MODEL VC-6041(B)

DIGITAL STORAGE OSCILLOSCOPE

OPERATION MANUAL

Hitachi Denshi, Ltd.

CONTENTS

NOTES

1. This instrument should be adjusted at an ambient temperature of +20°C (+68°F) for best overall accuracy.
   Allow at least 15 minutes warmup before proceeding.
2. Polyvinyl chloride (PVC) film is attached on the enclosure and the front panel of the oscilloscope to protect the metal surface. If the PVC film is damaged by scratches, remove it.
3. To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.
4. For safety operation of the instrument chassis and cabinet, be sure to connect the ground lead of the GND (ground) terminal to the earth ground, if a two-wire AC power system is used.
   Be sure to ground the system, otherwise a shock hazard may result.

1. GENERAL

The Hitachi VC-6041 is the Digital Storage Oscilloscope combined with the functions of conventional oscilloscope. The VC-6041 facilitates the observation of a transient signal, ensures the same quality of intensity for a magnified sweep, and feeds out the stored data.

2. FEATURES

(1) Maximum sampling rate of 40 MHz
(2) Stores repeated waveforms with frequencies up to 40 MHz
(3) Stores transient event with frequencies up to 10 MHz
(4) Memory capacity of 4k words per channel
(5) Up to two waveforms can be saved
(6) Up to two saved waveforms can be displayed
(7) Record mode is provided for external output of stored waveform when PLOT mode is selected
(8) Roll mode convenient for low speed waveform observations
(9) Cursor function
(10) Signal averaging up to 256 sweeps
(11) Digital output available through the General Purpose Interface Bus (GPIB)
(12) Usable as a conventional dual-trace 40 MHz oscilloscope

3. COMPOSITION

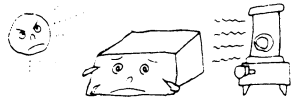
(1)	VC-6041	1 set
(2)	Accessories	
	Spare fuse	1 pc.
	AT-10AKI. 5 probes	2 pcs.
	Operation manual	1 copy
	Dustproof cover	1 pc.

4. PRECAUTIONS

Precautions to be observed to lengthen the service life of this instrument.

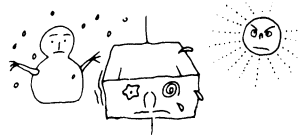
INSTALLATION SITE

- Avoid installing instrument in an extremely hot or cold place.
  - Avoid placing this instrument in a place exposed to sunlight for a long period of time, in a closed car in midsummer, or in the room near a heating device.
  - Do not use instrument that has been left outdoors on a cold winter day.
  - The operating ambient temperature is 0 to 40°C (32°F to 104°F).

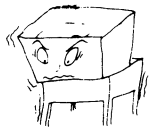


  - Avoid moving the instrument rapidly from a hot place to cold place and vice versa, or condensation may form inside the instrument.
- Keep the instrument away from damp air, water, and dust. Unexpected trouble may be caused when the instrument is placed in a damp or dusty place.

The operating ambient humidity is 35 to 85%.
Since an accidental intrusion of water may also cause troubles, do not place a water-filled container such as a vase on the instrument.



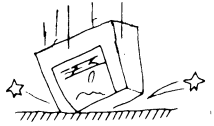
- Do not place the instrument in a place where vibration is strong. Avoid using the instrument at a place vibrating violently. Since this is a precision instrument, excessively strong vibration may cause damage.
- Do not bring a magnet close to the instrument or do not use the instrument near an equipment generating strong magnetic force.



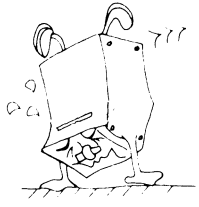
HANDLING

- Do not place a heavy object on the instrument.
- Do not block the ventilation holes.

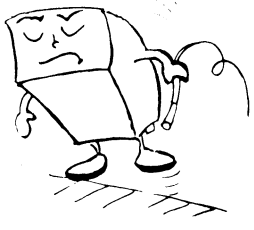
- Do not apply a heavy shock to the instrument.



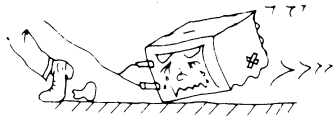
- Do not insert a wire, pin, etc. through the ventilation hole.
- Do not try to turn the instrument upside down. Otherwise knobs may be broken.



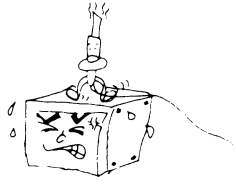
- Do not let the instrument stand in upright position leaving coaxial cable with BNC connector connected to the connector on the rear panel. Otherwise, the cable may be damaged.



- Do not drag the set, leaving the probe attached to it.
- Press the handle at both pivot points and turn it to the desired position.

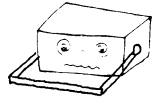


- Do not leave a hot soldering iron on the cabinet or the screen.



When operation is faulty

Recheck the operating procedure and if problem persists, contact a nearby Hitachi Denshi service station or agent.



Care and repair

- Removal of stain from the case
  - When the outside of the case is stained, remove the stain by first wiping it lightly with a cloth moistened with neutral washing agent and then wipe the surface with a dry cloth.
- Never use strongly volatile agent such as benzine and thinner.

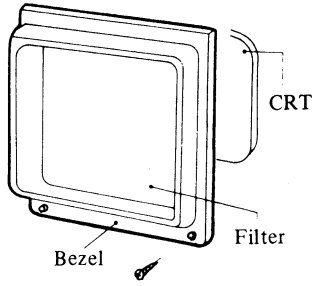
- When dust has accumulated inside, remove it by using dry brush, or by using a blower, etc.

NOTE: When opening the case, pull out the power supply plug beforehand without fail.
When cleaning the inside, ensure that no electricity remains in the capacitors of the power supply circuit.

- Removal of Stains from CRT face
  - Stained surface of CRT screen tends to cause measuring errors. The screen face become accessed when the bezel is removed.

Remove the stains on CRT face and filter by using a clean and soft cloth, paying attention not to impair them.
When the stain is extremely heavy, wash them with neutral washing agent and then leave them stand until the moisture is removed naturally.

- If the screen is installed while it is moistened, waterrings may form and the waveform may be blurred and become uneasy for observation. Pay attention not to leave finger prints on it.



Operation precautions

- Check the line voltage.
  The operating voltage range of this oscilloscope is as shown in the Table 4-1. Check the line voltage without fail before turning on the power switch. When it is intended to use the oscilloscope on voltage other than specified, reset the line voltage selector. The voltage selector can be accessed by removing the cap of the fuse holder.

When using this oscilloscope on voltages other than specified, contact a nearby Hitachi Denshi service station or agent for replacing the power supply cable and the fuse.

Table 4-1. Operating voltage range

Rating	Operating voltage range (50/60Hz)
100V AC	90V to 110V AC
120V AC	108V to 132V AC
220V AC	198V to 242V AC
240V AC	216V to 264V AC

- Use only specified fuses
  In order to protect the circuit against overcurrent, a 5A (for 100V AC or 120V AC) or 3A (for 220V AC or 240V AC) is used on the primary side of the power supply. When this fuse is blown out, check thoroughly the cause, repair any faulty point present, and then replace with the specified. Otherwise, fault may be caused or danger may be invited.
  (Particularly, do not use a fuse other than the specified in current capacity and in length.) The standards of the fuses are as follows.

Table 4-2. Fuse

	Shape (Diameter x length)mm	JIS number
5A	6.35 x 31.8	MF61NM250V 5A AC
3A	6.35 x 31.8	MF61NM250V 3A AC

- Do not increase the intensity excessively
  Do not increase the intensity of the spot and trace excessively. Your eyes may be strained and the fluorescent surface of CRT may be burnt.

- Do not apply an excessive voltage.
  The input withstand voltage of each input connector and probe input is as follows. Never apply a voltage higher than specified.

INPUT without probe	300V (DC + AC peak at 1 kHz)
INPUT with probe	600V (DC + AC peak at 1 kHz)
EXT TRIG INPUT	300V (DC + AC peak at 1 kHz)
EXT BLANKING	30V (DC + AC peak)

- Check the push buttons
  Check that one of the switches [NON STORE] [NORM] [ROLL] [AVG] or [HOLD] is always set ON.
  Before measurement with the equipment, make sure that the proper switch from the above is selected ON. If all the swithes are set OFF, the equipment is set to a kind of stand-by mode, and does not operate. The normal operation mode is recovered when one of the above switches is selected.

5. DESCRIPTION OF PANELS AND CONTROLS

The controls, connectors, and indicators are arranged for easy use. In the NON STORE mode, the VC-6041 operates as a conventional oscilloscope. The front panel consists of section A that selects measurement condition and section B that selects operating mode.

Fig. 5-1 Front panel/Section A

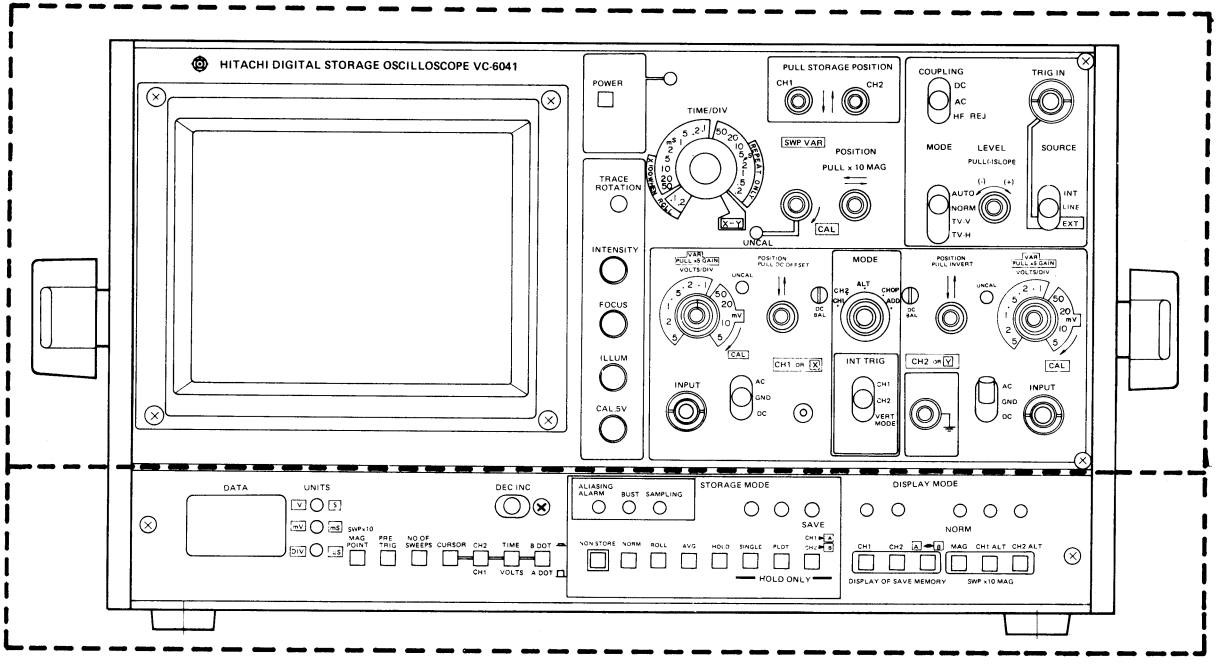


Fig. 5-2 Front panel/Section B

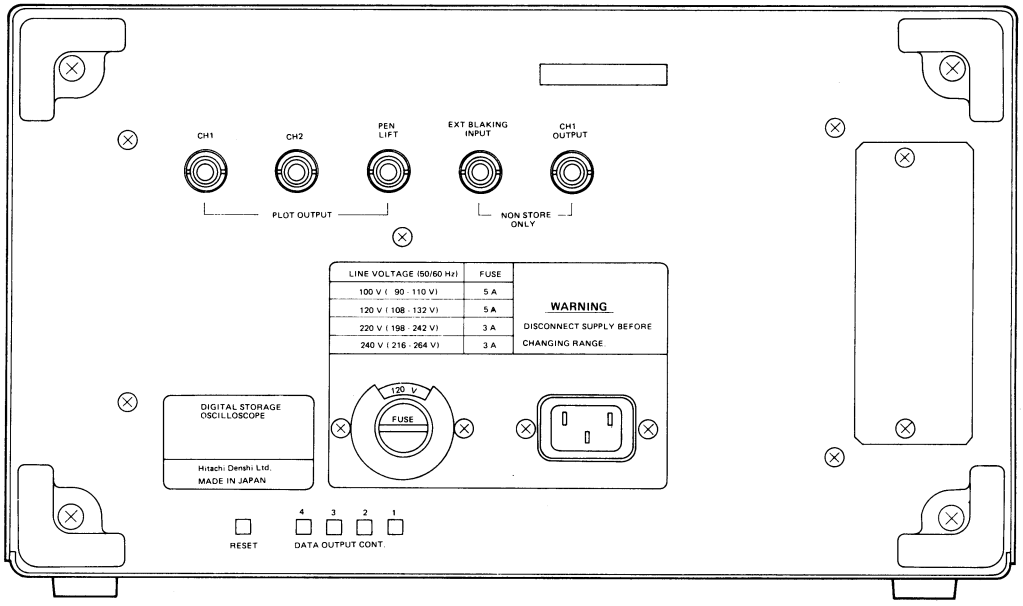
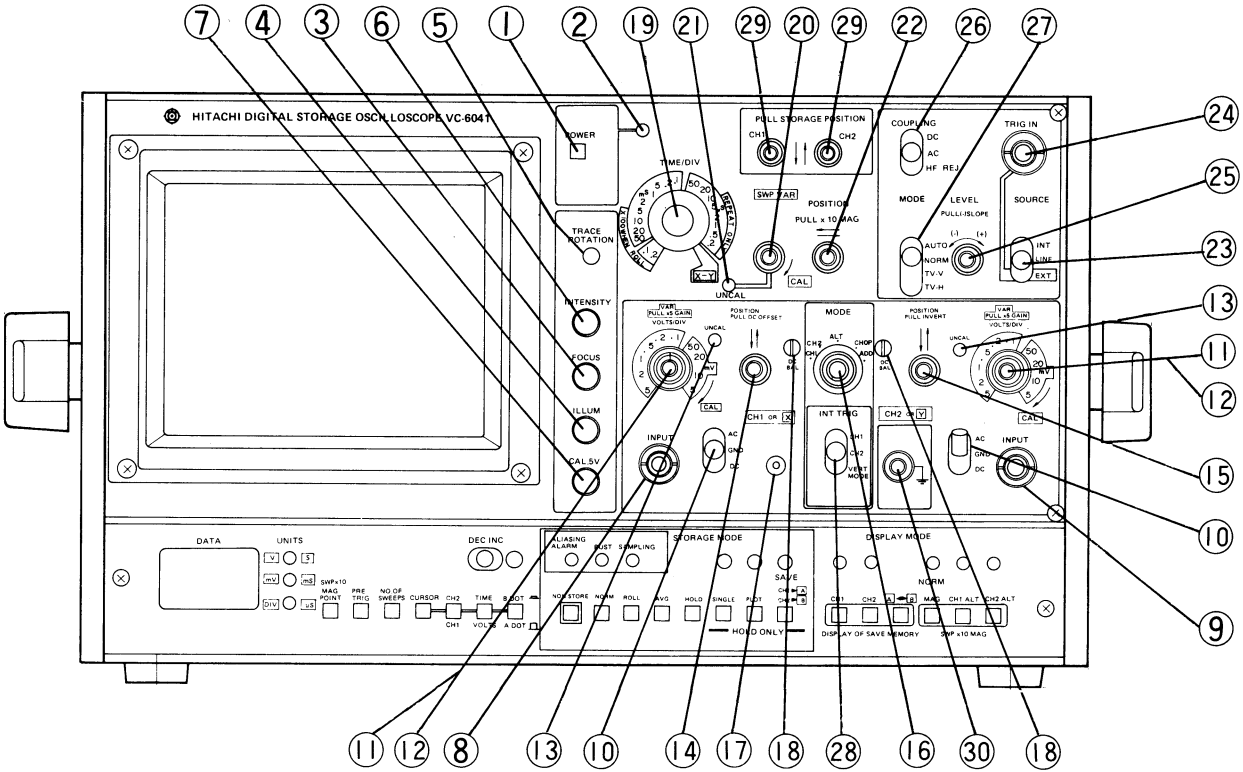


Fig. 5-3 Rear panel

5.1 FRONT PANEL CONTROLS : SECTION A



5.1.1 CRT controls

① POWER switch

After checking the line voltage, set the POWER switch off and insert the AC power supply cord in the AC cord receptacle. POWER on push-in (⎍). POWER off release (⎍).

② POWER lamp

The red lamp goes on when the power supply is ON.

③ FOCUS control

After setting INTENSITY, adjust FOCUS until the trace is clearly difined. The focus in then corrected automatically.

④ ILLUM control

Control graticule illumination. Clockwise rotation lightens the graticule. Illumination is useful for viewing in a dark area or for photographing.

⑤ TRACE ROTATION control

Used to align the trace of CRT with the horizontal graticule.

⑥ INTENSITY control

Brightness is increased by rotating INTENSITY clockwise. Rotate INTENSITY fully counterclockwise before turning the POWER on.

⑦ CAL 0.5V terminal

Output terminal provides a calibration square wave of 1 kHz at 0.5V. This is used to calibrate the probe.

5.1.2 Controls of veritcal deflection system

⑧ CH1 INPUT connector (BNC)

BNC connector for vertical axis input. The signal input to this connector becomes the X-axis signal when the instrument is used as an X-Y oscilloscope.

⑨ CH2 INPUT connector (BNC)

The signal input to this connector becomes vertical axis input. When the instrument is used as an X-Y oscilloscope, the signal input to this connector is the Y-axis signal.

⑩ AC-GND-DC input coupling switches

The switches are used to select the coupling mode between the input signal and vertical axis amplifier.

AC: At this position the signal is connected through a capacitor. The DC component of the input signal is cut off and only the AC component is displayed.

GND: At this position the input of the vertical axis amplifier is grounded.

DC: At this position the input signal is directly connected to the vertical axis amplifier and displayed, including the DC component.

⑪ VOLTS/DIV select switches

A step attenuator which selects vertical deflection factor. Set it to an easily observable range corresponding to

the amplitude of the input signal.
Multiply the reading by 10 when the 10:1 probe is used in combination with the instrument.

⑫ **VAR/PULL X5 GAIN control**

Fine control is used to vary the vertical deflection sensitivity. Attenuation of more than 1/2.5 is obtained when this control is rotated in the reverse direction of the arrow to the fully counterclockwise position. This control is used when comparing waveforms.
Normally this control is rotated in the direction of the arrow to the CAL position. When the knob is at PULL position (pull-out), the gain of the vertical axis is magnified by 5 times and the maximum sensitivity becomes 1 mV/DIV.

⑬ **UNCAL lamp**

Red light comes on when VAR is out of CAL detent position.

⑭ **POSITION PULL DC OFFSET control**

This controls vertical positioning of the CH1 trace. The trace rises by the clockwise rotation of this knob and falls by the counterclockwise rotation. For a detailed or high accuracy measurement, or the digital reading of the voltage using DC OFFSET function, a magnified waveform observation is available by pulling out the knob. Keep the push-in for normal observation.

⑮ **POSITION PULL INVERT control**

This controls vertical positioning of the CH2 trace. The trace rises by the counterclockwise rotation. When the knob is at PULL position (pull-out), this is used to inverse the polarity of the input signal applied to CH2. This control is used in the comparison of two waveforms having different polarity or in the observation of the waveform of the signal difference (CH1−CH2) in the ADD mode.

⑯ **MODE select switch**

This switch is used to select vertical operation mode.

CH1: Only the signal that is being applied to CH1 appears on the screen.

CH2: Only the signal that is being applied to CH2 appears on the screen.

ALT: Signals applied respectively to CH1 and CH2 appear on the screen alternatively at each sweep. This setting is used when the sweep time is 10 μs/div or faster. On the storage mode, this setting provides alternate display of the CH1 and CH2 waveforms even if any Time/Div range is selected.

CHOP: In this mode the input signals applied respectively to CH1 and CH2 are switched at about 250 kHz.

This mode is used when the sweep time is 20 μs/div or slower in 2-channel observation. In the storage mode, two waveforms are alternately displayed when 10 μs/div to 0.2 μs/div range is selected. On the ranges, 0.2 s/div to 20 μs/div, a CHOP observation is provided.

ADD: The algebraic sum of the input signals applied respectively to CH1 and CH2 appears on the screen.

Note: In STORAGE mode, combination of V-MODE switch and TIME/DIV switch selects the following modes.

Sampling mode	V-MODE / Time /div	CH1	CH2	ALT	CHOP	ADD / DIFF
Normal and single mode	0.2 μs to 5 μs	CH1	CH2	ALT	ALT	ADD/DIFF
	10 μs	CH1	CH2	ALT	ALT	ADD/DIFF
	20 μs to 0.2 s	CH1	CH2	ALT	CHOP	ADD/DIFF
ROLL mode	500 ms to 20 s	CH1	CH2	CHOP	CHOP	ADD/DIFF
AVG mode	0.2 μs to 0.2 s	CH1	CH2	ALT	ALT	ADD/DIFF

⑰ **DC OFFSET VOLT OUT connector**

This connector is the output connector to readout the voltage with a digital multimeter, etc., when the instrument is set to the DC OFFSET mode.

⑱ **DC BAL adjustment controls**

These controls are used for the attenuation (ATT) balance adjustment.

5.1.3 Controls of horizontal deflection system

⑲ **TIME/DIV select switch**

Sweep time ranges in 19 steps from 0.2 μs/div to 0.2 s/div in the NON STORE mode.

X-Y : This position is used when using the instrument as X-Y oscilloscope.
In this position the X (horizontal) signal is connected to the input of CH1, the Y (vertical) signal is connected to the input of CH2.
Vertical deflection sensitivity is selected at CH2 VOLTS/DIV, horizontal deflection sensitivity is selected at CH1 VOLTS/DIV.
The vertical positioning is controlled with the CH2 POSITION knob; the horizontal with CH1.
In the storage oscilloscope mode, sweep time ranges in 14 steps, from 10 μs/div to 0.2 s/div in the NORMAL mode (Note 1); 5 steps from 0.2 μs/div to 5 μs/div in the REPEAT mode (Note 2); or 6 steps, from 500 ms/div to 20 s/div in the ROLL mode. In storage mode, X-Y is used for an X-Y display of waveform that has been held by HOLD operation (Note 3).

Note 1) The transient waveform and repetitious waveforms are provided for observation.
Note 2) Only repetitious waveform can be observed.
Note 3) When X-Y display is performed without HOLD operation, the instrument displays the X-Y display of the storaged memory data but not assured. Be sure to HOLD the display, then perform X-Y display.

⑳ **SWP VAR control**

In the normal oscilloscope mode, this control varies sweep rate. At the CAL position, the sweep time is calibrated to the value indicated by TIME/DIV.
Counterclockwise rotation delays the sweep by a step of 2.5 times or more. Normally this control is kept fully rotated on the CAL positon.
This control is effective only in the NON STORE mode.

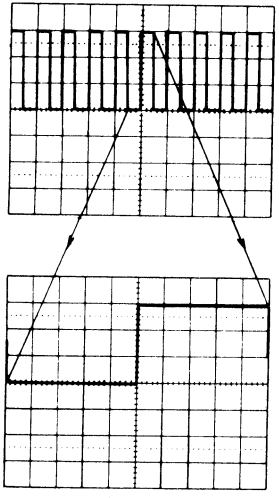
㉑ **UNCAL indicator**

This indicator lights red when SWP VAR is out of CAL detent.

㉒ POSITION PULL X10 MAG control

This control is used to move the trace in horizontal directions. It is effective in the measurement of the time duration of waveform.

PULL X10 MAG operation



Magnified waveform

The sweep is magnified 10 times by pulling out the POSITION control. The sweep time is 10 time the sweep speed obtained by TIME/DIV: in other words, the reading is 1/10 of the sweep time indicated.

5.1.4. Trigger system

㉓ SOURCE select switch

This switch is used to select the trigger source.

INT: The input signal applied to CH1 or CH2 becomes the trigger signal.

LINE: This position is used when observing a signal synchronizing the AC power source frequency.

EXT: External trigger signal applied to TRIG INPUT becomes the trigger signal.

㉔ TRIG IN connector (BNC)

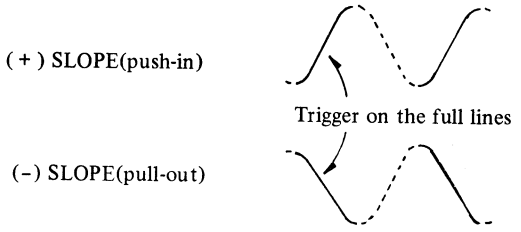
Input terminal for external trigger signal.

㉕ TRIG LEVEL control

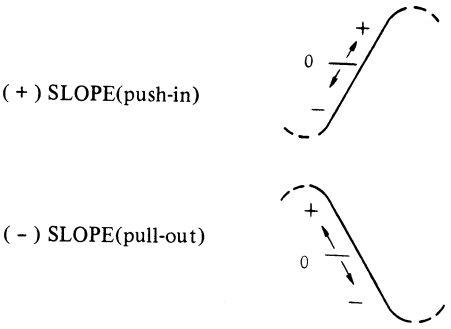
This control is used to decide at which portion of the waveform the sweep is to be started. This control also performs SLOPE switching.

Push-in position (normal state) is for (+) SLOPE and PULL (pull-out) is for (-) SLOPE.

Explanation of trigger polarity SLOPE



Explanation of trigger LEVEL



(26) COUPLING switch

Determines the method of coupling used in the trigger circuit. In DC setting, the input signal is directly coupled including the DC component. In AC setting, the DC component of the input signal is cut off and only the AC component is coupled. In HF REJ setting, the DC component of the input signal and the HF component more than about 1 MHz is cut off. (Useful to monitor the noisy waveform of comparative low frequency.)

(27) TRIG MODE select switch

AUTO: Establishes automatic trigger sweep. A stable waveform is displayed when there is a trigger signal. When there is no trigger signal, a free run observation is available. Keep the switch to the AUTO position for the usual setting. In the storage mode, the display is renewed with or without trigger signal.

NORM: Establishes trigger sweep only. No trace is displayed when there is not trigger signal available.
Use NORM mode also for triggering a low frequency signal less than 25 Hz.
In the storage mode, the display is kept in the HOLD mode when no trigger available. (The display is not renewed.)

TV-H: This position is used when observing the horizontal triggering of television signal.

TV-V: This position is used when observing the vertical triggering of television signal.

Note: Both TV-H and TV-V synchronize only when the sync signal is negative.

(28) INT TRIG select switch

Selects the internal trigger source when the SOURCE select switch (23) is set to INT.

CH1: The input signal applied to CH1 becomes the trigger signal.

CH2: The input signal applied to CH2 becomes the trigger signal.

VERT MODE: For the dual trace display, the trigger changes alternately corresponding to the input signals of each channels CH1 and CH2.

5.1.5 Vertical position and others

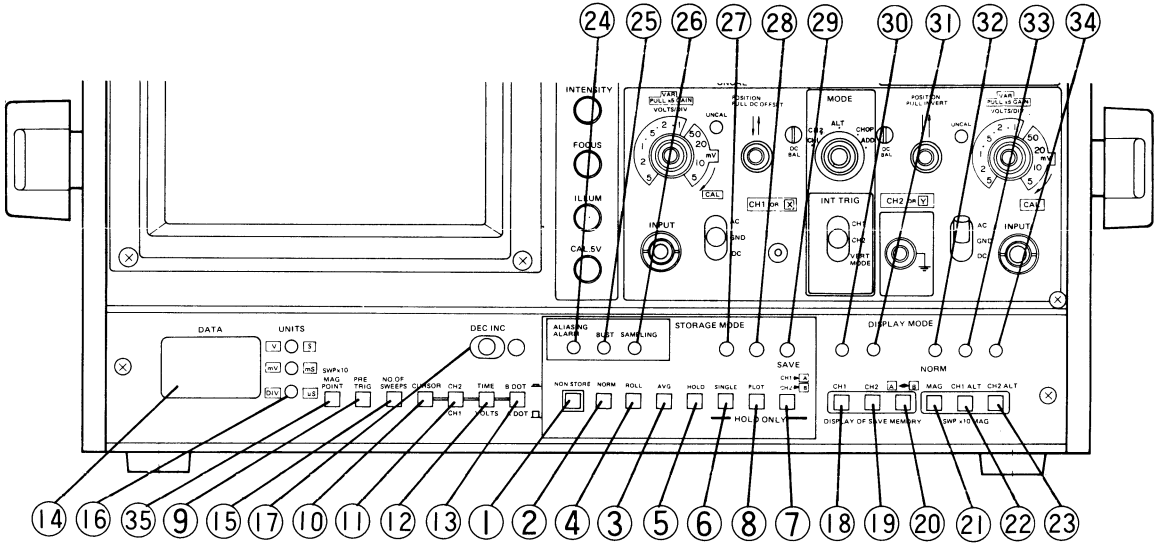
(29) STORAGE POSITION control

Vertical positions in the storage mode are controlled by pulling out and rotating the STORAGE POSITION control knob. Push-in for normal operation.

(30) GND ternimal

Ground ternimal of the oscilloscope.

5.2 FRONT PANEL : SECTION B



5.2.1 Storage mode

① **NON STORE switch**

Selects operation as a conventional oscilloscope.

② **NORM switch**

Selects operation as a normal storage oscilloscope.

③ **AVG switch**

Averages the input signal for a selected number of sweeps of the accumulated waveforms. Selects the number of sweeps from 2 to 256 by presssing the NO.OF SWEEPS switch. The average cycle is displayed when the calculation is established by the number selected by NO.OF SWEEPS switch. The number of sweeps is set by DEC/INC switch. The old calculated display remains on the screen until new calculation is completed to replace the old waveform display.

④ **ROLL switch**

Shifts data of the waveform to the left on the screen replacing new data on the right.

⑤ **HOLD switch**

Holds the input signal on the screen.

⑥ **SINGLE switch**

Displays a single sweep of the input signal by pressing the SINGLE switch when the HOLD switch is pressed.

⑦ **SAVE switch**

Transfers data from buffer memory to save memory, then stores.

⑧ **PLOT switch**

An analog output signal of the displayed waveform is obtained to be supllied as a recorder output.

5.2.2 Data indication

⑨ **PRE TRIG switch**

Displays a dot at the trigger point and displays pretrigger amount in division unit on the DATA indicator. The pre-trigger dot can be changed by DEC/INC switch. However, the PRE TRIG switch is invalid in the both REPEAT and ROLL modes, and the pre-triggering amount becomes 0 div in these modes.

⑩ **CURSOR switch**

Displays two cursor dots (A dot, B dot) on the displayed trace by using CH1/CH2 select switch. Measurement is displayed on the DATA indicator.

⑪ **CH1/CH2 select switch**

Selects the channel waveform on which the cursor dot is displayed. Selects either CH1 or CH2 button to obtain the cursor dot on the desired channel waveform.

⑫ **TIME/VOLT select switch**

Selects the cursors (TIME or VOLT) to be displayed on the screen. Voltage and time differences between the cusors are displayed on the DATA indicator.

⑬ **A DOT/B DOT select switch**

Selects the cursor dot (A or B) to be shifted. The shift is made by the DEC/INC switch.

⑭ **DATA indicator**

Seven-segment LED indicator displays the measurement made on the stored waveform.

⑮ **NO. OF SWEEPS**

When pressed in the average (AVG) mode, the number of sweeps to be averaged is displayed on the seven-segment DATA indicator.

⑯ **UNITS indicators**

Three dual-color LEDs (red and green) are used to indicate the scale-factors (red illuminates for V, mV and DIV

measurements: green illuminates for s, ms and μs measurements).

- When CH1 or CH2 mode is selected.
  The units are indicated by the selection made on the VOLTS/DIV and TIME/DIV controls.
- ADD (DIFF) mode
  Unit data is indicated according to the CH1 VOLTS/DIV. When the CH1 and CH2 have different VOLTS/DIV settings, always CH1 units are indicated.
- VAR
  Data appears on the indicator, however, the data may not be correct as the calculation is performed in premises that the VAR control is at the CAL detent.

⑰ DEC/INC switch

The position of the cursor, the amount of pre-trigger mode, the magnification range in stroage mode, and the number for average are selected by shifting this switch. All results derived from switch selection are displayed on the DATA indicator.

㉟ SWP X10 MAG POINT switch

By pressing the button the nagnification starting points are displayed on the current waveform by two dots.
Operation on the DEC/INC switch provides lateral positioning of the dots.

5.2.3 Display mode

⑱ CH1 switch

The first pressing of the switch button displays the save memory A waveform at where the CH1 waveform has been displayed, and lights up the green LED.
The second pressing will restore the CH1 current waveform display. Then the LED goes off. Each pressing of the switch repeats the above operations alternately.

⑲ CH2 switch

The first pressing of the switch button displays the saved waveform B at where the CH2 waveform has been displayed; the LED indicator lights up red.
The waveform display of the signal applied to CH2 is restored by the second pressing; the indicator lights off.

⑳ [A]◄►[B] switch

When the CH1 and/or CH2 is on, the operation of the switch can swap the SAVE memory A with the SAVE memory B. See item 6.5.4 SAVE MEMORY DISPLAY for details.

㉑ NORM MAG switch

Displays the waveform of X10 magnification on the CRT.

㉒ CH1 ALT switch

Displays magnified waveform of CH1 where CH2 display has been, while the current CH1 waveform display is held as it is. The CH2 display disappears.

㉓ **CH2 ALT switch**

Displays magnified waveform of CH2 where CH1 display has been, while the current CH2 waveform display is held as it is. The CH2 display disappears.

5.2.4 Indicators

㉔ **ALIASING ALRM lamp (red)**

The LED lights up to give warning against aliasing when the frequency of the sync signal is higher than ¼ of the sampling clock.

㉕ **BUSY lamp (red)**

The LED lights up when the microcomputer is occupied with GPIB.

㉖ **SAMPLING lamp (red)**

Lights up while sampling data.

㉗ **SINGLE lamp (green)**

Lights up until the waveform on the CRT is completely renewed in the SINGLE mode.

㉘ **PLOT lamp (green)**

Lights up while transferring data to the recorder or to the printer.

㉙ **SAVE lamp (green)**

The lamp lights up while storing the data of waveform displayed on the CRT into the save memory. When the save memory process is finished and data is stored, the LED extinguishes.

㉚ **CH1 lamp (green)**

Lights up while the save memory A is displayed where the CH1 real time display has been. CH1 lamp (red)
Lights up while the save memory B is displayed where the CH1 real time display has been.

㉛ **CH2 lamp (red)**

Lights up while the save memory B is displayed where the CH2 real time display has been. CH2 lamp (green)
Lights up while the save memory A is displayed where the CH2 real time display has been.

㉜ **NORM MAG lamp (red)**

Lights up while NORM MAG is operating.

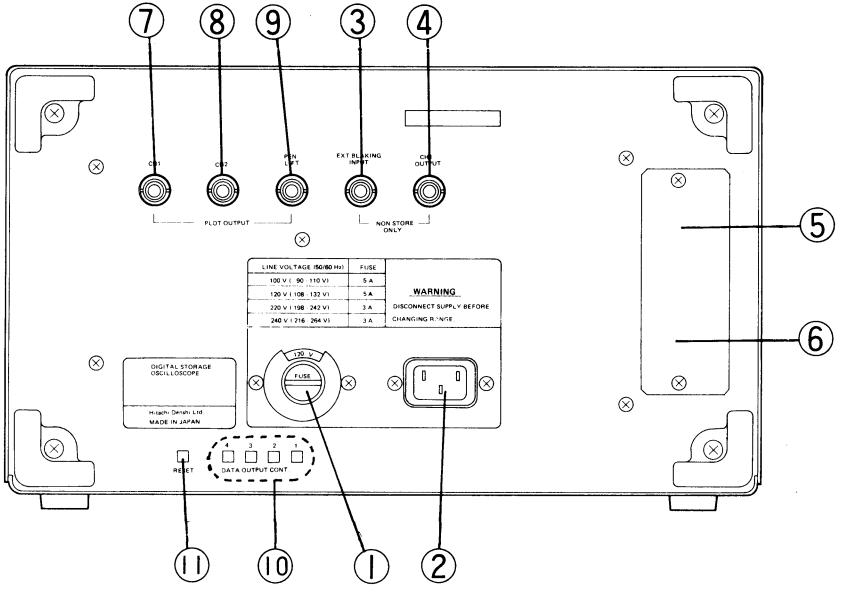
㉝ **CH1 ALT lamp (red)**

Lights up while CH1 ALT switch is operating.

㉞ **CH2 ALT lamp (red)**

Lights up while CH2 ALT switch is operating.

5.3 REAR PANEL



① **FUSE holder/Line voltage selector**

Selects line voltage supplied to the oscilloscope.

② **AC cord receptacle**

Connects between the oscilloscope and the power cord.

③ **EXT BLANKING INPUT connector**

Input connector for intensity modulation. The connector is DC coupling. The intensity is reduced with a positive signal and increased with a negative signal.

④ **CH1 OUTPUT connector (BNC)**

Output connector used to connect a frequency counter or other devices. Provides an output signal with an amplitude of 20 mV of around per division of displayed CH1 signal terminated with 50 ohms.

⑤ **GPIB connector (Option)**

For the connection of other devices by means of a GPIB. Conforms to IEEE Std. 488-1978.

⑥ **GPIB switch (Option)**

The five switches set the binary talk address.

⑦ **PLOT OUTPUT (CH1) connector (BNC)**

When a pen recorder is connected, CH1 data is provided. When an X-Y recorder is connected, either one of CH1 or CH2 data is provided as required.

⑧ **PLOT OUTPUT (CH2) connector (BNC)**

When a pen recorder is connected, CH2 data is provided. When an X-Y recorder is connected, X axis sweep signal is provided.

⑨ **PLOT OUTPUT (PEN LIFT) connector (BNC)**

Pen up : High level 2.0V or more
Pen down: Low level 0.8V or less

⑩ **DATA OUTPUT CONT switches**

For the selection of plot speed, and Y-t or X-Y output mode.

⑪ **RESET**

Push this switch when the equipment is disabled because the microcomputor or the controls on the front panels are locked. The normal operation is restored.

6. OPERATING PROCEDURE

6.1 OPERATING PREPARATIONS

6.1.1 Graticule

The graticule is internally marked on the CRT screen to enable the accurate measurements without parallax error. The graticule is marked with eleven vertical and nine horizontal major divisions. In addition, each major division is divided into five minor divisions. Vertical deflection factors and horizontal timing, as well as the storage mode VOLTS and TIME cursors, are calibrated to the graticule so that measurements of amplitude and time duration may be made directly on the displayed waveform.

6.1.2 Grounding

The most reliable signal measurements are made when the unit under test are connected together by a common grounding lead in addition to the signal cable or probe after the instrument being properly grounded to the earth ground. The ground lead on the probe provides the best ground method for signal interconnection and ensures the maximum amount of shielding of the signal cable in the probe cable. A separate ground lead from the unit under test may be connected to the oscilloscope chassis ground connector located on the lower right of the front panel.

6.1.3 Method for connection signals

The first step of measurement is to connect the desired

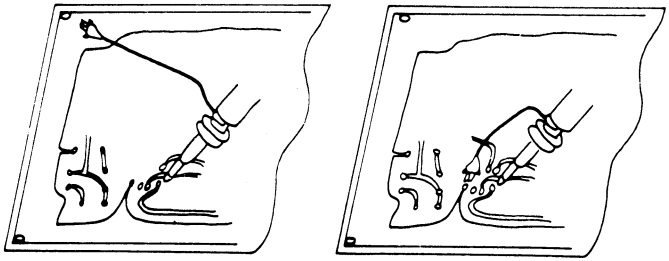
signal for measurement to the oscilloscope properly.

(1) When using a probe

Use the standard probe, AT-10AK 1.5 for measuring a high frequency wave for high accuracy.
On the x10 mode, the input signal is attenuated in the probe by 1/10 before it is fed to the oscilloscope. Hence, the AT-10AK is disadvantageous in low level signal observations, however, is quite advantageous in high level signal observation providing the extended measuring range.
The x1 mode provides no attenuation in the input signal.

CUATIONS:

- Do not apply a signal which exceeds 600V (DC + peak AC)
- Bring the grounding point of the ground lead of the probe close to the point to be measured when measuring a rapid rising signal or high frequency signal. Long grounding lead wire may cause waveform distortions such as ringing and overshoot.



Correct Wrong

Fig. 6-1 Connection of grounding lead wire

- Multiply the reading of VOLTS/DIV by 10 in the x10 mode. For example, if the VOLTS/DIV is 50 mV/div, then read the waveform as 50 mV/div x 10 = 500 mV/div.

(2) Direct connection

When connecting a signal directly to the oscilloscope not using the attached probe AT-10 AK1.5, pay attention to the following points in order to minimize the measurement errors.

- When performing observation using an unshielded wire, no trouble should occur when the circuit to be measured is of low impedance with high level.
  However, measurement error may be caused by static stray coupling with other circuit and power line. This measurement error cannot be ignored even in low frequency region. In general, it is better to avoid measuring with unshielded connecting wire. When using a shielded wire connect one end of the shield to the GND terminal of the oscilloscope and the other end to the grounding of the circuit to be measured. It is desirable to use a coaxial cable with BNC type connector.
- The following cautions must be observed when performing a wide band measurement. It is necessary to terminate a cable with a resistor of the characterstic impedance when measuring a rapid rising waveform or a high frequen-

cy wave. Especially when using a long cable, the absence of a terminating resistor will lead to a measurement error derived from ringing phenomenon.
Some measuring circuits require a terminating resistor equal to the characteristic impedance of the cable also on the measurement point. BNC type terminating resistor (50 ohms) is conveniently used for this purpose.

- In order to perform measurement with the measuring circuit in proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit to be measured.
- The stray capacity of the shield wire must be taken into account when performing measurement with a long shielded wire. Since the shielded 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 probe to minimize the effects on the circuit.

- When the length of the shielded wire used or the length of the non-terminated cable reaches 1/4 wave length or its multiples within the band of the oscilloscope (1/4 wave length is about 1.5 meter, when using a coaxial cable at 40 MHz), oscillation may be caused near the 5 mV/div range.
In this case, connect the cable or shielded wire to the input connector through a serially connected 100 ohms to 1 k ohms resistor, or perform measurement at other VOLTS/DIV range.

6.1.4 Input coupling capacitor precharging

When the AC-GND-DC switch is on the GND position, the input signal is connected to ground through a precharging circuit consisted of the coupling capacitor and a 1 M ohms resistor. This circuit allows the input coupling capacitor to be charged to the average DC-voltage level of the signal applied to the probe. Thus, a large voltage transient that could be applied to the amplifier input are not generated when the input coupling is switched from GND to AC. The precharging circuit also provides a measure for protection to the external circuitry by reducing the current levels that can be drawn from the external cirucitry during coupling capacitor charging.
Observe the following procedure whenever the probe tip is connected to a signal source having a different DC level than the previously applied.

(1) Set the AC-GND-DC switch toGND before connecting the probe tip to a signal source.
(2) Touch the probe tip to the oscilloscope chassis ground. Wait several seconds for the input coupling capacitor to discharge.
(3) Connect the probe tip to the signal source.
(4) Wait several seconds for the input coupling capacitor to charge.
(5) Set the AC-GND-DC switch to AC. A signal with a large DC component can be vertically positioned within the graticule area, and the AC component of the signal can be measured in the normal manner.

6.1.5 Instrument cooling

To maintain adequate instrument cooling, the ventilation holes in the equipment cabinet must remain open, and the air filter must be clean. The air filter should be visually checked every few weeks and cleaned or replaced if dirty. More frequent inspections are required under severe operating conditions.

6.1.6 Presetting for usual observation

For usual observation, leave the following non-calibrating function section set to "CAL" position.

VAR	Rotate in the direction of arrow. The VOLTS/DIV is calibrated to its indicating value.
SWP VAR	Rotate in the direction of arrow. The TIME/DIV is calibrated to its indicating value.

6.2 OPERATOR'S CHECKS AND ADJUSTMENTS

To verify the operation and accuracy of your instrument, perform the following checks and adjustments before making a measurement.

Warm-up time required to meet all the instrument's specification is 20 minutes.

6.2.1 Trace rotation adjustment

(1) Obtain a normal sweep display.

(2) Set the CH1 AC-GND-DC switch to GND to display a free-running baseline trace with no vertical deflection.

(3) Use the CH1 vertical POSITION control to move the trace to the center horizontal gracicule line.

NOTE: Normally, if the resulting trace is parallel to the center horizontal graticule line, the trace rotation adjustment should not be required.

(4) If the resulting trace is not parallel to the center horizontal graticule line, use a small-bladed screwdriver to rotate the trace rotation adjustment screw located just beside the CRT graticule, to align the trace with the horizontal graticule line.

6.2.2 Probe compensation

Misadjustment of probe compensation is one of the sources of measurement error. Most attenuator probes are equipped with compensation adjustments.

To ensure optimum measurement accuracy, always compensate the oscilloscope probe before making measurements. Probe compensation is accomplished as follows:

(1) Set the both VOLTS/DIV switches to 10 mV and set both AC-GND-DC swithes to DC.

(2) Using the approximately 1 kHz CALIBRATOR square-wave signal as the input signal, obtain a normal sweep display presentation (See Item 6.1 OPERATING PREPARATIONS).

(3) Check the waveform presentation for overshoot and rounding. Readjust the probe compensation, if necessary, for flat tops on the waveforms (See Fig. 6-3).

- To avoid measurement error, put the probe in the following correction state and check it before measurement without fail.
  Connect the tip of the probe to the CAL 0.5 V output terminal of 1 kHz calibration square wave voltage. When this correction capacitance is at optimum the waveform takes the shape as shown in Fig. 6-2 (a). If the waveform is as shown in Fig. 6-2 (b) or (c), rotate the semifixed adjusting screw on the matching box of the probe by using a screwdriver until the optimum state is obtained.

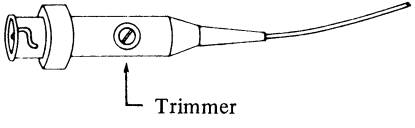


Fig. 6-2

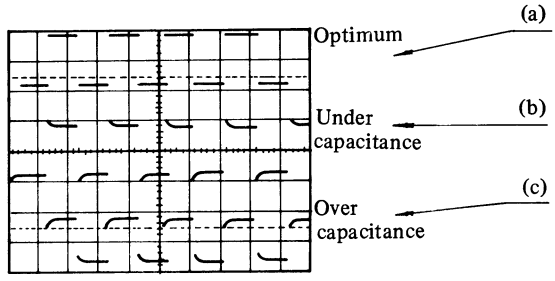


Fig. 6-3

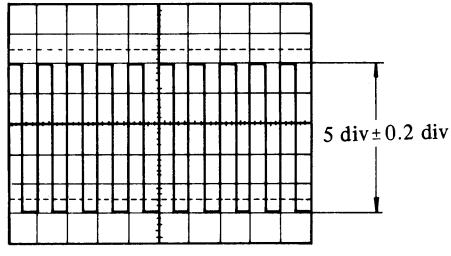


Fig. 6-4

6.2.3 Vertical gain check

(1) Set the controls and the switch as follow to obtain a normal sweep.
VOLTS/DIV (CH1 and CH2) 10mV

TIME/DIV	1ms
AC-GND-DC	DC

(2) Connect a 10:1 probe to the CH1 input connector. Connect the probe tip to the CALIBRATOR terminal on the instrument front panel.
(3) Adjust INTENSITY for the desired display brightness and adjust FOCUS control for best defined display.
(4) Adjust TRIGGER LEVEL control for a stable display of the CALIBRATOR signal.
(5) Use the vertical POSITION control to vertically center the display of the CALIBLATOR signal.
(6) Check for a vertical display amplitude of 5 divisions ±0.2 divisions. (See Fig. 6-4).

6.2.4 External horizontal gain check

(1) Perform steps 1 through 4 of VERTICAL GAIN CHECK procedure to obtain a stable display of the CALIBLATOR signal.
(2) Set the TIME/DIV switch to the X-Y position.
(3) Check for a display of two dots separated horizontally by 5 divisions (±0.2 division).
(4) Set the TIME/DIV switch back to 1 ms.

DIGITAL STORAGE OPERATION CHECK

6.2.5 Vertical deflection accuracy check

(1) Perform vertical gain check.
(2) Press NORM on the storage mode switch section.
(3) Check that the amplitude of stored waveform is 5 divisions (±0.2 division).

6.2.6 Voltage cursor accuracy check

(1) Select CH1 vertical deflection. Set the sensitivity at 10 mV/div. VAR at CAL detent. Select DC position with AC-GND-DC switch.
(2) Align the base line of the trace to the center of the second horizontal scale line from the bottom by adjusting the V. POSITION control.
(3) Set the VOLTS and CURSOR buttons. Move the cursor dots and set them as Fig. 6-5 by operating DEC/INC switch.

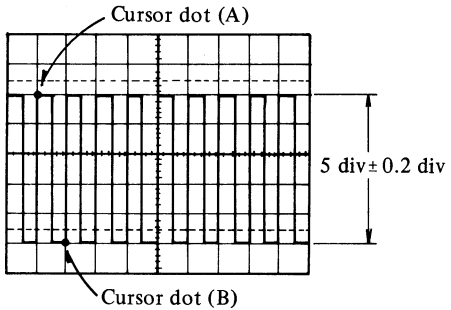


Fig. 6-5

(4) Check for the volts cursors separated vertically by 5 ± 0.2 division. Also check 50.0 mV is displayed on DATA indicator.

6.2.7 Time cursor accuracy check

(1) Select 1 ms/div by TIME/DIV.
(2) Set the TIME and CURSOR bottons. Then adjust INTENSITY so that the intensity modulated cursor dots are distinct from trace.
(3) Set A DOT select switch at the A DOT position and operate DEC/INC control switches to locate the cursor dot A to the second vertical graticule line from the left.
(4) Operate A DOT/B DOT select switch and DEC/INC control swithces to remove the cursor dot B.
(5) Obtain 8.0 and ms indication on DATA and UNIT indicators.
(6) Check for a display of two dots separated horizontally by 8 divisions ± 0.2 division. (See Fig. 6-6).

NOTE: The above check procedure also provides the check of horizontal deflection accuracy.

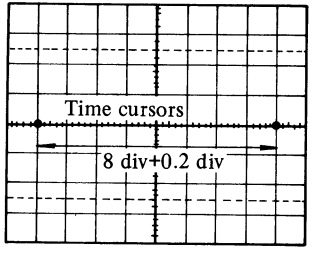


Fig. 6-6 Time cursor accuracy

6.3 TO OBTAIN DISPLAY

Be sure to check that the proper line voltage is supplied before setting the POWER switch ON. The voltage indications are given on the rear panel for reference.
Connect the power cable from the rear panel into an outlet, then set the controls and switches as follows:

POWER	OFF (push-out position)
INTENSITY	Fully counterclockwise
FOCUS	Midrange
AC-GND-DC	GND
POSITION (CH1)	Midrange
MODE	CH1
TRIG MODE	AUTO
TRIG SOURCE	INT
INT TRIG	CH1
TRIG LEVEL	Midrange
TIME/DIV	0.5 ms/div
POSITION (CH2)	Midrange
NON STORE	Push-in

After setting above, turn ON the POWER, and 15 seconds later, rotate the INTENSITY clockwise. Then the trace will appear. If the observation is to start immediately set the FOCUS control at a point where the trace is sharpest. If the instrument is to remain un-used, rotate INTENSITY counterclockwise to reduce the brightness.

6.4 OSCILLOSCOPE DISPLAYS

The following procedures will allow the operator to obtain the most commonly used oscilloscope displays.

6.4.1 Normal sweep display

Preset the instrument controls as follows:

Vertical

VOLTS/DIV	: Proper setting determined by amplitude of signal to be applied
VOLTS/DIV VAR	: Calibrated detent (Fully clockwise) OFF (Push-in position)
AC-GND-DC	: AC
Vertical POSITION	: Midrange
MODE	: CH1

Display

INTENSITY	: Fully counterclockwise
FOCUS	: Midrange
ILLUM	: Midrange

Horizontal

TIME/DIV	: 0.5 ms/div
X10 MAG	: OFF (Push-in position)
Horizontal POSITION	: Midrange
SWP VAR	: Calibrated detent (Fully clockwise)

Trigger

LEVEL	: Midrange
SOURCE	: INT
COUPLING	: AC
MODE	: AUTO
INT TRIG	: CH1

Digital Storage

NON STORE	: ON (Push-in-position)

(1) When the above procedures are completed, push the POWER button in ON and allow the instrument time to warm up. Using an proper probe or a properly terminated coaxial cable, then apply a signal to the CH1 input connector. The signal source output impedance determines the termination required when using a coaxial cable to interconnect test equipment.

Caution

Allow 15 minutes for warmup time.

(2) Set the channel 1 VOLTS/DIV switch and the Vertical and Horizontal POSITION controls to locate the display within the graticule area.
(3) Adjust the TRIGGER LEVEL control for a stable display.
(4) Set the TIME/DIV switch for the desired number of cycles

of displayed signal. Then adjust the FOCUS control for the best defined display, if necessary.

GENERAL MEASUREMENT

(1) In the case of observing a single waveform.
Use CH1 or CH2. Make the following settings when using CH1.

MODE (V deflection system)	: CH1
TRIG MODE	: AUTO
TRIG SOURCE	: INT
INT TRIG	: CH1

Under these settings almost all the repetitive signals of about 25 Hz or more applied to CH1 can be synchronized and observed by only adjusting TRIG LEVEL. Since the MODE of horizontal axis is at AUTO position, the trace appears even when no signal is present or when input coupling switch is at GND position. This means that the measurement of DC voltage can be measured. The following switching is needed when observing low frequency signals of about 25 Hz or less.

TRIG MODE : NORM

Synchronization can be effected by operating the LEVEL control under this setting.

When using only CH2, use the instrument after making the following settings.

Vertical MODE	: CH2
TRIG SOURCE	: INT
INT TRIG	: CH2

(2) ADD measurement
Set the vertical MODE switch to ADD. This provides a waveform showing the added product of two waveforms.

6.4.2 MAGNIFIED SWEEP DISPLAY

(1) Set the controls to obtain a normal sweep display.
(2) Adjust the horizontal POSITION control to move the area to be magnified within the center CRT graticule division (0.5 division on each side of the center vertical graticule line). Change the TIME/DIV switch setting as required.
(3) Pull out the x10 MAG button switch to ON and adjust the horizontal POSITION control for precise positioning of the magnified display.
To obtain the sweep rate, divide the TIME/DIV switch setting by 10.

6.4.3 ALTERNATE SWEEP DISPLAY

Dual Waveform Measurement

Two waveforms are displayed when ALT or CHOP is selected by the vertical MODE switch.

For the observation of high frequency repetitive waveform, select ALT. Select CHOP for low frequency waveform observations. For the observation of phase difference, trigger with a phase advanced signal.

(1) Obtain a normal sweep display.
(2) Adjust TIME/DIV for a desired sweep rate.
(3) Select ALT by the vertical MODE switch.

6.4.4 X-Y display

X-Y mode is usually used for a comparative observation of the frequency and phase of the two sinusoidal signals.

(1) Rotate TIME/DIV control fully clockwise to X-Y position. Use two coaxial cables or probes of the same length. Connect one to apply the vertical signal (Y-axis) to CH2 or Y connector, and the other to apply the horizontal singnal (X-axis) to CH1 or X connector.

(2) Adjust INTENSITY for the best defined display as intensity may vary in the X-Y mode.

6.5 DIGITAL STORAGE DISPLAY

The following procedures explain how to set up and use the digital storage capabilities of the VC-6401. Certain conditions of vertical MODE selection and storage mode selection will store waveforms under a priority plan. See Table 6-1.

6.5.1 Normal storage mode display

(1) Obtain a normal waveform display desired to be stored in the NON STORE mode.

(2) Depress [NORM] switch.

(3) In this mode, the display and storage respond to front panel trigger control. Waveforms acquired and displayed at low sweep rates require increased time to change as the sweep rate decreases (e.g. a waveform acquired at a sweep rate of 1s/div required approximately 10 seconds for the sweep time and the triggering signal must be received after the sweep in progress is completed). Therefore, at the slower sweep speed a longer delay is required before the display responds after changing a front-panel control.

(4) When the TIME/DIV is set in the range of 10 μ/div to 0.2 s/div (14 steps), both transient and repeat waveform can be stored. When the TIME/DIV is set in the range of 0.2 μ/div to 5 μ/div (5 steps; REPEAT ONLY range), only repeat waveform can be stored.

ⓐ No start point apears when REPEAT ONLY range is selected. Check the waveform start point on the repeated waveforms of 2nd cycle or after.

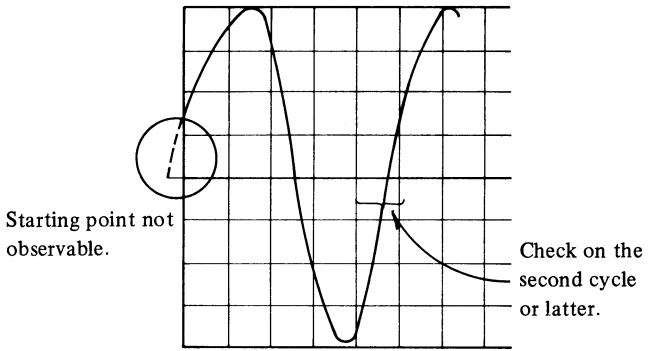


Fig. 6-7 Display of REPEAT ONLY

ⓑ Allow more than 13 seconds approx. for the storage of an input signal lower than 1 kHz.

ⓒ A noise interference may occur when a signal of low frequency is put into storage.

It is recommended to use sine waves of 1 MHz or higher or square waves of 0.3 μs or faster rise time waves are used for storage observations.

Table 6-1: Priority plans in the combination of vertical mode and storage mode.

Save reference LED's / Vertical mode	OFF	CH1 (green) ON	CH1 (red) ON	CH2 (red) ON	CH2 (green) ON	CH1 (green) CH2 (red)	CH1 (red) CH2 (green)
CH1	CH1	SAVE A	SAVE B	CH1 and SAVE B	CH1 and SAVE A	SAVE A and SAVE B	SAVE B and SAVE A
CH2	CH2	SAVE A and CH2	SAVE B and CH2	SAVE B	SAVE A	SAVE A and SAVE B	SAVE B and SAVE A
ALT	CH1 and CH2	SAVE A and CH2	SAVE B and CH2	CH1 and SAVE B	CH1 and SAVE A	SAVE A and SAVE B	SAVE B and SAVE A
CHOP	CH1 and CH2	SAVE A and CH2	SAVE B and CH2	CH1 and SAVE B	CH1 and SAVE A	SAVE A and SAVE B	SAVE B and SAVE A
ADD	ADD	SAVE A	SAVE B	ADD and SAVE B	ADD and SAVE A	SAVE A and SAVE B	SAVE B and SAVE A

* Storage mode: NORM, ROLL, AVG or HOLD mode.

6.5.2 Average mode display

This is used to extract a repetitive signal that is mixed with noises.

(1) Set TRIG MODE to NORM position. Obtain a stable display by adjusting trigger LEVEL control. This ensures stable triggering on low-repetition-rate waveforms.
(2) Set PRE TRIG by pushing the switch. Acquire pre-trigger waveform.
(3) Push in [AVG] switch.
(4) Change the number of sweeps to be accumulated in the display using the following procedure, if required. The number is automatically set to 2 at power on.
   ⓐ Press [NO. OF SWEEPS] push button in. DATA indicator displays the number of sweeps to be averaged.
   ⓑ Sliding [DEC/INC] switch to the right increases the number of sweeps to be averaged, while sliding to the left decreases the number.
   ⓒ Averaging begins as soon as a new selection is made on the front panel control.

NOTE: The number of sweeps to be accumulated in the averaged waveform is selectable from 2 to 256 in a binary sequence. The digital storage circuitry acquires the selected number of sweeps to be averaged, then display the average waveform while the required sweeps are being accumulated for the next averaging. This cycle continues in a repetitive manner until a new mode is selected. Changing a front-panel control that affects the data being acquired will start the accumulation process over, to obtain the selected number of sweeps at the new control setting.
*When 256 is selected for averaging, it takes about 1 minute before the data is displayed on the screen. SAMPLING indicator LED flickers to indicate that the averaging process is on.

6.5.3 Save storage mode display

(1) Push [HOLD] switch.
(2) Push [SAVE] storage mode button.
(3) CH1 waveform data is stored in A memory while CH2 waveform data is stored in B memory. SAVE indicator lights up green while save operation.
(4) In order to display the waveform data stored in the SAVE memory, follow the procedure in section 6.5.4: Save memory display.

6.5.4 Save memory display

(1) Press DISPLAY MODE: [CH1]. The save memory A waveform is displayed on the screen where CH1 waveform has been displayed. CH1 indicator LED lights up green. Push to release DISPLAY MODE [CH1] switch again. CH1 LED goes off. Repeat the above procedure each time DISPLAY MODE [CH1] is used.

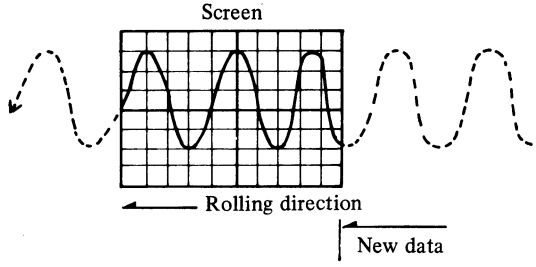
(2) Press DISPLAY MODE : [CH2]. The save memory B

waveform is displayed on the CH2 display portion of the screen. CH2 indicator LED lights up red. If push the switch again, the CH2 LED goes off. The above procedure is repeated each time DISPLAY MODE : [CH2] switch is used.

(3) Reversed display with SAVE memory A and B
The position of display can be reversed on the screen.
ⓐ Press DISPLAY MODE : [CH1] (See 6.5.4. (1))
ⓑ Press DISPLAY MODE : [A]◄►[B] .
Display the save memory B waveform at the position where CH1 waveform has been displayed. CH1 indicator changes red from green.
ⓒ Press [A]◄►[B] switch again.
The save memory A waveform appears where CH1 waveform has been positioned.
ⓓ Press DISPLAY MODE [CH1] . This will return the oscilloscope in real time input waveform display.
* The reverse position for save memory A and B waveforms are also obtained with CH2 switch and by the same procedure. Of course, the indicator LED's are also reversed in colors from the above description.

6.5.5 Roll display

(1) When the time range is within ROLL, the [ROLL] switch of STORAGE MODE switches establishes the roll mode operation.
(2) When the time range is within ROLL, the data is acquired with X100 TIME/DIV, and the ROLL mode display is obtained. A dot on the right end of the screen indicates the renewal point of data.



***ROLL:** The waveform on the screen rolls continuously from the right to left.

NOTE: Roll mode is available within the TIME/DIV range shown below.
When the TIME/DIV is set to range other than ROLL, the display will be the same as the ROLL display with 5 ms.

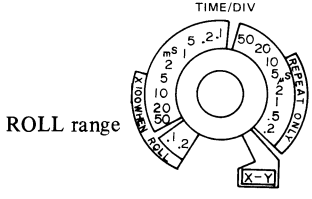


Fig. 6-8

6.5.6 Magnified display (In TIME/DIV)

There are three magnified displays: (1) NORM MAG (2) CH1 ALT MAG and (3) CH2 ALT MAG.

(1) NORM MAG display

The normal magnification provides a display digitally magnified by ten times.

ⓐ Press SWP X10 MAG POING switch, then press INC switch. Dots will appear to indicate the starting of the magnification on the normal waveform. The dots can be laterally moved on the screen by the DEC/INC switch.

ⓑ Press the NORM MAG of DISPLAY MODE switches. A X10 sweep appears on the screen displaying the normal waveform starting from the dots.

* When dual traces are displayed, both CH1 and CH2 are magnified.

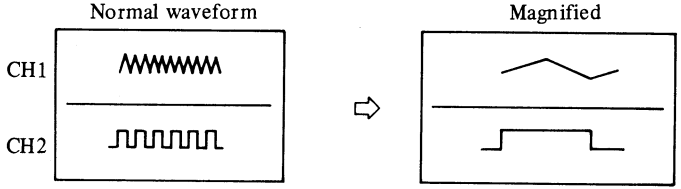


Fig. 6-9

(2) CH1 ALT MAG display

ⓐ Press SWP X10 MAG POINT switch.

ⓑ Move the position of dots by DEC/INC switches.

ⓒ Press CH1 ALT button of DISPLAY MODE. This holds CH1 display as it is, while the CH2 waveform disappears from the screen and X10 display of 1 division of CH1 waveform appears on CH2 position.

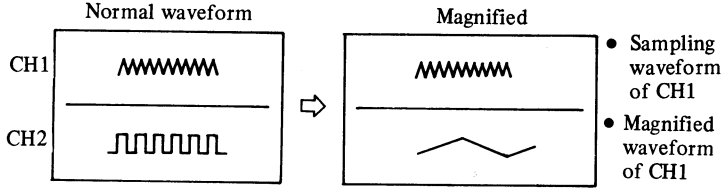


Fig. 6-10

(3) CH2 ALT MAG DISPLAY

a Press SWP X10 MAG POINTS switch.

b Adjust DEC/ INC switch to move the position of dot.

c Press CH2 ALT of DISPLAY MODE. The normal CH2 waveform is held as it is, while CH1 waveform disappears and X10 display of CH2 appears where CH1 display has been.

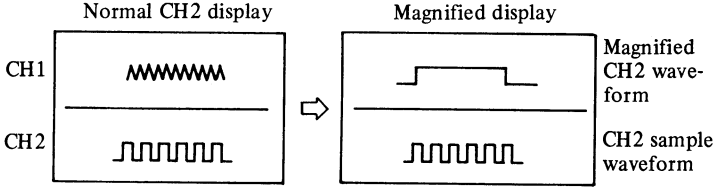


Fig. 6-11

NOTES: 1) Obtain X10 MAG display with NON STORE mode.
Store the waveform and perform the above procedures (1) through (3). The display will be magnified by (10 x 10 = 100) 100 times.
2) The vertical positioning of ALT MAG display is available by the PULL STORAGE POSITION knob.

6.5.7 Plot output

(1) Establish storage mode with the NORM, ROLL, AVG switches on. Hold the current sampling waveform whith the HOLD switch.
(2) Press the PLOT switch.
The recorder output is available, and a green light indicates the recorder output. If recorder output is completed, the PLOT LED goes off.
For a cancellation of recorder output, release either HOLD or PLOT by pressing the button later than 3 seconds after recorder output starts.
(3) Recorder output terminals.
The BNC connectors are provided on the rear panel for recorder outputs.

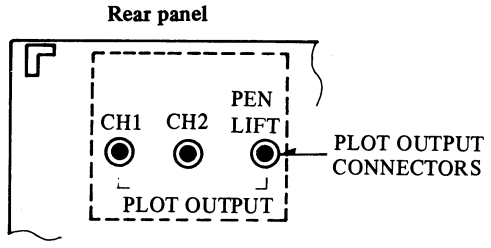


Fig. 6-12

6.5.8 Cursor

In STORAGE MODE, the cursors are used to select measurement points on the displayed waveforms of each NORM, HOLD and AVG modes. Voltage and time difference between two dots are displayed on the seven segment DATA indicator. Cursor can be clearly read if the contrast with the waveform is increased by the counterclockwise rotation of INTENSITY knob.

(1) Press the CURSOR switch.
(2) Select a channel, CH1 (Push-out) or CH2 (Push-in).
(3) Select TIME (Push-in) or VOLT (Push-out) measurement.
(4) Determine whether A or B DOT is going to be moved, and select. Then operate DEC/INC switch till dot reaches the desired position.
(5) The measurement between two cursor dots are indicated on seven segment DATA indicator.

6.5.9 Digital data output (option)

The measuring conditions and waveform data is provided through GPIB interface.

(1) Measurement status data

① Vertical axis
- Input coupling (AC/DC)
- : Sensitivity (VOLTS/DIV)
- : Vertical mode
- : Pre-trigger point
- : Ground reference

② Horizontal axis : Sweep time (TIME/DIV)

(2) Waveform data : The displayed waveform CH1 and CH2, or the waveform data stored in SAVE memory A and B.

For detailed information on interface or command, see the separate instruction manual on the GPIB (option).

7. MEASUREMENT

7.1 NON STORAGE MEASUREMENT

The first thing to do are as follows:

(1) Bring the INTENSITY and FOCUS at optimum position for easy reading.
(2) Display the waveform as large as possible to minimize the reading error.
(3) Check the capacity correction when using a probe. (See 6.2.2 ; Probe compensation)

7.1.1 DC voltage measurement

Set AC-GND-DC to GND and position the zero level trace properly. The zero level trace does not need to be in the center screen. Sets VOLTS/DIV appropriately and set AC-GND-DC to DC. Since the trace deflects by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift width by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/div, and deflection is 4.2 div , DC voltage is 50 mV/div x 4.2 = 210 mV. However, if the probe AT10 AK1.5 is in use, the true DC value of the signal becomes 10 times the value measured, or 50 mV/div x 4.2 X10 = 2.1V as shown in Fig. 7-1.

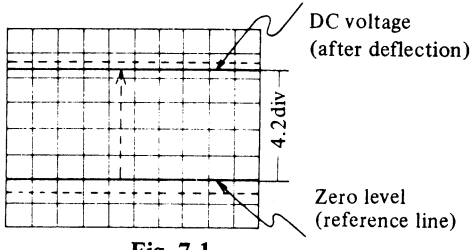


Fig. 7-1

7.1.2 AC voltage measurement

The same as in paragraph 7.1.1 : DC voltage measurement, move the zero level trace to the position easy for observation. As shown in Fig. 7-2, when VOLTS/DIV is 1 V/DIV, 1 V/div x 5 = 5 Vp-p (50 Vp-p when using the probe AT-10 AK 1.5). When magnifying and observing a small amplitude singnal, superimposing on a high DC voltage, set AC-GND-DC to AC. The DC component is cut off and AC voltage can be observed by increased sensitivity.

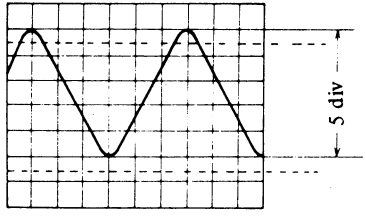


Fig. 7-2

7.1.3 Measurement of frequency and period

This will be explained by Fig. 7-3 as an example.

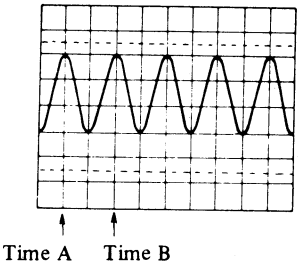


Fig. 7-3

One period covers the time A and time B, which are separated from each other by 2.0 div on the screen.
When the sweep time is 1 ms/div, the period is given by 1 ms/div x 2.0 = 2.0 ms.
Accordingly, the frequency is 1/2.0 ms = 500 Hz. (However, when the knob X10 MAG is at pulled out position, TIME/DIV must be converted to 1/10 since the trace is magnified.)

7.1.4 Measurement of time difference

Triggering signal source SOURCE is selected as offering reference signal when measuring the time difference between two signals.
In Fig. 7-4, assume that pulse trains as shown in (a). Then (b) shows the case when CH1 is taken as the triggering signal source and (c) the case where CH2 is taken. This means that CH1 is used as the triggering signal when investigating the length of time by which the signal of CH2 is delayed from the signal of CH1. CH2 is used in the reversed case. In other words, the signal leading in phase is selected as the triggering signal source.
If this process is reversed, the portion to be measured may sometimes not appear on the screen.
Read the time difference by the interval between 50% amplitude points of the two signals. Sometimes the superimposing method is more convenient from the point of view of procedure.

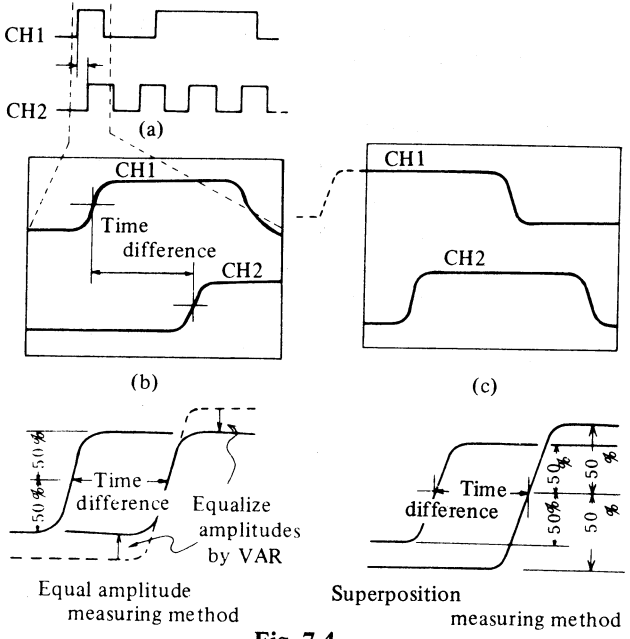


Fig. 7-4

NOTE: Since the pulsed wave contains many high-frequency wave components (higher harmonics) depending on its width or period, pay the same attention as given to high frequency signals when handling it. Accordingly, use a probe or coaxial cable and shorten the earth lead wire as much as possible.

7.1.5 Measurement of rise (fall) time.

To measure the rise time pay attention not only to the above-mentioned items but also to measurement error. The following relationship exists between 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.

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

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope, the effect of the rise time of the oscilloscope on the measurement can be neglected. However, if both are close to each other, measurement error may be caused.
The true rise time is given by

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

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

$$fc \times tr = 0.35$$

Where, fc : Frequency band (Hz)
tr : Rise time (s)

7.1.6 Triggering for complexed waveform

In the case shown in Fig. 7-5 (a) where two waveforms greatly differnt in amplitude alternate, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected as Y line, two waveforms, 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. 7-8 (b), for which no synchronization can be taken.
In such a case, rotate LEVEL clockwise until the trigger level comes to Y'line. Then the waveform on the screen becomes the one is shown in Fig. 7-8 (c) above which starts with B and advances to C, D, E, F, . . . and which allows synchronization.

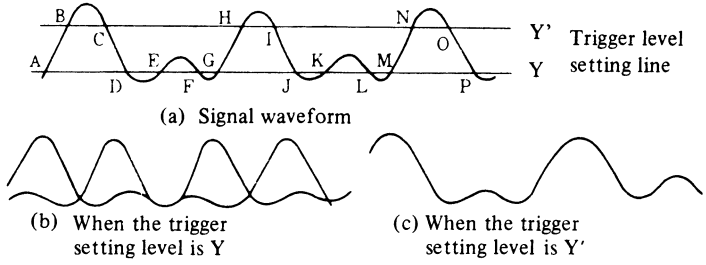


Fig. 7-5 Triggering for complexed waveform

7.1.7 Triggering for observing two waveforms

(1) When two signals on CH1 and CH2 have the same frequencies or the frequencies of an integral number or the frequencies in a relation of a specific time difference, the INT TRIG switch selects either CH1 or CH2 as a reference signal. CH1 position selects CH1 signal as a reference, and CH2 position selects CH2 signal.

(2) For an observation of signals of different frequencies, set the INT TRIG switch to VERT MODE. The trigger signal is acquired separately for each channel, and the waveform of the each channel is stably triggered.

VERT MODE

Trigger signal is obtained in the following steps.

① Set the SOURCE switch to INT.
② Set the INT TRIG switch to VERT MODE.
③ Select the MODE switch.

Relation of trigger signal sources and switches

SOURCE		INT			LINE	EXT
INT TRIG switch		CH1	CH2	VERT MODE		
V MODE	CH1	CH1	CH2	CH1	Line	External
	CH2	CH1	CH2	CH2		
	ALT	CH1	CH2	CH1, CH 2(ALT)		
	CHOP	CH1	CH2	ADD		
	ADD	CH1	CH2	ADD		

When the SOURCE switch to INT, INT TRIG switch to VERT MODE, and MODE switch to ALT, the input signals applied to CH1 and CH2 become trigger source alternatively at each sweep. Consequently, even for an observation of two waveforms of different frequencies, the waveform of the each channel is stably triggered.

In this case, the signal should be applied to both CH1 and CH2, and the two signals have the same level portion in excess of the rated amplitude each other. There should be a common portion of levels available that is above the rated amplitude of CH1 and CH2.

When a sinewave is applied to CH1, and a square wave is applied CH2, "A"s in Fig. 7-6 are the levels possible for triggering.

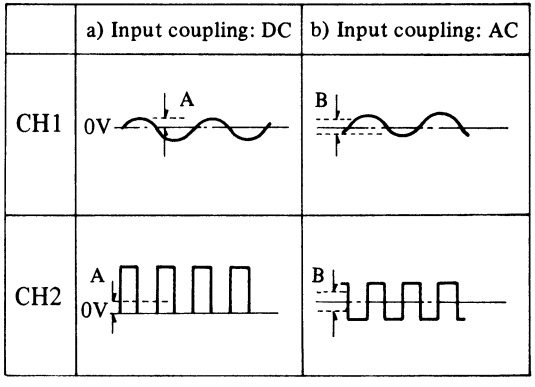


Fig. 7-6

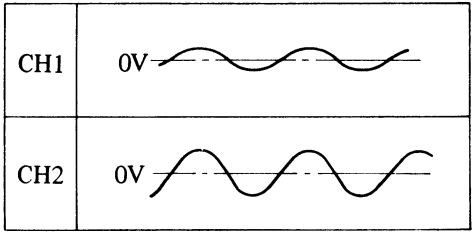
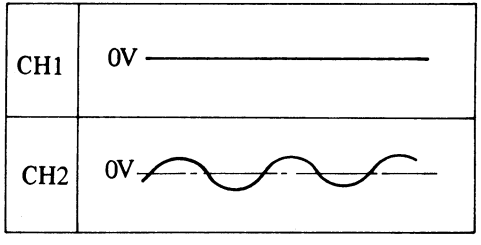


Fig. 7-7

In order to expand the trigger range, AC coupling is applied to the CH2 side.
When either the CH1 or CH2 input signal is smaller as shown in Fig. 7-7, adjust the VOLTS/DIV switches and to obtain sufficient amplitudes.

The VERT MODE triggering requires 1.5 div more than the amplitude required for an observation of CH1 or CH2.
The VERT MODE triggering is not possible when the signal is applied to only one channel as illustrated on Fig. 7-8.



Do not trigger with the VERT MODE when $\frac{\text{VAR}}{\text{PULL}}$ x5 GAIN are in the pulled out position (x5 GAIN mode).

7.1.8 How to use TV exclusive trigger

(1) On the composite video signal of TV waveform
With TV waveform observation, composite signals containing video signal, blanking pedestal signal, and synchronizing signal are often measured, as shown in Fig. 7-9. However, since the waveform is complex, a special circuit is needed to effect a stable triggering with vertical waveform.

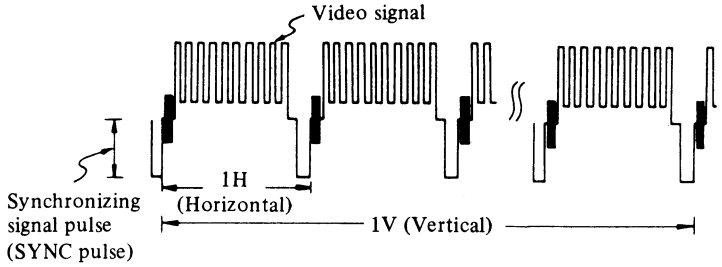
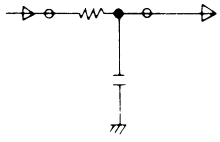
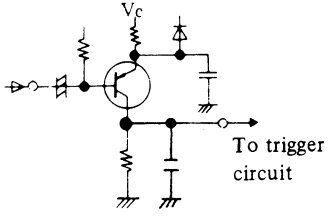


Fig. 7-9

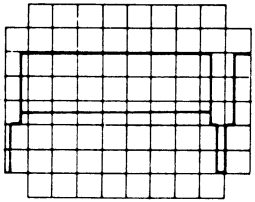
(2) Difference in the circuits from conventional oscilloscopes
The Hitachi VC-6041 oscilloscope provides the TV exclusive separator circuit as shown below.

Table 7-1

	Exclusive cirucit for conventional oscilloscope		Exclusive circuit for this instrument (Principle drawing)
	General cirucit	**Simple synchronizing circuit**	**TV exclusive synchronizing separator circuit**
Circuits	Video signal To trigger circuit 	To trigger circuit 	
Features	Hard to trigger, because video signal is applied directly as trigger signal.	Triggering is more easily effected than in the circuit shown at left, because the signal is integrated to remove high frequency components.	Stable trigger is obtained since SYNC pulse is picked up, amplified, and then integrated to remove high frequency components.

(3) Operation

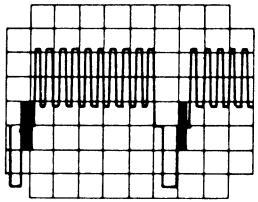
To observe vertical signal



MODE: TV-V

Fig. 7-10

To observe horizontal signal

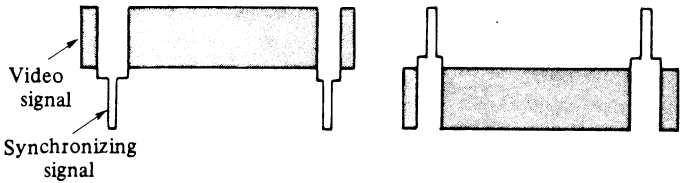


MODE TV-H

Fig. 7-11

NOTE: (1) When this oscilloscope is in the TV mode, trigger level operation is unnecessary.
(2) This oscilloscope triggers with only (-) synchronizing signal.

(REFERENCE)



(a) Example of (-) synchronizing signal

(b) Example of (+) synchronizing signal

Fig. 7-12

7.1.9 DC OFFSET

The oscilloscope provides the DC offset voltage display of ±1 to ±100V according to the range.
Fig. 7-13 shows the function of DC OFFSET.

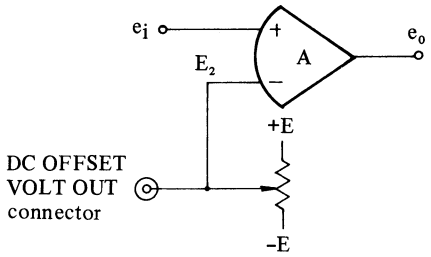


Fig. 7-13 Diagram of DC OFFSET

There is following relation among the differential amplifier output voltage e_o, the input voltages e_i and E_2

$$e_o = A(e_i - E_2)$$
$$e_i = E_{DC} + e_{AC}$$

(Where E_{DC} is a DC input and e_{AC} is an AC input)

Set the controls so that $E_2 = e_{DC}$ is attained.
Then $e_o = A \cdot e_{AC}$ is obtained.
The DC component can be removed for an observation.

Table 7-2 OFFSET voltage ranges

VOLTS/DIV	DC OFFSET voltage
5mV/div – 50mV/div	more than ±1V (x1)
0.1V/div – 0.5V/div	more than ± 10V (x10)
1V/div – 5V/div	more than ±100V (x100)

When V VAR/PULL X5 GAIN switch is in the UNCAL mode or is pulled out, the output voltage of DC OFFSET is not calibrated When measured with an external digital multimeter (DMM), multiply the DMM reading by the multiplier written above in indentation ( ).

Read next paragraph for the detailed explanation of measurement with a DMM connection.

7.1.10 Measurement by the DC OFFSET function

In order to readout the voltage level digitally, connect a DMM to the DC OFFSET output terminal and set the oscilloscope to the DC OFFSET mode. See Fig. 7-14.

(1) Measuring DC component

Align level ⓑ with the center graticule and read the DMM digital value. (+2 V should be displayed.)

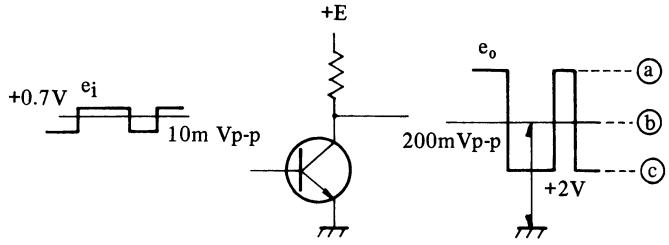


Fig. 7-14 Transistor amplifier

(2) Measuring AC component

When the above is performed with an input sensitivity of 50 mV/division, then 4 divisions amplitude must be present on the oscilloscope screen.

The AC component is observable on the oscilloscope screen where as the DC component is measurable on a DMM, and there is no need for any complicated switching as such needed for conventional oscilloscopes. Moreover, the DC OFFSET function provides readings of peak to peak value (p-p) of e_0 on a DMM.

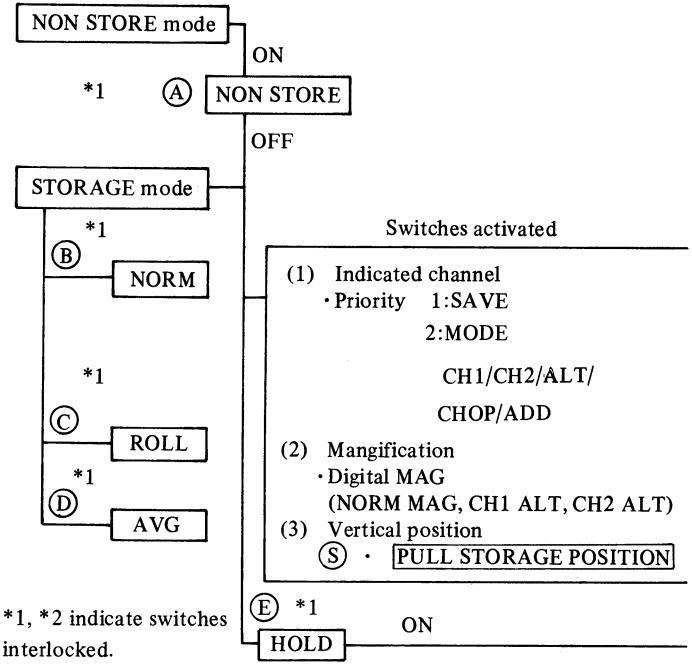
Align level ⓐ with the center graticule line on the screen, read the DMM value and name it V(a). Then align level ⓒ with the graticule line and readout V(c). The peak to peak (p-p) is the difference between V(a) and V(c), and the value

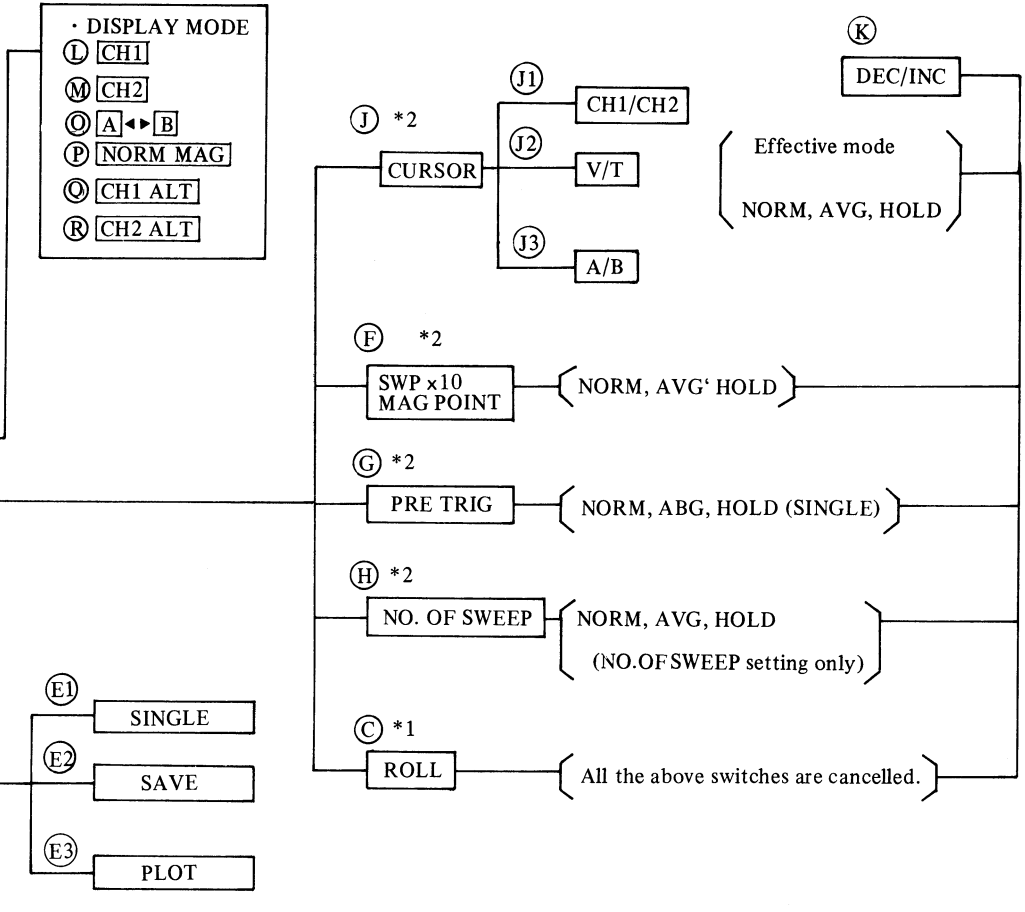
can be read digitally on the DMM.

As explained above, the DC OFFSET function with DC OFFSET output terminal offers an improved operational convenience and a highly accurate measurement in detailed waveform portions.

7.2 DIGITAL STORAGE MEASUREMENT

1. Switches used in the digital storage measurement




· DISPLAY MODE
Ⓛ CH1
Ⓜ CH2
Ⓝ A◄►B
Ⓟ NORM MAG
Ⓠ CH1 ALT
Ⓡ CH2 ALT
Ⓚ
DEC/INC
Ⓙ *2
CURSOR
Ⓙ1
CH1/CH2
Ⓙ2
V/T
Ⓙ3
A/B
Effective mode
NORM, AVG, HOLD
Ⓕ *2
SWP x10 MAG POINT
NORM, AVG' HOLD
Ⓖ *2
PRE TRIG
NORM, ABG, HOLD (SINGLE)
Ⓗ *2
NO. OF SWEEP
NORM, AVG, HOLD
(NO.OF SWEEP setting only)
Ⓒ *1
ROLL
All the above switches are cancelled.
Ⓔ1
SINGLE
Ⓔ2
SAVE
Ⓔ3
PLOT

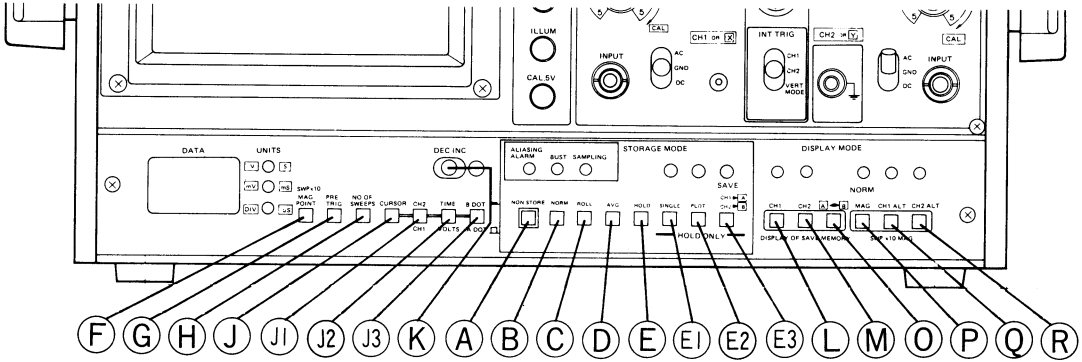


Fig. 7-15: Front panel/Section B

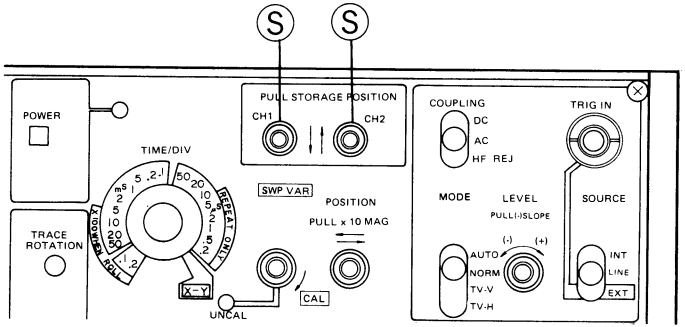


Fig. 7-16 Front panel/Section A

2. The indicators operate during STORAGE mode

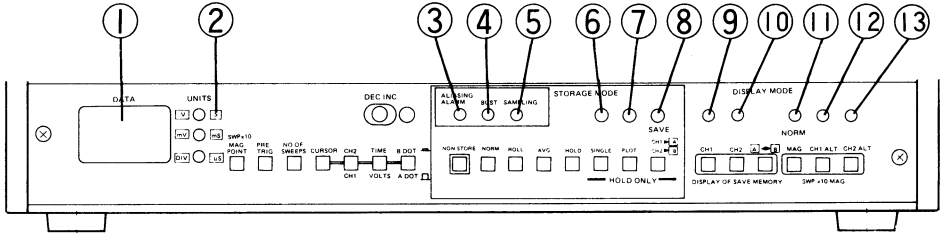


Fig. 7-17 Front panel/Section B

① DATA indicator

Pre-trigger point, time and voltage reading by cursors, average number of accumulated waveforms, and magnifying point are indicated by LEDs.

② UNITS in two colors

Indicates the units for figures indicated on DATA indicator, ①.
Green: s, ms, and μs
RED: V, mV and DIV

③ ALIASING ALARM (red)

Alarms possible aliasing when the frequency of sync signal is higher than ¼ of sample clock frequency.

④ BUSY (red)

Lights up red to indicate the microcomputer is busy at GPIB and no more switch control can be accepted.

⑤ SAMPLING (red)

Lights up to indicate that data sampling is under progress.

⑥ SINGLE (green)

Lights up while a waveform is proceeding in SINGLE mode. Lights off when a sweep is completed.

⑦ PLOT (green)

Lights up to indicate that the PLOT (printer) output is available.

⑧ SAVE (green)

Illuminates while the data process is performing to store the displayed waveform into save memory.

⑨ **CH 1 (green)**

Lights while the save memory A is displayed where the real time CH1 waveform has been displayed.

CH 1 (red)

Lights while the save memory B is displayed where the real time CH1 has been displayed.

⑩ **CH 2 (red)**

Lights while the save memory B is displayed where the real time CH2 display has been.

CH 2 (green)

Lights while the save memory A is displayed where the real time CH2 display has been.

⑪ **NORM MAG (red)**

Lights up to indicate that waveform is magnified in NORM MAG mode.

⑫ **CH 1 ALT (red)**

Lights up to indicate that the waveform is magnified in the CH1 ALT mode.

⑬ **CH2 ALT (red)**

Lights up to indicate that the waveform is magnified in the CH2 ALT mode.

7.3 DIGITAL STORAGE MEASUREMENT

The following procedures explain how to set up and use the digital storage capacities for the VC-6041.

(1) Obtain the optimum INTENSITY and FOCUS for easy measurement.
(2) Display the optimum waveform size to minimize reading errors.
(3) Check that the optimum capacitance correction is obtained when using a probe. (See 6.2.2 Probe compensation.)

7.3.1 Normal mode (NORM)

This is the most basic measurement mode in the storage mode display. The input signal is dititized by the sample clock which is matching the TIME range. Repeated display is obtained in this mode.

(1) DC voltage measurement
ⓐ Initial control setting: Front panel/Section A
- Trigger
  - MODE: AUTO
  - LEVEL: Midrange
  - SOURCE: INT
  - INT TRIG: CH1
- Horizontal axis
  - TIME/DIV: As required
  - SWP VAR: Calibrated detent (fully clockwise)
  - POSITION: Midrange

PULL X10 MAG: Off (Push-in)

- Vertical axis

  VOLTS/DIV: as required

  VOLTS/DIV VAR: Calibrated detent (Fully clockwise)

  AC-GND-DC: DC (AC for AC coupling)

  POSITION: Midrange

  MODE: CH1

Set the AC-GND-DC switch to GND and vertically position the baseline trace to fix the zero (0) line. This does not need to be the center graticule line.

Adjust VOLTS/DIV at the desired position. Then select DC by the AC-GND-DC switch.

Trace moves according to the amount of the DC voltage.

Measure the amplitude to trace movement. Multiply the indicated VOLTS/DIV number on the control to obtain the real DC voltage.

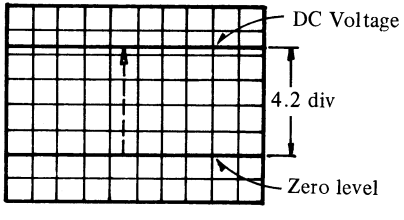


Fig. 7-18

See Fig. 7-18. If VOLTS/DIV is set to 50 mV/div.

50 mV/div x 4.2 = 210 mV

When the probe AT-10 AK1.5(10:1) is used, the voltage of signal is ten times.

50 mV/div x 4.2 x 10 = 2.1V

ⓑ Trigger point setting (Set at 0.0, if not necessary)

Press [PRE TRIG] switch. Set the pre-trigger portion by operating [DEC/INC] switch.

(The position can be varied by each 0.1 division from 0 up to 9.9 divisions.) The trigger point is indicated by a dot and the division number indicated on seven segment indicator.

Example: To display pre-trigger by 4 divisions.

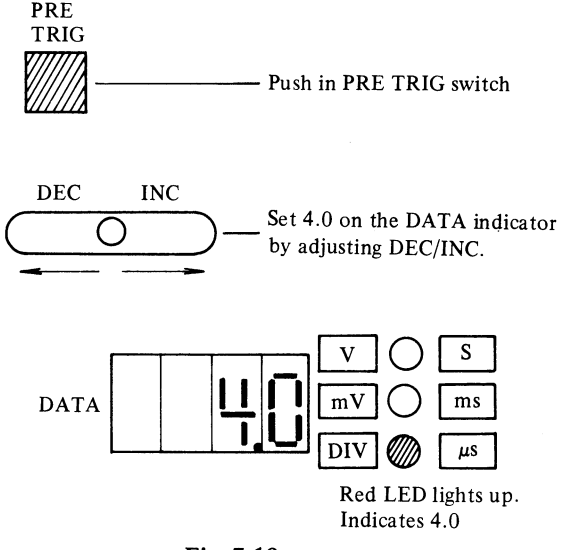


Fig. 7-19

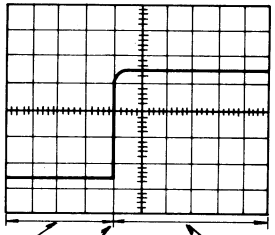


Fig. 7-20 Display sample of pre-trigger waveform

(2) AC voltage measurement

ⓐ Primary adjustment

Set the zero level on the screen at desired position. Follow procedures done for DC measurement. See Fig. 7-21. When VOLTS/DIV is set to 1V/div.

1V/div x 5 = 5 Vp-p

(When the probe AT-10 AK 1.5 (10:1) is used, it will be 50 Vp-p.)

When a small amplitude signal, that is superimposed onto a high DC voltage is measured, set AC-GND-DC to AC. Then DC component is cut off. Rotate VOLTS/DIV to obtain an enlarged reading of component.

ⓑ Trigger point setting

Perform the same procedure as (1) DC voltage measurement.

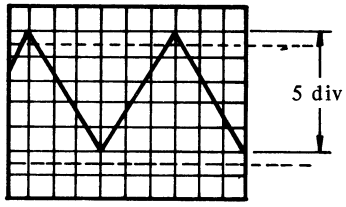
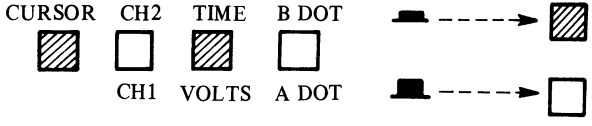


Fig. 7-21

(3) Time and voltage measurement of acquired waveform by the STORAGE mode. The following explains the CURSOR function.



Ⓐ Press the [CURSOR] switch.

Ⓑ Select the desired channel to position cursor dot.

CH1 . . . . . (Push-out position)

CH2 . . . . . (Push-in position)

*As an example, CH1 has been selected.

Ⓒ Select measurement for TIME or VOLTS.

VOLTS . . .

TIME . . . .

*As an example, TIME has been selected.

Ⓓ Turn the lever switch [DEC/INC] to INC side. A cursor dot appears on the CH1 waveform display on the screen.

Ⓔ Position the cursors A and B to select the desired size of cycle of a waveform on the screen.

(See Fig. 7-23: A cycle between the time A and time B.)

A DOT . . . . ⊓

B DOT . . . . ⊓

i) Position the cursor dot A: Select A DOT by pushing the DOT button out.
Operate [DEC/INC] till the desired cursor position is obtained.

ii) Position the cursor dot B: Select B DOT by pushing DOT button in.
Operate [DEC/INC] till the desired cursor position is obtained.

Ⓕ Display on the DATA indicator

As an example, 2.0 divisions on screen has been selected as a waveform cycle by the above procedure Ⓐ to Ⓔ . If a sweep time is 1 ms/div, (1 ms x 2.0 = 2.0 ms), the number 2.0 appears on the DATA indicator. (See Fig. 7-22)

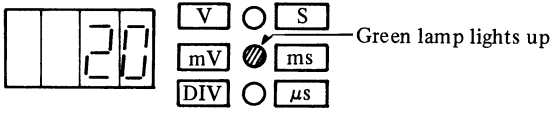


Fig. 7-22

Therefore the frequency will be: 1/2.0 ms = 500 Hz

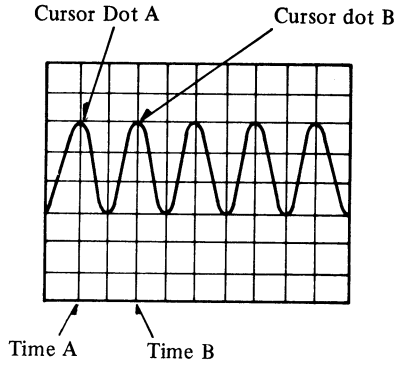


Fig. 7-23

(4) Magnified sweep

The digital storage oscilloscope VC-6041 is provided with Ⓐ PULL X10 MAG and Ⓑ SWP X10 MAG functions. Ⓐ PULL X10 MAG can be used in both oscilloscope and storage oscilloscope modes.

Position the measuring portion of waveform to the scale center by the horizontal POSITION control knob. Then pull out the X10 MAG switch.

The measuring portion will be magnified on both sides from the center. The sweep speed set by TIME/DIV is ten times of the actual speed.

Divide the TIME/DIV reading by 10 to obtain the actual speed.

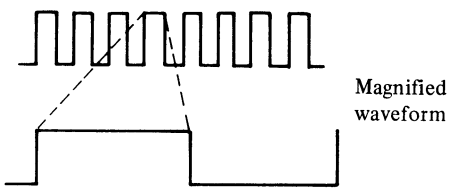


Fig. 7-24

Ⓑ SWP X10 MAG can be used only with the storage mode.

Ⓑ-1 NORM MAG

The current waveform display is digitally magnified by ten times.

ⓐ Push in [SWP X10 MAG POINT].
A dot appears to indicate the magnification starting point on the waveform. Operate [DEC/INC] to position the dot at the desired position.
Operate on INC side when no dot appears.

ⓑ Press the [NORM MAG] switch in the DISPLAY MODE control section. The red LED lights up.

◉ ← Red LED lights.
NORM
MAG
□

One division of the normal waveform is magnified by 10 times starting from the above described starting dot.

NOTE: When dual traces are displayed on the screen, both CH1 and CH2 are magnified from the starting dots.

Example:

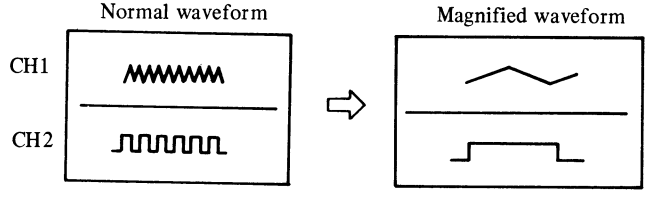


Fig. 7-25

Ⓑ-2 CH1 ALT MAG

ⓐ Press [SWP X10 MAG POINT].
Operate [DEC/INC] to position the dot at the desired position.

ⓑ Press the [CH1 ALT] switch in the DISPLAY MODE control section. The CH1 waveform is held on the CH1 position, where X10 magnified CH1 display appears on the CH2 position. Red LED lights up.

◉ ← Red LED lights.
CH1 ALT
□

Therefore, the CH2 display disappears from the screen.

Example:

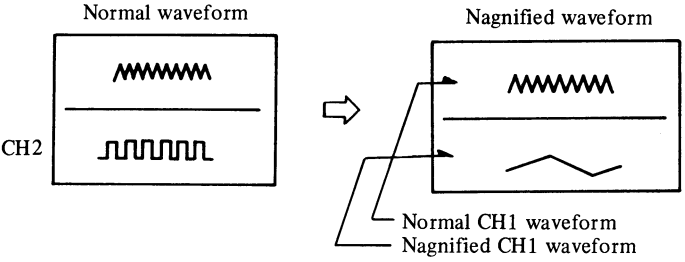


Fig. 7-26

(B-3) CH2 ALT MAG

Follow the same procedures as (B-2) CH1 ALT MAG, except operate CH2 switches where defined as CH1 in the former section (B-2) . Red LED lights up.

⊙ ← Red LED lights.
CH2 ALT
□

(Press the CH2 ALT switch in the DISPLAY MODE control section.)

Example:

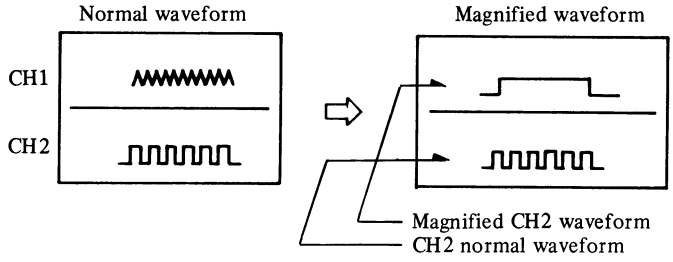


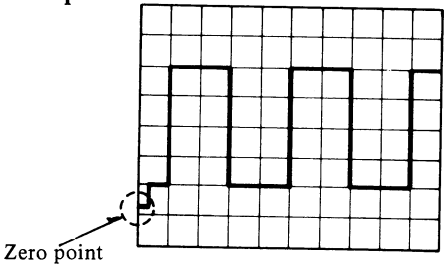
Fig. 7-27

NOTE: PULL X10 MAG and NORM MAG or CH1/ALT, or CH2/ALT can be operated together at once. Perform NORM MAG, CH1/ALT, or CH2/ALT. Then pull out PULL X10 MAG. By this, the input waveform will be magnified by (10 x 10 = 100) a hundred times. Divide the TIME/DIV reading by 100 to obtain the actual speed.

(5) PLOT output of displayed waveform data. See 7.3.6.
(6) Storing displayed waveform data to the SAVE memory. See 7.3.7 (1).
(7) Display of stored waveform in save memory. See 7.3.7 (2).
(8) Zero point display
The equipment employs a zero point display function.

ⓐ Set the NORM switch of STORAGE MODE on the push in position. Then select GND of the AC-GND-DC switch. Then select the zero level at a described position for easy reading.
ⓑ Then switch AC-GND-DC to the DC position.
ⓒ The DC level is observed on the screen, and the zero point is displayed at the horizontal 0.025 div (at 0.25 div in X10 MAG display).

Example:

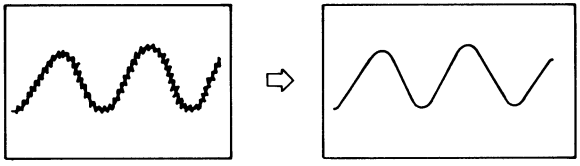


NOTE: 1) The separate adjustment is required for each CH1 and CH2 displays.
2) In the ADD mode, the zero point appears after both GND selection of CH1 and CH2 has been performed.
3) When the vertical position is readjusted after the settings, select GND again and repeat the procedure.

ⓓ In order to clear zero point display;
- Select AC or DC on the AC-GND-DC switch.
- Select ADD of the V. MODE switches.

7.3.2 Average mode (AVG)

(1) DC voltage measurement
ⓐ Initial adjustment (Front panel/Section A)
Perform the same procedure as instructed in 7.3.1 (1) DC voltage measurement.
ⓑ Setting trigger point
ⓒ Setting number of sweeps
i) Press NO. OF SWEEPS
The number "2" automatically appears on the DATA indicator as the POWER is set on.
ii) Operate DEC/INC to set the desired number for accumulation of sweep to be averaged. (2 to 256 accumulation is available.) When the maximum 256 is selected it takes one minute to average the data and to display the averaged waveform. The SAMPLING LED illuminates to indicate averaging is under process.
ⓓ Press AVG
The AVG display appears on the screen showing the average waveform of acquired sweeps of accumulated numbers instructed by operator.



Non-average waveform

The waveform averaged by 32 sweeps.

Fig. 7-28

(2) AC voltage measurement

ⓐ Initial adjustment

Take the same setting method as 7.3.1 (2). AC voltage measurement.

ⓑ Trigger point setting

Follow the procedure 7.3.1 (1).

ⓒ Setting average number

i) Press the [NO. OF SWEEPS] switch.

ii) Operate [DEC/INC] switch to obtain the desired number of sweep accumulation.

ⓓ Press [AVG] push button.

(3) Measurement of TIME and VOLTS of the acquired waveform. Follow the measurement procedure instructed on 7.3.1 (3).

(4) Sweep magnification

See 7.3.1 (4).

(5) PLOT output of the display data.

See 7.3.6.

(6) Storing the display data to SAVE memory.

See 7.3.7 (1).

(7) How to display stored waveform in SAVE memory.

See 7.3.7 (2).

7.3.3. ROLL MODE

When TIME DIV is set within the ROLL range, data is acquired with X100 TIME/DIV and displays the waveform in the ROLL mode.

During the ROLL mode is actuated, the operation of CURSOR,. SWP X10 MAG POINT, PRE TRIG, NO. OF SWEEPS are inactivated.

(1) Initial setting (Front panel/Section A)

- Trigger
  - MODE : AUTO
  - LEVEL : Midrange
  - SOURCE : INT
  - INT TRIC : CH1
- Horizontal axis
  - TIME/DIV : As required with in ROLL range between 5 ms to 2s.
  - SWP VAR : Calibrated detent (Fully clockwise)
  - POSITION : Midrange
  - PULL X10 MAG : Off (Push-in)
- Vertical axis
  - VOLTS/DIV : As required
  - VOLTS/DIV VAR : Calibrated detent (Fully clockwise)
  - AC-GND-DC : DC (Select AC for AC coupling)

POSITION : Midrange
MODE : CH1

(2) Press the [ROLL] button in the STORAGE MODE switch section. Data is acquired and begins display on the screen in ROLL mode.

(3) Press the [NORM] or [HOLD] button to release the ROLL mode.

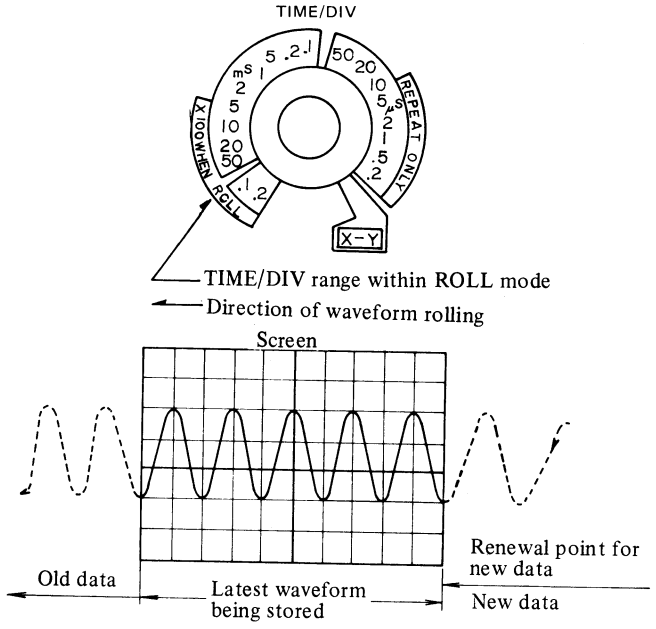


Fig. 7-29

ROLL mode: Repeats shifting stored waveform to the left by displaying new data at the far right.

×100 TIME/DIV : The TIME/DIV within ROLL mode range is provided with 5ms to 2s scale indication. However actual sampling is multiplied by 100 and it means 500ms/DIV to 200s/DIV are available.

(Example) When TIME/DIV is on 5ms. The sampling will be 500ms/division and therefore the one entire screen time to be renewed will be 500ms/DIV × 10 DIV = 5s.

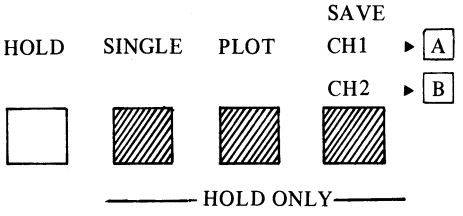
7.3.4 HOLD

When the [HOLD] button is pressed, any of NON STORE, NORM, ROLL or AVG sampling will be cancelled and the display data at the time of HOLD execution will be held on the screen.

Note. When the [HOLD] button is pressed in the NON STORE mode, the stored waveform kept in memory prior to the present NON STORE mode in either NORM, ROLL or AVG mode is displayed.

(1) Initial setting
All the front panel operation are disabled as either of NON STORE, NORM, ROLL, AVG mode sampling exclusively operates to freezed the display data in the HOLD mode.

(2) HOLD can be operated with the following three functions.



The above SINGLE, PLOT and SAVE can be operated only when HOLD is set on. Only HOLD mode explanation follows here.

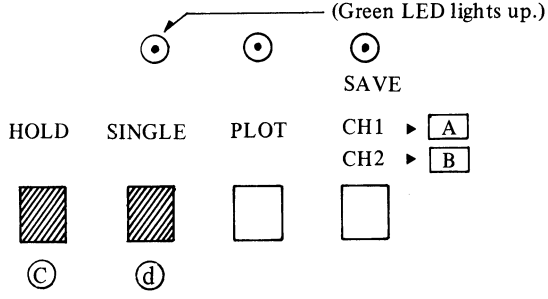
(3) TIME VOLTS measurement in the HOLD mode
ⓐ Press the [HOLD] button.
The display holds the current data at the time [HOLD] was pressed.
ⓑ Press the [CURSOR] switch.
Perform the procedure according to 7.3.1 (3) and on.

(4) Sweep magnification in the HOLD mode SWP ×10 MAG can be operated.
ⓐ NORM MAG
ⓑ CH1 ALT MAG
ⓒ CH2 ALT MAG
Perform the procedure according to 7.3.1 (4) Ⓑ and on.

7.3.5 SINGLE operation in the HOLD mode

This operation perform one sampling which renews the waveform display on the screen.

(1) SINGLE operation
ⓐ Perform 7.3.1 (1) on the front panel.
ⓑ Press the [HOLD] button.
ⓒ Press the [SINGLE] button.
ⓓ Green LED just above the SINGLE button lights up until the display appears on the screen.



ⓔ When the green light goes off, the SINGLE operation is finished. The new waveform appears and is held on the screen.

> The SINGLE function is highly effective in the observation of a transient event.

(2) Waveform measurement in SINGLE acquisition
The SINGLE mode measurement offers a normal ob-

servation of waveform done in the oscilloscope mode. However more effective observation is available by using the following functions:

ⓐ Measurement of TIME and VOLTS by using CURSOR.
See 7.3.1 (3).

ⓑ Magnified sweep
See 7.3.1 (4).

ⓒ PLOT output of waveform data
See 7.3.6.

ⓓ Storing waveform data into SAVE memory function.
See 7.3.7 (1).

ⓔ Displaying stored waveform data
See 7.3.7 (2)

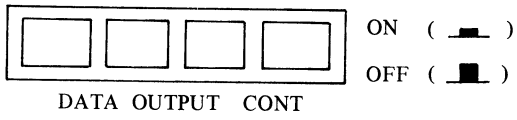
7.3.6 PLOT OUTPUT of waveform data

Display waveform is supplied to the PLOT output.

(1) The DATA OUTPUT CONT switches on the rear panel selects the plot speed and output mode.

Table 7-3. Data output control

	Speed	Rear panel switches 4	3	2	1	Remarks
Y-t output (Pen recorder)	1 s/div	X	OFF	OFF	OFF	CH1 and CH2 simultaneous output. CH1 data [CH1] CH2 data [CH2] See Fig. 7-30.
	2 s/div	X	OFF	OFF	ON	
	5 s/div	X	OFF	ON	OFF	
	10 s/div	X	OFF	ON	ON	
X-Y output	1 s/div	X	ON	OFF	OFF	CH1 and CH2 data [CH1] x axis sweep waveform [CH2] See Fig. 7-32.
	2 s/div	X	ON	OFF	ON	
	5 s/div	X	ON	ON	OFF	
	10 s/div	X	ON	ON	ON	



(2) Operation Procedure

ⓐ Select the data output control mode by pushing rear panel switches as shown in Table 7-3.

ⓑ Hold the waveform display by pressing HOLD button.

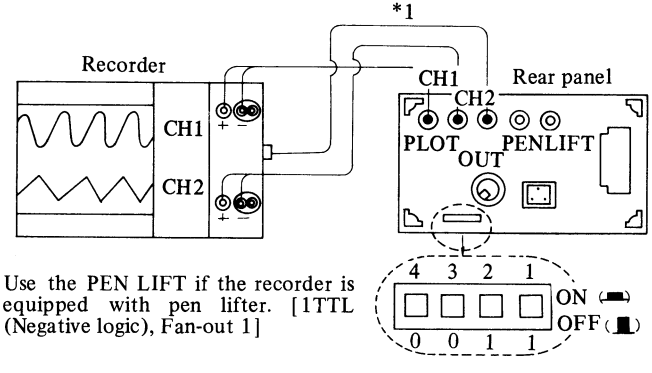
ⓒ Press PLOT button.

Green LED lamp lights up, and the data output begins. When the data output is completed, the LED lights off to indicate the end of the PLOT mode.

In order to end the data output before it is completed, press PLOT again later than 3 seconds after plot output starts. The PLOT mode is cancelled and the LED goes off.

Y-t output

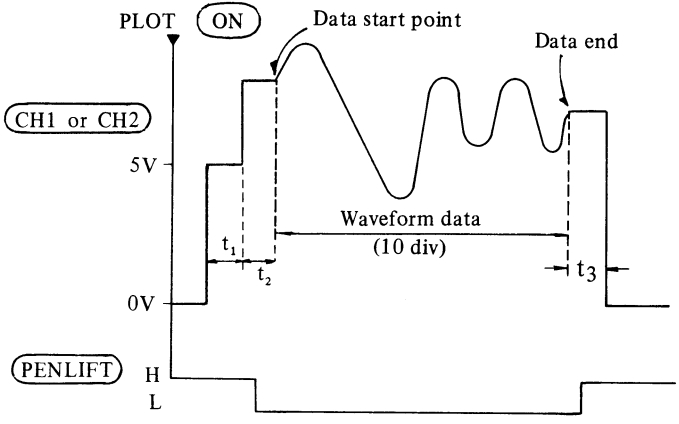
i) Example of connection



*1 Use the PEN LIFT if the recorder is equipped with pen lifter. [1TTL (Negative logic), Fan-out 1]

Fig. 7-30

ii) Output condition



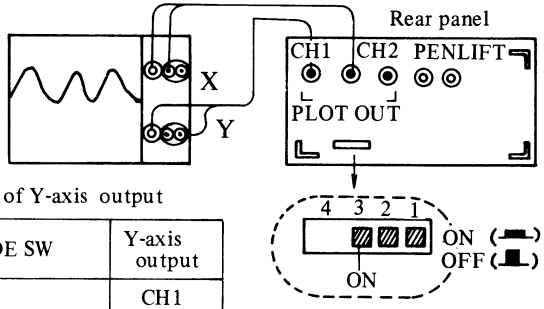
t_1, t_2, t_3 = 2 seconds approx.

Fig. 7-31

When the PLOT switch is depressed during data output, level of CH1 or CH2 becomes 0 V and PENLIFT level is set to High. However, in case the PLOT switch is depressed at both period of t1 and t2, this plot function has no influence on both levels of CH1 or CH2 and PENLIFT.

X-Y output

i) Example of connection



Setting of Y-axis output

V-MODE SW	Y-axis output
CH1	CH1
CH2	CH2
ALT, CHOP, ADD	CH1

Fig. 7-32

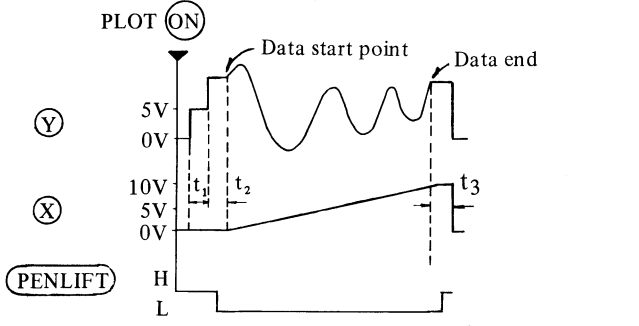


Fig. 7-33

When the PLOT switch is depressed during data output, level of X-axis and Y-axis becomes 0V and PEN-LIFT level is set to high. However, in case the PLOT switch is depressed at both period of t_1 and t_2, this plot function has no influence on both levels of X-axis, Y-axis and PENLIFT.

7.3.7 SAVE and reference display in the HOLD mode

The waveform sample displayed in the STORAGE mode can be stored in the SAVE memory function. The SAVE memory data can be displayed on the screen by the reference operation.

(1) SAVE operation

ⓐ When the STORAGE mode obtains the digitized display, press the HOLD switch to hold the display.

ⓑ Then press the [SAVE / CH1 ▶ A / CH2 ▶ B] switch.

CH1 data is stored into A memory, CH2 data is stored into B memory.

Green LED lights up during SAVE operation.

ⓒ The CH1 and CH2 waveform data is now stored.

CAUTIONS

The saved data will be broken, if next operations were done.

1) The data will be canceled, if the POWER is set off.

2) The data will be broken, if the AVG mode processing was done.
3) The old saved data will be replaced by a new one, if operate by the above save procedure again.

(2) Displaying save data waveform

Perform the following procedure in order to display the waveform data being stored in the SAVE memory.

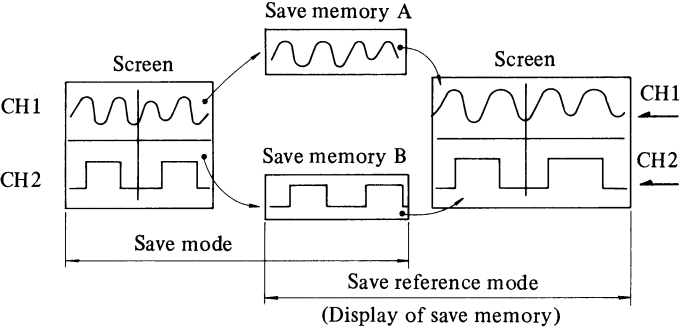
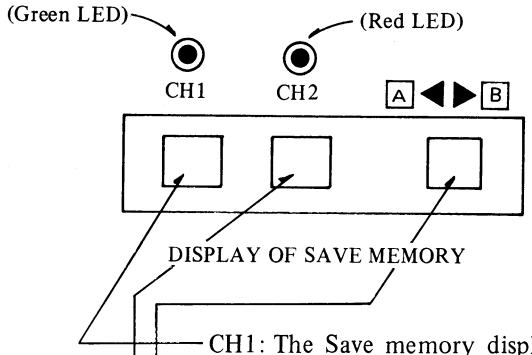


Fig. 7-34

ⓐ Operate three switches of DISPLAY OF SAVE MEMORY switches on the DISPLAY MODE switch section.



CH1: The Save memory display appears on the CH1 section on the screen.
Green LED lights up.
Second push releases the mode and the display will be the current real time waveform again.
The LED lights off.

CH2: Push switch to display the Save memory display on the CH2 section on the screen. The red LED lights up to indicate the Save memory being displayed.

A ◂▸ B: When either of CH1 or CH2 is set on, Save memory can be reversed in display position.

Example

* Press [CH1] — Display of Save memory A is positioned in CH1 section, and the green LED lights up.

Press [A◄►B] — Display of Save memory B is positioned in CH1 section, and the red lights goes on. Save A disappears, green LED goes off.

Press again [A◄►B] — Display of Save memory A returns to the CH1 position. Green LED lights up.

Display of Save memory B dissapears from CH1 position. Red LED lights off.

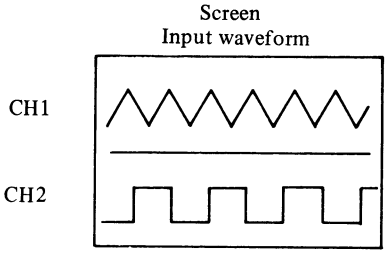
* Press again [CH1] — The display regains the current waveform.

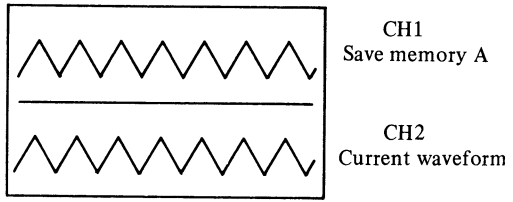
*) In case of example about CH2, alternate A with B and green with red and substitute CH1 by CH2 in the above explanation.

NOTE: The above operations are effective in NORM, and HOLD operations of the STORAGE MODE switch sections, except ROLL and AVG.

[Example]

Comparison of CH1 current waveform with SAVE memory A waveform.





Reverse (by input terminal)

Connect CH1 input into CH2 connector. Then compare the waveform with save memory display on CH1.

7.3.8 XY display of the waveform acquired in the HOLD mode

ⓐ Initial setting (Front panel/section A)

- Trigger

MODE	AUTO
LEVEL	Mid-range
SOURCE	INT
INT TRIG	CH1

- Horizontal axis

TIME/DIV	Any position except X-Y , display 2 cycles of a waveform
SWP VAR	Calibrated detent
POSITION	Mid-range
PULL X10 MAG	OFF (Pushed-in)

- Vertical axis

VOLTS/DIV	As required
VOLTS/DIV VAR	Calibrated detent (Fully clockwise)
AC-GND-DC	DC (AC for AC coupling)
POSITION	Mid-range
MODE	ALT or CHOP

ⓑ Establish NON STORE mode for the display desired to be observed in X-Y display. After verifying the waveform, push the [NORM] switch of STORAGE MODE section. The data is acquired.

NOTES: 1) If the zero point display is operating while an X-Y display, the phase of the X-Ydisplay may be out of place. Verify that the zero point display is released with obtaining the NORM or HOLD mode.
To release the zero point display, reset the AC-GND-DC selector in the A section to AC or DC, after selecting ADD with V, MODE set the ALT or CHOP switch in.
2) Display two cycles in 10 divisions. The phase deviation may increase when more than two cycles are displayed because of the horizontal resolution.

ⓒ When the waveform to be X-Y displayed is obtained in the NORM mode, switch the mode to HOLD by pressing the [HOLD] button.

ⓓ When HOLD mode is established, rotate and set the TIME/DIV control at [X-Y] position.

8. SPECIFICATIONS

CRT

Type	Large 6″ screen with internal graticule. Approximate 12 kV acceleration potential.
Phosphor	P31 standard
Graticule	8 x 10 div (1div = 10 mm) internal graticule
Focussing	Possible (with automatic focus correction circuit)
Trace rotation	Present
Brightness adjustment	Possible
Scale illumination	Variable

Z-AXIS INPUT (INTENSITY MODULATION)

DC-coupled, positive-going signal decreases intensity:
5 Vp-p signal causes noticeable modulation at normal

Intensity	DC to 2 MHz
Input impedance	47 kΩ (typ.)
Maximum input voltage	30V (DC + peak AC)

VERTICAL DEFLECTION SYSTEM (2 identical channels)

Bandwidth and rise time	DC to at least 40 MHz and rise time 8.8 ns or less. DC to at least 7 MHz and rise time 50 ns or less at magnifier extends. The AC coupled lower-3 dB point is 10 Hz or less.
Deflection factor	5 mV/div to 5 V/div in 10 calibrated steps in a 1-2-5 sequence. Uncalibrated continuous control extends deflection factor to at least 12.5V per division in the 5 V/div position. X5 MAG increases sensitivity of each deflection factor setting to 1 mV/div.
Accuracy	X1 : ±3%, X5 : ±5%
Display modes	CH1, CH2 (normal or invert), Alternate, Chopped (approximate 250 kHz), Added
Input impedance	Approximately 1M ohm in parallel with 30 pF
Maximum input voltage	300V (DC + peak AC) or 500 Vp-p AC at 1 kHz or less
Input coupling	AC-GND-DC
DC offset	±1 to ±100V (Uncalibrated when in V. UNCAL or/and V. MAG mode)
DC offset volt out	Provides the DC offset voltage.

HORIZONTAL DEFLECTION SYSTEM

Sweep time	• Non storage mode

0.2 μs/div to 0.2 s/div
(1-2-5 sequence of 19 steps)
- Normal mode
  10 μs/div to 0.2 s/div
  (1-2-5 sequence of 14 steps)
- Repeat mode
  0.2 μs/div to 5 μs/div
  (1-2-5 sequence of 5 steps)
- Roll mode
  500 ms/div to 20 s/div
  (1-2-5 sequence of 6 steps)

(**Note**: Repeat mode is available only with repetitive waveforms)

Maximum sweep time	20 ns/div (at X10 MAG)
Sweep fine adjustment	2.5 times or more (Calibrated detent)
Accuracy	±3%
Sweep magnifying	x10, Accuracy : ±5%
Position adjustment	Possible

TRIGGERING SYSTEM

Trigger modes	Automatic, Normal, TV (TV-H or TV-V)
Trigger source	Internal (CH1, CH2, VERT MODE) Line, External
Trigger slope	+, -
TV sync polarity	TV (-)

Triggering sensitivity and frequency

Frequency	Internal	External
20 Hz to 5 MHz	0.5 div	200 mV
5 MHz to 40 MHz	1.5 div	800 mV

TV-V sensitivity	SYNC section less 1 div or 1V
AUTO low band	Approximately 30 Hz
Trigger coupling	AC : 20 Hz to full bandwidth DC : DC to full bandwidth HF REJ: Attenuates signals below approximately 1 MHz
External trigger input impedance	Approximately 1M ohm in parallel with 30 pF (except HF REJ)
Maximum input voltage	300V (DC + AC peak) at 1 kHz or 600V (p-p) AC

X-Y OPERATION (CH1 ; Horiz. CH2 ; Vert)

Note : X-Y operation is possible in oscilloscope mode only. In storage mode, this operation is possible after storaging.

Deflection factor	Same as vertical deflection
X-bandwidth	DC to at least 500kHz $^{+1\ dB}_{-3\ dB}$
Phase error	3° or less from DC to 50 kHz

CALIBRATOR

An approximate 1 kHz frequency 0.5V (±3%) square wave

SIGNAL OUTPUT

CH1 VERT SIGNAL OUTPUT
Output voltage is at least 20 mV/div into a 50 ohm load.
Bandwidth is 50 Hz to at least 5 MHz.

DIGITAL STORAGE

WAVEFORM STORAGE

Memory capacity	4000 W/CHx 2
Vertical base resolution	8 bits/10 div
Horizontal base resolution	400 steps/div
Maximum sampling rate	Single channel sampling; 40 MHz Dual channel sampling; 20 MHz Sampling rate depends on the time range. (400 samples/div)
Maximum storage frequency (Maximum amplitude accuracy; 30% or less)	• 40 MHz at single channel and for repetitive signal. • 20 MHz at dual channel and for repetitive signal • 10 MHz at single channel for one shot signal • 5 MHz at dual channel for one shot signal

DATA ACQUISITION

NORM storage mode **AVG mode**	Renews the data by each triggering Averages input signals by the selected number of sweeps and displays the consequence after the averaging reaches the selected number. (The number of times: exponent of 2, maximum 256 times)
HOLD mode	Holds the waveform displayed on the CRT by the HOLD swich
SINGLE sweep	Renews the display by the first trigger and no more trigger is actuated.
ROLL mode	Shifts the data right to left consequently on the CRT. (Renewed point is the right end.)

DATA SAVE

Up to two waveforms can be displayed on CRT saved by the SAVE switch. Up to two storaged waveforms can be displayed on the CRT.
In the AVG mode, however, the saved waveforms are destroyed.

PRE-TRIGGER

Changeable 0 to 9.9 div
(Changeable every 0.1 div)
Trigger position is displayed on the CRT waveform as a dot in the DATA indicator.

PLOT OUTPUT

Y axis output:
(Data output)

Two channels (Y-t output)
One channel (X-Y output)
1 V/div ±100 mV

X axis output
for X-Y recorder:
(sweep output)

One channel
1 V/div ±100 mV

Output time:
(both X and Y)

Four steps of 1, 2, 5, 10 s±5% div

Load resistance:
(both X and Y)

2 k ohms or more

Pen lift:

TTL negative, Fan out 1

DIGITAL OUTPUT

(Option)

Provides data by GPIB interface.
Data: (Measurement conditions and waveform)
Measurement conditions:
Vertical mode, Input coupling
TIME/DIV, VOLTS/DIV,
Pre-trigger, Ground reference
Waveform: Decimal progression
(By block transfer system)

CURSOR DISPLAY

Displays the time or voltage difference between specified cursors.

X-Y DISPLAY

Provides X-Y display of stored waveform.

MAGNIFYING DISPLAY

Magnifies and displays one division of the waveform after storage by ten times starting from the cursor point.

POWER SUPPLY

VOLTAGE	FUSE
100V (90 to 110V)	5A
120V (108 to 132V)	5A
220V (198 to 242V)	3A
240V (216 to 264V)	3A

Frequency 50 to 60 Hz
Power consumption Approx. 120W

ENVIRONMENT

Operation temperature 0 to 40°C (30 to +104°F)
Operation humidity 35 to 85%
Temperature for guaranteed specifications +10 to +35°C (+50 to +90°F)
Humidity for guaranteed specifications 45 to 85%
Storage and transport temperature -20 to +70°C (-4 to +158°F)
Storage and transport humidity 35 to 85% (70% of less in the temperature of 50°C/114°F)

DIMENSIONS AND WEIGHT

Dimensions Approx. 330(W) x 190(H) x 470(D) mm [12.9(W) x 7.5(H) x 18.5(D) inch]
Weight Approx. 15 kg (33 lbs)

9. ADJUSTMENT

The VC-6041 provides an easy attenuation balance adjustment of vertical deflection.

1) Set the AC-GND-DC switches of both CH1 and CH2 to GND. Set the TRIG MODE switch to AUTO.
2) While adjusting VOLTS/DIV switches to positions between 5 to 10 mV, make adjustment of $\frac{DC}{BAL}$ control with a screw driver so that a stable trace is obtained.

10. SERVICE AND MAINTENANCE

1) Give special care in handling and storing the VC-6041, as the equipment contains various components of precision and high voltage.
2) Keep the graticule screen clean by occasional wiping with soft cloth or a chamois.
3) The favorable ambient temperature for storing the equipment is -10 to +60°C (+14 to 140°F).

PERIODIC CALIBRATION

In order to maintain the performance for stable measurement periodic calibration is recommended at each 1000 operation hours or at each 26 weeks.