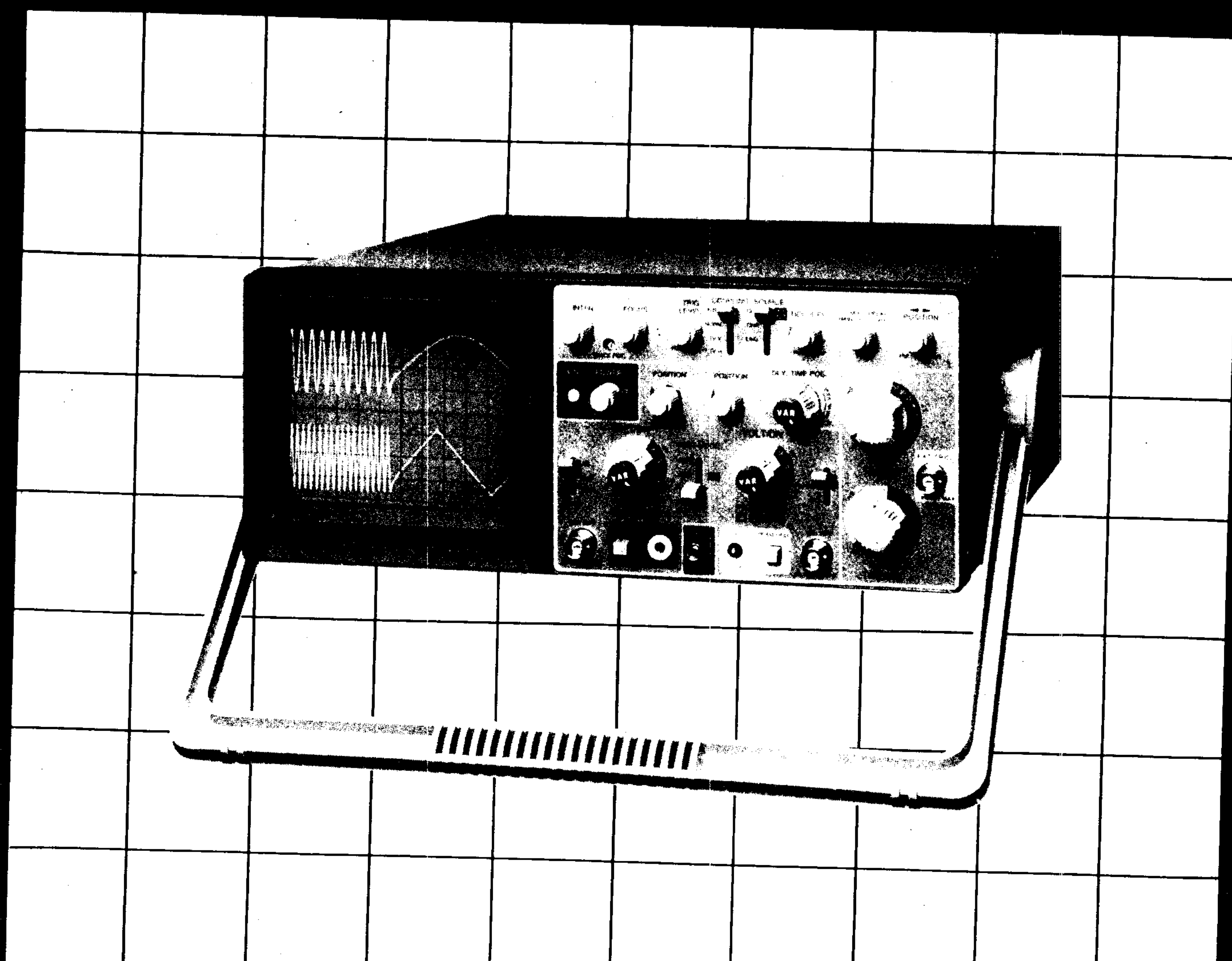
OPERATION-MANUAL

OSCILLOSCOPE



CONTENT

GENERAL

DESCRIPTION

The model PS-XX0/XX1/XX5 oscilloscope is a dual-channel oscilloscope with frequency bandwidth 20~60 MHz at -3db; maximum sweep 10 nS/ DIV; maximum sensitivity 1 mV/DIV and 150 mm rectangular CRT with internal graticule.

The oscilloscope is rugged, easy to operate, and highly reliable. It also provide many convenient feature and special functions which make itself be an ideal instrument for research, production, education, and development in electronic device or circuitry.

FEATURES

(1) **Ease of Operation**
All control and function switchs are laid out in the most convenient locations making the oscilloscope extremely easy to operate.

(2) **High Input Impedance**
The input impedance of CH 1, CH 2 is 1MΩ +/- 2%, 25 pF +/- 10 pF.

(3) **Variable Hold Off Function**
Signals with complex repeating periods which resist triggering can be stably triggered with a simple adjustment of the hold cff level.

(4) **X-Y Operation**
CH 1 can be applied as horizontal deflection (X axis) while CH 2 provides vertical deflection (Y axis).

(5) **Trigger of TV Sync**
The oscilloscope has a sync separator circuit, which allows triggering for TV-H and TV-V signal.

(6) **High Sensitivity**
1 mV/DIV maximum vertical sensitivity.
10 nS/DIV maximum sweep rate.

(7) **Sweep Mix Function (PS-XX5 only)**
The main sweep and the delay sweep can be viewed at the same time.

(8) **CH 2 Output (PS-XX5 only)**
CH 2 output which on near panel can be connected to frequency counters and other devices.

(9) **Z Modulation (PS-XX5 only)**
Input terminal is used for external intensity modulation signal.

(10) **Component Test (PS-XX1/XX5)**
Capacitor, indictor, diode, transistor and zener can be also viewed on screen.

(11) **Beam Finder (PS-XX1/XX5)**
Trace can be return to CRT viewing area regardless of setting horizontal, vertical or intensity controls when press beam finder button.

(12) **Illumination Control (PS-XX1/XX5)**
Graticule illumination can be adjusted according to brightness of circumstance.

20 MHz OSCILLOSCOPE SPECIFICATIONS

CATHODE RAY TUBE

6 inch diagonal, rectangular screen with internal graticule 8 x 10 DIV (1 DIV = 1 cm), B31 phosphor, 2kV accel voltage.

VERTICAL DEFLECTION

Bandwidth
DC-20 MHz (-3db).

Sensitivity
1 mV/DIV – 1 V/DIV (5 MHz, -3db), x5 gain selected.
5 mV/DIV – 5 V/DIV.

Attenuator
1-2-5 sequence, 10 step with variable control.

Input Impedance
1MΩ +/– 2%, 25 pF +/– 10%.

Max. Input Voltage
400V (DC + AC peak).

Rise Time
About 17.5 nS.

Over Shoot
Less than 5%.

Operation Mode
CH 1, CH 2, DUAL (ALT, CHOP).

Algebraic Addition
CH 1 + CH 2, CH 1 – CH 2.

Inverter
CH 2 only.

HOIZONTAL DEFLECTION

X-Y Mode switch selectable using X-Y switch
CH 1: X axis.
CH 2: Y axis.

Accuracy
Y-Axis +/– 3%.
X-Axis +/– 6%.

Bandwidth
DC – 1 MHz (-3db).

X-Y Phase Difference
Approximately 3° at 50 kHz.

SWEEP SYSTEM

Sweep Display Mode
Main, Mix, Delay (PS-205 only).

Hold Off Time
5:1 continuously variable.

MAIN SWEEP

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Variable Time Control
5:1, uncalibrated, continuously variable between steps.

10X, +/– 10%, extend sweep speed up to 10 nS/DIV.

DELAY SWEEP (PS-205 only)

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Sweep Magnification
10X, +/– 10%, extend sweep speed up to 10 ns/DIV.

Delay Time Position
Variable control to locate desirable waveform for extending.

TRIGGERING

Trigger Coupling
AUTO, NORM, TV-V, TV-H.

Trigger Source
CH 1, CH 2, ALT, LINE, EXT.

Slope
+/–

TRIGGER SENSITIVITY

COUPLING	BANDWIDTH	INT	EXT
TV-V	DC - 1 kHz	1.0 DIV	0.5 Vp-p
TV-H	1 kHz - 100 kHz	1.0 DIV	0.5 Vp-p
AUTO	100 Hz - 20 MHz	1.5 DIV	0.5 Vp-p
NORM	100 Hz - 20 MHz	1.5 DIV	0.5 Vp-p

Dimensions
324 (W) x 398 (D) x 132 (H) mm.

Net Weight
Approx. 7.6 kg.

Rated Range of Use
10°C–35°C, 10–80% R.H.

Test Voltage
Max. 6 Vrms (open circuit).

Test Current
Max. 11 mA (shorted).

Test Frequency
Line Frequency.

Components
Capacitor, Inductor, Diode, Transistor, Zener etc.

CH 2 OUTPUT (PS-205 only)

Output level
100 mV/DIV (no load).
50 mV/DIV (with 50Ω load).

Bandwidth
20 Hz-20 MHz (-3db).

Graticule Illumination (PS-201, 205 only)
Adjustable.

Calibrator
Square wave about 1 kHz, 2 Vp-p ±3%.

Z-Modulation (PS-205 only)
Positive TTL signal, low level blank intensity at any intensity, high level unblank any intensity.

Trace Rotation
Adjustable on front panel.

Power Source
110V, 125V, 220V, 240VAC, 50/60 Hz.

Power Consumption
Approx. 38 Watts.

Limits of Operation
0°C–50°C, 10–80% R.H.

Storage Environment
–30°C–70°C, 10–90% R.H.

25 MHz OSCILLOSCOPE SPECIFICATIONS

CATHODE RAY TUBE

6 inch diagonal, rectangular screen with internal graticule 8 x 10 DIV (1 DIV = 1 cm), B31 phosphor,

VERTICAL DEFLECTION

Bandwidth
DC-25 MHz (-3db).

Sensitivity
1 mV/DIV – 1 V/DIV (10 MHz, -3db), x5 gain selected.
5 mV/DIV – 5 V/DIV.

Attenuator
1-2-5 sequence, 10 step with variable control.

Input Impedance
1MΩ +/– 2%, 25 pF +/– 10%.

Max. Input Voltage
400V (DC + AC peak).

Rise Time
About 14 nS.

Over Shoot
Less than 5%.

Operation Mode
CH 1, CH 2, DUAL (ALT, CHOP).

Algebraic Addition
CH 1 + CH 2, CH 1 – CH 2.

Inverter
CH 2 only.

HOIZONTAL DEFLECTION

X-Y Mode switch selectable using X-Y switch
CH 1: X axis.
CH 2: Y axis.

Accuracy
Y-Axis +/– 3%.
X-Axis +/– 6%.

Bandwidth
DC – 1 MHz (-3db).

X-Y Phase Difference
Approximately 3° at 50 kHz.

SWEEP SYSTEM

Sweep Display Mode
Main, Mix, Delay (PS-255 only).

Hold Off Time
5:1 continuously variable.

MAIN SWEEP

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Variable Time Control
5:1, uncalibrated, continuously variable between steps.

10X, +/– 10%, extend sweep speed up to 10 nS/DIV.

DELAY SWEEP (PS-255 only)

Sweep Speed
0.1 μs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Sweep Magnification
10X, +/– 10%, extend sweep speed up to 10 ns/DIV.

Delay Time Position
Variable control to locate desirable waveform for extending.

TRIGGERING

Trigger Coupling
AUTO, NORM, TV-V, TV-H.

Trigger Source
CH 1, CH 2, ALT, LINE, EXT.

Slope
+/–

TRIGGER SENSITIVITY

COUPLING	BANDWIDTH	INT	EXT
TV-V	DC - 1 kHz	1.0 DIV	0.5 Vp-p
TV-H	1 kHz - 100 kHz	1.0 DIV	0.5 Vp-p
AUTO	100 Hz - 25 MHz	1.5 DIV	0.5 Vp-p
NORM	100 Hz - 25 MHz	1.5 DIV	0.5 Vp-p

Dimensions
324 (W) x 398 (D) x 132 (H) mm.

Net Weight
Approx. 7.6 kg.

Rated Range of Use
10°C–35°C, 10–80% R.H.

Test Voltage
Max. 6 Vrms (open circuit).

Test Current
Max. 11 mA (shorted).

Test Frequency
Line Frequency.

Components
Capacitor, Inductor, Diode, Transistor, Zener etc.

CH 2 OUTPUT (PS-250, 255 only)

Output level
100 mV/DIV (no load).
50 mV/DIV (with 50Ω load).

Bandwidth
20 Hz- 25 MHz (-3db).

Graticule Illumination (PS-251, 255 only)
Adjustable.

Calibrator
Square wave about 1 kHz, 2 Vp-p ±3%.

Z-Modulation (PS-250, 255 only).
Positive TTL signal, low level blank intensity at any intensity, high level unblank any intensity.

Trace Rotation
Adjustable on front panel.

Power Source
110V, 125V, 220V, 240VAC, 50/60 Hz.

Power Consumption
Approx. 38 Watts.

Limits of Operation
0°C–50°C, 10–80% R.H.

Storage Environment
–30°C–70°C, 10–90% R.H.

40 MHz OSCILLOSCOPE SPECIFICATIONS

CATHODE RAY TUBE

6 inch diagonal, rectangular screen with internal graticule 8 x 10 DIV (1 DIV = 1 cm), B31 phosphor,

VERTICAL DEFLECTION

Bandwidth
DC-40 MHz (-3db).

Sensitivity
1 mV/DIV – 1 V/DIV (10 MHz, -3db), x5 gain selected.
5 mV/DIV – 5 V/DIV.

Attenuator
1-2-5 sequence, 10 step with variable control.

Input Impedance
1MΩ +/– 2%, 25 pF +/– 10%.

Max. Input Voltage
400V (DC + AC peak).

Rise Time
About 8.8 nS.

Over Shoot
Less than 5%.

Operation Mode
CH 1, CH 2, DUAL (ALT, CHOP).

Algebraic Addition
CH 1 + CH 2, CH 1 – CH 2.

Inverter
CH 2 only.

HOIZONTAL DEFLECTION

X-Y Mode switch selectable using X-Y switch
CH 1: X axis.
CH 2: Y axis.

Accuracy
Y-Axis +/– 3%.
X-Axis +/– 6%.

Bandwidth
DC – 1 MHz (-3db).

X-Y Phase Difference
Approximately 3° at 50 kHz.

SWEEP SYSTEM

Sweep Display Mode
Main, Mix, Delay (PS-405 only).

Hold Off Time
5:1 continuously variable.

MAIN SWEEP

Sweep Speed
0.1 μs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Variable Time Control
5:1, uncalibrated, continuously variable between steps.

10X; +/– 10%, extend sweep speed up to 10 nS/DIV.

DELAY SWEEP (PS-405 only)

Sweep Speed
0.1 μs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Sweep Magnification
10X, +/– 10%, extend sweep speed up to 10 ns/DIV.

Delay Time Position
Variable control to locate desirable waveform for extending.

TRIGGERING

Trigger Coupling
AUTO, NORM, TV-V, TV-H.

Trigger Source
CH 1, CH 2, ALT, LINE, EXT.

Slope
+/–

TRIGGER SENSITIVITY

COUPLING	BANDWIDTH	INT	EXT
TV-V	DC - 1 kHz	1.0 DIV	0.5 Vp-p
TV-H	1 kHz - 100 kHz	1.0 DIV	0.5 Vp-p
AUTO	100 Hz - 40 MHz	1.5 DIV	0.5 Vp-p
NORM	100 Hz - 40 MHz	1.5 DIV	0.5 Vp-p

Dimensions
324 (W) x 398 (D) x 132 (H) mm.

Net Weight
Approx. 7.6 kg.

Rated Range of Use
10°C–35°C, 10–80% R.H.

Test Voltage
Max. 6 Vrms (open circuit).

Test Current
Max. 11 mA (shorted).

Test Frequency
Line Frequency.

Components
Capacitor, Inductor, Diode, Transistor, Zener etc.

CH 2 OUTPUT (PS-405 only)

Output level
100 mV/DIV (no load).
50 mV/DIV (with 50Ω load).

Bandwidth
20 Hz-40 MHz (-3db).

Graticule Illumination (PS-401, 405 only)
Adjustable.

Calibrator
Square wave about 1 kHz, 2 Vp-p ±3%.

Z-Modulation (PS-405 only).
Positive TTL signal, low level blank intensity at any intensity, high level unblank any intensity.

Trace Rotation
Adjustable on front panel.

Power Source
110V, 125V, 220V, 240VAC, 50/60 Hz.

Power Consumption
Approx. 38 Watts.

Limits of Operation
0°C–50°C, 10–80% R.H.

Storage Environment
–30°C–70°C, 10–90% R.H.

50 MHz OSCILLOSCOPE SPECIFICATIONS

CATHODE RAY TUBE

6 inch diagonal, rectangular screen with internal graticule 8 x 10 DIV (1 DIV = 1 cm), B31 phosphor,

VERTICAL DEFLECTION

Bandwidth
DC-50 MHz (-3db).

Sensitivity
1 mV/DIV – 1 V/DIV (10 MHz, -3db), x5 gain selected.
5 mV/DIV – 5 V/DIV.

Attenuator
1-2-5 sequence, 10 step with variable control.

Input Impedance
1MΩ +/– 2%, 25 pF +/– 10%.

Max. Input Voltage
400V (DC + AC peak).

Rise Time
About 7.0 nS.

Over Shoot
Less than 5%.

Operation Mode
CH 1, CH 2, DUAL (ALT, CHOP).

Algebraic Addition
CH 1 + CH 2, CH 1 – CH 2.

Inverter
CH 2 only.

HOIZONTAL DEFLECTION

X-Y Mode switch selectable using X-Y switch
CH 1: X axis.
CH 2: Y axis.

Accuracy
Y-Axis +/– 3%.
X-Axis +/– 6%.

Bandwidth
DC – 1 MHz (-3db).

X-Y Phase Difference
Approximately 3° at 50 kHz.

SWEEP SYSTEM

Sweep Display Mode
Main, Mix, Delay (PS-505 only).

Hold Off Time
5:1 continuously variable.

MAIN SWEEP

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Variable Time Control
5:1, uncalibrated, continuously variable between steps.

10X, +/– 10%, extend sweep speed up to 10 nS/DIV.

DELAY SWEEP (PS-505 only)

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Sweep Magnification
10X, +/– 10%, extend sweep speed up to 10 ns/DIV.

Delay Time Position
Variable control to locate desirable waveform for extending.

TRIGGERING

Trigger Coupling
AUTO, NORM, TV-V, TV-H.

Trigger Source
CH 1, CH 2, ALT, LINE, EXT.

Slope
+/–

TRIGGER SENSITIVITY

COUPLING	BANDWIDTH	INT	EXT
TV-V	DC - 1 kHz	1.0 DIV	0.5 Vp-p
TV-H	1 kHz - 100 kHz	1.0 DIV	0.5 Vp-p
AUTO	100 Hz - 40 MHz	1.5 DIV	0.5 Vp-p
NORM	100 Hz - 40 MHz	1.5 DIV	0.5 Vp-p

Dimensions
324 (W) x 398 (D) x 132 (H) mm.

Net Weight
Approx. 7.6 kg.

Rated Range of Use
10°C–35°C, 10–80% R.H.

Test Voltage
Max. 6 Vrms (open circuit).

Test Current
Max. 11 mA (shorted).

Test Frequency
Line Frequency.

Components
Capacitor, Inductor, Diode, Transistor, Zener etc.

CH 2 OUTPUT (PS-505 only)

Output level
100 mV/DIV (no load).
50 mV/DIV (with 50Ω load).

Bandwidth
20 Hz-40 MHz (-3db).

Graticule Illumination (PS-505 only)
Adjustable.

Calibrator
Square wave about 1 kHz, 2 Vp-p ±3%.

Z-Modulation (PS-505 only).
Positive TTL signal, low level blank intensity at any intensity, high level unblank any intensity.

Trace Rotation
Adjustable on front panel.

Power Source
110V, 125V, 220V, 240VAC, 50/60 Hz.

Power Consumption
Approx. 38 Watts.

Limits of Operation
0°C–50°C, 10–80% R.H.

Storage Environment
–30°C–70°C, 10–90% R.H.

60 MHz OSCILLOSCOPE SPECIFICATIONS

CATHODE RAY TUBE

6 inch diagonal, rectangular screen with internal graticule 8 x 10 DIV (1 DIV = 1 cm), B31 phosphor, 12kV accel voltage.

VERTICAL DEFLECTION

Bandwidth
DC- 60 MHz (-3db).

Sensitivity
1 mV/DIV – 1 V/DIV (15 MHz, -3db), x5 gain selected.
5 mV/DIV – 5 V/DIV.

Attenuator
1-2-5 sequence, 10 step with variable control.

Input Impedance
1MΩ +/– 2%, 25 pF +/– 10%.

Max. Input Voltage
400V (DC + AC peak).

Rise Time
About 5.8 nS.

Over Shoot
Less than 5%.

Operation Mode
CH 1, CH 2, DUAL (ALT, CHOP).

Algebraic Addition
CH 1 + CH 2, CH 1 – CH 2.

Inverter
CH 2 only.

HOIZONTAL DEFLECTION

X-Y Mode switch selectable using X-Y switch
CH 1: X axis.
CH 2: Y axis.

Accuracy
Y-Axis +/– 3%.
X-Axis +/– 6%.

Bandwidth
DC – 1 MHz (-3db).

X-Y Phase Difference
Approximately 3° at 50 kHz.

SWEEP SYSTEM

Sweep Display Mode
Main, Mix, Delay (PS-605 only).

Hold Off Time
5:1 continuously variable.

MAIN SWEEP

Sweep Speed
0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy
+/– 3%.

Variable Time Control
5:1, uncalibrated, continuously variable between steps.

10X, +/– 10%. extend sweep speed up to 10 nS/DIV.

DELAY SWEEP (PS-605 only)

Sweep Speed

0.1 µs/DIV – 2.0 s/DIV in 1-2-5 sequence, 23 steps.

Accuracy

+/– 3%.

Sweep Magnification

10X, +/– 10%, extend sweep speed up to 10 ns/DIV.

Delay Time Position

Variable control to locate desirable waveform for extending.

TRIGGERING

Trigger Coupling

AUTO, NORM, TV-V, TV-H.

Trigger Source

CH 1, CH 2, ALT, LINE, EXT.

Slope

+/–

TRIGGER SENSITIVITY

COUPLING	BANDWIDTH	INT	EXT
TV-V	DC - 1 kHz	1.0 DIV	0.5 Vp-p
TV-H	1 kHz - 100 kHz	1.0 DIV	0.5 Vp-p
AUTO	100 Hz - 60 MHz	1.5 DIV	0.5 Vp-p
NORM	100 Hz - 60 MHz	1.5 DIV	0.5 Vp-p

Dimensions

324 (W) x 398 (D) x 132 (H) mm.

Net Weight

Approx. 7.6 kg.

Rated Range of Use

10°C–35°C, 10–80% R.H.

Test Voltage

Max. 6 Vrms (open circuit).

Test Current

Max. 11 mA (shorted).

Test Frequency

Line Frequency.

Components

Capacitor, Inductor, Diode, Transistor, Zener etc.

CH 2 OUTPUT (PS-605 only)

Output level

100 mV/DIV (no load).

50 mV/DIV (with 50Ω load).

Bandwidth

20 Hz-60MHz (-3db).

Graticule Illumination (PS-601, 605 only)

Adjustable.

Calibrator

Square wave about 1 kHz, 2 Vp-p ±3%.

Z-Modulation (PS-605 only).

Positive TTL signal, low level blank intensity at any intensity, high level unblank any intensity.

Trace Rotation

Adjustable on front panel.

Power Source

110V, 125V, 220V, 240VAC, 50/60 Hz.

Power Consumption

Approx. 38 Watts.

Limits of Operation

0°C–50°C, 10–80% R.H.

Storage Environment

–30°C–70°C, 10–90% R.H.

PRECAUTION BEFORE OPERATING

Unpack the oscilloscope

Upon receipt of the instrument, please unpack and inspect it for any damage which might have been sustained during transportation. If any sign of damage is found, please notify the dealer.

Environments

The normal ambient temperature range of this oscillosocpe is 5 C to 40 C, and the maximum relative humidity 80% for temperatures up to 31 C, decreasing linearly to 50% relative humidity at 40 C, This instrument is for INDOOR USE ONLY.

This equipment has been evaluated to INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY) II. POLLUTION DEGREE 2.

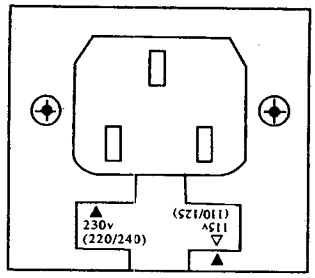
Check the Line Voltage

The oscilloscope can operate on any one ot the line voltages shown in the below table, by inserting the line voltage selector plug in the corresponding position on the rear panel. Before connecting the power plug to an AC line outlet, be sure to check that the voltage selector plug is set in the correct position corresponding to the line voltage. Note the oscilloscope may not properly operate or may be damaged if it is connected to a wrong AC line voltage.

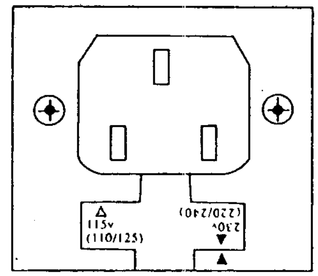
When line voltage are changed, replace fuses also as required.

SELECTOR	LINE VOLTACE	FUSE
115V	100-130V 50/60 Hz	800mA
230V	200-260V 60/60 Hz	600mA

Voltage selector plug on rear panel of instrument it shown below.



Line Voltage Range: 100~130
Fuse 800mA
Selector: 115V



Line Voltage Range: 200~260
Fuse 600mA
Selector: 230V

Hints for operating oscilloscope

Observe the following suggestions for successful instrument operation:

* **NEVER** place heavy objects on oscilloscope.
* **NEVER** place a hot soldering iron on or near the cabinet or especially near the CRT screen.
* Do not insert wires, pins, or other metal objects into ventilation holes.
* Do not move or pull oscilloscope with power cord or input probe cord. Especially never move instrument when power cord or signal input leader is connected to a circuit.
* If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

CONTROL AND INDICATORS

OPERATING CONTROLS, INDICATORS, AND CONNEDTORS

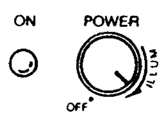
FRONT PANEL

Fig 1, 2, 3 show the model PS XX0/XX1/XX5 oscilloscope front panel operating controls, indicators, and signal input connectors.

CRT CIRCUIT

POWER .... (30)

Main power switch of the instrument. When this switch is turned on, the LED (32) above the switch is also turned on.

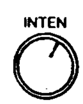


ILLUM .... (30)

Graticule illumination adjustment (PS-XX1/XX5 only).

INTENSITY control .... (31)

Controls brightness of display. Clockwise rotation increases brightness.



FOCUS control .... (28)

After obtaining appropriate brightness with INTENSITY, adjust FOCUS for clearest line.

BEAM FINDpushbutton .... (12)

Brings beam trace to center area of screen regardless of location (PS-XX1/XX5 only).

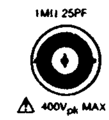
TRACE ROTATION .... (29)

Semi-fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.

VERTICAL DEFLECTION

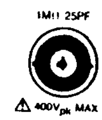
CH 1 (X) input .... (1)

Vertical input terminal of CH1. During X-Y operation, this becomes X-axis (abscissa) input terminal.



CH 2 (Y) input .... (13)

Vertical input terminal of CH2. During X-Y operation, this becomes Y-axis (ordinate) input terminal.



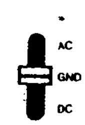
DC/GND/AC switches ....(2)(14)

Selects following input coupling options for CH1(1), CH2 (13):

DC: dc coupling, all signal are directly connected to attenuator.

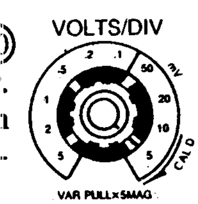
GND: input signal is switched off and attenuator is grounded.

AC: blocks dc signal component allowing only AC signal to pass into attenuator.



CH1/CH2 VOLT/DIVswitches ....(4)(10)

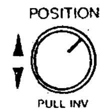
CH1 (X)/CH2 (Y) attenuator. Selects deflection factor from 5v/div to 5mv/div (1-2-5 sequence, 10 positions).



VARIABLE ....(5)(11)

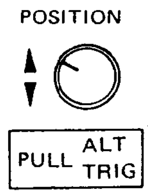
Fine adjustment of sensitivity, with a factor of 1/3 or lower of the panel-indicated value. At the CAL position, sensitivity is calibrated to the panel-indicated value. When this knob is pulled out (x5 MAG state), the amplifier sensitivity is multiplied by 5 times.

POSITION .... (25)



CH2 vertical positioning control of trace or spot. Pulling up position is inverter.

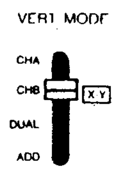
POSITION .... (27)



CH1 vertical positioning control of trace or spot. Pulling up position is ALT TRIG.

VERT MODE .... (7)

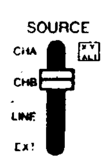
Selects the operation mode of the vertical DEFLECTION.
CH1: CH1 operates alone.
CH2: CH2 operates alone and (X-Y) switch.
DUAL: Dual-channel operation with CH1 and CH2 swept alternately. Suitable for observation with fast sweep speeds.



CHOP: The operation between channels chopped at a frequency of approximately 500 kHz of displayed channels. Suitable for observation with slow sweep speeds. When use chop, pull up HOLDOFF switch.
ADD: For measurement of algebraic sum or difference of CH1 and CH2 signals, employing the function of CH2 PULL INV switch.

TRIGGERING

TRIGGER SOURCE switch ....
.... (23)



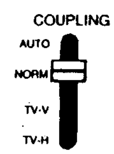
Selects the trigger source by setting switch to
CH1: The CH1 signal become the trigger source regardless of theVERTICAL MODE selection.
CH2: The CH2 signal become the trigger source.
LINE: AC line signal is used as trigger source.
EXT: Trigger signal is obtained from EXT TRIG connector.

EXT TRIG input terminal .... (16)

Signal from EXT TRIG connector becomes trigger source. To use this function, set TRIGGER SOURCE switch (23) to the EXT position.

TRIGGER COUPLING switch ....
.... (24)

Selects trigger mode
AUTO: In automatic triggering mode, sweep is generated in absence of adequate trigger signal; automatically reverts to triggered sweep operation when adequate triggered signal is present.



NORM: In normal triggering mode, sweep is only generated when adequate trigger signal is present.
TV-V: Trigger bandwidth range is DC – 1kHz
TV-H: Trigger bandwidth range is 1kHz – 100kHz

SLOPE AND TRIG LEVEL ... (26)

Selects triggering slope:
"+" Triggering occurs when trigger signal crosses trigger level in a positive-going direction. Push down to be slop "+".

"–" Triggering occurs when trigger signal crosses trigger level in a negative-going direction. Pull up to be slop "–".

"+" slope

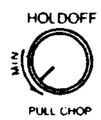
Triggering point

"–" slope

Triggering point

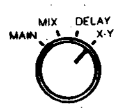
TRIG LEVEL knob is for displaying a synchronized stationary waveform and setting a start point for the waveform.
As this knob is turned in clockwise direction, the triggering level move upward on the displayed waveform; as the knob is turned in counterclockwise, the triggering level moves downward.

HOLD OFF control .... (21)
Signal with complex repeating periods which resist triggering can be stably triggered with a simple adjustment of the HOLD OFF knob.



TIME BASE

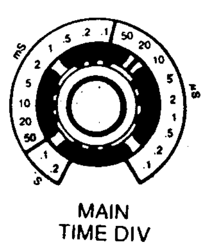
MAIN, MIX AND DELAY switch
.... (19)
Selects the sweep for the main, mix or delay mode and for X-Y switch.



PS-405

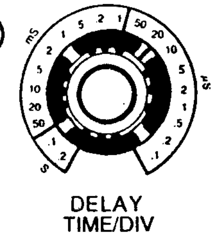
PS-400/401

MAIN TIME/DIV .... (15)
Provides step selection of sweep rate from .2s/DIV to .1 µs/DIV in 1-2-5 step.



POSITION (PULL x 10) .... (18)
Horizontal position control Select ten times sweep magnification when pulled out, normal when pushed in.

DELAY TIME/DIV .... (17)
Selects the sweep rate for delay sweep.

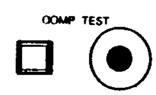


DELAY TIME POSITION
.... (20)
(PS-XX5 only)
Variable control to locate desirable waveform for extending.

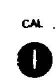
VAR CONTROL .... (22)
Provides continuously variable sweep rate by a factor of 5.

OTHERS

COMP TEST jacks .... (3) (6)
Input banana jacks to test component function (PS-XX1/XX5 only).



CAL (Vp-p) .... (9)
This terminal delivers the calibration voltage of 2 Vp-p, approximately 1 kHz, positive square wave.



GND .... (8)
Ground terminal of oscilloscope mainframe.

REAR PANEL (Fig 4, 5)

Z AXIS INPUT .... (38)
(PS-XX5 only)
Input terminal for external intensity modulation signal.

CH 2(Y) SIGNAL OUTPUT .. (39)
(PS-XX5 only)
Delivers the CH 2 signal with a voltage of approximately 100 mV per 1 DIV of graticule. When terminated with 50 ohms, the signal is attenuated to about a half. May be used for frequency counting, etc.

AC power input connector ...... (37)
Input connector of the AC power of the instrument. Connect the AC power cord (supplied) to this connector.

AC voltage selector plug and fuse .... (36)
For selecting the AC voltage of the instrument by aligning its arrowhead mark in the corresponding position and fuse is inside.

Studs .... (40)
Studs for laying the oscilloscope on its back to operate it in the upward posture. Also used to take up the power cord.

PS-XX0 FRONT PANEL

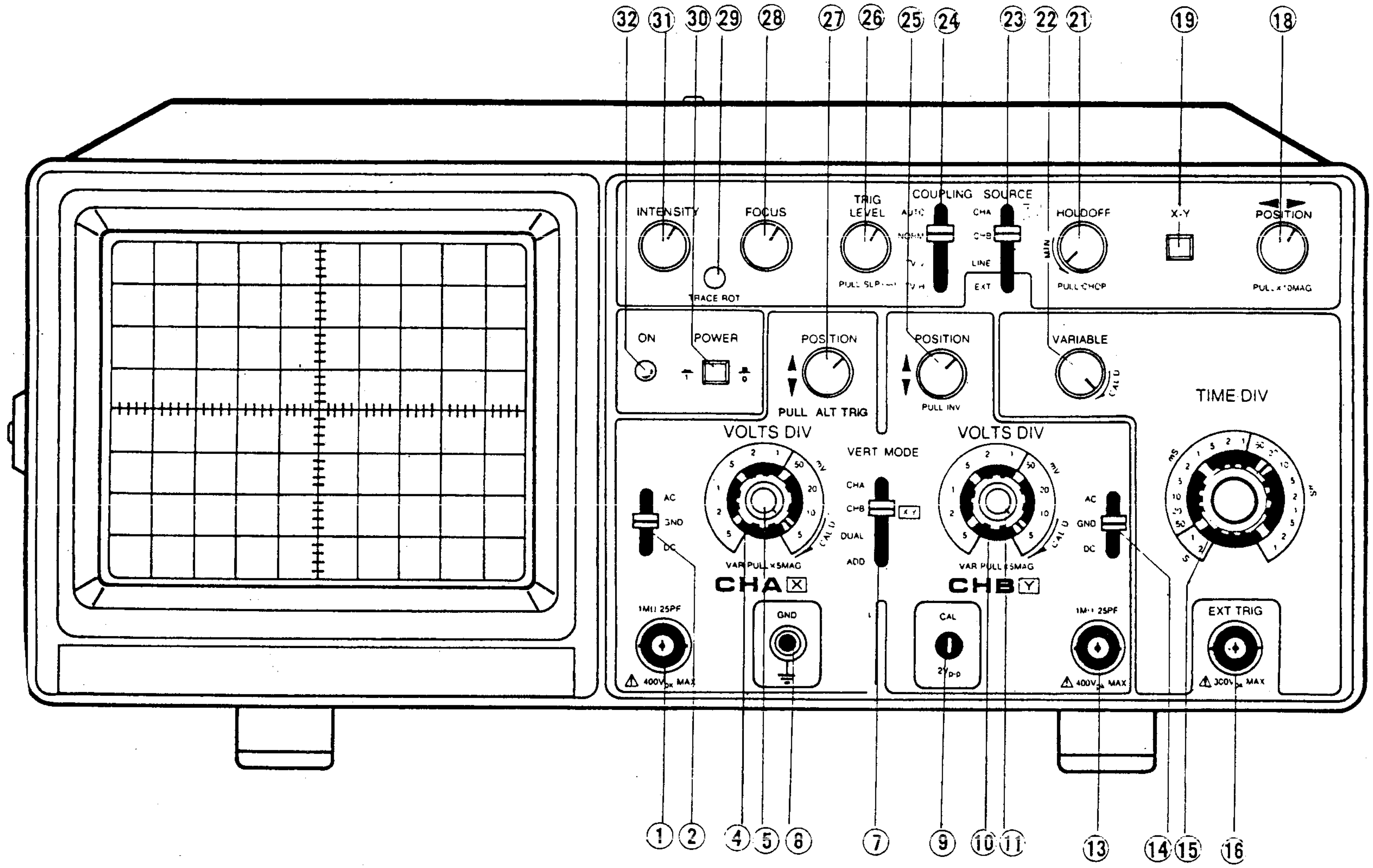


Fig. 1

PS-XX1 FRONT PANEL

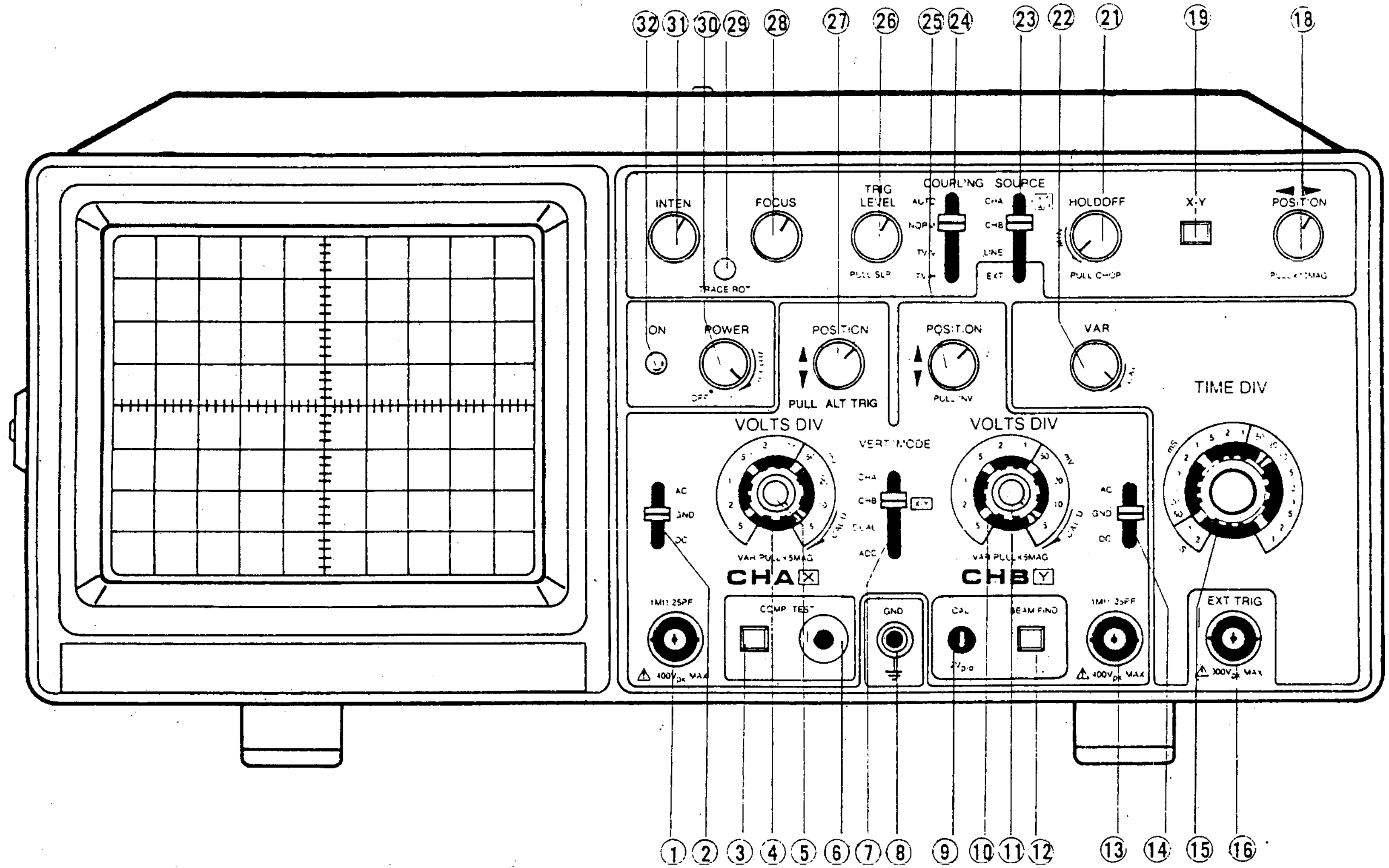


Fig. 2

PS-XX5 FRONT PANEL

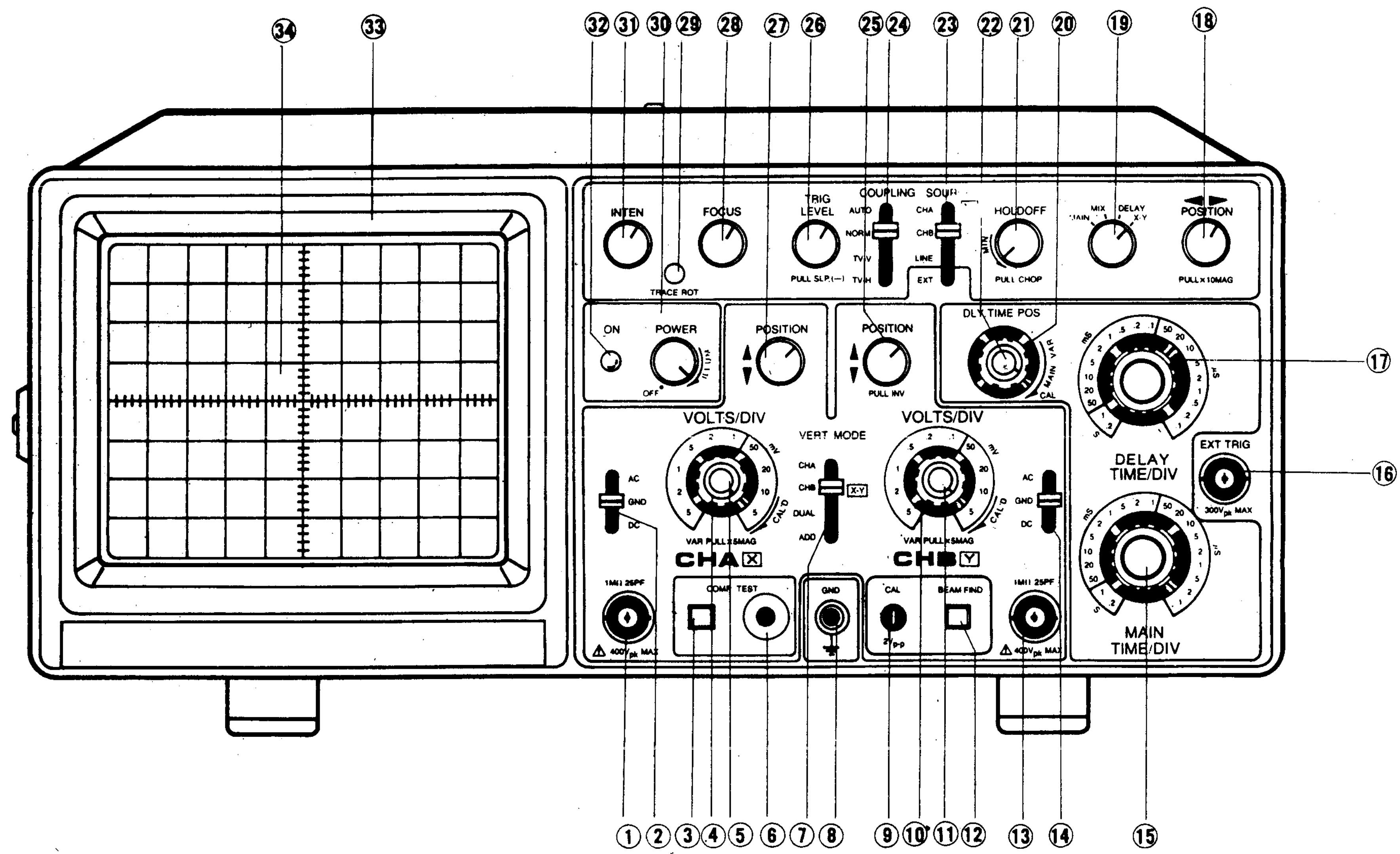


Fig. 3

PS-XX0/XX1 REAR PANEL

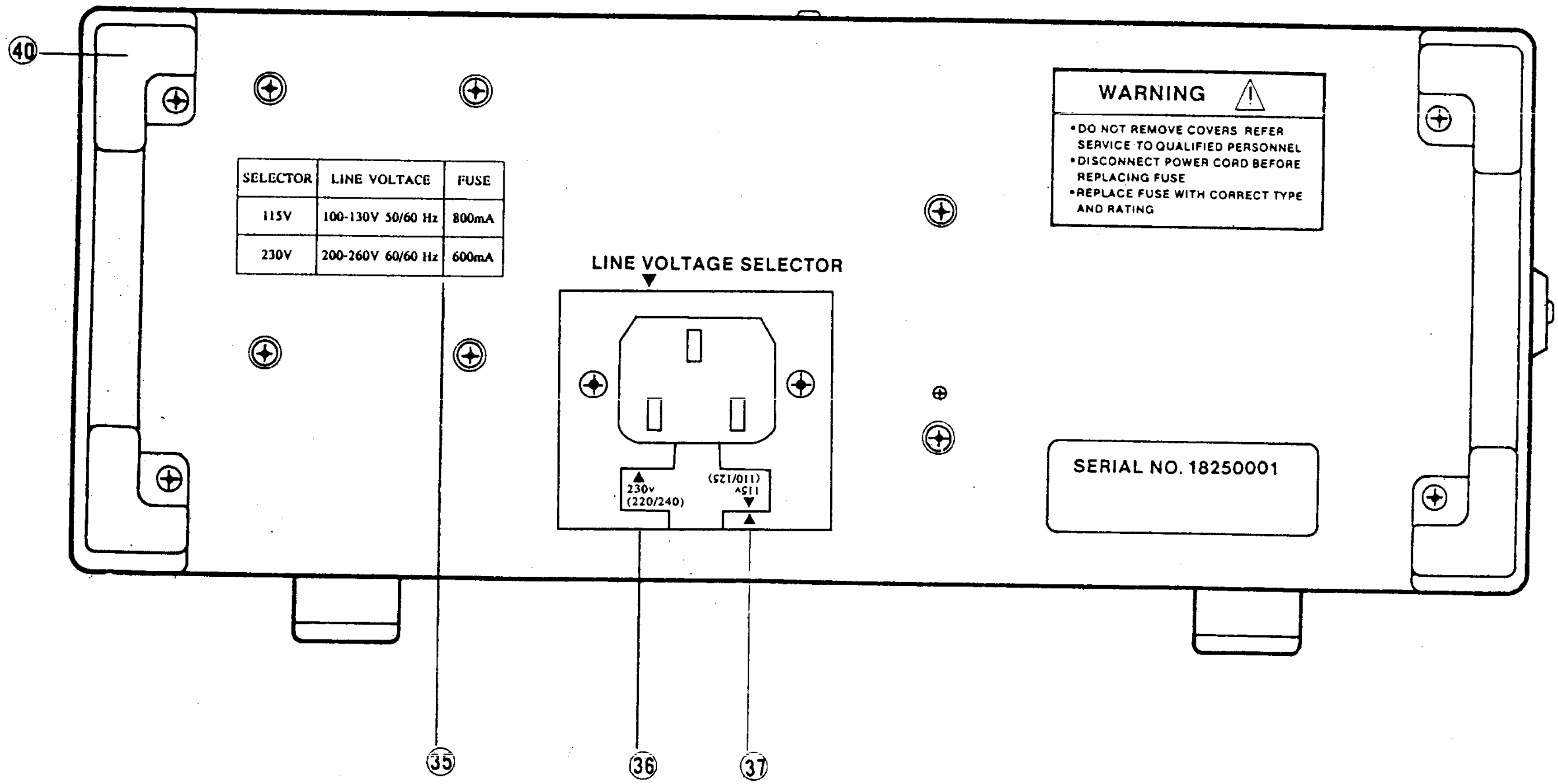


Fig. 4

PS-XX5 REAR PANEL

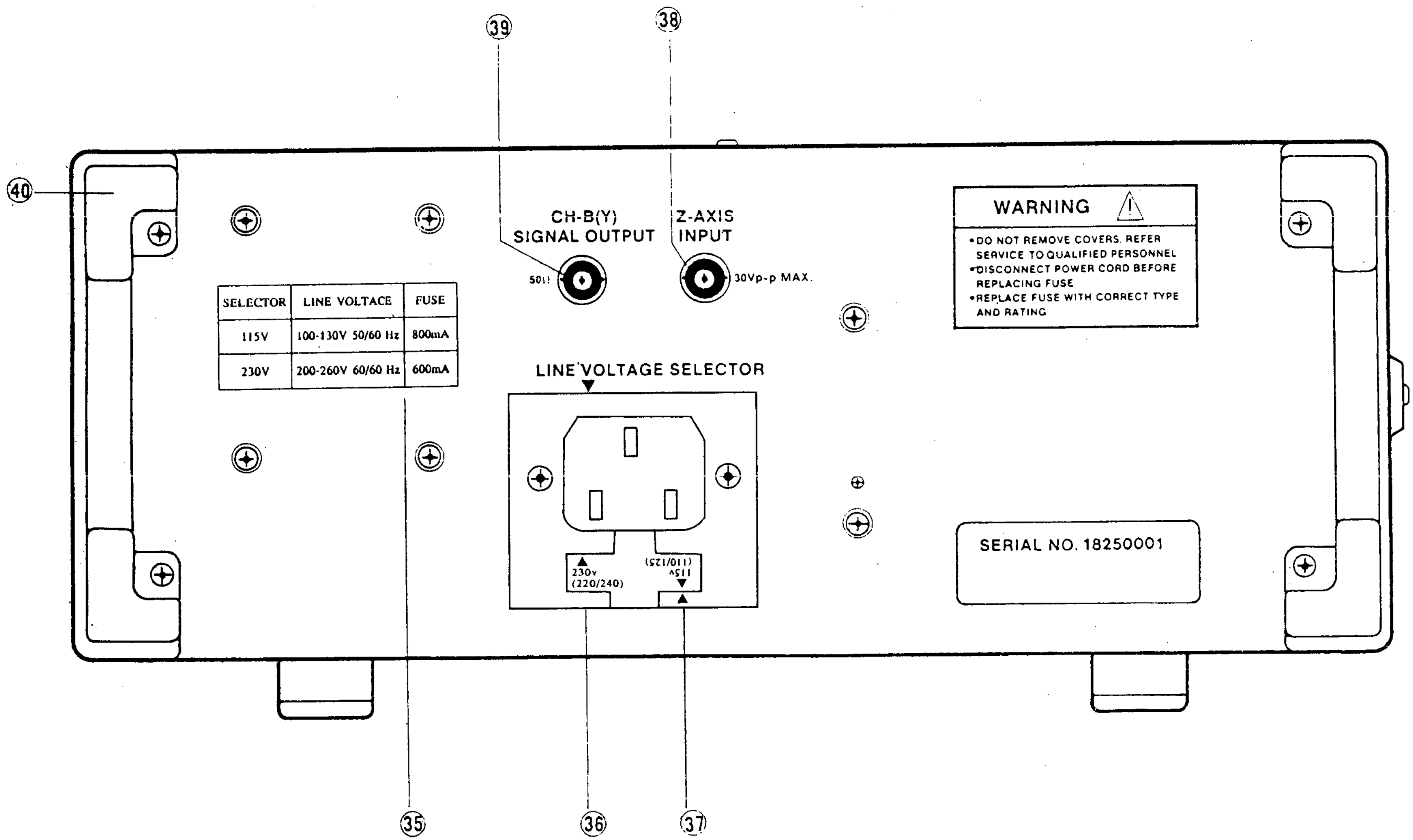


Fig. 5

WARNING (safety precautions)

The following precautions must be observed to help prevent electric shock.

1. When the oscilloscope is used to make measurements in equipment that contains high voltage, there is always a certain a mount of danger from electrical shock. The person using the oscilloscope in such condition should be a qualified electronics technician or otherwise trained and qualified to work in such circumstances.

2. Do not operate this oscilloscope with the cover removed unless you are a qualified service technician. High voltage up to 1250 volts is present when the unit is operating with the cover removed.

3. The ground wire of the 3 – wire AC POWER plug places the chassis and housing of the oscilloscope at earth ground.
Use only a 3 - wire outlet, and do not, attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard.

CAUTION (Equipment protection precautions)

The following precautions will help avoid damage to the oscilloscope

1. Never allow a small spot of high brilliancy to remain stationary on the screen for more than a few seconds. The screen may become permanently burned, a spot will occur when the scope is set up for X-Y operation and no signal is applied. Either reduce the intensity so the spot in barely visible, apply signal, or switch back to normal sweep operation. It is also advisable to use low intensity with ATUO triggering and no signal applied for long periods. A high intentsity trace at the same position could cause a line to become permanently burned onto the screen.

2. Do not obstruct the ventilating holes in the case, as this will increase the internal temperature.

3. Excessive voltage applied to the input jacks may damage the oscilloscope. The maximum ratings of the inputs are as follows:

Input terminal	Maximum allowable input voltage
CH1, CH2 inputs	400 Vpeak (DC + AC peak)
EXT TRIG input	300 Vpeak (DC + AC peak)
Probe inputs (X10)	600 Vpeak (DC + AC peak)
Z-Modulation input	30 Vpeak (DC + AC peak)

Never apply external voltage to oscilloscope output jacks.

4. Always connect a cable from the ground terminal of the oscilloscope to the chassis of the equipment under test. Without this precaution, the entire current for the equipment under test may be drawn through the probe chip leads under certain circumstances. Such conditions could also pose a safety hazard, which the ground cable will prevent.

OPERATING TIPS

The following recommendations will help obtain the best performance from the oscilloscope.

1. Always use the probe ground clips for best results, attached to a circuit ground point near the point of measurement. Do not rely solely on an external ground wire in lieu of the probe ground clips as undesired signals may be induced.

2. Avoid the following operating conditions:
   a. Direction sunlight.
   b. High temperature and humidity.
   c. Mechanical vibration.
   d. Electrical noise and strong magnetic fields, such as near large motors, power supplies, transformers, etc.

3. Occasionally check trace rotation, probe compensation, and calibration accuracy of the oscilloscope.

4. Terminate the output of a signal generator in its characteristic impedance to minimize ringing, especially if the signal has fast edges such as square waves or pulses. For example, the typical 50 Ω output of a square wave generator should be terminated into an external 50 Ω terminating resistor and connected to the oscilloscope with 50 Ω coaxial cable.

5. Probe compensation adjustment matches the probe to the input of the scope. For best results, compensation should be adjusted initially, then the same probe always used with the same channel. Probe compensation should be readjusted when a probe from a different oscilloscope is used.

PREPARE EFFORE USE

Check the AC line voltage selector plug on the rear panel of the oscilloscope in correct position for the AC line voltage before connecting the power cord to the AC line outlet.
Set the switches and controls of the front panel as shown below.

* POWER (30) in OFF position.
* INTENSITY (31) in mid-position.
* FOCUS (28) in mid-position.
* VERT MODE (7) in CHA position.
* CH1 and CH2 amplitude VAR (5) (11) to CAL.
* CH1-position and CH2-position (25) (27) to mid-position.
* AC-GND-DC (2) (14) in GND.
* VOLT/DIV (4) (10) to 50 mV/DIV.
* TIME/DIV (15) to 0.5mS/DIV.
* Sweep VAR (22) to CAL.
* COUPLING (24) in AUTO position.
* SOURCE (23) in CH1 position.
* TRIG LEVEL (26) is push down to "+".
* MAIN/MIX/DELAY (X-Y) (19) to MAIN position. (PS-205 only)
* POSITION (18) to mid-position.

INITIAL STARTING PROCEDURE

1. Turn the power switch on and make sure that the POWER pilot LED is lit.

2. A trace should appear on the CRT screen, if trace are not found, press BEAM FIND button to locate trace.

3. Adjust CH 1 POS control and HORIZONTAL POS control to center trace on CRT screen. Adjust the trace brightness with the INTENSITY control, and the trace sharpness with the Focus control.

4. Connect the probe (in the 10:1 division ratio) to the CH 1 INPUT terminal, and apply the 2 Vp-p CALIBRATOR signal to the probe tip.
5. Set the AC-GND-DC switch at the AC state. A waveform as shown in Fig 6.

6. Single channel operation with CH 2 also can be made in a similar manner.

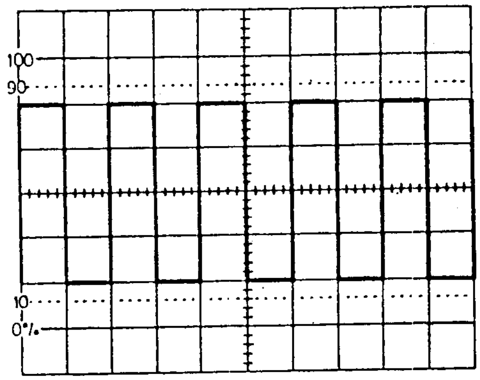


Fig. 6

DUAL–CHANNEL OPERATION

Dual-channel includes ALT (set VERT MODE in DUAL position and push down the HOLD OFF switch) and CHOP (set VERT MODE in DUAL position and pull out the HOLD OFF switch).

In the ALT mode, one sweep displays the CH 1 signal and the next sweep displays the CH 2 signal in an alternating sequence. This mode is normally used for viewing high-frequency or high-speed signals at sweep times of 1 mS/DIV and faster.

In the CHOP mode, the sweep is chopped and switched between CH 1 and CH 2. Chop sweep is normally used for viewing low-frequency or low-speed signals at sweep times of 1 mS/DIV and slower.

ADD OPERATION

When th VERT MODE switch is set to ADD, the algebraic sum of CH 1 + CH 2 is displayed as a signal trace.

When the CH B position knob is pulled out (PULL INV), the algebraic difference of CH 1 – CH 2 is displayed.

X-Y OPERATION

When the MAIN-MIX-DELAY switch is set to X-Y position, the VERT MODE switch is set to CH 2 (X-Y) and trigger source switch to CH 1 (X-Y) position, the oscilloscope operates as an X-Y scope with the CH 1 signal for the X-axis and the CH 2 signal for the Y-axis. Notice that the bandwidth of the X-axis becomes DC to 1 MHz (-3db). When high frequency signals are displayed in the X-Y operation, pay attention to the frequency bandwidth and phase difference between X and Y axis.

TRIGGERING

Proper triggering is essential for efficient operation of an oscilloscope. In order to obtain a stable display in single-trace or dual-trace operation, The user of the oscilloscope must make himself throughly familiar with the triggering functions and procedures.

1. Trigger Source Switch

The TRIGGER SOURCE switch selects the signal to be used as the sync trigger.

CH 1 SET the SOURCE switch to CH 1. The CH 1 signal becomes the trigger sources regardless of the vertical Mode selection.

CH 2 SET the SOURCE switch to CH 2. The CH 2 signal becomes the trigger source regardless of the Vertical Mode selection.

LINE – The AC power line frequency signal is used as the trigger signal. This method is effective when the measured signal has a relationship with the AC line frequency, especially for measurements of low level AC noise of audio circuits, thyristor circuits, etc.

EXT – The sweep is triggered with an external signal applied to the external trigger input terminal.
An external signal which has a periodic relationship with respect to the measured signal is used. Since the measured signal (vertical input signal) is not used as the trigger signal, the waveform display can be done independent of the measured signal.

ALT when the ALT dual-trace VERTICAL MODE is selected, set the source switch to CH 1 and PULL CH 1 position VR.

2. Trigger Coupling Switch

This switch is used to select the coupling of the triggering signal to the trigger circuit in accordance with the characteristics of the measured signal.

AUTO: When no triggering signal is applied or when triggering signal frequency is more than 100Hz, sweep runs in the free run mode.

NORM: When no triggering signal is applied, sweep is in a ready state and the trace is blanked out. Used primarily for observation of signals of 100Hz or lower.

TV-V: Trigger bandwidth range is DC ~ 1KHz when signal is more than 1 DIV.

TV-H: Trigger bandwidth range is 1KHz ~ 100KHz when signal is more than 1 DIV.

This is convenient for checking amplitudes, waveshape, or waveform period measurements, and even permits simultaneous observation of two waveforms which are not related in frequency or period. However, this setting is not suitable for phase or timing comparison measurements. For such measurements, both traces must be triggered by the same sync signal.

3. TRIG LEVEL Control

The TRIG LEVEL control adjusts the start of the sweep to almost any desired point on a waveform. On sine wave signals, the phase at which sweep begins is variable. Note that if the TRIG LEVEL control is rotated toward its extreme + or – setting, no sweep will be developed in the normal trigger mode because the triggering threshold exceeds the peak amplitude of the sync signal.

4. SLOP Switch

This switch selects the slope (polarity) of the triggering signal.

Push down the switch to be set in the "+" state, triggering occurs as the triggering signal crosses the triggering level in the direction of signal increase (i.e, positive direction).
Pull up the switch to be set in the "–" state, triggering occurs as triggering signal crosses the triggering level in the direction of signal decrease (i.e, negative direction).

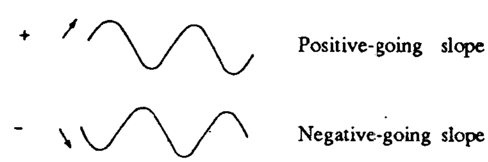


Fig. 7

5. HOLD OFF

Controls hold-off time between sweep signals to obtain stable display when triggering an aperiodic signal. The control hold off time ranges from 1 to 5 times timebase.

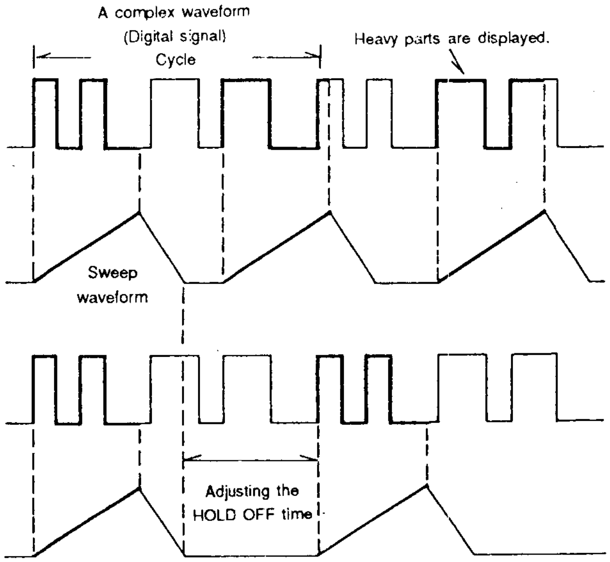


Fig. 8

Fig. 8 ① shows a case for HOLD OFF knob at the NORM position. Various different waveforms are overlapped on the screen, making the signal observation unsuccessful.
Fig. 8 ② shows a case in which the undesirable portion of the signal is held off.
The same wavefotms are displayed on the screen without overlapping.
In such a case, the sweep can be stably synchronized to the measured signal waveform by adjusting the HOLD OFF time (sweep pause time) of the sweep waveform.

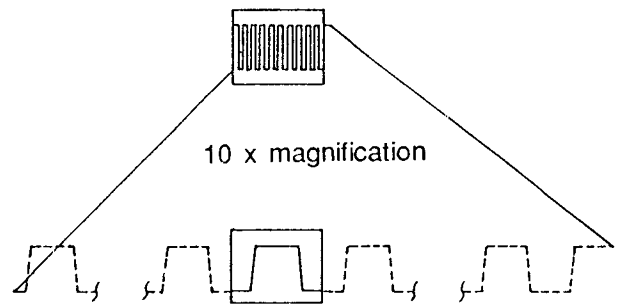
TIME BASE

1. Sweep TIME/DIV Control

Set the sweep TIME/DIV control to display the desired number of cycles of the waveform. If there are too many cycles displayed for good resolution, switch to a faster sweep time. If only a line is displayed, try a slower sweep time. When the sweep time is faster than the waveform being observed, only part of it will be displayed, which may appear as a straight line for a square wave or pulse waveform.

2. Sweep Magnification

When a certain position of the displayed waveform is needed to be expanded timewise, a faster sweep speed may be used. However, if the required portior is far away from the starting point of the sweep, the required portion may run off the CRT screen. In such a case, pull out (set in the x10 MAG state) the POSITION switch KNOB. When this is done, the displayed waveform is expanded by 10 times to right or left with the center of screen at the center of expansion.



Any part can be covered by means of POSITION control.
Fig. 9

The sweep time during the magnification operation is obtained as follows:
(Value indicated by TIME/DIV switch) x 1/10
Thus, the unmagnified maximum sweep speed (0.1 μsec/DIV) can be made faster with magnification as follows:
0.1 μsec/DIV x 1/10 = 10 nsec/DIV

When the sweep is magnified and the sweep speed has become faster than 0.1 μsec/DIV, the trace may become darker.

3. MAIN/MIX/DELAY Switch

When turn the switch to MAIN position, the waveform of display on the screen is main sweep only.
When turn the switch to MIX position, the waveform of display on the screen is shown in Fig 10

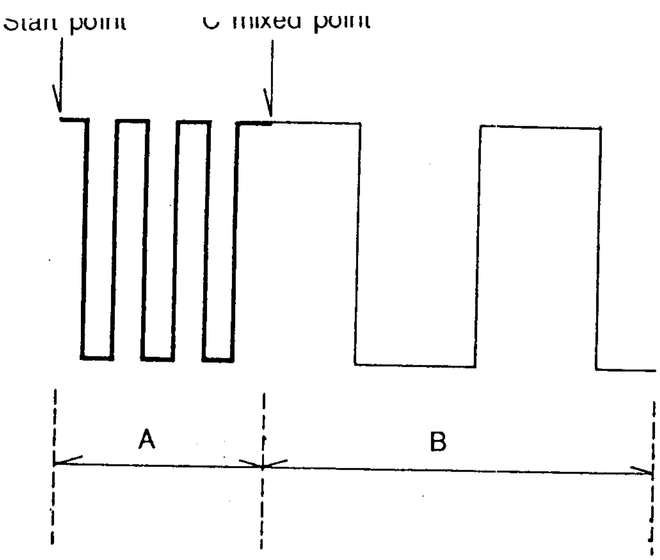


Fig. 10

The portion of A is main sweep which is set by the MAIN TIMEBASE. The portion of B is delay sweep which is set by the DLEAY TIMEBASE. The mixed point C is continuously variable by means of the DELAY TIME POSITION ⑳ switch.
When turn the switch to DELAY position. A portion of Fig 10 disappears, the mixed point C replaces the position of starting point and B portion of Fig 10 displays only on the screen.
Note: DELAY timebase must be faster than MAIN timebase and not exceed 10 times.

X-Y OPERATION

X-Y operation permits the oscilloscope to perform many measurements not possible with conventional sweep operation. The CRT display becomes an electronic graph of two instantaneous voltages. The display may be a direct comparison of the two voltages such as stereoscope display of stereo signal outputs. However, the **X-Y** mode can be used to graph almost any dynamic characteristic if a transducer is used to change the characteristic (frequency, temperature, velocity, etc.) into a voltage. One common application is frequency response measurements, where the Y axis corresponds to signal amplitude and the X axis corresponds to frequency.

1. Press the **X-Y** switch. In this mode, channel 1 becomes the X axis input and channel 2 becomes the Y axis input. All **VERTICAL MODE** switches should be disengaged for X-Y operation.

2. The X and Y positions are now adjusted using the **X POS**ition and the channel 2 **POS**ition controls respectively.

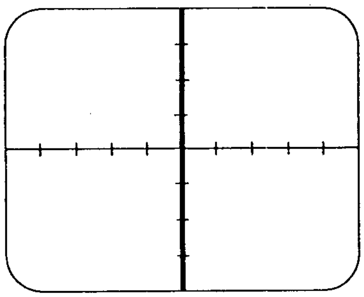
3. Adjust the amount of vertical (Y axis) deflection with the **CH 2 VOLTS/DIV** and **VARIABLE** controls.

4. Adjust the amount of horizontal (X axis) deflection with the **CH 1 VOLTS/DIV** and **VARIABLE** controls.

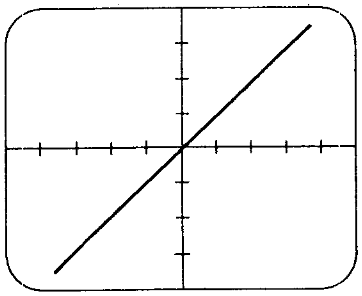
COMPONENT TEST

1. Press in COMP TEST pushbutton to place oscilloscope in component test operating mode.
2. Disconnect CH1 and CH2 input connectors.
3. Insert diode or zener diode, LED, capacitor, etc., between COMP TEST socket and ground
4. Verify that displayed waveform are similar to the Test Patterns shown in Fig 11.
5. When you have finished component testing, press COMP TEST pushbutton to out position. This disables component test mode of operation.

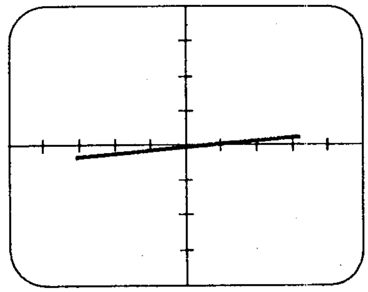
WAVEFORM CHART



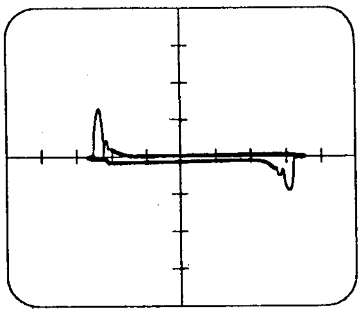
0 Ω (short)



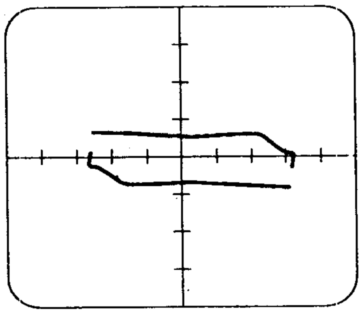
500 Ω resistor



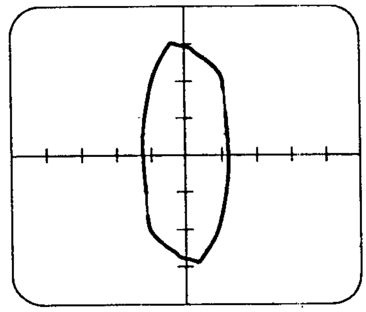
10 kΩ resistor



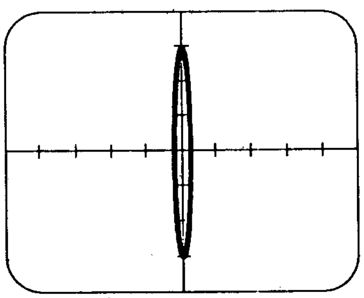
.1 µF ceramic capacitor



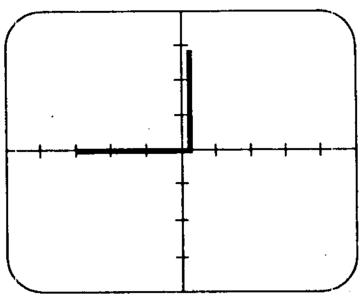
1 µF electrolytic capacitor



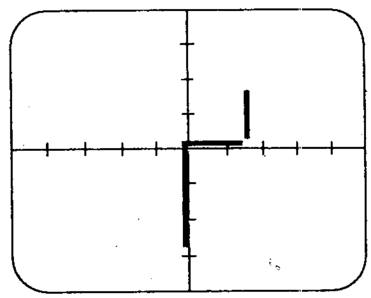
10 µF electrolytic capacitor



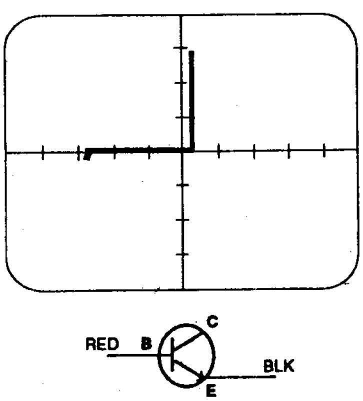
100 µF electrolytic capacitor



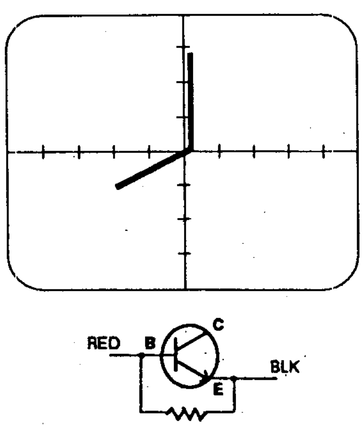
Silicon diode

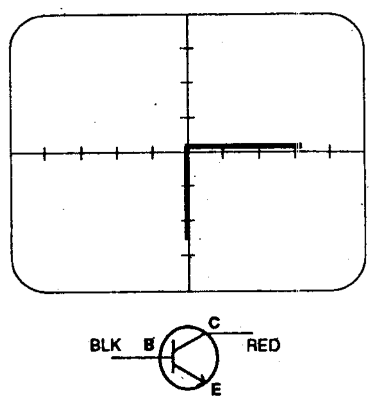


4.7 V zener diode



See "Caution" on Page 24





See "Caution" on Page 24

DC VOLTAGE MEASUREMENTS

(Refer to Fig. 12)

The following technique may be used to measure the instantaneous de level at any portion of a waveform, or to measure a dc voltage where no waveform is present.

1. Connect the signal to be measured to the input jack and set the **CH 1/CH 2** switch to the channel to be used. Set the **VOLTS/DIV** and sweep **TIME/DIV** controls to obtain a normal display of the waveform to be measured. The **VARIABLE** control must be set to **CAL**.

2. Set the **COUPLE** switch to **AUTO** and the **AC-GND-DC** switch to **GND**. This establishes a trace at the zero volt reference. Using the POSition control, adjust the trace to the desired reference level position, making sure not to disturb this setting once made.

3. Set the **AC-GND-DC** switch to **DC** to observe the waveform, including its dc component. If an inappropriate reference level position was selected in step 2 or an inappropriate **VOLTS/DIV** setting was made, the waveform may not be visible at this point (deflected completely off the screen). This is especially true when the dc component is large with respect to the waveform amplitude. If so, reset the **VOLTS/DIV** control and repeat steps 2 and 3 until the waveform and the zero reference are both on the screen.

4. Use the X **POS**ition control to bring the portion of the waveform to be measured to the center vertical graduation line of the graticule scale.

5. Measure the vertical distance from the zero reference level to the point to be measured (at least 3 divisions desirable for best accuracy). The reference level can be rechecked by momentarily returning the **AC-GND-DC** switch to **GND**.

6. Multiply the distance measured above by the **VOLTS/DIV** setting and the probe attenuation ratio as well. Voltages above the reference level are positive and voltages below the reference level are negative.

The measurement is summarized by the following equation:

DC level + Vert div x **VOLTS/DIV** x Probe

For the example shown in Fig. 12, the point being measured is 3.8 divisions from the reference level (ground potential). If the **VOLTS/DIV** control is set to 0.2 V and a 10:1 probe is used, the dc voltage level is calculated as follows:

DC level = 3.8 (div) x 0.2 (V/div) x 10 = 7.6 V

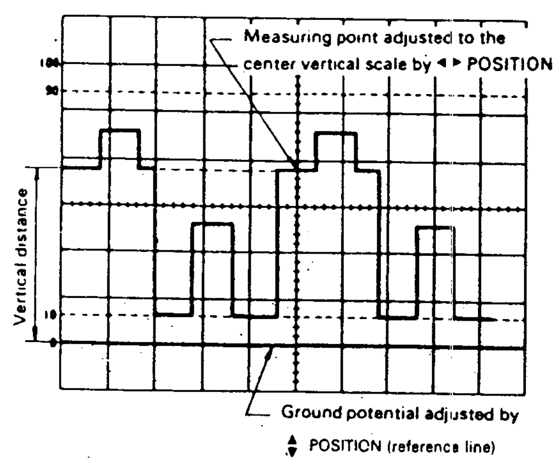


Fig. 12 DC Voltage Measurement.

MEASUREMENT OF VOLTAGE BETWEEN TWO POINTS ON A WAVEFORM
(Refer to Fig. 13)

This procedure may be used to measure peak-to-peak voltages, or for measuring the voltage difference between any two points on a waveform.

1. Connect the signal to be measured to the input connector, set the **CH 1/CH 2** switch to the channel to be used, and set the **AC-GND-DC** switch to AC. Set the **VOLTS/DIV** and sweep **TIME/DIV** controls to obtain a normal display of the waveform to be measured. The **VARIABLE** control must be set to **CAL.**

2. Using the **POS**ition control, adjust the waveform position such that one of the two points falls on a major horizontal graduation line.

3. Using the **X POS**ition control, adjust the second point to coincide with the center vertical graduation line.

4. Measure the vertical distance between the two points (at least 3 divisions desirable for best accuracy). Multiply the number of divisions by the setting of the **VOLTS/DIV** control. If a probe is used, further multiply this by the probe attenuation ratio.

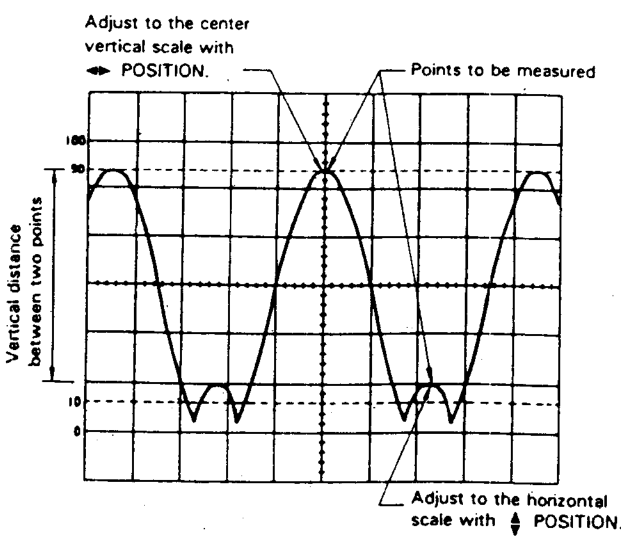


Fig. 13 Voltage Measurement.

The measurement is summarized by the following equation:

Voltage = Vert div x VOLTS/DIV x probe

For the example shown in Fig. 13, the two points are separated by 4.4 divisions vertically. If the **VOLTS/DIV** setting is 20 mV and a 10:1 probe is used, the voltage is calculated as follows:

Voltage = 4.4 (div) x 20 (mV/div) x 10
= 880 mV

TIME MEASUREMENTS
(Refer to Fig. 14)

This is the procedure for making time (period) measurements between two points on a waveform. The two points may be the beginning and ending of one complete cycle if desired.

1. Connect the signal to be measured to the input connector and set the **CH 1/CH 2** switch to the channel to be used. Set the **VOLTS/DIV** and sweep TIME/DIV controls to obtain a normal display of the waveform to be measured. Be sure the VAR SWEEP control is set to **CAL.**

2. Using the **POS**ition control, set one of the points to be used as a reference to coincide with the horizontal center line. Use the **X POS**ition control to set this point at the intersection of any vertical graduation line.

3. Measure the horizontal distance between the two points (at least 4 divisions desirable for best accuracy). Multiply this by the setting of the sweep **TIME/DIV** control to obtain the time between the two points. If **X10** magnification is used, multiply this further by 1/10.

The measurement is summarized by the following equation:

Time = Hor div x **TIME/DIV**

(x 1/10 if **X10** is used)

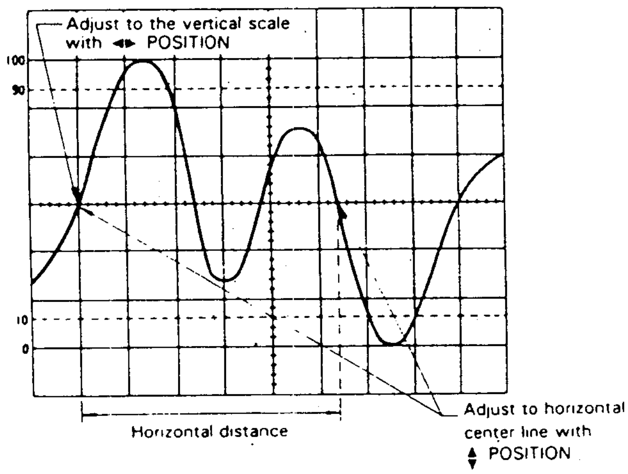


Fig. 14 Time Measurement.

For the example shown in Fig. 14, the horizontal distance between the two points is 5.4 divisions. If the TIME/DIV is 0.2 ms and X10 magnification is not used, the time period is calculated as follows:

$$\text{Time} = 5.4\ (\text{div}) \times 0.2\ (\text{ms/div}) = 1.08\ \text{ms}$$

FREQUENCY MEASUREMENTS

Method No. 1
(Refer to Fig. 15)

Frequency measurements are made by measuring the time period of one cycle of waveform and calculating the frequency, which equals the reciprocal of the time period.

1. Set up the oscilloscope to display one cycle of waveform (see Fig. 15).
2. Measure the time period of one cycle an calculate the frequency as follows:

$$\text{Freq} = \frac{1}{\text{Period}}$$

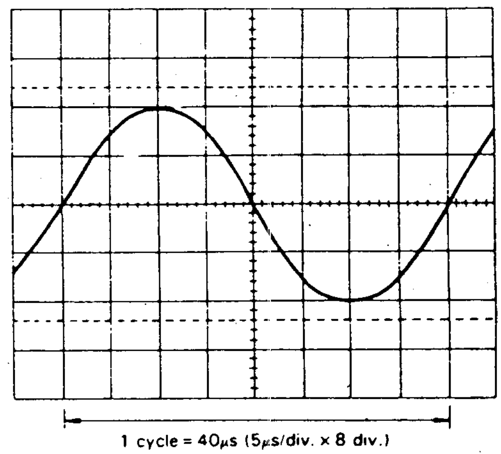


Fig. 15 Frequency Measurement.

In the example shown in Fig. 15, a period o 40 μs is observed. Substituting this value into th above equation, the frequency is calculated a: follows:

$$\text{Freq} = \frac{1}{40 \times 16^{-6}} = 2.5 \times 14^{4} = 25\ \text{kHz}$$

Method No. 2
(Refer to Fig. 16)

While the previously described method relies upon direct period measurement of one cycle, the frequency may also be measured by counting the number of cycles present in a given time period.

1. Set the the oscilloscope to display several cycles of the waveform. The **VAR SWEEP** control must be set to **CAL.**

2. Count the number of cycles of waveform between a chosen set of vertical graduation lines (see Fig. 16).

3. Multiply the number of horizontal divisions by the sweep **TIME/DIV** setting to calculate the time span. Multiply the reciprocal of this value by the number of cycles present in the time span. If **X10** magnification is used, multiply this further by 10. Note that errors will occur for displays having only a few cycles.

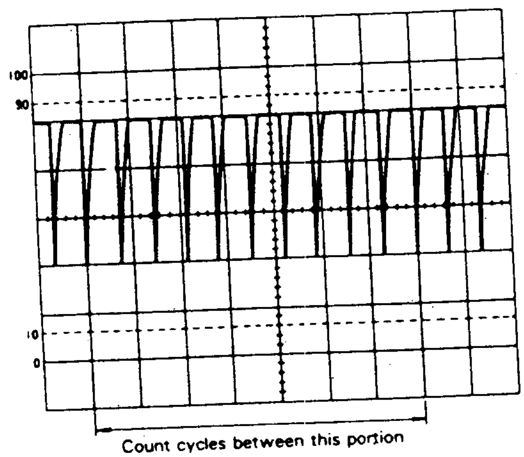


Fig 16. Alternate Method of Frequency Measurement.

The measurement is summarized by the following equations:

$$\text{Freq} = \frac{\text{No of cycles (x 10 for X10)}}{\text{Hor div x } \mathbf{TIME/DIV}}$$

For the example shown in Fig. 16, there are 10 cycles within 7 divisions. If the sweep **TIME/DIV** is 5 µs and **X10** magnification is not used, the frequency is calculated as follows:

$$\text{Freq} = \frac{10 \text{ (cycles)}}{7 \text{ (div) x } 5\ (\mu s)} = 285.7 \text{ kHz}$$

PULSE WIDTH MEASUREMENTS
(Refer to Fig. 17)

1. Apply the pulse signal to the input jack and set the **CH 1/CH 2** switch to the channel to be used.

2. Use the **VOLTS/DIV** and **VARIABLE** controls to adjust the display so the waveform is easily observed. Use the **POSition** control to position the pulse over the center horizontal graduation lines.

3. Measure the distance between the leading edge and trailing edge of the pulse (along the center horizontal graduation line). Be sure that the **VAR SWEEP** control is set to **CAL.** Multiply the number of horizontal divisions by the sweep **TIME/DIV**, and if **X10** magnification is used, further multiply this value by 1/10.

The measurement is summarized by the following equation:

Pulse Width = Hor div x **TIME/DIV**

(x 1/10 if **X10** is used)

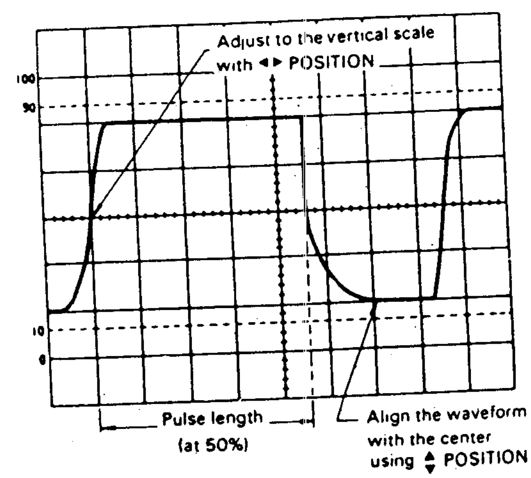


Fig. 17 Pulse Width Measurement.

For the example shown in Fig. 17, the pulse width at the center of the pulse is 4.6 divisions. If the sweep TIME/DIV is 0.2 ms and X10 magnification is used, the pulse width is calculated as follows:

Pulse Width =
4.6 (div) x 0.2 (ms/div) x 1/10
= .092 ms or 92 µs

PULSE RISE TIME AND FALL TIME MEASUREMENTS
(Refer to Fig. 18)

For rise time and fall time measurements, the 10% and 90% amplitude points are used as starting and ending reference points.

1. Apply a signal to the input jack and set the **CH 1/CH 2** switch to the channel to be used. Use the **VOLTS/DIV** and **VARIABLE** controls to adjust the waveform peak to peak height to six divisions.

2. Using the **POSition** control, adjust the display so that the waveform is centered vertically on the display. Set the sweep **TIME/DIV** control to as fast a setting as possible while still being able to observe both the 10% and 90% points. Set the **VAR SWEEP** control to the **CAL** position.

3. Use the **X POSition** control to adjust the 10% point to coincide with a vertical graduation line and measure the horizontal distance in divisions between the 10% and 90% points on the waveform. Multiply this by the sweep **TIME/DIV** setting and also by 1/10 if the **X10** magnification mode was used.

NOTE

Be sure that the correct 10% and 90% lines are used. For such measurements the 0, 10, 90, and 100% points are marked on the CRT screen.

The measurement is summarized by the following equation:

Rise Time = Hor div x **TIME/DIV**
(x 1/10 if **X10** is used)

For the example shown in Fig. 18, the horizontal distance is 4.0 divisions. The sweep TIME/DIV setting is 2 µs. The rise time is calculated as follows:

Rise Time = 4.0 (div) x 2 (µs/div) = 8 µs

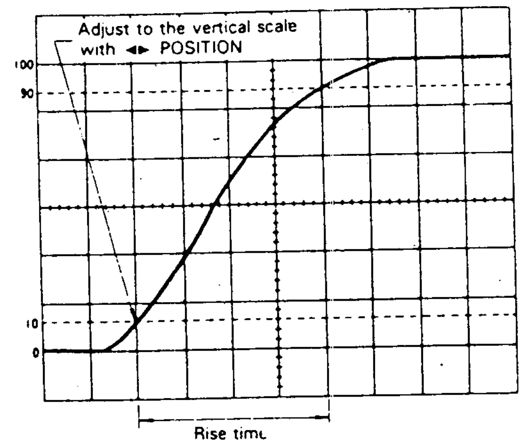


Fig. 18. Rise Time and Fall Time Measurement

TIME DIFFERENCE MEASUREMENTS
(Refer to Fig. 19)

This procedure is useful in measurement of time difference between signals that are synchronized to one another but skewed in time.

1. Apply the two signals to the **CH 1** and **CH 2** input jacks and select the dual-trace display mode (either the **CHOP** or **ALT** mode). **CHOP** is usually chosen for low frequency signals and **ALT** for high frequency signals.

2. Select the faster of the two signals as the trigger **SOUREC** and use the **VOLTS/DIV** and sweep **TIEM/DIV** controls to obtain and easily observed display.

3. Use the POSition controls to superimpose both waveforms to intersect the center horizontal graduation line as shown in Fig. 19. Use the **X POSition** control to set the reference signal coincident with one of the vertical graduation lines.

4. Measure the horizontal distance between the two signals and multiply this distance (in divisions) by the sweep **TIME/DIV** setting. If **X10** magnification is used, multiply this again by 1/10.

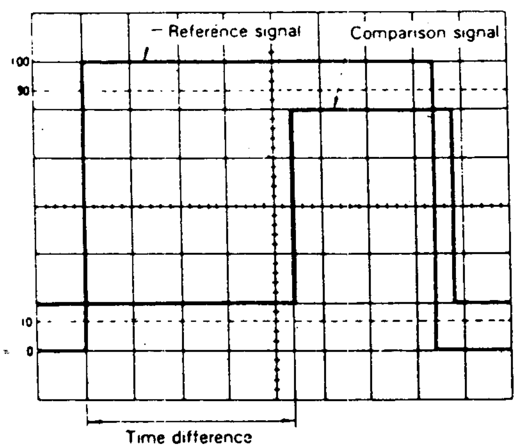


Fig. 19 Time Difference Measurement.

The measurement is summarized by the following equation:

Time = Hor div x **TIME/DIV**
(x 1/10 if **X10** is used)

For the example shown in Fig. 19, the horizontal distance measured is 4.4 divisions. If the sweep **TIEM/DIV** is 0.2 ms and **X10** magnification is not used, the time difference is calculated as follows:

Time = 4.4 (div) x 0.2 (ms/div)
= 0.88 ms or 880 μs

PHASE DIFFERENCE MEASUREMENTS

Method No. 1
(Refer to Fig. 20)

This procedure is useful in measuring the phase difference of signals of the same frequency.

1. Apply the two signals to the **CH 1** and **CH 2** input jacks, selecting the dual-trace display mode (either **ALT** or **CHOP**).

2. Set the trigger **SOURCE** switch to the signal which is leading in phase (or to **LINE** if device is line voltage operated) and use the **VOLTS/DIV** controls to adjust the two waveforms so they are equal in amplitude.

3. Use the POSition controls to position the waveforms in the vertical center of the screen. Use the **TIME/DIV** and **VAR SWEEP** controls to adjust the display so one cycle of the reference signal occupies 8 divisions horizontally (see Fig. 20). The **TRIG LEVEL** and **X POSition** controls are also useful in achieving this display. The display should be as shown in Fig. 20, where one division now represents 45° in phase.

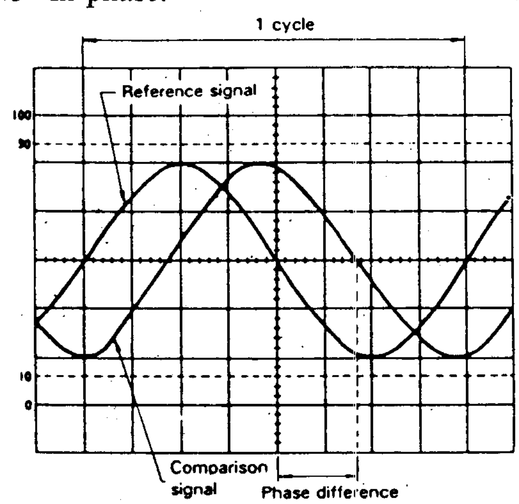


Fig. 20. Phase Difference Measurement.

4. Measure the horizontal distance between corresponding points on the two waveforms. Multiply the distance (in divisions) times 45° per division to obtain the phase difference.

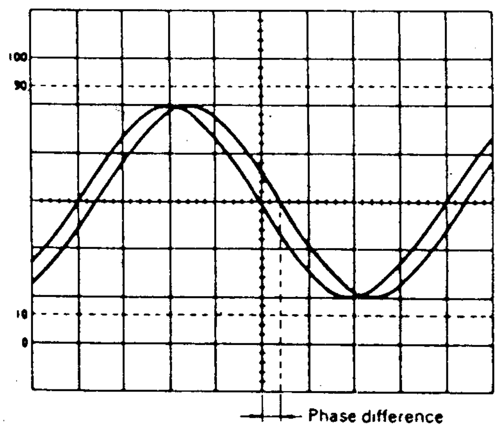
The measurement is summarized by the following equation:

Phase difference = Hor div x 45°/div

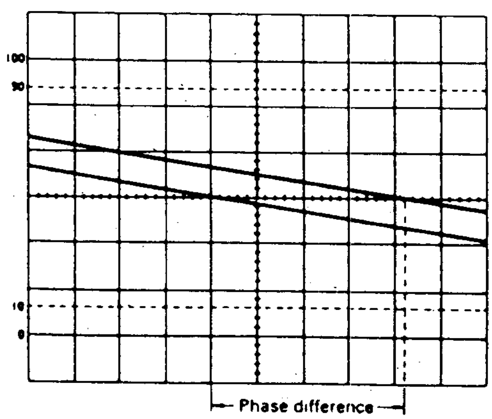
For the example shown in Fig. 20, the horizontal distance is 1.7 divisions. Thus, the phase difference is calculated as follows:

Phase difference = 1.7 x 45°/div = 76.5°

Method No. 2
(Refer to Fig. 21)



One cycle adjusted to occupy 8 div.



Expanded sweep waveform display.

Fig. 21. Measuring Small Phase Difference.

The above procedure allows 45° per division, which may not give the desired accuracy for small phase differences.

If greater accuracy is required, the sweep **TIME/DIV** setting may be changed to expand the display as shown in Fig. 21, but the **VAR SWEEP** setting must not be touched. If necessary, the **TRIG LEVEL** may be readjusted. For this type of operation, the relationship of one division to 45° no longer holds. Instead the following equation must be used:

$$\text{Phase diff} = \text{Hor div} \times 45°/\text{div} \times \frac{A}{B}$$

Where:
A = New **TIME/DIV** setting.
B = Original **TIME/DIV** setting.

A simpler method of obtaining more accuracy quickly is to simply use **X10** magnification for a scale factor of 4.5°/division.

X-Y MODE APPLICATIONS

Phase Measurements
(Refer to Fig. 22)

A dual-trace method of phase measurement was previously described. A second method of phase measurement requires calculations based on the Lissajous patterns obtained using X-Y operation. Distortion due to non-linear amplification can also be displayed.

A sine wave is applied to the audio circuit being tested. The same sine wave is also applied to the vertical input of the oscilloscope, and the output of the tested circuit is applied to the horizontal input of the oscilloscope. The amount of phase difference between the two signals can be calculated from the resulting waveform.

1. Using an audio generator with a pure sinusoidal signal, apply a sine wave test signal at the desired test frequency to the audio network being tested.

2. Set the signal generator output for the normal operating level of the circuit being tested. If desired, the circuit's output may first be observed on the oscilloscope with normal sweep operation. If the test circuit is overdriven, the sine wave display on the oscilloscope is clipped and the signal level must be reduced.

3. Connect channel 2 to the input and channel 1 to the output of the test circuit. Set channel 1 and 2 gain controls for exactly the same amplitude waveform on the display in normal sweep operation.

4. Select X-Y operation by pressing the **X-Y** switch.

5. If necessary, repeat step 3, readjusting the channel 1 and 2 gain controls for a suitable viewing size. Some typical results are shown in Fig. 22.

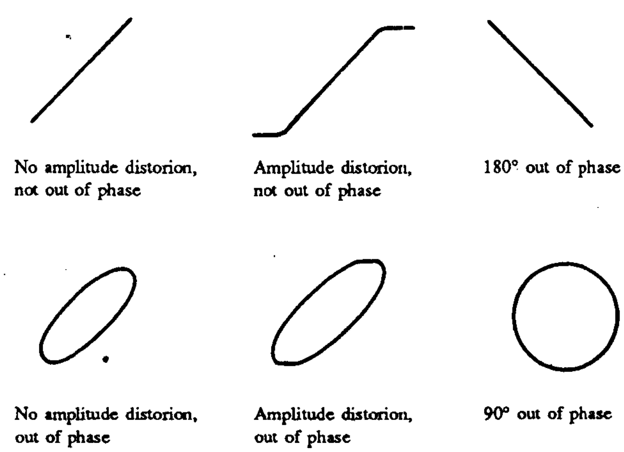


Fig. 22 Typical X-Y Phase Measurement Displays

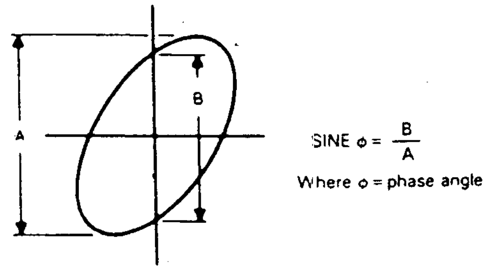


Fig. 23 Phase Measurement, X-Y Operation.

If the two signals are in phase, the oscilloscope trace is a straight diagonal line. If the vertical and horizontal gain are properly adjusted, this line is at a 45° angle. A 90° phase shift produces a circular oscilloscope pattern. Phase shift of less (or more) than 90° produces and elliptical oscilloscope pattern. The amount of phase shift can be calculated from the oscilloscope trace as shown in Fig. 23.

Frequency Response Measurements
(Refer to Fig. 24)

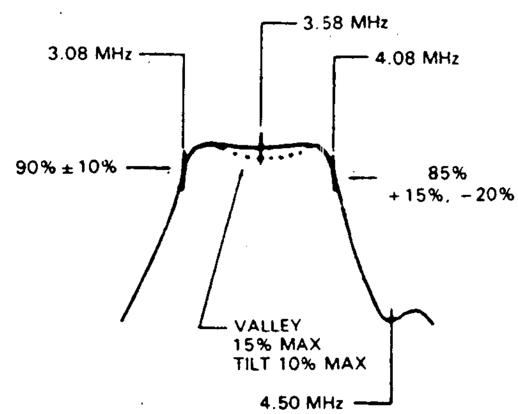


Fig. 24. Frequency Response Measurement.

A sweep generator and the X-Y mode of this oscilloscope may be used to measure the audio or rf frequency response of an active or passive device up to 20 MHz, such as an amplifier, band pass filter, coupling network, etc.

1. Connect the audio or rf output of the sweep generator to the input of the circuit under test and the output of the test circuit to channel 2 (vertical axis) of the oscilloscope. A demodulator probe will give a "text book" frequency response display as shown in Fig. 24, but a standard probe can be used which will result in an envelope display.

2. Connect the sweep ramp voltage of the sweep generator to the channel 1 input of the oscilloscope.

3. Set the **X-Y** switch to the **X-Y** position (engaged) and adjust the channel 1 and 2 controls for a suitable viewing size.

WARNING

A following instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform any servicing other contained in the operating instructions unless you are qualified to do so.

High voltage up to 1,250 volts is present when covers are removed and the unit is operating, Remember that high voltage may be retained indefinitely on high voltage capacitors. Also remember that ac line voltage is present on line voltage input circuits any time the instrument is plugged into an ac outlet, even if turned off. Unplug the oscilloscope and discharge high voltage capacitors before performing service procedures.

FUSE REPLACEMENT

If the fuse blows, the pilot light will go out and the oscilloscope will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with the correct value fuse. For 115 V line voltage operation, use a 800 mA, 250 V fuse. For 230 V line voltage operation, use a 600 mA, 250 V fuse. The fuse is located on the rear panel. Be sure that the fuse is installed so that the correct line voltage is selected (see LINE VOLTAGE SELECTION).

LINE VOLTAGE SELECTION

To select the desired line voltage, simply insert the fuse and fuse holder so that the appropriate voltage is at the top (pointed to by the arrow). Be sure to use the proper value fuse (see label on rear panel).

PERIODIC ADJUSTMENTS

Screwdriver adjustments only need to be checked and adjusted periodically. Probe compensation and trace rotation adjustments are included in this category. Procedures are given below.

Probe Compensation

1. Connect probes to **CH 1** to **CH 2** input jacks. Repeat procedure for each probe.
2. Touch top of probe to **CAL** terminal.
3. Adjust oscilloscope controls to display 3 or 4 cycles of **CAL** square wave at 5 or 6 divisions amplitude.
4. Adjust compensation trimmer on probe for optimum square wave (minimum overshoot, rounding off, and tilt). Refer to Fig 28.

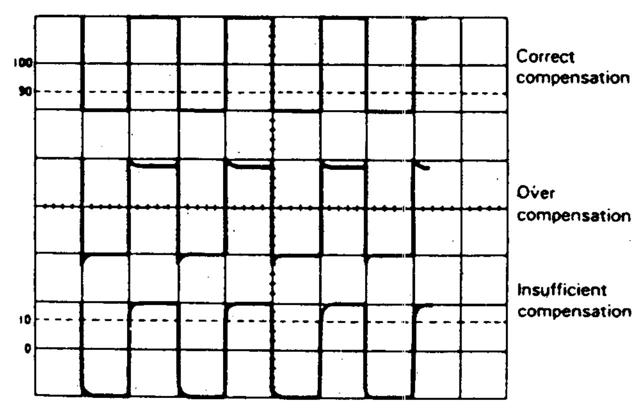


Fig 28. Probe Compensation Adjustment

Trace Rotation Adjustment

1. Set oscilloscope controls for a single trace display in **CH 1** mode, and with the channel 1 **AC-GND-DC** switch set to **GND**.

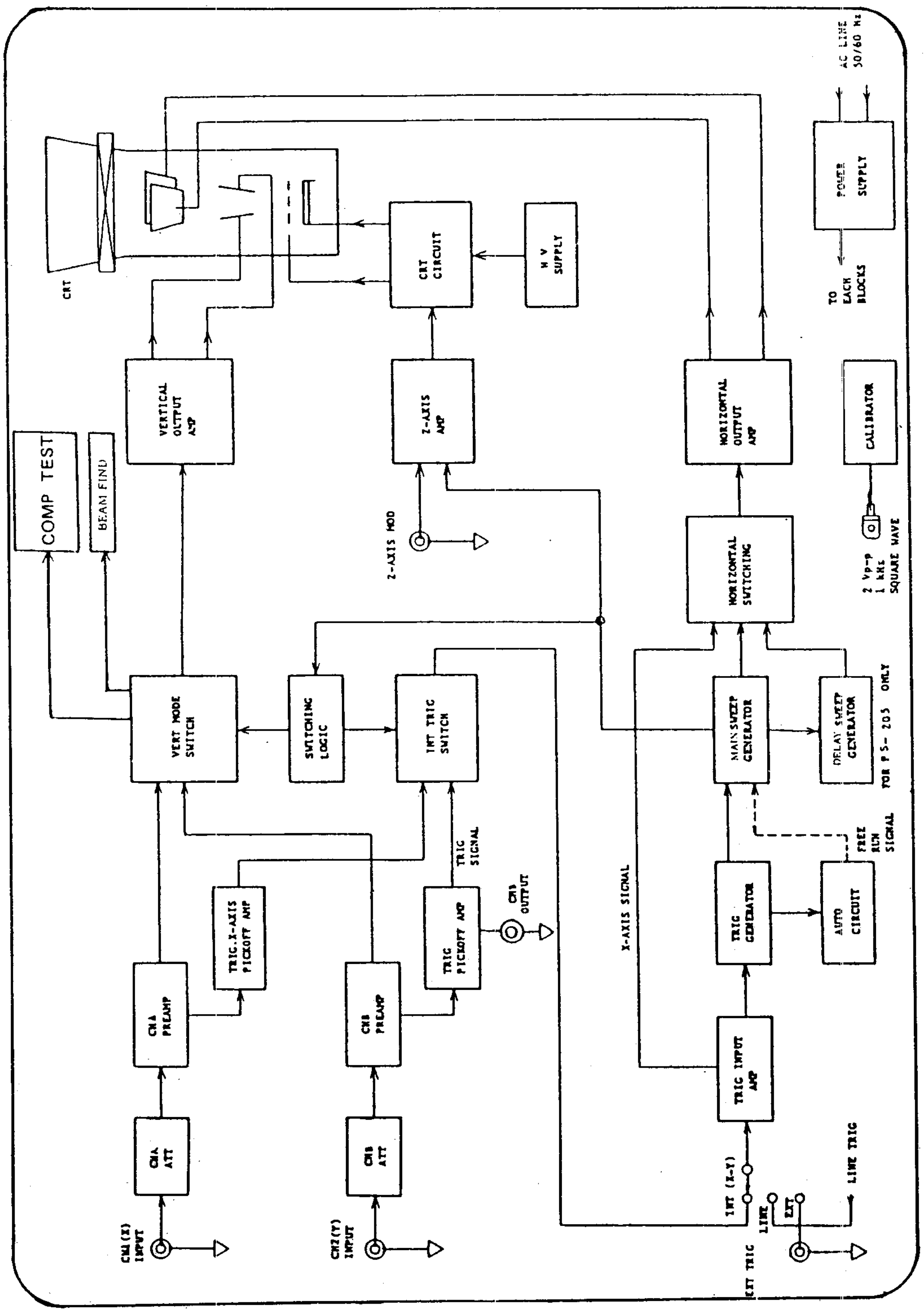
2. Use the channel 1 **POS**ition control to position the trace over the center horizontal line on the graticule scale. The trace should be exactly parallel with the horizontal line.

3. Use the **TRACE ROTATION** adjustment on the front panel to eliminate any trace tilt.

CALIBRATION CHECK

A general check of calibration accuracy may be made by displaying the output of the **CAL** terminal on the screen. This terminal provides a square wave of 2 Vp-p. This signal should produce a displayed waveform amplitude of four divisions at 0.5 V/div sensitivity for both channel 1 and 2 (with probes set for direct). With probes set for 10:1, there should be four divisions amplitude at 50 mV/DIV sensitivity. The **VARIABLE** controls must be set to **CAL** during this check.

BLOCK DIAGRAM



MACHINERY ASSEMBLY DIAGRAM