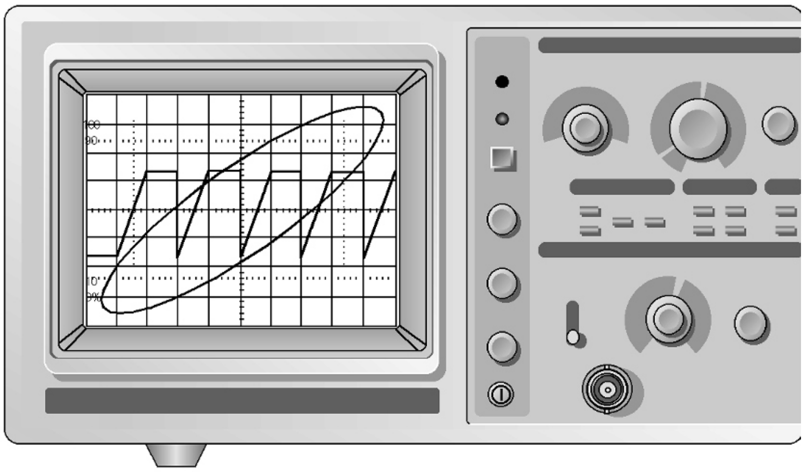
EZ

Oscilloscope

OS-3020D/40D/60D

Digital Storage Oscilloscope
Operation Manual



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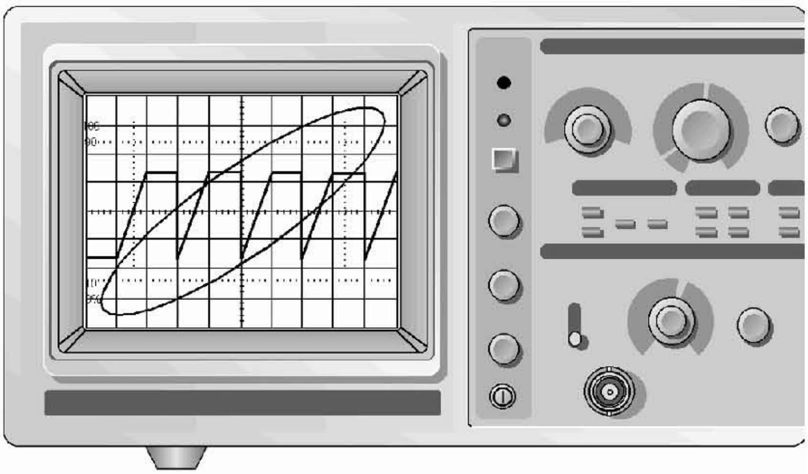


EZ Digital Co.,Ltd.

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: EZ Digital Co., Ltd.

Manufacturer's Address: 222-28, Nae-dong, Ojeong-gu,
Bucheon-si, Gyeonggi-do
R.O.K, 421-160

Declares that the product:

Product Name: OSCILLOSCOPE

Model Numbers: OS-3020D, OS-3040D, OS-3060D,

Date: Aug. 18. 1995.

Conforms to the following product specifications:
Certified by TÜV Rheinland

Safety: EN 61010-1: 1993
(IEC 1010-1: 1990+A1:1992, modified)

EMC: EN 50081-1: 1992
EN 50082-1: 1992

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Bucheon, Gyeonggi — C. Y. Kim

Location

Cheol Young Kim
Quality Assurance Manager

Safety Summary

Safety Precautions

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the oscilloscope. This safety information applies to all operator and service personnel.

Caution and warning statements.

CAUTION : Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING : Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.

Symbols

Caution(refer to accompanying documents) and Warning.

Protective ground(earth) symbol.

Introduction

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

EZ Digital Co.,Ltd.

Note

1. To fully maintain the precision and reliability of the product use it within the range of standard setting (temperature 10℃～35℃, humidity 45%～85%).

2. After turning on-power, please allow a pre-heating period of as long as some 15 minutes before use.

3. This equipment should be used with a triple line power cord for safety.

4. For quality improvement the exterior design and specifications of the product can be changed without prior notice.

5. If you have further questions concerning use, please contact the EZ Digital service center or sales outlet.

Warranty

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

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

We charge customers for repairs after the one-year warranty period has been expired. Provided that against any failure resulted from the user's negligence, natural disaster or accident, we charge you for repairs regardless of the warranty period.

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

– CONTENTS –

1. Description of product

1-1. Introduction

This product OS-3000DSRS is the 2 channel digital storage oscilloscope which is equipped with A/D converter.
It combines the benefits of digital scope to measure, store, interpret and communicate the rapid trace, with the benefits of analog scope to measure the wide band width, 2 time axis generator, delay sweep and separated TV trigger signal.
It reduces the measurement error, and uses 6% squared type CRT with internal flourescent scale which enables to take the photograph of observed waveform.

(1) High speed optical frequency band width
A/D converter installed on each channel samples the input signal at the max. rate of 20MHz samples/sec. Any signal with perfect repeatedness can be stored. (Max. 20-60 MHz)
This product can be used as an ordinary real time oscilloscope with frequency range between 20 and 60MHz.

(2) Large storage capacity
Each channel has 2kW memory. Since it can indicate the waveform composed of 1kW data, it measures any rapidly changing transition trace with high accuracy.

(3) Waveform save
It has 1kW memory to save two waveforms stored in each channel.

(4) Multi-Function
It has a variety of following functions to interpret a wide range of signals :
- Roll mode function to measure low signal.
- Average function to eliminate noise from the signal and to measure the pure signal.

(5) Output

It uses both RS-232C interface function to input/output the digital data to the personal computer, and RS-232C to conduct screen hardcopy through digital plotter. It also interprets and records the stored data.

(6) CRT and cursor readout

It can promptly perform the operation and measurement using both the CRT readout function to display the set information of panel and the cursor readout function to display the voltage difference (ΔV), time difference (ΔT) and frequency difference ($1/\Delta T$) between two cursors.

1-2. Specifications

Spec. \ Model	OS-3020D	OS-3040D	OS-3060D
***CRT**			
1. Configuration and useful screen	6-inch rectangular screen with internal graticule ; 8×10 DiV (1 div=1cm), marking for measurement of rise time. 2mm subdivisions along the central axis.		
2. Accelerating potential	+1.9kV approx. (ref. cathode)	+11.5kV approx. (ref. cathode)	
3. Phosphor	P31 (standard)		
4. Focussing	possible(with autofocus correction circuit)		
5. Trace rotation	provided		
6. Scale illumination	variable		
7. Intensity control	provided		
***Z-Axis input (Intensity Modulation)**			
1. Input signal	Positive going signal decreases intensity. (+5Vp-p or more signal cases noticeable modulation at normal intensity settings.)		
2. Band-width	DC-2MHz (-3dB)		DC-3.5MHz (-3dB)
3. Coupling	DC		
4. Input impedance	20-30k-ohms		
5. Maximum input voltage	30V (DC+peak AC)		
***Vertical Deflection**			
1. Band-width (-3dB) DC coupled	DC to 20MHz normal DC to 7MHz magnified	DC to 40MHz normal DC to 7MHz magnified	DC to 60MHz normal DC to 10MHz magnified
AC coupled	10Hz to 20MHz normal 10Hz to 7MHz magnified	10Hz to 40MHz normal 10Hz to 7MHz magnified	10Hz to 60MHz normal 10Hz to 10MHz magnified
2. Modes	CH1, CH2, ADD, DUAL (CHOP;Time/div switch - 0.2s to 5ms ALT;Time/div switch 2ms to 0.2μs		CH1,CH2,ADD,DUAL (CHOP : Time/div switch 0.2s to 5ms ALT:Time/div switch 2ms to 0.1μs
3. Deflection Factor	5mV/div to 5V/div in 10 calibrated steps of a 1-2-5 sequence. Continuously variable between steps at least 1 : 2.5 x5 MAG ; 1mV/div to 1V/div in 10 calibrated steps.		
4. Accuracy	normal ; ±3%, magnified ; ±5%		
5. Input impedance	approx. 1M-ohm in parallel with 25pF± 3pF		
6. Maximum input voltage	Direct ; 300V(DC+peak AC), (with probe ; refer to probe specification)		
7. Input coupling	AC-DC,GND		
8. Rise time	17.5ns or less (50ns or less;x5)	8.8ns or less (50ns or less;x5)	5.8ns or less (35ns or less;x5)
9. CH1 out	approx. 20mV/div into 50 ohms ; DC to 10MHz (-3dB)		
10. Polarity inversion	CH2 only		
11. Signal delay	none	delay cable supplied	

<table>
<tr><th>Spec. / Model</th><th>OS-3020D</th><th>OS-3040D</th><th>OS-3060D</th></tr>
<tr><td>* Horizontal Deflection
1. Display modes</td><td colspan="3">A, A int, B, B TRIG'D, X-Y</td></tr>
<tr><td>2. Time base A</td><td colspan="2">0.2μs/div to 0.2s/div in 19 calibrated steps, 1-2-5 sequence. uncalibrated continuous control between steps at least 1 : 2.5</td><td>0.1μs/div to 0.2s/div in 20 calibrated steps 1-2-5 sequence uncalibrated continuous control between steps at least 1 : 2.5</td></tr>
<tr><td>Hold-off time</td><td colspan="3">variable with the holdoff control</td></tr>
<tr><td>3. Time base B</td><td colspan="2">0.2μs/div to 0.2μs/div in 7 calibrated steps, 1-2-5 sequence.</td><td>0.1μs/div to 10μs/div in 7 calibrated steps1-2-5 sequence</td></tr>
<tr><td>Delayed sweep</td><td colspan="3">1 div or less to 10 div or more</td></tr>
<tr><td>Delay time jitter</td><td colspan="3">better than 1 : 20000</td></tr>
<tr><td>4. Sweep magnification</td><td colspan="2">10times (maximum sweep rate;20ns/div)
Note;50ns/div, 20ns/div of A TIME BASE are uncalibrated.</td><td>10times(maximum sweep rate: 10ns/div</td></tr>
<tr><td>5. Accuracy</td><td colspan="3">±3%, (0℃ to 50℃), additional error for magnifier ±2%</td></tr>
<tr><td>* Trigger System
1. Modes</td><td colspan="3">AUTO, NORM, TV-V, TV-H</td></tr>
<tr><td>2. Source</td><td colspan="3">CH1, CH2, LINE, EXT</td></tr>
<tr><td>3. Coupling</td><td colspan="3">AC</td></tr>
<tr><td>4. Slope</td><td colspan="3">+ or −</td></tr>
<tr><td>5. Sensitivity and Frequency
AUTO, NORM</td><td>| 20Hz-2MHz | 2MHz-20MHz
INT | 0.5div | 1.5div
EXT | 0.2Vp-p | 0.8Vp-p</td><td>| 20Hz-2MHz | 2MHz-40MHz
INT | 0.5div | 1.5div
EXT | 0.2Vp-p | 0.8Vp-p</td><td>| 20Hz-2MHz | 2MHz-60MHz
INT | 0.5div | 1.5div
EXT | 0.2Vp-p | 0.8Vp-p</td></tr>
<tr><td>TV-V, TV-H</td><td colspan="3">at least 1 div or 1.0Vp-p Composite Sync.</td></tr>
<tr><td>6. External trigger
Input impedance</td><td colspan="3">1M-ohm in pararall with approx. 30pF</td></tr>
<tr><td>Max. input voltage</td><td colspan="3">250V(DC+peak AC)</td></tr>
<tr><td>* X-Y Operation
1. X-axis</td><td colspan="3">(same as CH1 except for the following)
Deflection factor ; same as that of CH1
Accuracy ; ±5%
Frequency response ; DC to 500kHz (-3dB)</td></tr>
<tr><td>2. Y-axis</td><td colspan="3">same as CH2</td></tr>
<tr><td>3. X-Y phase difference</td><td colspan="3">3° or less (at DC to 50kHz)</td></tr>
<tr><td>* Readout Function
1. Cursor readout function</td><td colspan="3">Voltage reference ΔV ; Δ-REF
Time reference ΔT ; Δ-REF
Frequency reference 1/ ΔV ; Δ-REF</td></tr>
<tr><td>2. Panel setting displays</td><td colspan="3">Vertical axis (CH1, CH2)V/DIV, UNCAL, MAG (converted value)
Horizontal axis : S/DIV, UNCAL, MAG (converted value)</td></tr>
<tr><td>3. Effective cursor range from center graticule</td><td colspan="3">Vertical : within±3 div
Horizontal : within±4 div</td></tr>
<tr><td>4. Resolution</td><td colspan="3">1/25 div</td></tr>
</table>

<table>
<tr><th>Spec. \ Model</th><th>OS-3020D</th><th>OS-3040D</th><th>OS-3060D</th></tr>
<tr><td>• Digital storage function
1. Display memory</td><td colspan="3">1000Words/CH</td></tr>
<tr><td>2. Save memory</td><td colspan="3">1000Words/CH × 2</td></tr>
<tr><td>3. Acquisition memory</td><td colspan="2">5us/div ~ 20s/div : 2000words/CH
0.2us/div ~ 2s/div : 1000words/CH</td><td>5us/div ~ 20s/div : 2000 words/CH
0.1us/div ~ 2us/div : 1000words/CH</td></tr>
<tr><td>4. Vertical resolution</td><td colspan="3">25point/div</td></tr>
<tr><td>5. Horizontal resolution</td><td colspan="3">100Point/div</td></tr>
<tr><td>6. Maximum sapmling rate</td><td colspan="3">20Ms/s</td></tr>
<tr><td>7. Digital Band Width
single shot event</td><td colspan="3">5MHz(4 samples/Cycle)</td></tr>
<tr><td>repetive event</td><td>20MHz
7MHz at Y axis x5 MAG</td><td>40MHz
7MHz at Y axis x5 MAG</td><td>60MHz
7MHz at Y axis x5 MAG</td></tr>
<tr><td>8. Data acquisition method</td><td colspan="3">· NORM mode : storage the data each time trigger
· AVG mode : averaging from 4 to 256 times
· ROLL mode : data is continuously stored on the CRT
· HOLD mode : data is held for the NORM, AVG, ROLL
· SINGLE mode : waveform is held after stored</td></tr>
<tr><td>9. Display Function</td><td colspan="3">· SMOOTH : the storage waveform is displayed by dots or smooth
· INTERPOLATION : the storage waveform is displayed by dot, linear of sine interpolation
· ALI MAG : Simultaneously displaying the original waveform and its magnified waveform
· GO-NOGO : judgement and comparing of acquisition signal</td></tr>
<tr><td>10. Data save</td><td colspan="3">Up to two storage data can be saved.
Saved data can be recalled to the display whenever required.</td></tr>
<tr><td>11. Pre-trigger</td><td colspan="3">Variable (0.04 div step)</td></tr>
<tr><td>12. Plotter</td><td colspan="3">plotter output of the CRT displayed information to an HP-GL plotter via the RS-232C interface.</td></tr>
<tr><td>13. Data output</td><td colspan="3">RS-232C</td></tr>
<tr><td>14. Magnified display</td><td colspan="3">× 10 by Time/div switch or MAG switch</td></tr>
<tr><td>15. X-Y operation</td><td colspan="3">Sigle trace X-Y X axis = CH 1   *X axis = SA
Y axis = CH 2   Y axis = SB
Dual trace X-Y X axis = CH 1
Y axis = CH 2
Sensitivity X axis : CH 1 1mV ~ 5 V/div ± 5%
Y axis : CH 2 1mV ~ 5 V/div ± 5%
Phase error 3° or less from DC ~ 50 KHz</td></tr>
<tr><td>16. Sweep time</td><td colspan="2">0.2µs/div~20s div
repetitive signal:0.2µs/div~2µs/div
roll mode:0.5µs/div~20s/div
ALT: 0.5µs/div~20s div
CHOP: 1ms/div~20s/div</td><td>0.1µs/div~20s div
repetitive signal:0.1µs/div~2µs div
roll mode:0.5µs/div~20s/div
ALT:0.1µs/div~0.5ms/div
CHOP:0.1ms/div~20s/div</td></tr>
<tr><td>17. Readout function</td><td colspan="3">〈Panel setting display〉
V/div, uncal, MAG.
S/div, uncal, MAG.
X-Y, Trigger point, no. of averaging, roll mode, smoothing, interpolation method,
save memory information.
probe setting
〈Cursor readout〉
Voltage difference ΔV : Δ-Ref
Time difference ΔT : Δ-Ref
Frequency 1/Δt : Δ-Ref
Pretrigger TRG : Δ</td></tr>
</table>

<table>
<tr><th>Spec. / Model</th><th>OS-3020D</th><th>OS-3040D</th><th>OS-3060D</th></tr>
<tr><td>*Calibrator(probe adj)</td><td colspan="3">approx. 1kHz frequency, 0.5V (±3%) squarewave
duty ratio : 50%</td></tr>
<tr><td>*Power Supply
1. Voltage range</td><td colspan="3">
<table>
<tr><th rowspan="2">voltage range</th><th colspan="2">Fuse(250V)</th></tr>
<tr><th>UL198G</th><th>IEC127</th></tr>
<tr><td>100(90 - 110V)/AC</td><td rowspan="2">2A</td><td rowspan="2">F2A</td></tr>
<tr><td>120(108 - 132V)/AC</td></tr>
<tr><td>220(198 - 242V)/AC</td><td rowspan="2">1A</td><td rowspan="2">F1A</td></tr>
<tr><td>230(207 - 250V)/AC</td></tr>
</table>
</td></tr>
<tr><td>2. Frequency</td><td colspan="3">50 / 60Hz</td></tr>
<tr><td>3. Power consumption</td><td>approx. 70W.</td><td>approx. 70W.</td><td>approx. 70W.</td></tr>
<tr><td>*Physical Characteristics
1. Weight</td><td>approx. 8kg</td><td>approx. 8kg</td><td>approx. 8kg</td></tr>
<tr><td>2. Dimension</td><td colspan="3">320 m (W) × 140 m (H) × 430 m (L)</td></tr>
<tr><td>*Environmental Characteristics
1. Temperature range for rated operation</td><td colspan="3">+10℃ to + 35℃ (+50°F to +95°F)</td></tr>
<tr><td>2. Max. ambient operating temperature</td><td colspan="3">0℃ to + 40℃ (+32°F to +104°F)</td></tr>
<tr><td>3. Max. storage temerature</td><td colspan="3">−20℃ to + 70℃ (−4°F to +158°F)</td></tr>
<tr><td>4. Humidity range for rated operation</td><td colspan="3">45% to + 85% RH</td></tr>
<tr><td>5. Max. ambient operating humidity</td><td colspan="3">35% to + 85% RH</td></tr>
<tr><td>* Safety</td><td colspan="3">EN61010-1 overvoltage CAT II, degree of pollution 2.
Approval: TÜV/</td></tr>
<tr><td>* EMC</td><td colspan="3">Interferdnce: EN50081-1
Susceptability: EN50082-1, IEC801-2, 3, 4</td></tr>
</table>

<Caution>:Sources like small hand-held radio transceivers, fixed station radio and television transmitters, vehicle radio transmitters and cellular phones generate electromagnetic radiation that may induce voltages in the leads of a test probe In such cases the accuracy of the oscilloscope cannot be guaranteed due to physical reasons.

1-3. Points to be checked prior to use

Comply with the following procedures for safety and to prevent damage to the product prior to operating this product.

1-3-1. Line voltage selection

Before use, check the voltage.
This instrument must be operated with the correct line voltage selector switch setting to prevent damage in reference to table 1-1.
To change the line voltage selection :

1. Decide the voltage range and fuse in reference to table 1-1.
2. Make sure the instrument is disconnected from the power source.
3. Pull out the Line Voltage Selector switch on the rear panel. Select the arrow mark position of the switch from Table 1-1. Slide the arrow mark to the desired position and plug it in.

〈Caution〉 : This product has the ground chassis (3 wire power cord is used). Check whether any other equipment connecting with this product requires the transformer before use. If so, do not connect the DC/AC or the hot chassis equipment if no transformer is available.
Do not directly connect it to the AC power nor to the circuit directly connected to the AC power.
Otherwise serious personal injury or damage to this product for a long time without trouble.

Table 1-1. Line voltage selection and fuse ratings

Line voltage	Arrow mark position	Fuse Ratings(250V)	
		UL198G	IEC127
90 − 110 VAC	100	2A	F2A
108 − 132 VAC	120		
198 − 242 VAC	220	1A	F1A
207 − 250 VAC	230		

1-3-2. Installation and handling precautions

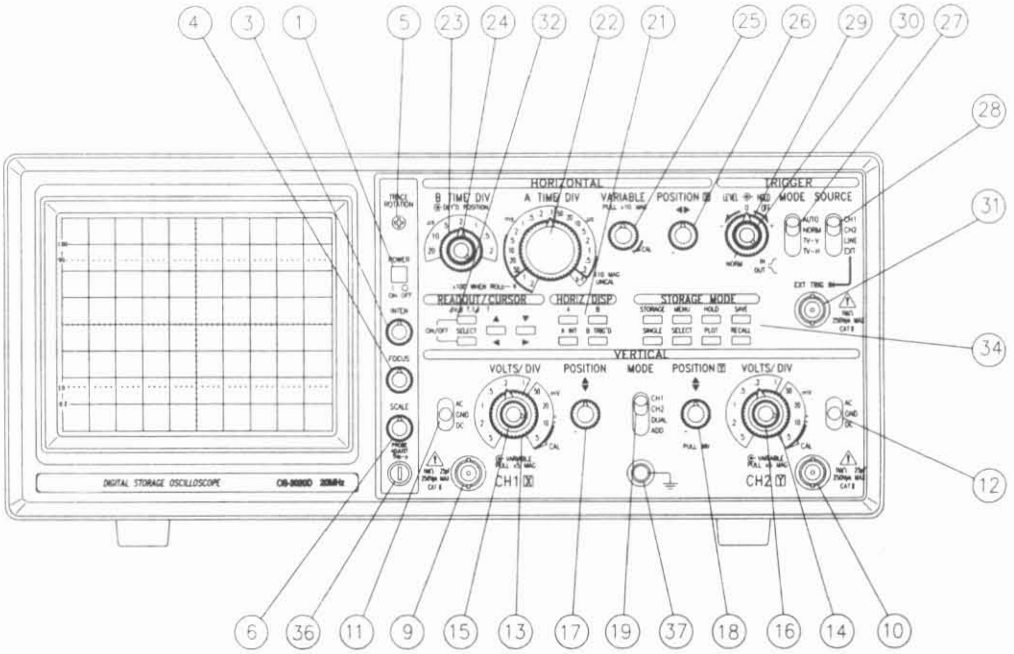
When placing the OS-3000DSRS in service at your workplace, observe the following precautions for best instrument performance and longest service life.

1. Avoid placing this instrument in an extremely hot or cold place. Specifically, don't leave this instrument in a close car, exposed to sunlight in midsummer, or next to a space heater.
2. Do not use this instrument immediately after bringing it in from the cold. Allow time for it to warm to room temperature. Similarly, don't move it from a warm place to a very cold place, as condensation might impair its operation.
3. Do not expose the instrument to wet or dusty environments.
4. Do not place liquid-filled containers on top of this instrument. A spill could seriously damage the instrument.
5. Do not use this instrument where it is subject to severe vibration, or strong wind.
6. Do not place heavy objects on the case, nor block the ventilation holes.
7. Do not use this oscilloscope in strong magnetic fields, such as near motors.
8. Do not insert wires, tools, etc. through the ventilation holes.
9. Do not leave a hot soldering iron near the instrument.
10. Do not place this oscilloscope upside dow down on the ground, otherwise damage to the knobs may result.
11. Do not use this instrument upright while BNC cables are attached to the rear-panel connectors. This will damage the cable.
12. Do not apply voltages in excess of the maximum ratings to the input connectors or probes. (Refer to 1-2 specification)
13. This oscilloscope is to use UL listed double insulated probes only.

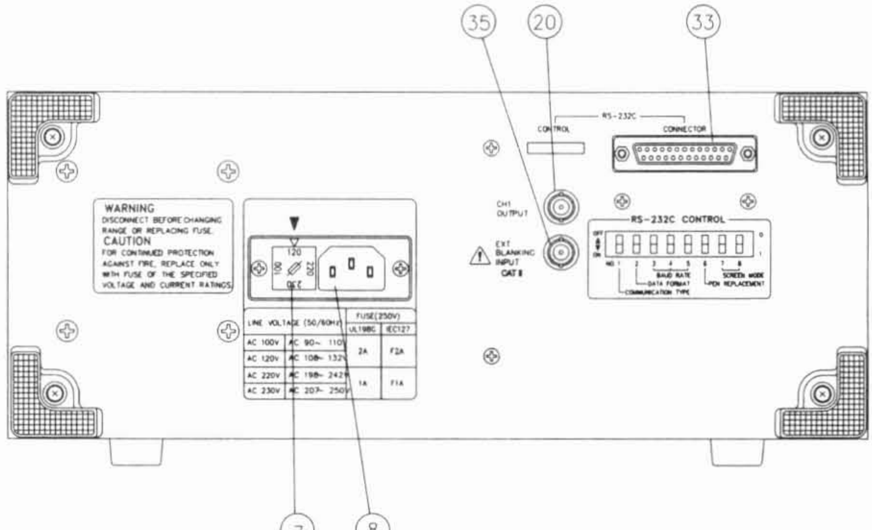
-4. Accessories

The below listed accessories are contained in the package of this instrument.

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

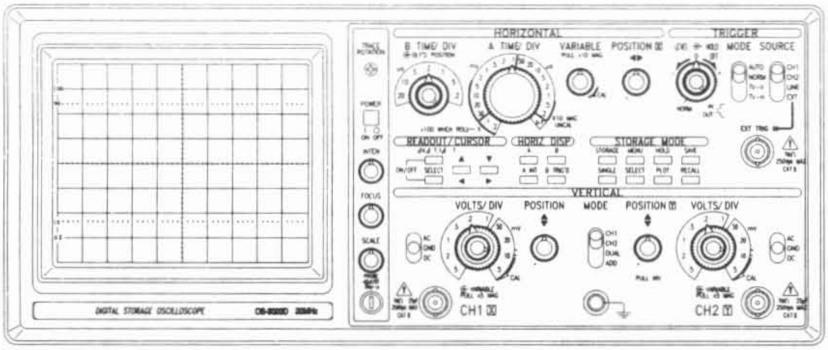


(A) FRONT PANEL ITEMS

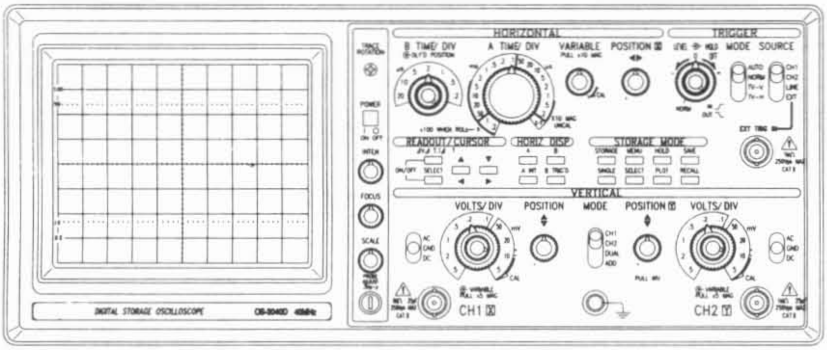


(B) REAR PANEL ITEMS

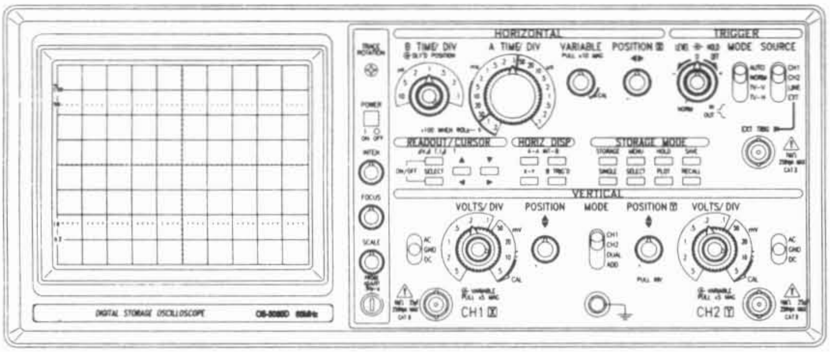
Fig. 2-1. OS-3020D front/rear views



OS-3020D



OS-3040D



OS-3060D

OS-3000DSRS Front Views

This section describes the measurement procedures and methods utilizing a variety of basic informations and functions needed for operating this instrument.

2-1. Function of each block

The numbers shown in the following descriptions represent each terminal indicated on Fig. 2-1.

2-1-1. Display and power blocks

[1] POWER SWITCH : Push in to turn instrument power on and off.

[3] INTENSITY : Adjust the brightness of CRT. Clockwise rotation increases brightness.

[4] FOCUS : Adjust sweep lines for obtaining the highest definition.

[5] TRACE ROTATION : Adjust sweep lines for obtaining the highest definition.

[6] SCALE ILLUM : It adjusts the brightness of scale, and useful when observation is made in a dark place or when taking the photograph of screen.

[7] VOLTAGE SELECTOR : Selection is permissible to make the voltage suitable for operating power.

[8] POWER CONNECTOR : Connection and removal of the AC power cord is easy when using.

2-1-2. Vertical amplifier block

[9] CH1, X IN CONNECTOR : Connects input signal to CH1 vertical amplifier or becomes a X-axis signal during X-Y operation.

<CAUTION> To avoid damage to the oscilloscope, do not apply more than 250V(DC+Peak AC) between "CH1" terminal and ground.

[10] CH2, Y IN CONNECTOR : Connects input signal to CH2 vertical amplifier or becomes a Y-axis signal during X-Y operation.

<CAUTION> To avoid damage to the oscilloscope, do not apply more than 250V(DC+Peak AC) between "CH2" terminal and ground.

[11][12] AC-DC,GND : To be used when selecting the method of coupling input signal to vertical amplifier.

AC	: Capacitor between input connector and vertical amplifier interrupts any DC component of the signal.
GND	: Connects input connector of vertical amplifier to the ground, thus establishing GND as a reference point.
DC	: By making direct connection between input connector and vertical amplifier, input signal is directly connected to vertical amplifier.
[13][14] VOLTS/DIV	: As being the attenuator by each step selecting vertical deflection sensitivity, measurement of waveform is practicable regardless of signal magnitude and those shall be used by having them placed at the appropriate position so as to make waveform measurement easy.
[15][16] VARIABLE	: As being the minute adjustor being used when having vertical deflection sensitivity continuously varied, if they are fully rotated counterclockwise the attenuation ratio becomes less than 1/2.5 of indicated value. When you pull out the knob, vertical axis sensitivity becomes x5 times. At time time, the maximum sensitivity becomes 1mV.
[17][18] POSITION	: Being used for moving vertical axis waveform. Clockwise rotation moves waveform up and counterclockwise rotation moves it down.
PULL CH2. INV[18]	: When pulled· out, the signal applied to CH2 appears inverted.
[19] V MODE SWITCH	: Being used for selecting the display mode of vertical axis.
CH1	: Displays only the signal input to CH1 on the CRT.
CH2	: Displays only the signal input to CH2 on the CRT.

DUAL : Two signals that are input to CH1 and CH2 appear on the CRT simultaneously.
CHOP : TIME/DIV 0.2s~5ms
ALT : TIME/DIV 2ms~0.2μs (* OS-3060D : 0.1μs)

ADD : Displays the algebraic sum of CH1 and CH2 signals.

[20] CH1 OUT CONNECTOR : Provides frequency counter or other devices with a part of signals that are input to CH1 by having them amplified.

2-1-3. Sweeps and trigger blocks

[21] HORIZONTAL DISPLAY : To select the sweep mode.

A : A pushbutton sweeps the CRT at the main (A) timebase rate when pressed.

A INT : A INT pushbutton sweeps the CRT at the main (A) timebase rate when pressed, and the B timebase intensifies a section of the trace(s). (In case of OS-3060D, press A and B simultanously).

B : The sector whose brightness is modulated is displayed on the screen in a magnified form. B'TRIG'D the delay sweep is triggered by the first trigger pulse.

X-Y : pushbutton provides X-Y operation. (only OS-3060D).

(* A sweep appears in STORAGE mode.)

* In OS-3000DSRS, the horizontal display is as follows (Fig. 2-2 and 2-3).

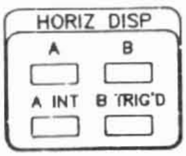


Fig. 2-2. OS-3020D, 3040D

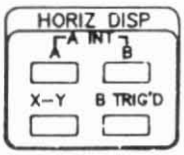


Fig. 2-3. OS-3060D

[22] A TIME/DIV : To select either the calibrated sweep rate of the main (A) timebase, and X-Y operation (* OS-3020D, OS-3040D) for delayed-sweep operation.

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

[24] DELAY TIME POSITION : To determine the exact starting point within the A timebase delay range at which the B timebase will begin sweeping.

[25] A VARIABLE : Being used for having A sweep time varied continuously from the calibrated position.

PULL X10 MAG : When you make the part to be magnified align with the central scale of the vertical axis by adjusting the position of the horizontal axis and when you pull the X10 MAG switch, the waveform, the left and the right of which are magnified centering around the middle, appears. At this time, sweep time becomes 1/10 of the indicated value of TIME/DIV.

[26] HORIZONTAL POSITION : Being used for adjusting horizontal position and being used independently of the time measurement of waveforms.
Clockwise rotation of the knob moves it to the right and counterclockwise rotation moves it to the left.

[27] TRIGGER MODE	:	Selects the sweep triggering mode.
AUTO	:	The sweep occurs automatically. When there is a triggering signal, the sweep triggered normally is obtained and the waveform stops. Where there is no signal and the trigger is not made, the sweep still occurs automatically. This position is convenient in general use.
NORM	:	Triggered sweep can be obtained, but when there is no triggering signal and triggering is not made, then the sweep does not occur, then the sweep does not occur. This mode is effective when the effective triggering is desired to be done in a low frequency (approx. 25Hz or less).
TV-V	:	Being used for measuring a composite video signal in a frame unit.
TV-H	:	This one is used for measuring a composite vedeo signal in a scanning line unit.
[28] TRIGGER SOURCE	:	This can select the convenient portion of the trigger source.
CH1	:	It can select the CH1 as the trigger source when there is a signal on CH1.
CH2	:	This can select the CH2 as the trigger source when there is a signal on CH2.
LINE	:	This one is used for observing a signal which is triggered on the frequency of AC power. It can also stable observe components derived from the power in which a measuring signal is contained.
EXT	:	External signal becomes the source of triggering signals. And this one is used when making a triggering regardless of the size of signals of vertical axis.

[29] HOLD OFF : This one makes complicated signal triggerred certainly by changing the HOLD OFF time of the main sweep. It is also effective in triggering such complicated signals as high frequency signal, irregular signal or digital signal, etc. by extending sweeping time. Adjust it slowly for the stabilized triggering. It is normally used after having it fully rotated counterclockwise.

[30] TRIG LEVEL : This one selects a starting point of triggering signal.
When the knob is rotated clockwise, the trigger point moves toward the +(positive) maximum value and when rotating it counterclockwise, it moves toward −(negative) maximum value.

TRIGGER SLOPE : Being used for selecting trigger slope of the initial sweep. When the switch is pressed, this switch selects positive(+) slope and when pulled, the switch indicates negative (−) slope.

[31] EXT TRIG IN : Being used for connecting external trigger signals to trigger circuits.

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

2-1-4. [32] READOUT

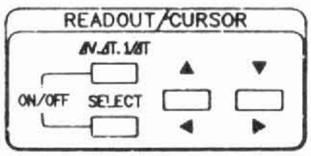


Fig. 2-4. Readout/Cursor

ⓐ SELECT : This switch selects cursor to change among △, REF, TRACKING (▲, REF) cursors.
The selected cursor is displayed on the top (or left side). (△, ▽)

ⓑ △V, △T, 1/△T : This switch switches among △V, △T, 1/△T modes.

ⓒ ON/OFF : Pressing △V and SELECT toggles the readout function ON or OFF.

ⓓ ▲◀, ▶▼ : Moves the selected cursor upward, downward, right or left.

2-1-5. [34]STORAGE

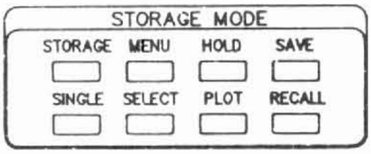


Fig. 2-5. Front panel storage mode switch

ⓔ STORAGE SWITCH : When LED goes out, it performs the normal realtime oscilloscope function. All the switches do not operate. Pressing this switch once lights up LED, enters into storage mode, and all the switches operate. Pressing this switch once more in storage mode enters into REAL TIME mode. In storage mode, LED blinks asynchronously along with sampling.

ⓕ MENU SWITCH : Press this switch to change average, interpolation, probe state, roll and smoothing ON/OFF. Whenever pressing this switch, the mode is changed, and the currently selected mode is displayed on the top right of CRT. Each set mode is changed by pressing SELECT switch under MENU switch.

ⓖ HOLD SWITCH : Pressing this switch stops sampling, and the waveform displayed on the screen stops and LED lights ON. Pressing this switch again releases HOLD state, and sampling begins.

ⓗ SAVE SWITCH : This switch stores the display waveform in the storage memory. The display waveform is stored by this switch in HOLD state. In non-HOLD mode, only the switch state is chantged.

ⓘ SINGLE SWITCH : This switch measures the change in the instantaneous (intermittent) waveform.

ⓙ SELECT SWITCH : This switch changes the MENU switch setting mode.

ⓚ PLOT SWITCH : This switch outputs the display waveform on the X-Y plotter. Pressing switch transmitts data and lights up LED. This switch operates only in the HOLD state (HOLD LED lights up).

ⓛ RECALL SWITCH : This switch is used to display the stored waveform on CRT again. Pressing this switch lights up the LED. When LED goes out after pressing this switch continuously it releases.

2-1-6. Miscellaneous

[33] DIP SWITCH and RS-232C CONNECTOR

DIP SWITCH : Sets the PLOT or communication mode at the time of plotter output or at the communication with computer.

RS-232C CONNECTOR : Connects RS-232C cable (Fig. 3-2 and 4-2) at the time of plotter output or at the communication with computer.

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

[36] CAL TERMINAL : Outputs the square wave (0.5V, 1kHz) to calibrate the probe and vertical amplifier.

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

2-2. Basic measurements

2-2-1. Connection of measuring signals

There are three different methods for observing signals by means of the oscilloscope as follows :

1. Method using lead wire
2. Method using coaxial cable
3. Method using probe for oscilloscope

1. Method using lead wire
   This method is the simple one but it can only be used in the event that the signal level you intend to measure is either a high level signal or a low impedance circuit (such as TTL circuit). At this time, ground wires shall be connected between the grounding terminal of oscilloscope and the grounding surface of objects to be measured. However, in case that the wire picks up hum and noise because the wire is not shielded, the measurement may often be difficult when measuring low level signals. As it is hard to have the wire connected to the connector of oscilloscope, using a binding adapter for BNC is desirable.
2. Method using coaxial cable
   This method is the most prevailing one which is widely used when an output connector is attached to the measureing object. As the shield coating of coaxial cable prevents hum and noise, accurate measurement can be performed.
   Since the coaxial cable are usually fitted with BNC connectors on each end and there are many varieties of types by their purposes, it just would be advisable to use a suitable one as needed. When measuring high frequency signals, a terminator having an impedance of the same value as the impedance of measuring signal sources shall be used, and the coaxial cables should also be matched with the terminator in terms of impedance. Even when using a long cable, should you use the subject method, an accurate measurement could be performed without affecting measurement signals.

3. Method using probe for oscilloscope

Using a probe is most preferable to any other alternatives when performing the measurement onto circuits. The probes are available with 1X (direct connection) position and 10X (attenuation) position. As the input signal attenuates by 1/10 with the input impedance of oscilloscope with probe increased at 10X position, measurement unit (VOLT/DIV) must be multiplied by ten (10). (e.g. it becomes 50mV X 10 = 0.05V in 50mV/DIV). As the probe of oscilloscope also uses shielded wires, it can prevent hum and noise. When you intend to perform the measurement by using the coaxial cable, you should exactly know the source impedance, the highest frequency involved, and the capacitance of the cable, etc.

If any of these factors are unknown, use a 10 X probe.

2-2-2. Adjustment during initial operation

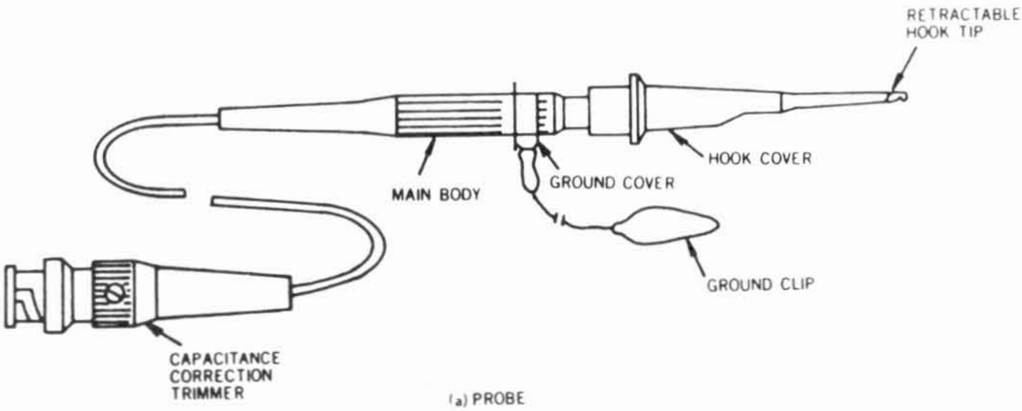
Comply with the following procedure before conducting the measurement :

1. Adjusting knob is as follows

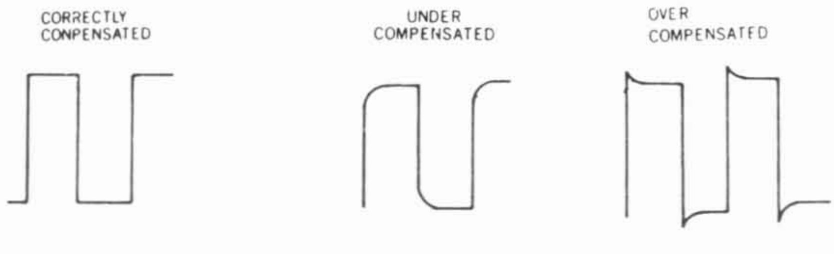
POWER SWITCH [1]	: OFF (released)
INTEN CONTROL [3]	: Fully counterclockwise
FOCUS CONTROL [4]	: Mid
AC-GND-DC SWITCH [11,12]	: AC
VOLT/DIV SWITCH [13,14]	: 20mV
VERTICAL POSITION CONTROL [17,18]	: In the middle and pushed in
VARIABLE CONTROL [15,16]	: Fully clockwise and pushed in
V. MODE SWITCH [19]	: CH1
TIME/DIV [22]	: 0.5ms
TIME VARIABLE [25]	: Fully clockwise and pushed in
HORIZONTAL POSITION [26]	: Mid
TRIGGER MODE [27]	: AUTO
TRIGGER SOURCE [28]	: CH1
TRIGGER LEVEL [30]	: Mid
HOLD OFF [29]	: NORM (max. CCW)

2. Connect the power cord to the power connector [8].

3. Press in the POWER switch [1]. About 30 seconds later, rotate the INTEN [3] control clockwise until the trace appears. And then, adjust brightness so as to make it suitable for observing.
   〈Caution〉 A burn-resistant material is used in the CRT. However if the CRT is left with an extremely bright dot or trace for a very long time, the screen may be damaged. Therefore, if a measurement requires high brightness, be certain to turn down the INTEN control immediately afterward. Also, get in the habit of turning the brightness way down if the scope is left unattended for any period of time.
4. Adjust the FOCUS control [4] to make it produce the finest and distinctest definition.
5. Make sure that the traces align with horizontal graticule lines by turning the CH1 vertical POSITION control [17]. Where the traces do not align with horizontal graticule lines, then make them align with each other by adjusting the TRACE ROTATION [5].
6. Turn the HORIZONTAL POSITION control [26] to make it align with the left-most graticule line.
7. Connect the PROBE to the CH1, X IN connector [9] to make it align with the left-most graticule line.
8. If the top and a certain portion of the square waves are tilted or pointed, adjust the control terminal of the PROBE by means of a small screwdriver as shown on Fig. 2-b(b).



(a) PROBE

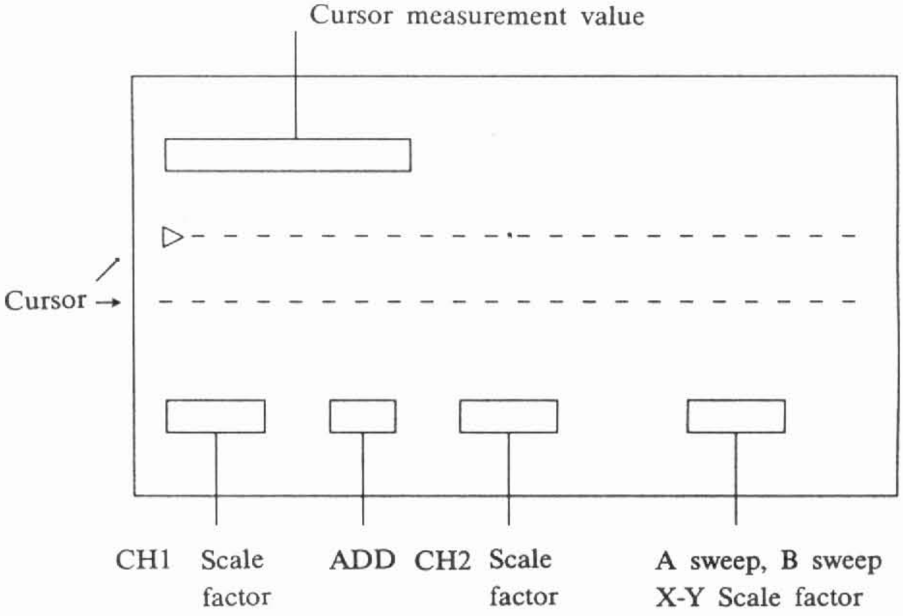


(b) EFFECTS OF PROBE COMPENSATION

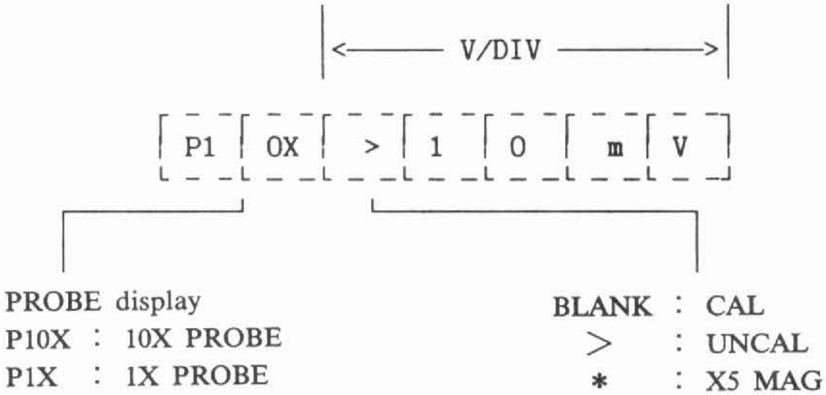
Fig. 2-6. Probe compensation

2-2-3. Data display

(1) Real time mode display



① CH1 and CH2 scale factor display



In ADD mode, "+" is displayed between scale factors of CH1 and CH2.

② A sweep, B sweep factor display and X-Y display

|<—— V/DIV ——>|

>	Ø.	5	m	s

BLANK : X1 CAL
* : X1Ø MAG
> : UNCAL

1)In X-Y operation mode, X-Y mode is displayed, and TIME/DIV setting data and B setting data disappear.
2)In B sweep mode, B TIME is displayed and TIME/DIV setting data disappear.

③ Cursor measurement display
The measured value between cursors is displayed.

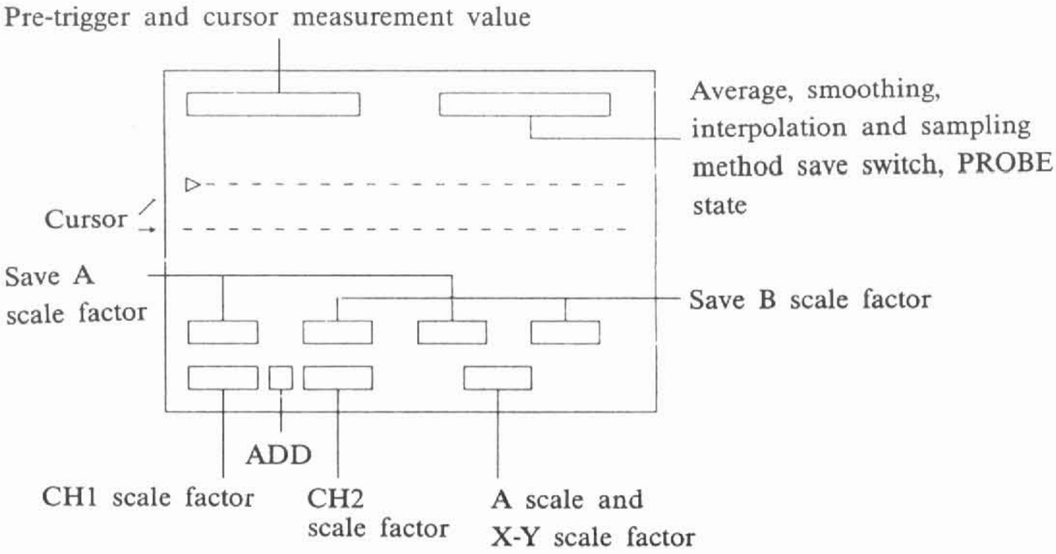
|<—— Measured value ——>|

△	V		+	3	Ø	.	0	V

△V : CH1, CH2, ADD, DUAL
△T : Time difference between two cursors for A TIME/DIV
1/△T : Reciprocal of △T

△V : +, −, mV, V, div
△T : +, −, µs, ms, s, div
1/△T : MHz, kHz, Hz, mHz, ?
"div" is displayed in the following cases :
- The measurement value of the channel selected by VERTICAL MODE switch is not in CAL mode.
- B sweep
- X-Y mode
- A sweep (UNCAL mode)
- CH1 and CH2 VOLTS/DIV are same with each other when the VERTICAL MODE is ADD.

(2) Storage mode display
Location of data display on CRT



NOTE : Waveform or even previously stored waveform may be displayed
while input signal is stored in storage mode. While waveform is stored, the instrument stores the setting condition associated with sweep factor and waveform. These valves are always displayed when waveform is displayed.

* CH1, CH2 and A sweep factors
  When CH1 and CH2 waveforms are displayed, the sweep factor corresponding to waveform is displayed.
* Pre trigger and cursor measurement
  The sweep waveform corresponding to the function selected using cursor selector switch and vertical mode switch is displayed.

* SAVE A and SAVE B sweep factor
  When the waveform is stored in the memory, V/DIV and TIME/DIV is displayed. When the stored waveform is displayed on the CRT by pressing RECALL switch, this sweep factor is displayed.

① CH1 and CH2 sweep factor display

P1	0X	>	1	0	m	V

Probe display
P10X : 10X probe
P1X : 1X probe

Blank : CAL
> : UNCAL
* : X5 MAG

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

|<—— S/DIV ——>|

>	0.	5	m	S

BLANK : X1 CAL (No horizontal magnification)
* : No interpolation
∩ : Sine wave interpolation
ʃ : Linear interpolation

X10 MAG (Horizontal magnification)

In X-Y operation, A sweep sweep factor disappears and X-Y is displayed.

③ Pre trigger setting display
Trigger point of display waveform against the trigger point of display waveform.

(Example : | P | T | | + | 1 | 0 | . | 0 | d | i | v |)

④ Refer to 2-2-5 for the display of average, smoothing, interpolation, sampling method.

⑤ Cursor measurement value display

The measured value between cursors is displayed.

Measured value

|<——————————————>|

△	V		+	3	0		0	V

△V1 : Volt difference between two cursors for CH1 and Dual sweep waveform.

△V2 : Volt difference between two cursors for CH2 sweep waveform.

△V : Volt difference between two cursors for ADD sweep waveform.

△V : +, −, mV, V, div

△T : +, −, ns, µs, ms, s, div

1 / △T : MHz, kHz, ?, mHz, div

△T : Time difference between two cursors for A sweep waveform

1/△T : Reciprocal of △T

"div" is displayed in the following case :

- The measurement value of the channel selected by VERTICAL MODE switch is not in CAL state.
- A sweep VAR mode is not in CAL mode at the equivalent sampling mode.
- X-Y mode
- In HOLD state, TIME/DIV switch exceeds the measurement MAG range.
- The VOLTS/DIV of CH1 and CH2 are not same with each other when vertical mode is ADD.

2-2-4. Real time mode mesurement

(1) Single-trace measurement

Single-trace measurement is the most elementary function of this measuring instrument.

Use this mode when you intend to measure one single signal. Since this instrument comprises two channels, just choose one of CH1 and CH2. CH1 has an OUTPUT terminal [20], and it is desirable for you to use it when you intend to measure the frequency by means of a frequency counter.

CH2, as the INVERT switch [18], is practicable to have the polarity of waveform inverted.

① Set the switches as indicated below when you use the CH1. The words in the bracket represent the setting when using CH2.

POWER [1]	: ON
AC-GND-DC [11], [12]	: AC
VERTICAL AXIS POSITION [17],[18]	: Mid rotation and pushed in
VARIABLE [15], [16]	: Fully CW and pushed in
V MODE [19]	: CH1 (CH2)
HORIZ. DISPLAY [21]	: A
A TIME VARIABLE[25]	: Fully CW and pushed
TRIGGER MODE [27]	: AUTO
TRIG SOURCE [28]	: CH1 (CH2)
TRIG LEVEL [30]	: Mid rotation
HOLD OFF [29]	: NORM (positioning it at the end of CCW)

② Position the trace on the center of CRT by adjusting the Vertical POSITION control.

③ Connect the signal by means of the IN connector [9] [10] and turn the VOLT/DIV [13], [14] so as to make the signal fully appear on the CRT.

〈Caution〉 Do not apply a signal greater than 250V (DC + peak AC) .

④ Turn the TIME/DIV switch [22] so as to make the signal become the desired cycle. For the general measurement display of 2 or 3 cycles is suitable but when measuring the closed up waveforms, display of 50-100 cycles is proper. And adjust the TRIGGER LEVEL control [30] with having it rotated to make a stable waveform appear.

⑤ If the signal to be measured does not trigger or the measurement is difficult because of its weakness though the VOLT/DIV switch is positioned on 5mV, pull the VARIABLE (PULL X5 MAG) [15] [16]. At this time, where the VOLT/DIV switch is set to 5mV, it becomes 1mV/DIV and the frequency wide band width decreases to 7 MHz. However, the noise increases on the trace.

⑥ If the signal you wish to observe is a high frequency, thus resulting in too many cycles though the TIME/DIV switch which is set to the position of 0.2μs, pull the TIME VARIABLE terminal (PULL X10 MAG) [25]. Then the sweep speed increases by ten [10] times so that 0.2μs becomes 20ns/div and 0.5μs becomes 50ns/div.

0.2 and 0.5μs MAG are the uncalibrated terminal and 1μs or less is the calibrated terminal. (When magnified by X10 in 1μs/div, the value is ±10% and when magnified by X10 in less than 1 μs, the value is ±5%).

⑦ When measuring DC or very low frequency, the AC coupling results in the attenuation of signal or distortion so that use the instrument after having the AC-DC,GND switch [11], [12] positioned to DC.

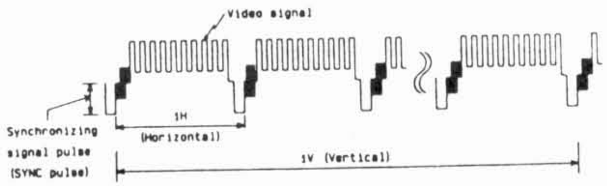
Caution : Where the waveform of very low AC level is loaded on the high DC voltage, it may not appear on DC position.
The NORM of TRIGGER MODE switch [27] is the position to be
reswept. When observing signal frequency below 25Hz, you can
also perform the measurement by adjusting the TRIGGER LEVEL
[30].

(2) Dual-trace measurement

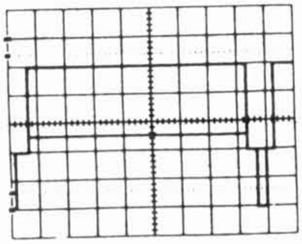
Dual-trace measurement is the major function of this instrument, OS-3000D. The measuring procedure is same as that of 2-2-4 single-trace measurement above with the exception of the following :

① Set the V MODE switch [19] to dual.
Use ALT for relatively high-frequency signals (TIME/DIV switch :0.2ms or faster), and use CHOP for relatively low-frequency signals (TIME/DIV switch : 0.5ms or slower).

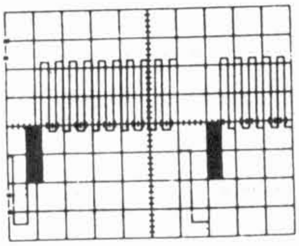
② If the two channels are of the same frequency, you can exactly initiate the triggering with TRIGGER SOURCE switch [28].



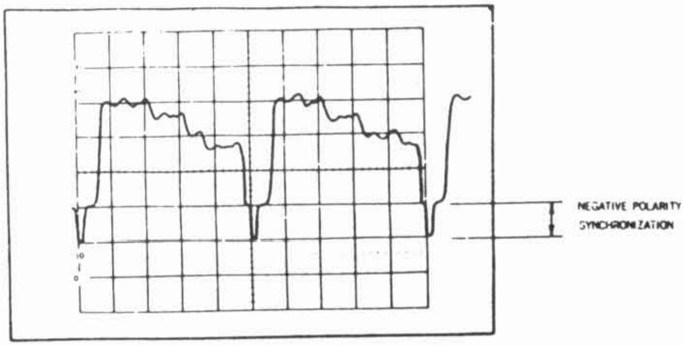
(a) Compositive video signal



(b) TV-V coupling



(c) TV-H coupling



(d) SYNC polarity

Fig. 2-7. TV sinc signal separation

(3) Trigger selection

Triggering is the most complicated operation to perform for the oscilloscope because this instrument has many requirements that have to be incidentally applied, and it requires an exact synchronization as well.

① Trigger mode selection

Auto trigger mode :

Since the synchronized sweep always appears, even though there exists no signal nor has the trigger adjusting been done improperly granting that there exists a signal, you have nothing to worry about that errors can possibly arise from the NORM.

However, where the signal frequency is less than 25Hz, the AUTO cannot be used. At this time, the measurement has to be done at the NORM position.

NORM trigger mode :

CRT beam appears only when the signal is synchronized. This trigger MODE does not cause the trace to appear in case that there is no signal, that the synchronization adjusting has been done improperly and that the vertical POSITION has been incorrectly adjusted or that the VOLT/DIV switch has been improperly positioned.

TV-V, TV-H trigger mode :

The cleanly synchronized waveform can be observed with separating the waveform such as a composite video signal (Fig. 2-7(a)) into the horizontal and vertical components by adding a TV sync separation circuit. For the synchronization of vertical components of the TV signal (Fig. 2-7(b)), set the Trigger MODE switch switch to TV-V. For the synchronization of horizontal components of the TV signal (Fig. 2-7(c)), set the Trigger MODE switch to TV-H. When the TRIGGER has been separated (Fig. 2-7(d)), the TV sync polarity should be negative(−).

② Trigger point selection

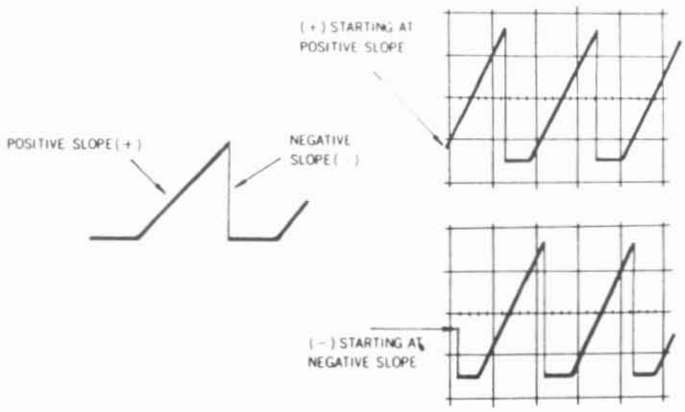
The SLOPE switch determines whether the sweep shall start from the rise-starting point or from the fall-starting point. (See Fig. 2-8).

Depressed switch represents the rise-starting point and released switch indicates the fallstarting point.

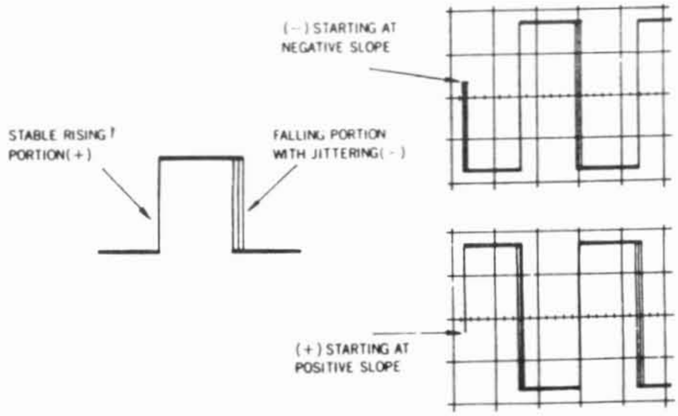
③ Trigger level selection

This position represents the starting point of the signal which is input with either CH1 or CH2.

The signal starting point varies as shown on Fig. 2-9 by turning the TRIGGER LEVEL control [30] to the left and right.



(a) Sawtooth waveform



(b) Square waveform

Fig. 2-8. Trigger point selection

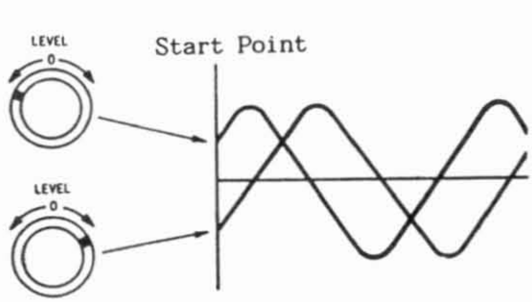


Fig. 2-9. Trigger level selection

(4) Addition and difference measurements

The measurement of the addition and difference is a function representing one waveform by adding two signals. The operation of the addition (ADD) represents the algebraic sum of the CH1 and CH2 signals, and the operation of the difference represents the algebraic difference between the CH1 and CH2 signals.

Measuring procedure of ADD of this instrument, OS-3000DSRS is as follows :

1. Set up per paragraph 2-2-4(2) dual-trace measurement.
2. Set both VOLTS/DIV switch [13] and [14] to the same position and turn the VARIABLE controls [15] and [16] fully clockwise until being click-stopped. Where the amplitude difference of the two signals is considerably large, reduce both VOLTS/DIV switches simultaneously as much as to make the amplitude of the larger signal be within the screen display.
3. Select the TRIGGER switch having the biggest signal.
4. Set the V. MODE switch [19] to ADD position〉

   Then, the algebraic sum of the CH1 and CH2 signals appears as a signal waveform. At this time, since the position change of Vertical POSITION controls [17] and [18] varies the measurement values, operation shall be prohibited.

   〈Note〉 If the two input signals have the same phase, the two signals appear as the algebraic sum of the individual traces (e.g. 4.2 DIV + 1.2 DIV = 5.4 DIV).

   Where the two input signals have 180° counter-phase, the two signals appear as the difference (e.g. 4.2 DIV − 1.2 DIV = 3.0 DIV).

5. If the p-p amplitude of the resultant trace is very small signal, perform the measurement after having a large marking made on the screen display with adjusting both VOLTS/DIV switches.

There is another method measuring the algebraic sum of the two signals of this instrument.

That is the method performing the measurement at the same time when pulling the CH2 Vertical POSITION control [18] on which "PULL CH2 INV" is marked.

When the CH2 Vertical POSITION control is pulled and the input signal has the same phase, the waveform of ADD will be the difference of amplitude (e.g. 4.2 DIV − 1.2 DIV = 3.0 DIV).

If the input signals have 180° of phase difference, the two signals will be the arithmetic sum of the amplitude (e.g. 4.2 DIV + 1.2 DIV = 5.4 DIV).

(5) X-Y operation

The internal time bases are not used in X-Y operation and the deflections of both the vertical and horizontal directions are all operated via external signals.

Trigger switches and their associated controls and connectors are inoperative in the X-Y mode.

Proceed with the X-Y operation as follows :

1. Turn the TIME/DIV switch [22] fully clockwise to its X-Y position.

   Caution : When appearing as the spot without being swepts, the spot would damage the CRT phosphor. As such, reduce the trace intensity to prevent it from becoming too bright.

   (* OS-3060D: Press X-Y switch on the horizontal display [21])

2. If you apply the vertical signal to the CH2, Y IN connector [10] and the horizontal signal to the CH1, X IN connector [9], the trace appears.

   Then, adjust the trace to the proper brightness.

3. Adjust the trace height with the CH2 VOLTS/DIV switch [14] and the trace width with the CH1 VOLTS/DIV switch [13]. Adjust the PULL X5 MAG switches [15] [16] and the VARIABLE as needed. The TIME VARIABLE control [25] is measured when it remains pushed in.

4. If you wish to move the waveform vertically (Y axis), adjust the CH2 Vertical POSITION control [18] and adjust the Horizontal POSITION control [26] when you intend to move the waveform horizontally (X-axis).
   (The CH1 Vertical POSITION control [17] does not operate in the X-Y mode).
5. The phase of the vertical (Y-axis) signal can be inverted 180° by pulling the CH2 Vertical POSITION knob [18].

(6) Delayed-time base operation

The OS-3000DSRS contains two axis. The A time axis start sweep immediately up given with trigger, and B time axis starts 2nd time axis. They are used to measure the complicated and horizontally magnified waveform.

① Basic delayed sweep. For delayed sweep, proceed as follows :

A. Set up the instrument for whatever vertical mode you desire.

B. Make sure the B TRIG'D pushbutton is out.

C. Press the A INT HORIZ DISPLAY pushbutton. A section of the trace(s) will brighten.

〈Note〉 The intensified portion will be quite small if there is a large difference between the setting of the A and B TIME/DIV switches.

D. Turn the B TIME/DIV switch [23] until the intensified portion of the trace widens to an amount equal to the portion of the trace you wish to magnify (see Fig. 2-6(b)).

E. Turn the DELAY TIME POS control [24] to position the intensification over the portion of the trace you wish to magnify.

F. Press the B HORIZ DISPLAY pushbutton. That portion of the trace intensified in Step 5 now appears as spreaded over the full width of the CRT screen. The trace now displayed is being swept by the B timebase (Fig. 2-6(c)).

G. If needed, additional enlargement is possible by pulling the A VARIABLE knob [25] for PULL X10 MAG.

② Triggered B sweep

In basic delayed sweep, the B timeaxis is not triggered by a signal event, it begins when the main (A timebase) sweep cross comparate level setting by DELAY TIME POS. knob. The only problem with this is that main timeaxis jitter becomes apparent in the B sweep at high ratios of A to B TIME/DIV switch setting (100 : 1 and up).

To prevent this, the B sweep can be triggered by the signal itself, or a time-relate trigger signal. The DELAY TIME POS control then determines the minimum delay time between A and B sweeps : the actual delay time will be that plus the additional time until the next available trigger. The result is that actual delay time is variable only with step resolution, in increments of the interval betwen triggers.

The maximum magnification possible by this technique is several thousand times. (CRT brightness being the limiting factor.

③ For triggered B sweep, proceed as follows :

A. Set up the scope for basic delayed sweep as described in the preceding paragraphs.

B. Press in the B TRIG'D pushbutton [21], and adjust the Trigger LEVEL control [30] if necessary. The B timeaxis is now triggering on the same trigger signal as the A timebase. The start of B sweep will always be a leading or trailing edge of the trigger signal : turning the DELAY TIME POS control will not change this.

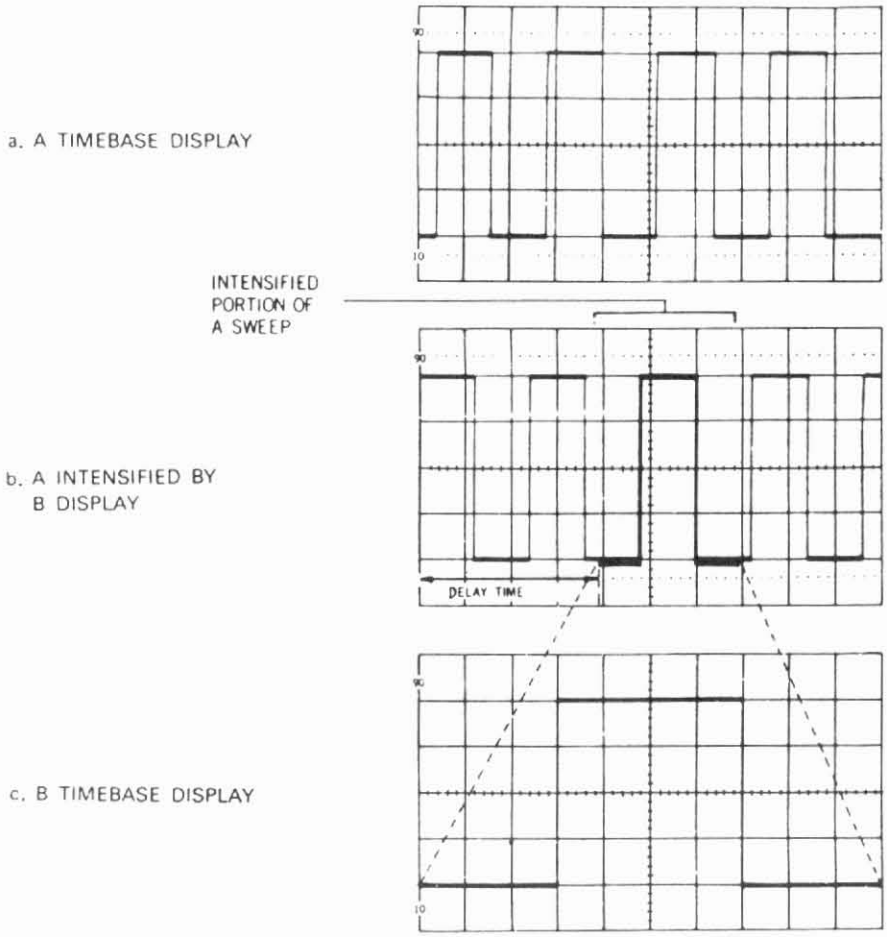


Fig. 2-10. Sweep magnification by B time axis

2-2-5. Digital storage function

Digital storage function operates in the following sequence :

(1) NORMAL storage mode (NORM)

① NORMAL storage mode (NORM) displays the waveform to be stored in the real mode.

② Press storage switch.

③ Waveform sweeps all the trigger devices depending on the setting of adjustor in the front size. The waveform to be stored is displayed on the CRT. It sweep speed is low, the retrieval and display of waveform require more time. It takes about three seconds to retrieve and display waveform in the sweep range of 0.1 s/div. Trigger signal is generated after that time.

If sweep speed is low, therefore, waveform is not displayed on the CRT immediately upon adjusting the adjustor on the front side.

④ When TIME / DIV fadjustor is between 5μs / div and 0.2s / div the intermittent and repeated waveforms may be stored.

⑤ Pressing HOLD switch in NORMAL STORAGE mode stops the correction operation by CRT display, and the CRT display stops.

(2) Equivalent sampling mode (EQUIV)

When TIME / DIV switch is set between 0.2μs / div and 2μs / div.
(* OS-3060D: 0.1μs/div ~ 2μs/div) The repeated waveform can be stored in the EQUIV mode. Pay attention to the followings in this mode:

① The edge initially rising or dropping in trace (left end) may not be displayed in the repeated mode range. In this case, measure the rising or dropping edge of waveforms appearing after the first one.

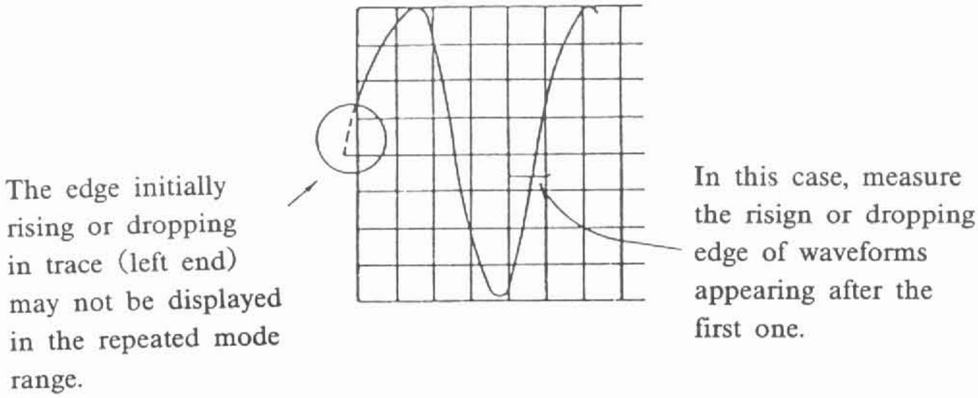


Fig. 2-11. EQUIV mode

② It takes longer than 5 seconds to store input signal below 1kHz (for 200Hz input).

③ The noise may be included when storing low frequency signal. It is desirous to use spherical wave with rising time shorter than 0.3μs or sine wave with frequency higher than 1MHz.

Note : Sampling rate in storage mode :
When there is no horizontal magnification in storage mode, total horizontal scale of 10div. on CRT is composed of 1000 sampling data.

(3) ROLL mode

The displayed waveform flows to the left from the right.
Correction point for new data and ROLL mode make it easy to measure the signal lower than 100Hz or so. To stop the ROLL mode, press HOLD switch to hold the final waveform on CRT.

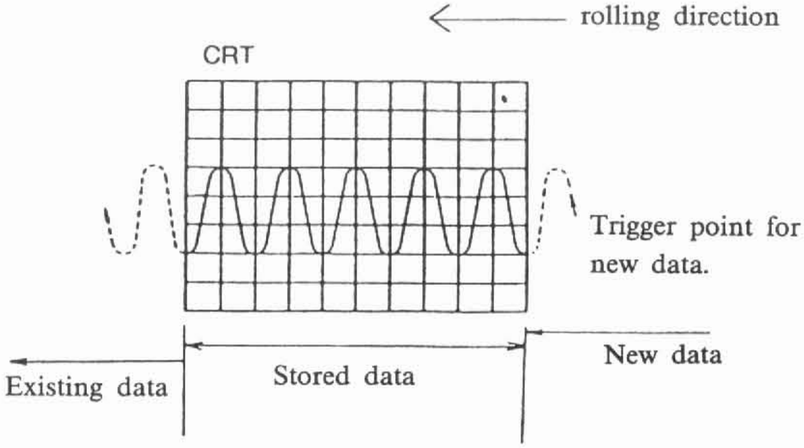


Fig. 2-12. ROLL mode

Note : a) ALIASING distinction

If the input signal having frequency higher than a half the sample clock frequency is added in the sweep range when measuring signal in storage mode (NORM, AVG), ALIASING occurs.
In this case, the waveform obtained by sample clock frequency from the input signal frequency is displayed.
This waveform may be regarded as correct.
If ALIASIANG is doubtful, convert into REAL TIME mode to

check whether it is same as the operating mode display being measured.
It ALIASING occurs, the waveform of NORM mode (input signal frequency - sampling clock frequency) is displayed with its top and bottom section nearly flat. So it is possible to decide ALIASING in consideration of the difference between these two displays.

b) ROLL waveform correction

ROLL mode is possible in high speed range (up to 0.5s/div.). If vertical mode is set to DUAL, the waveform does not move smoothly at 0.5s/div, which occurs depending on the relation between the waveform data and display rate. In reality, the waveform is normal.

(4) Single operation in NORM mode

With storage mode set to NORM, pressing SINGLE switch performs NORM

mode smapling, and renews the waveform on the tube surface. Then it automatically converts into HOLD state.

① SINGLE operation procedure

a) Set storage mode to NORM, and adjust the adjustor knob to store and display input signal in the operation mode.

b) Set trigger mode switch to NORM, and set trigger level to such a location as suitable to measure input signal.

c) Press SINGLE switch

② Pressing SINGLE switch converts into input signal trigger standby state. When trigger signal is applied, the SINGLE sampling is carried out. The SINGLE switch LED continues to light up when the input signal trigger is not detected. If trigger signal is applied or trigger mode is set to AUTO, SINGLE switch LED goes out, and automatically converts into HOLD state. (Hold LED lights up).

③ When trigger mode switch is set to AUTO, SINGLE treatment is performed if input signal is not triggered. So the DC signal can be measured in this mode.

④ When trigger signal enters in NORM mode, the NORM sampling occurs for the waveform data corresponding to one tube surface, and all the data renew the tube surface into new waveform data. This function is effective in storing the instaneous waveform.

Note : SINGLE does not operate in averaging, ROLL, EQUIV or MAG state. When vertical mode is dual (ALT), CH1 (or CH2) performs signale operation.

(5) HOLD mode

Pressing HOLD switch in EQUIV, NORM or ROLL mode sets HOLD mode.

In this mode, sampling operation stops in each operating mode. When mode enters into HOLD mode, the waveform display data are continuously displayed. When the waveform data displayed after HOLD mode are set, the waveform data can not be moved vertically.

(6) SAVE operation (SAVE)

The waveform data sampled and displayed in storage mode can be stored in the storage memory. Data which are stored in the storage memory can be displayed on the CRT.

SAVE operation

① Use SAVE switch to set the storage memory concerned.

② Sampling data are displayed in storage mode. Press HOLD switch to stop waveform.

③ Pressintg SAVE switch saves the suspended waveform in the storage memory.

④ When storage switch LED lights up instantaneously, it means that waveform is stored.

⑤ When vertical mode switch is set to CH1, CH2 or ADD, waveform is stored storage memory A and B in turn whenever pressing SAVE switch. When vertical mode switch is set to DUAL, CH1 waveform is stored in storage memory A while CH2 waveform is stored in storage memory B.

(7) Storage memory display (RECALL)

The details stored in storage memory in HOLD mode are displayed on the CRT in next operation, and comparable with current waveform.

① Pressing this switch once, recall switch displays both the waveform stored in storage memory A and the set value (V/div. and TIME/DIV) regardless of vertical mode switch. Pressing this switch once more, the waveform stored in storage memory B is displayed. Pressing this switch one more time displays both the waveform stored in storage memory A and B and the set value.

Pressing this switch again erases displayed waveform and set value.

② The waveform data displayed in storage mode cannot be moved vertically.

(8) X-Y plotter output (PLOT)

Waveform displayed in HOLD mode is sent to X-Y plotter through RS-232C by pressing PLOT S/W.

(PLOT switch operates only in HOLD mode.)

Refer to item 3 for more details.

(9) Horizontal magnification display (Time axis MAG)

There are two horizontal maganification methods in storage operation :

1. Magnification (X10) by X10 MAG switch.
2. HOLD waveform magnification by TIME/DIV.

(1) X10 MAG

Displayed waveform magnified ten times from the center of original waveform in the tube surface storage.

The waveform which is stored in save memory can not be magnified.

ⓐ Pulling X10 MAG switch displays 1div. sector magnified ten times from the center of original waveform.

※ If it is displayed on both sides of CH1 and CH2, the 1div. sector magnifies ten times from the center of CH1 and CH2 original waveform.

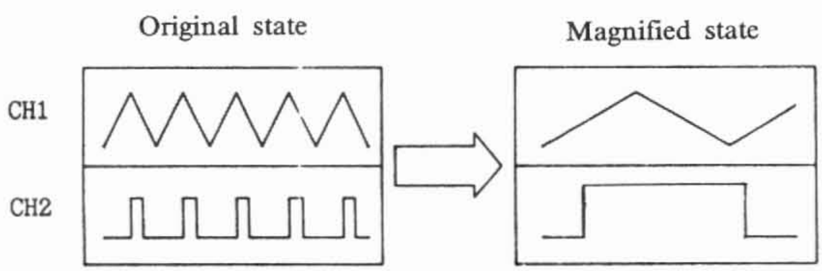


Fig. 2-13. X10 MAG

ⓑ When switch is released by pressing X10 MAG switch, it returns to the original waveform.

(2) HOLD waveform magnifiaction using TIME/DIV switch

When storage waveform is displayed on the tube surface in HOLD mode, manipulating TIME/DIV switch makes it possible to continuously magnify and display up to ten times the TIME/DIV switch set value. Magnification is done from the center of original waveform as in (1).

[Example of magnification operation]

ⓐ Display the original waveform and set HOLD mode.

ⓑ Turn TIME/DIV switch clockwise to change TIME/DIV to rapid set value. When TIME/DIV set value is changed on the tube surface waveform is magnified as corresponding to the set value.

(i) Original
TIME/DIV = 1ms/div
HOLD mode

(ii) Rotating TIME / DIV switch, it magnifies two times with TIME/ DIV = 0.5ms/div.

(iii) Rotating TIME / DIV again switch, it magnifies ten times with TIME/ DIV = 0.5ms/div.

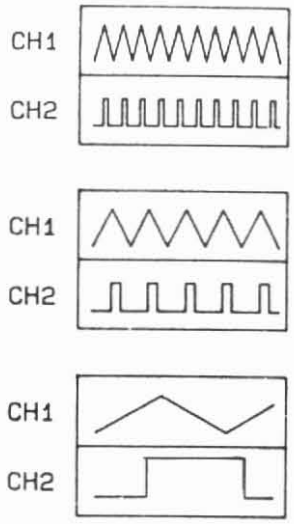


Fig. 2-1. HOLD waveform magnification

ⓒ This operation performs horizontal magnification up to ten times. Therefore TIME/DIV switch can set a tenth the original waveform. But TIME/DIV display is not changed and waveform is not magnified any more even if you turns TIME/DIV clockwise beyond that extent.

ⓓ When magnification is displayed, the magnification rate is gradually reduced and returned to the original waveform by setting the TIME/DIV set switch to the slower side while turning TIME/DIV switch counterclockwise.

(10) Interpolation

As the horizontal magnification rate increases, sine wave looks stepwise and pulse wave goes amiss.

In this case, interpolation makes it easy to watch the waveform.

Interpolation is divided into linear and sine interpolations.

Every time you press MENU selector switch, interpolation selection function converts as follows :

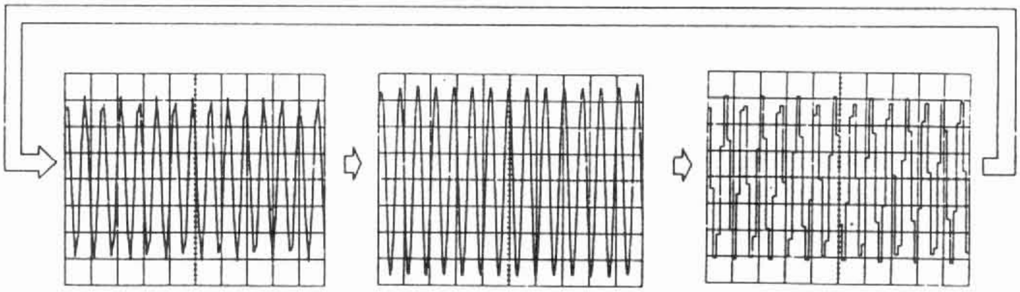
→ Linear interpolation → sine interpolation → no interpolation

The current interpolation mode is indicated as symbol on the sweep sweep factor on the bottom right of tube surface. Selecting linear/sine interpolations makes pulse/sine wave of input signal clearly displayed on the tube.

(1) Indicate the original waveform, and set the HOLD mode.

(2) Carry out horizontal magnification display using X10 MAG or TIME/DIV. switch, and have the waveform to be interpolated displayed on the tube surface.
(Refer to (9) horizontal magnification display for horizontal magnification operation).

(3) In (2), interpolation proceeds in the following sequence whenever pressing INTERPOLATION switch.



Linear interpolation　　Sine interpolation　　No interpolation

Fig. 2-15 Interpolation

In X10 MAG magnification, pressing X10 MAG after interpolation stops interpolation and normal magnification display enters into effect.
In normal magnification, pulling X10 MAG after interpolation stops interpolation and X10 MAG magnification display enters into effect.

(11) ALT MAG mode

An original waveform and magnified waveform are displayed simultaneously. When awaveform of CH1 displayed and ALT MAG mode is selected, the original waveform and its maguified waveform are displayed simultaneously.
To perform the ALT MAG display of a waveform of CH2, set the vertical mode to CH2 first, and then set in the ALT MAG mede.

VERTICAL MODE	NORMAL DISPLAY	ALT MAG
CH1 CH2	CH1 WAVEFORM CH2 WAVEFORM	CH1 original waveform / CH1 magnified waveform CH2 original waveform / CH2 magnified waveform
DUAL	DUAL(CH1, CH2) WAVEFORM	DUAL(CH1, CH2) original waveform / DUAL (CH1 + CH2) magnified waveform
ADD	ADD(CH1 + CH2) WAVEFORM	ADD(CH1 + CH2) original waveform / ADD (CH1 + CH2) magnified waveform

EX) ALT MAG OPERATION (CH1)

1) Set the vertical mode to CH1 first, and displayed the waveform of CH1
2) Press HOLD switch to stop waveform.
3) Use MENU switch to set ALT MAG mode and then select ALT MAG on.
4) Manipulating TIME / DIV switch makes it possible to continuously magnify and display up to ten times the TIME / DIV switch set value.
5) Move the CURSOR to a magnified point by the MAG POINT cursor
6) The magnified waveform is displayed at approximately 3div below the original waveform

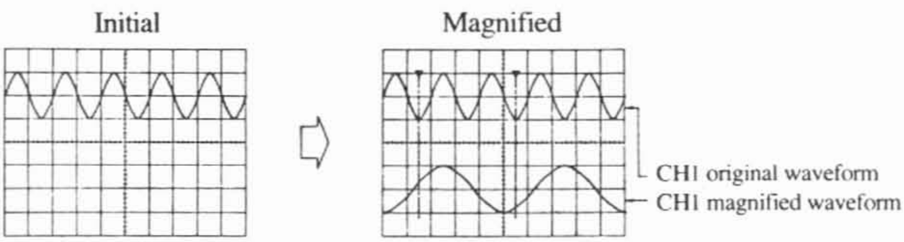


Fig. 1 - 1

(12) GO-NOGO mode

The GO-NOGO judgement function is used to judge if te acquired signal is in the judgement domain (Boundary) set on the CRT screen.
The input signals acquired in sequence are compared with the boundary.
When the results satify the conditions (COMPARE, HOLD), these processing are performed automatically.
This function is used to monitor abnormal phenomena which will occur not so frequently, or to detect undesired samples which will output signlas different from the reference signal.

GO – NOGO OPERATION

1) GO-NOGO is performed by limited conuitions please confirm the operating condition. (The mode AVERAGING, ROLL, MAG, DUAL, SINGLE, RECALL other than operating).
2) Use MENU switch set GO-NOGO mode.
3) Selet the condition to issue GO-NOGO from the following two option.
   ① When a waveform is out of the judgement domain
   ② 〃 is only comparing
4) Use MENU selector switch set GO-NOGO judgement domain.
   pressing MENU selector switch changes mode in the following sequence.
   0.4div → 0.8div → 1.2div → 0.4div
5) To perform GO-NOGO operation, press RCALL Switch
6) XH : Comparing waveform in the judgment domain
   OH : If the result waveform is out of the judgment domain
   Holds a waveform on the screen.

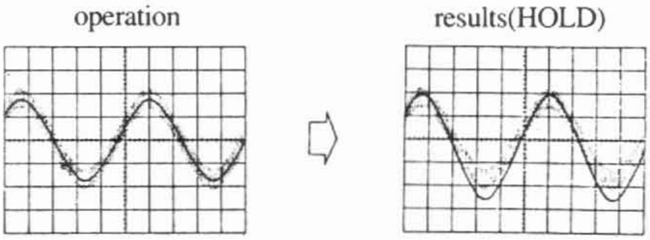


Fig. 1 – 2

(13) MENU mode

Using MENU switch, it is possible to set interpolation, waveform smoothing ON/OFF in average horizontal magnification whenever pressing MENU switch. [PROB], [SMTH], [AVG], [ROLL] and [ITPL] appear on the top of CRT one by one and LED lights up.
Pressing the switch again releases MENU mode, and LED goes out.

① Probe factor selector mode (PROB)
When MENU LED lights up and [PROB] is displayed on the top right of CRT, you can select PROBE factor.

P	R	O	B			X	1	0

X1 : 1 X PROBE
X10 : 10 X PROBE

Using menu selector switch, it is possible to select X10/X1 mode.

② Smoothing selector mode (SMTH)
When MENU LED lights up and [SMTH] is displayed on the top right of CRT, SMOOTHING turns ON/OFF.

S	M	T	H			O	F	F

OFF : NO SMOOTHING
ON : SMOOTHING

In OFF state, storage waveform is displayed in dots.
Turning it ON, the dots are connected to display smooth waveform. If sampling frequency is low in connection with input signal (when signal with more than 5 cycles per each sector), it is displayed with amplitude low. In this case, set smoothing mode to OFF to display the waveform with amplitude similar to that of input signal.

③ AVERAGING setting mode (AVG)

When MENU LED lights up and [AVG] is displayed on the top right
of CRT, the number of averaging operations can be set.

A	V	G				N	O	R	M

NORM	:	No averaging operation
4	:	4 averaging oprerations
16	:	16 averaging operations
64	:	64 averaging operations
256	:	256 averaging operations

The number of averaging operations is changeable using MENU selector switch. Pressing MENU selector switch changes NORM from 4 thru 256.

The average waveform is displayed after data is obtained for the set sweep number. The average of next data is obtained in the number same as the number of sweeps, and the average waveform display is corrected.

Thus it is possible to detect non-repetitive signal under the influence by non-trigger noise.

The number of averaging operations is same as the set average number. In ROLL mode, no averaging operation is carried out.

④ ROLL selector mode

When MENU LED lights up and [ROLL] is displayed on the top right of CRT, ROLL ON/OFF can be selected.

R	O	L	L			O	N	

ON : ROLL ON

OFF : ROLL OFF

ROLL ON/OFF is carried out using MENU selector switch.

⑤ Interpolation selector mode (ITPL)

When MENU LED lights up and [ITPL] is displayed on the top right of CRT, you can select interpolation.

I	T	P	L			O	F	F

OFF : No interpolation

SIN : Sine interpolation

LIN : Linear interpolation

Mode is selected using MENU selector switch. Pressing this switch changes mode in the following sequence :

LIN → SIN → OFF → LIN

Interpolation is to interpolate the magnified waveform data when magnifying the display waveform horizontally (excluding storage waveform). In OFF position, waveform is magnified horizontally. In SIN position, the initial waveform becomes similar to sine wave. If the square wave is connected in this state, considerable ranging takes place, and the displayed waveform looks different from the input waveform. In this case, set switch to LIN from OFF. In LIN position, data are interpolated linearly and waveform is displayed more smoothly than in OFF position.

Note : In SIN position, set the amplitude of input signal below 8 DIV on CRT. If any signal with large amplitude is connected on the CRT, tortion is observed in the top and bottom sector of waveform. After waveform stops in ROLL mode, the interpolation operates depending on the selection between MAG X10 mode and TIME/DIV. If ROLL waveform does not stop, both the MAG X10 and interpolation modes do not operate.

⑥ ALT MAG selector mode (AMAG)

When MENU LED lights up and [AMAG] is displayed on the top right of CRT, you can select ALT MAG.

A	M	A	G			O	F	F

OFF : ALT MAG OFF
ON : ALT MAG ON

ON/OFF can be selected using MENU selector switch.

⑦ GO-NOGO selector mode (G-No)

When MENU LED lights up and [G-NO] is displayed on the top right of CRT, you can select GO-NOGO.

1)

G	-	N	G			→	X	H		O	H

XH : COMPARE
OH : HOLD

XH / OH can be selected using MENU selector switch.

2) IF XH mode (or OH mode) is selected,

G	-	N	G			0 .	4	d	i	v

0.4div : JUDGEMENT DOMAIN 0.4div
0.8div : JUDGEMENT DOMAIN 0.8div
1.2div : JUDGEMENT DOMAIN 1.2div

Pressing MENU selector switch changes mode in the following sequence

0.4div → 0.8div → 1.2div → 0.4div

⑧ Menu display in the mode Ø the than MENU mode

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

N	O	R	M				A	V	1	6		SA		S	M	

- SM : Smoothing on
- BLANK : Smoothing off

- SA : SAVE Memory A
- SB : SAVE Memory B

- BLANK:Not average
- AV4:4times of average
- AV16:16times of average
- AV64:64times of average
- AV256:256times of average

- EQUIV :EQUIVALENT SAMPLING
  (0.2μs / div(60MHz:0.1μs/ div) to 2μs / div)
- NORM : NORMAL SAMPLING
  (5μs/ div to 0.2s / div)
- ROLL : ROLL MODE
  (0.5s / div to 0.2s / div)

(14) X-Y operation

The internal time axis is not used for X-Y measurement.

X-Y operation is carried out as follows :

1. Set the vertical mode selector switch to DUAL.
   (If it is set to CH1, CH2 or ADD, error may OCCUR).
2. Pressing HOLD switch in EQUIV, NORM or ROLL mode enters into HOLD mode. Then sampling operation stops while waveform display data are displayed continuously.
3. Turn A TIME/DIV switch [22] completely clockwise to X-Y position. (* OS-3060D: Set horizontal mode selector switch to X-Y)

   〈Note〉 :If it is displayed in dots and not deflected, the fluorescent surface of CRT may be damaged. If the brightness is to high, lower it.

2-3. MEASUREMENT APPLICATIONS

This section contains the measurement procedures applying basic functions of this instrument, OS-3020D.
Though only some of them are introduced, we assure you that a variety of specific measurement can also be performed based on the said functions.
As the measurement applications set out herein are the important and essential particulars, it is desirable for you to make yourself familiar with those basic operating procedures while you use the oscilloscope.

2-3-1. Amplitude Measurement

The latest trigger sweep oscilloscope has two major functions.
The first of these is to measure the amplitude.
It is practicable to perform all the measurement with the oscilloscope ranging from the simple waveforms to the complex ones.
The oscilloscope in general has two different voltage measurements, namely peak-to-peak (p-p) measurement and instantaneous peak-to-peak (p-p) measurement.
Instantaneous voltage measurement is to measure the voltage of each point on the waveform from a ground reference.
In order for you to perform the aforementioned measurements exactly, make sure that the VARIABLE controls are fully turned clockwise.

(1) Peak-to-Peak (p-p) Voltage Measurement

1. Set up the vertical mode switches of the oscilloscope in the same manner as that set out in 2-2. BASIC MEASUREMENTS.
2. Adjust the TIME/DIV switch [22] in such a manner as to form a waveform of as many as two or three cycles and the VOLTS/DIV switch shall be so adjusted as to make the waveform be on the CRT screen display.
3. Adjust the Vertical POSITION controls [17] and [18] properly and make the end of the waveform align with the horizontal graticule line of the CRT screen display. (See Fig. 2-7).
4. Adjust the Horizontal POSITION control [26] and make the end of the waveform be on the central vertical line of the CRT screen display. (This line is graduated in 0.2 scale divisions).

5. Count the number of divisions of both the top and bottom of the waveform and multiply the resultant number by the value of the VOLTS/DIV switch, thus resulting in the peak-to-peak voltage.
   For example, if the value of the VOLTS/DIV switch was set to 2V when the waveform same as that shown in Fig. 2-16 had been measured, it would in fact be 8.0 Vp-p.
   (4.0div×2.0V=8.0V)
6. If the indication of the vertical magnification is X5, divide the measured value by 5.
   However, if the probe is 10:1, multiply the voltage by 10.
7. When measuring a sine wave below 100Hz or a square wave below 1KHz, set the AC-DC,GND switches to DC.
   CAUTION : Where the waveform is loaded with the high potential DC voltage, the above measurement is difficult.
   At this time, perform the measurement with setting the AC-DC,GND switches to DC.
   (When the measurement of AC component is needed).
   : For any instrument equipped with readout function, movin

   cursor to the top and bottom of waveform displays the potential difference V on the screen.

(2) Instantaneous Voltage Measurement

1. Set up the vertical mode switch of the oscilloscope in the same manner as that set out in 2-2.
   BASIC MEASUREMENT above.
2. Adjust the TIME/DIV switch [22] or [23] so as to become a complete waveform and set the VOLTS/DIV switch to produce 4 to 6 divisions (See Fig. 2-17).
3. Set the AC-DC,GND switch (11) or (12) to GND.
4. Turn the Vertical POSITION control [17] or [18] and make it align with either the lowest central horizontal graticule line (in case of positive (%) signal) or the uppermost one (when the signal is negative(-)).
   NOTE : The vertical POSITION controls must not be touched until the measurement is completed.

5. Set the AC/GND/DC switch to DC.
   If the signal is positive (+), the waveform appears above the ground reference line and where the signal is negative (−), the waveform appears below the ground reference line.
   CAUTION : Where the DC voltage is relatively greatly loaded compared with the waveform, then measure the AC portion separately from others with setting the AC-DC,GND switch to AC.
6. Make the point you wish to measure align with the central vertical graticule line on the CRT screen display by moving the Horizontal POSITION control [26].
   Since the central vertical graticule is graduated in scales at every 0.2 division, the measurement is easy to perform.
   In the example cited for Fig. 2-7, if the VOLTS/DIV switch is positioned at 0.5V, the value becomes 2.5V (5.0 div×0.5V=2.5V).
7. If the X5 magnified movement is performed, divide the value measured in paragraph 6 above by 5 and where the X10 PROBE is used, multiply the resultant value by 10.
8. After setting READ OUT cursor (X) at the GND level, positioning △ cursor (+) to the waveform to be measured displays the instantaneous voltage on the screen.

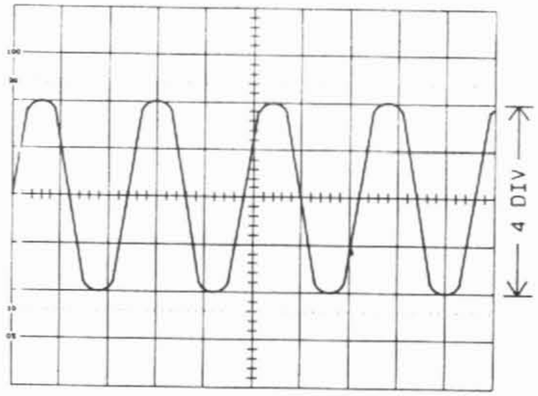


Fig. 2-16. PEAK-TO-PEAK VOLTAGE MEASUREMENT

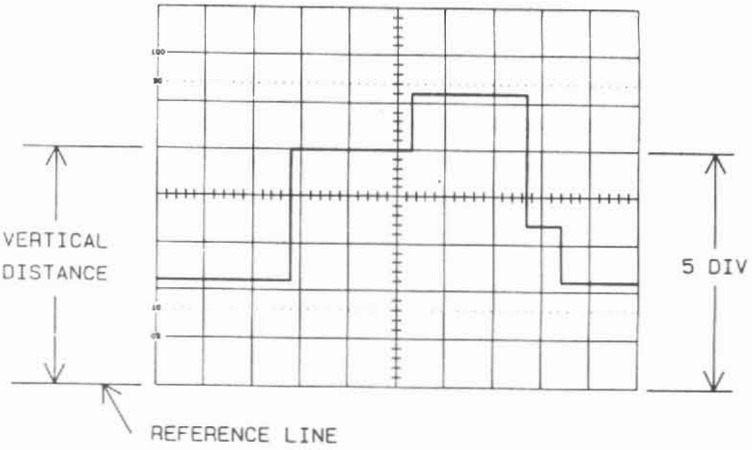


Fig. 2-17. INSTANTANEOUS VOLTAGE MEASUREMENTS

2-3-2. Time Interval Measurements

The second most important measurement of the synchronous-sweep oscilloscope is the very measurement of time interval.
Since the divisions uniformly marked on the CRT screen are all calibrated to the time bases, the time interval measurement is practicable.

(1) Basic Technique

The basic technique for measuring time interval is described in this section. In addition, characteristics measurement and variation technique using this technique will be helpful, if you apply the following procedures :

1. Set up switches in the same manner as that described in 2-2-4.
2. Set the TIME/DIV switch [22] in such a manner as to make the waveform appear on CRT screen display as large as possible.
   Turn the TIME VARIABLE control [25] fully clockwise until being clickstopped.
   Otherwise you so do, the measured value will be inaccurate, thus requiring you to exercise due care.
3. Adjust the Vertical POSITION controls [17] and [18] and make the waveform you wish to measure align with the central horizontal graticule line.
4. Turn the Horizontal Position control [26] and make the left side of the waveform correspond to the vertical gracitule line.
5. Count the number of graticule divisions up to the point you intend to measure. Horizontal central line is graduated in divisions ranging to 0.2 division.

6. If you multiply the value measured in Item 5 above by the value set by the TIME/DIV switch, the time you wish to measure will be obtained. If the TIME/VRIABLE knob [25] is pulled (X10 magnified mode), divide the measured value by 10.

(2) Period, Pulse Width, and Duty Cycle Measurement

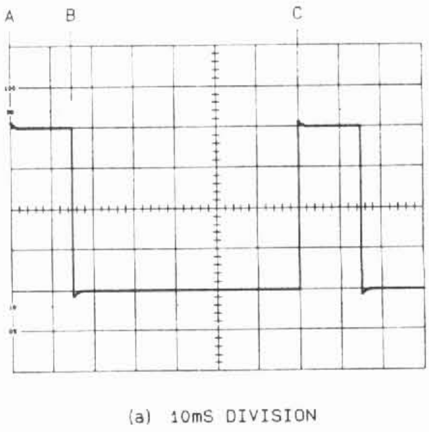
If you make good use of the measurement based on the basic technique, you can also measure the period of pulse, pulse width, and duty cycle, etc. When a complete period of pulse of the signal appears on the CRT screen display, the period of pulse of that time can be measured.
For example, if the TIME/DIV switch were set to 10ms, the measured value of one cycle between A and C in Fig. 2-9 would be a waveform having a period of cycle of 10ms×7=70ms.
The pulse width represents the time between A and B.
In Fig. 2-18, it is 1.5 division so that it becomes 1.5div×10ms= 15ms. However, in this example, as an 1.5 division is a rather short distance, should you set the TIME/DIV switch to 2ms, it would be seen magnified as shown on Fig. 2-18b.
Then, though the pulse is short, the measurement accuracy becomes increasingly better. Where it is still displayed small even with adjusting the TIME/DIV switch, it is advisable to perform the measurement under X10 magnified condition by pulling the A VARIABLE knob

(25).
When pulse width and period are known, duty cycle can be calculated.
Duty cycle is the percentage against ON-time of the pulse period (total of ON-and OFF-time).
In Fig. 2-18, the duty cycle is as follows :

$$\text{Duty cycle } (\%) = \frac{\text{Pulse width}}{\text{Period}} \times 100 = \frac{A \rightarrow B}{A \rightarrow C} \times 100$$

$$\text{(e.g) Duty cycle } (\%) = \frac{15\text{ms}}{70\text{ms}} \times 100 = 21.4\%$$

※Measure the cycle by moving cursor. Then measure the pulse width. The duty cycle of required waveform is obtained by applying the measured value to the formula.



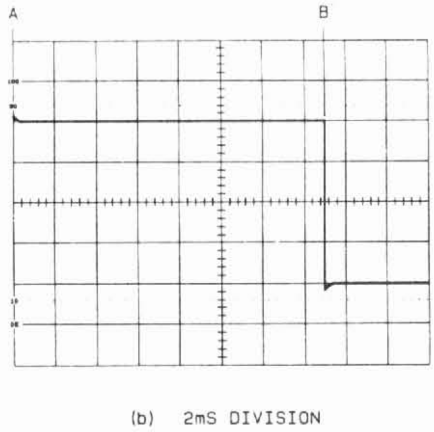


Fig. 2-18. TIME INTERVAL MEASUREMENT

2-3-3. Frequency Measurement

When an accurate measurement is needed, a frequency counter shall be used. If you have the frequency counter connected to the CH1 OUTPUT connector [20] on the rear panel of the oscilloscpe, you will enjoy the convenience and advantage to perform both the waveform observing and frequency measurement simultaneously. However, when a frequency counter is not available, the oscilloscope can directly measure the modulated waveform that can hardly be measured by means of a frequency counter, or the waveform bearing a lot of noise. Frequency is interrelated to the period. First of all, in brief, you can simply obtain the frequency by calculating with 1/t assuming that you have already known the period "t" appearing in section 2-3-2 Time Interval Measurement. With applying the formula of 1/t, when period is depicted in seconds, the frequency is Hertz(Hz) ; period in milliseconds(ms) yields frequency in kilohertz(kHz) ; period in microseconds (μs) yields frequency in megahertz(MHz).

The accuracy of frequency is determined by an accurate calibration of the timebase and careful measurement of the period.

2-3-4. Phase Difference Measurements

Phase difference in phase angle between signals can be measured using the dualtrace method of phase measurement or Lissajous diagrammatic method of phase measurement in the X-Y mode of the oscilloscope.

(1) Dual-trace Method

This method works with any type of waveform. Even if the waveforms are different from each other or the phase difference is great, the measurement up to 20MHz is practicable.

Measurement shall comply with the following :

1. Set the switches as described in 2-2-4 Dual-trace Measurement. Connect one signal to the CH1 IN connector [9] and another one to the CH2 IN connector [10]

   NOTE : Where the frequency is becoming higher, use the same probe or the cable having an equal delay time so that an measurement error can be reduced.

2. Position the Trigger SOURCE switch [28] toward the stable waveform. At this time, move another waveform upward or downward by adjusting the vertical POSITION control so as to make the said waveform invisible.
3. Move the waveform to the center adjusting the vertical POSITION control, and make the waveform occupy 6 divisions.
4. Adjust the Trigger LEVEL control [30] and ensure that the beginning point of the waveform corresponds exactly to the starting point of the horizontal graticule line (See Fig. 2-19).
5. Adjust the TIME/DIV switch [22] TIME VARIABLE control [25], and the horizontal POSITION control [26] properly so as to make one cycle of the waveform become 7.2 divsions. When this is done, each major horizontal division represents 50° and each subdivision represents 10°.
6. Perform the same procedure as that described in Item 3 above so as to have another waveform already moved to be invisible also displayed on center of the horizontal graticule line.
7. The horizontal distance between the beginning points on the horizontal axis of two waveforms is the phase difference. For example, the phase difference shown in Fig. 2-10 is 5.2 divisions, hence 60°

8. If the phase difference is less than 50o, the measurement can be performed closely using X10 magnification mode. In this case, note that one major division represents 5°.
9. For any instrument equipped with READOUT function, measuring T value after moving cursor as shown in the figure makes it possible to measure the phase difference in the entire cycle.

(2)Lissajous Pattern Method

This method can only be used where the waveform is sine wave. Measurements can possibly be performed at frequencies even higher than 500KHz depending on wide band width of the amplifier. However, in order for you to maintain the maximum accuracy provided in features, it is desirable to conduct the measurement at the phase difference less than 20kHz.

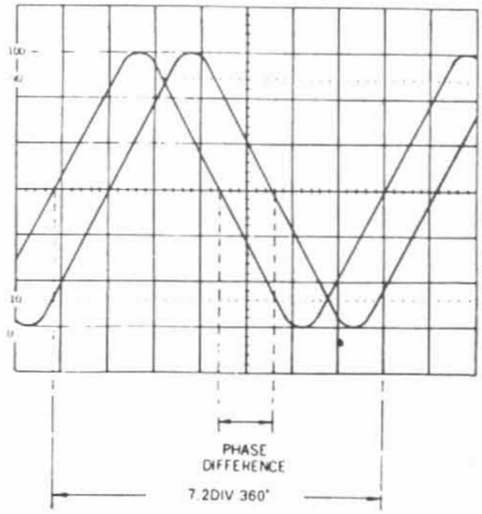
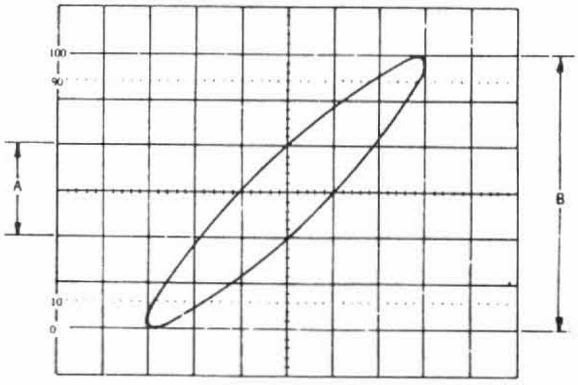
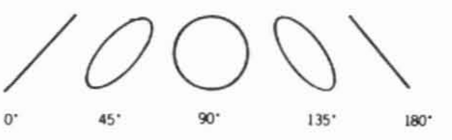


Fig. 2-19. DUAL-TRACE METHOD OF PHASE MEASUREMENT



PHASE DIFFERENCE(angle θ) = $\sin^{-1}\frac{A}{B}$

(a) PHASE ANGLE CALCULATION



(b) LISSAJOUS-PATTERNS OF VARIOUS PHASE ANGLES

Fig. 2-20. LISSAJOUS METHOD OF PHASE MEASUREMENT

Phase difference measurement shall comply with the following procedure :

1. Rotate the TIME/DIV switch fully clockwise and set it to the X-Y position.

   CAUTION : At this time, the trace on the CRT screen is so bright that it could often damage the CRT phosphor. So reduce the trace intensity properly.

2. Make sure that CH2 POSITION [18] and PULL X5 MAG knob [16] are pushed in.
3. Connect one signal to the CH1, X IN connector [9], and another signal to the CH2, Y IN connector [10].
4. Center the waveform by adjusting the CH2 vertical POSITION control [18], and adjust the CH2 VOLTS/DIV switch [14] and VARIABLE control [16] together so as to make the waveform become 6 divisions (the waveform exists on the 100% and 0% graticule line).
5. Adjust the CH1 VOLTS/DIV switch [13]. and VARIABLE to make the waveform become 6 divisions as done in Item 4 above.
6. Precisely center the waveform to have it exactly positioned right on the horizontal center by adjusting the horizontal POSITION control [26].
7. Count the number of divisions indicated by the waveform along the central vertical graticule line. You may count moving the waveform by means of the CH2 position control for close measurement.
8. The phase difference of the two signals (angle θ) is equal to the arc sine of A B (the number divided by 6 in Item 7 above). For example, when the waveform is same as the described in Figure 2-20a, if you perform the calculation according to Item 7 above, the resultant is the arc sine value of $2 \div 6 = 0.3334$. which is converted into 19.5° in terms of the angle.

   $$\text{PHASE DIFFERENCE (angle } \theta) = \sin^{-1}\frac{A}{B}$$

9. The simple method can directly be applied to angles less than 90°. As for angles greater than 90°, add 90° thereto. So that you are required to determine its value with referring to various phase angle indicated in Fig. 2-11(b).

   NOTE : The conversion of sine angle can be obtained in accordance with trigonometric function table and trigonometric function expression.

10.For any instrument equipped with READOUT function measuring A and B values after moving cursor as shown in the figure makes it possible to calculate the phase difference (θ).

2-3-5. Risetime Measurement

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

To measure rise and fall time, proceed as follows :

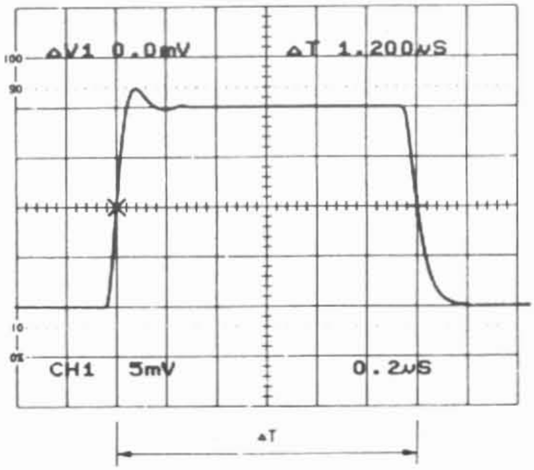
1. Connect the pulse you wish to measure to the CH1 IN connector [9], and set the AC-DC,GND switch [11] to AC.
2. Adjust the TIME/DIV switch [22] to display about 2 cycles of the pulse. Make sure that the TIME VARIABLE control [25] is rotated fully clockwise and pushed in.
3. Center the pulse vertically by adjusting the CH1 vertical POSITION [17].
4. Adjust the CH1 VOLTS/DIV switch [13] so as to make top of the pulse be closest to the 100% graticule line, and the bottom of the pulse be closest to the 0% line. Where the correspondence is not made, then rotate the VARIABLE control [15] slightly counterclockwise with making graticule lines of both sides deviate a little to make the both pulse peaks rest exactly on the 100% and 0% graticule lines, respectively. (See Fig. 2-21).
5. Adjust the horizontal POSITION control [26] and make the rising edge rest on the central vertical graticule line (crosses at the 10% point).
6. If the risetime is sloas compared to the period, no further magnification is necessary. If, however, the risetime is as short as to correspond almost to the vertical graticule line, make an adjustment as described in Item 5 above by pulling the TIME VARIABLE/PULL X10 MAG control [25] (See Fig. 2-21(b)).

7. Count the number of horizontal divisions between the 10% point (central vertical graticule line) and the 90% point.
8. Multiply the number of divisions counted in Item 7 above by the numerical value of the TIME/DIV switch, then you will obtain the measured risetime. Where the mode is X10 magnification, divide the value of the TIME/DIV setting by 10. For example, if the TIME/DIV switch was set to 1μs, and the measurement was conducted as shown in Figure 2-11a, the risetime would be 360ns. (1000ns ÷ 10 = 100ns, 100ns ×3.6div = 360ns : because the mode is X10 magnification).
9. When measuring falltime, simply make the 10% point in fall time align with the central vertical graticule line, and perform the measurement conforming to the procedure set out in Items 7 and 8 above.
10. When measuring the rise and fall time, note that 17.5ns-Rise time (tr)=0.35/f_{-3dB} which is transition time is contained in the OS-3020D oneself. Therefore the real transition time (tc) is composed of measure transition time (tm) and tr.
The above all is explained with the following formula:

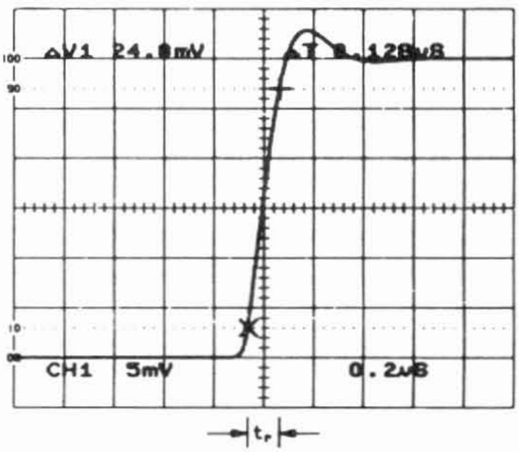
$$t_c = \sqrt{t_m^2 - t_r^2}$$

t_c = Real transition time
t_m = Measured transition time
t_r = Rise time of oscilloscope
tr = 17.5ns: OS-3020D
tr = 8.8ns: OS-3040D
tr = 5.8ns: OS-3060D

※ For the instrument equipped with READOUT function, positioning cursor and △ cursor to 10% and 90% respectively makes it possible to measure rise/fall time.



a. BASIC DISPLAY SETUP



b. WITH HOPIZONTAL MAGNIFICATION

Fig. 2-21. RISETIME MEASUREMENT

3. X-Y plotter digital output

All the data displayed on the screen is the output appearing on the X-Y plotter connected with this instrument through RS-232C cable. The op/eration of instrument is described as follows. Refer to the plotter operation manual attached to plotter for instructions on the X-Y plotter operation.

3-1. X-Y plotter

HP-GL (RS-232C specification) plotter

3-2. Specification

(1) Character and cursor
All the characters and cufsors displayed on the screen are plotted.

(2) Waveform data
All the waveform data displayed on the screen are platted. The horizontal and vertical waveforms with 10 and 8 div are plotted. In magnification mode, only the magnified sector is plotted.

(3) Grid and scale
The grid with horizontal and vertical 10 and 8 div are plotted. In horizontal and vertical rids, the 0.2 div nit scale is plotted.

(4) Screen mode
Setting DIP S/W on the rear side makes it possible to select four screen modes. Refer to chapter 3.4, SETTING for more details.

(5) Pen replacement
It is possible to specify the pen replacement using DIP S/W on the rear side. Refer to chapter 3.4, SETTING for more details.

(6) Example of plottings
Fig. 3-1 (a) thru 3-1 (d) show the example of plottings.

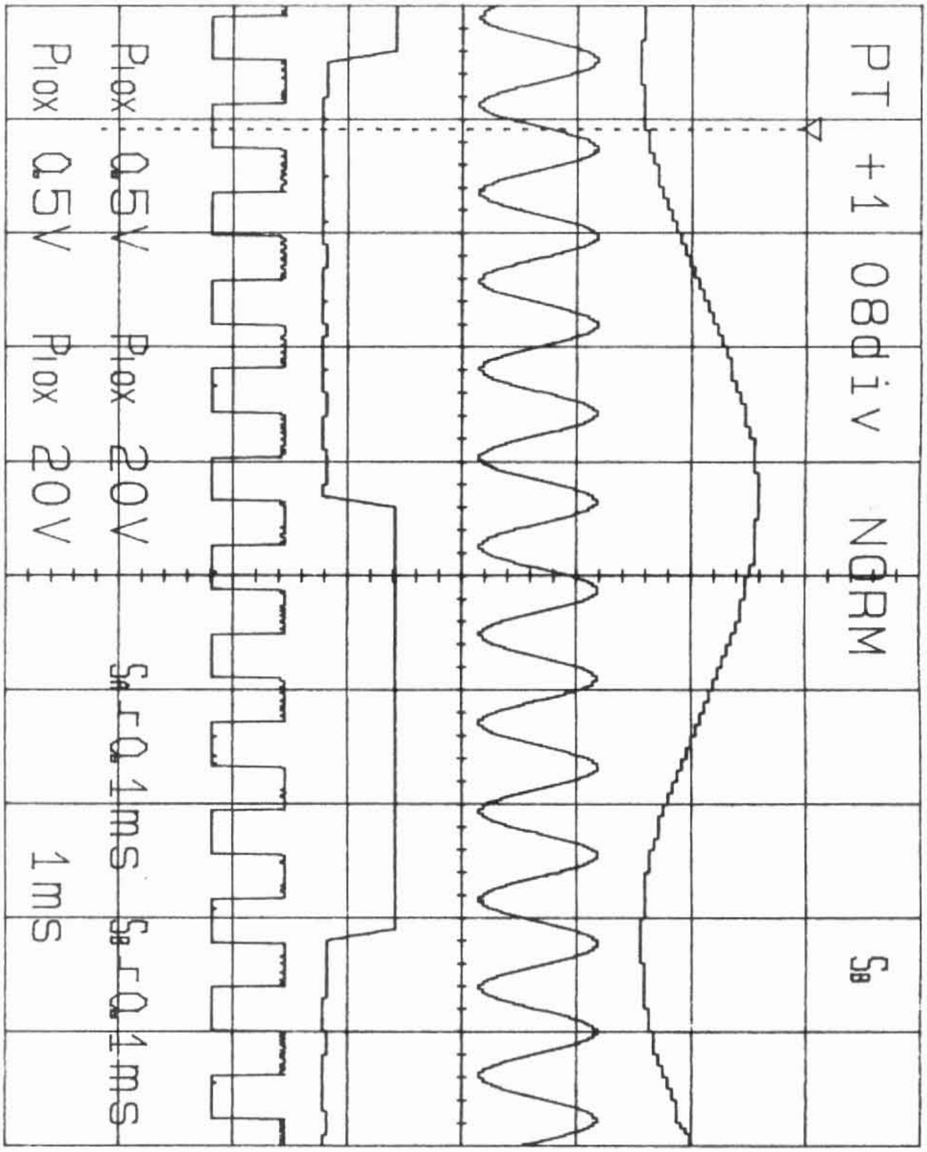


Fig. 3-1 (a) PLOT OUTPUT DISPLAY 1

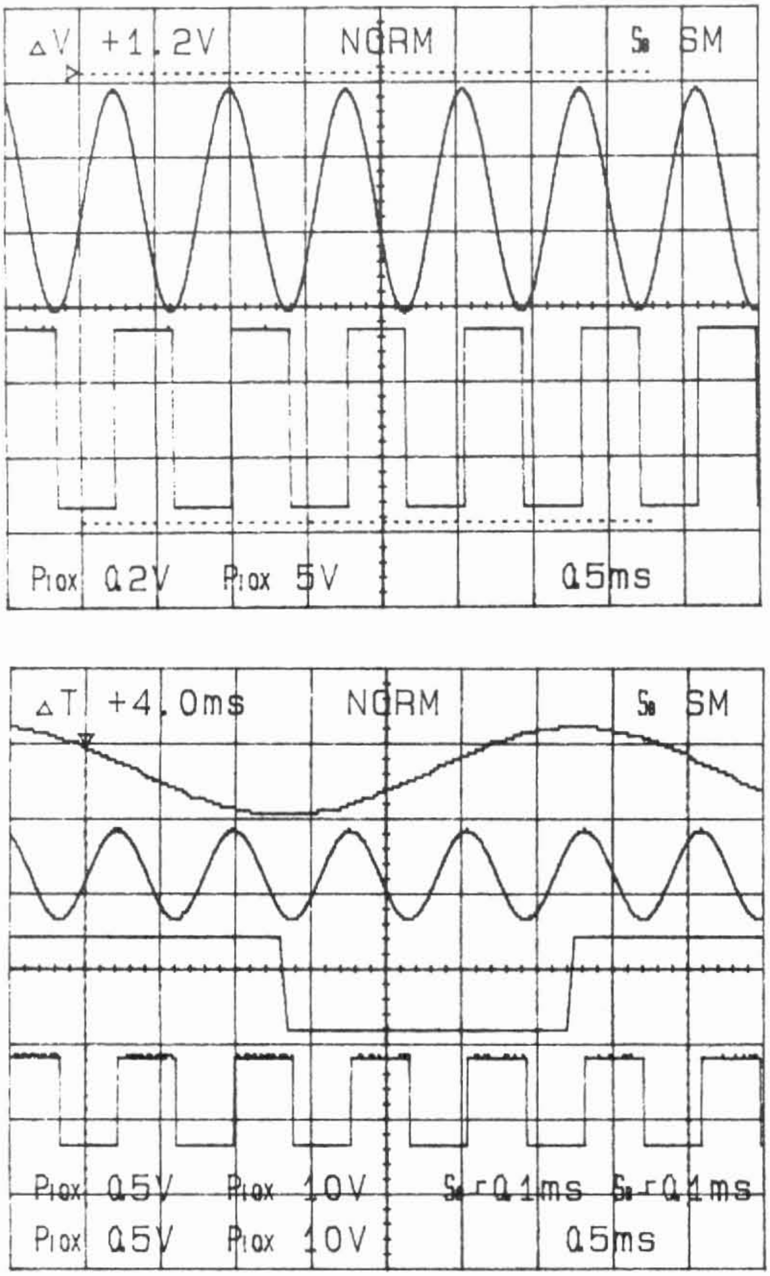


Fig. 3-1 (b) PLOT OUTPUT DISPLAY 2

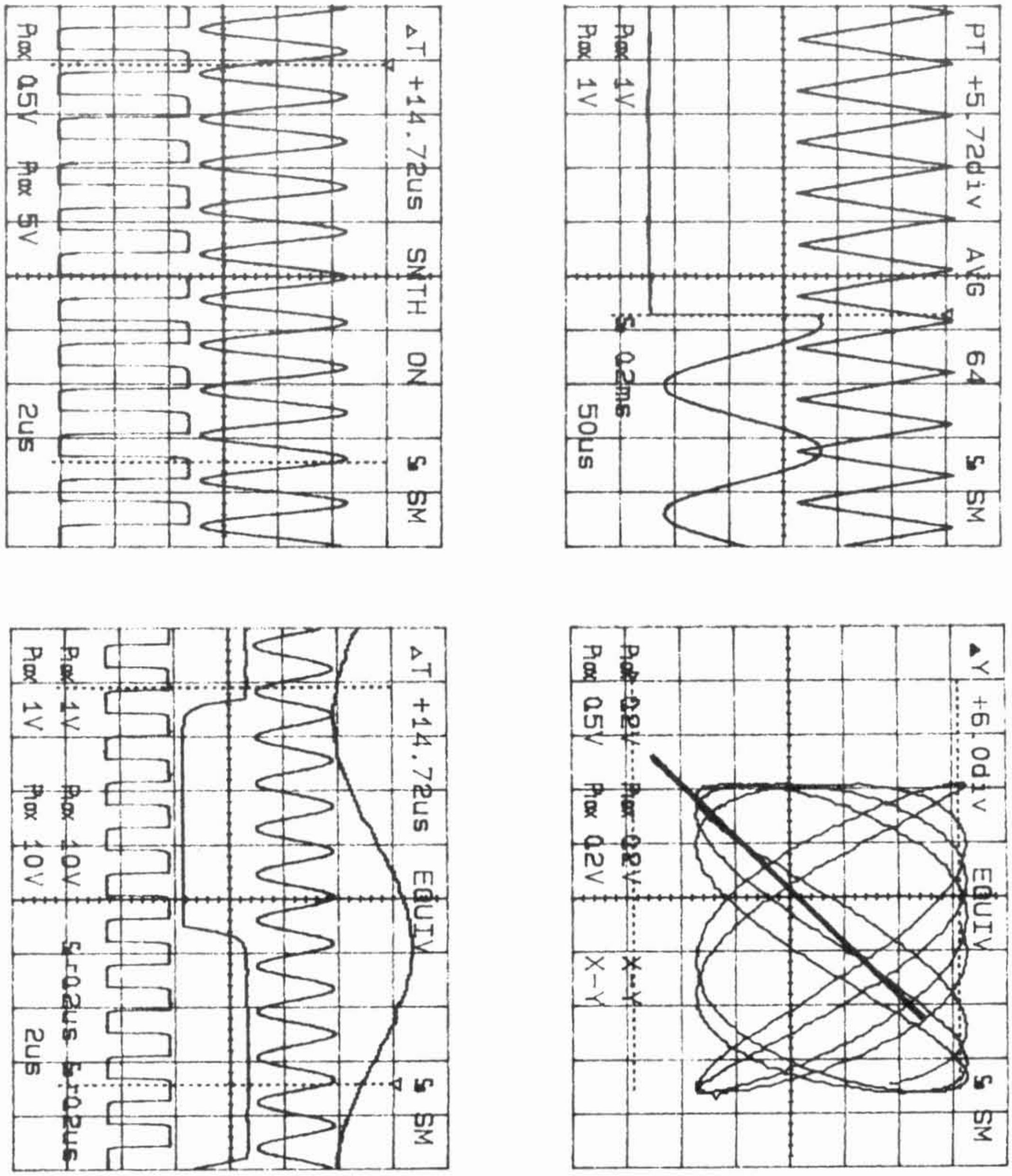


Fig. 3-1 (c) PLOT OUTPUT DISPLAY 3

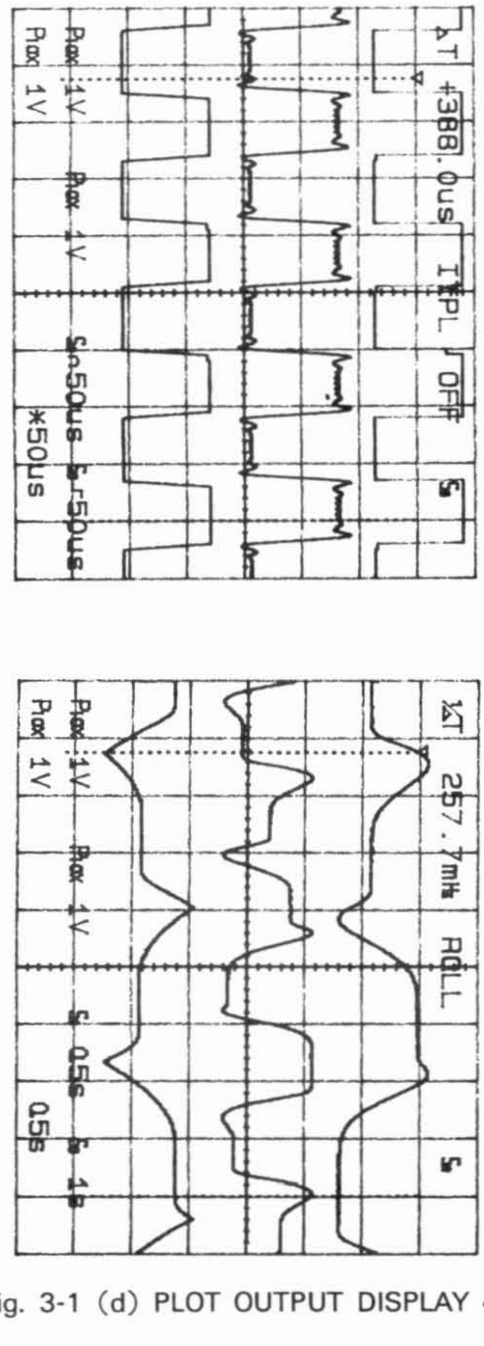


Fig. 3-1 (d) PLOT OUTPUT DISPLAY 4

3-3. Connections

Connect X-Y plotter with the connector on the rear side using RS-232C interface cable. Fig 3.2 shows the wiring of RS-232C interface cable used to connect the graphic plotter HP7475A with the instrument.

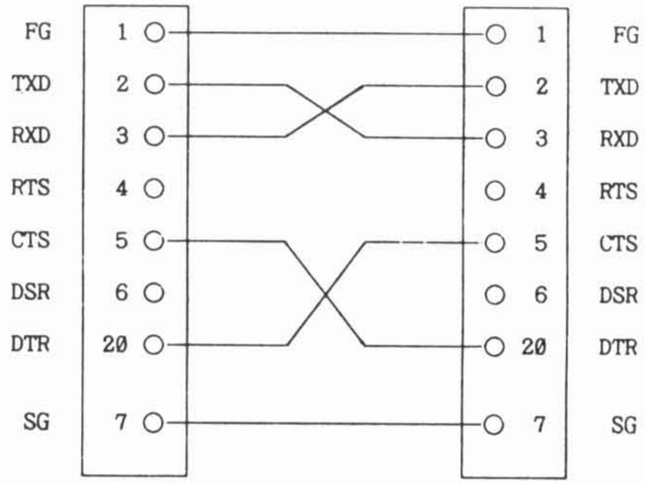
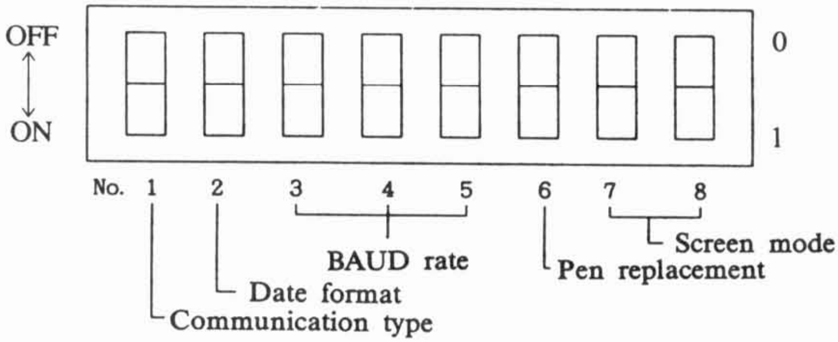


Fig. 3-2 RS-232C INTERFACE CABLE WIRING

3-4 Setting

Using DIP S/W on the rear side, set both the PLOT and communication modes.



Ex 1) HP7475A plotter (9600 BAUD RATE)

NO.	1	2	3	4	5	6	7	8
state	0	1	1	1	1	1	0	0

(Oscilloscope side)

NO. Pin name	9 S2	8 S1	7 Y	6 US	5 A3	4 B4	3 B3	2 B2	1 B1
State	Ø	Ø	Ø	Ø	Ø	1	Ø	1	Ø

〈Plotter side〉

Ex 2) HITACHI 681-XA PLOTTER (9600 BAUD RATE)

NO.	1	2	3	4	5	6	7	8
State	Ø	Ø	1	1	1	1	Ø	Ø

(Oscilloscope side)

NO.	1	2	3	4	5	6	7	8	9	9
State	Ø	1	1	Ø	1	1	Ø	1	Ø	Ø

(plotter side)

(1) PLOT Mode

(a) Screen mode setting

Screen size can be set using DIP S/W No. 7 and 8. One mode is selected out of the modes in table 3-1.

Table 3-1. Screen mode setting

Screen mode	DIP S/W NO. 7	DIP S/W NO. 8	Descriptions	Screen Size (mm)
1	OFF	OFF	One screen is plotted in a sheet of A4 paper	175×140 Refer to Fig. 3−1 (a)
2	ON	OFF	Two screens are plotted in a sheet of A4 paper	118×95 .8 Refer to Fig. 3−2 (b)
3	OFF	ON	Four screens are plotted in a sheet of A4 paper	87×70 Refer to Fig. 3−1 (c)
4	ON	ON	Two screens are plotted in a sheet of A4 paper	87×70 Refer to Fig. 3−1 (d)

(b) Pen replacement setting

It is possible to set the pen replacement listed in table 3-2 using DIP S/W 6.

Table 3-2 Pen replacement setting

DIP S/W NO. 6	Pen feplacement
OFF	NO
ON	YES

When DIP S/W 6 is set to OFF, six colors are used for plotting. Table shows the details of plot and corresponding pen number.

Table 3-3. Pen number corresponding to the details of plot.

<table>
<tr><th colspan="3">Details of plot</th><th>Pen number</th></tr>
<tr><td colspan="3">GRID AND SCALE</td><td>1</td></tr>
<tr><td rowspan="4">WAVEFORM</td><td colspan="2">CH1</td><td>3</td></tr>
<tr><td colspan="2">CH2</td><td>4</td></tr>
<tr><td colspan="2">SAVE A</td><td>5</td></tr>
<tr><td colspan="2">SAVE B</td><td>6</td></tr>
<tr><td colspan="3">CURSOR</td><td>2</td></tr>
<tr><td rowspan="8">Character</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</td></tr>
<tr><td>SAVE B</td><td>6</td></tr>
<tr><td rowspan="3">TIME RANGE</td><td>SWEEP</td><td>1</td></tr>
<tr><td>SAVE A</td><td>5</td></tr>
<tr><td>SAVE B</td><td>6</td></tr>
<tr><td colspan="2">Others</td><td>1</td></tr>
</table>

(2) Communication mode

Set baud rate and data format depending on the plotter specification and use. Same baud rate and data format should be set in the instrument and plotter.

(a) Baud rate setting

It is possible to set RS-232C baud rate as shown in table 3-4 using DIP S/W 3,4 and 5.

Table 3-4 Baud rate setting

DIP S/W			BAUD RATE
NO. 3	NO. 4	NO. 5	
OFF	OFF	OFF	300 BAUD
ON	OFF	OFF	600 BAUD
OFF	ON	OFF	1200 BAUD
ON	ON	OFF	2400 BAUD
OFF	OFF	ON	4800 BAUD
ON	OFF	ON	9600 BAUD
OFF	ON	ON	〃
ON	ON	ON	〃

(B) Data format setting

It is possible to set RS-232C data format as shown in table 3-5 using DIP S/W 2.

Table 3-5 Data format setting

DIP S/W	Data Format
No. 2	
OFF	START BIT + 8BIT + 1STOP BIT
ON	START BIT + 8BIT + 2STOP BIT

(c) Communication mode setting

DIP S/W 1 sets RS-232C communication type (unilateral or bilateral) Unilateral communication means the plotter output and bilateral communication means the communication with personal computer.

Table 3-6 Communication type setting

DIP S/W No. 1	Communication type
OFF	Unilateral (plotter output)
ON	Bilateral (communication with personal computer)

Note : Before turning on the instrument, check DIP S/W setting. If you want to change the DIP S/W setting for communication mode, make it sure to turn on the instrument after the setting.

3-5. Operation

When the instrument is in HOLD mode, pressing [PLOT] S/W starts plotting. Red lamp lights up while plotting is carried out. When plotting is over, lamp goes out and pen is released.

3-6. RS-232C interface

The instrument is equipped with RS-232C as a standard function. This function enables personal computer to control the plotting operation as well as data input/output to/from computer. This communication function can not be used together with the output to the X-Y plotter.
Do not use the X-Y plotter output function (plotter output using PLOT S/W) when you use the computer communication function.

3-7. Major troubles

If X-Y plotter does not operate normally, check the followings :
(1) Cable wiring is not done in accordance with Fig. 3-2.
(2) X-Y plotter power turns off.
(3) Communication type setting (DIP S/W 1) is wrong.
(4) The instrument is not in HOLD mode.
(5) Baud rate and data format are not properly set (Set them correctly after turning power off. Refer to paragraph 3.4 (2))
(6) Baud setting is not correct on the plotter side.
(7) When plotting stops, turn plotter power off and on to initialize plotter. Then try to perform plotting.

4. RS-232C

4-1. Introduction

RS-232C is the serial communication interface standardized by U.S. Electronic Industry Association, and transmits and receives digital data through RS-232C interface.

4-2. Specification

(1) Electric feature	:	EIA RS-232 is applicable
(2) Transmission type	:	Non-synchronization
(3) Stop big length	:	1 bit/2 bits
(4) Character length	:	8 bits
(5) Parity bit	:	disabled
(6) Separating character	:	C/R
(7) Transmission rate	:	300, 600, 1200, 2400, 4800 or 9600 BAUD
(8) Communication protocal	:	Hardwire hand shake

4-3. Connector pin alignment and signal technology

(1) Fig. 4-1 and table 4-2 shows the RS-232C connector pin alignment and pin functions, respectively.

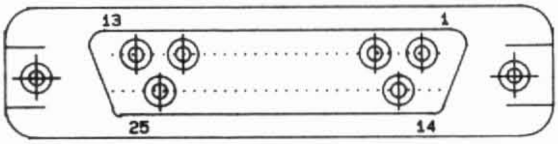


Fig. 4-1. RS-232C connector pin alignment

NOTE : Use DB-25P (FEMALE) which is used for connector cable.

Table 4-1. RS-232C Connector terminal

Pin No.	Signal	Function	Signal direction
1	FG (AA)	GND configuration	
2	TXD (BA)	Data transmission	OUT
3	RXD (BB)	Data reception	IN
4	RTS (CA)	Transmission request	OUT
5	CTS (CB)	Transmission request	IN
6	NC	Non-connection	
7	SG (AB)	Signal GND	
8	NC	Non connection	
9	〃	〃	
10	〃	〃	
11	〃	〃	
12	〃	〃	
13	〃	〃	
14	〃	〃	
15	〃	〃	
16	〃	〃	
17	〃	〃	
18	〃	〃	
19	〃	〃	
20	〃	〃	
21	〃	〃	
22	〃	〃	
23	〃	〃	
24	〃	〃	
25	NC	Non connection	

(2) RS-232C interface signals are as follows:

①FG : Ground configuration
Chassis ground cable

②TXD : Data transmission
Data output signal transmission
+9V level ----- "0" (space)
−9V level ----- "1" (mark)

③RXD : Data reception
Data input signal reception

④RST : Transmission request
This output signal indicates the transmission request state, and is used to control the data transmission function at modem transmission part.
"0" (space) − carrier transmission request
"1" (mark) − carrier stop request

⑤CTS : Transmission permission
This input signal controls modem transmission part, and is in an indication state when modem transmission part is allowed to transmit.

⑥SG : Signal ground
Signal ground cable

4-4. Connection

Connect the instrument to personal computer using RS-232C interface cable. Interface varies depending on personal computer type. So read operation manual carefully before connecting it to personal computer, and select proper interface cable. Fig 4-2 shows the RS-232C interface cable wiring used for connecting GoldStar Precision Co., Ltd's personal computer B-16 with the instrument.

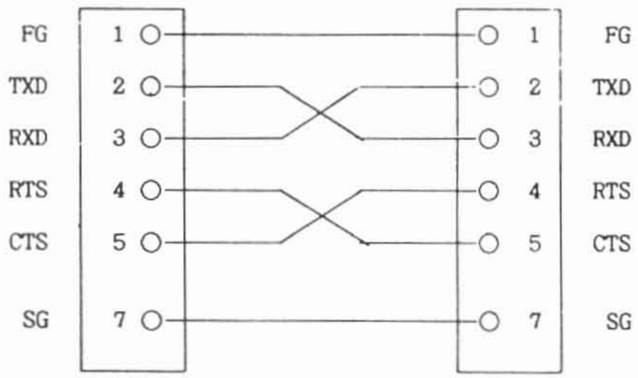


Fig. 4-2. RS-232C INTERFACE CABLE WIRING

4-5. Operating function and function command

If the instrument is connected with personal computer through RS-232C interface, it is possible to use personal computer with appropriate programs. Function command designate the program operation to be carried out by instrument. It is possible to prepare a set of programs using personal computer to configure the automatic measurement system having a variety of functions. The functions to be used by using RS-232C and function commands are described as follows :

(1) Panel setting

Panel setting enables the communication with personal computer in both storage or non storage mode. For data communication, set it to storage mode to transmit accurate data.

(2) Operating function

① Waveform data transmission

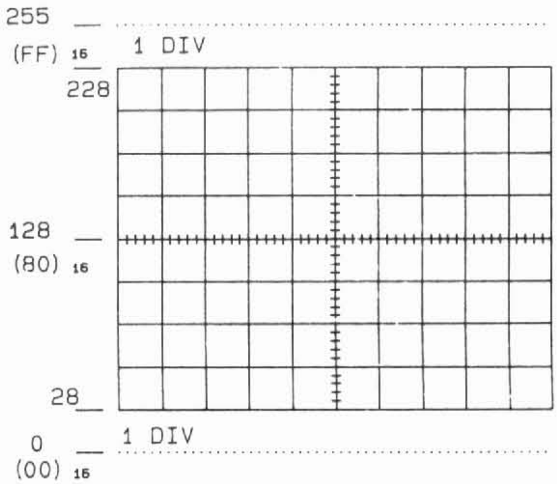
The instrument has the following six data memories.
CH1 acquisition memory storing CH1 waveform data.
CH2 acquisition memory storing CH2 waveform data.
Two sweep trace memories (SAVE A and B)
CH1 display memory
CH2 display memory

CH1 and CH2 acquisition memories have each 2000 data load capacity depending on the sample mode. CH1 and CH2 display memories two sweep trace memories have 1000 data load capacity. CH1 and CH2 display memories and two save memories can be transmitted using personal computer.

Table 4-2 Sampling mode and acquisition

Sample mode	Acquisition memory capacity
ROLL	1000
NORM	2000
EQUIV	2000

The number of data to be transmitted each time is selected within the memory capacity. Decimal ASCII system or binary system is selected as data transmission type. Waveform data of each memory is 8 bits. That is to say, it is between 0 and 255 for decimal number and between (00) 16 and (FF) 16 for hexadecimal number. The scope of these data corresponds to ten vertical div. on the CRT.
The data corresponding to central crosshair is 128. ((80) 16 in haxadecimal number). Data 0 ((00) 16) means the location one step lower than graticule line. Data 255((FF)16) means the location one step higher than graticule line.



② Measurement condition data transmission (Character transmission)
It is possible to transmit the waveform measurement condition to SAVE memory A or B using personal computer command. All the data are transmitted except for special data. The data format for the measurement condition is subject to ASCII system.

③ Waveform data reception
The details in SAVE memory A and B can be changed using waveform data coming from personal computer. Set RECALL S/W to ON so that the rewritten data are displayed on the CRT.

④ Measurement condition data reception (character reception)
The measurement condition data coming from personal computer can be registered as the data for SAVE memory A or B waveform. When RECALL S/W is set to ON, the data of VOLTS/DIV and TIME/DIV are displayed on the CRT.

4-6. Transmission data format

The transmission data format is as follows:

(1) Waveform data transmission format

After receiving Ri command (i=1~4) the instrument transmits the waveform data in the following format. Refer to table 4-4 for each item.

● ASCII System

#	i	@	,	m	m	m	m	,	n	n	n	n	,	D1	,	D2	,	D3	,		,	DN	,	DEL

● Binary System

#	i	@	,	m	m	m	m	,	n	n	n	n	,	D1	D2	D3		DN	DEL

(2) Waveform data reception format

● ASCII System

#	i	@	,	m	m	m	m	,	n	n	n	n	,	D1	,	D2	,	D3	,		,	DN	,	DEL

● ASCII System

#	i	@	,	m	m	m	m	,	n	n	n	n	,	D1	D2	D3		DN	DEL

Comma (,) is the separing character code. DEL type is C/R. In binary system, D1 thru DN are binary data, and remainings are ASCII code data. In binary system the separating character code are not used for D1 thru DN data.

(3) Measurement condition data transmission and reception format.

After instrument receives Ro command, the memory waveform measurement condition data are transmitted in the following format. Refer to table 4-5 for more details. When the instrument receives Wo command, it receives the data sent in the following format, and register them as measurement condition data for the designated SAVE memory.

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

Table 4-3. Function command

No.	Function	Command	Description	Transmission format
1	Transmission/ reception signal check	S1 command	• Check the transmission/ reception signal to enable communication with personal computer.	| S | 1 | DEL |
2	Waveform data transmission	Ri command	• The transmission of waveform data stored in memory i is designated by the data number (nnnn) Whose head has address data (mmmm). • ASCII or binary system may be designated as transmission method by X on the right column. • After transmitting this command, personal computer receives the designated data.	R i(mmmm, nnnn, X) DEL "i" denotes the memory number. i: Memory 1: CH1 Display memory 2: CH2 Display memory 3: Save memory A 4: Save memory B "mmmm": Front address of memory Four digit integer: 0000－0999 "nnnn": Number of transmitted data Four digit integer: 0001－1000 (save memory, CH1 and CH2 display memory) x=A: ASCII system B: Binary system

No.	Function	Command	Description	Transmission format
3	Measurement condition data transmission (Charcter transmission)	Ro command	• designates the transmission or waveform measurement comdition data stored in the memory "i". • After transmittion this command, personal computer receives the designated data.	R | o | (| i |) | DEL "i" (=1～4) denotes the memory number.
4	Waveform data reception	Wi command	• Personal computer transmits mits waveform data to the instrument to designate SAVE memory A and B in order to write a series of data from the front memory address (mmmm). • ASCII or binary system may be designated as transmission method by X on the right column. • After transmitting this command, personal computer transmits waveform.	W i(mmmm, nnnn, X) DEL "i" denotes the memory number. "i" should be 3 or 4 i | Memory 3 | Save memory A 4 | Save memory B "mmmm" : Front address of memory Four digit integer : 0000－0999 "nnnn" : Number of transmitted data Four digit integer : 0001－1000 (save memory, CH1 and CH2 display memory) x=A : ASCII system B : Binary system

No.	Function	Command	Description	Transmission format
5	Mesurement condition data reception (Character reception)	Wo command	• Personal computer transmits the measurement condition to the instrument, and designates memory to save the waveform measurement condition data stored in the SAVE memory A and B. • After transmitting this command, personal computer transmits measurement condition data.	| W | o | (| i |) | DEL | "i" denotes the memory number. "i" should be 3 or 4 | i | Memory | | 3 | Save memory A | | 4 | Save memory B |

Table 4−4. Waveform data transmission format

No.	Item	Name	Type	ASCII System		Binary System	
				Data code	Byte	Data code	Byte
1	i@	Memory number	"i" is 1 thru 4 (Note 2)	ASCII	3	ASCII	3
2	mmmm	Front address	Decimal number, Four digits 0001−1000	ASCII	4	ASCII	4
3	nnnn	Data number	Decimal number, Four digits 0001−1000	ASCII	4	ASCII	4
4	Di	Data	• ASCII system, Decimal number Three digits/1 data 000−255 • Binary system 8 bits binary data	ASCII	3	Binary number	1
5	DEL	Separating character	C/R	ASCII	1	ASCII	1

Note 1 : Separating character data format is C/R.

Note 2 : 3 or 4 is designated in reception mode.

Table 4-5. Mesurement condition data transmission/reception format

No.	Item	Name	Type	Number of bytes (Note 3)	
				Trans.	Rec.
1	@i	Memory number	"i" is 3 or 4	3	3
2	V.M	vertical mode	CH1, CH2, CHOP (Dual trace mode is contained) One of ADDs	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 : Alignment at (note 1) the left end Unit : S, MS, MICS (Alignment at the left end)	9	9
5	B.T	B TIME/DIV	B TIME range value : Alignment at (note 1) the left end Unit : S, MS, MICS (Alignment at the left end)	9	9
6	V.C	VOLT CAL	CAL or UNCAL(Alignment at the left end)	5	5
7	P.F	PROBE Factor	PIX of P1OX (Alignment at the left end)	4	4
8	V.D	VOLTS/DIV	VOLT range value : Alignment at the (Note 2) the left end) Unit : V, MV (Alignment at tne left end)	7	7
9	RSV	Spare		9	9
10	N.S	Number of sweeps		3	3
11	RSV	Spare		2	2
12	DEL	Separating characthe		1	1

Note : 1. For example, 50ms and 0.2ms are indicated as 50ms(alignment at the left end)
and 0.2ms respectively (alignment at the left end).
2. For example, 50mv and 5mv are indicated as 50mv (alignment at the left end)
and 5mv respectively (alignment at the left end).
3. They are "reception" and "transmission" from the viewpoint of instrument.

4-7. Separating character

Controller transmits the separating character to inform the instrument of the end of data in order to transmit waveform data or function command message. The separating character is C/R.

4-8. Abnormal operation handling

Instrument sends the return code to response to the message command, or inform personal computer of the state. The following shows the type of these state bytes.

No.	State byte	Description
1	41	Command is normally treated.
2	61	Command error
3	62	Data error
4	63	Data detail error

The command error return code is transmitted when format error occurs in the message command.

4-9. RS-232C interface cable connection and instrument operation

(1) 3Connect instrument with personal computer using RS-232C cable.
(2) Set the communication mode between instrument and personal computer in accordance with paragraph 3.4. (2).
(3) Though it is possible to communicate with personal computer in storage mode or NON storage mode, set storage mode in order to ensure accurate data transmission.

4-10. Selection of program for data transmission

Run the simple test program to ensure satisfactory execution of program by sending the function command the instrument and by checking the data received from instrument ("S1" command). This simple test program checks whether it is possible to communicate with system. The program shall be subject to the personal computer which runs the program itself. Read the computer operation manual carefully prior to transmission in order to ensure data buffer area and to set the separating character.

4-11. Major reasons of abnormal data transmission

In case data are not transmitted satisfactorily, check the followings :

(1) Cable is not wired in accordance with fig. 4-2.

(2) "S1" command is not executed in the first place.

(3) There may occur error in data reception function at 9600 baud.

(4) There may occur error in EQUIVALENT or MAG mode at the rate higher than 4800 baud.

(5) The instrument mode does not concide with personal computer communication mode.

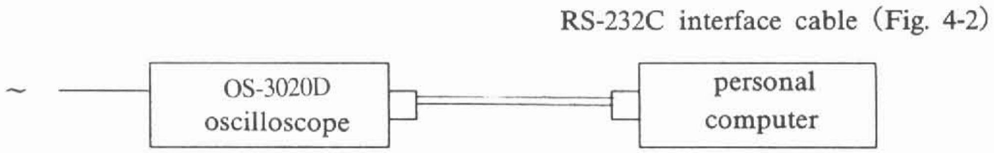
(6) The personal computer port setting (COM 1 or COM 2) is not correct.

(7) If communication mode is changed, turn the instrument power off and on.

4-12. Programming example

Following is the example of programs executed when the instrument is connected with personal computer. Before connecting personal computer, set the instrument in reference to the communication mode as described in paragraph 3.4 (2). In this section, the programs for the personal computer compatible with IBM personal computer is used as an example of each function command.

Input signal



Following communication mode is used as an example of program.

(a) Baud rate : 4800 BAUD

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

(c) Separating character : C/R

〈DIP S/W on oscilloscope side〉

NO.	1	2	3	4	5	6	7	8
state	1	Ø	Ø	Ø	1	1	Ø	Ø

〈Computer program side〉

OPEN "COM1 (or COM2) : 4800, N, 8, 1, CS, DS, CD" FOR RANDOM AS # 1

(1) Program example 1 "S1" command

"S1" command is alway executed in the first place. This is a program to check that communication function is enabled.

Program example

The following program is the program for IBM compatible personal computer.

```
10 ' **** S1 COMMAND *****
20 ' **** EXECUTE THIS PROGRAM UNTIL RTN$ IS A(HEX41)
30   OPEN "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
40   PRINT #1, "S1"
50   LINE INPUT #1, RTN$
60   RTN = ASC(RTN$)
70   IF RTN <> &H41 THEN 100
80   PRINT "RI RUTURN="; RTN$
90   GOTO 110
100  PRINT "ERROR STATUS="; RTN
110  CLOSE #1
120  END
```

(Explanation) By running "S1" command in the first place, it is possible to check whether it is possible to communicate with computer (transmission/reception). This should be repeated until instrument sends response "A" (Hex 41).

(2) Program example 2 "Ri" command

This program receives 50 words of CH1 waveform from zero address using "Ri" command.

Program example 2-1 : ASCII code conversion; IBM compatible personal computer

```
10  ' **** Ri(mmmm, nnnn, X) COMMAND *****
20  '
30  ' i ----> 1: display memory ch1
40  '         2: display memory ch2
50  '         3: SAVE memory A
60  '         4: SAVE memory B
70  ' mmmm ->    start address
80  ' nnnn ->    data number
90    OPEN "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
100   PRINT #1, "R1(0000,0050,A)"
110   LINE INPUT #1, RTN$
120   PRINT "RI RUTURN="; RTN$
130   CLOSE #1
140   END
```

Program example 2-2 : Binary code conversion. IBM compatible personal computer

```
10  ' **** Ri(mmmm, nnnn, X) COMMAND *****
20  '       DRAW BINARY DATA FORM
30  ' ***********************************
40    OPEN "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
50    PRINT #1, "R1(0000,0050,B)"
60    RTN$ = INPUT$(14, 1)
70    FOR I = 1 TO 49
80       WRK$ = INPUT$(1, 1)
90       RTN$ = RTN$ + MID$(STR$(ASC(WRK$)), 2) + ","
100   NEXT I
110   PRINT "R1 RUTURN="; RTN$
120   CLOSE #1
130   END
```

(3) Program example 3 "Ro" command

This program receives and displays the sweep trace memory A measurement condition data using "Ro" command.

Program example 3 : IBM compatible personal computer

```
10          **** Ro(i) COMMAND *****
20    OPEN "COM1:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
30    PRINT #1, "Ro(3)"
40    LINE INPUT #1, RTN$
50    PRINT "Ro RUTURN="; RTN$
60    CLOSE #1
70    END
```

(4) Program example 4 "Wi" command

This program writes data in sweep trace memory A using "Wi" command. The 0 thru 999 address waveform data are written in sweep trace memory as shown in fig. 4-3.

Program example 4-1 : ASCII code conversion

```
10 ' *** WI(mmmm, nnnn, x) COMMAND (GW-BASIC) ****
20  DIM A$(1000)
30  CNT = 0
40  FOR I = 1 TO 2
50     FOR B = 1 TO 250
60        IF B >= 100 THEN B$ = MID$(STR$(B), 2, 3)
70        IF B < 100 THEN B$ = "0" + MID$(STR$(B), 2, 2)
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 "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM 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
```

Program example 4-2 : ASCII code conversion

```
10 ' *** WI(mmmm, nnnn, x) COMMAND (GW-BASIC) ****
20 ' binary data trans
30   DIM A$(1000)
40   CNT = 0
50   FOR I = 1 TO 2
60      FOR B = 1 TO 250
70         B$ = CHR$(B)
80         A$(B + CNT * 250) = B$
90      NEXT B
100     CNT = CNT + 1
110     FOR B = 1 TO 250
120        C = 251 - B
130        B$ = CHR$(C)
140        A$(B + CNT * 250) = B$
150     NEXT B
160     CNT = CNT + 1
170  NEXT I
180  OPEN "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
190  PRINT #1, "W3(0000,1000,B)"
200  LINE INPUT #1, RTN$
210  RTN = ASC(RTN$)
220  IF RTN <> &H41 THEN 330
230  PRINT "Wi COMMAND PASS"
240  PRINT #1, "#3@,0000,1000,";
250  FOR I = 1 TO 999
260  PRINT #1, A$(I);
270  NEXT I
280  PRINT #1, A$(I)
290  LINE INPUT #1, RTN$
300  RTN = ASC(RTN$)
310  IF RTN <> &H41 THEN 330
320  GOTO 340
330  PRINT "ERROR STATUS="; HEX$(RTN)
340  CLOSE #1
350  END
```

(5) Program example 5 "Wo" command

This program registers the measurement condition data stored in sweep trace memory A using "Wo" command.

```
10 ' *** Wo(i) COMMAND (GW-BASIC) ***
20   DAT$ = DAT$ + "#3@, "                'memory number
30   DAT$ = DAT$ + "CH1 , "               'vertical mode
40   DAT$ = DAT$ + "A, "                  'horizontal mode
50   DAT$ = DAT$ + "50ms       , "        'A Time/Div
60   DAT$ = DAT$ + "20ms       , "        'B Time/Div
70   DAT$ = DAT$ + "CAL  , "              'volt CAL
80   DAT$ = DAT$ + "P10X, "               'probe factor
90   DAT$ = DAT$ + "0.5V    , "           'volts/Div
100  DAT$ = DAT$ + "10DIV      , "        'delay amount
110  DAT$ = DAT$ + "1  , "                'No of sweep
120  OPEN "COM2:4800,N,8,1,CS,DS,CD" FOR RANDOM AS #1
130  PRINT #1, "Wo(3)"
140  LINE INPUT #1, RTN$
150  RTN = ASC(RTN$)
160  IF RTN <> &H41 THEN 230
170  PRINT "Wo COMMAND PASS"
180  PRINT #1, DAT$
190  LINE INPUT #1, RTN$
200  RTN = ASC(RTN$)
210  IF RTN <> &H41 THEN 230
220  GOTO 240
230  PRINT "ERROR STATUS="; HEX$(RTN)
240  CLOSE #1
250  END
```

5. USER MAINTENANCE GUIDE

In order for you to use better this instrument, OS-3000DSRS, please refer to the following. And if any failure occurs during use, please contact the EZ Digital service center for professional repair service.

5-1. Cleaning

If the outside of the case is stained, remove the stain by wiping it lightly with cloth moistened with neutral detergent, and then wipe out the cleaned surface again with a dry cloth. In case where the surface got rusty, wipe the surface with cloth saturated with alcohol. Do not use strong volatile solvents such as benzine or thinner.
When you clean the surface of the CRT, wipe out the surfaces of the filter and the CRT carefully with soft cloth moistened with mild detergent after having the front case and the filter disassembled first. Under no circumstances shall the abrasive or strong solvents be used. And then, reassemble the filter and front case after having them thoroughly dried so as to prevent dew from being formed on their surfaces. Take care not to leave any hand mark or the like on the surface of the CRT or filter.

5-2. Calibration

To maintain the accuracy of the measurement, calibration of OS-3000DSRS should be performed at least every 1000 service hours when the instrument is used continuously, and every 6 months when used intermittently. So far as the calibration of this instrument is concerned, please contact the EZ Digital, calibration and inspection agency authorized by the government.

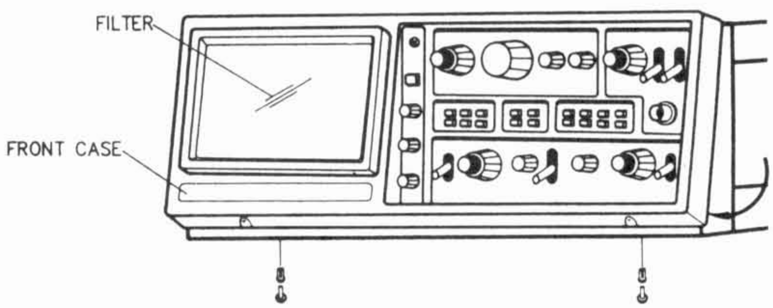
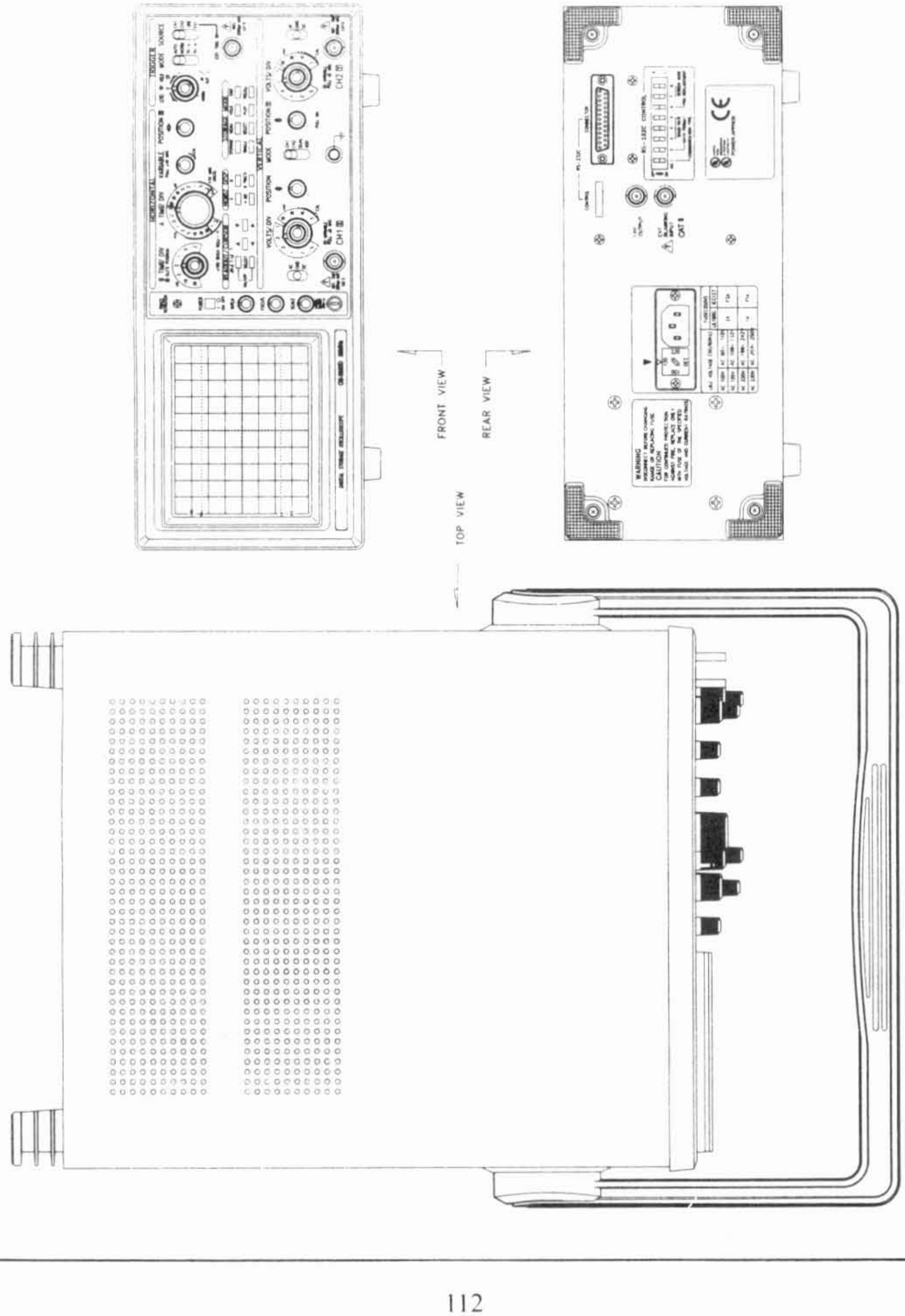


Fig. 5-1. FILTER DISASSEMBLYING

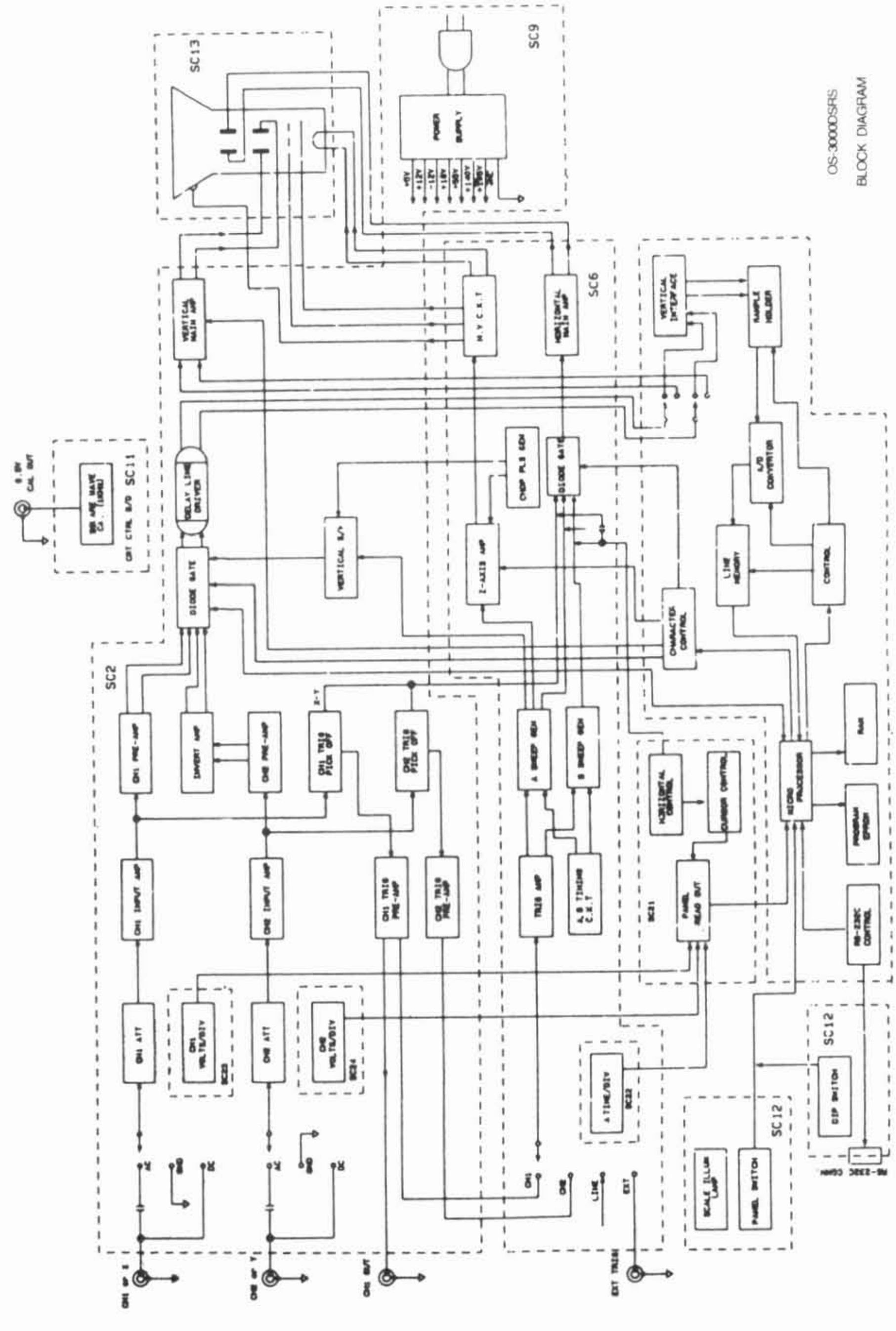
6. OS-3000DSRS DIAGRAMS

6-1. External Views

OS-3020D/OS-3040D/OS-3060D



6-2. Block Diagram



EZ Digital Co.,Ltd.

The specifications are subjected to change without notice.