XJ 4241

Dual-trace

Portable Oscilloscope

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GENERAL

The type XJ4241 is a transistorized dual-trace portable oscilloscope that partly adopts integrated circuits. It combines small size and light weight with the ability to make precision waveform measurements.

Its vertical system provides 0 - 10 MHz bandwidth and the deflection factors from 0.01 to 5 V/div. When magnified, its highest deflection factor is 2 mV/div. Its horizontal deflection system provides calibrated sweep rate from 0.2 us to 100 ms/div. A x 5 horizontal magnifier allows each sweep rate to be increased 5 times and provides a maximum sweep rate of 40 ns/div in 0.2 us/div position.

Because it has two identical vertical input channels, it can not only be used for qualitative and quantitative measurement, but the phase of two relevant signal which have same frequency as well. The XJ4241 also has the function of Y_2-X which can be used to display the Lissajous figure. Therefore, XJ4241 is a useful test instrument for production, maintenance and adjustment of electronic appliances, such as television set, tape-recorder and radio etc. In addition, it can serve as a monitoring instrument for programme control machines.

SECTION 1. SPECIFICATIONS

Characteristics	Performance Requirements		
VERTICAL DEFLECTION SYSTEM			
Deflection Factor Range	0.01 V/div to 5 V/div, 9 steps, in a 1-2-5 sequence.		
Accuracy	± 5%		
Range of V/div VERNIER Control	Continuously variable between settings. Increase deflection factor by at least 2.5 to 1.		
Accuracy for x 5 MAG.	± 10%		
Bandwidth			
DC Coupled	0 to 10 MHz -3dB		
AC Coupled	10 Hz to 10 MHz -3dB		
Input Characteristics			
Resistance	1 MΩ ± 5%		
Capacitance	35 PF or less		
Maximum Input Voltage	250 V ($DC+AC_{p-p}$)		
Step Response	0.01 V/div	0.02 V/div	0.01 V/div (x5 mag.)
Risetime	35 ns	35 ns	50 ns
Overshoot	5 %	---	---
Drift	1 div/h or less in 0.01 V/div (not x 5 mag.)(after 1h pre-warming time under normal temperature)		
Channel Interference	1:25 or less (5 MHz)		
HORIZONTAL DEFLECTION SYSTEM			
Sweep Rate	0.2 us/div to 100 ms/div, 2 x 9 steps, in a 1-2-5 sequence.		

<table>
<tr><td rowspan="2">Accuracy</td><td colspan="3">Unmagnified</td><td colspan="3">Magnified x 5</td></tr>
<tr><td colspan="3">± 5 %</td><td colspan="3">± 10 %</td></tr>
<tr><td>VERNIER Control Range</td><td colspan="6">Continuously variable between calibrated setting. Extends the sweep rates by at least a factor of 2.5.</td></tr>
<tr><td>Sweep Linearity</td><td colspan="6">10 % or less in 1 ms/div setting (do not include mag.)</td></tr>
<tr><td rowspan="5">Trigger Sensitivity</td><td rowspan="2">Mode</td><td rowspan="2">Unit</td><td rowspan="2">Frequency range</td><td colspan="3">Min.Volt.</td></tr>
<tr><td>Int.</td><td colspan="2">Ext.</td></tr>
<tr><td rowspan="2">Norm</td><td>ms</td><td>10Hz - 20KHz</td><td>1div</td><td colspan="2">.5V_{p-p}</td></tr>
<tr><td>us</td><td>10Hz - 5 MHz</td><td>1div</td><td colspan="2">.5V_{p-p}</td></tr>
<tr><td>HF</td><td>us</td><td>5MHz - 10MHz</td><td>1div</td><td colspan="2"></td></tr>
<tr><td>Y_2-X Frequency Response
AC Coupled</td><td colspan="6">10 Hz - 100 KHz -3dB</td></tr>
<tr><td>Maximum Input Voltage (EXT TRIG)</td><td colspan="6">5 V_{p-p}</td></tr>
<tr><td colspan="7">CATHODE - RAY TUBE</td></tr>
<tr><td>Type</td><td colspan="6">9SJ150Y14 rectangular screen.
(3 inches, internal graticule)</td></tr>
<tr><td>Useful Screen</td><td colspan="6">6 x 10 div (1 div = 6 mm)</td></tr>
<tr><td colspan="7">OTHERS</td></tr>
<tr><td>Calibration Signal
Frequency
Amplitude</td><td colspan="6">Square wave
1 KHz ± 2 %
1 V_{p-p} ± 2 %</td></tr>
<tr><td>Environmental Condition
Ambient Temperature
Relative Humidity</td><td colspan="6">
0 - + 40°C
90 % or less (+ 40°C)</td></tr>
<tr><td>Power Supply</td><td colspan="6">220 V ± 10 %, 50 Hz ± 5 %</td></tr>
<tr><td>Apparent Power</td><td colspan="6">Approx. 44 VA. (Power consumption</td></tr>
</table>

	approx. 18 W).
Prewarming Time	10 min, above 0°C 30 min, 0°C or under 0°C.
Dimension	240 W x 122 H x 280 D mm.
Weight	Approx. 3.8 Kg.

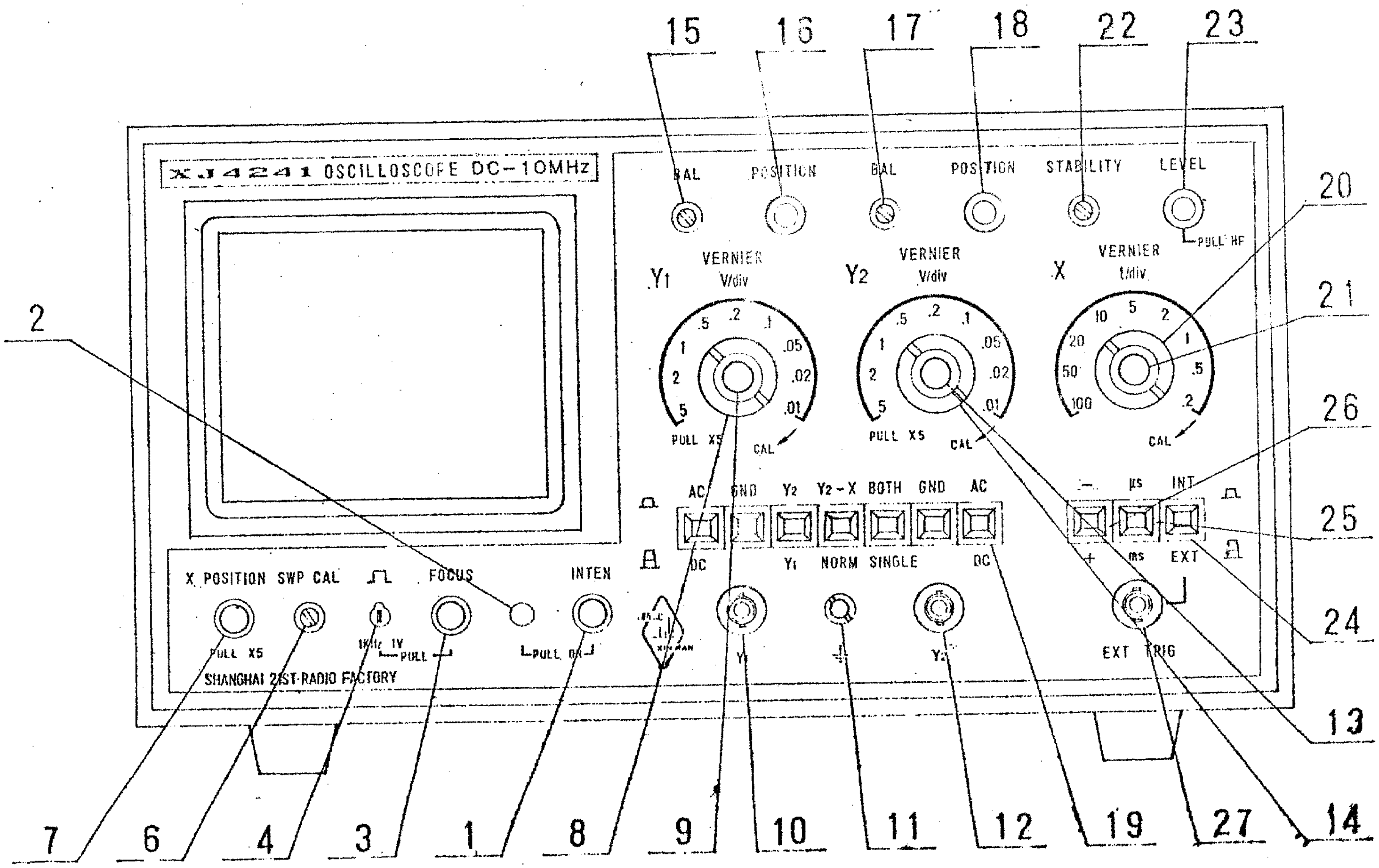


Fig.2.1 Indication of Panel Controls

SECTION 2. DESCRIPTION OF PANEL CONTROLS

1. PULL ON --- Power switch (1K3):
INTEN (1W7):

A combination control that turns instrument power on or off (pull ON - push OFF) and also controls the brightness of the display.

2. Power Indicator Lamp (3BG1):

When this lamp goes on in red, it indicates that power switch is on and the instrument is connected to a power source.

3. FOCUS (W1):

To focus the trace or spot on the CRT screen.

PULL --- Calibration signal switch (K1,K2):

When the switch is pulled out, the CZ2 provides 1KHz, 1V calibration signal.

4. ⎍(CZ2):

Output of calibration signal.

5. Astigmatism (W2) (Rear panel):

Used in conjunction with the FOCUS control to obtain a well-defined display.

6. SWP CAL (W4):

Adjust the sweep voltage of horizontal amplifier for calibrated sweep rate.

7. X POSITION (W5):

Controls horizontal position of display. Pull MAGx5.

8. V/div (20K1):

Y_1 vertical attenuator.

It selects vertical deflection factor from 0.01 V/div - 5 V/div in 9 steps.

9. VERNIER (20W1):

Y_1 variable potentiometer.

A control knob for fine, continuous attenuation of input signal. For quantitative measurement of the input signal, this knob should be set in the CAL position (full clockwise).

10. Y_1 (20CZ1):

Y_1 input socket.

11. ⏚:

Ground terminal of the instrument.

12. Y_2 (20CZ101):

Y_2 input socket.

13. VERNIER (20W101):

Y_2 variable potentiometer.

14. V/div (20K101):

Y_2 vertical attenuator.

15. BAL (21W1):

Y_1 balance.

Screwdriver adjustment to balance the input amplifier in different positions of the V/div switch.

16. POSITION (21W2):

Y_1 position.

A control to adjust the vertical position of the trace or spot.

17. BAL (22W1):

Y_2 balance.

18. POSITION (22W2):

Y_2 position.

19. Vertical Mode Switch (20K2):

It is a seven-step (self-locking) button switch.

a. AC/DC switch (left) (20K2A):

Y_1 input coupling.

Selects method of coupling input signal to input amplifier.

In the AC position (button in) of this push-push switch, signals are capacitively coupled to the vertical amplifier. The DC component of the input signal is blocked.

In the DC position (button out) of the push-push switch, all components of the input signal are passed to the input amplifier.

b. GND (left) (20K2B):

Y_1 ground.

In the position (button in) of this push-push switch, the input of the vertical amplifier is disconnected from the input connector and grounded to aid in determining the ground potential of the display.

c. AC/DC (right) (20K2G):

Y_2 input coupling.

d. GND (right) (20K2F):

Y_2 ground.

e. Y_2/Y_1, Y_2-X/NORM, BOTH/SINGLE (middle) (20K2C-D):

Vertical operating mode selection.

These three push-push buttons determin vertical operating mode as follow table:

<table>
<tr><td rowspan="3"></td><td colspan="2" rowspan="3">SINGLE</td><td rowspan="3">BOTH</td><td colspan="2">Sweep rate unit</td><td>Mode</td></tr>
<tr><td colspan="2">ms</td><td>CHOP</td></tr>
<tr><td colspan="2">us</td><td>ALT</td></tr>
<tr><td></td><td>NORM</td><td>Y_2-X</td><td colspan="2">NORM</td><td colspan="2">Y_2-X</td></tr>
<tr><td>Y_1</td><td>Display channel
Y_1</td><td>Y_1-Y
Y_2-X</td><td colspan="2">Int. trigger source
Y_1</td><td colspan="2">Y_1-Y
Y_2-X
Two Lissajous figures can be shown</td></tr>
<tr><td>Y_2</td><td>Display channel
Y_2</td><td>Y_2-Y
Y_2-X</td><td colspan="2">Int. trigger source
Y_2</td><td colspan="2">Y_2-Y
Y_2-X</td></tr>
</table>

Note: When two Lissajous figures are displayed, the trigger sweep mode should be set in HF if operating mode is ALT. And the sweep should be stoped if operating mode is CHOP.

20. t/div (30K1):

Sweep rate switch from 0.2 - 100 in 9 steps. Its unit is determined by sweep time unit switch.

21. VERNIER (30W1):

Fine control of the sweep time.

22. STABILITY (31W3):

It is used for cortrolling the operation mode of the sweep circuit. In normal condition, it should be set in the state of waiting trigger. And then, if you adjust LEVEL knob, the stable waveform will be displayed on the screen.

23. LEVEL (31W2, 31K1):

Select the amplitude point on the trigger signal at which the sweep is triggered. When this knob is pulled out, the sweep is in free run state (HF).

24. INT/EXT --- Trig. source select switch (1K1):

INT: The input signal applied to vertical amplifier becomes the triggering signal.

EXT: The signal applied to EXT socket becomes the trigger signal.

25. us/ms --- Sweep rate unit switch (32K1):

When the switch is set to "ms"(button out), the unit of the sweep switch(t/div) is ms. Meanwhile, its vertical operating mode is CHOP when two trace displaying mode is selected.

When the switch is set to "us"(button in), the unit of the sweep switch(t/div) is us. Meanwhile, its vertical operating mode is ALT.

26. -/+ --- Triggering slope switch (1K2):

Selects slope of the trigger signals shich starts the sweep.

27. EXT (CZ1):

Input socket for external triggering signal.

28. Trace Rotation (W3) (Rear panel):

Screwdriver adjustment to align trace with horizontal graticule lines.

SECTION 3. OPERATING INSTRCTIONS

3.1 Pre-start Operation

The XJ4241 is designed to be used with a single-phase, three-wire AC system. If a three to two-wire adapter is used to connect this instrument to a two-wire AC power system, be sure to connect the ground lead of the adapter to earth(ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential and pose a shock hazard.

Before connecting the instrument to the AC power source, you should check the line voltage: AC 220V ± 10%. Because XJ4241 adopts switch power circuit (no line power transformer), it can works well on AC 150V or DC 200V, but not above AC 250V.

It is recommended for the operators to familiarize themselves with the contents of this Operators Manual, especially the sections Specification, Doscription of Panel Controls and this section in order to utilize the oscilloscope.

The following steps demonstrate the use of the controls and connections of the XJ4241.

Place the power switch off (push in) and insert the power cord plug into the line outlet. Then put the front panel controls as follows:

INTENSITY	Fully counter-clockwise
FOCUS	Centered
AST.	Centered
Vertical Mode Switch	All out
Y_1 & Y_2 V/div	0.2 V/div
Y_1 & Y_2 VARIABLE	CAL

Trig. Slope Switch	+
Sweep Rate Unit	us
Trig. Source Select Switch	INT.
t/div	100
LEVEL	Pull out
Y_1 & Y_2 Position	Midposition
X Position	Midposition

Pull the power switch on. The instrument becomes operational several seconds after it is switched on. Turn the INTENSITY control clockwise until the desired intensity is obtained.

Connect the calibration signal to the input of Y_1 and Y_2 with proper wire. Adjust trigger LEVEL to synchronize the waveform. A waveform shown as Fig.3.1 should be displayed. Then, you can do any measurement that you want.

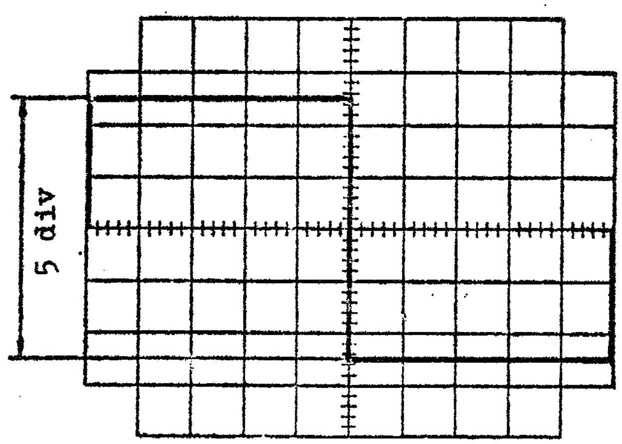


Fig.3.1 A Square Waveform in Normal Condition

3.2 Time Measurement

1. Time Interval Measurement

The time interval between two optional points on a waveform can be read directly from the t/div indication. For time interval measurement, proceed as below.

Set the sweep time VERNIER control in the CAL position and display a stable triggered waveform. Set the t/div switch in a position which facilitates reading of distance D as shown in Fig.3.2.

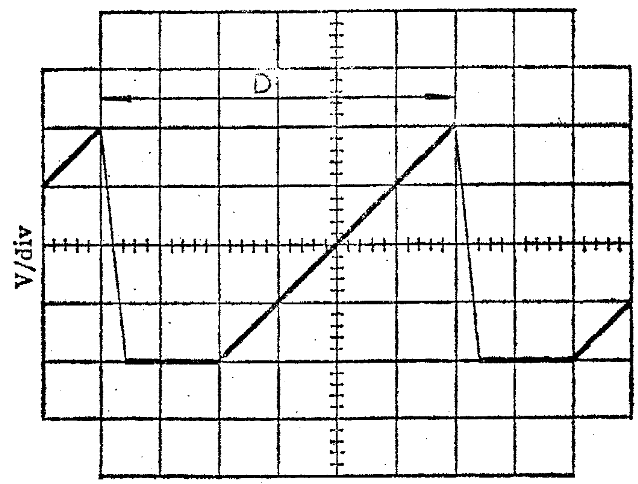


Fig.3.2 Time Interval Measurement

The time interval between the two points is calculated from equation (3-1).

Time D (sec) = t/div indication (sec/div)
x distance between the two points on graticule
x reciprocal of MAG switch value (3-1)

The reciprocal of the magnifier value is 1 when the display is not magnified and it is 0.2 when magnified.

2. Risetime Measurement

If the frequency of signal is higher than the sweep frequency, the risetime of pulse front edge can be measured.

Set the controls as follows:

Y VERNIER	CAL
Y input coupling	AC or DC
Trigger source	INT
Trigger slope	-
t/div switch	0.5 us/div
X MAG.	x 5

Adjust to produce a display exactly five divisions in amplitude.

Center the display around the center horizontal line with the vertical POSITION control.

Adjust the LEVEL control to obtain a stable display.

By means of the horizontal position control, move the waveform so that its lower 10% level crosses the vertical center line of the graticule. Read the distance from the vertical line to the point where the rising edge crosses the upper 10% line. The rise time T_r can be obtained by equation (3-2). (See example in Fig.3.3)

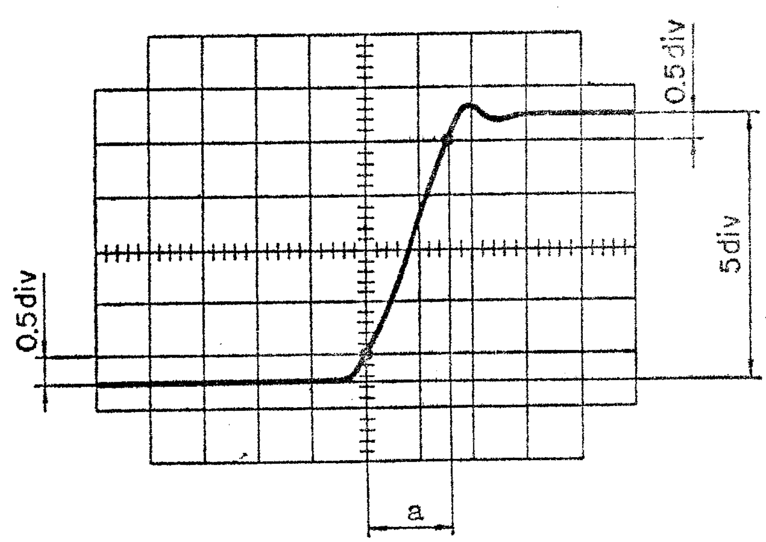


Fig. 3.3 An Example of Rise Time Measurement

$$T_r = a \times 0.2 \times 0.5 \text{ us} \qquad (3\text{-}2)$$
$$= 1.6 \times 0.2 \times 0.5 \text{ us} = 0.16 \text{ us} = 160 \text{ ns}$$

When the rise time of the measured pulse is three times larger than that of XJ4241 (35ns), the effect of the latter on the former is negligible. When the former is very short, however, the effect of the latter will cause errors. In such a case, the measured value must corrected employing equation (3-3).

$$T_r = \sqrt{T_{r2}^2 - T_{r1}^2} \qquad (3\text{-}3)$$

T_r: True value

T_{r2}: Measured value

T_{r1}: Rise time of XJ4241

For example as above:

$T_{r2} = 160$ ns, $T_{r1} = 35$ ns

$$T_r = \sqrt{T_{r2}^2 - T_{r1}^2} = 156.1 \text{ ns}$$

3.3 Phase Measurement

The phase shift of a network, e.g. lagging phase of sinewave after passing through an amplifier, can be measured with the oscilloscope in a manner as follows.

Method A:

Set the trigger source select switch to EXT, connect a lead signal A to the Y_1 input socket and external trigger input socket respectively. Adjust the LEVEL control to obtain a stable display. And then adjust the t/div switch and X position control to situate the waveform shown as Fig.3.4. Its one cycle of the signal is T div. Leaving the settings of the controls unchanged (trigger source select switch, t/div, VERNIER, LEVEL, X POSITION). Connect lagging signal B instead of leading signal A to the Y_1 input socket and read the distance between P and P' (D).

The phase shift ϕ of these two signals is

$$\phi = \frac{D}{T} \times 360^\circ \qquad (3-4)$$

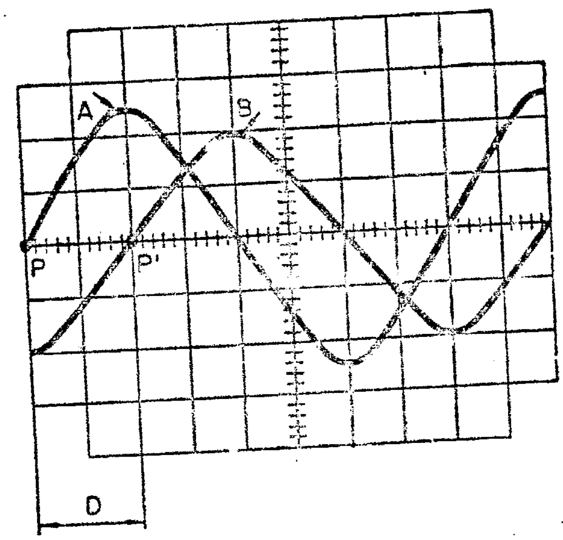


Fig.3.4 Phase Measurement of Two Signals
of Same Frequencies

Method B:

Because the phase between two vertical channels of this instrument is very small, you can measure the phase of the signal by using "ALT" mode ("CHOP" mode can be used when the frequency of the signal is lower). The first several steps are just same as method A. You can connect lagging signal B to the Y_2 input socket instead of connectting it to Y_1 input socket. Also, the phase is $\phi = \frac{D}{T} \times 360^\circ$ (see Fig.3.4).

Method C: Lissajous Figures

Set the vertical mode switch to Y_2-X and connect the leading signal A to Y_2. And adjust the amplitude of the signal so that the abscissa of the waveform is A in div.

Then connect the lagging signal B to the Y_1 input socket, and adjust the V/div and VERNIER controls till the amplitude of the waveform is also exactly A in div (see Fig.3.5). If the distance on horizontal center line is B indiv, the phase shift between two signals is

$$= \arcsin \frac{A}{B} \qquad (3\text{-}5)$$

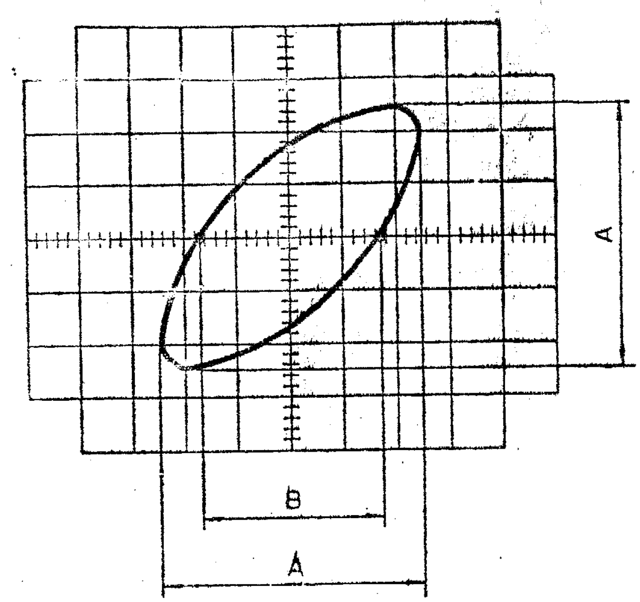


Fig. 3.5 Lissajous Figure

When the frequency of the signal is lower than 300 Hz or higher than 100 KHz, there is a intrinsic phase between the horizontal system and vertical system of the instrument. On this condition, you can use Y_2-Y/Y_2-X Lissajous Figure to calculate the intrinsic phase. Then, you can deduct it.

3.4 Voltage Measurement

For direct reading of voltage values in quantitative measurements from the V/div indication, the VERNIER control must be turned fully clockwise.

1. DC Voltage Measurement

For DC voltage measurement, proceed as follows:

Display a trace in the free run mode and select a fast sweep time so that the trace will appear steady. Set the "GND" switch in the ground state. Now the vertical position of the trace represents the reference line (zero volt level). Move the zero volt level to a position convenient for measurement. Then, set the AC/DC switch to the DC state (push out the "GND" switch), apply the DC signal to the instrument, and read the distance between the displayed DC signal level and the zero volt level on the graticule.

If the signal level is deflected beyond the viewing area, turn the V/div switch to a position where the signal level reading can be conveniently made.

The signal voltage can be known by using equation (3-5):

Voltage (V) = V/div indication x H (div) (3-5)

"H(div)" denotes the deflection distance from the zero volt level to the deflected signal level.

When 10:1 probe is used:

Voltage (V) = V/div indication x 10 x H (div) (3-6)

2. AC Voltage Measurement

If the AC/DC switch is set in the DC position to measure an AC signal superimposed on a DC component and if the DC component is large as compared with the AC component, the AC component may be deflected off the viewing area due to the large DC component.

In sush a case, it may be possible to bring the AC component waveform back into the viewing area by turning the vertical position control. Also, it is possible to bring back the waveform by turning the V/div switch so that the overall waveform amplitude is reduced. With such a reduced deflection amplitude, however, accurate measurement can not be expected.

For accurate measurement in such a case above, the AC/DC switch must be set in the AC position so that the DC component is eliminated and the AC component alone can be displayed with a sufficiently large deflection amplitude for accurate measurement.

Denoting the display amplitude with "H div", the AC voltage can be calculated employing equation (3-5) or (3-6) represents the peak-to-peak voltage (V_{p-p}). For calculation of the effective voltage ($V_{r.m.s.}$), equation (3-7) must be used.

$$\text{Voltage } (V_{r.m.s.}) = \frac{\text{Voltage } (V_{p-p})}{2\sqrt{2}} \qquad (3\text{-}7)$$

3. Instaneous Voltage Measurement

A reference level is needed in instantaneous voltage measurement. Normally, the reference level can be the earth potential or other reference level.

Proceed as follows:

Connect the reference level to the instrument by testing probe. Pull the "LEVEL" out. Adjust vertical POSITION to move the trace on proper position of the screen (reference level). And then, the vertical POSITION can not be moved.

Connect the testing probe to the signal which would be measured. Push in the "LEVEL" and adjust it to obtain a stable displayed waveform. Read the distance B (div) between the reference level and the point on instantaneous waveform.

$$\text{The instantaneous voltage } (V) = n \times A \times B \qquad (3\text{-}8)$$

n: attenuation ratio of probe

A: step reading of vertical V/div switch

For example, (see Fig.3.6) when the 10:1 probe is used and the V/div switch is on 0.5V/div, the instantaneous voltage (point P to reference level) = 10 x 0.5 V/div x 5.5 div = 27.5 V.

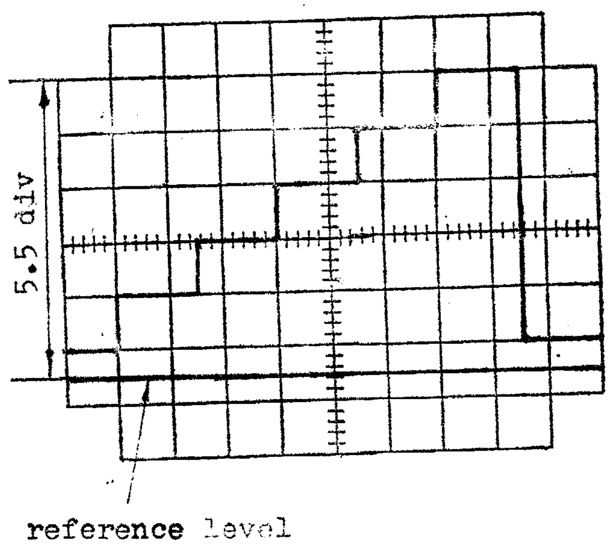
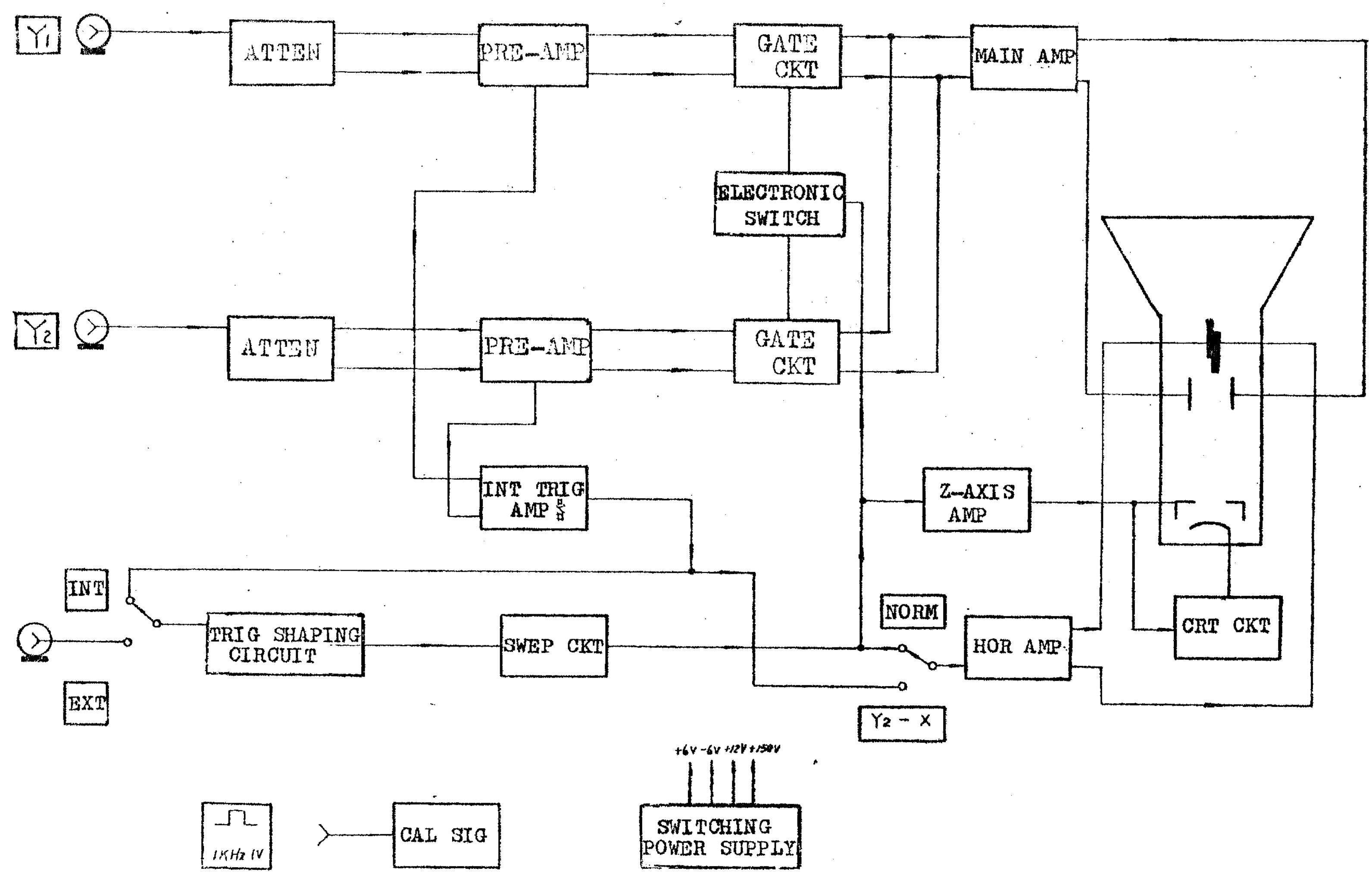


Fig. 3.6 Instantaneous Voltage Measurement


Y1
ATTEN
PRE-AMP
GATE CKT
MAIN AMP
ELECTRONIC SWITCH
Y2
ATTEN
PRE-AMP
GATE CKT
INT TRIG AMP
Z-AXIS AMP
INT
TRIG SHAPING CIRCUIT
SWEP CKT
EXT
NORM
HOR AMP
CRT CKT
Y2 - X
1KHz 1V
CAL SIG
+6V -6V +12V +150V
SWITCHING POWER SUPPLY