pressing this button.The time between two cursors is displayed with cursor menu on the upper side of the CRT. It corresponds to the setting of TIME/DIV.

1/T button

When both the V and T buttons are latched in, two vertical cursors appear. The reciprocal of the time (frequency) between two cursors is displayed with cursor menu on the upper side of the CRT.

(GND REF, V, and T buttons are interlocked.)

㊵ REF button

Moves the reference cursor of the alternated long and short dash line by turning the CURSOR control.

㊶ △ button

Moves the delta cursor of the dotted line by turning the CURSOR control.

TRACKING button

When both the REF and △ buttons are latched in the

two cursors displayed on the CRT are moved simultaneously by turning the CURSOR control.
(REF and △ buttons are interlocked.)

㉘ CURSOR control

A clockwise turn moves the cursor up or screen right side; counterclockwise turn moves the cursor down or screen left side.
Turn with a pushing motion of the knob will produce a fast cursor movement.

NOTE:
This control sets delay time when the CURSOR/DVM select or lever is set downwards (DLY POS).

(b) DVM function (When CURSOR/DVM lever is set to the down position.)

This DVM function is available only for a CH1 operation. The measurements for DC voltage, AC voltage, and frequency are displayed on the upper side of the CRT.

NOTE:
The DVM function is not available in the single sweep mode or for the signal exceeding the screen.

㊲ DCV button

When the CH1 input coupling switch is set to DC, the DC voltage of the channel 1 signal is measured and displayed on the upper side of the CRT.
In the AC mode of the CH1 input coupling switch, a question mark '?' will indicate an error.

㊳ ACV button

When the ACV button is latched in, the AC voltage of channel 1 is measured and displayed on the upper side of the CRT.
The unit displays with a symbol '~'. When the CH1 vertical deflection factor is uncalibrated, a message 'UNCAL' is displayed for voltage.

NOTE:
The ACV measurement is accurate only for a sine wave. Refer to item 8-(16).

㊴ FREQ button

When the FREQ button is latched in, the frequency of channel 1 is displayed on the upper right side of the CRT.

NOTE:
The frequency counter may miscount for the small duty cycle pulse and the small amplitude signal.
(DCV, ACV, and FREQ button are interlocked.)

㊵ REL button

When the REL button is depressed, the result which is compared the CH1 signal voltage with the reference voltage is displayed.

In the DCV mode, the deflection from the reference voltage is displayed. In the ACV mode, the reference (0 dB) is used to compare with a signal supplied to Channel 1, and the result is displayed in dB on the upper side of the CRT.

The voltage measured at the setting changed from NORM to REL will be the reference. If a question mark '?' is displayed in the REL mode, measure it again in the NORM mode.

Then press the REL button.

When the reference voltage in ACV REL mode is 0.0 mV or 0.0V, a question mark '?' will be displayed.

NOTE:

The REL mode measurement is not available among the different VOLTS/DIV ranges.

For example, if taking the reference at 5 mV/DIV range, it can not be compared with the signal measured at 10 mV/DIV range.

㊶ NORM button switch

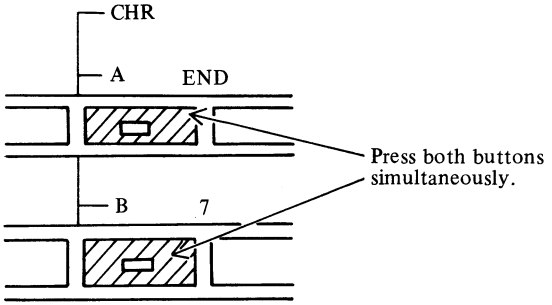
When the NORM button is latched in, the voltage being measured (DC voltage or AC voltage) of the signal applied to Channel 1 is displayed on the upper side of the CRT. If the NORM button is latched in with the REL button, the reference established during REL mode is displayed on the upper right side of the CRT. (REL and NORM button are interlocked.)

(6) Comment display function

Comment (30 characters maximum in one line) can be displayed on the CRT by pressing the buttons in the TRIGGER/CHARACTER section.

㊷ [CHR] (Character)

Comment display mode can be set by pressing both [A] and [B] buttons simultaneously, and a cursor "_" (underline) will blink on the CRT. All the LED indicators in TRIGGER/CHARACTER section buttons will go off.



In the comment display mode, each button on the TRIGGER/CHARACTER section performs its shifted function (marked in blue on the upper right of each button).

㊸ [0] to [9] and [·]

Figures 0 to 9 and a period can be displayed.

㊹ [←] [→]

The number of letters, symbols, etc. can be selected and displayed.

When [→] is pressed, displays are made in the sequence of A, B, C. . . . When [←] is pressed, displays are made in the reverse sequence of →, ←, ↓ . . . .

When [←] or [→] continues to be pressed, character is changed one after another in the same sequence as the above.

Displayed letters or symbols can be registered by pressing the [WR] (Write) button.

㊺ [WR] (Write)

By pressing this button after setting every letter or symbol by the [←] or [→] button, the selected letter or symbol is registered as a comment.

㊻ [↓]

The comment display can be moved to the next line.

After reaching the bottom (7th) line of the comment display area, the comment display is next moved to, the top (2nd) line.

[LOC] (Location) and [→]

By pressing both [LOC] and [→] buttons simultaneously, the comment display can be shifted right by one column. (Excluding the case that the cursor is on the rightmost position)

When shifting horizontal position of the character display continuously, first hold down the [LOC] button, and then press the [→] or [←] button repeatedly.

㊼ [LOC] and [←]

㊽ By pressing both [LOC] and [←] buttons simultaneously, the comment can be shifted left by one column. (Excluding the case that the top character of the comment is on the leftmost position)

When shifting the column continuously, first hold down the [LOC] button, and then press the [→] or [←] button repeatedly.

㊾ [BS] (Back space)

The comment can be corrected.

When this button is pressed, the cursor is shifted left by one column and delete the character presented at that the new position of the cursor, and a new character can be displayed. (Excluding the case that the cursor is

on the leftmost position)

⑤⓪ END

Comment display mode is terminated.
When this button is pressed, the TRIGGER mode will be set, and the A-trigger setting conditions will be displayed.

(7) Miscellaneous

⑤① CAL 0.5V terminal

A 0.5V–1kHz squarewave signal is available through a tip terminal for probe calibration.

⑤② GND terminal

Earth terminal grounding.

(8) Rear panel

⑤③ AC input connector

Provides the connection point for the AC power source to the instrument.

⑤④ FUSE holder

Install a fuse corresponding to the LINE VOLTAGE selector setting voltage.
For fuse replacement, disconnect the power cable and remove the fuse holder cover by rotating it counter-clockwise.
After replacement, secure the cover by rotating it clockwise.

⑤⑤ EXT BLANKING INPUT connector

Provides an input connection for an external blanking signal. The trace displayed on the CRT may be intensity-modulated, pulse signal or time-scale marks can be generated.
5V AC signal applied to the connector.

⑤⑥ ⑤⑦ GATE OUTPUT connector

A: Output terminal for a positive squarewave simultaneously occuring with the A trigger sweep.
(Output: TTL level)

B: Output terminal for a positive squarewave simultaneously occuring with the B trigger sweep.
(Output: TTL level)

⑤⑧ CH1 OUTPUT connector

Makes the channel 1 input signal available for further analysis.

NOTE:
Do not use the CH1 OUTPUT when the CH1 x5 GAIN switch is pulled. The CH1 OUTPUT signal may contain noise in that mode.

6. HOW TO PRODUCE THE TRACE

Before turning ON the POWER switch, insure the AC supply voltage is within the range of 108 to 132 V for 120V AC supply, 198 to 242V for 220V AC supply, and 216 to 264V for 240V AC supply .
Connect the power cord on the rear panel to an AC outlet and set the controls as follows.

AC-GND-DC	GND
POSITION	Midrange, push in
Horizontal display mode	A
Trigger MODE	AUTO

Turn the POWER switch on and rotate the INTENSITY A & B control clockwise, and a trace appears.
Adjust the FOCUS control to obtain the sharpest trace.
When this instrument is not used, with power supplied, rotate the INTENSITY control counterclockwise to decrease the intensity. This protect the CRT from image burn.

NOTE:
For normal operation, the following function must be set in the 'CAL' position.

VAR PULL x5 GAIN	Push in and rotate in the direction of arrow. In this case the VOLTS/DIV is calibrated to the indicated value.
PULL SWP VAR	Push in the knob or rotate in the direction of arrow. In this case the TIME/DIV is calibrated to the indicated value.

Align the trace with the horizontal graticule line at the center of the screen by operating CH1 POSITION control. In some cases, the trace may be slightly oblique to the scale by the effect of earth magnetism.
In this case, align the trace with the horizontal graticule line at the center of the screen by properly adjusting the semi-fixed variable resistor TRACE ROTATION on the front panel.

General measurement

(1) Observing a single waveform

Use Channel 1 or 2 when not observing the phase difference between two waveforms or when engaging in an operation other than X-Y operation.
Make the following settings when using Channel 1.

VERT MODE switch	CH1
A trigger MODE switch	AUTO
A trigger SOURCE switch	CH1
AC-GND-DC switch	AC or DC

Under these settings all repetitive signals higher than 30 Hz applied to Channel 1 can be triggered on and observed by adjusting the A trigger LEVEL control, with a TIME/DIV range between 2 ms/DIV and 20 ns/DIV. Since the A trigger MODE is set to the AUTO position. A trace appears even when no signal is present or when AC-GND-DC switch is in the GND position. Therefore, DC voltage measurement can be made when the switch is placed to DC. When observing low frequency signals below 30 Hz, the following switch settings are required;

A trigger MODE switch NORM
A trigger COUPLING switch DC
Triggering can be effected by operating the LEVEL control under this setting. When using only Channel 2, set the following switches to CH2;
VERT MODE switch: CH2
A trigger SOURCE switch: CH2

(2) Observing two waveforms

Observation of two waveforms can be made easily by setting the VERT MODE switch to ALT or CHOP. Set the VERT MODE switch to ALT for observation of high repetition frequency signals. While for low frequency signals, set it to CHOP. When the TIME/DIV switch is set to 1 ms or slower, select CHOP mode for flicker free observation.
ALT: 0.5 ms/DIV to 20 ns/DIV
CHOP: 1 ms/DIV to 0.5 s/DIV
To measure phase difference, trigger on the leading signal.

(3) Observing waveform in the X-Y mode

X-Y oscilloscope is available by pressing the X-Y button, in the horizontal display mode.
Input and position controls are as follows.

	Input connector	Position control
X-axis signal (Horizontal axis signal)	CH1 INPUT	CH1 POSITION
Y-axis signal (Vertical axis signal)	CH2 INPUT	CH2 POSITION

The BW LIMIT 20 MHz button must be in the released position (button off) for the X-Y operation. The LEDs for trigger do not light up in X-Y operation.

(4) Vert mode switch

(a) In quad trace alternate mode, signals are displayed in order of Channel 1, 2, 4, and 3.
(b) When none of the switch are latched in, signals of Channels 1 and 2 are displayed in the ALT mode.

7. METHOD FOR CONNECTING SIGNALS

The first step of measurement is to connect the signal to the oscilloscope properly. Do it with utmost care.

(1) When using a probe

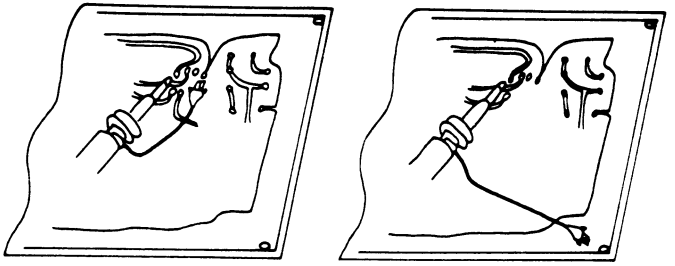
Use the AT-10AL 1.5 probe, with the 10:1/1:1 selector switch set to 10:1, when measuring a high frequency signal. Since the input signal is attenuated by this probe to 1/10, this probe is not recommended for low level signals.

Bandwidth limitings will occur when the probe is set to 1:1. Therefore, all high frequency measurement must be made with a 10:1 selection.

<CAUTIONS>

- Do not apply a signal to the input in excess of 500V (DC + peak AC at 1 kHz).
- Connect the probe ground lead as close as possible to the point being measured especially when measuring a fast rise time or a high frequency signal. Long probe ground leads may cause waveform distortions, such as ringing and overshoot.
  For better measurements, it is recommended to be use the standard ground lead attachment be used with the AT-10AL 1.5 probe.

Connection of ground lead



(a) Proper (b) Improper

- Multiply the reading of VOLTS/DIV by 10.
  For example, if the VOLTS/DIV switch is set to 50 mV/DIV, then read the waveform as
  50 mV/DIV x 10 = 500 mV/DIV
- To avoid measurement error, probe calibration must be done especially when probes are changed on the instrument. Connect the probe tip to the CAL output terminal and the probe tip to the GND terminal. A 1 kHz square wave should be displayed with flat tops. Any distortion in the presentation is caused by incorrect probe compensation. If overshoot or undershoot is present, turn the screwdriver adjustment in the probe for a flat-top presentation.

(a) Optimum (b) Capacity too small (c) Capacity too large

(2) Direct input connection

When connecting a signal directly to the oscilloscope not using an AT-10AL 1.5 probe, pay attention to the following points in order to minimize measurement error.

- When performing observations using a bare lead wire, no trouble occurs when the circuit to be measured is of low impedance and high level.
  However, measurement error may be caused by stray coupling with other circuits and power line.
  This measurement error cannot be ignored even in low frequency regions.
  In general, avoid measuring with non-shielded wire. When using a shielded wire, connect one end of the shield to the ground terminal of the oscilloscope and the other end to the ground of the circuit to be measured. It is desirable to use a coaxial cable with a BNC type connector.
- The following cautions must be observed when performing a wide bandwidth measurement. It is necessary to terminate the cable with a characteristic impedance, when measuring a rapidly rising waveform or a high frequency wave.

The absence of a termination resistor will necessarily lead to a measurement error derived from ringing phenomenon in long cable. Some measuring circuits require a termination resistor equal to the characteristic impedance of the cable also be applied at the measurement point.

A BNC type termination resistor (50 Ω) is conveniently used for this purpose.

- In order to perform measurements with the circuit put it in a proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit being measured.
- The stray capacity of the shield wire must be taken into account when performing measurements with a long shield.

  Since the shield wire normally in use has a capacity of about 100 pF per meter, its effect on the circuit to be measured cannot be ignored.

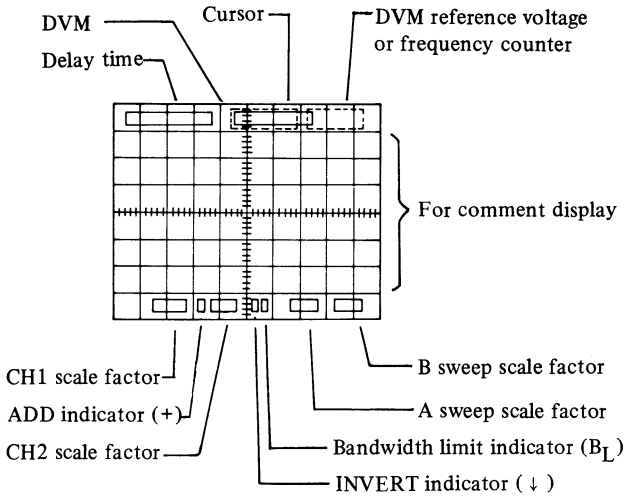
  Use a x10 probe to minimize the effect on the circuit.
- When the length of the shield wire used or when the length of the non-terminated cable reaches 1/4 the wave length or its multiples within the band of the V-1100A (1/4 the wave length is about 0.5 meter when using a coaxial cable at 100 MHz), oscillation may be caused near 5 m V/DIV range.

  This is caused by the reasonance between the externally connected high-Q inductance and the input capacity. Reduce the Q by connecting the cable or shield wire to the input connector by the resistors connected in series, or by performing measurements at another VOLTS/DIV range.

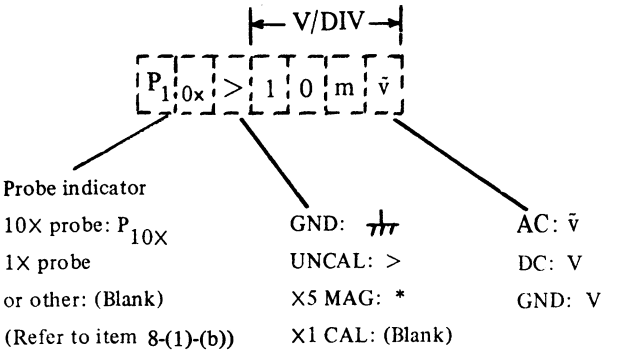
8. MEASURING PROCEDURES

(1) Readout function

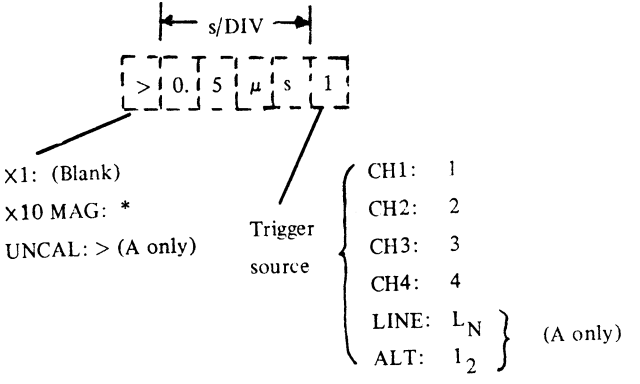
(a) Display allocation on the CRT



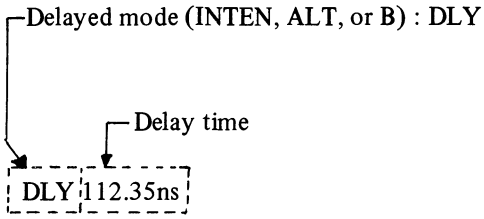
(i) Scale factor format of CH1 and CH2



(ii) Scale factor format of A and B' sweeps



(iii) Delay time



(a) The units becomes 'DIV' in the uncalibrated sweep rate.

(b) A mark greater than '>' is displayed on the left of numerals in the NORM of B trigger MODE.

(c) When the A sweep rate is faster than B, the warning 'DLY A<B' is displayed.

(iv) Measuring value of cursor and DVM

i) CURSOR mode

Function	Cursor menu	Units
(a) V	V1 and/or V2 +/–	mV (or V, mṽ, ṽ)
(b) ΔV	ΔV1 and/or ΔV2 +/–	mV (or V)
(c) ΔV%	ΔV1 and/or ΔV2 +/–	%
(d) ΔT	ΔT +/–	ns (or μs, ms, s)
(e) ΔT%	ΔT +/–	%
(f) 1/ΔT	1/ΔT	MHz (or kHz, Hz)
(g) PHASE	PHASE +/–	°

NOTE:

° (a), (b), (c) ..... V1 and V2 indicate the measuring channels, V1 for channel 1 and V2 for channel 2.

° (a) ..... The units are displayed corresponding to the input coupling, 'mṽ' or 'ṽ' for AC, 'mV' or 'V' for DC.

ii) Units in DVM mode

	DC V	AC V	FREQ
DVM measuring value	mV, V	mṽ, ṽ, dB	Hz, kHz, MHz
DVM reference voltage	mV, V	mṽ, ṽ	

NOTE:

In the REL mode of DCV function, 'Δ' is displayed at the left side of the numerals.

(b) How to apply various attenuation of the probe.

(1) Turn CURSOR/DLY POS control to the right (+) or left (-) when pressing the AUTO button of MODE buttons. For instance, when changing the scale factor from x1 to x10 at 10 mV/DIV range, turn CURSOR/DLY POS control to the right (+) while pressing AUTO button of MODE buttons. Then, the readout is changed from '10 mV/DIV' to '0.1V/DIV' and a multiplication mark 'P10x' is displayed. When changing from x10 to x1, turn CURSOR/DLY POS control to the left (-) while

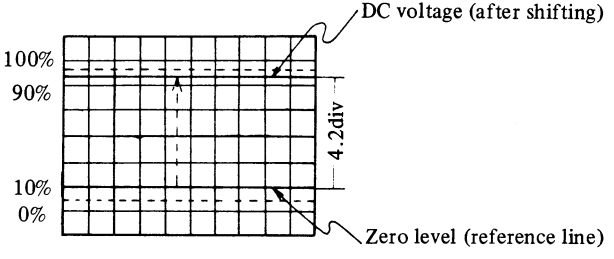
pressing the AUTO button of MODE buttons.
Then, the readout will be changed from '0.1 V/DIV' to '10 mV/DIV' and a multiplication mark 'P_{10x}' will disappear.

(2) Basic triggering method.

Set the horizontal display mode switch to A. The oscilloscope will automatically set the A mode trigger.
When the display mode switch is set to ALT, INTEN or B, A/B trigger switch alternately selects A mode trigger (main sweep) or B mode trigger (delayed sweep).
The condition being selected by MODE, SOURCE, and COUPLING is applied to either A or B the indicated mode trigger.

(3) DC voltage measurement

(a) Observing measurement (Conventional method)

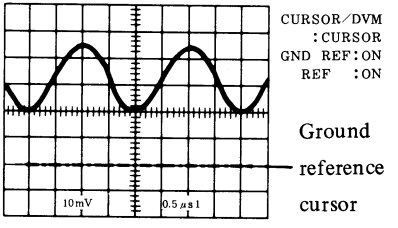


Set the AC-GND-DC switch to GND and obtain the baseline trace. Set the AC-GND-DC switch to DC and set the VOLTS/DIV switch to obtain an optimum amplitude waveform. Since the trace shifts by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/DIV, then 50 mV/DIV x 4.2 = 210 mV (However, if a 10 x probe is in use, the true value of the signal becomes 10 times the value, it will be 50 mV/DIV x 4.2 x 10 = 2.1V.)

(b) GND reference function

To activate the cursor for GND reference, the CURSOR/DVM lever must be set to the up position (CURSOR mode). Press both GND REF and REF button. A horizontal cursor indicating GND reference is always displayed on the CRT. This GND reference function

GND reference function



saves the conventional check of GND level in each measurement. The GND reference cursor interlocks with the signal and POSITION control rotation. The GND reference function is available for Channel 1 and Channel 2.

NOTE:

- When the ground level is off the screen, the GND reference cursor will blink as a warning indicator.
- In the QUAD VERT MODE and in the ALT horizontal display mode, the GND reference cursor is not display.

(c) V cursor measurement

To activate cursor measurement, the CURSOR/DVM lever must be set to the up position (CURSOR mode). Press both the GND REF and △ buttons, two horizontal cursors appear on the CRT.

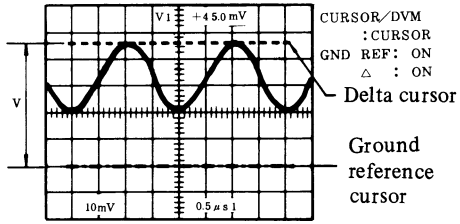
Position the reference cursor of the alternate long and short dash line by rotating the POSITION control and the delta cursor of the dotted line by turning the CURSOR control, the voltage from ground is displayed with the cursor menu "V" on the upper side of the CRT. The polarity of the voltage corresponds to the two cursor positions;

+: Delta cursor is located on the upper side of the reference cursor.

-: Delta cursor is located on the lower side of the reference cursor.

V cursor measurement

for the voltage from ground



Clockwise turn of the CURSOR control moves a cursor to the upper side; counterclockwise turn moves it to lower side. Turn the CURSOR control, holding it down for fast responce.

NOTES:

- GND reference cursor measuring function is available for Channel 1 and 2, but this function is available only for Channel 1 in the dual trace mode.

  In the QUAD VERT MODE and the ALT horizontal display mode, the GND reference cursor measuring function is not available. A word 'UNCAL' is displayed instead of a

measuring numerals in the UNCAL mode of vertical deflection factor.

In the ADD VERT MODE, the V cursor measuring function is available if Channel 1 and Channel 2 are the same range.

- When the ground level is off the screen, the GND reference cursor will blink as a warning indicator.

(d) DVM measurement

To activate the DVM function, the CURSOR/DVM lever is required to be set to the DVM side. Press the DCV and NORM buttons and CH1 input coupling to DC. The DC voltage of the signal applied to Channel 1 will be displayed on the upper side of the CRT.

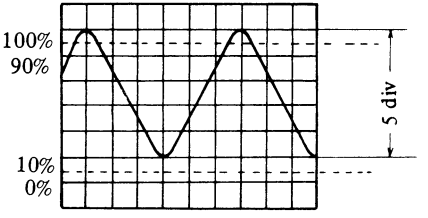
NOTE:

- When the CH1 input coupling is AC, a question mark '?' is displayed.
- DC drift may be cancelled by placing the CH1 AC-GND-DC function switch into GND.
- The DVM function is not available in the single sweep mode or for the signal exceeding the screen.

(4) AC voltage measurement

(a) Observing measurement (Conventional method)

The measuring method is same as [3] – (a) "DC voltage measurement", but there is no need of matching the zero level with the scale line. Position the baseline trace for easy observation. When magnifying a small-amplitude signal superimposed on a high DC voltage, set the AC-GND-DC switch to AC. The DC component will be blocked, therefore it is possible to increase the sensitivity. When one division represents 1 Vp-p, five divisions equal to 5 Vp-p.



(b) △V cursor measurement

To activate the cursor function, the CURSOR/DVM lever switch is required to be set to the CURSOR position. Press the V button, and two horizontal cursors appear on the CRT. Set the reference and delta cursor to a position to be measured by pressing the REF or △ button and turning the CURSOR control. Then, the voltage between the reference cursor and the delta cursor is displayed with the cursor menu "△V" on the upper side of the CRT. Pushing and turning of the CURSOR control moves it faster.

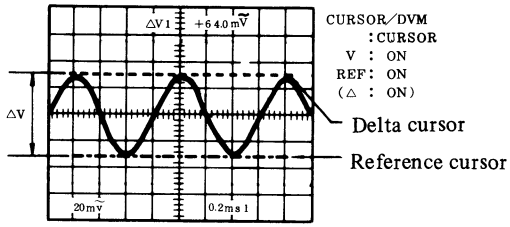
When pushing both the REF and △ buttons, the cursor function is in TRACKING mode. Two cursors move simultaneously by turning the CURSOR control.

NOTE:

△V cursor measurement is available for Channel 1 and Channel 2. But this function for the Channel 2 is available only in CH2 VERT MODE.

In the ADD VERT MODE, the V cursor measuring function is available if Channel 1 and Channel 2 are the same range.

△V% cursor measurement for an over shoot



(c) DVM measurement

To activate the DVM function, the CURSOR/DVM lever switch is set to the DVM position, and input coupling to AC. Press both the ACV and NORM button, AC voltage of the signal applied to Channel 1 is digital-displayed on the upper side of the CRT.

NOTE:

- The unit becomes 'mṽ' or 'ṽ'. When the deflection factor of the Channel 1 is uncalibrated, a word 'UNCAL' is displayed instead of the numerals.
- The ACV measurement is accurate only for a sine wave. Refer to item 8-(16).
- When a message 'OVER RANGE' is displayed, make a signal smaller in the screen by changing the VOLTS/DIV range.

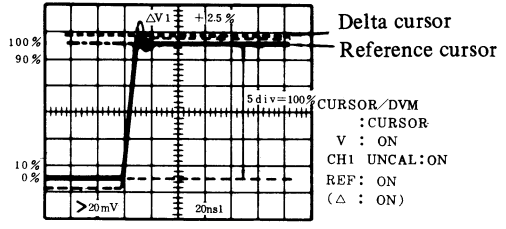
(5) Amplitude ratio measurement

(a) △V% cursor measurement

This cursor function is effective to measure the amplitude ratio which is based on 5 DIV (=100%), especially for overshoot measurement, etc. To activate the cursor function, the CURSOR/DVM lever is set to the CURSOR position. Press the V button and the horizontal cursors appear on the CRT. The amplitude of the square waveform as shown below requires a 5 DIV display by rotating the VAR control. Position the reference cursor to a 100% amplitude by pressing the REF button and turning the CURSOR control. Position the delta cursor to overshoot point by pressing the △ button and turning the CURSOR control. Then, the amplitude ratio between the reference cursor and the

delta cursor is displayed with the cursor menu "△V" on the upper side of the CRT.
Pushing and turning of the CURSOR control moves it faster.

△V% cursor measurement for an over shoot



NOTE:

- △V% cursor measurement is available for Channel 1 and Channel 2. However, this function only operates for channel 2 in the CH2 VERT MODE.

  In the ADD VERT MODE, △V% cursor measuring function is available if Channel 1 and Channel 2 are not the same range, or Channel 1 and/or Channel 2 are/is in the UNCAL mode.

(b) DVM measurement

This measurement is effective to compare the amplitudes of two signals.

Apply an input signal from a circuit to Channel 1. Press both the ACV and NORM buttons and measure in the setting. Then, push the REL buttons. This will cause to input signal to be memorized as the reference at 0 dB.

Apply an output signal from the circuit to Channel 1. The ratio of the output to the input, circuit gain, will be displayed in dB on the upper side of the CRT.
Push the NORM and REL buttons simultaneoursly. The reference voltage will be displayed on the upper right side of the CRT.

NOTE:

The REL mode measurement is not available among the different VOLTS/DIV ranges. For example, if taking the reference at 5 mV/DIV range, it can not be compared with the signal measured at 10 mV/DIV range.

(6) Frequency and period measurement

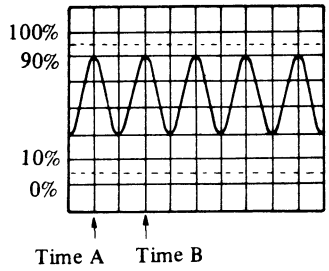
(a) Observing measurement (Conventional method)

The below illustration shows one period of time between A and B, which represents 2.0 DIV.
When the sweep time is 1 ms/DIV, the period is given by

$$1 \text{ ms/DIV} \times 2.0 = 2.0 \text{ ms}$$
$$= 2.0 \times 10^{-3} \text{s}$$

Accordingly, the frequency is

$$1/(2.0 \times 10^{-3}) = 500 \text{ Hz}$$



(b) △T cursor measurement

To activate CURSOR measurement, the CURSOR/DVM lever must be set to CURSOR.

Press the T button, and two vertical cursors appear on the CRT.

Set the reference and delta cursors so they appear on the positive or negative edge of the one period by pressing the REF or △ button and turning the CURSOR control. The time difference (△T) between the reference and delta cursors will be displayed on the upper side of the CRT.

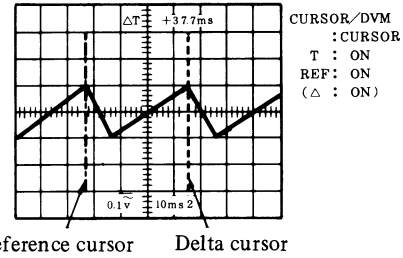
The positive or negative polarity corresponds to the two cursor positions;

+: The Delta cursor is located on the right side of the reference cursor.

-: The Delta cursor is located on the left side of the reference cursor.

Clockwise turn of the CURSOR control moves a cursor to right side; counterclockwise turn moves it to left side. Push and turn the CURSOR control moves if faster. When pushing both the REF and delta buttons, the cursor function is in TRACKING mode. Two cursors move simultaneously by turning the CURSOR control.

△T cursor measurement for a period



NOTE:

In ALT or X-Y operation of the horizontal display mode, the △T cursor measurement is not available.

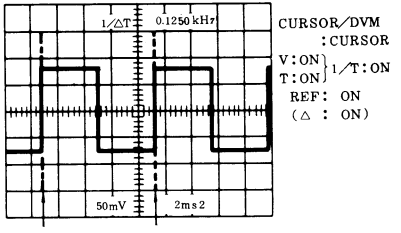
(c) 1/△T cursor measurement

To activate cursor measurement, the CURSOR/DVM lever must be set to CURSOR.

Push both the V and T buttons and two vertical cursors will appear on the CRT.

When the two cursors are superimposed at two edge points of the one period waveform by the CURSOR control, the reciprocal number of delta-time between two cursors is displayed on the upper side of the CRT. Push and turn of the CURSOR control moves it faster.

1/△T cursor measurement for frequency



Reference cursor Delta cursor

NOTE:

In ALT or X-Y operation of the horizontal display mode, the 1/△T cursor measurement is not available.

(d) DVM measurement

To activate the DVM function, the CURSOR/DVM switch must be set to DVM. Push in the FREQ button. The frequency of the Channel 1 signal digitally displayed on the upper side of the CRT.

The required amplitude to measure in the FREQ mode is more than 1 division at 0.12 kHz to 50 MHz and more than 2 divisions at 50 MHz to 99.9 MHz.

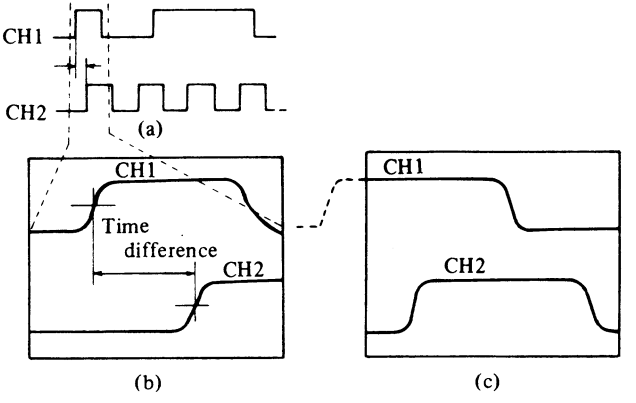
NOTE:

The frequency counter may miscount for the small duty cycle pulse and the small amplitude signal.

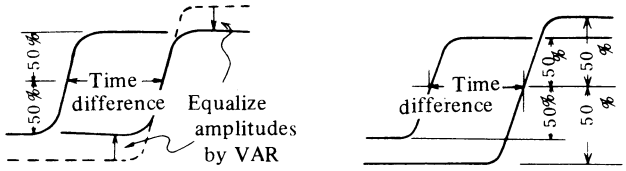
(7) Time difference measurement

(a) Observing measurement (Conventional method)

Select a "SOURCE" for the reference signal when measuring the time difference between two signals. Assume a pair of pulse trains are displayed as shown in (a), with CH1 selected as the trigger source. A signal delay appears



between CH1 and CH2 (b). The delay time is measured between the 50% amplitude points on both pulse leading edges. Accuracy of the reading will be based on the amplitude displayed for each pulse train. Therefore, the attenuators for CH1 and CH2 should be set to the same voltage settings. Care should be taken in selecting the starts with B and advances to C, D, E, F, ... and allows screen (c).



(a) Equal amplitude measuring method

(b) Suerposition measuring method

<CAUTIONS>

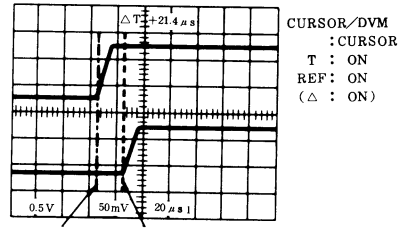
Proper circuit termination is required since high frequency components of the square wave are present. Therefore, use of correct probe or coaxial cable is necessary, with the ground lead kept as short as possible.

(b) △T cursor measurement

To activate △T cursor measurement, the CURSOR/DVM lever must be set to CURSOR.

Press the T button and two vertical cursors appear on the CRT. When the two cursors are placed at two measuring points on the waveform by the CURSOR control, the time difference (△T) between the two cursors is displayed on the upper side of the CRT.
Push and turn of the CURSOR control moves it faster.

△T cursor measurement for time difference



NOTE:
In the ALT or X-Y operation of the horizontal display mode, the △T cursor measurement is not available.

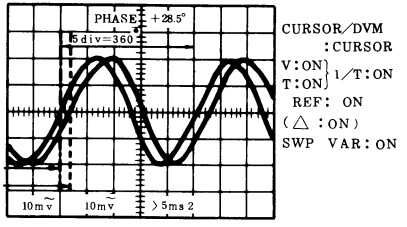
(8) PHASE cursor measurement

This cursor function is used to the measure the phase difference of two signals, whose period is set to 5 DIV (360°). To activate cursor measurement, the CURSOR/

DVM lever must be set to CURSOR. Press the T button, and two vertical cursors appear on the CRT. A one period signal shown below is set to 5 DIV by pulling and rotating the PULL SWP VAR control.

Set the two cursors at the measurement points selected on the one period waveform by pressing the REF or the △ buttons and turning the CURSOR control. The phase difference between the two cursors is displayed on the upper side of the CRT. Push and turn of the CURSOR control moves it faster.

PHASE cursor measurement



NOTE:

In the ALT or X-Y operation of the horizontal display mode, the PHASE cursor measurement is not available.

(9) Rise time and fall time measurement

(a) Observing measurement (Conventional method)

To measure the rise time, attention must be observed to measurement error. The following relationship exists among the rise time Trx of the waveform to be measured, the rise time Trs of oscilloscope, and the rise time Tro displayed on the screen.

$$Trx^2 + Trs^2 = Tro^2$$

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope (less than 3.5ns in our case), measurement error caused by the rise time of the oscilloscope can be neglected. However, if both are close each other, measurement error may be caused.

The true rise time is given by

$$Trx = \sqrt{Tro^2 - Trs^2}$$

In a circuit free from waveform distortion such as overshoot and sag, the following relationship is established between the frequency band and the rise time.

$$fc \times tr = 0.35$$

where, fc : Frequency band (Hz)

tr : Rise time (s)

The rise time and fall time are determined by the time elapsed between the 10% to 90% values of pulse width.

(b) △T cursor measurement

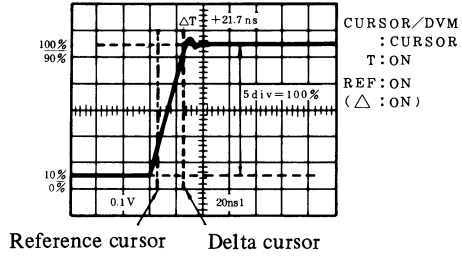
To activate cursor measurement, the CURSOR/DVM lever must be set to CURSOR.

Square waveform amplitude requires to be set to 5 DIV from 0% to 100% on the CRT as shown below by rotating the VAR control and the vertical POSITION control.

Push the REL or delta buttons and turn the CURSOR control for setting a cursor at a 10% point of the leading edge (or trailing edge) and the other cursor at a 90% point of leading edge (or trailing edge).

Then, the rise time or fall time between the reference and delta cursors is displayed on the upper side of the CRT.

△T cursor measurement for rise (fall) time



NOTE:

In ALT or X-Y operation of the horizontal display mode, the △T cursor measurement is not available.

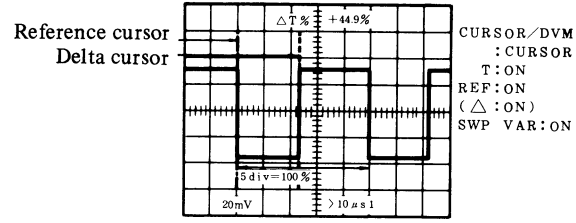
(10) △T% cursor measurement for duty cycle

To activate cursor measurement, the CURSOR/DVM lever must be set to CURSOR. Press the T button, and two vertical cursors appear on the CRT.

One period of square waveform must be set to 5 DIV, corresponding to 100%, on the CRT as shown below by pulling and rotating the PULL SWP VAR control.

Push the REL or delta buttons and turn the CURSOR control for setting the reference cursor at the leading edge and the delta cursor at the trailing edge. Then, the duty cycle between the two cursors is displayed on the upper side of the CRT.

△T% cursor measurement for duty cycle



NOTE:
In ALT or X-Y operation of the horizontal display mode, the △T% cursor measurement is not available.

(11) Single-shot signal measurement

Single sweep is conveniently used in signal photography and waveform measurements of irregular repetition (such as impulse waves, sound waves, switching noise).

[Test measurement]

Press the NORM button for the A trigger MODE. Apply a signal or repetitive waveform equivalent to a signal to a channel, and trigger it by rotating the LEVEL control. Then push the SGL button and confirm that single sweep is executed.

Remove the vertical axis input signal by setting the AC/GND/DC switch to GND. Press the SGL button and confirm that the READY indicator lights up. Apply the signal to be observed. After the single sweep, the READY indicator goes off.

Since single sweep is executed by changing the trigger level, even if no signal is supplied, do not rotate the trigger LEVEL control after pushing the SGL button.

(12) Triggering method

(a) Alternate triggering

Press the buttons CH1 and CH2 of SOURCE at the same time. When both signals of Channels 1 and 2 which are out of sync, a stabilized alternate waveform is obtained in the alternate triggering (ALT) mode. Both the LEDs CH1 and CH2 light up.

NOTE:
Trigger coupling is automatically set to the DC mode in the alternate triggering mode.
When the VERT MODE setting is changed from the ALT mode to the other modes, the trigger source is automatically set as follows.

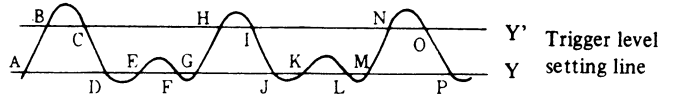
VERT MODE	SOURCE
ALT → CH1	CH1
ALT → CH2	CH2
ALT → CHOP	CH1
ALT → ADD	CH1

(b) Triggering of complexed waveform

In the case shown in Fig. (a) where waveforms greatly different in amplitude, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected by line Y, two wave will appear,

one starting with A and advancing to B, C, D, E, F, ... and the other starting with E and advancing to F, G, H, I . . . . ., will appear alternately on the screen. They will be doubled as shown in Fig. (b), for which no triggering can be taken.

In such a case, rotate the LEVEL control clockwise until the trigger level comes to Y' line. Then the waveform on the screen becomes the one as shown in Fig. (c) which starts with B and advances to C, D, E, F, ... and allows synchronization.



(a) Signal waveform

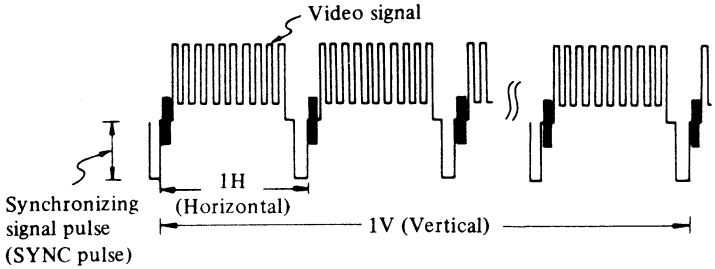
(b) When the trigger setting level is Y

(c) When the trigger setting level is Y'

Synchronization of complexed waveform

(c) TV trigger

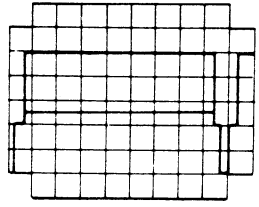
① On the image waveform of TV



In video work complexed signals containing video signal and sync signal are often measured.

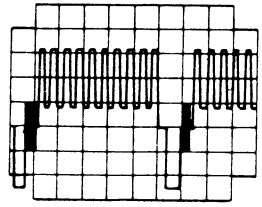
② Operation

To observe vertical signal



TRIG MODE: TV-V

To observe horizontal signal



TRIG MODE: TV-H

(NOTE) This oscilloscope synchronizes with only (-) synchronizing signal.

Since the sync pulse of video signal is generally (-), SLOPE is automatically set to (-) by setting COUPLING to TV-V or TV-H.

Trigger level operation is not required in the TV mode.

NOTE:

TV mode auto-triggering is not available for (+) sync whose video signal is inverted.

(13) Operating procedure of delayed sweep

Delayed sweep is used to magnify and observe any protion of a complexed waveform in the horizontal direction. There are two kinds of delay sweeps, one is AUTO delay sweep (continuous delay sweep) and the other NORM delay sweep (triggering delay sweep). These are selected by the B trigger MODE switch. Usually, the instrument is used in AUTO mode.

Although the AUTO delay sweep is easy to operate, the maximum magnification factor is limited to a few hundred times by delay jitter. On the other hand, since no jitter is generated in NORM delay sweep, this sweep has the feature to increase the magnification factor. The magnification factor is limited by the brightness of CRT to a few thousand times.

For setting of delay time, the CURSOR/ DVM lever must be set down (DLY POS mode).

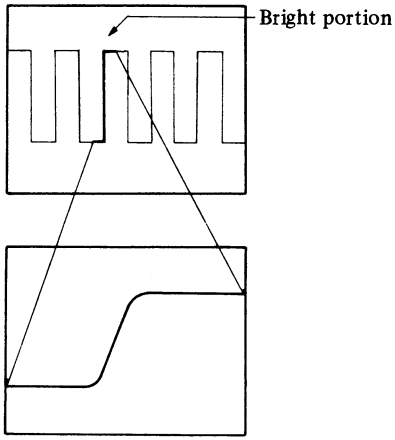
(a) AUTO (Continuous delay sweep)

Effect triggering by A sweep and set the switches as follows.

Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/ DIV
A/B	: B
B TRIG MODE	: AUTO

The high brightness portion of A sweep will appear (if not, adjust INTENSITY △ B).

Turn the DLY POS control, and the high brightness portion will move continuously. Push and turn of the DLY POS control moves if faster. Bring this high brightness portion to the position desired to be magnified. Then, the high brightness portion is magnified to occupy the full area of the screen. (When the horizontal display mode is set to INTEN, it is required to change the mode from INTEN to B.)



The time from a starting point of A sweep to that of the brightness portion is displayed on the upper side of the CRT. The sweep time is given by the B TIME/DIV.

NOTE:

The LEDs of SOURCE and COUPLING for B trigger do not come on in the AUTO mode of B trigger, since the SOURCE and COUPLING are of no effect.

In the AUTO mode of B trigger, the startpoint of B sweep is set by the DLY POS control.

(b) NORM (Triggering delay sweep)

Effect triggering by A sweep and set the controls as follows.

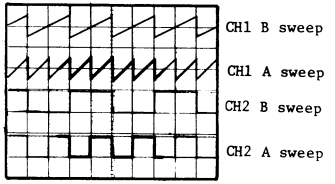
Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/DIV
A/B	: B
B TRIGGER MODE	: NORM
SLOPE	: Select (+) or (-) by the SLOPE switch.

Rotate the B trigger LEVEL control, the high brightness portion of A sweep appears. (This state is called the B-triggered state.) Rotate the DLY POS control, the high brightness portion moves to the next peak. Bring this high brightness portion to the position desired to be magnified by using DLY POS control and B trigger LEVEL. Then the high brightness portion is magnified to occupy the full area of the screen. (When the display mode is set to INTEN, it is required to change the mode from INTEN to B.)

The sweep time is given by the B TIME/DIV. In the NORM mode, a mark greater than '>' is displayed or the left side of the delay time numerals.

(c) ALT sweep

The ALT sweep function alternately displays main sweep (A) and delayed sweep (B) on the CRT.
The below figure shows the display in the ALT sweep mode.



A sawtooth waveform is applied to Channel 1 and a square waveform to Channel 2 in this case.
The B sweep trace can be moved up to about four divisions above the A sweep trace for the convenience of observation by the A/B SWP SEP control.
By pressing the QUAD button in the ALT sweep mode, four more traces, eight traces in total, appear on the CRT. The later four traces are A and B sweeps of Channels 3 and 4.

NOTE:
Since traces are alternately displayed in the ALT sweep mode, flicker can occur in the slow sweep rate.
To avoid this, set the TIME/DIV switch to the 0.2 ms/DIV or higher.

(d) Delay sweep in TV mode

i) In the TV-V mode for the A trigger COUPLING, the B trigger COUPLING is automatically set to TV-H.
The B COUPLING cannot be set to TV-H independent of A trigger.
ii) In the TV-H mode of A trigger, the B trigger MODE is automatically set to AUTO.

(14) Comment display

(a) Display specifications

i) Number of line: 1 line (Can be displayed in any specified vertical locations of 6-line on the CRT)
Number of characters: 30 characters maximum
Kind of characters:
Figures: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9
Letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, and Z

Symbols and others:

⬚ (space), · (period), :, –, ↑, ↓, ←, →, /, +, <, >, m, n, u, k, s, z, %, △ (delta), d, i, v, ° (degree), ∘, and ∗

ii) Display location

The CRT provides eight lines for display, however, available lines for the comment display are six excluding the top and bottom lines, The comment can be set in one line among the six lines.

The top and bottom lines are respectively used to display the measured values and set values.

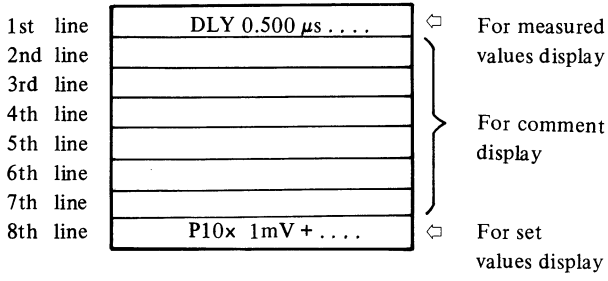


Fig. 8-1 Comment display location

(b) Comment display method

i) Display setting . . . . . CHR

In the TRIGGER mode, press both the A and B buttons simultaneously to set the comment display mode, then a blinking cursor will appear on the CRT.

ii) Cursor

A cursor "–" (underline) blinks to show the next display/input position.

iii) Figures and · (period) display

Figures and period can be displayed by the 0 to 9, and · buttons. When the button is pressed, the selected figure or period is registered as a comment, and the cursor is shifted right by one column.

Example:

198–
↑ Cursor Press the button 4.

1984– - - - - - - Figure 4 will be displayed.

iv) Letters symbols, etc.

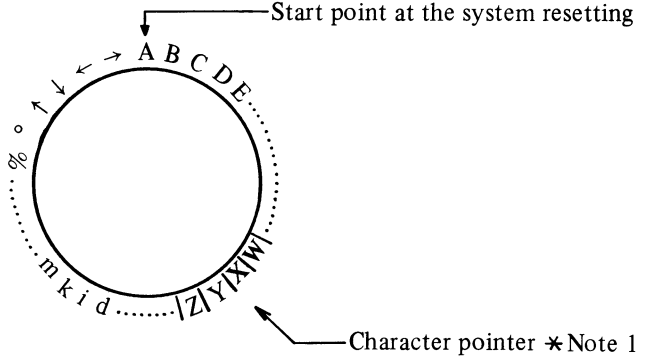
Letters, symbols, etc. can be selected and displayed by the → or ← button. When on of the buttons continues to be pressed, character is changed one after another.

When [→] is pressed, displays are made in the sequence of A, B, C. . . . When the last character "→" is displayed, the first character "A" will replace "→" in the next sequence. When [←] is pressed, displays are made in the reverse sequence of → , ← , ↓ . . . . When A is displayed, [→] will be next displayed.

Character display sequence is shown below:

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, (space), d, i, k, m, n, o, s, v, z, μ, △ (delta), +, -, ✱, /, :, <, >, %, ° (degree), ↑, ↓, ←, →.

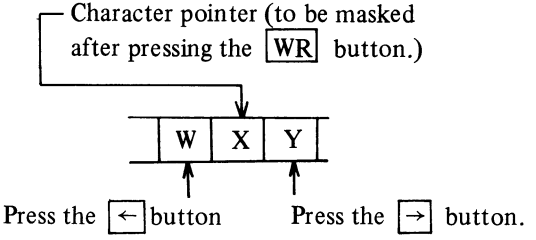
After displaying a letter or symbol by the [→] or [←] button, press the [WR] button to register the selected character as a comment and to shift the cursor right by one column.



✱NOTE 1:

Character pointer means a character which is to be registered when pressing the [WR] button.

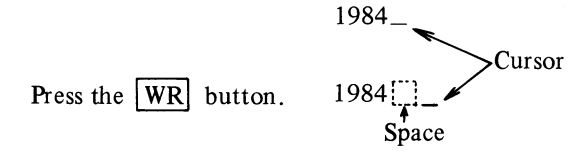
For example, when selecting a letter after registering letter X, press the [→] button to select Y or press the [←] to select W. In this time, X is masked. To select X again, press the [→] or [←] button.



v) Space display

To display a space by a method other than that of Item (b)-iv) , press the [WR] button before displaying a character.

Example:

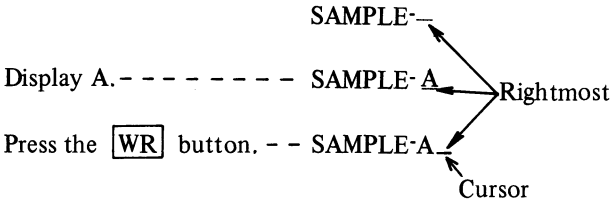


vi) When the cursor is on the rightmost position

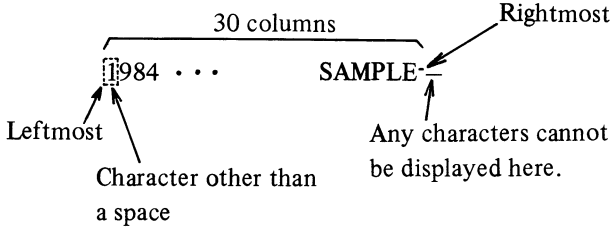
In the case that the cursor is on the rightmost position, display a character on the rightmost position, and the whole comment is shifted left by one column to register the character. (See Example 1.)

However, if a character other than a space is on the leftmost position, any characters cannot be displayed. (See Example 2.)

[Example 1:]



[Example 2:]



vii) Comment display location shift

Comment can be respectively shifted down by one line, and right and left by one column by the [↓], [LOC] and [→], and [LOC] and [←] buttons.

When the comment is shifted to the 7th line, it is next shifted to the 2nd line.

When the cursor is on the rightmost position, the comment cannot be shifted right.

When the top character of the comment is on the leftmost position, the comment also cannot be shifted left.

viii) Comment correction

Press the [BS] button to shift the cursor left by one column and to delete the character presented at that new position of the cursor, and then display a desired character. (Excluding the case that the cursor is on the leftmost position)

ix) Character continuous change

Letters, symbols, etc. can be continuously changed one after another by holding down the [→] or [←] button. As for other character display, select and display character one by one.

x) Confirmation of comment display

Since buttons in the TRIGGER/CHARACTER section do not light up when they are pressed, confirm that the correct comment is displayed on the CRT.

xi) End of comment display mode

Press the [END] button to terminate the comment display mode, to set the TRIGGER mode and to display A-trigger setting conditions.

(c) Comment storage and system resetting

The last comment and its display location is registered until the system resetting is performed. (To perform the system resetting, holding down the AUTO button, pull the PULL INITIAL SET (DLY POSI/CURSOR) control.)

★ System resetting is as follows:

① Comment display:
- ○ Comment: Nothing
- ○ Cursor: Sixth line, 21st column (for date display)
- ○ Letter selection: Begins with A

② Trigger setting:

	A-trigger	B-trigger
○ SLOPE:	+	——
○ MODE:	AUTO	AUTO
○ SOURCE:	CH1	——
○ COUPLING:	AC	——
○ A/B	A	——

③ Probe selection: x10

(d) Comment display procedures

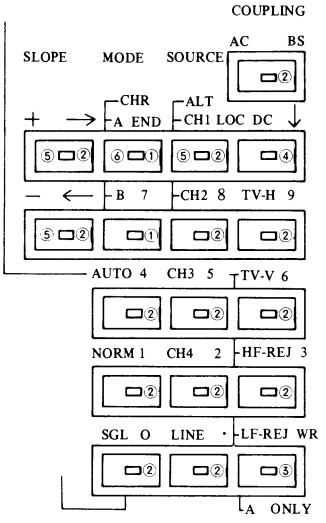


Fig. 8-2 Buttons for comment display (TRIGGER/CHARACTER section)

(Figures on each button are correspond to those of the procedures shown right.)

START

① Press both [A] and [B] buttons simultaneously.

② Display characters by [0] to [9], [·], [→], and [←] buttons.
For display correction, press the [BS] button.

③ Register letters, symbols, etc. displayed by pressing the [WR] button.

④ Move the comment to the desired line by pressing the [↓] button.

⑤ Shift the comment to the desired column by pressing the [LOC] and [→], or [LOC] and [←] buttons.

⑥ Press the [END] button to terminate the comment display mode and to set the TRIGGER mode.

END

(e) Comment display example

A comment display example according to the procedures described in (d) is shown below:

Desired comment: 1984/12/20 SAMPLE-A

i) Press both [A] and [B] buttons simultaneously. (Comment display mode start)

ii) Press the [1], [9], [8], and [4] buttons.

iii) Select / by pressing the [→] button, and press the [WR] button.

iv) Press the [1] and [2] buttons.

v) Press the [←] button once to select /, and press the [WR] button.

vi) Press the [2] and [0] button.

vii) Press the [WR] button once to display a space.

viii) Select S by pressing the [→] button, and press the [WR] button. Display and register A, M, P, L, and E by the same procedure as S.

ix) Press the [↓] button until the comment is moved to the desired line.

x) Holding down the [LOC] button, press the [→] button

xi) until the comment is shifted to the desired position.

Press the [END] button.

Refer to Fig. 8-3 "Example of comment display".

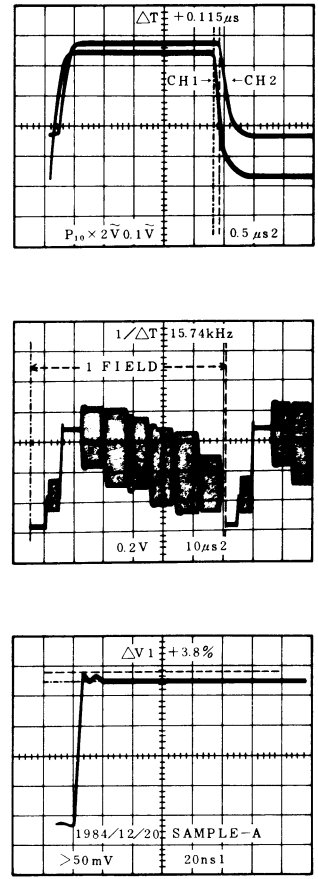


Fig. 8-3 Example of comment display

(15) Initial setting

In case of abnormal AC power or something the microprocessor built in the oscilloscope can malfunction pulling the CURSOR/DLY POS (PULL INITIAL SET) control out makes the microprocessor initial set condition or turning Power switch off and on will restore operation.

System reset function

All the functions of the oscilloscope can be returned to initial setting by the system reset function. Pull the INITIAL SET control as pushing the AUTO button of TRIGGER MODE so that the function is executed.

★ **System resetting is as follows:**

① Comment display:
- o Comment: Nothing
- o Cursor: Sixth line, 21st column (for date display)
- o Letter selection: Begins with A

② Trigger setting:

	A-trigger	B-trigger
o SLOPE:	+	———
o MODE:	AUTO	AUTO
o SOURCE:	CH1	———
o COUPLING:	AC	———
o A/B	A	———

③ Probe selection: x10

(16) List of cursor functions

	Function	OPERATION											
		CSR DVM	GND REF	V	T	REF	△	Others	Control for cursor positioning	Cursor menu	Units	Measurement and display	Inhibiting setting
1	GND REF	Up	ON	OFF	OFF	ON	OFF		CH1 Position or CH2 Position		–	Displays GND REF cursor.	(V. MODE) QUAD (H. MODE) ALT See NOTE 4.
2	V	Up	ON	OFF	OFF	OFF	ON		CH1 Position or CH2 Position CURSOR	V1 (V2)	mV V mṽ ṽ	Measures the voltage with respect to GND cursor.	
3	△V	Up	OFF	ON	OFF	*	*		CURSOR	△V1 (△V2)	mV V	Measures the voltage between delta sursor and REF cursor.	(V. MODE) See NOTE 4.
4	△V%	Up	OFF	ON	OFF	*	*	CH1 VAR or CH2 VAR	CURSOR	△V1 (△V2)	%	$\frac{\triangle - REF}{5\ div}$ × 100 [%] (5 div = 100%)	
5	△T	Up	OFF	OFF	ON	*	*		CURSOR	△T	ns μs ms s	Measures the time between delta cursor and REF cursor	(H. MODE) ALT X-Y
6	△T%	Up	OFF	OFF	ON	*	*	SWP VAR	CURSOR	△T	%	$\frac{\triangle - REF}{5\ div}$ × 100 [%] (5 div = 100%)	
7	1/△T	Up	OFF	ON	ON	*	*		CURSOR	1/△T	Hz kHz MHz	Measures the reciprocal number of delta time between two cursors.	
8	PHASE	Up	OFF	ON	ON	*	*	SWP VAR	CURSOR	PHASE	°	$\frac{\triangle - REF}{5\ div}$ ×360° (5 div=360°)	

NOTE:

(1) *: select the REF and △ buttons corresponding to the cursor to be moved.

(2) Cursor menus V1 and △V1 are for Channel 1, and V2 and △V2 for Channel 2.

(3) When any of the GND REF, V, T buttons is not depressed, no cursor appears.
In the other combinations which is not shown in the list, a question mark '?' is displayed.

(4) In the ADD VERT MODE, ("V^1_2" is displayed for cursor menu.)

① When CH1 and CH2 are the same range, GND REF, V, and △V cursor measurement are available.

② When the ranges of CH1 and CH2 are different,

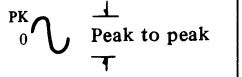
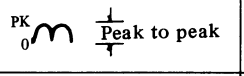
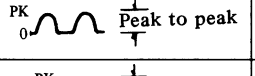
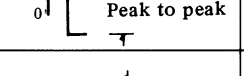
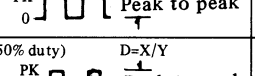
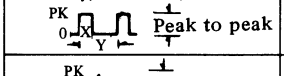
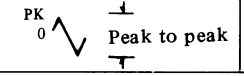
GND REF	: available
V	: disabled, " ? " is displayed.
△V	: percentage is displayed.

③ When CH1 and/or CH2 are/is in the UNCAL mode,

GND REF	: available
V	: disabled, "UNCAL" is displayed.
△V	: percentage is displayed.

(17) DVM·ACV mode measurement

In the DVM ACV measurement mode, V-1100A measures the average of the signal and displays r.m.s. for a sinewave signal. Therefore, signals except a sinewave are not measured accurately.
The relationships of some signals except a sinewave and its displayed numerals are shown below.

Input signal	Display	R.M.S.	Peak to peak	0 to peak	Average
	1.00	1.000	2.828	1.414	0.900
	1.00	1.000	1.414	1.414	0.900
	1.00	1.414	2.828	2.828	0.900
	1.00	0.900	1.800	0.900	0.900
	1.00	1.272	1.800	1.800	0.900
	1.00	0.9D½	0.9/D	0.9/D	0.9/D
	1.00	1.038	3.600	1.800	0.900

9. SPECIFICATIONS

- **CRT**

Configuration and useful screen	6-inch rectangular screen with internal graticule; 8 x 10 DIV (1 DIV = 1 cm), marking for measurement of rise time.
Accelerating potential	18 kV
External intensity modulation	DC to 3.5 MHz, maximum input voltage 20V (DC + peak AC)
Trace rotation	Present
Scale illumination	Variable

- **VERTICAL DEFLECTION**

Sensitivity	<CH1 and CH2> 5 mV to 5 V/DIV In 10 calibrated steps ±2% (at +10 to 35°C), x 5 1 mV/DIV, 2 mV/DIV ±4%, continuous variable control between steps at least 1:2.5 (with UNCAL displayed) <CH3 and CH4> 0.1 V/DIV, 0.5 V/DIV ±2% (at +10°C to 35°C)
Bandwidth	<CH1 and CH2> DC to 100 MHz (-3 dB) reference 8 division (bandwidth may be limited to 20 MHz by bandwidth limit switch) DC to 15 MHz (-3 dB) reference 8 division at 5 x magnification. <CH3 and CH4> DC to 100 MHz (-3 dB), reference 8 division
Rise time	3.5 ns, 24 ns at x5 magnification
Delay line	Permits viewing leading edge of displayed waveform.
Input coupling	<CH1 and CH2> AC-GND-DC, <CH3 and CH4> AC-DC
Input impedance	Direct: 1 MΩ approx. 28 pF using probe: 10 MΩ, approx. 12 pF

Maximum input voltage 400 V (DC + peak AC at 1 kHz)

Display modes CH1, CH2, (normal or invert) ALT, CHOP (approx. 250 kHz), ADD, QUAD

Quad mode Permits positioning independently

Polarity switching + or - (CH2 only)

X-Y operation CH1: X axis, CH2: Y axis, Sensitivity: 5 mV/div to 5 V/div (1 mV/div at x5 magnification bandwidth: DC to 2 MHz (-3 dB), phase error 3° or less from DC to 1 MHz.

Dynamic range 8 DIV or more

Common-mode rejection ratio At least 20 dB at 20 MHz

- **HORIZONTAL DEFLECTION**

Time Base A 20 ns/div to 0.5 s/div in 23 calibrated steps, 1-2-5 sequence.
x10 magnifier fastest sweep rate to 2 ns/DIV. Uncalibrated continuous control between steps 1: <2.5.

Time base B 20 ns/div to 50 ms/div in 20 calibrated steps, 1-2-5 sequence.
x10 magnifier fastest sweep rate to 2 ns/DIV.

Accuracy ±2% or less (at +10°C to 35°C). Additional error for magnifier ±2%

Display modes A only, Alternate, A intensified by B, B Delayed

Delay time jitter Better than 1:20,000

- **TRIGGER A AND B**

A trigger modes Automatic, Normal (For signals below 30 Hz), Single sweep, TV-V, TV-H

A trigger source A : CH1, CH2, CH3, CH4, ALT (CH1, CH2), LINE

A trigger sensitivity

	DC to 20 MHz	20 MHz to 100 MHz
CH1 and CH2	0.3 div	1.5 div
CH3 and CH4	0.5 div	1.5 div

A trigger coupling	AC, HF Rej, LF Rej, DC
A trigger slope	+ or -
A trigger variable holdoff	Adjustable control permits a stable triggering of repetitive complex waveform
B trigger modes	Automatic, Normal (CH1, CH2, CH3, and CH4)
B trigger source	CH1, CH2, CH3, CH4
B trigger couple	AC, DC
B trigger slope	+ or -
TV trigger	(-) sync pulse more than 1 div

- **READOUT FUNCTION**

Panel setting displays	Vertical axis : V/DIV (CH1 and CH2 only), INVERT, ADD, BW LIMIT 20 MHz, UNCAL, MAG (converted value), Input coupling (CH1 and CH2 only) Sweep rate : S/DIV, UNCAL, MAG (converted value) Others : Delay time, Trigger source
Cursor readout functions	V : $\triangle$ – GND $\triangle$V : $\triangle$ – REF $\triangle V\% : \frac{\triangle - REF}{5\ div} \times 100\ [\%]$ $\triangle$T : $\triangle$ – REF 1/$\triangle$T : $\triangle$ – REF $\triangle T\% : \frac{\triangle - REF}{5\ div} \times 100\ [\%]$ PHASE : Degree (5 div = 360°)
GND, REF function	Displays GND reference cursor of CH1 and CH2
Digital measurement	CH1 only

Functions

DVM DC Voltage : Corresponds to the screen
AC Voltage : 50 Hz to 10 MHz [Conversion method : Average measurement (rms value is calibrated for a sinewave signal)]

Frequency Counter : 0.12 kHz to 50 MHz more than 1 div
50 MHz to 99.9 MHz more than 2 div

Specification of Digital Measurement Function

DC Volts Meter (CH1 only)

Volts/div switch	Full Scale	Resolution	Accuracy (x1 Probe)
5 mV/div to 20 mV/div	±199.9 mV	$\frac{1}{2000}$ of F. S	± (1% of reading + 0.25% of F.S)
50 mV/div to 0.2 V/div	±1.999 V		± (2% of reading + 0.25% of F.S)
0.5 V/div to 2 V/div	± 19.99 V		± (2% of reading + 0.25% of F.S)
5 V/div	± 49.97 V		± (2% of reading + 0.25% of F.S)

* Measures average DC voltage on CH1 input.

** Input coupling switch should be set to DC position.

*** Additional error ±1.5% when using x10 probe.

**** Although resolution for 5V/div range is 0.025V, the least significant digit is displayed up to second decimal place, 0.00V, 0.02V, 0.05V or 0.07V.

AC Volts Meter (CH1 only)

	Full Scale	Accuracy (x1 Probe)
All ranges of CH1 Volts/div	Volts/div x 2.828 (≦8 div)	± (2% of reading + 1.8% F.S) at 1 kHz to 1 MHz ± (5% of reading + 1.8% F.S) at 50 Hz to 5 MHz ± (10% of reading + 1.8% F.S) at 5 MHz to 10 MHz

* Measures sinewave r.m.s. voltage on CH1 input.

** Additional error ±1.5% when using x10 probe.

*** Over 2 divisions signals are recommended for ACV measurement.

Frequency Counter (CH1 only)

Frequency	Display Format (Max. Frequency)	Resolution	Accuracy	Required Amplitude
f< 10 kHz	9.96 kHz	0.04 kHz		1 div
10 kHz≦f< 100 kHz	99.9 kHz	0.1 kHz	1 LSD	1 div
100 kHz≦f< 1 MHz	999 kHz	1 kHz	1 LSD	1 div
1 MHz≦f< 10 MHz	9.99 MHz	10 kHz	1 LSD	1 div
10 MHz≦f< 50 MHz	99.9 MHz	100 kHz	1 LSD	1 div
50 MHz≦f< 100 MHz	99.9 MHz	100 kHz	1 LSD	2 div
100 MHz≦f<	Over Range			

** Sinewave or 50% duty facter pulse.

- **Comment display function**

Number of line: 1 line

Number of Characters: 30 characters max.

Kind of characters:

Figures: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9

Letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, and Z

Symbols and others:

(space), · (period), :, –, ↑, ↓, ←, →, /, +, <, >, m, n, u, k, s, z, %, △ (delta), d, i, v, ° (degree), o, and ✳

Available lines for comment display:

Six lines excluding the top and bottom lines