MODELS VC-6025A/6045A

DIGITAL STORAGE OSCILLOSCOPE

OPERATION MANUAL

WARNING
TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

IMPORTANT
READ RULE FOR SAFE INSTALLATION, OPERATION AND INSTRUCTION CAREFULLY.
RETAIN THIS MANUAL FOR FUTURE REFERENCE.

Hitachi Denshi, Ltd.

READ THE IMPORTANT SAFETY-RELATED MARKINGS CAREFULLY BEFORE USE.

NOTE THE FOLLOWING SAFETY RELATED MARKINGS AND SYMBOLS.

(1) Terms

DANGER: Risk of hazard which causes serious injury to persons.

WARNING: Risk of hazard which may cause serious injury to persons.

CAUTION: Risk of hazard which may cause injury to persons, fire hazard or serious damage to the oscilloscope.

IMPORTANT: Important note not related to risk of hazard directly.

NOTICE: Important note not related to risk of hazard, but observed for installation, operation, maintenance, etc.

(2) Symbols

⚠ **DANGER** : DANGER

⚠ **WARNING** : WARNING

⚠ **CAUTION** : CAUTION

⏚ : PROTECTIVE GROUND TERMINAL

Note: The model and serial numbers of your OSCILLOSCOPE are important for you to keep for your convenience and protection. These numbers appear on the nameplate located on the rear of the oscilloscope. Please record these numbers in the spaces provided below, and **retain this manual for future reference.**

Model No _____ **Serial No.** _____

CONTENTS

IMPORTANT

SAFETY INSTRUCTIONS

CAUTION

RISK OF ELECTRIC SHOCK
DO NOT OPEN

CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER.
NO USER - SERVICEABLE PARTS INSIDE.REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

Explanation of Graphical Symbols

The lightning flash with arrowhead symbol, within an equilateral triangle, is intended to alert the user to the presence of uninsulated "dangerous voltage" within the oscilloscope's enclosure; that may be of sufficient magnitude to constitute a risk of electric shock to persons.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the oscilloscope.

WARNING : TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THIS OSCILLOSCOPE TO RAIN OR MOISTURE.

IMPORTANT

SAFEGUARDS

Read Instructions

All the safety and operating instructions must be read before the oscilloscope is operated.

Retain Instructions

The safety and operating instructions must be retained for future reference.

Heed Warnings

All warnings on the oscilloscope and in the operating instructions must be adhered to.

Follow Instructions

All operating and use instructions must be followed.

Cleaning

Unplug this oscilloscope from the power source before cleaning.Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.

⚠ CAUTION

Attachments

Do not use attachments not recommended by the oscilloscope manufacturer as they may cause hazards.

⚠WARNING

Water and Moisture

Do not use this oscilloscope near water - for example, near a bath tub, wash bowl, kitchen sink, or laundry tub, in a wet basement, or near a swimming pool, and the like.

⚠WARNING

Accessories

Do not place this oscilloscope on an unstable cart, stand, tripod, bracket, or table. **The oscilloscope may fall, causing serious injury to a person, and serious damage to the oscilloscope.** Use only with a cart, stand, tripod, bracket, or table recommended by the manufacturer, or sold with the oscilloscope. Any mounting of the oscilloscope should follow the manufacturer's instructions, and must use a mounting accessory recommended by the manufacturer.

⚠CAUTION

Ventilation

Slots and openings in the cabinet are provided for ventilation and to ensure reliable operation of the oscilloscope and to protect it from over-heating, and these openings must not be blocked or covered.

The openings must never be blocked by placing the oscilloscope on a bed, sofa, rug, or similar surface. This oscilloscope should never be placed in a built-in installation such as a bookcase or rack unless proper ventilation is provided or the manufacturer's instructions have been adhered to.

Power Sources

This oscilloscope should be operated only from the type of power source indicated on the marking label. If you are not sure of the type of power supply to your home, consult your oscilloscope dealer or local power company. The oscilloscopes are not intended to operate from battery power.

⚠WARNING

Plug

This item is applicable only to the oscilloscopes having the plug connected to the wall outlet.

Three-wire Grounding-Type Plug -This plug having a third (grounding) pin will only fit into a grounding-type power outlet. This is a safety feature.If you are unable to insert the plug into the outlet, contact your electrician to replace your obsolete outlet.Do not defeat the safety purpose of the grounding-type plug.

Power-Cord Protection

Power-supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying partic ular attention to cords at plugs, convenience receptacles, and the point where they exit from the oscilloscope.

Lightning

For added protection for this oscilloscope during a lightning storm, of when it is left unattended and unused for long periods of time, unplug it from the power source. This will prevent damage to the oscilloscope due to lightning and power-line surges.

⚠WARNING

Overloading

Do not overload power source and extension cords **as this can result in a risk of fire or electric shock.**

⚠**WARNING**

Object and Liquid Entry

Never push objects of any kind into this oscilloscope through openings as they may touch dangerous voltage points or short out parts that could result in a fire or electric shock. Never spill liquid of any kind on the oscilloscope.

⚠**WARNING**

Flammable and Explosive Substance

Avoid using this oscilloscope where there are gases, and also where there are flammable and explosive substances in the immediate vicinity.

Heavy Shock or Vibration

When carrying this oscilloscope around, do not subject the oscilloscope to heavy shock or vibration.

⚠**WARNING**

Servicing

Do not attempt to service this oscilloscope yourself as opening or removing covers may expose you to dangerous voltage or other hazards.Refer all servicing to qualified service personnel.

⚠**WARNING**

Damage Requiring Service

Unplug this oscilloscope from the power source and refer servicing to qualified service personnel under the following conditions:

a. When the power-supply cord or plug is damaged.
b. If liquid has been spilled, or objects have fallen into the oscilloscope.
c. If the oscilloscope has been exposed to rain or water.
d. If the oscilloscope does not operate normally by following the operating instructions. Adjust only those controls that are covered by the operating instructions as an improper adjustment of other controls may result in damage and will often require extensive work by a qual ified technician to restore the oscilloscope to its normal operation.

⚠**WARNING**

Replacement Parts

When replacement parts ar required, be sure the service technician has used replacement parts specified by the manufacturer or have the same characteristics as the original part. **Unauthorized substitutions may result in fire, electric shock or other hazards.**

Safety Check

Upon completion of any service or repairs to this oscilloscope, ask the service technician to perform safety checks to determine that the oscilloscope is in proper operating condition.

IMPORTANT

SAFETY OPERATIONS

Before operating the oscilloscope, be sure to check the following items.

⚠DANGER **⏚ PROTECTIVE GROUND TERMINAL**

Connection with the AC power source

Be sure to plug the power cord into an AC outlet provided with a protective ground terminal to avoid the risk of electric shock.

The oscilloscope is provided with the protective ground terminal and the three line power cord and plug to be connected to the AC power source.

The lead of the protective ground terminal is connected to the metallic part of the oscilloscope.

⚠WARNING

Replacement of fuse

Do not try to use any fuse other than the specified ones. Otherwise, further damage may occur and this could be dangerous.

Use only specified fuses. The oscilloscope is protected by the fuse on the primary side of the power supply. When this fuse blows, contact your nearest Hitachi Denshi representative.

⚠DANGER

Operation in gas

Do not use the oscilloscope in flammable gas or vapor to avoid possible explosion.

POWER switch

Before plugging in the AC cord, be sure to check that the POWER switch is set to OFF for protection of the oscilloscope.

⚠**WARNING**

Removal of the chassis cover

Do not remove the chassis cover to avoid the risk of electric shock since a high voltage presents inside the oscilloscope.

⚠**WARNING**

Use the oscilloscope within the specified line voltage.

The oscilloscope operates normally on the specified line voltage. If an abnormal operation occurs, turn off power for a short time and check the line voltage. If the line voltage is the specified voltage, turn on power. If the line voltage is out of the specified range (especially low voltage), the normal operation may not be restored even after the correct line voltage is applied.

Specified line voltage : AC 90-250V

IMPORTANT

WARNING MARKING

The caution label is printed on the rear of the oscilloscope. (Refer to Fig. A.)
The caution label is shown in Fig. B.
Observe the caution to assure proper handling.

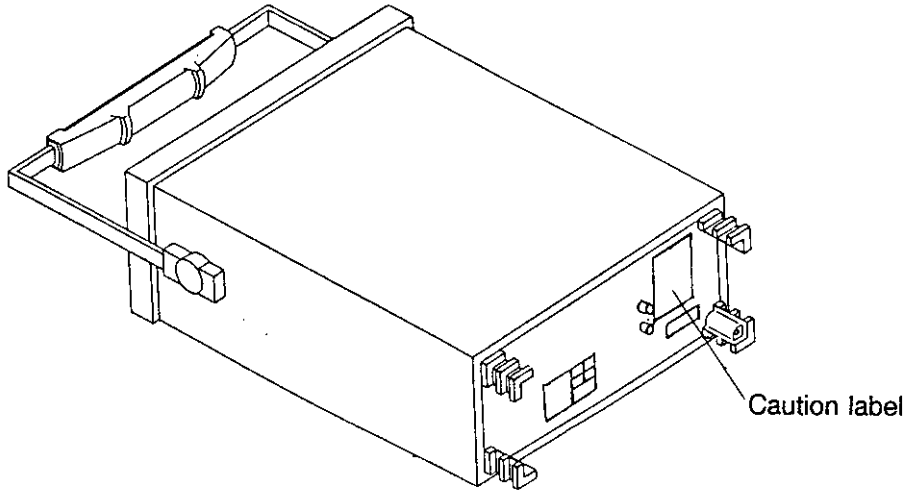
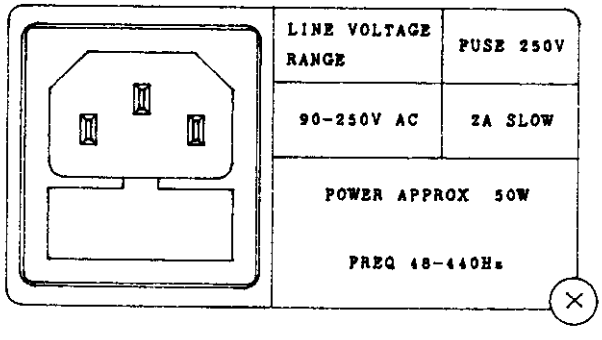


Fig. A



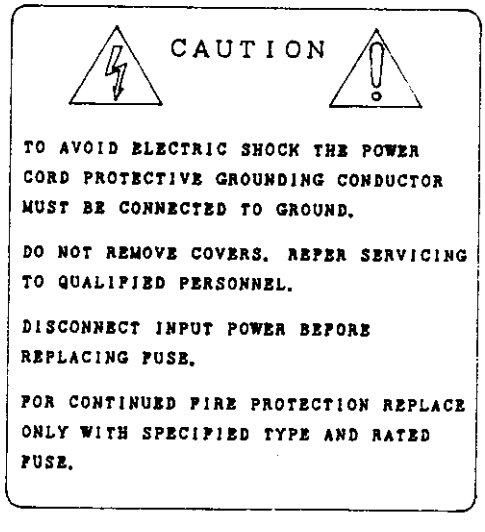


Fig. B

NOTES FOR A SAFETY OPERATION

Before operating the instrument, be sure to check the following items.

(1) Terms in this manual

WARNING: Indicates a possible injury to a body or danger to life if care is not taken as described.

CAUTION: Indicates possible damage to the instrument or other equipment if care is not taken as described.

(2) Symbols

DANGER : Indicates the part which may cause an injury to a body or danger to life.

DANGER : Indicates the high voltage part in the oscilloscope.

⚠CAUTION : Indicates to read the applicable items in this manual.

⏚ : Protective earth terminal.

(3) Notes for operation

1 Replacement of fuse

Use only specified fuses.

The instrument is protected by a 2A fuse on the primary side of the power supply.

When this fuse is blown out, contact your nearest Hitachi Denshi representative. Do not try to use any fuse other than the specified ones.

Otherwise, further damage may occur and this could be dangerous.

(IMPORTANT: Use only the fuse of same size and rating as specified.)

Shape (Diameter × length) mm	Type
5.2ϕ × 20	218002 (EAK 2A) (250V 2A)

2 OPERATION IN GAS

Do not use the oscilloscope in combustible gas or vapor to avoid possible explosion.

3 POWER switch

Before plugging in the AC cord, be sure to check that the POWER switch is set to OFF for protection of the instrument.

4 Removal of the chassis

To avoid the risk of electric shock, do not remove the chassis by yourself. Contact your nearest Hitachi Denshi representative.

NOTES

WARNING:

Do not remove the chassis cover since a high voltage presents inside the instrument. When parts inside the instrument need to be adjusted or replaced, contact your nearest Hitachi Denshi representative.

1 The built-in microprocessor may misoperate when turning the power switch on/off rapidly. Avoid rapid toggling of the power switch and allow three seconds or more for toggling.
Further, in case the line voltage rises from 0V to rated voltage slowly (for three seconds or more), the built-in microprocessor may malfunction. In this case, turn off the power switch once, and turn on it again in three seconds or more.
If the instrument is not restored to the normal state by performing this operation, perform the initial settings (while pressing the AUTO of the TIME/DIV switch, move the SELECTOR switch lever upward). In this case, the values are the initial settings shown in Table 8.2

2 In case of the storage mode, the intensities of both the waveform and readout (characters) are changed simultaneously by the INTEN control.

3 The trace intensity in the real-time mode or the storage mode may fluctuate slightly until the instrument is warmed after power up. It takes about 15 or 20 minutes until a stable measurement is ensured.
An error between the trace position in the real-time mode and that in the storage mode may occur. (Less than 0.5 div approx.)

4 Though the waveform is aligned with the graticule on the CRT in the storage mode, they may be deviated when plotted by the plotter. (Less than 0.5 div approx.)

CONTENTS

1. FEATURES

The Hitachi VC-6025A and 6045A is a high-speed digital storage oscilloscope is provided with a high-speed A-D converter for each channel to enable the measurement, memory, and analysis of high-speed phenomena.

(1) High speed and wide bandwidth

An A-D converter is provided for each channel, and the input signal can be sampled at the following maximum sampling rates.

Model	Maximum sampling rate
VC-6045A	40Msps, 2channels alternate sampling
	20Msps, 2channels simultaneous sampling
VC-6025A	20Msps, 2channels simultaneous sampling

100Msps, 1-channel sampling
25Msps, 4-channel simultaneous sampling

If the measured signal is of a complete repetition nature, the signal of up to 100MHz (50MHz for the VC-6025A) can be stored.

Further, the instrument can be used as a normal 100MHz(50MHz for the VC-6025A) realtime oscilloscope.

(2) Memory of waveforms (save function)

Two 1 kilo-word save memories are provided, and up to two sets of the stored waveform can be saved.
The saved waveform is retained up to approximately 48 hours after power is turned off, so that it is convenient to compare waveforms at a different place.

(3) Multiple functions

Multiple functions to analyze signals are provided.

- Roll mode function: Facilitates the measurement of a low-speed signal.

- Average function: Removes a noise component from the signal including random noises.
- Smoothing function etc.

(4) External Interface functions

Various output functions are built in to analyze and record storage data.

- RS-232C interface: Digital data is output to a personal computer, etc.
- Digital plot function: A hard copy of the display on the CRT is directly obtained by the X-Y plotter via the RS-232C.

(5) CRT readout and cursor measurement functions

The operation and the measurement can be made quickly.

- CRT readout function: Displays the characters of the setting information of the operation panel on the CRT.
- Cursor measurement function: Displays the voltage difference (ΔV), the time difference (ΔT), and the frequency ($1/\Delta T$) between cursors alphanumerically.

2. COMPOSITION

(1) Oscilloscope ..... 1 unit

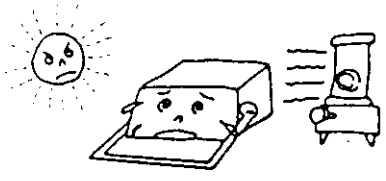
(2) Accessories

Probes, AT-10AP 1.5 ..... 2 pcs.
(AT-10AK1.5 for the VC-6025A)
Fuse, 2A (A spare fuse is provided in the fuse holder of the instrument) .... 1 pc.
Operation manual ..... 1 copy
AC power cord, 3-conductor ..... 1 pc.

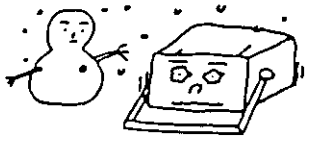
3. PRECAUTIONS

Installation

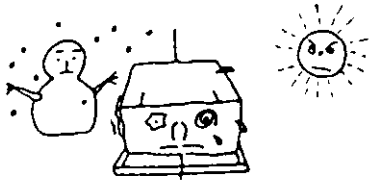
- Avoid installing the instrument in an extremely hot or cold place.
  - * Avoid placing the instrument in a place exposed directly to sunlight for a long time, in a car in mid-summer, or near a room heating device.
  - * The maximum operating ambient temperature is 40°C.



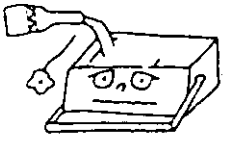
  - * Do not use the instrument outdoors for a long time on a cold winter day. The operating ambient temperature is 0°C or more.



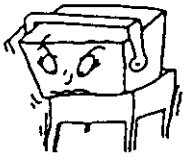
  - * Avoid moving the instrument from a hot place to a cold place and vice versa, or condensation may form inside the instrument.



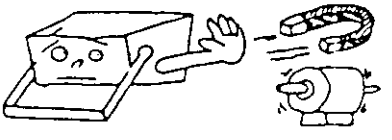
- Keep the instrument away from damp air, water, and dust. Unexpected trouble may be caused when the instrument is placed in a damp or dusty place.The operating ambient humidity is 45 to 85%. Do not place a liquid-filled container on the instrument. An accidental intrusion of liquid may also cause troubles.



- Do not place or use the instrument in a place subject to vibration.

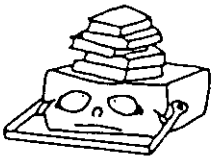


- Do not place the instrument near a magnet or a magnetic body. An oscilloscope uses electron beams. Therefore, do not bring a magnet close to the instrument or do not use the instrument near an equipment generating strong magnetic force.

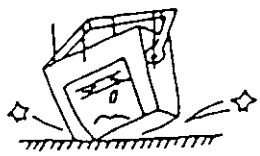


Operating considerations

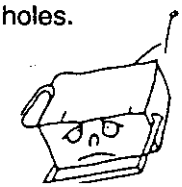
- Do not put a heavy object on the instrument.
- Do not block ventilation holes.



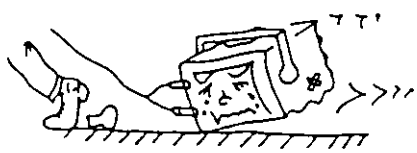
- Do not apply a heavy shock to the instrument.



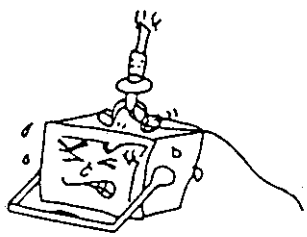
- Do not insert a wire, pin, etc. through ventilation holes.



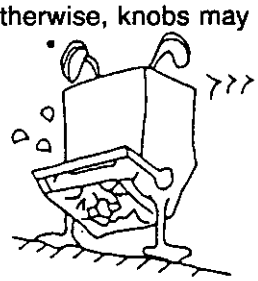
- Do not drag the instrument with a probe connected.



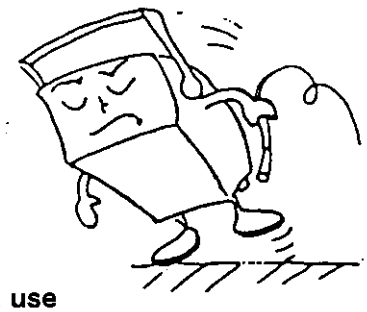
- Do not leave a hot soldering iron on or around the cabinet or the screen.



- Do not try to turn the instrument upside down. Otherwise, knobs may be broken.



- Do not use the instrument upright, leaving cables connected to terminals or connectors on the rear panel.
  Otherwise, the cables may be damaged.

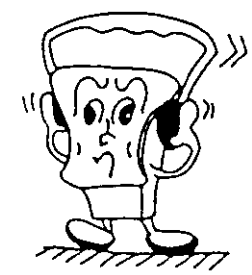


When not in use

When not in use, put the dust cover (open) on the instrument.

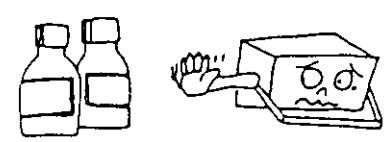
Handle

Press in both pivot points of the handle and turn to the desired position.



Care

- Removal of stain from the case
  * When the outside of the case is stained, wipe it lightly using a neutral detergent and then clean the surface with a dry cloth.



Never use a volatile agent such as benzine and thinner.

* When the panel surface is stained, remove the stain with a clean, soft cloth. When heavy stains are present, first use a diluted detergent or alcohol and then clean with a dry cloth.

Maintenance

(1) Use and store the instrument carefully to avoid damage to built-in precise components.
(2) Clean the scale plate from time to time with a clean soft cloth.
(3) The recommended ambient condition is 20°C, 65%.

Calibration interval

To maintain the instrument accuracy, perform the calibration after each 1000 hours of operation, or every six months if used infrequently.

Operating precautions

⚠ * Check the line voltage.
The operating voltage range of this instrument is 90 to 250V AC. Check the line voltage without fail before turning on the power switch.

* Do not increase the brightness too much.
Do not increase the brightness of the spot and trace too much. Your eyes may be tired and the phosphor screen of the CRT may be burnt.

* Do not apply an excessive voltage.
The maximum input voltages of connectors and probe are as follows.

INPUT direct	400V (DC + AC peak max. 1kHz)
When X 10 probe is used	500V (DC + AC peak max. 1kHz)
EXT BLANKING	30V (DC + AC peak)

CAUTION: Never apply a voltage higher than specified to avoid possible damage to the instrument.

4. OPERATION PANEL

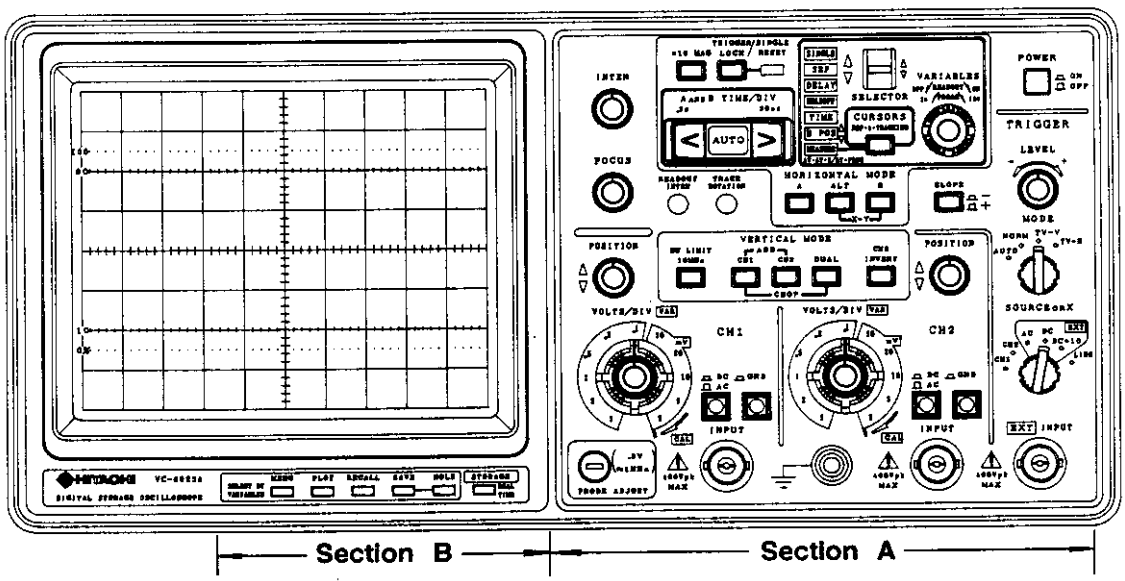
The digital storage oscilloscope is provided with the real time oscilloscope function and the digital storage function.

The front panel is designed to offer ease of operation, and the panel is composed of the Section A for setting of measurement conditions and of the Section B for setting of operation modes.

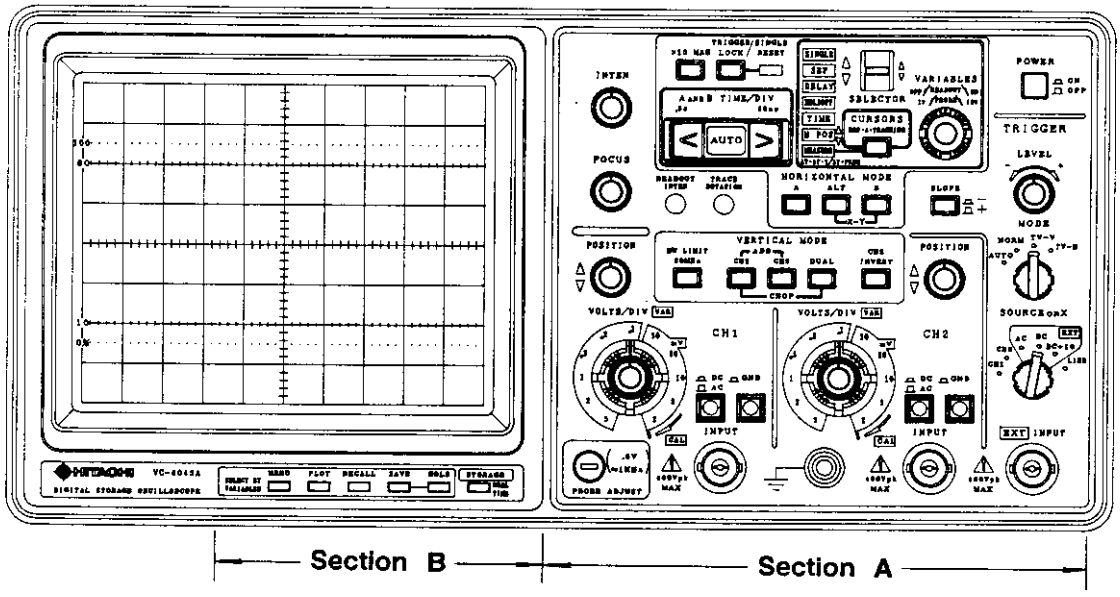
When the REAL TIME mode is selected (Green STORAGE LED goes off), the instrument functions as a real time oscilloscope. This mode is called the REAL TIME mode.

When the STORAGE mode is selected (Green LED lights or blinks), the instrument functions as a digital storage oscilloscope. This mode is called the STORAGE mode.

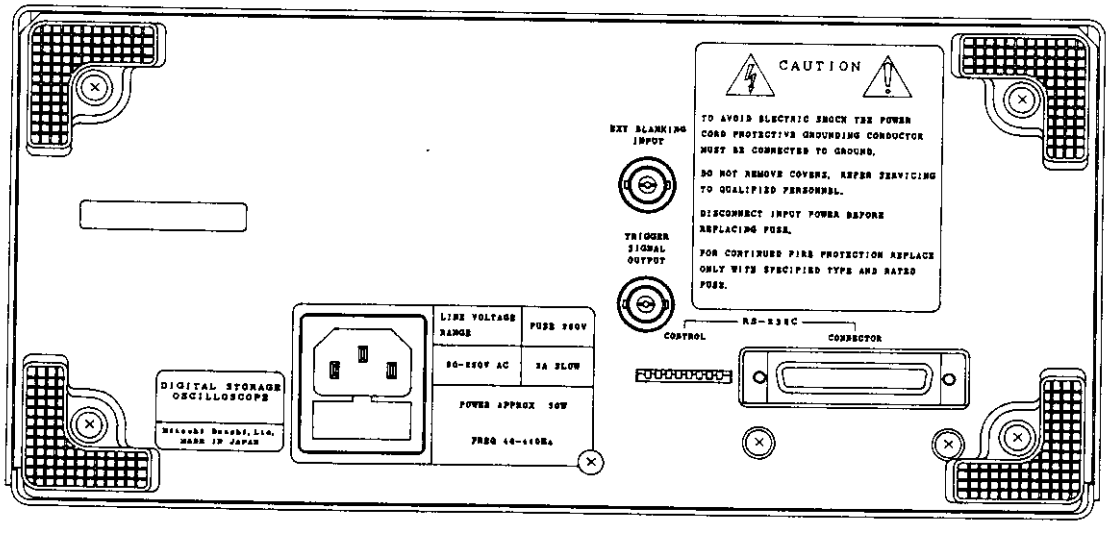
Refer to section 5.2 for the Front panel section B operation mode selection.



VC-6025A Front panel



VC-6045A Front panel



VC-6025A/6045A Rear panel

5. PANEL DESCRIPTION

5.1 Front Panel Section A

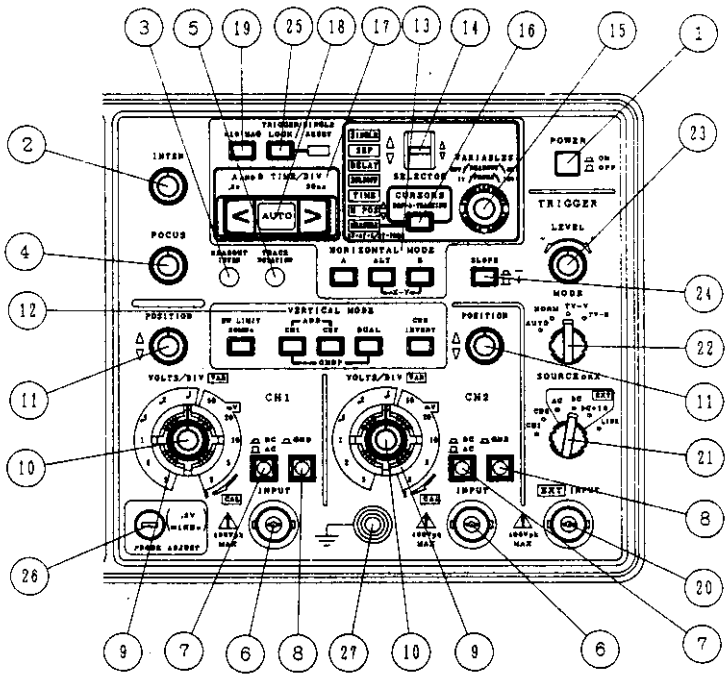


Fig. 5-1 Front Panel A section

(1) Power and CRT

① POWER switch

Power is ON in the pressed in position (▭), and OFF in the released out position (□).

② INTEN control

In the REAL TIME mode, a clockwise rotation increases the brightness of waveform.
In the STORAGE mode, a clockwise rotation increases the brightness of waveform and readout.

③ READOUT INTEN control (screwdriver adjustment)

A clockwise rotation increases the brightness of readout. (REAL TIME mode only)

④ FOCUS control

After obtaining appropriate brightness by the INTEN control ② , adjust the FOCUS control until the optimum trace is obtained. Though the focus is corrected automatically when the INTEN control is rotated, adjust the FOCUS control if necessary.

⑤ TRACE ROTATION control (screwdriver adjustment)

This control corrects the displacement of trace caused by external magnetic fields. Align the trace with the horizontal graticule line with this control.

(2) Vertical deflection system

⚠⑥ INPUT connectors

BNC connectors for CH1 and CH2 inputs.

⑦ AC-DC switch

This is an input coupling select switch.
When the switch is pressed in (⎓), the DC coupling mode is established. When the switch is released out (⎍), the AC coupling mode is established.
AC: Input signal is capacitively coupled to the vertical amplifier. The DC component of the input signal is blocked.
DC: All frequency components of the input signal are coupled to the vertical deflection systems.

⑧ GND switch

This is an input coupling select switch.
The input of the vertical amplifier is grounded in the pressed position (⏚).

⑨ VOLTS/DIV switch

This is a step attenuator which selects the sensitivity.
Set to an appropriate range according to the incoming signal level.
The VOLTS/DIV setting values of CH1 and CH2 are displayed at the lower left of the CRT.

⑩ VAR controls

These controls provide a continuous variable vertical deflection factor.
Attenuation of down to 1/2.5 is obtained by turning in a counterclockwise direction.
These controls are useful when comparing two waveforms or when measuring the rise time of a square waveform.
Normally set to the CAL position.

⑪ POSITION control

This is a control which adjusts the vertical position of the trace.
Clockwise rotation moves a trace upward, while counterclockwise rotation moves it downward.

NOTE: In the CH2 INVERT ON mode, the above operation is reversed.

⑫ VERTICAL MODE switch

This switch selects the operation mode of the vertical system.

CH1: Only the signal applied to CH1 is displayed.

CH2: Only the signal applied to CH2 is displayed.

DUAL: The signals applied to CH1 and CH2 are displayed as a dual trace.

The display in the REAL TIME mode is automatically selected by the TIME/DIV switch setting. When the TIME/DIV switch ⑰ is set to 5ms/DIV or slower, the CHOP mode is obtained. When the switch is set to 2ms/DIV or faster range, the ALTERNATE mode is obtained.
In the STORAGE mode, each of the signals applied to CH1 and CH2 is sampled at the same timing, and the stored waveforms of the dual trace are displayed.

CHOP: When CH1 and DUAL are pressed simultaneously, this mode is set.
When this mode is selected in the REAL TIME mode, the CHOP mode is selected even if the sweep range is set to the faster range. Input signals applied to CH1 and CH2 are switched at approximately 250kHz regardless of the sweep, and displayed on the CRT. This mode is used in a faster range when it is required to

measure a signal in the CHOP mode.
This mode performs the same operation as that of DUAL in the STORAGE mode.

NOTE:
To prevent triggering from chopping transients, apply a triggering signal to the EXT INPUT connector ⑳ and set the SOURCE OR X switch ㉑ to EXT, or set the internal trigger level very appropriately.

ADD: The algebraic sum of CH1 and CH2 is displayed when both CH1 and CH2 switches are pressed. This is the same in the STORAGE mode.

CH2 INVERT: The polarity of the CH2 signal is inverted. It is recommended to use this function when comparing the waveforms with different polarities or when measuring the difference signal between CH1 and CH2.

BW LIMIT
When this switch is pressed, the bandwidth is reduced to approximately 20MHz (10MHz for the VC-6025A)and the measurement is made by eliminating undesired high frequency signals from the waveform. The high frequency component over 20MHz(10MHz for the VC-6025A) is also eliminated from the trigger signal.

(3) Horizontal deflection system

⑬ HORIZONTAL MODE switch

Selects the operation mode of the horizontal deflection.

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

ALT: Both the main sweep (A) and the delayed sweep (B) are displayed.
In the STORAGE mode, the operation is the same as that in the A mode, and the sampling is performed at the speed corresponding to the A sweep time range.

B: The delayed sweep (B) appears on the CRT. The sweep time is controlled by the B TIME/DIV ⑰ .
In all the STORAGE modes other than the ROLL mode, the B sweep sampled at the speed corresponding to the B sweep time range is displayed when the A sweep time is from 2.5μs/DIV (5μs/DIV for the VC-6025A) to 0.1s/DIV.

X-Y: When the ALT and B switches are pressed simultaneously, an X-Y operation is available.

(14) SELECTOR switch

This switch selects a parameter switch function related to the horizontal axis or a cursor measurement function. Move the SELECTOR switch lever upward (▲) or downward (▼) until the desired function lamp lights. Then adjust the VARIABLES control (16) appropriately.

NOTE: The following functions can be selected either in the REAL TIME mode or the STORAGE mode. Moreover, in the STORAGE mode, the storage functions can be selected by the STORAGE switch (28) on the STORAGE MODE section (Front panel B section). When the MENU function is selected, all the lamps of the following functions go off. Use this switch to return to the following functions again.

SINGLE: Displays the main sweep (A) once.

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

DELAY: Used to set the delay time of the delayed sweep (B) starting point with respect to the main sweep (A) starting point. The delay time is displayed on the upper left side of the CRT and the B sweep window is indicated by the cursors.

HOLDOFF: Rotate the HOLDOFF control to obtain stable triggering for a complex signal, a high-frequency signal, an irregular signal, etc. The holdoff value is set to the minimum when the A TIME/DIV switch (17) is operated.

TIME (Variable):

Adjusts the sweep speed of the main sweep (A) continuously. When the control is turned fully clockwise, the sweep speed is calibrated to the A TIME/DIV switch (17) specified value (CAL state). Normally, set to the fully clockwise position (A = on the CRT).

The variable time is set to the CAL state when the A TIME/DIV switch (17) is operated. (Only in the REAL TIME mode)

H POS: This switch moves a trace to the horizontal direction.
Clockwise rotation moves a trace to the right side. Counterclockwise rotation moves a trace to the left side. In the STORAGE mode, the trigger point is

moved at the normal storage operation. (2.5μs/DIV~0.1S/DIV, 5μs/DIV~0.1S/DIV for the VC-6025A)

MEASURE: In this mode, ΔV,ΔT, 1/ΔT and FREQ can be selected and displayed in turn on the CRT by downward the SELECTOR switch, and measurements by cursors or automatically frequency counter are available.

ΔV: Two horizontal cursors appear. The voltage between the two cursors is calculated according to the setting of VOLTS/DIV (9) , and displayed with ΔV on the upper side of the CRT.

ΔT: Two vertical cursors appear. The time between the two cursors is calculated according to the setting of TIME/DIV (17) , and displayed withΔT on the upper side of the CRT.

1/ΔT: Two vertical cursors appear. The reciprocal of the time (frequency) between the two cursors is calculated according to the setting of TIME/DIV (17) , and displayed with 1/ΔT on the upper side of the CRT.

FREQ The frequency of the signal selected by the SOURCE OR X switch (21) is displayed after FREQ, on the upper side of the CRT.

NOTE: When this mode is selected with the DUAL of the VERTICAL MODE switches (12) pressed, the selection of display channels is performed in the CHOP mode. For measuring the waveform at high speed, release the FREQ mode.

(15) VARIABLES control

This control sets the function selected by the SELECTOR (14).

A combination use with the SELECTOR (14) can blank the readout on the CRT and calculate values of the 1X and 10X modes of a probe. When the MENU is selected in the STORAGE mode, the interpolation method, the number of average, and ON/OFF of the smoothing can be set.

⑯ **CURSORS REF. △.TRACKING control**

REF: Moves the reference cursor on the CRT. (▽ or ▷ is displayed on the reference cursor.)

△: Moves the measuring cursor on the CRT. (▽ or ▷ is displayed on the measuring cursor.)

TRACKING: Simultaneously moves the reference cursor and the measuring cursor with the interval between the two cursors unchanged.
(▽ or ▷ is displayed at the two cursors.)

⑰ **A AND B TIME/DIV switch**

This switch sets the sweep time of the main sweep (A) and the delayed sweep (B). The sweep is set by the HORIZONTAL MODE switch ⑬ and the TIME/DIV setting data is displayed on the CRT.

In each operation mode, the following sweep time is selectable.

- REAL TIME mode:
  A sweep time: 50ns/DIV to 0.5s/DIV (22 steps)
  B sweep time: 50ns/DIV to 50ms/DIV (19 steps)

  As the B sweep time, faster ranges than A sweep time are selected (with the exception of the 50ns).

- STORAGE mode:
  A sweep time: 50ns/DIV to 50s/DIV (28 steps)
  B sweep time: 2.5μs/DIV to 50ms/DIV (14 steps,)
  5μs/DIV to 50ms/DIV (13 steps, for the VC-6025A)

NOTES:

(a) In the STORAGE mode, the sampling method is changed automatically by the TIME/DIV switch.

50ns/DIV to 2μs/DIV.....Equivalent sampling mode (Only a repetitiv signal can be stored.)

2.5μs/DIV to 0.1s/DIV.....Normal sampling mode
(5μs/DIV to 0.1s/DIV for the VC-6025A)

0.2s/DIV to 50s/DIV.....ROLL mode

(b) In the equivalent sampling mode range of the A sweep time(50ns/VID~2μs/DIV), only a completely repetition signal can be stored. When a signal including a non-repetition component is stored in these ranges, the waveform different from the input signal may be displayed or the waveform on the CRT may not be updated with the STORAGE lamp (green LED) lit.

When a signal including a non-repetition component is stored, measure it in the normal sampling mode or ROLL mode.

⑱ AUTO

When the center of the TIME/DIV switch ⑰ is pressed, the AUTO lamp lights, and the trigger input signal is detected. Then the time range is changed automatically, and the waveform of approximately 1.6 to 4 cycles is displayed on the CRT. (But when the input signal is lower than 100Hz or not triggered properly, the time range is set to 5ms/DIV. When the signal is higher than approximately 8MHz, the time range is set to the highest speed range.) Moreover, the time range automatically follows the change of the input signal.

⑲ X10 MAG switch

This switch is used to magnify A and B sweeps by 10 times. In the REAL TIME mode, bring the portion of the waveform to be magnified to the center of the CRT by the horizontal POSITION control. Then press the X10 MAG switch to magnify the waveform in the horizontal direction. In the STORAGE mode, the storage waveform at 1 division from the MAG point marker is magnified by 10 times in the horizontal direction.

(4) Trigger system

⑳ EXT INPUT terminal

BNC connector for an external trigger signal, an external sweep signal, or an external X input.

㉑ SOURCE $_{OR}$ X switch

In the REAL TIME mode, this switch selects the trigger signal source or the X signal for an XY operation.
In the STORAGE mode, only the trigger signal source is selected. (The CH1 signal becomes the X signal for an XY operation in the STORAGE mode.)

CH1: The signal fed to CH1 is used as a signal source.
CH2: The signal fed to CH2 is used as a signal source.

EXT AC: The signal fed to EXT INPUT (20) is used as a signal source after the DC component and the very low frequency component are removed.
EXT DC: The signal fed to EXT INPUT (20) is used as a signal source as is. This signal is used when affecting synchronization to a very low frequency.
EXT DC ÷ 10: The signal fed to EXT INPUT (20) is attenuated to 10:1 and used a signal source. This signal is used when affecting synchronization to a very low frequency.
LINE: Used to measure the signal synchronized to a line frequency.

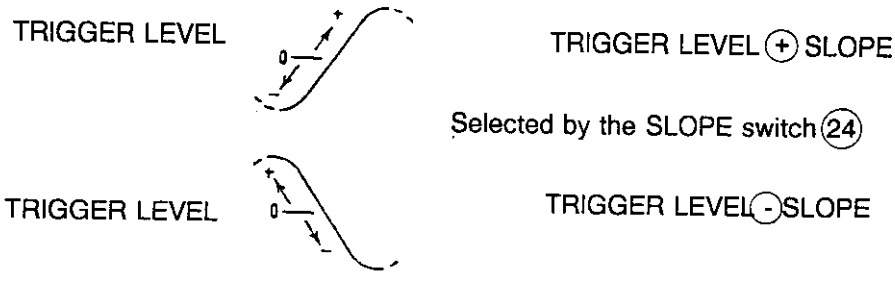
(22) MODE switch

AUTO: A sweep is performed automatically. When a trigger signal is applied, the normal sweep operation is performed and the waveform is stationary.
The instrument will automatically display a trace without an input signal being applied or out of trigger. This setting is convenient in most cases.
Normal trigger will be established by setting trigger level when a signal is applied to the input.
In the STORAGE mode, a waveform displayed on the CRT continues to be updated regardless of the presence of a trigger signal.
The trigger level automatically corresponds to the amplitude of the incoming signal and the signal is easily triggered.
NORM: Trace will appear when a sweep is triggered. Trace will not appear when a signal is not applied or when a signal is triggered properly. Use this mode when effecting synchronization to a very low frequency signal (30Hz or less) or for arming a single sweep. When the signal is not triggered properly in the STORAGE mode operation, a waveform is not updated and the traces are held.

TV-V: Used when measuring the vertical TV signal.
TV-H: Used when measuring the horizontal TV sweep signal.

(23) LEVEL control

By controlling the trigger level, the sweep start point of the waveform is set.

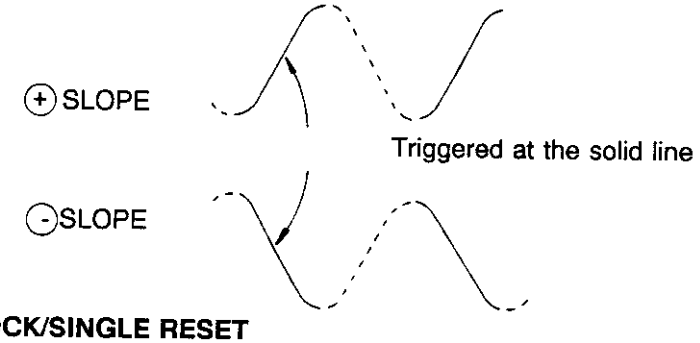


(24) SLOPE switch

This switch selects the slope of the signal that triggers the sweep.

When the switch is pressed in (⎍), sweep is triggered from the negative-going slope of the trigger signal.

When the switch is released out (⎍), sweep is triggered from the positive-going slope of the trigger signal.



(25) TRIGGER LOCK/SINGLE RESET

When SINGLE is not selected by the SELECTOR switch (14) :

When the TRIGGER LOCK switch is pressed and the lamp is lit, the triggering state before the lamp is lit is held. If the TRIGGER LOCK switch is pressed with the triggering executed before the lamp is lit, and the stable triggering is ensured when the sweep time and the variable time are changed.

When SINGLE is selected by the SELECTOR switch (14) :

When the SINGLE RESET switch is pressed and the lamp is lit, the single sweep is armed.

(5) Miscellaneous

㉖ PROBE ADJUST terminal

A 0.5V, 1kHz square wave signal is available.
This terminal is used for probe calibration.

㉗ GND terminal (⏚)

Grounding terminal

5.2 Front Panel Section B

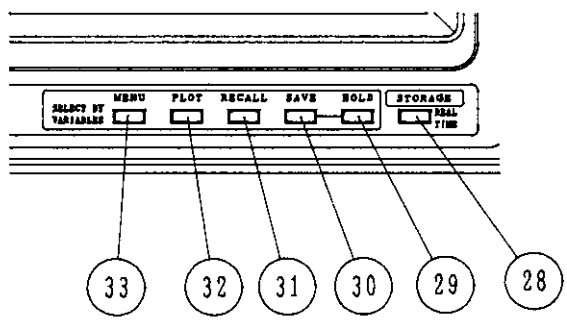


Fig. 5-2 Front Panel B section

㉘ STORAGE switch

When this LED goes off, the instrument functions as the normal realtime oscilloscope, the switches ㉙ thru ㉝ are all invalid, and all the LED's go off.

When this switch is pressed once, the LED lights, resulting in the STORAGE mode. In this case the switches ㉙ thru ㉝ are all valid.

When this switch is pressed again in the STORAGE mode, the REAL TIME mode is established again. In the STORAGE mode, the LED blinks in synchronism with sampling.

㉙ HOLD switch

Pressing this switch stops sampling, resulting in the hold state, and the LED lights.

Further pressing this switch releases the hold state and sampling starts.

(30) SAVE switch

This is the switch to store the display waveform in the save memory. This switch is valid only in the hold state (HOLD LED lights).

When this switch is pressed, the LED lights to indicate that the waveform is stored in the save memory.

(31) RECALL switch

This is the switch to display the saved waveform on the CRT again. When this switch is pressed, the LED lights.
The RECALL state is released by pressing this switch.

(32) PLOT

Press this switch to output the display waveform to the X-Y plotter connected externally. Then data starts to be transmitted and the LED lights. This switch is valid only in the hold state (HOLD LED lights).

(33) MENU

Press this switch to change the number of average, the interpolation method and the on-off of smoothing. Each pressing changes the setting mode and the present setting mode is displayed at the top right on the CRT. The settings in each mode are changed by the VARIABLES control (15).

5.3 Rear Panel

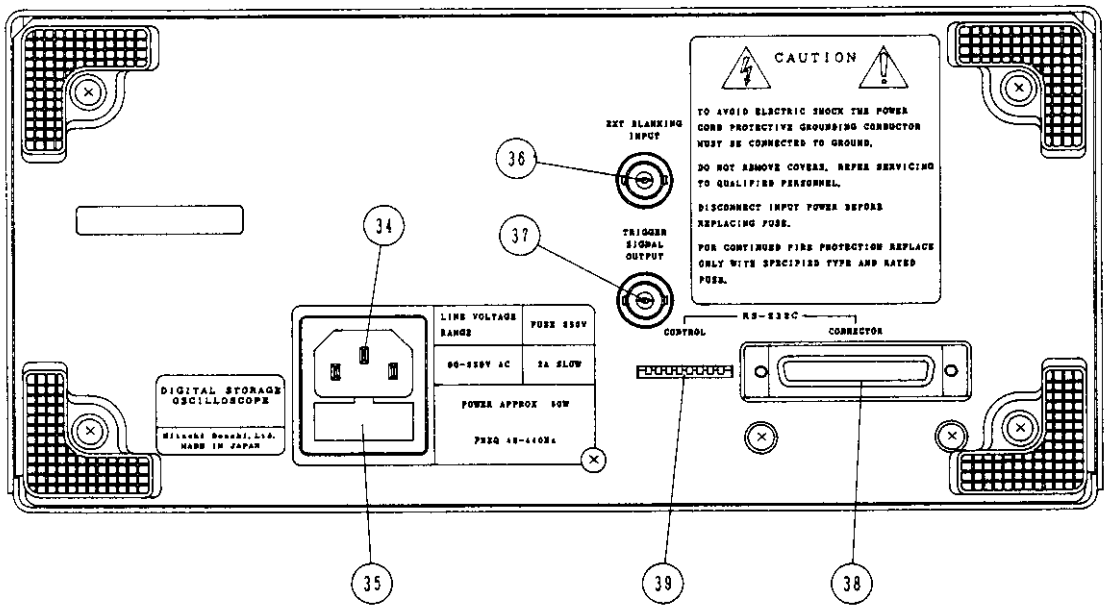


Fig. 5-3 Rear panel

(34) AC input connector

Connect the AC power source.

(35) FUSE

The fuse is inside the fuse holder.

CAUTION: When the fuse is blown out, contact your nearest Hitahci Denshi representative.

(36) EXT BLANKING INPUT terminal

This is a terminal for applying a blanking signal from an external source. This terminal is DC-coupled.

The intensity is lowered by a positive signal, while it is increased by a negative signal.

(37) TRIGGER SIGNAL OUTPUT connector

The signal selected by the SOURCE OR X switch (21) is available.

(38) RS-232C connector

Connect the plotter or other equipment through the RS-232C interface.

(39) RS-232C switches

The eight switches set the data such as the transfer rate etc. (Refer to section 9.4.)

6. HOW TO PRODUCE THE TRACE

At first, verify that the AC supply voltage is within the specified range.(90V~250V)
Then connect the power cord on the rear panel to an AC outlet and set the controls as follows.

GND :	⎓ (Pressed mode)
POSITION :	Midrange
HORIZONTAL MODE :	A
TRIGGER MODE :	AUTO
VERTICAL MODE :	CH1

After completion of the above settings, turn on the POWER switch. The LED's on the front panel light for a while, and soon unnecessary LED's go off.

Press STORAGE switch to establish the REAL TIME mode while the green STORAGE LED lights.

When the INTEN control is turned clockwise, the trace appears. For immediate measurement, adjust the FOCUS control to obtain the sharpest possible trace.

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

When this instrument is not in use, with power supplied, rotate the INTEN control counterclockwise to decrease the intensity. This protects the CRT from burning and prolongs its life.

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

VOLTS/DIV VAR :	Rotate fully clockwise. In this case, the VOLTS/DIV is calibrated to the indicated value and is changed from the UNCAL display " > " to the calibration display "Blank".

TIME/DIV VAR :

Set the TIME by the SELECTOR (14) , and turn the VARIABLES control clockwise until A = is displayed on the CRT.

The variable time is initialized when the time range of the A sweep is changed. At this time, the A TIME/DIV is calibrated to the indicated value.

7. METHOD FOR CONNECTING SIGNALS

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

WARNING : When connecting the probe or the signal input cable to the circuit to be measured, be sure to connect the ground side of the probe or the signal input connector to the ground side of the signal source.
If not, potential difference between the instrument and other equipment or earth ground may result in shock hazard and damage the instrument, the probe, and other equipment.

(1) Using probes

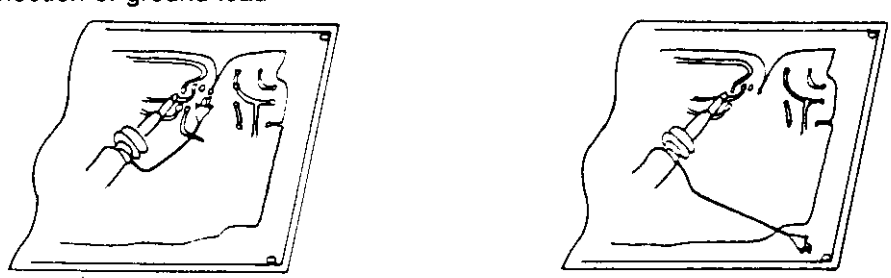
Use the supplied probe to measure a high frequency signal accurately.
Supplied probe: AT-10AS1.5
When this probe is used, the input signal is attenuated to 1/10.
This probe is convenient to measure a large signal because a measuring range becomes wide, though it is inconvenient for a small signal.

NOTES:

a) Do not apply a signal in excess of 500V (DC + peak AC at 1kHz or less) to the input.

b) Connect the probe ground lead as close as possible to the point being measured especially when measuring a signal with a fast rise time or a high frequency signal.
Long probe ground leads may cause waveform distortions, such as ringing and overshoot.

Connection of ground lead

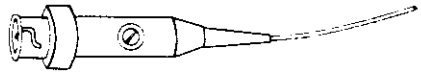


Proper　　Improper

Fig. 7-1

c) To avoid effect of the ground lead in high frequency measurement, it is recommended to use the standard ground lead attachment with the AT-10AS1.5 probe.

d) To avoid a measurement error, probe compensation must be done especially when probes are changed. Connect the probe tip to the PROBE ADJUST 0.5V output terminal and the probe ground lead to the GND terminal. A 1kHz square wave should be displayed with flat tops. Any distortion in the presentation is caused by incorrect probe compen sation. If overshoot or undershoot is present, turn the screwdriver adjustment in the probe for a flat-top presentation.



Screwdriver adjustment

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

Fig. 7-2

(2) Direct connections

When connecting signals without using the supplied probe, pay attention to the following points in order to minimize a measurement error.

- When using an unshielded lead, there should be no trouble, provided the circuit under measurement is of low impedance source and high level. However, in most cases, measurement errors may be caused by stray coupling with other circuits or power line interference. This can cause errors even at low frequencies. In general, avoid measuring with an unshielded lead.
- When using a shielded wire, it is desirable to use a coaxial cable with a BNC type connector. If a BNC type connector is not available, connect one end of the shield to the ground terminal of the instrument and the other end to the ground of the circuit to be measured.

- The following precautions must be observed when performing a wide bandwidth measurement. It is necessary to terminate the cable with a characteristic impedance, when measuring a fast rise waveform or a high frequency wave. The absence of a termination

resistor will result in a measurement error due to a ringing phenomenon when a long cable is used. Some measuring circuits require a termination resistor equal to the characteristic impedance of the cable. (A BNC type termination resistor is recommended for this purpose).

- In order to perform measurements with the circuit in a proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit being measured.

- The stray capacity of the shield wire must be taken into account when performing measurements with a long shield wire. Since a shield wire has a capacity of about 100pF per meter, its effect on the test circuit cannot be ignored. Use a X10 probe to minimize the effect on the circuit.

- When a shield wire or a non-terminated cable is used, and the cable length reaches 1/4 the wave length or its multiples (1/4 the wave length is about 0.75 meter when using a coaxial cable at 100MHz), oscillation may be caused in the 2 to 5mV/DIV ranges.
  This is caused by the resonance between the externally connected high - Q inductance and the input capacity. Reduce the Q by connecting the cable or shield wire to the input connector by the resistors from 100Ω to 1kΩ connected in series, or by performing measurements at another VOLTS/DIV range.

8. BASIC OPERATIONS AND MEASUREMENT PROCEDURES

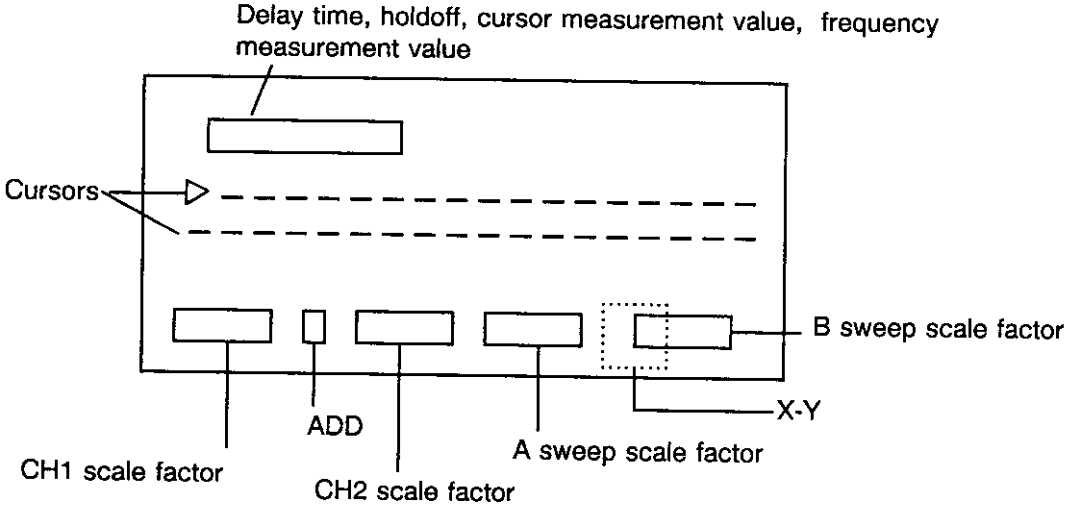
The measurement is provided with the REAL TIME mode function and the STORAGE mode function, and the selection of the modes can be made by the switch of the STORAGE MODE section. The basic operations are described below.

NOTE: Prior to measurements, allow 20 minutes of warmup time.

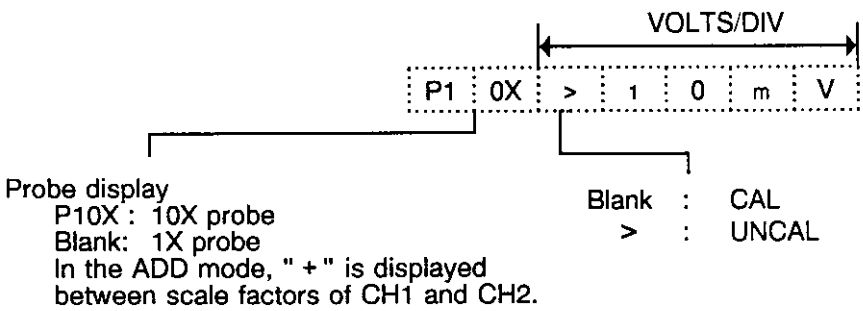
8.1 Data Display

(1) REAL TIME mode display

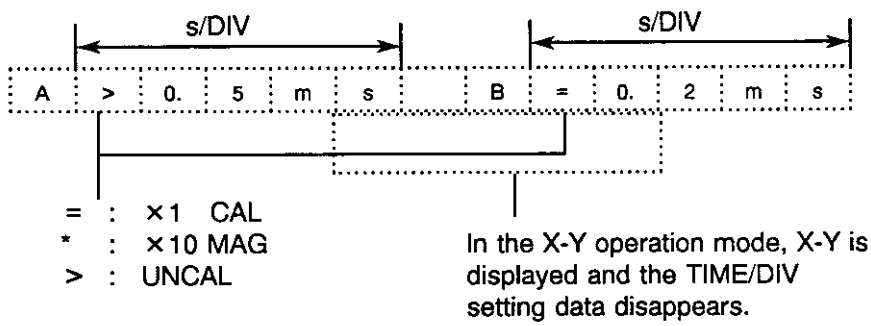
Data display positions on the CRT



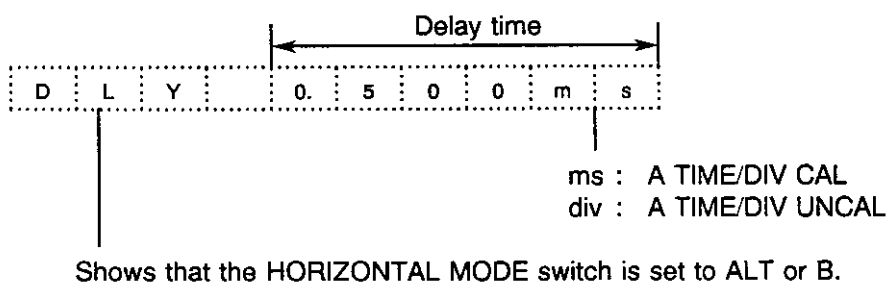
① CH1 and CH2 scale factor displays



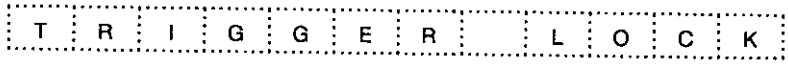
② A and B sweep scale factor displays and X-Y display



③ Delay time display



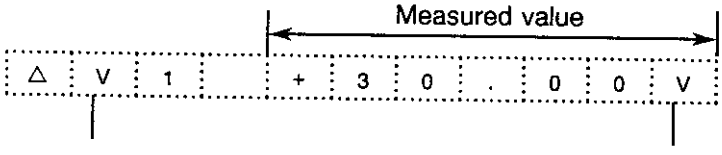
④ HOLDOFF and TRIGGER LOCK displays



Displayed in the TRIGGER LOCK mode.

⑤ Cursor measurement value display

A measurement value between cursors is displayed.

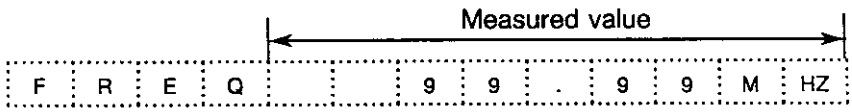


ΔV1: CH1
ΔV2: CH2
ΔV 1_2: ADD
ΔTA: Time difference between two cursors for A TIME/DIV
1/ΔTA: Reciprocal number of ΔTA
ΔTB: Time difference between two cursors for B TIME/DIV
1/ΔTB: Reciprocal number of ΔTB

ΔV: +, −, mV, V, div
ΔT: +, −, ns, μs, ms, div
1/ΔT: mHz, Hz, kHz, MHz, ?
"div" is displayed in the following cases:

- The measured value in the channel selected by the VERTICAL MODE switch is not in the CAL state.
- The VERTICAL MODE is set to ADD, and the VOLTS/DIV settings of CH1 and CH2 are not equal.
- The HORIZONTAL MODE switch is A, and the TIME switch and the VARIABLES control function (UNCAL state, CRT display: >)

⑥ Frequency counter display



- The frequency of the trigger signal source selected by the SOURCE OR X switch is displayed. When the triggering of the displayed waveform is unlocked and the waveform can not be measured, "---" is displayed.

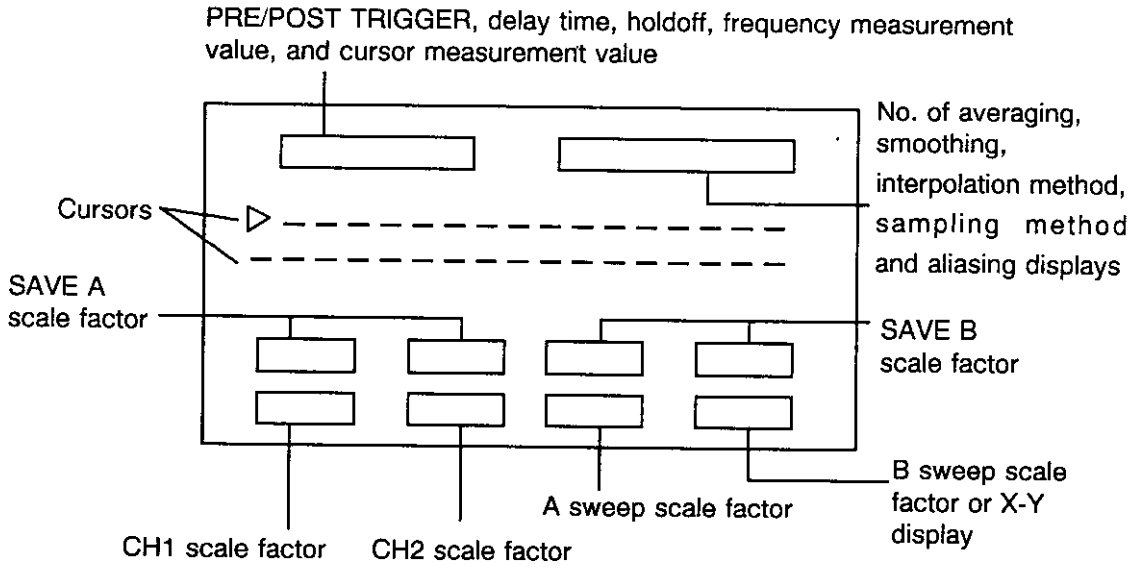
NOTES:

a) If the readout display is not needed, select H POS by the SELECTOR switch, and move the SELECTOR switch upward to light TIME . When rotating the VARIABLES control counterclockwise while holding the SELECTOR upward the display disappears. To obtain the readout display again, select H POS , move the SELECTOR switch upward, and rotate the VARIABLES control clockwise, while holding the SELECTOR switch upward.

b) If the P10X display is not needed, select H POS by the SELECTOR switch and rotate the VARIABLES control counterclockwise while holding SELECTOR switch downward. Then the probe display disappears.
To obtain the display again, select H POS , hold the SELECTOR switch downward, and rotate the VARIABLES control clockwise.
The probe display can be switched to only the channels selected by the VERTICAL MODE switch.

(2) STORAGE mode display

Data display positions on the CRT



NOTE :

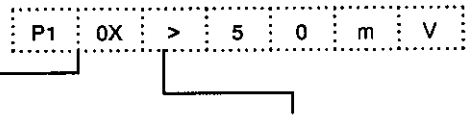
In the STORAGE MODE, the waveform can be displayed while the input signal is stored. Moreover, the waveform previously stored can be displayed. The instrument stores the scale factor and the setting conditions related to the waveforms as far as the waveform is stored. When the waveform is displayed, these values can be displayed at any time.

a) CH1, CH2 and sweep scale factors
When the waveform of CH1 or CH2 is displayed, the scale factors corresponding to the waveform are displayed.

b) PRE/POST TRIGGER, hold-off, delay time frequency measurement value, and cursor measurement value.
The cursor measurement value of the sweep waveform corresponding to the function selected by the SELECTOR switch and the VERTICAL MODE switch is displayed.

c) SAVE A, SAVE B scale factor
The VOLTS/DIV and TIME/DIV are displayed when the waveform is saved in the save memory.
This scale factor is displayed only when the save waveform is displayed on the CRT by pressing the RECALL switch.

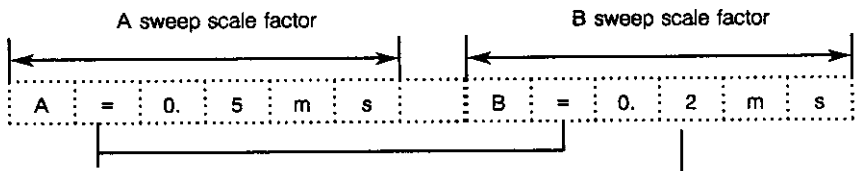
① CH1 and CH2 scale factor displays



Probe display
P10X : 10X probe
Blank : 1X probe
In the ADD mode, " + " is displayed between scale factors of CH1 and CH2.

Blank: CAL
>: UNCAL

② A and B sweep scale factor displays and X-Y display



= : ×1 CAL (No horizontal magnification)
> : ×1 UNCAL
* : No interpolation
∩ : Sine interpolation
⌐¬ : Linear interpolation

×10 MAG Horizontal magnification

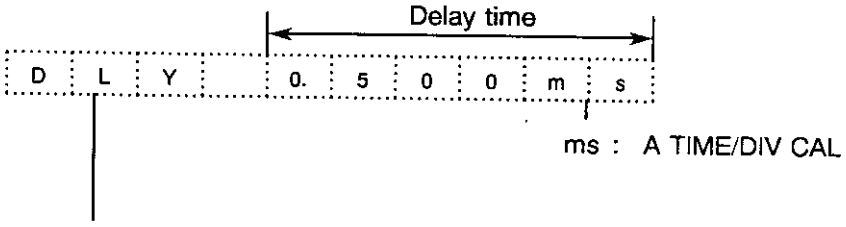
In the X-Y operation, the scale factor of the B sweep disappears, and the X-Y is displayed. This means that the waveform stored with the scale factor of A sweep is displayed in the X-Y mode.

③ PRE/POST TRIGGER setting display

The trigger point of a display waveform is displayed.

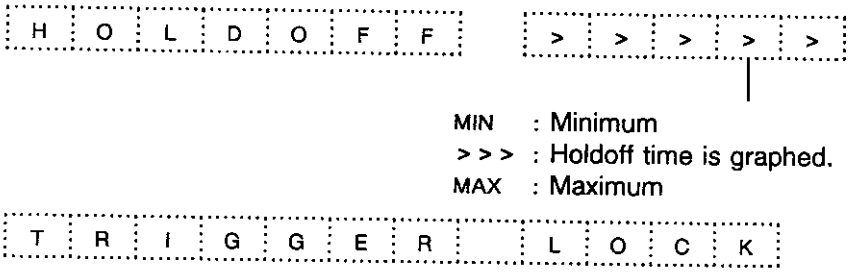
Example:

④ Delay time display



Shows that the HORIZONTAL MODE switch is set to ALT or B.

⑤ HOLDOFF and TRIGGER LOCK displays



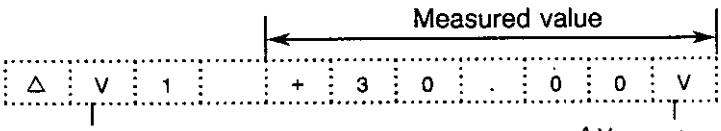
Displayed in the TRIGGER LOCK mode.

⑥ Displays of No. of averaging, smoothing, interpolation method, sampling method and aliasing displays.

For these displays, refer to items 8.3 (11) and (12).

⑦ Cursor measurement value display

A measurement value between cursors is displayed.



ΔV1: Voltage difference between two cursors for the CH1 sweep waveform

ΔV2: Voltage difference between two cursors for the CH2 sweep waveform

ΔTA: Time difference between two cursors for the A sweep waveform

1/ΔTA: Reciprocal number of ΔTA

ΔTB: Time difference between two cursors for the B sweep waveform

1/ΔTB: Reciprocal number of ΔTB

ΔV: +, −, mV, V, div

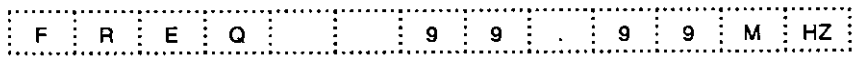
ΔT: +, −, ns, μs, ms, div

1/ΔT: mHz, Hz, kHz, MHz, ?

"div" is displayed in the following cases :

- The measurement value in the channel selected by the VERTICAL MODE switch is not in the CAL state.
- The VERTICAL MODE is set to ADD, and the VOLTS/DIV setting of CH1 and CH2 are not equal.
- The HORIZONTAL MODE switch is A, and the TIME switch and the VARIABLES control function (UNCAL state, CRT display: >)

⑧ Frequency counter display



- The frequency of the trigger signal source selected by the SOURCE OR X switch is displayed. When the triggering of the displayed waveform is unlocked and the waveform can not be measured, "---" is displayed.

ⓐ Readout display appears when the power is turned on. If this display is not needed, select H POS by the SELECTOR, move the SELECTOR upward to light TIME , and rotate the VARIABLES counterclockwise while holding the SELECTOR upward. The readout display then disappears.

To obtain the readout display again, select H POS , move the SELECTOR upward, and rotate the VARIABLES clockwise, while holding the SELECTOR upward.

ⓑ The P_{10X} display is initialized when the power is turned on. To blank the display, select H POS , hold the SELECTOR downward, and rotate the VARIABLES counterclockwise.

To obtain the display again, select H POS , hold the SELECTOR downward, and rotate the VARIABLES clockwise. The probe display can be switched to 1X or 10X only for the channel selected by the VERTICAL MODE switch.

8.2 REAL TIME Mode

The instrument works as a conventional oscilloscope.

(1) Normal sweep display

① Set the switches, and controls as shown in Table 8-1.

Check that the green LED Of the STORAGE switch goes off. If not, press this switch to establish the REAL TIME mode.

Table 8-1 Initial setting of basic display

Vertical axis	VOLTS/DIV	Set according to the amplitude of the applied signal.
	VAR	CAL (Fully clockwise)
	AC-DC	AC
	GND	Off (Pulled out)
	POSITION	Mid-position
	VERTICAL MODE	CH1
CRT display	INTEN FOCUS	Proper position Mid-position
Horizontal axis	HORIZONTAL MODE	A
	X10 MAG	Off (Pulled out)
Trigger	LEVEL	Mid-position
	MODE	AUTO
	SOURCE OR X	CH1

② Connect the signal to CH1 INPUT connector using a probe or a coaxial cable which meets the input impedance. Refer to Section 7 for connection.

③ Adjust the INTEN control for proper illumination.

④ Adjust the VOLTS/DIV of CH1 and the vertical POSITION control so that the trace is displayed within the CRT screen.

⑤ Adjust the LEVEL control for stable display.

⑥ Adjust the TIME/DIV switch so that the trace is displayed at a proper cycle. Use the FOCUS control, if necessary.

(2) In the case of measuring a single waveform

Use CH1 or CH2 when measuring a single waveform.
Make the following settings when using CH1:

VERTICAL MODE switch : CH1
SOURCE $_{OR}$ X switch : CH1
MODE switch : AUTO
AC-DC switch : AC or DC

Under these settings, almost all the repetitive signals of approximately 30Hz or more supplied to CH1 can be triggered and measured by adjusting the TRIG LEVEL control (within high sweep range from 2ms/DIV of the TIME/DIV switch.) Since the TRIGGER MODE of the horizontal axis is at AUTO, the trace appears even when no signal is present or when the GND switch is at GND. This means that the DC voltage can be measured.
The following switching is needed when measuring low frequency signals of approximately 30Hz or less.

MODE switch : NORM

Triggering can be effected by operating the LEVEL control under this setting.
When using CH2 only, use the instrument after making the follwing settings.

VERTICAL MODE switch: CH2
SOURCE $_{OR}$ X switch: CH2

(3) In the case of measuring two waveforms

Measurement of two waveforms can be made easily by setting the VERTICAL MODE select switch to DUAL.

NOTES:

a) When the A TIME/DIV setting is at 5ms/DIV or slower in the DUAL mode, the mode is automatically set to the CHOP mode.

When the TIME/DIV setting is at 2ms/DIV or higher, the mode is automatically set to the ALTERNATE mode.
If the CHOP mode is required when the TIME/DIV setting is at 2ms/DIV or higher, press both the CH1 and DUAL switches.

b) To measure the phase difference, trigger on the leading signal.

(4) In the case of measuring a waveform in the X-Y mode

When the HORIZONTAL MODE is set to X-Y, this instrument operates as an X-Y oscilloscope.
The X (horizontal) axis input is selected by the SOURCE $_{OR}$ X.
The Y (vertical) axis input can be used in CH1, CH2, and the dual trace.

NOTES:

a) Set the horizontal magnifying switch (X10 MAG) to off.
b) Set the BW LIMIT switch to off.

(5) How to use the ADD

When the ADD switch of the VERTICAL MODE is pressed, the sum of two waveforms can be measured.

8.3 Digital Storage Functions

The operating procedures of the digital storage functions are described below.

(1) Normal sampling mode (NORM)

When the TIME/DIV control is set to 2.5μs/div(5μs/div for the VC-6025A) to 0.1s/DIV, both the single and the repetition waveforms can be stored.

① Display the waveform to be stored in the REAL TIME mode.

② Press the STORAGE switch.(Green STORAGE LED light or blink)

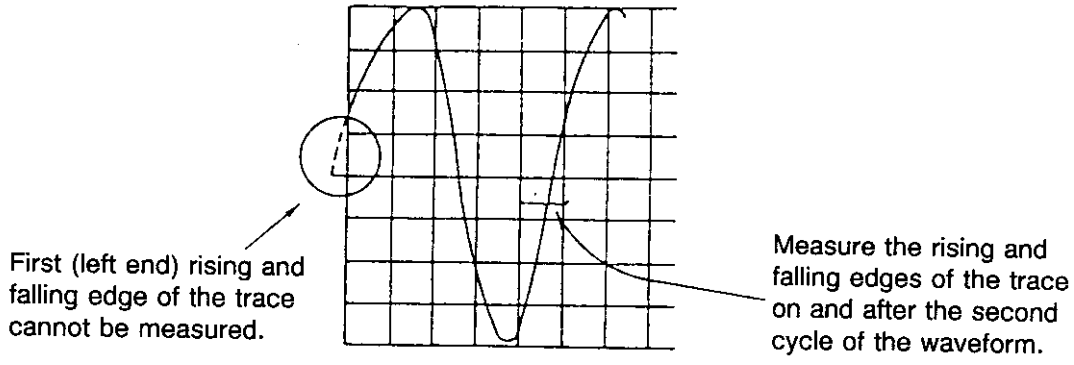
③ In this mode, a waveform is swept every trigger according to the setting state of controls on the front panel, the waveform to be stored is displayed on the CRT as it is. The slower the sweep rate, the longer the time is required for the acquisition and display of the waveform. (It takes approximately 3 seconds until a waveform is acquired at the sweep range of 0.1s/div.) The trigger signal is generated thereafter. Therefore, when the sweep rate is slow, the waveform is not displayed on the CRT immediately after the controls on the front panel have been adjusted.

④ When the HOLD switch is pressed in the normal sampling mode, the updating operation of the CRT display stops, and the CRT display at that time can be held. Precautions for the repeat mode range are shown below.

(2) Equivalent sampling mode (EQUIV)

When the TIME/DIV control is set to 50ns/div to 2μs/DIV, only the repetition waveform can be stored in the equivalent sampling mode. Note the following items in this mode.

a) The first (left end) rising and falling edges of the trace may not be displayed in the repeat mode range. In this case, measure the rising or falling edge on the second or later cycles of the waveform.



Display in the equivalent sampling mode

b) It takes 5 seconds or more to store the input signal of 1kHz or lower (for the 200Hz input).

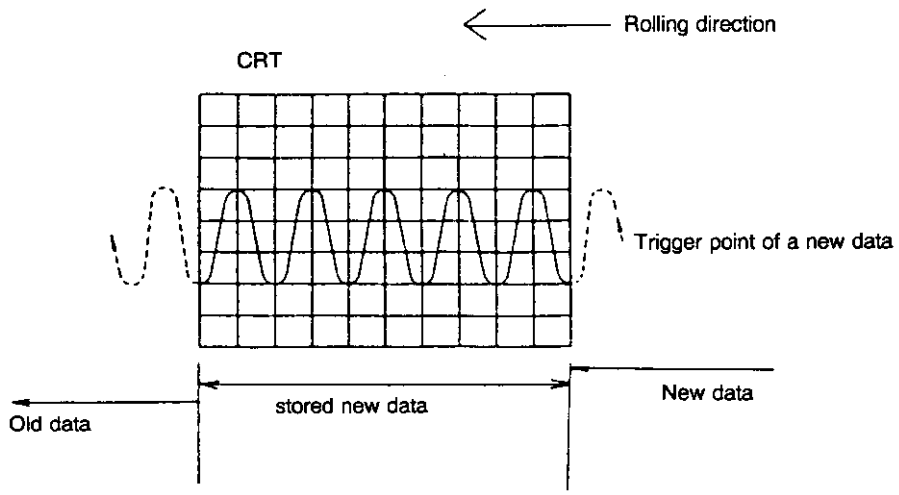
c) When the low frequency signal is stored, noise can be mixed. It is recommended to use a sine wave of 1MHz or higher or a square wave with the rise time which is faster than 0.3μs.

NOTE: Number of the displayed data

In the normal display without horizontal magnification in the STORAGE mode, the horizontal full scale of 10 div on CRT consists of 1000 sampling data.

(3) ROLL mode

When the TIME/DIV control is set to 0.2s/DIV to 50s/DIV, the displayed waveform is rolled from right to left. The right end of each trace is the updating point of a new data. The ROLL mode facilitates measurement of a signal of approximately 100Hz or lower.



Press the HOLD switch to stop the ROLL mode and hold the final waveform on the CRT.

In the ROLL mode, the SINGLE sweep can not be selected.

NOTES:

a) Discrimination of aliasing
When measuring the signal in such STORAGE mode as NORM, AVG, etc., aliasing can occur when an input signal which has more than half of the frequency with respect to the sample clock frequency at the sweeping range is added.
When aliasing occurs, the waveform of the input signal frequency minus the sample clock frequency will be displayed. It is possible that this display is judged a correct waveform.
If aliasing is doubted, place the instrument in the REAL TIME mode, and check if the measuring waveform is the same as the waveform in the measuring mode. Consequently, the warming message ALIAS 2 is displayed for less than 2 samples per input signal cycle, and ALIAS 10 is displayed for less than 10 samples per input signal cycle.

b) Updating of the ROLL waveform
The ROLL mode at the high speed ranges (up to 0.2s/div) is available. For some input signal, the movement of its waveform may not be seen smoothly at the range from 0.2 to 0.5s/div. This phenomena is caused by the relationship between the updating of the waveform data and the display speed. Actually the waveform data itself is correct.

c) Note on the ROLL mode operation

- Set the HORIZONTAL MODE switch to A to measure a waveform in the ROLL mode. When the switch is set to ALT or B, it is impossible to change of time range and to perform the cursor measurement. (The delay sweep can not be performed.)
- When the signal is held with the DUAL switches of the VERTICAL MODE pressed, the starting point of trace of CH1 may differ from that of CH2. (0.05 div approx. or less)

(4) SINGLE mode

When the SINGLE switch mode is selected by the SELECTOR switch in the STORAGE mode, the sampling of each operation mode is processed for one screen data.

① Single operation procedure

a) Establish the STORAGE mode (50ns/div to 0.1s/div, invalid in the ROLL mode) and adjust the controls so that the input signal is stored and displayed in the operation mode.

b) Set the TRIGGER MODE switch to NORM, and set the LEVEL at the proper position to measure the input signal.

c) Establish the SINGLE mode by the SELECTOR switch.

d) Press the SINGLE RESET switch to establish the trigger wait mode (LED lights).

e) When the trigger signal is supplied, the waveform data corresponding to one screen is sampled. When all the data are prepared, the screen display is updated. This is effective for the storage of a transient waveform.

② When the SINGLE switch is pressed in the above operation, the instrument is placed in the wait state of a trigger signal. The SINGLE sampling processing is not performed until the trigger signal is applied.
While the trigger of the input signal is not detected, the SINGLE RESET LED continues to light. When a signal for trigger is applied, or when the trigger mode is set to AUTO, the SINGLE processing is performed. Then the LED goes off, and this state is released.

③ In case that the TRIGGER MODE switch is set to AUTO, this instrument generates an AUTO TRIG signal periodically to perform the SINGLE processing if this instrument is not triggered by the input signal. Therefore, a DC signal can also be measured in this mode.

NOTE:AVG mode

A trigger signal in excess of the number of the designated sweep must be fed.
A sampling of 1000 data (corresponding to one sweep) is performed when ever a trigger signal is fed, and the data is accumulated. When the number of the designated sweep finishes, the accumulated waveform data is averaged, and the result is displayed on the CRT.

- When the above operation mode is processed once, the SINGLE operation finishes, and the LED above the PLOT switch goes off. The waveform on the CRT is held.

(5) HOLD mode

When the HOLD switch is pressed in the EQUIV, NORM, or ROLL mode, the HOLD mode is set. In this mode, the sampling operation in each operation mode is interrupted, the waveform display data at the time when the mode was changed to the HOLD mode is continued to display. After HOLD, the displayed waveform data can not be moved up and down.

(6) Save operation (SAVE)

The waveform data which is sampled and displayed in the STORAGE mode can be stored in the save memory.

The data stored in the save memory can be displayed on the CRT by the RECALL operation.

a) The sampling data is displayed in the STORAGE mode.
When the HOLD switch is pressed, the waveform is held.(HOLD mode)

b) The held waveform data is stored in the save memory by the following operation. (The SAVE switch functions only in the HOLD mode.)

c) The save switch LED lights momentarily to indicate that the waveform has been saved.
The saved waveform data continues to be saved unless a new waveform data is stored by the above operation.

d) When the VERTICAL MODE switch is set to CH1, CH2 or ADD, each pressing the SAVE memory saves the waveform in the save memories A and B alternately. When the VERTICAL MODE switch is set to DUAL, the CH1 waveform is saved in the save memory A, and at the same time, the CH2 waveform is saved in the save memory B.

(7) Display of the save memory (RECALL)

The contents of the save memory stored by the save operation in the HOLD mode are displayed on the CRT by the following operation, and can be com pared with a current waveform.

As the waveform data displayed in the save mode is saved in the save memories, the save waveform can not be moved up or down.

① When the CH1, CH2 or ADD switch of VERTICAL MODE is pressed

Pressing the RECALL switch once displays the waveform stored in the save memory A(S_A). Pressing it again displays the waveform stored in the save memory B(S_B). When the switch is pressed further, the save waveform disappears.

② When the VERTICAL MODE switch is set to DUAL

Pressing the RECALL switch displays the waveform stored in the savememories A(S_A) and B(S_B) and the waveforms of CH1 and CH2 simultaneously.
When the switch is pressed further, the save waveforms disappear.

(8) Output to the X-Y plotter (PLOT)

The waveform displayed in the HOLD mode is fed out to the X-Y plotter via the RS-232C by pressing the PLOT switch. (The PLOT switch functions only in the HOLD mode.) Press the PLOT switch again to interrupt plotting.

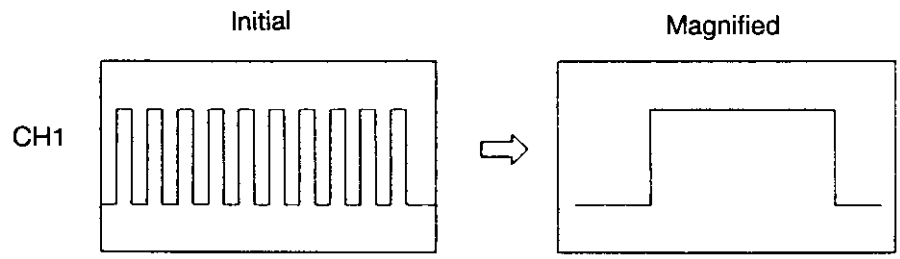
For details, refer to section 9.

(9) Horizontal magnifying display (Magnification of time axis)

A storage waveform displayed on the CRT is magnified by 10 times from the position pointed by the center of the CRT screen.

a) Move the portion to be magnified to the center of the screen. Use the VARIABLES rotary control to move the portion. The clockwise rotation moves the portion to the right, and the counterclockwise rotation moves it to the left. (H POS LED lights.)

b) When the X10 MAG switch is pressed, the data at 1 div at the center of the screen is magnified by 10 times.



c) Press the X10 MAG switch again. The initial waveform will be displayed.

NOTE :When the sampling is made in the ROLL mode, the horizontal magnification by the above operation can not be performed.
However, the horizontal magnification in the HOLD state is possible.

(10) Memory back-up function

The instrument has a memory back-up function. Therefore, the waveform data stored in the save memory and the panel setting conditions can be retained for approximately 48 hours after turning off the power of the instrument.

As only the setting data of section A on the front panel is retained, the instrument always is activated in the REAL TIME mode even though it has been in the STORAGE mode before turning off power.
In (11) MENU mode, the initial settings become as shown in Table 8-2 when turning on power.

To use this function properly, consider the following note.

NOTE :To store data for more than 48 hours, it is necessary to charge the memory backup element for more than 10 minutes before turning off the power.
To store the SAVE data, be sure to turn on the power for more than 10 minutes, before turning off the power.

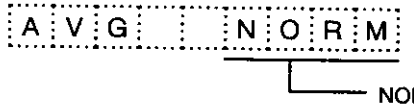
(11) MENU mode

The settings of the number of average, the interpolation method in the horizontal magnification mode, and the on-off of the waveform smoothing can be made by the MENU switch.

Each pressing the MENU switch displays the AVG , INTRPL , and SMOOTH at the top right of the CRT in sequence and the LED lights. Further pressing the switch releases the MENU mode and the LED goes off.

① AVG setting mode

When the MENU LED lights and the AVG is displayed at the top right of the CRT, the number of average can be set.



NORM	:	Average is not performed.
2	:	Average is performed 2 times.
4	:	Average is performed 4 times.
16	:	Average is performed 16 times.
64	:	Average is performed 64 times.
256	:	Average is performed 256 times.

The number of average is changed by the VARIABLES control. Clockwise rotation changes NORM to 2 to 4 to 16 to 64 to 256 to NORM.

The averaged waveform is displayed after the data of the set sweep number has been acquired. When the number of average is 16, data is acquired 16 times (the STORAGE LED blinks 16 times). Then the data is averaged and the average waveform display is updated.
Thus, the non-repetitive signal affected by asynchronous noise can be picked up.
In the ROLL mode, the average operation is not performed.
But, when the number of averaging is set in the ROLL mode and the sweep time is set to except for the ROLL mode, the average operation is performed.

When the number of averaging is changed during averaging, the actual change is made after the previous average operation is completed. When holding a waveform, press the HOLD switch after the average operation is performed setting times.

② Interpolation method selection mode

When the MENU LED lights and the INTRPL is displayed at the top right of the CRT, the interpolation method can be selected.

OFF : No interpolation
SIN : Sine interpolation
LIN : Linear interpolation

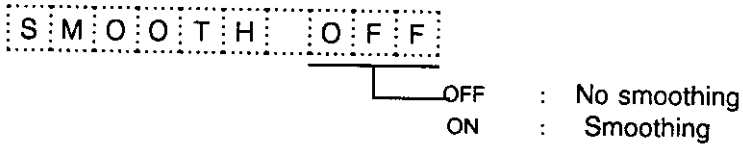
The mode selection is made by the VARIABLES control. Clockwise rotation changes the mode from OFF to LIN to SIN. Interpolation is to shape a coarse waveform resulting from magnifying the waveform in the horizontal direction (except for the save waveform) by calculation.

In case of OFF, the waveform is magnified as is in the horizontal direction.
In case of LIN, data is interpolated linearly, and the waveform is displayed smoother than that at OFF.
In case of SIN, the SIN operation is performed, so that the initial wave form is shaped to be a waveform close to a sine wave. This is effective for a sine wave.
When a square wave is connected in this state, ringing becomes remarkable, and the displayed waveform seems to be different from the input waveform. In this case, change the setting to OFF or LIN.

NOTE :
In case of SIN, set the amplitude of the input signal to less than 8 div on the CRT.0
When the signal having a amplitude larger than the CRT is connected, waveform distortion is observed at the upper and lower portions of the waveform.
To perform the interpolation in the ROLL mode, held the ROLL waveform and press the X10 MAG switch. The MAG X10 switch is not valid when the ROLL waveform is not held.

③ Smoothing selection mode

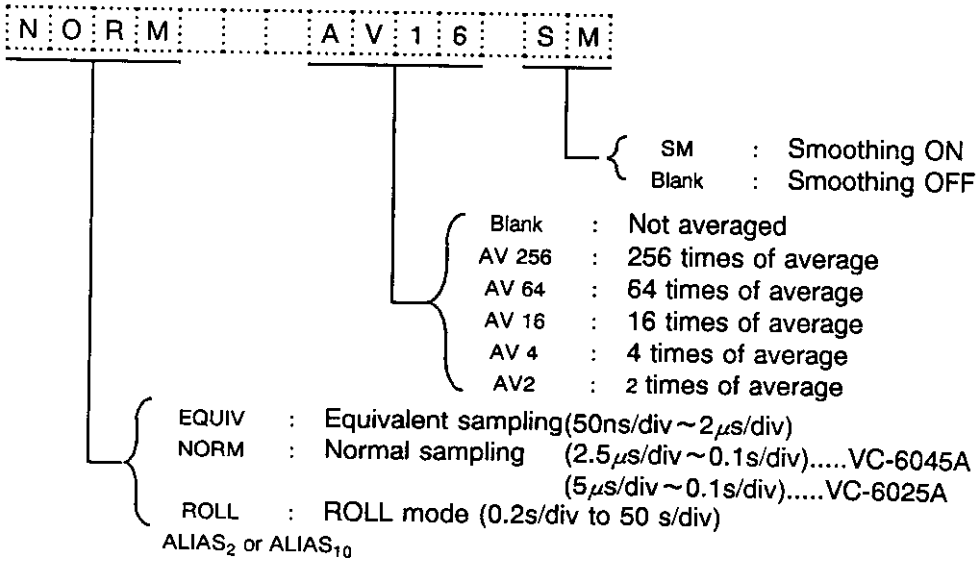
When the MENU LED lights and the SMOOTH is displayed at the top right of the CRT, the smoothing is made on and off.



In case of OFF, the storage waveform is displayed by dots. When changed to ON, the dots are connected smoothly, resulting in the smooth waveform display.
When the sampling frequency is low with respect to the input signal frequency (when the signal having more than 5 cycles per division is connected), the amplitude may be displayed small. In this case, set the smoothing mode to OFF to display the waveform of the similar amplitude with the input signal. The ON/OFF selection is made by the VARIABLES control.

(12) Menu display in the modes other than MENU

In the modes other than MENU, the setting information of the number of average, interpolation and smoothing is displayed as follows.



NOTE :
ALIAS 2 is displayed when the number of sampling per cycle of the input signal is less than 2. Thus, an aliasing error is indicated. When the number of samplings per cycle of the input signal is less than 10, ALIAS10 is displayed to indicate that the number of

samplings is insuf ficient. In this case, the display of sampling method (EQUIV, NORM or ROLL) disappears.

(13) Measurement of the waveform in the X-Y mode

① When the X-Y switches of HORIZONTAL MODE are pressed, the instrument operates in the dual trace (X-Y) mode regardless of VERTICAL MODE.

② The CH1 input signal is used for the X (horizontal) axis input and CH2 input signal is used for the Y (vertical) axis input.
When the RECALL switch is pressed, the following dual trace X-Y waveforms are measured.
CH1 and save memory A is X axis
CH2 and save memory B is Y axis

③ For the SAVE and RECALL operations in the X-Y mode, refer to the item (6) Save operation and (7) Display of the save memory.

(14) DLY operation

Partial magnification due to delay sweep can be made by the HORIZONTAL mode switch.

① Set the HORIZONTAL mode switch to A and display the waveform.

② Set the HORIZONTAL mode switch to ALT. Then the delay time is displayed at the top of the CRT together with the DLY cursors. The distance between the DLY cursors is determined by the TIME/DIV settings of the A and B sweeps. Partial magnification can be set by the VARIABLES control.

③ Prior to the TIME/DIV setting change of the A sweep, set the HORIZONTAL mode to A.

NOTE :
Though the DLY cursors can be moved by the VARIABLES control, it is impossible to move them to the left side of the TRG cursors.
When the TRG cursors are moved in the A mode (H.POS) after the DLY cursors have been set in the ALT mode, the positions of the DLY cursors may be changed when the mode is set to ALT again.

(15) Measurement of the waveform before the trigger point (PRETRIGGER)

Although a conventional oscilloscope displays the trigger point only at the left end of the screen since the sweep starts at the trigger point of the signal, the instrument can display the trigger point anywhere on the screen in 0.1 div steps, using the PRETRIGGER function in the STORAGE mode so that it is possible to measure the waveform before trigger point precisely.

a) When the H.POS LED is selected by the SELECTOR switch, the position of the trigger point is displayed (div).

b) The position of the trigger point is set by the VARIABLES control.

c) Example:
In the case of 4.0 div setting, the signal before the rising edge of the waveform (the triggered point) can be observed as shown below.

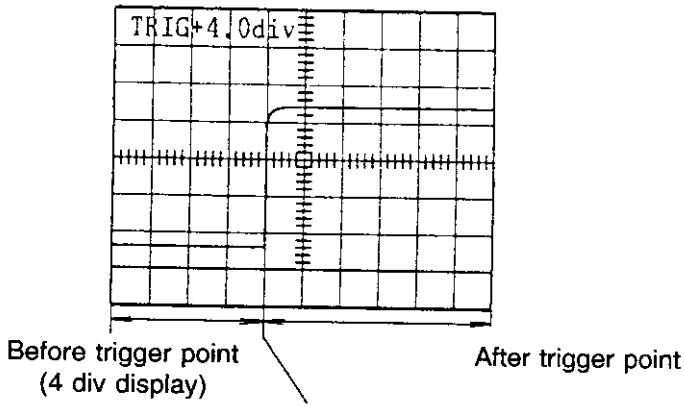


Fig. 8-1

8.4 General Measurement

(1) Voltage measurement

① △V cursor measurement

The measurable area by the △V cursors is 3 divisions above and below the center horizontal graticule line.

Set the VOLTS/DIV switch so that a waveform is within the area. When a signal including a DC component is measured in the DC coupling mode, adjust the POSITION control so that the GND trace is within the measurable area.

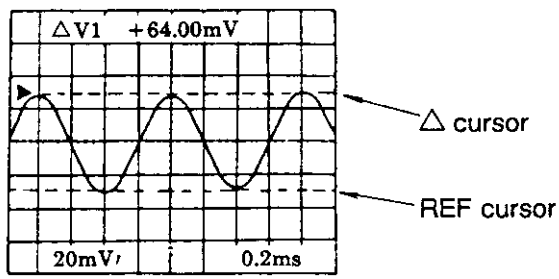


Fig. 8-2

When the MEASURE is selected by the SELECTOR, two horizontal cursors appear on the CRT. The voltage between the reference cursor and the cursor is displayed with "△V" on the upper side of the CRT. The voltage becomes " + " when the △cursor is above the reference cursor, while it is "–" when the △ cursor is below the reference cursor.

The cursor selected by the CURSORS △REF. △.TRACKING switch moves up when the VARIABLES control is turned clockwise, while it moves down when the control is turned counterclockwise. Therefore, the voltage between two cursors can be measured.

To measure the voltage from the GND line, press the GND switch to display the GND line, and align the reference cursor with the GND line. Switch the input coupling mode to DC, and align the △ cursor with the level to be measured.

NOTES:

a) When the DUAL mode is selected in the REAL TIME mode, the measurement value of CH1 (ΔV1) is displayed.

b) When the HORIZONTAL MODE is X-Y, or when the HORIZONTAL MODE is ALT in the REALTIME mode, the △V cursor measurement can not be selected.

c) The resolution of the ΔV cursor is 100 points/div in the REAL TIME mode and 25 points/div in the STORAGE mode. Consequently, the measured data is slightly different from the REAL TIME mode to the STORAGE mode.

d) The measurement value is displayed in DIV when the VOLTS/DIV switch and the VARIABLES control function produce an uncalibrated sweep.
(UNCAL state, CRT display: >)

② Visual measurement

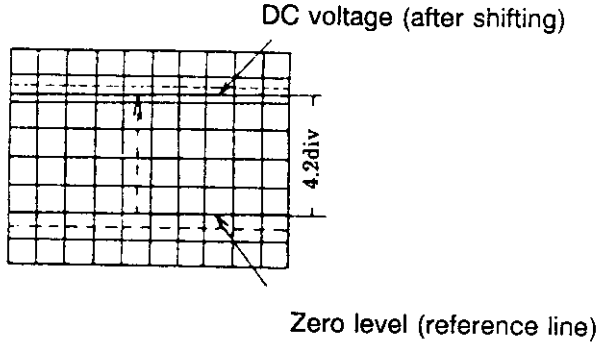


Fig. 8-3

Set the GND switch to GND and obtain the base-line trace. Set the AC-DC switch to DC and set the VOLTS/DIV switch to obtain an optimum amplitude waveform. Since the trace shifts by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift by the indicated value of VOLTS/DIV. For instance Fig. 8-3, when VOLTS/DIV is 50mV/DIV, then 50mV/DIV x 4.2 = 210mV (However, if the 10X probe is in use, the true value of the signal becomes 10 times the value, it will be 50mV/DIV x 4.2 x 10 = 2.1V).

(2) Time and frequency measurement

① △T cursor measurement

When the MEASURE is selected by the SELECTOR switch, the △V cursor appears on the CRT. Then, when the SELECTOR switch is moved downward once so that the △T cursor measurement mode is established, the measurement value will be displayed with △T on the upper side of the CRT.

The measurable area by the △T cursor is 4 divisions to each side from the center vertical graticule line.

Set the TIME/DIV switch so that the desired portion of a waveform is as large as possible.

The two cursors selected by the CURSORS REF. △. TRACKING switch can be shifted by the VARIABLES control.

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

+: The △ cursor is located on the right side of the reference cursor.
– : The △ cursor is located on the left side of the reference cursor.

Clockwise rotation of the VARIABLES control moves the △ cursor to the right; counterclockwise rotation moves it to the left.

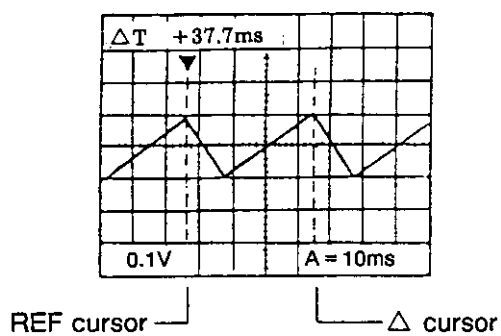


Fig. 8-4

NOTES:

a) When the HORIZONTAL MODE is X-Y, or when the HORIZONTAL MODE is ALT in the REAL TIME mode, the ΔT cursor measurement can not be selected.

b) The measurement value is displayed in DIV when the TIME switch and the VARIABLES control function produce an uncalibrated sweep.
(UNCAL state, CRT display: >)

c) In the normal sampling mode and the ROLL mode, the TIME VAR function is invalid.

② 1/ΔT cursor measurement

When the MEASURE is selected by the SELECTOR switch, two cursors will appear on the CRT. When the SELECTOR switch is moved downward twice, 1/ΔT is displayed on the upper side of the CRT.

When the two cursors are set to the peaks of the waveform corresponding to one period by the VARIABLES control, the reciprocal number of Δ-time between two cursors is displayed with 1/ΔT on the upper side of the CRT.

Clockwise rotation of the VARIABLES control moves the Δ cursor to the right; counterclockwise rotation of the control moves the cursor to the left.

NOTES:

a) When the HORIZONTAL MODE is X-Y, or when the HORIZONTAL MODE is ALT in the REAL TIME mode, the 1/ΔT cursor measurement cannot be selected.

b) The measurement value is displayed in DIV when the TIME switch and the VARIABLES control function produce an uncalibrated sweep.
(UNCAL state, CRT display: >)

c) In the normal sampling mode and the ROLL mode, the TIME VAR functionis invalid.

③ Visual time measurement

The illustration(Fig. 8-5) shows one period of time between A and B, which represents 2.0 DIV.

When the sweep time is 1ms/DIV, the period is given by 1ms/DIV x 2.0 = 2.0ms (2.0 x 10^{-3}s).

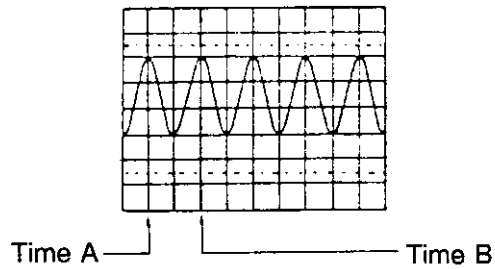
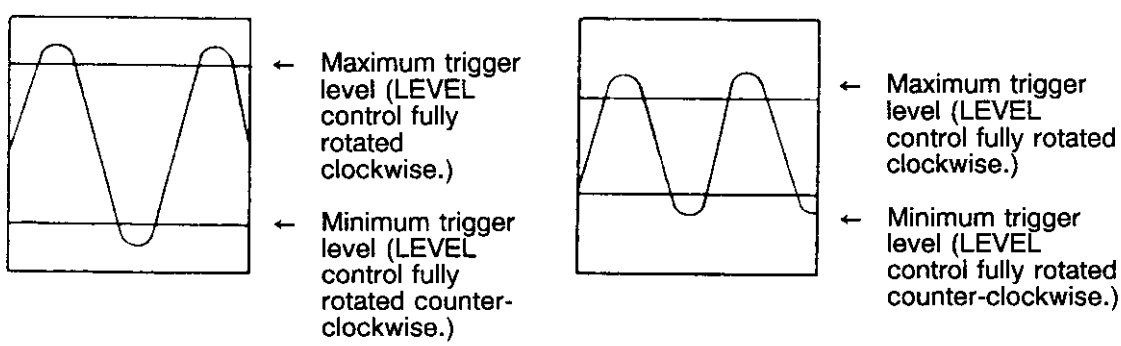


Fig. 8-5

④ Visual frequency measurement
The above result, 2.0 ms (2.0 x 10^{-3}s), is converted so that the frequency is given by $1/(2.0 \times 10^{-3})$ = 500Hz

(3) Operation of the AUTO trigger function

When the TRIGGER MODE switch is set to AUTO, the instrument automatically displays a sweep if an input signal is not applied.
The trigger level is set according to the amplitude of input signal as shown in Fig. 8-6 (a) and (b).
The AUTO TRIGGER LEVEL setting function eliminates troublesome triggering.



(a) Input signal of large amplitude

(b) Input signal of small amplitude

Fig. 8-6

When the MODE switch is set to NORM, the trigger level is set regardless of the input signal level.

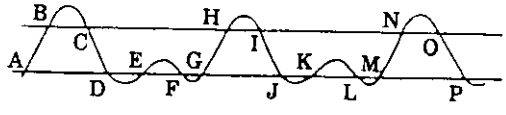
NOTE :

When the MODE switch is set to AUTO, it takes 2 or 3 seconds to obtain a stable trigger since the trigger level is automatically set according to the amplitude of an input signal.

(4) How to trigger a complex waveform

In the case shown in Fig. 8-7 (a) where waveforms are greatly different in amplitude, the waveform is doubled if the TRIGGER LEVEL control is not set properly. In the case where the trigger level is selected by line Y, two waves, one starting with A, advancing to B, C, D, E, F,... and the other starting with E, advancing to F, G, H, I..., will appear alternately on the screen. They will be doubled as shown in Fig. 8-7 (b).

In such a case, rotate the LEVEL control clockwise until the trigger level comes to Y' line. Then the waveform on the screen becomes the one as shown in Fig. 8-7 (c) which starts with B and advances to C, D, E, F,... and allows triggering.



(a) Signal waveform

(b) When the trigger setting level is Y

(c) When the trigger setting level is Y'

Fig. 8-7 Triggering of complex waveforms

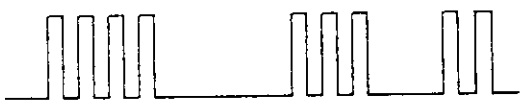
(5) Operation of the HOLDOFF function

① In case of measuring a high frequency signa

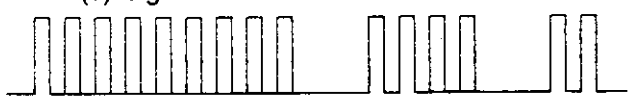
Slight jitter may occur on a high frequency signal of approximately 5MHz or more. In this case, adjust the HOLDOFF control so that the jitter is eliminated and a stable trigger is obtained.

② In case of measuring a complex waveform as shown in Fig. 8-8 (a)

It is possible that the triggering is doubled as shown in Fig. 8-8 (b) by the TRIGGER LEVEL control. In such a case, light the HOLDOFF by the SELECTOR switch and adjust the VARIABLES control to obtain the proper waveform as shown in Fig. 8-8 (c).



(a) Signal waveform



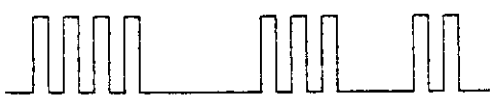
(b) Before using HOLDOFF

(c) After using HOLDOFF

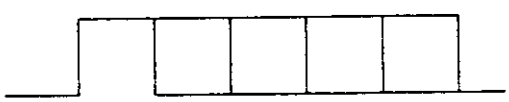
Fig. 8-8 Triggering of complex waveforms

(6) Operation of the TRIGGER LOCK function

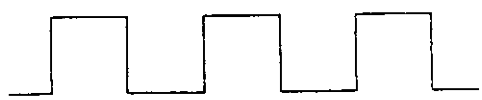
Triggering can be doubled when the sweep range is changed after performing the HOLDOFF adjustment. In such a case, necessity to performing the HOLDOFF adjustment again.
When the TRIGGER LOCK LED is lit with the waveform triggered, the trig gering is not doubled if the sweep range is changed.
If the TRIGGER LOCK function is not required, press the TRIGGER LOCK switch again so that the LED goes off and this function is released.



(a) Waveform triggered by HOLDOFF, etc.



(b) Magnified with TRIGGER LOCK OFF



(c) Magnified with TRIGGER LOCK ON

Fig. 8-9 Triggering of complex waveforms

NOTE: The A TIME/DIV range and the TIME VARIABLES range in the TRIGGER LOCK mode cannot be set to the slower than that when the signal is locked.

(7) Operation of the TV trigger SYNC function

① TV video signal

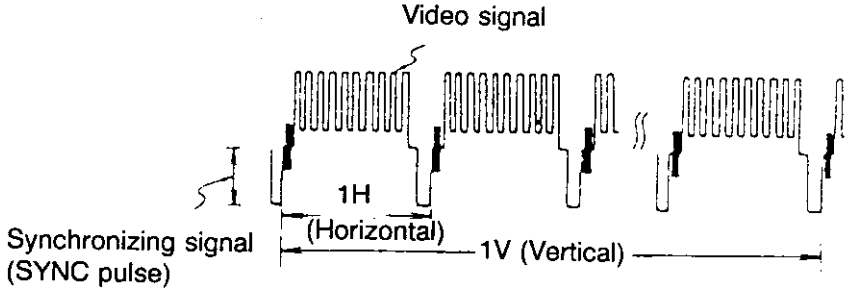
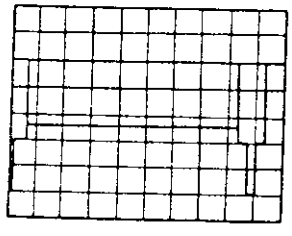


Fig. 8-10

In video work, a composite video signal containing a video signal, a blanking signal, a pedestal signal, and a synchronizing signal is often measured.

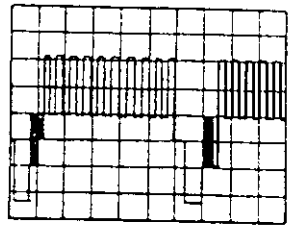
② Operation

To observe a vertical signal



TRIGGER MODE: TV-V

To observe a horizontal signal



TRIGGER MODE: TV-H

Fig. 8-11

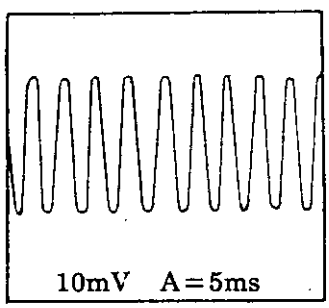
The polarities of the video and synchronizing signals are automatically set.

The trigger level setting is not required in the TV mode.

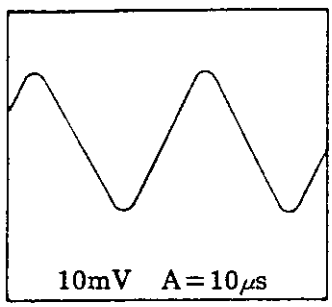
(8) Operation of the AUTO range function

In the normal measurement, the sweep range is set by the TIME/DIV switch. When the AUTO lamp is lit by pressing the AUTO switch with the signal triggered, the input signal is detected,

the sweep range is automatically set, and the waveform of 1.6 to 4 cycles is displayed on the CRT. This is recommended when the time relation of an input signal is unknown or the input frequency changes with time.



(a) Before using AUTO range



(b) After using AUTO range

Fig. 8-12

NOTES:

a) The AUTO range does not function when the trigger is not obtained. The AUTO range functions with the trigger signal selected by the SOURCE $_{OR}$ X and MODE switches.

b) Since the operable time range is 5ms/DIV to 50ns/DIV, the signal of 100Hz or less, or 8MHz or more is not displayed as the waveform of 1.6 to 4 cycles. The time range is set to 5ms/DIV for the signal of 100Hz or less or in case of out of trigger, and set to 50ns/DIV (maximum) for the signal of approximately 8MHz or more.

c) The HORIZONTAL MODE switch should be set to A.

d) When the AUTO range functions with the VERTICAL MODE switch set to DUAL, the dual trace operation is always performed in the CHOP mode. For measuring the waveforms at high speed, release the AUTO range function by setting the A $_{AND}$ B TIME/DIV switch to the high speed mode or the low speed mode.

e) In case of measuring a complex waveform such as a TV signal, it may take several seconds to perform the AUTO range function.

f) In case of measuring a complex waveform, the time range can be automatically changed and the waveform cannot be measured easily. In this case, release the AUTO range function.

g) To release the AUTO range, set the A AND B TIME/DIV switch to either side.

h) In the X10 MAG mode, the waveforms of 1.6 to 4 cycles are magnified by 10 times.

(9) Operating procedure of the delayed sweep

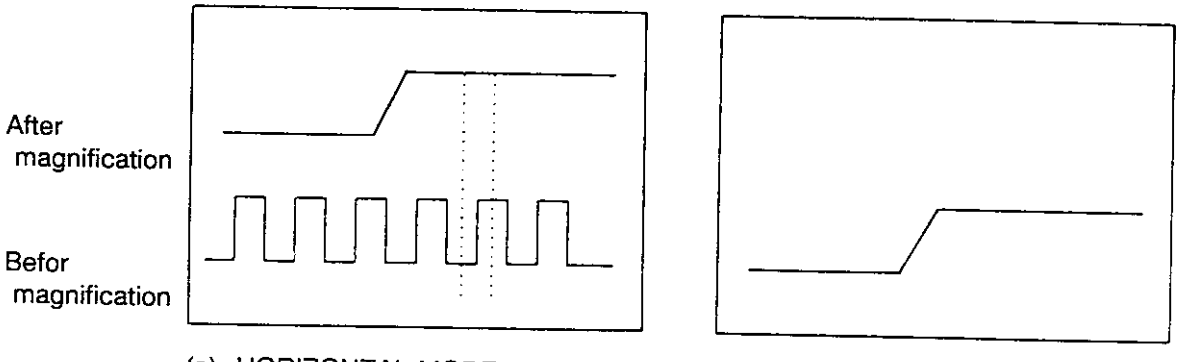
① REAL TIME mode

A delayed sweep is used to magnify any portion of a complex waveform in the horizontal direction.

Press the A switch of the HORIZONTAL MODE, effect triggering by A sweep and set the switches as follows.

A TIME/DIV :	As desired
HORIZONTAL MODE:	ALT
B TIME/DIV :	Set to the time range to be magnified.

A and B sweeps appear simultaneously on the CRT, DELAY is automatically set by the SELECTOR, and the two cursors will appear. The two cursors will move continuously by the VARIABLES control. Bring the cursors to the position to be magnified. Then, the waveform between the cursors is magnified to occupy the full area of the screen.
The time from a starting point of the A sweep to that of the B sweep is displayed on the upper left side of the CRT. To measure the magnified waveform only, set the HORIZONTAL MODE to B.



(a) HORIZONTAL MODE: ALT (b) HORIZONTAL MODE: B

Fig. 8-13

The B sweep trace can be shifted vertically approximately ±3 divisions with respect to the A sweep trace for the convenience of measuremenet by the [SEP]. The vertical variable range is initialized to approximately +2 divisions with respect to the A sweep trace. By setting the VERTICAL MODE to the dual mode in the ALT sweep mode, two more traces, four traces in total, appear on the CRT.

NOTES:

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

b) The time range of the B sweep is designed to be always higher than that of the A sweep (except in the 50ns/DIV). Prior to change of the time range of the A sweep with the HORIZONTAL MODE switch set at ALT or B, set the HORIZONTAL MODE switch to A again.

c) As the magnification ratio increases in the delay sweep mode, the intensity decreases. If the focus of the trace is adjusted to be optimum at this time, a proper focus cannot be obtained for characters, which is not suitable for photographing. Therefore, do not increase the intensity too much, or blank characters for photographing.

d) The interval between two cursors in the delay sweep mode is designed to be always 0.5div or more on the CRT, so that easy observation is ensured when the magnification ratio is increased.
Therefore, all the waveform between the cursors is not magnified when the magnification ratio is increased. To verify what part of the A sweep is magnified, check the delay time displayed on the upper left side of the CRT and the A sweep times.

e) The cursors which indicate delay position disappear when the X10 MAG mode is established.

② STORAGE mode

This mode is used for sampling the portion of a signal delayed by a certain time from the trigger point of the A sweep at a high speed and measuring the signal precisely.

Select the A switch of the HORIZONTAL MODE and trigger the signal and set the TIME/DIV switch as follows.

A TIME/DIV: Set this control so that the delay time is within 10 divisions on the CRT.
For example, if the delay time is 8ms, set this control at a slower range than 1ms/DIV.

Then, set the HORIZONTAL MODE to B, and the SELECTOR is automatically set to DELAY. The waveform is changed to the B sweep waveform and the TIME/DIV display is changed to B TIME/DIV.

a) Set the delay time displayed at the upper left side of the CRT to the desired value by the VARIABLES control.
The waveform start point at the left side of the screen is delayed by the set time from the trigger point of the A sweep.

b) Set the B TIME/DIV to the time range to be measured.

NOTES:

a) The B sweep can be set for the time range of 2.5μs/DIV to 50ms/DIV (5μs/DIV to 50ms/DIV for the vc-6025A)

b) As in the REAL TIME mode, the B sweep time range is not made slower than the A sweep time.
When the HORIZONTAL MODE is set to B, the A TIME/DIV can not be changed. When changing the time range of the A sweep, reset the HORIZONTAL MODE switch to A.

c) When the PRETRIGGER is set in the B sweep mode, the time from the trigger point of the A sweep to the PRETRIGGER corresponds to the delay time set previously.

(10) Measurement of single shot phenomena

To measure a single-shot signal and a complex waveform such as an impulse wave, an audio signal, noise from a switch, etc., the STORAGE mode is usually used. However, the following measurement is sometimes possible in the REAL TIME mode.

① Single sweep measurement for a waveform to be easily triggered

Set the HORIZONTAL MODE to A, and the TRIGGER MODE to NORM. Connect a vertical signal to be observed or a repetitive waveform having the same amplitude as the above signal, and rotate the TRIGGER LEVEL control to obtain a proper triggering.

Select SINGLE by the SELECTOR switch, press the SINGLE RESET switch, and check that the single sweep is performed. Disconnect the vertical signal from the instrument (press the GND switch, for example), press the SINGLE RESET switch again, and check that the SINGLE RESET LED lights.

When the vertical signal is connected again, the single sweep is performed.
At the time, the SINGLE RESET LED goes off.

② Single sweep measurement for a waveform hard to be triggered

Set the TRIGGER MODE to AUTO, the HORIZONTAL MODE to A, and select SINGLE by the SELECTOR switch.

Press the SINGLE RESET switch so that the single sweep is performed.

NOTES:

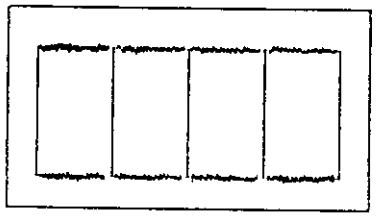
a) If the TRIGGER LEVEL control is rotated, the sweep is performed even when no signal is supplied. After the SINGLE RESET LED lights, do not rotate the TRIGGER LEVEL control.

b) For a general single shot measurement, set the TRIGGER MODE to NORM.

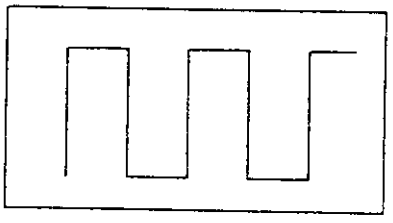
c) When the HORIZONTAL MODE is set to ALT or B, the single sweep cannot be performed.

(11) Operation of the BW LIMIT function

When it is hard to measure or trigger a signal because a high-frequency component of more than 20MHz(more than 10MHz for the VC-6025A) is superimposed on the signal, use the BW LIMIT function.
By the BW LIMIT function, the component of approximately 20MHz(more than 10MHz for the VC-6025A) or more of the sync signal can be eliminated.



(a) Before the BW LIMIT functions



(b) After the BW LIMIT functions

NOTE :When the BW LIMIT function is used, the frequency bandwidth is approximately 20MHz(more than 10MHz for the VC-6025A).

(12) High accurate time base calibration

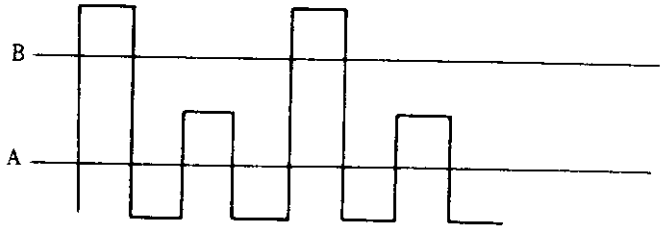
When the power is turned on, the built-in microprocessor automatically starts to calibrate the time base.

To perform a more accurate time base calibration and the waveform measurements which correspond to ambient conditions, turn off the power after approximately fifteen minutes from the power on, and then turn it back to on after approximately three seconds.

(13) FREQ counter measurement

When the MEASURE is selected by the SELECTOR switch, the△V cursor is displayed.
Then downward the SELECTOR switch three times to display the FREQ on the upper part of the CRT.

The frequency is measured from the trigger point since the counter is interlocked with trigger.
A specific frequency in a complex waveform can be measured by varying the level.
For instance, when applying the signal shown below, the frequency of the whole waveform is measured in case the trigger point is A, or the frequency of the bigger pulse is measured in case the trigger point is B.



Note: The frequency can not be measured when the signal is not triggered since the counter is interlocked with a trigger signal.

When the signal is not triggered or the input signal is 20Hz or less, " FREQ....." is displayed.

(14) System reset

In case of abnormal AC power, etc., the built-in microprocessor can mal function. In this case, press the POWER switch to OFF, and then ON after three seconds or more to reset the microprocessor. Allow approximately twenty seconds for the instrument to be operated after completion of the automatic calibration.

(15) Initial settings

When power is turned on after the elapse of the waveform and panel setting data back-up time, or when the initial settings are performed (while pressing the AUTO of the TIME/DIV switch, upward the SELECTOR switch), the initial settings become as shown in Table 8-2.

Table 8-2 Initial settings

Item		Initial settings	Item		Initial settings
Probe factor		P_{10X}	AUTO range		OFF
Readout		ON	TRIGGER LOCK		OFF
SELEC-TORS	Setting function	H·POS	SINGLE RESET		OFF
	SEP	approx. +2div	CURSORS REF·△·TRACKING		REF
	DELAY	1div equivalent	Storage panel	STORAGE	REAL TIME mode
	HOLD OFF	Min		HOLD	OFF
	TIME	CAL		RECALL	OFF
	H·POS	0div		MENU	OFF
	MEASURE	V···6div H···8div	Storage menu	AVG	NORM
	SINGLE	OFF		INTRPL	LIN
Time range	A	1ms		SMOOTH	ON
	B	0.5ms			

9. DIGITAL PLOT OUTPUT TO THE X-Y PLOTTER

All the data displayed on the screen is output to the X-Y plotter only by connecting this instrument and the X-Y plotter with the RS-232C cable.

The operation of the instrument is described below.

For the operation of the X-Y plotter, refer to the operation manual attached to the plotter.

9.1 Applicable X-Y Plotter

Hitachi Graphic Plotter 681-XA (RS-232C interface specifications) or completely compatible unit.

9.2 Specifications of Plot

(1) Letters and cursor

All the letters and cursors displayed on the screen are plotted.

(2) Waveform data

All the waveform data displayed on the screen is plotted. The waveforms of the horizontal axis of 10 divisions and the vertical axis of 10 divisions are plotted.
In the magnification mode, the magnified portion only is plotted.

(3) Grids and scale

The grids of the horizontal axis of 10 divisions and the vertical axis of 8 divisions are plotted. The scale of 0.2 div unit on the horizontal and vertical center grids is plotted.

(4) Screen mode

The four screen modes are selectable by setting the DIP switches on the rear. For details, refer to item 9.4 Setting.

(5) Pen replacement mode

Replacement of pens can be designated by the DIP switches on the rear. For details, refer to item 9.4 Setting.

(6) Examples of plot

Figs. 9-1(a) thru 9-1(d) illustrate examples of the plot output.

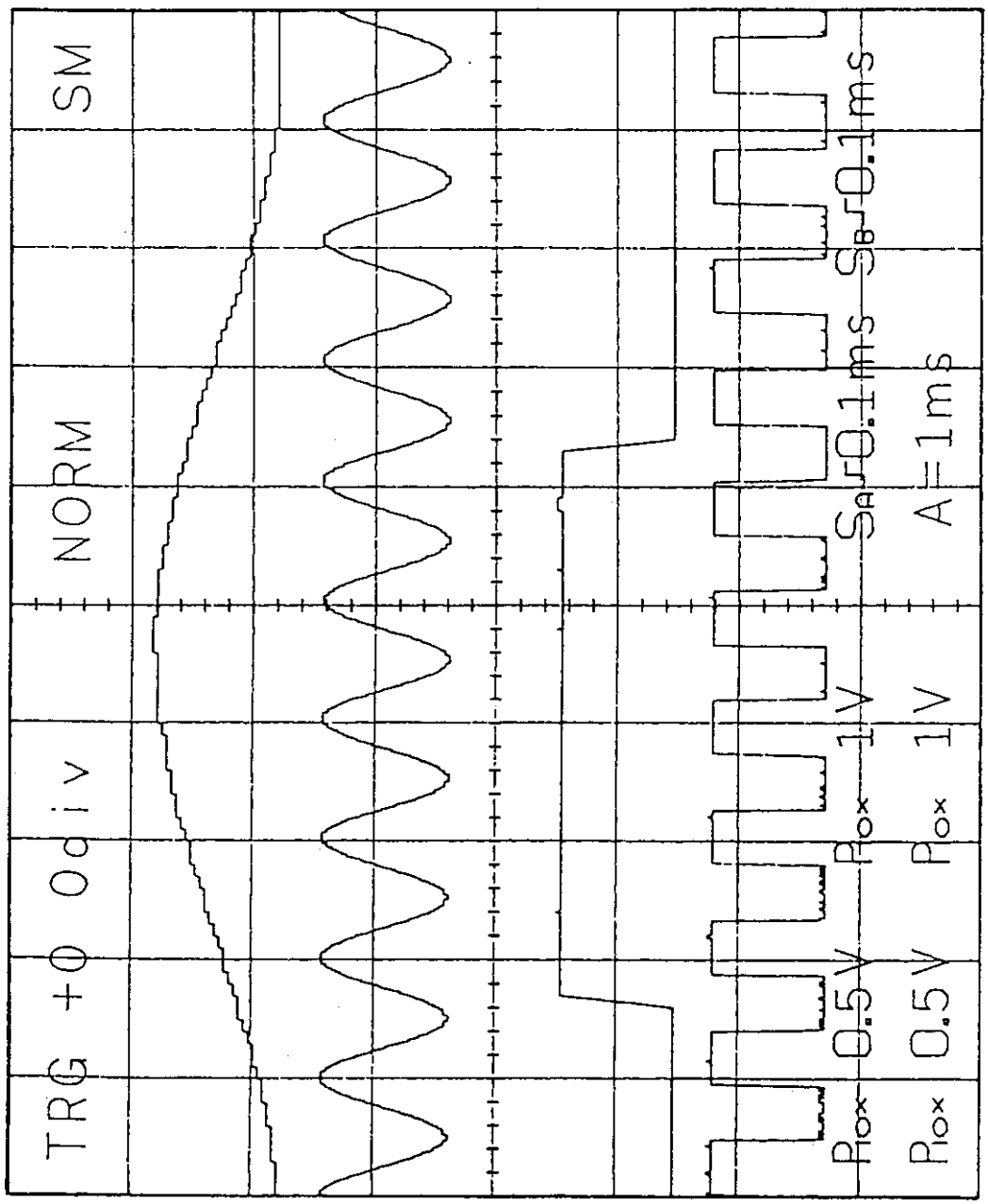
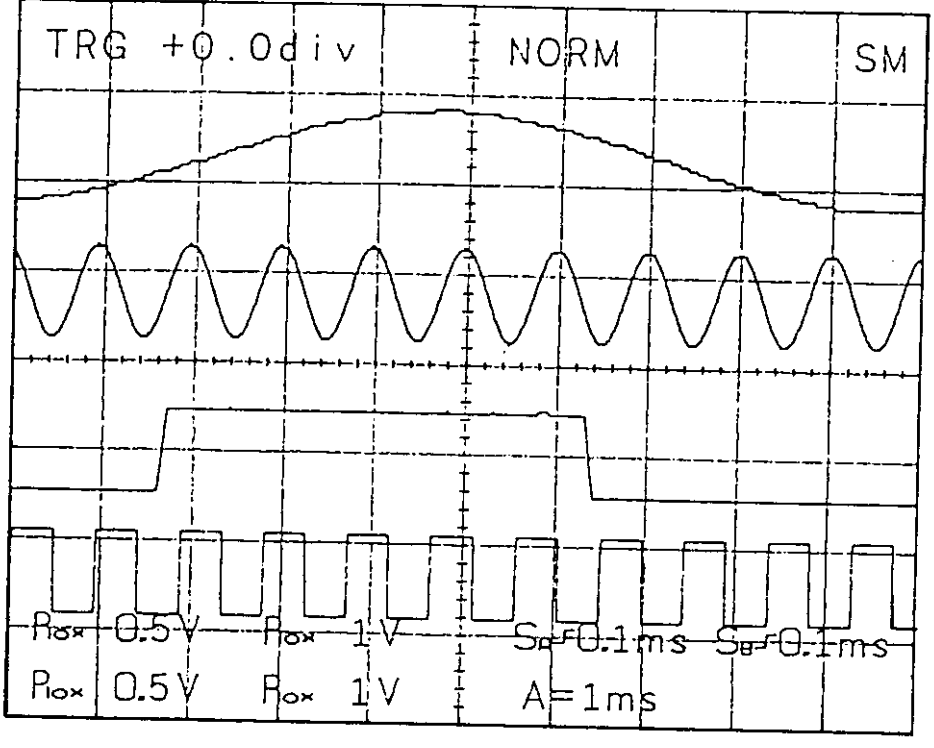


Fig. 9-1(a) Plot output display 1



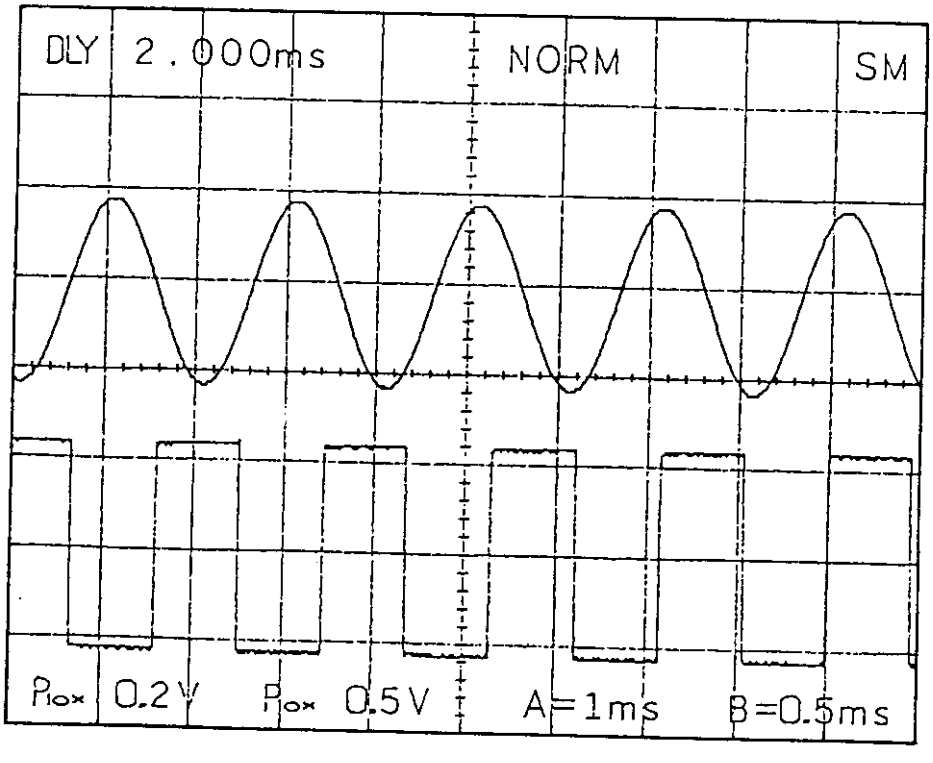


Fig. 9-1 (b) Plot output display 2

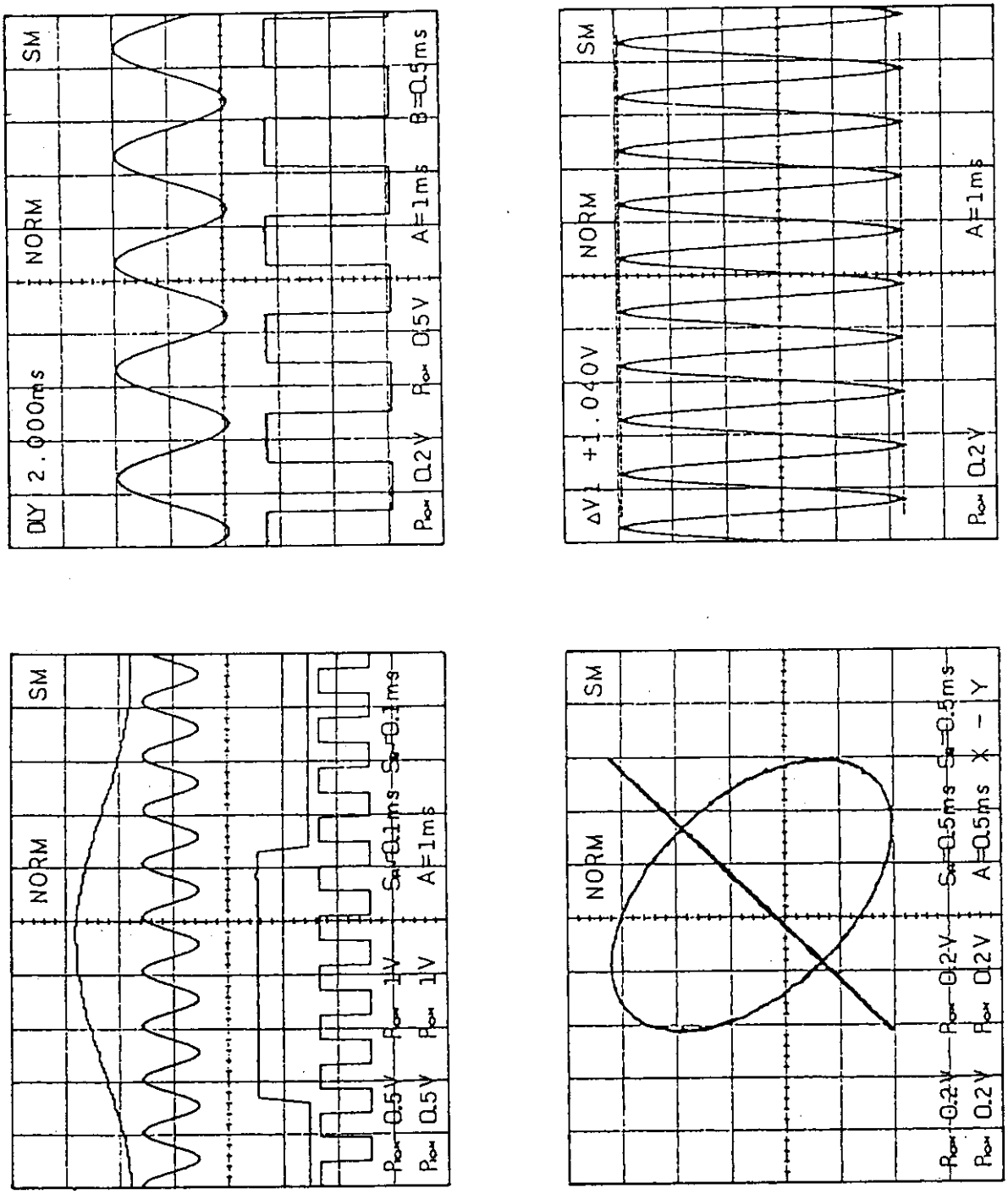
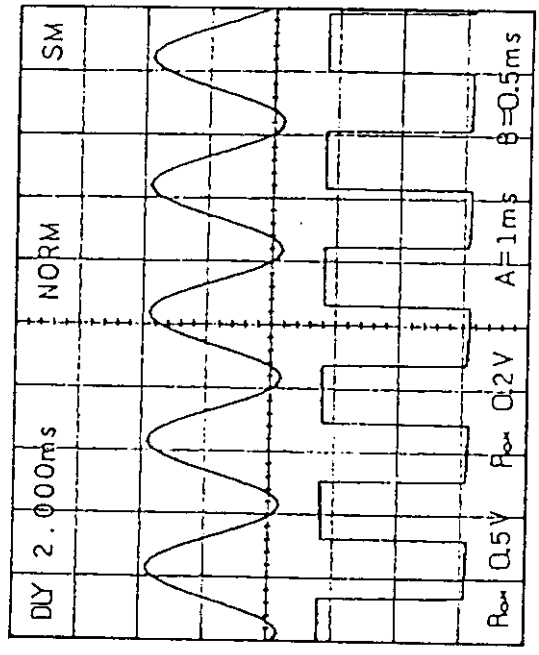


Fig. 9-1 (c) Plot output display 3



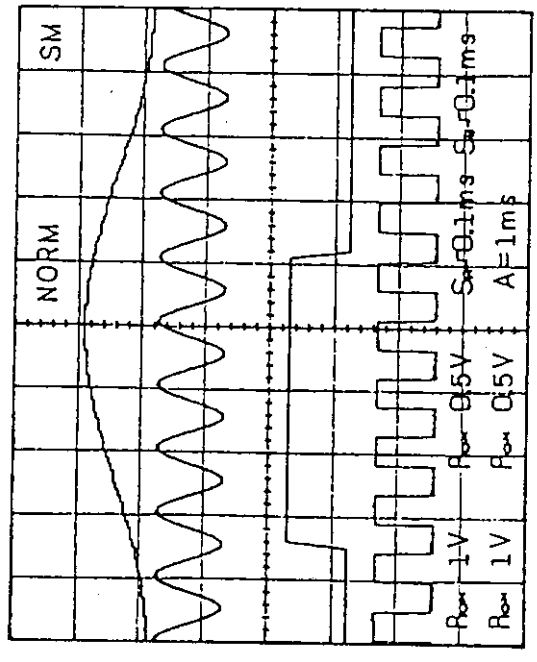


Fig. 9-1 (d) Plot output display 4

9.3 Connection

Connect the connector on the rear with a X-Y plotter by the RS-232C interface cable.
Prior to connection of a plotter, read the related manual carefully and use the appropriate interface cable, because interface is changed in accordance with types of plotter. Fig. 9-2 illustrates the wiring of the RS-232C interface cable used for the connection of the Hitachi Graph Plotter 681-XA and the instrument.

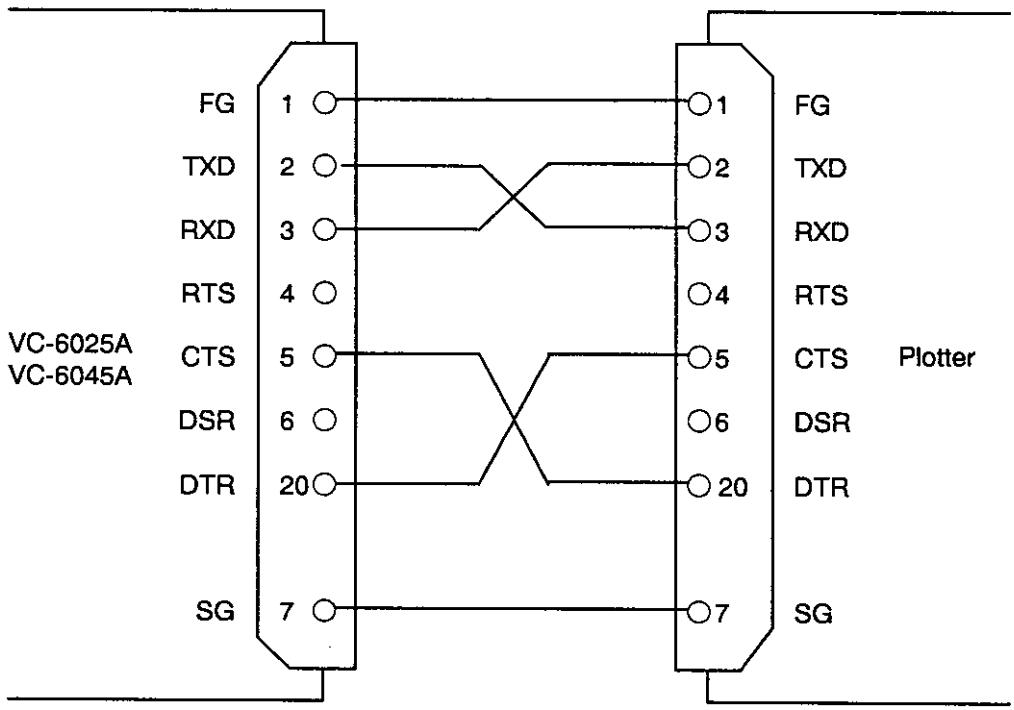
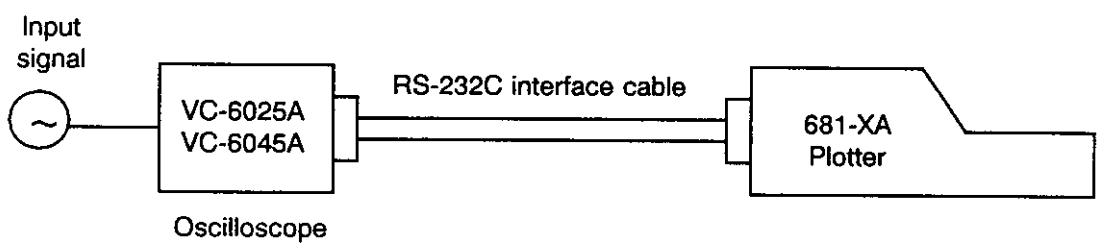


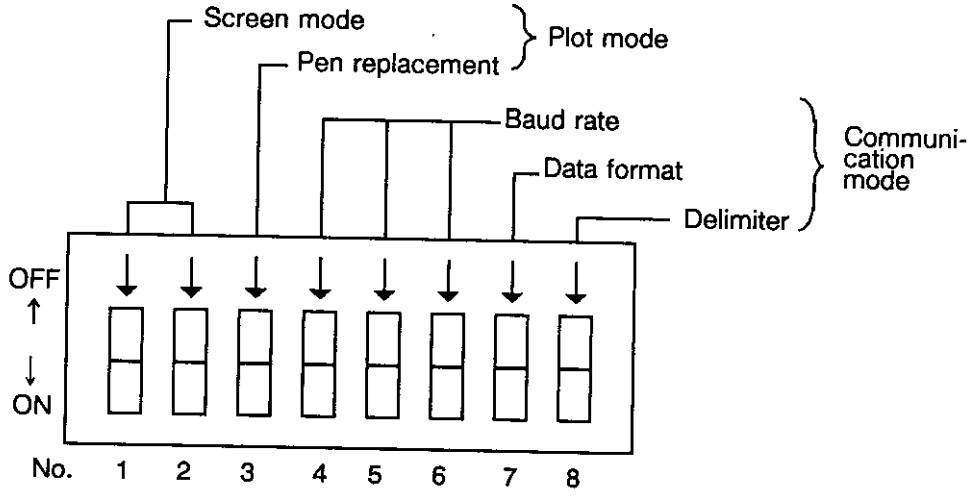
Fig. 9-2 Wiring diagram of the RS-232C interface cable



NOTE: RS-232C interface cable for Hitachi Graph Plotter 681-XA: No.4287 (option)

9.4 Setting

Set the plot mode and the communication mode by the DIP switches on the rear.



(1) Plot mode

(a) Screen mode setting

The screen size can be set by No. 1 and 2 of the DIP switches, and one of the modes listed in Table 9-1 is selected.

Table 9-1 Screen mode setting

Screen mode	DIP switches		Content	Screen size (mm)
	No.1	No.2		
1	ON	ON	One screen is plotted on a sheet of A4 size paper.	170mm × 170mm (Refer to Fig. 9-1 (a).)
2	ON	OFF	Two screens are plotted on a sheet of A4 size paper.	120.8mm × 120.8mm (Refer to Fig. 9-1 (b).)
3	OFF	ON	Four screens are plotted on a sheet of A4 size paper.	85mm × 85mm (Refer to Fig. 9-1 (c).)
4	OFF	OFF	Two screens are plotted on a sheet of A4 size paper.	85mm × 85mm (Refer to Fig. 9-1 (d).)

(b) Pen replacement setting

The pen replacement can be set as listed in Table 9-2 by No. 3 of the DIP switches.

Table 9-2 Pen replacement setting

DIP switches	Pen replacement
No.3	
ON	No
OFF	Yes

When No. 3 of the DIP switches is OFF, six kinds of colors can be used for the contents of plot.

Table 9-3 lists the contents of plot and the corresponding pen numbers.
For the plotter whose usable pens are Five or less, the corresponding pen numbers are different. In case of the Hitachi graph plotter 681-XA, the pen numbers are listed in parentheses.

Table 9-3 Contents of plot and corresponding pen numbers

<table>
<tr><td colspan="3">Contents of plot</td><td>Pen No.</td></tr>
<tr><td colspan="3">Grid and scale</td><td>1</td></tr>
<tr><td colspan="2" rowspan="4">Waveform</td><td>CH1</td><td>3</td></tr>
<tr><td>CH2</td><td>4</td></tr>
<tr><td>SAVE A</td><td>5 (1)</td></tr>
<tr><td>SAVE B</td><td>6 (2)</td></tr>
<tr><td colspan="3">Cursor</td><td>2</td></tr>
<tr><td rowspan="9">Char-
acters</td><td rowspan="4">VOLTS
/
DIV</td><td>CH1</td><td>3</td></tr>
<tr><td>CH2</td><td>4</td></tr>
<tr><td>SAVE A</td><td>5 (1)</td></tr>
<tr><td>SAVE B</td><td>6 (2)</td></tr>
<tr><td rowspan="4">Time
range</td><td>A sweep</td><td>1</td></tr>
<tr><td>B sweep</td><td>1</td></tr>
<tr><td>SAVE A</td><td>5 (1)</td></tr>
<tr><td>SAVE B</td><td>6 (2)</td></tr>
<tr><td colspan="2">Others</td><td>1</td></tr>
</table>

(2) Communication mode

Set the baud rate and the data format and so on according to the specifications and applications of the plotter.
The same baud rate and data format must be set to the instrument and the plotter.

(a) Baud rate setting

The baud rate of the RS-232C interface can be set as listed in Table 9-4 by No. 4 to 6 of the DIP switches.

Table 9-4 Baud rate setting

DIP switches			Baud rate
No. 4	No. 5	No. 6	
ON	ON	ON	300 baud
ON	ON	OFF	600 baud
ON	OFF	ON	1200 baud
ON	OFF	OFF	2400 baud
OFF	ON	ON	4800 baud
OFF	ON	OFF	9600 baud
OFF	OFF	ON	9600 baud
OFF	OFF	OFF	9600 baud

(b) Data format setting

The data format of the RS-232C can be set as illustrated in Table 9-5 by No. 7 of the DIP switches.

Table 9-5 Data format setting

DIP switches	Data format
No. 7	
ON	START BIT + 8BIT +1STOP BIT
OFF	START BIT + 8BIT +2STOP BIT

(c) Setting of delimiters

The delimiters needed for the data transfer with the personal computer through the RS-232C can be set, as listed in Table 9-6, by changing the No.8 of the DIP switches. As the delimiters are not added in the plot output mode, this setting is not needed

Table 9-6 Setting of delimiters

DIP switches	Delimiters
No. 8	
ON	C/R L/F
OFF	C/R

Note: As for the communication mode setting, check the settings of the DIP switches before turning on the instrument.
When changing the settings of the DIP switches for the communication mode, change the settings first and then turn on the instrument.

9.5 Operation

(1) Execution of plotting

When the instrument is in the HOLD mode, press the PLOT switch. Then, the plotting starts immediately. While the plotting is being executed, the red LED switch lights.

When the plotting finishes, the LED goes off and the pen is released.

(2) Release of plotting operation

When the PLOT switch is pressed again during the plotting operation, the plotting operation stops. Thus an unnecessary plotting operation can be stopped.

9.6 RS-232C Interface

The instrument is provided with the RS-232C as a standard function. With this function, it is possible to perform the control by a personal computer, and input and output the waveform data to the computer. These communication functions can not be used with the output function to the X-Y plotter.

Do not execute the X-Y plotter output function (plot output by the PLOT switch) when using the communication function.

9.7 Major Causes of Troubles

When the X-Y plotter does not operate normally, check the following items.

(1) Cable is poorly connected or not connected.

(2) The power of the X-Y plotter is off.

(3) The X-Y plotter is not in the LISTEN ONLY mode, or in the error state. (See the operation manual of the X-Y plotter.)

(4) The instrument is not in the HOLD mode.

(5) The baud rate and data format are not set correctly.
(Turn off the power and set them correctly. See item 9.4 (2).)

(6) The interface cable in use is not correct. (See item 9.3.)

(7) Notes on plot interruption
To prevent a possible mis-operation of the plotter, the instrument transmits the initialize commands ("ESC.K", "ESC.R") of the X-Yplotter prior to the start of plot. When the plotter which does not accept these commands is used, mis-operation may be caused. If plotting is interrupted, turn off the X-Y plotter, and then turn onit to initialize the plotter. Thus proceed the plot.

NOTE: Use only the X-Y plotter designed for the HP-GL* command.

* The HP-GL is a registered trademark of HEWLETT-PACKARD.

10. RS-232C

10.1 General

The RS-232C is the serial communication interface standardized by the Electronic Industries Association in the United States of America. This instrument can transmit and receive digital data through the RS-232C interface.

10.2 Specifications

(1) Electrical:	Conforms to the EIA RS-232C.
(2) Type of tranmission:	Asynchronous
(3) Length of stop bit:	1 bit/2 bits
(4) Character length:	8 bits
(5) Parity bit:	Inhibit
(6) Delimiter:	C/R L/F or C/R
(7) Transmission rate:	300, 600, 1200, 2400, 4800 or 9600 baud
(8) Communication protocol:	Hard wired handshake

10.3 Connector Pin Arrangement and Signal Description

(1) Fig. 10-1 illustrates the pin arrangement of the RS-232C connector, and Table 10-1 lists the pin functions.

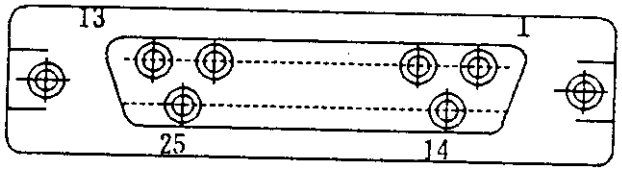


Fig. 10-1 Pin arrangement

NOTE: Connector DB-25P (female) applicable for connection cable is used.

Table 10-1 Terminals of the RS-232C connector

Pin No	Signal	Function	Direction of signal
1	FG (AA)	Frame GND	
2	TXD (BA)	Transmit Data	OUT
3	RXD (BB)	Receive Data	IN
4	RTS (CA)	Request To Send	OUT
5	CTS (CB)	Clear To Send	IN
6	NC	NON CONNECT	
7	SG (AB)	SIGNAL GND	
8	NC	NON CONNECT	
9	↑	↑	
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24	↓	↓	
25	NC	NON CONNECT	

(2) Each signal of the RS-232C interface is described below.

① FG: Frame Ground
Ground line for chassis

② TXD: Transmit Data
Transmit data output signal
Normally in the mark state *1

③ RXD: Receive Data
Receive data input signal
Normally in the mark state *1

④ RTS: Request To Send
This output signal indicates the request-to-send state.
This signal is used to control the transmission function of data transfer at the modem transmission section.
"0" (space): Carrier transmission request
"1" (mark): Carrier stop request

⑤ CTS: Clear To Send
This input signal controls the modem transmission section
This signal becomes in the mark state when the modem transmission section is in the Clear-To-Send state.

⑥ SG: Signal Ground
Ground line for signal

*1 -9 V level --- "0" (space), +9 V level --- "1" (mark)

10.4 Connection

Connect the instrument with a personal computer by the RS-232C interface cable. Prior to connection of a personal computer, read the related manual carefully and use the appropriate interface cable, because interface is changed in accordance with types of personal computers.

Fig. 10-2 illustrates the wiring of the RS-232C interface cable used for the connection of the Hitachi personal computer B-16 and the instrument.

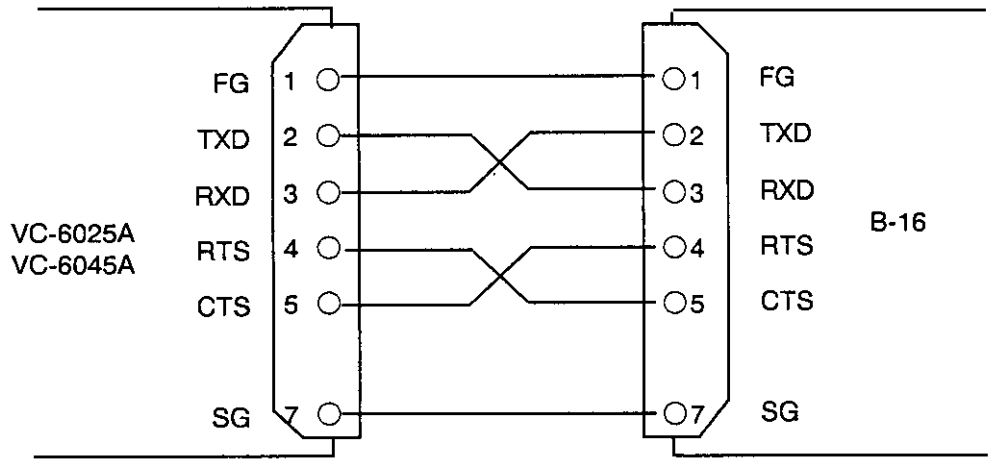


Fig. 10-2 Wiring diagram of the RS-232C interface cable

NOTE: RS-232C cable for the personal computer: No.4290 (option)

10.5 Operating Functions and Function Commands

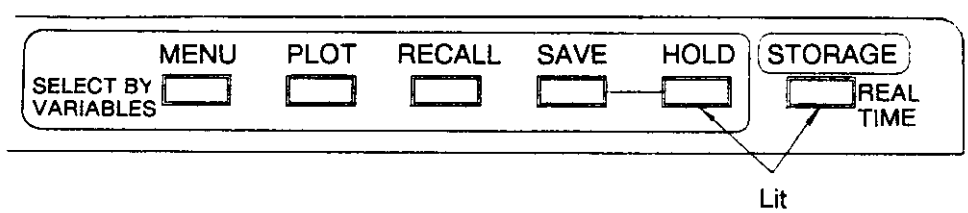
Various operations can be performed under an appropriate program on a personal computer when the instrument is connected with the personal computer, using the RS-232C interface.

Function commands are the commands which designate operations to be executed by the instrument from the program. A highly versatile automatic measuring system can be constituted by programming the operations in sequence at the personal computer.

Functions and function commands available through the RS-232C are described below.

(1) Panel setting

To operate the instrument from the personal computer, set the instrument to the STORAGE mode and the HOLD state. Check that the STORAGE mode setting switch LED and the HOLD LED on the front panel are lit.



(2) Operating functions

① Sampling start function

The personal computer can start the following sampling operation. The SINGLE operation of the normal sampling is performed only once. However, the SINGLE operation is not performed in the ROLL mode. When receiving this command, the instrument makes the normal sampling of the waveform data equivalent to the data of one whole picture.

When all the data is prepared, the waveform on the CRT is updated and the instrument returns to the HOLD state.
Also, the sampled waveform data acquired by the above procedure can be transferred to the personal computer using the waveform data transmitting function③.

② Sweep range setting function

Sweep range can be set to sample a signal with the sampling start function①.

When the HORIZONTAL MODE is set to A or ALT, the time range is set as the data of the A sweep range. When the HORIZONTAL MODE is set to B, the time range is set as the data of the B sweep range.

After completion of the sweep range setting, the A sweep range must be greater than the B sweep range. When data out of this relationship istransmitted, the relationship of the sweep ranges are automatically corrected at the main unit side.

③ Waveform data transmission function

The instrument has the following 6 data memories:
Two acquisition memories which store the CH1 and CH2 waveform data
Two save memories (SAVE A and B)
Two display memories of CH1 and CH2

Each of the CH1, and CH2 acquisition memories has the capacity of loading 1000, 2000 or 4000 data in accordance with the sample mode as shown in Table 10-2. Each of the two save memories (SAVE A and B), and CH1 and CH2 display memories has the capacity of loading 1000 data.

The waveform data can be transmitted to the personal computer from any of the six memories.

The data in the CH1 and CH2 acquisition memory can not be read in the avearage mode. The acquisition memory which is invalid in the HOLD mode, eq. the CH2 acquisition memory at the time when the VERTICAL MODE switch is set to CH1, can not be read.

Table 10-2 Sampling mode and acquisition memory capacity sampling mode

Input mode	Sample mode	Acquisition memory capacity	Number of data transferred to the personal computer
V MODE = DUAL or H MODE = X-Y	ROLL	2000	2048
	NORM	2000	2048
	EQUIV	1000	1024
Other than above	ROLL	4000(2000)	4096(2048)
	NORM	4000(2000)	4096(2048)
	EQUIV	1000	1024

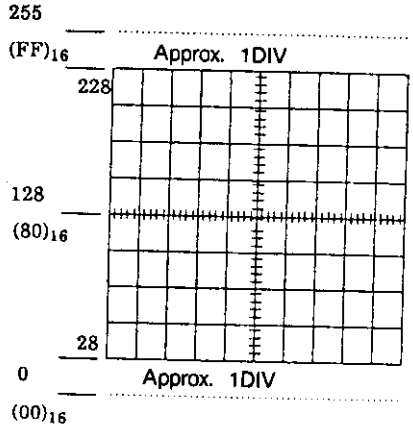
NOTES:

a) The averaging is not executed in the ROLL mode.

b) The numbers in parentheses for the VC-6025A.

c) The difference of data which acqusition memory capacity and the number of data transferred between the personal computer and the instrument is unsettled.

d) Though the save memory and the display memory have the capacity of loading 1000 data, 1024 data can be transferred between the personal computer and the instrument. In this case, the difference of data (24 data) is unsettled.
The number of the data which is transferred at one time can be selected appropriately within the range of the memory capacity. Either the decimal ASCII system or the binary system can be selected as the data transfer format.
The waveform data of each memory is 8 bits, i.e., 0 to 255 for the decimal system and $(00)_{16}$ to $(FF)_{16}$ for the hexadecimal system. These data ranges correspond to 10 vertical divisions of the CRT screen.
The data of the center horizontal graticule line is 128 ($(80)_{16}$ for the hexadecimal system). The data zero ($(00)_{16}$ for the hexadecimal system) corresponds to the position one division lower than the bottom graticule line. The data 255 ($(FF)_{16}$ for the hexadecimal system) is equal to the position one division higher than the top graticule line.



④ Transmission function of the measuring condition data

The instrument stores the data of the measuring conditions under which the data loaded in the memories was sampled. By the command from the personal computer, the measuring condition of a waveform in a certain memory can be transmitted.

Data is transmitted as a whole at a time of transfer. A specific data alone cannot be transmitted. The data format of the measuring conditions conforms to the ASCII system.

⑤ Receive function of the waveform data

The contents of the SAVE memory A or the SAVE memory B can be changed by the waveform data from the personal computer.
Press in the RECALL switch so that the rewritten data is displayed on the CRT.

⑥ Receive function of measuring condition data

The measuring condition data from the personal computer can be registered as the data for the waveform of the SAVE memory A or the SAVE memory B.
When the RECALL switch is pressed in, the data on VOLTS/DIV and TIME/DIV is displayed on the CRT.

⑦ Parameter calculation function

The following parameters can be calculated for any of the four memory waveform data CH1 acquisition memory and CH2 acquisition memory, SAVE A and SAVE B.

a) Maximum value
b) Minimum value
c) Mean value

⑧ Transmission function of parameters

The calculated results of the item ⑦ calculation can be transmitted.

10.6 Format of Transfer Data

The arrangement format of the transferred data according to the function command is shown below. (Each function command and format are shown in Table 10-3.)

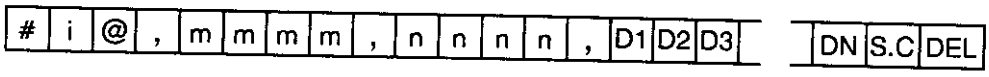
(1) Transmitting format of the waveform data

After receiving the Ri command (i = 1 to 6), the instrument transmits the waveform data according to the following format. For details of each item, refer to Table 10-4.

- ASCII system

#	i	@	,	m	m	m	m	,	n	n	n	n	,	D1	,	D2	,	D3	,			,	DN	,	S.C	DEL

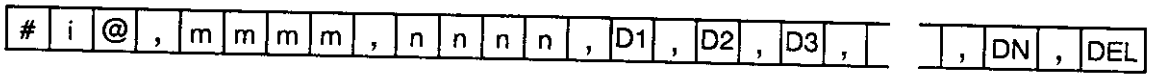
- Binary system



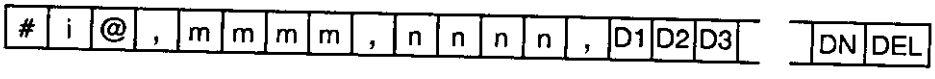
(2) Receiving format of the waveform data

After receiving the Wi command (i = 3, 4,), the instrument transmits the waveform data according to the following format. For details of each item, refer to Table 10-4.

- ASCII system



- Binary system



The comma (,) is a data punctuate code.

The format of DEL is C/R L/F or C/R. For the setting, refer to item 9.4 (2). In the binary system, D1 to DN and S.C are the binary data and the others are ASCII code data.
A punctuate code is not used among each data from D1 to DN. Do not add the sum check(S.C) to the receiving format of the waveform data.

(3) Transmitting and receiving format of measuring condition data

After the instrument receives the R0 command, the measuring condition data of the prescribed memory waveform is sent according to the following format.
For details of each item, refer to Table 10-5.

Also, when the instrument receives the W0 command, it receives and registers the data sent according to the following format as the measuring condition data of the prescribed SAVE memory.

#	i	@	,	V.M	,	H.M	,	A.T	,	B.T	,	V.C	,	P.F	,	V.D	,	D.T	,	N.S	,	S.C	DEL

"i" indicates the memory number which is the same as "i" of the commands R0(i) and W0(i). Do not add the sum check(S.C) to the receiving format of the measuring condition data.

(4) Transmitting format of parameters

When the instrument receives the commands G1 to G3, the parameters of the waveform data of the prescribed memory is sent according to the following format.

- Maximum value

#	i	@	,	M	A	X	,	X	X	X	,	S.C	DEL

"i" is the memory number. The instrument transmits the parameters by adding the i data designated by the G1 (i) command.

XXX is the ASCII code data with the maximum value data of 3 digits in the decimal system.

- Minimum value

#	i	@	,	M	I	N	,	X	X	X	,	S.C	DEL

"i" is the memory number. The instrument transmits the parameters by adding the i data designated by the G2 (i) command.

XXX is the ASCII code data with the minimum value data of 3 digits in the decimal system.

- Mean value

#	i	@	,	A	V	R	,	X	X	X	,	S.C	DEL

"i" is the memory number. The instrument transmits the parameters by adding the i data designated by the G3 (i) command.
XXX is the ASCII code data with the mean value data of 3 digits in the decimal system.

The sum check (S.C) and the delimiter (DEL) are the same as the transmission of the measuring condition data. Refer to Table 10-5.

Table 10-3 Function Commands (1/5)

<table>
<tr><th>No.</th><th>Function</th><th>Commands</th><th>Contents</th><th>Transmitting format</th></tr>
<tr><td>1</td><td>Sampling
Norm single</td><td>S1
command</td><td>• Performs the single operation under the measuring condition which is previously set, and orders the command to retain the waveform data on the display memory.</td><td>S | 1 | DEL</td></tr>
<tr><td>2</td><td>Sweep range setting function</td><td>TM
command</td><td>• Designates the sweep range for a single sampling.
• When the horizontal mode is at A or ALT:
A TIME/DIV is set.
• When the horizontal mode is B:
B TIME/DIV is set.
A TIME/DIV≧ B TIME/DIV</td><td>T | M | (| t | t | t | t | | u | u | u | u |) | DEL

tttt: Time range values
(One of 0.1, 0.2, 0.5, 1.0, 2.0, 2.5, 5.0, 10.0, 20.0, 50.0)
2.5 is only VC-6045A
uuuu: Unit
(One of S, MS, MICS, NS)</td></tr>
<tr><td>3</td><td>Waveform data trans-mission</td><td>Ri
command</td><td>• Designates the transfer of the waveform data stored in the Memory i by the data number (nnnn) with the address data (mmmm) at the head.
• Either the ASCII system or the binary system can be designated as the transmission method by X in the right column.</td><td>R | i | (| m | m | m | m | , | n | n | n | n | , | x |) | DEL

"i" indicates the memory number.
<table><tr><th>i</th><th>Memory</th><th>i</th><th>Memory</th></tr><tr><td rowspan="2">1</td><td rowspan="2">CH1 acquisition memory</td><td>3</td><td>SAVE memory A</td></tr><tr><td>4</td><td>SAVE memory B</td></tr><tr><td rowspan="2">2</td><td rowspan="2">CH2 acquisition memory</td><td>5</td><td>CH1 display memory</td></tr><tr><td>6</td><td>CH2 display memory</td></tr></table></td></tr>
</table>

Table 10-3 Function Commands (2/5)

No.	Function	Commands	Contents	Transmitting format
3			• The personal computer receives the prescribed data after transmitting this command. • For the acquisition memory capacity, refer to Table 10-2.	"mmmm": Leading address in memories Four-digit integer: 0-1023, 2047, 4095 (CH1, and CH2 acquisition memories) 0-1023 (Save memories A and B, CH1, and CH2, display memories) "nnnn": Number of transferred data Four-digit integer: 1-1024, 2048, 4096 (CH1, and CH2 acquisition memories) 1-1024 (Save memories A and B, CH1, and CH2, display memories) x = A: ASCII system x = B: Binary system

Table 10-3 Function Commands (3/5)

<table>
<tr><th>No.</th><th>Function</th><th>Commands</th><th>Contents</th><th>Transmitting format</th></tr>
<tr><td>4</td><td>Transmission of measuring condition data</td><td>R0 command</td><td>• Designates the transfer of the measuring condition data at the time of sampling the waveform that Memory i stores.
• The personal computer receives the prescribed data after transmitting this command.</td><td>R | 0 | (| i |) | DEL

"i" (= 1 to 4, 7 to 9, A) indicates the memory number as shown in No.3</td></tr>
<tr><td>5</td><td>Receiving of waveform data</td><td>Wi command</td><td>• Transmits the waveform data from the personal computer to the instrument to designate the SAVE memory A and B to write the data in sequence beginning with the leading address mmmm.
• The ASCII system or the binary system can be designated as the transmission method by X in the right column.
• The personal computer transmits the waveform data after transmitting this command.</td><td>W | i | (| m | m | m | m | , | n | n | n | n | , | x |) | DEL

"i" indicates the memory number.
"i" must be 3 or 4.

i | Memory
3 | SAVE memory A
4 | SAVE memory B

"mmmm": Leading address written in Four-digit integer: 0000 to 1023
"nnnn": Number of transferred data
Four-digit integer: 0001 to 1024
X = A: ASCII system
X = B: Binary system</td></tr>
</table>

Table 10-3 Function Commands (4/5)

No.	Function	Commands	Contents	Transmitting format
6	Receiving of measuring condition data	W0 command	• Transmits the measuring condition from the personal computer to the instrument, and designates the instrument to register the measuring condition data of the waveform that the SAVE memory A or B stores. • The personal computer transmits the measuring condition data after transmitting this command.	W 0 (i) DEL "i" indicates the memory number, "i" must be 3 or 4. i: 3 = SAVE memory A; 4 = SAVE memory B
7	Parameter calculation			
i)	The maximum value	E1 command	• Designates the calculation of the maximum value of the waveform data that the memory i stores.	E 1 (i) DEL
ii)	The minimum value	E2 command	• Designates the calculation of the minimum value of the waveform data that the memory i stores.	E 2 (i) DEL
iii)	The mean value	E3 command	• Designates the calculation of the mean value of the waveform data that the memory i stores.	E 3 (i) DEL

"i" indicates the memory number.

i	Memory
1	CH1 acquisition memory
2	CH2 acquisition memory
3	SAVE memory A
4	SAVE memory B

Table 10-3 Function Commands (5/5)

No.	Function	Commands	Contents	Transmitting format
8	Transmitting function of parameter			
i)	The maximum value	G1 command	• Designates the transmission of the maxmum value calculated from the waveform data of Memory i.	G 1 (i) DEL
ii)	The minimum value	G2 command	• Designates the transmission of the minimum value calculated from the waveform data of Memory i.	G 2 (i) DEL
iii)	The mean value	G3 command	• Designates the transmission of the mean value calculated from the waveform data of Memory i. • The waveform data must be calculated previously by the commands E1 to E3. • The personal computer receives the prescribed data after transmitting this command.	G 3 (i) DEL "i" (=1 to 4,) indicates the memory number as shown in No. 7 .

Table 10-4 Format of the Transmission of the Waveform Data

No.	Item	Name	Format	ASCII system		Binary system	
				Data code	Bytes	Data code	Bytes
1	#i@	Memory number	"i" is 1 to 6(NOTE 4)	ASCII	3	ASCII	3
2	mmmm	Leading address	Decimal, four digits 0000 ~1023,2097, 4095 (NOTE 5)	ASCII	4	ASCII	4
3	nnnn	Data number	Decimal, four digits 0001~1024, 2048, 4096 (NOTE 5) (NOTE 6)	ASCII	4	ASCII	4
4	Di	Data	· ASCII system Decimal, three digits/1 data 000~255 · Binary system 8-bit binary data	ASCII	3	Binary	1
5	S.C	Sum check (NOTE 1) (NOTE 2)	· ASCII system Hexadecimal ASCII data 00 to FF · Binary system 8-bit binary data	ASCII	2	Binary	1
6	DEL	Delimiter	C/R L/F or C/R (NOTE 3)	ASCII	1~2	-----	1~2

NOTE 1: The Sum check data adds all the former data (including symbols like a comma, etc.) by the binary system, and uses the least significant 8 bits of the data obtained as a result.

NOTE 2: Do not add S.C in the receiving mode.

NOTE 3: The format of a delimiter data is C/R L/F or C/R. For the setting, refer to item 9.4 (2).

NOTE 4: In the receiving mode, 3, or 4, can be designated.

NOTE 5: For details, refer to Table 10-2.

NOTE 6: In the transmitting mode, the number of data can be designated between 0001 and 1024, 0001 and 2048, 0001 and 4096 but data of 1001 to 1024, 2001 to 2048, or 4001 to 4096 is unsettled. For example, when 1024 is designated, the last 24 data are unsettled.

Table 10-5 Transmitting and receiving format of measuring condition data

No.	Item	Name	Format	Byte number (NOTE 1)	
				Trans-mitting	Receiv-ing
1	#i@	Memory number	"i" is 1 to 4, (NOTE 2)	3	3
2	V.M	Vertical Mode	One of CH1, CH2, DUAL, ADD (Right justify)	4	4
3	H.M	Horizontal Mode	A (including ALT mode) or B	1	1
4	A.T	A TIME/DIV	A TIME range value: F3.1 (NOTE 3) Unit: S, MS, MICS or NS (Right justify)	9	9
5	B.T	B TIME/DIV	B TIME range value: F3.1 (NOTE 3) Unit: S, MS or MICS(Right justify)	9	9
6	V.C	VOLT CAL	CAL or UNCAL (Right justify)	5	5
7	P.F	Probe factor	P1X or P10X (Right justify)	4	4
8	V.D	VOLTS/DIV	VOLT range value: F3.1 (NOTE 3) Unit: V, MV (Right justify) (NOTE 4)	7	7
9	D.T	Delay amount	0.20 to 10.00 DIV: F4.2 (NOTE 3)	9	9
10	N.S	No. of sweeps	1, 2, 4, 16, 64, 256 (NOTE 5)	3	3
11	S.C	Sum check	Hexadecimal ASCII data 00 to FF	2	0 (NOTE 6)
12	DEL	Delimiter	C/R L/F or C/R (NOTE 7)	1 to 2	1 to 2

NOTE 1: "Transmitting" and "Receiving" are described, viewed from the instrument.

NOTE 2: In the receiving mode, only 3, or 4 can be designated.

NOTE 3: F3.1 indicates a three-digit figure with one decimal place. (For example, 50.0)
A space symbol of over one word is placed between the value and the unit.

NOTE 4: When the VOLTS/DIV settings of CH1 and CH2 are different in the ADD mode, the data is transmitted with ADD only.

NOTE 5: Setting of the number of average in the six modes, 1, 2, 4, 16, 64 and 256 (1: NORM, 2: 2times, 4: 4 times, 16: 16 times, 64: 64 times and 256: 256 times)

NOTE 6: Do not add a sum check data in the receiving mode.

NOTE 7: The format of a delimiter data is C/R L/F or C/R. For the setting, refer to item 9.4 (2).

10.7 Delimiter

For the transmission of the waveform data or the function command message, the controller sends a delimiter to indicate the end of data to the instrument. The delimiter can select C/R L/F or C/R.
For the setting, refer to item 9.4 (2).

10.8 Processing of Abnormal Operation

The instrument sends the return code in order to respond to a message command, or to inform the personal computer of the status. The following is the format and the meaning of these status bytes.

No.	Status byte	Description
1	41	Processing for a command is completed normally.
2	61	Command error
3	62	Waveform data error (data is not 0 to 255)
4	63	Measuring condition data content error
5	64	Excessive data number
6	65	Insufficient data number
7	67	Protocol error

The return codes of the command error are transmitted when there is a format error in the message command.

10.9 Connection of the RS-232C Interface Cable and the Activation of the Instrument

(1) Connect the RS-232C cable between the instrument and the personal computer.

(2) Set the communication mode of the instrument and the personal computer according to item 9.4 (2).

(3) Set the instrument power to on, set the front panel controls and set the instrument in the STORAGE mode and HOLD mode. Now, the data transfer is possible. Perform the operation according to the commands from the personal computer.

10.10 Creation of Programs for Data Transfer

To facilitate programming, first execute a simple test program, send the function command to the instrument by the simple program, and check the resultant data received from the instrument. This simple test program will check the system validation and then a complete program can be written.

The following program statement depends on the employed personal computer. Before transmission, read carefully the employed personal computer manual, because the personal computer may require preparation such as data buffer area reservation and delimiter setting.

10.11 Major Causes of Abnormal Data Transfer

Check the below items again when data transfer is not executed properly.

(1) A cable is not connected or power of any equipment in the system is not turned on.

(2) The instrument is not in the HOLD mode. Verify that the panel setting are as specified in item 10.5 (1).

(3) The trigger mode is in the NORM trigger mode, and the trigger signal is not connected. (When the single sweep is executed by the S1 command from the personal computer.)

(4) The function command does not correspond to that of the instrument.

(5) The instrument does not correspond to the setting of the communication mode of the personal computer.

(6) The format of delimiter does not correspond to that of the instrument.

(7) The instrument is not initialized after the communication mode changes. When the instrument is turned on, the instrument reads the DIP switch settings and memorizes the data. Consequently, the communication mode can not be changed while the power is on.

(8) The function with which the instrument is not provided is executed. (PPC, GET, TCT, etc.)

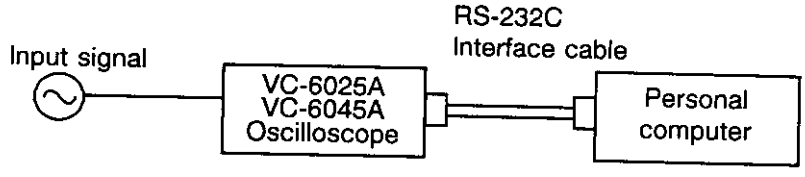
(9) The buffer area of the data is not provided. (Trans mission of a large amount of data is requested for the instrument though a listener has a small amount of buffer area.)

(10)There is an error in program. Use of decimal and hexadecimal systems is not proper.

10.12 Programming Example

The following is an example of the programs executed when the instrument and the personal computer are connected. Prior to the connection with the personal computer, set the instrument, referring to the communication mode described in item 9.4 (2).

In this section, the GW-BASIC program of IBM.XT* is used as an example for each function command.



The following communication mode is used for the example of the above program.

(a) Baud rate : 9600 baud

(b) Data format : START BIT + 8 BIT + 1 STOP BIT

(c) Delimiter : C/R

(1) Program example 1 "S1" command

The NORMAL SINGLE mode is activated by the "S1" command. This is a program for observing the operation until the sampling is completed.

* THE IBM. XT is a trademark of IBM CORP.

Program example 1

```
10  ' *** S1 COMMAND (GW-BASIC) ***            · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1      · RS-232C OPEN
30  PRINT #1,"S1"                              · S1 Command transmit
40  LINE INPUT #1,RTN$                         · Return code receive
50  RTN=ASC(RTN$)
60  IF RTN<>&H41 THEN 110                      · Return code check
70  ' **********************                  · As the time range is set,
80  ' ** ANOTHER PROGRAM **                    · another progresss can be
90  ' **********************                  · executed.
100 GOTO 120                                   ·
110 PRINT "ERROR STATUS=";HEX$(RTN)            · Return code display
120 CLOSE #1                                   · RS-232C CLOSE
130 END                                        ·
```

(Explanation)

The instrument activates the sampling by "S1" command. When the sampling is completed, the return code inform that the operation is completed satisfactory. The lines from 40 to 60 observe the return code. If the return code is 65 (41 for hexadecimal), the operation is completed with a satisfactory result and it is possible to proceed another program (e.g., a program to read a waveform data).

(2) Program example 2 "TM" command

This is a program for setting the time range to 5ms/DIV by the "TM" command.
With this program, it is possible to know that the setting is completed normally (just like the program example 1).

Program example 2

```
10  ' *** TM(tttt uuuu) COMMAND (GW-BASIC) ***  · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1       · RS-232C OPEN
30  PRINT #1,"TM(5.0 MS)"                       · TM Command transmit
40  LINE INPUT #1,RTN$                          · Return code receive
50  RTN=ASC(RTN$)                               ·
60  IF RTN<>&H41 THEN 110                       · Return code check
70  ' **********************                   · As the single sweep
80  ' ** ANOTHER PROGRAM **                     · finishes, another program
90  ' **********************                   · can be executed.
100 GOTO 120                                    ·
110 PRINT "ERROR STATUS=";HEX$(RTN)             · Return code display
120 CLOSE #1                                    · RS-232C CLOSE
130 END                                         ·
```

(3) Program example 3 "Ri" command

This is a program to receive 50 words of the CH1 waveform data from the 0 address by the "Ri" command.

Program example 3-1: ASCII code transfer
Program example 3-2: Binary code transfer

Program example 3-1

```
10  '***Ri(mmmm,nnnn,x) COMMAND (GW-BASIC) ***      · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1           · RS-232C OPEN
30  PRINT #1,"R1(0000,0050,A)"                      · Ri Command transmit
40  LINE INPUT #1,RTN$                              · Waveform data receive
50  PRINT "R1 RETURN=";RTN$                         · Waveform data display
60  CLOSE #1                                        · RS-232C CLOSE
70  END
```

Program example 3-2

```
10  '***Ri(mmmm,nnnn,x) COMMAND (GW-BASIC) ***      · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1           · RS-232C OPEN
30  PRINT #1,"R1(0000,0050,B)"                      · Ri Command transmit
40  RTN$=INPUT$(14,1)                               · Waveform data receive
50  FOR I=1 TO 52                                   .
60      WRK$=INPUT$(1,1)                            .
70      RTN$=RTN$+MID$(STR$(ASC(WRK$)),2)+","       .
80  NEXT I                                          .
90  PRINT "R1 RETURN=";RTN$                         · Waveform data display
100 CLOSE #1                                        · RS-232C CLOSE
110 END
```

(4) Program example 4 "R0" command

This is a program to receive the measuring condition data of CH1 by the "R0" command and display the data.

Program example 4

```
10  ' *** R0(i) COMMAND (GW-BASIC) ***              · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1           · RS-232C OPEN
30  PRINT #1,"R0(1)"                                · R0 Command transmit
40  LINE INPUT #1,RTN$                              · CH1 setting condition receive
50  PRINT "R0 RETURN=";RTN$                         · Display
60  CLOSE #1                                        · RS-232C CLOSE
70  END                                             .
```

(5) Program example 5 "Wi" command

This is a program to write data in the save memory A by the "Wi" command. The lines 30 to 200 set the waveform data to be transmitted to the instrument to the letter variable A$. Set the waveform data according to application. "Wi" command is transmitted by the line 220, and the waveform data set to A$ is written in the save memory A by the lines 270 to 310. The waveform data from the 0 address to the 999 address is written in the save memory A as shown in Fig. 10-3.

Program example 5-1: ASCII code transfer
Program example 5-2: Binary code transfer

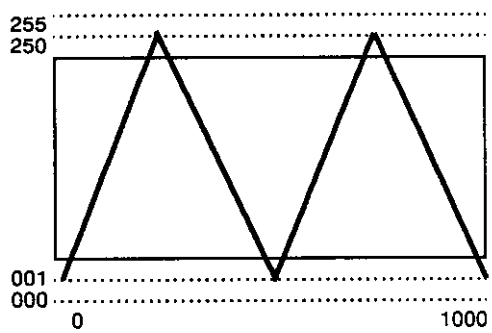


Fig. 10-3

Program example 5-1

```
10  ' *** Wi(mmmm,nnnn,x) COMMAND (GW-BASIC) ***      · Comment
20  DIM A$(1000)                                      · Set waveform data to the
30  CNT=0                                             · character variable A$.
40  FOR I=1 TO 2                                      · (Set the triangle wave
50      FOR B=1 TO 250                                · (001-250, 250-001) shown
60          IF B>=100 THEN B$=MID$(STR$(B),2,3)       · in Fig.10-3 by the
70          IF B<100 THEN B$="0"+MID$(STR$(B),2,2)    · 1000-word ASCII code.)
80          IF B<10 THEN B$="00"+MID$(STR$(B),2,1)    ·
90          A$(B+CNT*250)=B$+","                      ·
100     NEXT B                                        ·
110     CNT=CNT+1                                     ·
120     FOR B=1 TO 250                                ·
130         C=251-B                                   ·
```

```
140         IF C>=100 THEN B$=MID$(STR$(C),2,3)
150         IF C<100 THEN B$="0"+MID$(STR$(C),2,2)
160         IF C<10 THEN B$="00"+MID$(STR$(C),2,1)
170         A$(B+CNT*250)=B$+","
180     NEXT B
190     CNT=CNT+1
200 NEXT I
210 OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1
220 PRINT #1,"W3(0000,1000,A)"
230 LINE INPUT #1,RTN$
240 RTN=ASC(RTN$)
250 IF RTN<>&H41 THEN 360
260     PRINT "Wi COMMAND PASS"
270 PRINT #1,"#3@,0000,1000,";
280 FOR I=1 TO 999
290     PRINT #1,A$(I);
300 NEXT I
310 PRINT #1,A$(I)
320 LINE INPUT #1,RTN$
330 RTN=ASC(RTN$)
340 IF RTN<>&H41 THEN 360
350 GOTO 370
360 PRINT "ERROR STATUS=";HEX$(RTN)
370 CLOSE #1
380 END
```

· RS-232C OPEN
· Wi Command transmit
· Return code receive
· Return code check
· Waveform data transmit
· Return code receive
· Return code check
· RS-232C CLOSE

Program example 5-2

```
10  ' *** Wi(mmmm,nnnn,x) COMMAND (GW-BASIC) ***
20  DIM A$(1000)
30  CNT=0
40  FOR I=1 TO 2
50      FOR B=1 TO 250
60          B$=CHR$(B)
70          A$(B+CNT*250)=B$
80      NEXT B
90      CNT=CNT+1
100     FOR B=1 TO 250
110         C=251-B
120         B$=CHR$(C)
130         A$(B+CNT*250)=B$
140     NEXT B
150     CNT=CNT+1
160 NEXT I
170 OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1
180 PRINT #1,"W3(0000,1000,B)"
190 LINE INPUT #1,RTN$
```

· Comment
· Set waveform data to the
· character variable A$.
· (Set the binary data
· of the triangle wave
· shown in Fig. 10-3.)
· RS-232C OPEN
· Wi Command transmit
· Return code receive

```
200 RTN=ASC(RTN$)                                    ·
210 IF RTN<>&H41 THEN 320                            · Return code check
220     PRINT "Wi COMMAND PASS"                      ·
230 PRINT #1,"#30,0000,1000,";                       · Waveform data transmit
240 FOR I=1 TO 999                                   ·
250     PRINT #1,A$(I);                              ·
260 NEXT I                                           ·
270 PRINT #1,A$(I)                                   ·
280 LINE INPUT #1,RTN$                               · Return code receive
290 RTN=ASC(RTN$)                                    ·
300 IF RTN<>&H41 THEN 320                            · Return code check
310 GOTO 330                                         ·
320 PRINT "ERROR STATUS=";HEX$(RTN)                  ·
330 CLOSE #1                                         · RS-232C CLOSE
340 END                                              ·
```

(6) Program example 6 "W0" command

This is a program to register the measuring condition data in the save memory A by the "W0" command.

Program example 6

```
10  ' *** WO(i) COMMAND (GW-BASIC) ***               · Comment
20  DAT$ = DAT$+"#30,"                               · Set the setting condition data
30  DAT$ = DAT$+" CH1,"                              · registered to the character
40  DAT$ = DAT$+"A,"                                 · variable DAT$.
50  DAT$ = DAT$+"  50.0 MS,"                         ·
60  DAT$ = DAT$+"  20.0 MS,"                         ·
70  DAT$ = DAT$+"  CAL,"                             ·
80  DAT$ = DAT$+"P10X,"                              ·
90  DAT$ = DAT$+"50.0 MV,"                           ·
100 DAT$ = DAT$+"10.00 DIV,"                         ·
110 DAT$ = DAT$+"  1,"                               ·
120 OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1            · RS-232C OPEN
130 PRINT #1,"WO(3)"                                 · WO command transmit
140 LINE INPUT #1,RTN$                               · Return code receive
150 RTN=ASC(RTN$)                                    ·
160 IF RTN<>&H41 THEN 230                            · Rerurn code check
170     PRINT "WO COMMAND PASS"                      ·
180 PRINT #1,DAT$                                    · Setting condition data transmit
190 LINE INPUT #1,RTN$                               · Return code receive
200 RTN=ASC(RTN$)                                    ·
210 IF RTN<>&H41 THEN 230                            · Return code check
220 GOTO 240                                         ·
230 PRINT "ERROR STATUS=";HEX$(RTN)                  ·
240 CLOSE #1                                         · RS-232C CLOSE
250 END                                              ·
```

(7) Program example 7 "E1", "E2", "E3", "G1", "G2", and "G3" commands

The program example 7-1 shows processes from the calculation of the maximum value to the reception and display of the maximum data.

The "E1" command is calculated by the line 30 and the calculation of the maximum value of CH1 is designated. The lines 40 to 60 are for the observation of the return code and the check that the calculation of the maximum value is completely normally. The lines 80 and 90 input the maximum data by the "G1" command.

The program example 7-2 shows a process from the calculation of the minimum value to the reception and display of the minimum data.

The program example 7-3 shows a process from the calculation of the mean value to the reception and display of the mean data.

Program example 7-1

```
10  ' *** E1(i) G1(i) COMMAND (GW-BASIC) ***      · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1         · RS-232C OPEN
30  PRINT #1,"E1(1)"                              · E1(i) Command transmit
40  LINE INPUT #1,RTN$                            · Return code receive
50  RTN=ASC(RTN$)                                 .
60  IF RTN<>&H41 THEN 120                         · Return code check
70      PRINT "E1 COMMAND PASS"                   .
80  PRINT #1,"G1(1)"                              · G1(i) Command transmit
90  LINE INPUT #1,RTN$                            · Maxmum data receive
100 PRINT "MAX DATA=";RTN$                        · Display
110 GOTO 130                                      .
120 PRINT "ERROR STATUS=";HEX$(RTN)               .
130 CLOSE #1                                      · RS-232C CLOSE
140 END                                           .
```

Program example 7-2

```
10  ' *** E2(i) G2(i) COMMAND (GW-BASIC) ***      · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1         · RS-232C OPEN
30  PRINT #1,"E2(1)"                              · E2(i) Command transmit
40  LINE INPUT #1,RTN$                            · Return code receive
50  RTN=ASC(RTN$)                                 .
60  IF RTN<>&H41 THEN 120                         · Return code check
70      PRINT "E2 COMMAND PASS"                   .
80  PRINT #1,"G2(1)"                              · G2(i) Command transmit
90  LINE INPUT #1,RTN$                            · Minimum data receive
```

```
100 PRINT "MIN DATA=";RTN$                          · Display
110 GOTO 130                                        ·
120 PRINT "ERROR STATUS=";HEX$(RTN)                 ·
130 CLOSE #1                                        · RS-232C CLOSE
140 END                                             ·
```

Program example 7-3

```
10  ' *** E3(i) G3(i) COMMAND (GW-BASIC) ***        · Comment
20  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1           · RS-232C OPEN
30  PRINT #1,"E3(1)"                                · E3(i)Command transmit
40  LINE INPUT #1,RTN$                              · Rturn code receive
50  RTN=ASC(RTN$)                                   ·
60  IF RTN<>&H41 THEN 120                           · Return code check
70      PRINT "E3 COMMAND PASS"                     ·
80  PRINT #1,"G3(1)"                                · G3(i) Command transmit
90  LINE INPUT #1,RTN$                              · Average value data receive
100 PRINT "AVR DATA=";RTN$                          · Display
110 GOTO 130                                        ·
120 PRINT "ERROR STATUS=";HEX$(RTN)                 ·
130 CLOSE #1                                        · RS-232C CLOSE
140 END                                             ·
```

The examples of the programs for function commands are illustrated above.

It is recommended to creat your own programs, using the above programs, according to the specific system application.

11. SPECIFICATIONS

The following specifications are applicable to the VC-6025A, and VC-6045A oscilloscopes unless otherwise noted.

CRT

Graticule:	6-inch screen, with internal graticule 0%, 10%, 90% and 100% markers 8 x 10 DIV (1 DIV = 1cm)
Phosphor:	P31
Accelerating potential:	17kV approx. (12kV approx. for the VC-6025A)
External intensity modulation:	Coupling: DC coupling (dark at positive voltage) Voltage: 5Vp-p or more Maximum input voltage: 30V (DC + AC peak) or 30Vp-p AC at 1kHz or less Bandwidth: DC to 5MHz

Vertical deflection system

Sensitivity:	2mV/DIV to 5V/DIV ±3% (switchable in 11 steps) Continuously variable by fine control
Bandwidth:	DC to 100MHz -3dB(DC to 50MHz-3dB for the VC-6025A) 2mV/DIV: DC to 20MHz -3dB(DC to 10MHz-3dB for the VC-6025A) AC low pass: 10Hz-3dB
Rise time:	3.5ns approx.(7ns approx. for the VC-6025A) 2mV/DIV: 17.5ns approx.(35ns approx. for the VC-6025A)
Delay time:	Leading edge can be monitored (only in real-time mode).
Maximum input voltage:	400V (DC + AC peak at 1kHz)
Input coupling:	AC, DC, GND
Input impedance:	1M ohms ±1.5%, 23pF ±3PF

Display modes: CH1, CH2, DUAL, CHOP (250kHz approx.), and ADD (DIFF mode can be established when the CH2 is in the INVERT mode.)

Bandwidth limiting function: 20MHz(10MHz for the VC-6025A)

Polarity selection: ± (CH2 only)

Common-mode rejection ratio (CMRR): 20dB minimum at 20MHz
(20dB minimum at 10MHz for the VC-6025A)

X-Y operation:

Input: X-axis: Channel selectable from CH1, CH2, EXT and EXT ÷ 10(CH1 only in storage mode)
Y-axis: Channel selectable from CH1, CH2, and CH1&CH2 (CH2 only in storage mode)

Sensitivity: CH1, CH2: 2mV to 5V/DIV ± 5%
EXT:0.1V/DIV ± 5%
EXT ÷ 10:1V/DIV ± 5%

Phase error: 3° or less from DC to 50kHz (in real-time mode only)

X axis bandwidth: DC to 500kHz (-3dB) (by time range in storage mode)

Horizontal deflection system

Sweep mode: Main sweep, continuous delay sweep, alternate sweep (in real-time mode only), single sweep

Sweep time: REAL TIME mode

A(main) sweep:50ns/DIV to 0.5s/DIV
Continuously variable (UNCAL)

B(delay) sweep:50ns/DIV to 50ms/DIV

STORAGE mode
For refer to the item "DIGITAL STORAGE FUNCTIONS"

Accuracy:

	10 to 35°C	0 to 40°C
X1	±3%	±4%
MAG×10	±4%	±6%

(in real-time mode)

Holdoff time: Variable

Delay time: 1μs to 5s

Delay jitter: 1/20,000 or less

Sweep magnification: X10

Maximum sweep rate: 5ns/DIV

Alternate separation: Variable (in real-time mode only)

Trigger lock function: Provided

Auto range function: Provided

Triggering

Trigger mode: AUTO, NORM, TV-H, TV-V, and SINGLE

Trigger source: A: CH1, CH2, EXT(AC, DC, DC ÷ 10) and LINE
B: Automatically corresponds to A

TV mode: Exclusive sync separator circuit provided
Sensitivity:SYNC section INT: 1 DIV or more
(SYNC polarity: –)
EXT: 200mVp-p or more

Trigger level variable range:
AUTO: Automatically corresponds to the trigger signal
NORM: INT: ±4DIV or more
EXT: ±0.4V or more
EXT ÷ 10: ±4V or more

Trigger sensitivity:

NORM MODE:

VC-6045A	DC~20MHz	20MHz~100MHz
VC-6025A	DC~10MHz	10MHz~50MHz
INT(CH1, CH2)	0.35DIV	1.5DIV
EXT	50mV	150mV

AUTO MODE:

VC-6045A	30Hz~100Hz	100Hz~20MHz	20MHz~100MHz
VC-6025A	30Hz~100Hz	100Hz~10MHz	10MHz~50MHz
INT(CH1, CH2)	1.5DIV	1.0DIV	1.5DIV
EXT	150mV	100mV	150mV

Trigger coupling: INT:DC
EXT:AC, DC, and DC÷10

Trigger polarity: ±

External input: Impedance:1MΩ±5%, 25pF±6pF
Voltage: 400V(DC + AC peak at 1KHz)

AUTO low frequency band: 30Hz

Readout function

Panel setting display: Vertical axis: V/DIV(CH1, CH2), UNCAL, probe conversion, ADD (+)
Sweep speed: S/DIV, UNCAL, MAG (converted value)
Other: Delay time, X-Y, trigger, number of average, aliasing error display,smoothing display, sampling mode display,interpolation system, hold-off

Cursor readout function

Voltage difference ΔV : Δ–REF (CH1 and CH2 waveforms)

Time difference ΔT : Δ–REF

Frequency 1/ ΔT : Δ– REF

Frequency counter

Frequency measurement: Source: A trigger signal selected by SOURCE OR X switch
Measuring range: 20Hz to 100MHz(20Hz to 50MHz for the VC-6025A)
Time base error: ±100ppm (15 to 35°C)

VC-6045A display format

Ranges	Display format	Resolution	Accuracy
20Hz≦f<100Hz	99.99Hz	0.01Hz	±1 LSD (time base error + resolu-tion)
100Hz≦f<1kHz	999.9Hz	1.0Hz max	
1kHz≦f<10kHz	9.999kHz	0.002kHz max	
10kHz≦f<100kHz	99.99kHz	0.04kHz max	
100kHz≦f<1MHz	999.9kHz	0.1kHz	
1MHz≦f<10MHz	9.999MHz	0.002MHz max	
10MHz≦f<100MHz	99.99MHz	0.01MHz	
100MHz≦f	(100.0MHz)	Not specified	

VC-6025A display format

Ranges	Display format	Resolution	Accuracy
20Hz≦f<100Hz	99.99Hz	0.01Hz	±1 LSD (time base error + resolution)
100Hz≦f<1kHz	999.9Hz	1.0Hz max	
1kHz≦f<10kHz	9.999kHz	0.002kHz max	
10kHz≦f<100kHz	99.99kHz	0.04kHz max	
100kHz≦f<1MHz	999.9kHz	0.1kHz	
1MHz≦f<10MHz	9.999MHz	0.002MHz max	
10MHz≦f<50MHz	49.99MHz	0.01MHz	
50MHz≦f	(50.0MHz)	Not specified	

Memory backup function: The panel conditions and the contents of save memory can be retained for 48 hours after power off.

External output

TRIGGER SIGNAL OUT: Output voltage: 25mV/DIV approx. (Full scale on the CRT)
50-ohm termination
Frequency response: DC to 10MHz (-3dB)
Output impedance: 50 ohms approx.

Calibrator

Waveform : 1kHz±20%, square wave
Voltage : 0.5V ±1%

DIGITAL STORAGE FUNCTION

Maximum sampling rate:
VC-6045A
40M sps(2.5μs/DIV):2 channels alternate samping
20M sps(5μs/DIV):2 channels simultaneous sampling
VC-6025A
20M sps(5μs/DIV):2 channels simultaneous sampling

Memory capacity

Acquisition memory:
4000 words (1-channel and 2.5μs/DIV to 50s/DIV:only in the VC-6045A)
2000 words/channel
(2 channels and 2.5μs/DIV to 50s/DIV:for the VC-6045A)
(2 channels and 5μs/DIV to 50s/DIV for the VC-6025A)
1000 words/channel
(1 channel or 2 channels and 2μs/DIV to 50μs/DIV)

Display memory: 1000 words x 4 waveforms

Save memory: 1000 words x 2 waveforms (backup)

Vertical resolution: 250 points/10 DIV

Horizontal resolution: 100 points/DIV

Maximum storage frequency:

A single shot signal

5MHz(Maximum amplitude error:30% or less)

Repetition signal

VC-6045A: 100MHz-3dB

20MHz-3dB at 2mV/DIV

VC-6025A: 50MHz-3dB

10MHz-3dB at 2mV/DIV

Sweep time

Sampling	Sweep time
Equivalent sampling(Repetitive trace, and only A sweep)	50ns/div~2μs/DIV
A sweep realtime sampling(single shot trace)	2.5μs/DIV~0.1s/DIV (5μs/DIV~0.1s/DIV for the VC-6025A)
A sweep realtime sampling(single shot trace)	2.5μs/DIV~50ms/DIV (5μs/DIV~50ms/DIV for the VC-6025A)
Roll (A sweep only)	0.2s/DIV~50s/DIV

- Alternate sampling for the range of 50ns/DIV to 2.5μs/DIV(50ns/DIV to 2μs/DIV for the VC-6025A) in 2-channel modes.
- 2 channels simultaneous sampling for the range of 5μs/DIV to 50s/DIV.

Interpolation function: Linear interpolation or sine interpolation selectable (effective only in magnified display mode)

Smoothing display: ON/OFF possible

Pretrigger:

VC-6045A:Maximum 0 to 20 DIV (1 channel and 2.5μs/DIV to 0.1s/DIV)
(in 0.1 DIV steps)
VC-6025A:Maximum 0 to 10DIV(in 0.1DIV steps)

Posttrigger:

Maximum 0 to 10 DIV (1 channel and 2.5μs/DIV to 0.1s/DIV)
(in 0.1 DIV steps) :only in the VC-6045A

Data acquisition

NORM storage mode: Updates a data on the CRT at each triggering.

AVG mode: Averages input signals by the selected number of sweeps and displays the result after the averaging has reached the selected number.
(Number of average: 2, 4, 16, 64 and 256)

ROLL mode: Writes new data at the right edge of the CRT and shifts waveform from right to left continuously on the CRT. (The updating point is the right end.)

HOLD mode: Holds the waveform displayed on the CRT.

SINGLE sweep: Performs an operation of the NORM storage, or AVG mode once at each pressing of the SINGLE RESET switch in the HOLD mode, and updates the data on the CRT.

Data save:

Up to two waveforms on the CRT can be saved.
Two stored waveforms can be displayed on the CRT with the two sampling waveforms.

Plotter output:

A hard copy can be produced by the plotter by using the HP-GL through RS-232C.
6 colors available

External output:

The RS-232C interface is provided as a standard.

Magnifying display:

A storage waveform can be magnified ten times in the horizontal direction.
(A save waveform cannot be magnified.)

Power supply

Voltage:	90V to 250V AC
Frequency:	48 to 440Hz
Power consumption:	50W approx.

Environment

Temperature	
Operating:	0 to 40°C
Full specification:	10 to 35°C
Storage:	–20 to +70°C
Humidity:	
Operating:	45 to 85%
Storage:	35 to 85% (70% or less at the temperature of 50°C or more)

Dimensions and weight

Dimensions:	275(W) x 130(H) x 360(D)mm approx. (10.8 x 5.1 x 14.2 in. approx.)
Weight:	6.5kg approx. (14.3 lb. approx.)

Other

EMI	Conforms with VDE0871, Category B