INSTRUCTION MANUAL

OSCILLOSCOPE

MODEL COS5020-ST

KIKUSUI ELECTRONICS CORPORATION

(KIKUSUI PART NO. Z1-507-820)

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1. GENERAL

1.1 Description

Kikusui Model COS5020-ST is a dual-trace oscilloscope with a 6-inch-rectangular-screen bistable storage CRT, with total frequency bandwidth of DC - 20 MHz, with the maximum sensitivity 1 mV/DIV, and with the maximum writing speed 20 μsec/DIV (50 DIV/msec) when its enhanced mode is employed.

It is incorporated with the various convenient features and excellent functions, an ideal instrument for a wide range of research and development works on electronic devices and equipments, various industrial tests and inspections, and physical and chemical studies.

1.2 Features

(1) BHD-type bistable storage CRT:

The BHD-type bistable storage CRT has a phosphor screen which provides a function as a storage target screen, making itself more resistant against burning. The CRT employs BHD (black matrix hybrid mesh dot screen), improving the contrast.

(2) AUTO ERASE mode:

The AUTO ERASE mode provides the automatic "record → hold → erase" actions for the measured signal for each sweep cycle. With this feature, operation can be conveniently done without manually pressing the ERASE button. The hold time is adjustable for a range of approximately 1 - 30 seconds with the ERASE INTERVAL control.

(3) ENHANCE mode:

The normal writing speed of the oscilloscope is 40 μsec/DIV (25 DIV/msec). When the oscilloscope is set to the ENHANCE mode, the writing speed can be increased to 20 μsec/DIV (50 DIV/msec) or higher with the ENHANCE LEVEL control.

(4) REMOTE ERASE terminal:

A terminal for remote erase control with an external signal (TTL CMOS logic signal) is provided on the rear panel, facilitating the oscilloscope with the capability to be used in a production line.

(5) High intensity circuit:

The acceleration voltage is high (3.15 kV) so that a sufficiently high trace intensity is attained even at the highest sweep speed. The reading electron acceleration voltage also is high (300 V) and thus the stored waveforms also can be displayed with a sufficiently high trace intensity.

(6) High stability with less drift:

The oscilloscope employs a newly-developed temperature compensation circuit, thereby greatly reducing drift of base lines and DC balance disturdance caused by temperature change.

(7) A trigger level lock function which makes triggering adjustment procedure unnecessary:

A newly-developed trigger level lock circuit is incorporated. This circuit eliminates the requirement for the troublesome triggering adjustment procedure not only for display of regular signals but also for that of video signals and large duty cycle ratio signals.

(8) Linear focus circuit:

A linear focus circuit is incorporated so that the best focus is maintained irrespective of intensity change.

(9) Excellent operability:

Lever switches and pushbutton switches of light torque type are used. These switches and other controls are laid out in the most rational locations by considering their purposes and the frequencies used, thereby attaining an excellent operability.

2. SPECIFICATIONS

CRT Circuit

Item	Specification	Remarks
Type	6-inch rectangular, direct-viewing bistable storage tube	
Phosphor	P31	Green
Effective screen size	8 × 10 DIV	1 DIV = 9.5 mm (0.37 in.)
Acceleration voltage	Approx. 3.15 kV	
Writing speed	40 μsec/DIV (25 DIV/msec) During ENHANCE mode operation, can be increased to up to 20 μsec/DIV (50 DIV/msec) or higher	
Read time	Approx. 60 minutes	
Erase time	Approx. 0.5 sec	
Storage section Operation mode	NORM: Normal oscilloscope operation STORAGE: Storage oscilloscope operation ENHANCE: Operation with enhanced writing speed. Adjustable with ENHANCE LEVEL control. ERASE: To erase the written waveform. During the SINGLE SWEEP mode operation, the RESET operation is done after the ERASE operation and the oscilloscope is reset to the READY state. HOLD: The waveform on the screen is instantaneously held and stored. The store state is released if changed to the NORM mode.	

Item	Specification	Remarks
AUTO ERASE	"Write → hold → erase" actions are done for each sweep cycle. The hold time is adjustable with the ERASE INTERVAL control for 1 - 30 seconds.	

Vertical axes

Item	Specification	Remarks
Sensitivity	NORM: 5 mV - 5 V/DIV ×5 MAG: 1 mV - 1 V/DIV	1-2-5 sequence, 10 ranges
Sensitivity accuracy	NORM: ±3% or better ×5 MAG: ±5% or better	10 to 35°C (50 to 95°F), 1 kHz, at 4 or 5 DIV
Vernier vertical sensitivity	To 1/2.5 or less of panel-indicated value	
Frequency bandwidth	NORM: DC - 20 MHz, within -3 dB ×5 MAG: DC - 15 MHz, within -3 dB AC coupling: Low limit frequency 10 Hz	At 50 kHz, 8 DIV
Rise time	NORM: Approx. 17.5 nsec 5 MAG: Approx. 23 nsec	
Input impedance	1 MΩ ±2%, 25 pF ±2 pF	
Square wave characteristics	Overshoot: Not greater than 5% Other distortions: Not greater than 3% (At 10 mV/DIV range)	Other ranges: 3% added to the values shown in the left column. 10 to 35°C (50 to 95°F)
DC balance shift	NORM: ±0.5 DIV ×5 MAG: ±2.0 DIV	
Display modes	CH1: CH1 single channel CH2: CH2 single channel DUAL: CHOP: 0.5 sec - 1 msec/DIV ALT: 0.5 msec - 0.2 μsec/DIV ADD: CH1 + CH2	When CH1 POSITION knob is pulled out (CHOP ONLY position), the two traces are displayed in the CHOP mode over the entire ranges.

Item	Specification	Remarks
Chopping repetition frequency	Approx. 250 kHz	
Input coupling	AC/GND/DC	
Maximum allowable input voltage	400 V (DC + AC peak)	AC: 1 kHz or lower
Common mode rejection ratio	50:1 or better at 50 kHz, sinusoidal wave	Applicable only when sensitivities of CH1 and CH2 are equal.
Isolation between channels	1000:1 or better at 50 kHz 30:1 or better at 40 MHz	At 5 mV/DIV range
CH1 signal output	Approx. 100 mV/DIV when open; approx. 50 mV/DIV when 50-ohm termination	
CH2 INV BAL	Balanced point variation, at the center of screen: 1 DIV or less	PULL CH2 POSITION

Triggering

Item	Specification	Remarks
Triggering source	CH1, CH2, LINE, and EXT (CH1 and CH2 can be selected only when the vertical mode is DUAL or ADD. In other cases, triggering source is automatically selected by the VERT MODE switch.)	
Coupling	AC, HF REJ, TV, DC	
Polarity	+ or -	
Sensitivity	DC - 10 MHz: 0.5 DIV (0.10 V) DC - 40 MHz: 1.5 DIV (0.20 V) Video signal: 2.0 DIV (0.25 V) AC coupling: Attenuates signal components of lower than 10 Hz HF REJ: Attenuates signal components of higher than 50 kHz	The values enclosed in the parentheses are the input sensitivities during the EXT triggering mode opration.

Item	Specification	Remarks
Triggering modes	AUTO: Sweeps run in the free mode when no triggering input signal is applied.	Satisfies the sensitivity specification for signal repetition frequency of 50 Hz or higher.
	NORM: When no triggering signal is applied, the trace is in the READY state and not displayed.	
	SINGLE: One-shot sweep with triggering signal. Can be reset to the READY state by means of RESET switch. The READY lamp (LED) turns on during the READY state or in the sweep operation.	
LEVEL LOCK	Satisfies the value of the above trigger sensitivity plus 0.5 DIV (0.05 V) for signal of duty cycle 20:80 and repetition frequency 50 Hz - 20 MHz.	
EXT triggering signal input	EXT HOR input terminal is used in common.	
Input impedance	1 MΩ ±2%, approx. 30 pF	
Maximum allowable input voltage	100 V (DC + AC peak)	AC frequency not higher than 1 kHz

Horizontal axis (Time base)

Item	Specification	Remarks
Sweep time	NORM: 0.5 μsec - 1 sec/DIV ×10 MAG: 50 nsec - 0.1 sec/DIV	1-2-5 sequence, 20 ranges
Sweep time accuracy	NORM: ±3%	10 to 35°C (50 to 95°F)
Vernier sweep time control	To 1/2.5 or slower of the panel-indicated value	
Holdoff time	Continuously variable to 2 times or higher of sweep length (time) at 0.5 μsec/DIV - 1 msec/DIV ranges	

Item	Specification	Remarks
Sweep magnification	10 times (maximum sweep time 50 nsec/DIV)	
Magnified sweep time accuracy	1 μsec/DIV - 1 sec/DIV ranges: ±5% 0.5 μsec/DIV ranges: ±8%	10 to 35°C (50 to 95°F)
Linearity	NORM: ±3% ×10 MAG: ±5% (8% at 0.5 μsec/DIV)	
Position shift caused by sweep magnification	Within 1 DIV at CRT screen center	
X-Y mode	X-axis: CH1 input signal Y-axis: CH2 input signal	Triggering signal coupling in DC mode.
Sensitivity	Same as CH1 vertical axis	
Sensitivity accuracy	NORM: ±4% ×5 MAG: ±6%	10 to 35°C (50 to 95°F), at 1 kHz, 4 or 5 DIV
Frequency bandwidth	DC - 500 kHz (-3 dB)	
X-Y phase difference	Not greater than 3° at DC - 50 kHz	
EXT HOR mode	Trace swept by an external horizontal signal applied to the EXT TRIG IN terminal. Vertical axis modes are CH1, CH2, DUAL and ADD modes in the CHOP mode.	
Sensitivity	Approx. 0.1 V/DIV	
Frequency bandwidth	DC - 500 kHz (-3 dB)	
Phase difference between vertical axis	Within 3° (at DC - 50 kHz)	

Z axis

Item	Specification	Remarks
Sensitivity	3 Vp-p (Trace becomes brighter with negative input.)	
Frequency bandwidth	DC - 5 MHz	
Input resistance	Approx. 5 kΩ	
Allowable input voltage	50 V (DC + AC peak)	AC frequency not higher than 1 kHz

Calibration voltage

Item	Specification	Remarks
Waveform	Positive-going square wave	
Frequency	1 kHz ±20%	
Duty ratio	Within 45:55	
Output voltage	2 Vp-p, ±2%	
Output resistance	Approx. 2 kΩ	

Remote erase terminal

ON-OFF control with TTL and CMOS signal. The ERASE action is triggered by the rising edge of the signal; it is inhibited by the LOW (ON) level of the signal.

Line power requirements

Voltage: 100 V, 115 V, 215 V, 230 V; with ±10% allowance.
Selectable by connector change.

Frequency: 50 Hz or 60 Hz

Power consumption: Approx. 65 VA

Operating environment

To satisfy specifications: 5 to 35°C (41 to 95°F), 85% RH

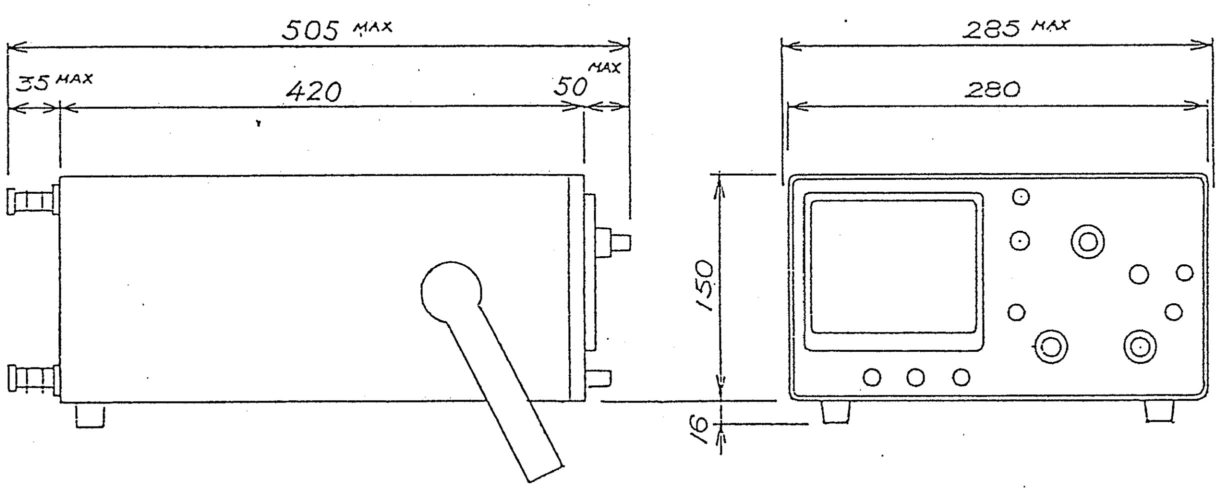
Maximum operating ranges: 0 to 40°C (32 to 104°F), 90% RH

Mechanical specifications

Mainframe dimensions: 280 W × 150 H × 420 D mm
(11.02 W × 5.91 H × 16.54 D in.)

Maximum dimensions: 285 W × 200 H × 505 D mm
(11.22 W × 7.87 H × 19.88 D in.)

Weight: Approx. 7.8 kg (17.2 lbs)



Accessories

P060-S probes (10:1, 1:1; 1.5 m) ..	(89-03-0300)	.....	2
942A terminal adaptors	(W4-986-011)	.....	2
Power cord			1
Instruction manual			1

3. PRECAUTIONS BEFORE OPERATING THE OSCILLOSCOPE

3.1 Unpacking the Oscilloscope

The oscilloscope shipped from the factory has been fully inspected and tested. Upon receipt of the instrument, immediately unpack and inspect it for any damage which might have been caused during shipment. If any sign of damage is found, immediately notify the bearer and/or the dealer.

3.2 Checking the Line Voltage

The oscilloscope can operate on any one of the line voltages shown in the table below, 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 that the oscilloscope may not operate or may be damaged if it is connected to a wrong voltage AC line.

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

Selector plug position	Nominal voltage	Voltage tolerance	Fuse
A	100 V	90 - 110 V	1 A
B	115 V	104 - 126 V	
C	215 V	194 - 236 V	0.5 A
D	230 V	207 - 253 V	

3.3 Environments

The normal ambient temperature range of this instrument is 0 to 40°C (32 to 104°F). Operation of the instrument outside of this temperature range may cause damage to the circuits.

Do not use the instrument in a place where strong magnetic or electric field exists. Such fields may disturb the measurement.

3.4 CRT Intensity

In order to prevent permanent damage to the CRT phosphor, do not make the CRT trace excessively bright nor leave the spot stationary for an unreasonably long time.

3.5 Withstanding Voltages of Input Terminals

The withstanding voltages of the instrument input terminals and probe input terminals are shown in the following table. Do not apply a voltage higher than these limits.

Input terminal	Maximum allowable input voltage
CH1, CH2, inputs	400 V (DC + AC peak)
EXT TRIG input	100 V (DC + AC peak)
Probe inputs	600 V (DC + AC peak)
Z AXIS input	50 V (DC + AC peak)

Note: AC frequency not higher than 1 kHz

3.6 Precautions for Storage Mode of Operation

(1) If the power of the oscilloscope is turned on when it is set in the STORAGE mode, the entire screen will become the STORAGE state. When this state occurrs, be sure to press the ERASE button once or twice. If the oscilloscope is left in this state without pressing the ERASE button for a long time, the life of the CRT will be shortened.

When the oscilloscope is changed from the NORM mode to the STORAGE mode, the CRT screen is automatically erased. However, if the stored state is partially remaining on the CRT screen, press the ERASE button once or twice.

(2) The maximum allowable read time is approximately 60 minutes. Note that, if the CRT is left in the stored state for longer than 60 minutes, the storing capacity and writing speed of the CRT may be degraded. From the viewpoint of longevity of the CRT, store the signals only for the minimum required periods.

Avoid also the following from the viewpoint of the longevity of the CRT.

(a) A high intensity spot left stationary on the CRT.

(b) A high intensity sweep left stationary on the CRT.

(c) A high intensity trace at a low sweep speed (1 msec/DIV or slower) left stationary on the CRT.

(3) Regarding Item (2) above, note that degradation of the CRT will be accelerated if the trace is left held on the CRT screen by pressing the HOLD button which securely holds the waveform on the CRT screen. Be careful not to leave the CRT screen in this state for a prolonged period.

4. OPERATION METHOD

4.1 Explanation of Front Panel (See Figures 4-1.)

o CRT circuits:

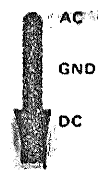
POWER	(3)	Main power switch of the instrument. When this switch is turned on, the LED (2) above the switch is also turned on.
INTEN	(4)	Controls the brightness of the spot or trace
FOCUS	(6)	For focusing the trace to the sharpest image.
ILLUM	(8)	Graticule illumination adjustment.
TRACE ROTATION	(7)	Semi-fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.
Bezel	(35)	For installing a camera mount in one-touch operation.
Filter	(36)	Blue filter for ease of waveform viewing. Can be removed in one-touch operation.

o Vertical axis:

CH1 (X) input	(11)	Vertical input terminal of CH1. During X-Y operation, this becomes X-axis (abscissa) input terminal.

CH2 (Y) input ...... ⑱ Vertical input terminal of CH2. During X-Y operation, this becomes Y-axis (ordinate) input terminal.

AC-GND-DC .... ⑩⑲ Switch for selecting connection mode between input signal and vertical amplifier.



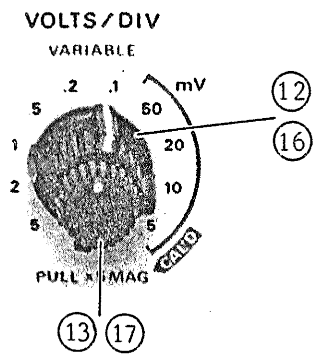
AC: AC coupling

GND: Vertical amplifier input is grounded and input terminals are disconnected.

DC: DC coupling

VOLTS/DIV .... ⑫⑯ Select the vertical axis sensitivity, from 5 mV/DIV to 5 V/DIV with 10 ranges.

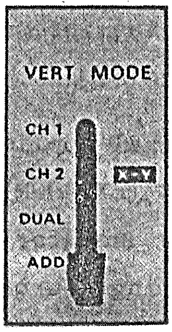
VARIABLE .... ⑬⑰ Fine adjustment of sensitivity, with a factor of 1/2.5 or higher of the panel-indicated value. At the CAL'D position, sensitivity is calibrated to the panel-indicated value. When this knob is pulled out (x5 MAG state), the amplifier sensitivity is multiplied by 5 times.



POSITION .... ⑨⑳ Vertical positioning control of trace or spot.

VERT MODE .... ⑭ Selects operation modes of CH1 and CH2 amplifiers. Also selects internal triggering source signal.

CH1: The oscilloscope operates as a single-channel instrument with CH1 alone. The CH1 input signal is used as the internal triggering source signal.



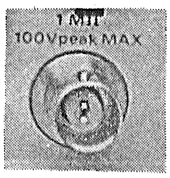
CH2: The oscilloscope operates as a single-channel instrument with CH2 alone. The CH2 signal is used as the internal triggering source signal.

DUAL: The oscilloscope operates as a dual-channel instrument with both CH1 and CH2. The internal triggering source signal is selected by SOURCE switch (26).

ADD: The oscilloscope displays the algebraic sum (CH1 + CH2) or difference (CH1 - CH2) of the two signals. The pulled out state of CH2 POSITION knob (20) provides the difference (CH1 - CH2). The internal triggering source signal is selected by SOURCE switch (26).

o Triggering

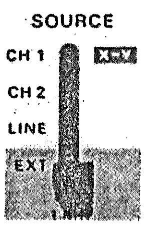
EXT TRIG (EXT HOR) .. (23) input terminal



This terminal is used in common for external triggering signal and external horizontal signal. To use this terminal, set SOURCE switch (26) to the EXT position.

SOURCE .... (26)

Selects the internal triggering source signal. Also select the EXT HOR input signal.



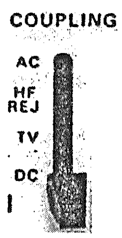
CH1 X-Y : When the VERT mode switch (14) is set at the DUAL or ADD position, selects CH1 for the internal triggering source signal. During the X-Y mode operation, selects CH1 for the X-axis signal.

CH2: When the VERT mode switch ⑭ is set at the DUAL or ADD position, selects CH2 for the internal triggering source signal.

EXT: The external signal applied through EXT TRIG (EXT HOR) input terminal ㉓ is used for the external triggering source signal. During the X-Y, EXT HOR mode operation, the X-axis operates with the external sweep signal.

Note: When the VERT MODE switch is set to the CH1 or CH2 position, internal triggering source signal selection cannot be made by the SOURCE signal. In such cases, a triggering source signal is set by the VERT MODE switch.

COUPLING .... ㉕ Select coupling mode between triggering source signal and trigger circuit; select connection of TV sync trigger circuit.



AC: AC coupling

HF REJ: AC coupling, with components higher than 50 kHz rejected.

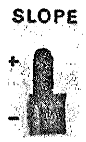
DC: DC coupling

TV: The trigger circuit is connected to the TV sync separator circuit and the sweeps are synchronized with the TV V or TV H signal at a rate selected by the TIME/DIV switch ㉚.

TV V: 1 sec/DIV - 0.1 msec/DIV.

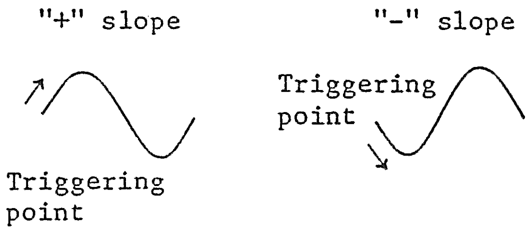
TV H: 50 µsec/DIV - 0.5 µsec/DIV.

SLOPE .... (24) Selects the triggering slope.



"+": Triggering occurs when the triggering signal crosses the triggering level in the direction of signal increase (i. e., positive direction).

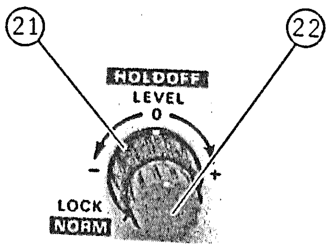
"-": Triggering occurs when the triggering signal crosses the triggering level in the direction of signal decrease (i. e., negative direction).



HOLDOFF .... (21)

LEVEL .... (22)

These double-knob controls are for holdoff time adjustment and triggering level adjustment.



The HOLDOFF time control is used when the signal waveform is complex so that stable triggering cannot be attained with LEVEL knob (22) alone.

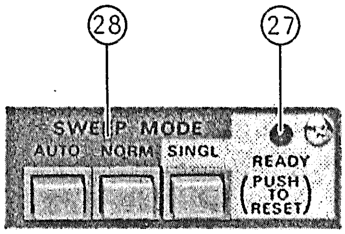
The LEVEL knob is for displaying a synchronized stationary waveform and setting a start point for the waveform.

As this knob is turned in "→ +" direction, the triggering level moves upward on the displayed waveform; as the knob is turned in " - ←", the triggering level moves downward.

When set at the LOCK position, the triggering level is automatically maintained at the optimum value irrespective of the signal amplitude (from very small amplitude to large amplitude), requiring no manual adjustment of triggering level.

o Time Base

SWEEP MODE .... (28) Selects the desired sweep mode.



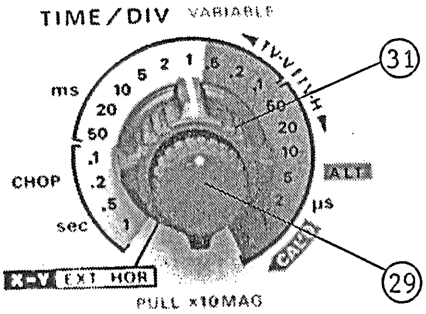
AUTO: When no triggering signal is applied or when triggering signal frequency is less than 50 Hz, sweep runs in the free run mode.

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 50 Hz or lower.

SINGLE: (PUSH TO RESET) Used for single sweep operation (one-shot sweep operation), and in common as the reset switch.

When the three buttons are at the pushed out position, the circuit is at the signal sweep mode. The circuit is reset as this button is pressed. When the circuit is reset, the READY lamp (27) lights on. The lamp goes off when the single sweep operation is over.

TIME/DIV ⑶1



When this switch is set to the X-Y | EXT HOR position, the oscilloscope operates as an X-Y scope with CH1 for the X-axis or operates at the EXT HOR mode with an external sweep input signal for the X-axis.

VARIABLE .... ㉙
PULL ×10 MAG

Vernier control of sweep time. The sweep time can be made slower by a factor of 2.5 or more of the panel-indicated value.

The panel-indicated values are calibrated with this knob set at the CAL'D position.

The pulled out position of this knob is for the ×10 MAG state.

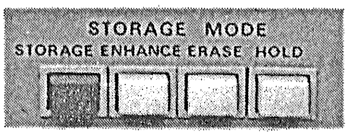
POSITION ⑶2

Vertical adjustment of the trace or spot.

o Storage Section

STORAGE MODE ⑶0

Selects the required display mode during the STRORAGE operation.



STORAGE: When this button is set at the pushed-out position (⎍), the instrument operates as a regular oscilloscope. When this button is set at the pushed-in position (⊓), the instrument operates as a storage oscilloscope.

ENHANCE: To increase the writing speed. Adjust to the optimal writing speed with the ENHANCE LEVEL knob (34) .

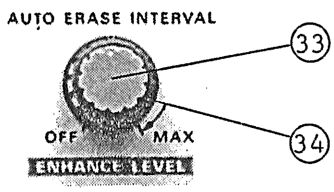
ERASE: To erase the waveform stored on the CRT.

During the SINGLE SWEEP mode operation, the reset action automatically follows the erase action and the oscilloscope is reset to the STANDBY state.

HOLD: The waveform displayed on the CRT is instantaneously held and stored. If the STORAGE button is set to the NORM position (⊓), the HOLD position is released.

AUTO ERASE INTERVAL .. (33)

To adjust the auto erase interval, with on-off switch for the auto erase mode. During the auto erase mode operation, "write→hold (display)→ erase" actions are done for each sweep cycle. The hold time is adjustable for approximately 1 - 30 seconds.

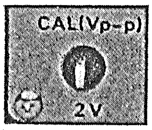


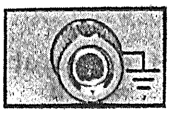
ENHANCE LEVEL .... (34)

To adjust the enhance level when the ENHANCE button of STORAGE MODE switch (30) is set at the pushed-in position (⊔). For details, see Section 4-10 (2) "ENHANCE Operation."

o Others

CAL (Vp-p) .... (1) This terminal delivers the calibration voltage of 2 Vp-p positive square wave at approximately 1 kHz. The output resistance is approximately 2 kΩ.





.... (15) Ground terminal of oscilloscope mainframe.

4.2 Explanation of Rear Panel

- Z AXIS INPUT .... (37) Input terminal for external intensity modulation signal.
- CH1 SIGNAL OUTPUT .. (38) Delivers the CH1 signal with a voltage of approximately 100 mV per 1 DIV or graticule. When terminated with 50 ohms, the signal is attenuated to about a half. May be used for frequency counting, etc.
- REMOTE ERASE .... (39) Input terminal for external control signal for the remote erase mode operation.
- AC Power Input Circuit

  AC power input connector .... (40) Input connector of the AC power of the instrument. Connect the AC power cord (supplied) to this connector.

  FUSE .... (41) Fuse in the primary circuit of the power transformer. Fuse rating is shown in Table (44).

  AC voltage selecting connector .... (42) For selecting the AC voltage of the instrument.

  AC voltage selector plug .... (43) For selecting the AC voltage of the instrument by aligning its arrowhead mark in the corresponding position as shown in Table (44).
- Studs .... (45) Studs for laying the oscilloscope on its back to operate it in the upward posture. Also used to take up the power cord.

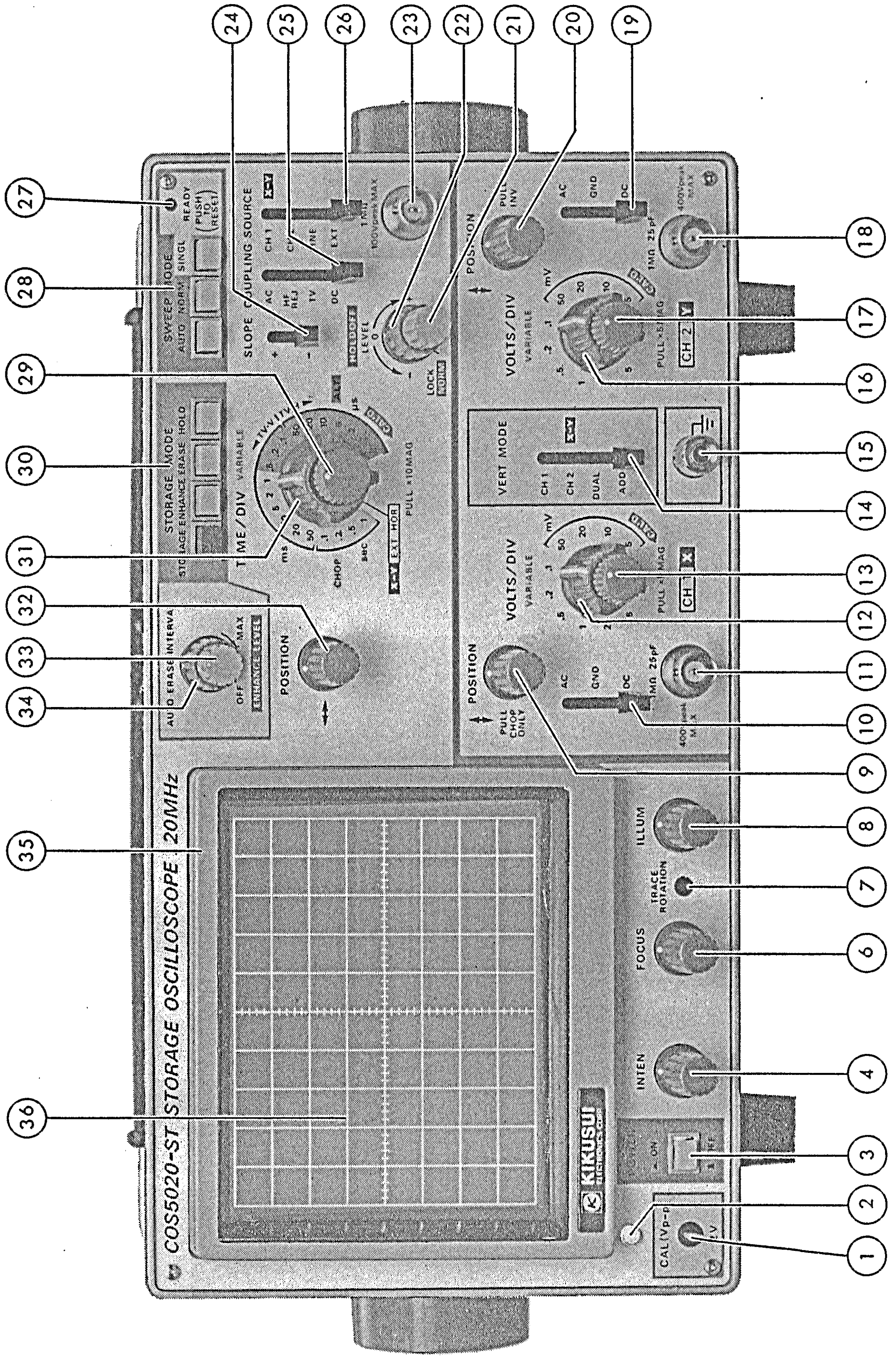
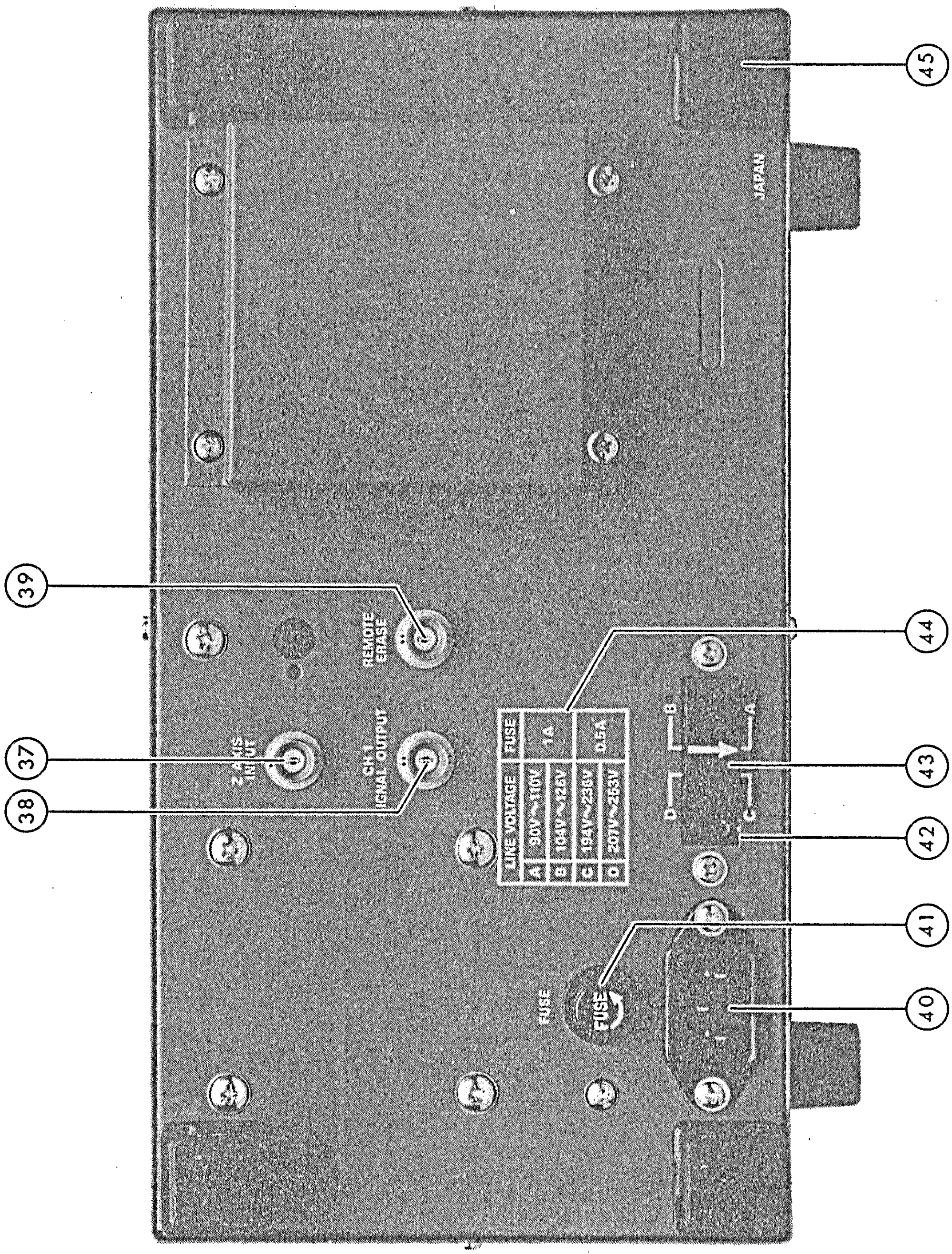


Figure 4-1



37
38
39
40
41
42
43
44
45
REMOTE ERASE
CH 1 SIGNAL OUTPUT
LINE VOLTAGE
FUSE
JAPAN

Figure 4-2

4.3 Basic Operation

Before connecting the power cord to an AC line outlet, check that the AC line voltage selector plug on the rear panel of the instrument is correctly set for the AC line voltage. After ensuring the voltage setting, set the switches and controls of the instrument as shown in the following table.

Item	No.	Setting
POWER	③	OFF position
INTEN	④	Clockwise (3-o'clock position)
FOCUS	⑥	Mid-position
ILLUM	⑧	Counterclockwise position
VERT MODE	⑭	CH1
↕ POSITION	⑨ ⑳	Mid-position, pushed in
VOLTS/DIV	⑫ ⑯	50 mV/DIV
VARIABLE	⑬ ⑰	CAL'D (clockwise position), pushed in
AC-GND-DC	⑩ ⑲	GND
SOURCE	㉖	CH1
COUPLING	㉕	AC
SLOPE	㉔	+
LEVEL	㉒	LOCK (counterclockwise)
HOLDOFF	㉑	NORM (counterclockwise)
SWEEP MODE	㉘	AUTO
STRAGE MODE	㉚	STRAGE OFF (NORM opelation)
TIME/DIV	㉛	0.5 msec/DIV
VARIABLE	㉙	CAL'D (clockwise), pushed in
↔ POSITION	㉜	Mid-position

After setting the switches and controls as indicated above, connect the power cord to the AC line outlet and, then, proceed as follows:

1) Turn-ON the POWER switch and make sure that the power pilot LED is turned on. In about 20 seconds, a trace will appear on the CRT screen. If no trace appears even after about 60 seconds, repeat the switch and control settings as shown in the above table.

2) Adjust the trace to an appropriate brightness and to the sharpest image with the INTEN control and FOCUS control.

3) Align the trace with the horizontal center line of graticule by adjusting the CH1 POSITION control and TRACE ROTATION control (screwdriver adjustment).

4) Connect the probe (supplied) to the CH1 INPUT terminal, and apply the 2 Vp-p CALIBRATOR signal to the probe tip.

5) Set the AC-GND-DC switch in the AC state. A waveform as shown in Figure 4-3 will be displayed on the CRT screen.

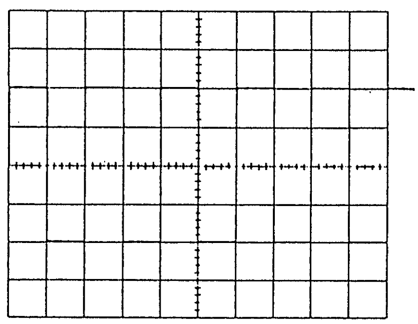


Figure 4-3

6) Adjust the FOCUS control until the sharpest trace image becomes available.

7) For signal viewing, adjust the VOLTS/DIV switch and TIME/DIV switch to appropriate positions so that the signal waveform is displayed with an appropriate amplitude and an appropriate number of peaks.

8) Adjust the ↕ POSITION and ↔ POSITION controls to appropriate positions so that the displayed waveform is aligned with the graticule and the voltage (Vp-p) and period (T) can be read as desired.

The above procedure is the basic operating procedure of the oscilloscope for single-channel operation with CH1. Single-channel operation with CH2 also can be made in a similar manner. Further operation methods are explained in the subsequent paragraphs.

4.4 Dual-channel Operation

Change the VERT MODE switch to the DUAL position so that the other trace (CH2) also is displayed. (The trace explained in the preceding section was for CH1.) At this state of procedure, the CH1 trace has the square wave of the calibration signal and the CH2 trace has a straight line since no signal is applied to this channel yet.

Now, apply the calibration signal also to the vertical input terminal of CH2 with the probe as was the case for CH1. Set the AC-GND-DC switch at the AC position. Adjust vertical POSITION knobs (9) and (20) so that two channels of signals are displayed as shown in Figure 4-4.

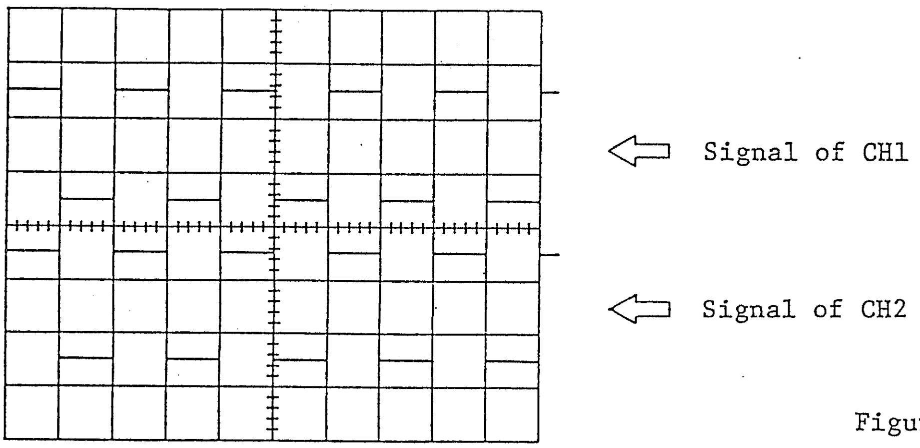
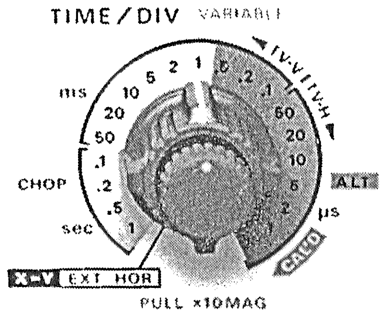


Figure 4-4

During the dual-channel operation (DUAL or ADD mode), either the CH1 or CH2 signal must be selected as the triggering source signal by means of the SOURCE switch. If both CH1 and CH2 signals are in a synchronized state, both waveforms can be displayed stationary; if not, only the signal selected by the SOURCE switch can be displayed stationary.

Selection between CHOP mode and ALT mode is automatically made by the TIME/DIV switch. The 1 msec/DIV and lower ranges are used with the CHOP operation and the 0.5 msec/DIV and higher ranges are used with the ALT operation.

Figure 4-5



When the ↕ POSITION knob is pulled out, the two traces are displayed with the CHOP operation over the entire ranges.

4.5 ADD Operation

An algebraic sum of the CH1 and CH2 signals can be displayed on the screen by setting the VERT MODE switch at the ADD position. The displayed signal becomes the difference between CH1 and CH2 signals if the CH2 POSITION knob is pulled out (PULL INV).

For accurate addition or subtraction, it is a prerequisite that the sensitivities of the two channels be adjusted accurately at the same value by means of the VARIABLE knobs. Vertical positioning can be made with the ↕ POSITION knob of either channel. In view of the linearities of the vertical amplifiers, it is most advantageous to set both knobs in their mid-positions.

4.6 X-Y Operation and EXT HOR Operation

When the TIME/DIV switch is set at the [X-Y | EXT HOR] positon, the internal sweep circuit is disconnected and the trace in the horizontal direction is driven by the signal selected by the SOURCE switch. When the switch is set to the CH1 [X-Y] position, the oscilloscope operates as an X-Y scope with the CH1 signal for the X-axis; when it is set to the EXT position, the oscilloscope operates in the EXT HOR (external sweep) mode.

o X-Y operation

The X-Y mode is operated with the VERT MODE switch selected for CH2 [X-Y] and the TIME/DIV switch in the fully counter clockwise position. CH1 becomes the X axis while CH2 becomes the Y axis, whose position is controled by the horizontal position knob. The bandwidth of the X axis becomes DC to 500 kHz (-3 dB).

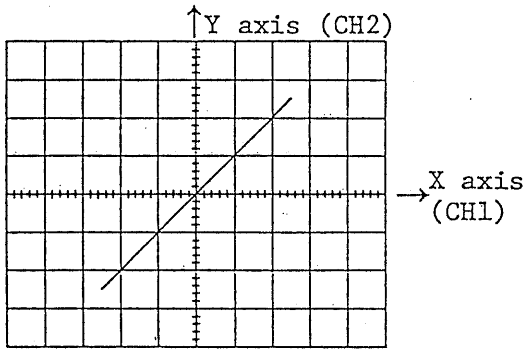


Figure 4-6

o EXT HOR (external sweep) operation

The external signal applied through the EXT HOR terminal (23) drives the X axis. The Y axis is controled with any channel or channels as selected by the VERT MODE switch. When the DUAL mode is selected by the switch, both CH1 and CH2 signals are displayed in the CHOP mode.

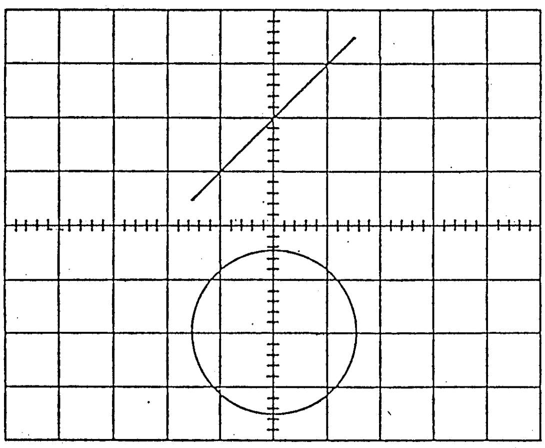


Figure 4-7. Dual-channel X-Y operation

4.7 Triggering

Proper triggering is essential for an efficient operation of the oscilloscope. The user of the oscilloscope must become thoroughly familiar with the triggering functions and procedures.

(1) Functions of SOURCE Switch:

To display a stationary pattern on the CRT screen, the displayed signal itself or a trigger signal which has a time relationship with the displayed signal is required to be applied to the trigger circuit. The SOURCE switch selects such a triggering source.

CH1:
CH2: This internal trigger method is used most commonly. The signal applied to the vertical input terminal is branched off from the preamplifier and is fed to the trigger circuit through the VERT MODE switch. Since the triggering signal is the measured signal itself, a very stable waveform can be readily displayed on the CRT screen.

During the single-sweep mode opration, the signal of the channel selected by the VERT MODE switch is used as the triggering source signal.

During the DUAL or ADD operation, the signal selected by the SOURCE switch is used as the triggering source signal.

LINE: The AC power line frequency signal can also be used as the triggering signal. This mathod is effective when the measured signal has a close relationship with the AC line frequency, especially for measurements of low level AC noise of audio equipment, 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 is not used as the triggering signal, waveform can be displayed more independently of the measured signal.

The above triggering source signal selection function are summarized in the following table.

SOURCE \ VERT MODE	CH1	CH2	DUAL	ADD
CH1	Triggered by CH1 signal	Triggered by CH2 signal	Triggered by CH1 signal	
CH2			Triggered by CH2 signal	
LINE	Triggered by LINE signal			
EXT	Triggered by EXT TRIG input signal			

(2) Functions of 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.

AC: This coupling is used for AC triggering which is used most commonly. As the triggering signal is applied to the trigger circuit through an AC coupling circuit, stable triggering can be attained without being affected by the DC component of the input signal. The low-range cut off frequency is 10 Hz (-3 dB).

When the ALT trigger mode is used and the sweep speed is slow, jitter may be produced. In such a case, use the DC mode.

HF REJ: The triggering signal is fed to the trigger circuit through an AC coupling circuit and a low pass filter (approximately 50 kHz, -3 dB). The higher components of the trigger signal are rejected through the low pass filter and the lower components alone of the trigger signal are applied to the trigger circuit.

TV: This conpling is used for TV triggering for observation of TV video signals. The triggering signal is AC-coupled and fed via the trigger circuit (level circuit) to the TV sync separator circuit. The separator circuit picks off the sync signal, which is used to trigger the sweep. Thus, the video signal can be displayed very stably.

Being linked to the TIME/DIV switch, the sweep speed is switched for TV.V and TV.H as follows:

TV.V: 1 sec - 0.1 msec
TV.H: 50 μsec - 0.2 μsec

The SLOPE switch should be set in conformity with the video signal as shown in Figure 4-9.

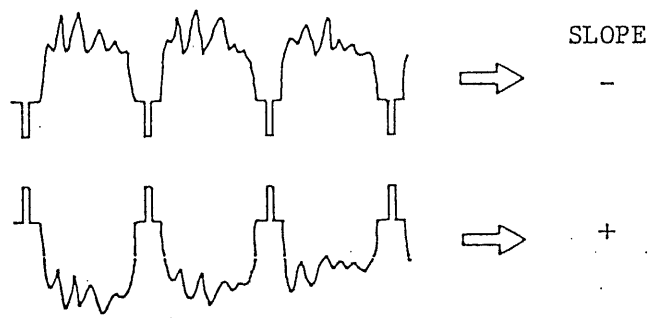


Figure 4-8

DC: The triggering signal is DC-coupled to the trigger circuit. This mode is used when triggering is desired with the DC component of the triggering signal or when a very low frequency signal or a signal of large duty cycle ratio is needed to be displayed.

(3) Functions of SLOPE switch:

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

"+": When set in the "+" state, triggering occurs as the triggering signal crosses the triggering level in the direction of signal increase (i.e, positive direction).

"-": When set in the "-" state, triggering occurs as the triggering signal crosses the triggering level in the direction of signal decrease (i.e, negative direction).

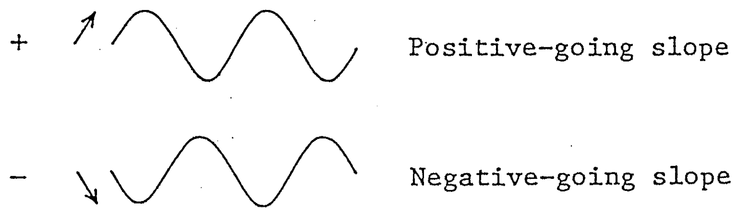


Figure 4-9

(4) Functions of LEVEL (LOCK) control:

The function of this control is to adjust the triggering level and display a stationary image. At the instant of the triggering signal crossing the triggering level set by this control, the sweep is triggered and a waveform is displayed on the screen.

The trigger level changes in the positive direction (upward) as this control knob is turned clockwise and it changes in the negative direction (downward) as the knob is turned counter-clockwise. The rate of change is set as shown in Figure 4-10.

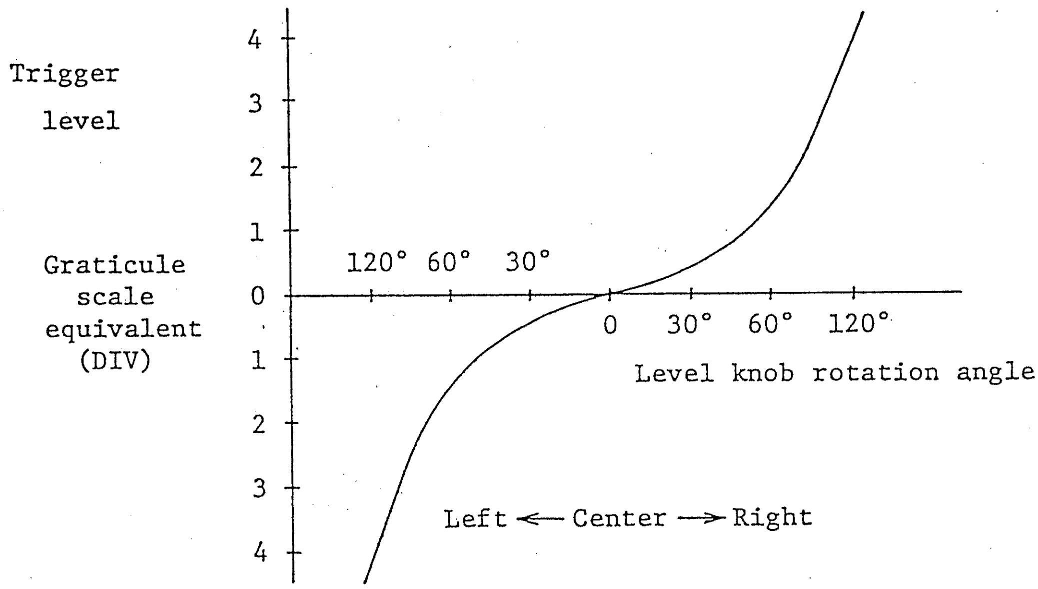


Figure 4-11

o LEVEL LOCK

When the LEVEL knob is set at the LEVEL LOCK position, the triggering level is automatically maintained within the amplitude of the triggering signal and stable triggering is made without requiring level adjustment (although jitter may not be suppressed during the ALT mode operation). This automatic level lock function is effective when the signal amplitude on the screen or the input voltage of the external triggering signal is within the following range:

50 Hz - 10 MHz: 1.0 DIV (0.15 V) or less
50 Hz - 20 MHz: 2.0 DIV (0.25 V) or less

(5) Functions of HOLD OFF control:

When the measured signal has a complex waveform with two or more repetition frequencies (periods), triggering with the above-mentioned LEVEL control alone may not be sufficient for attaining a stable waveform display. 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. The control covers at least the time of one full sweep, for sweeps faster than 1 msec/DIV.

Figure 4-11 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.

Figure 4-11 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.

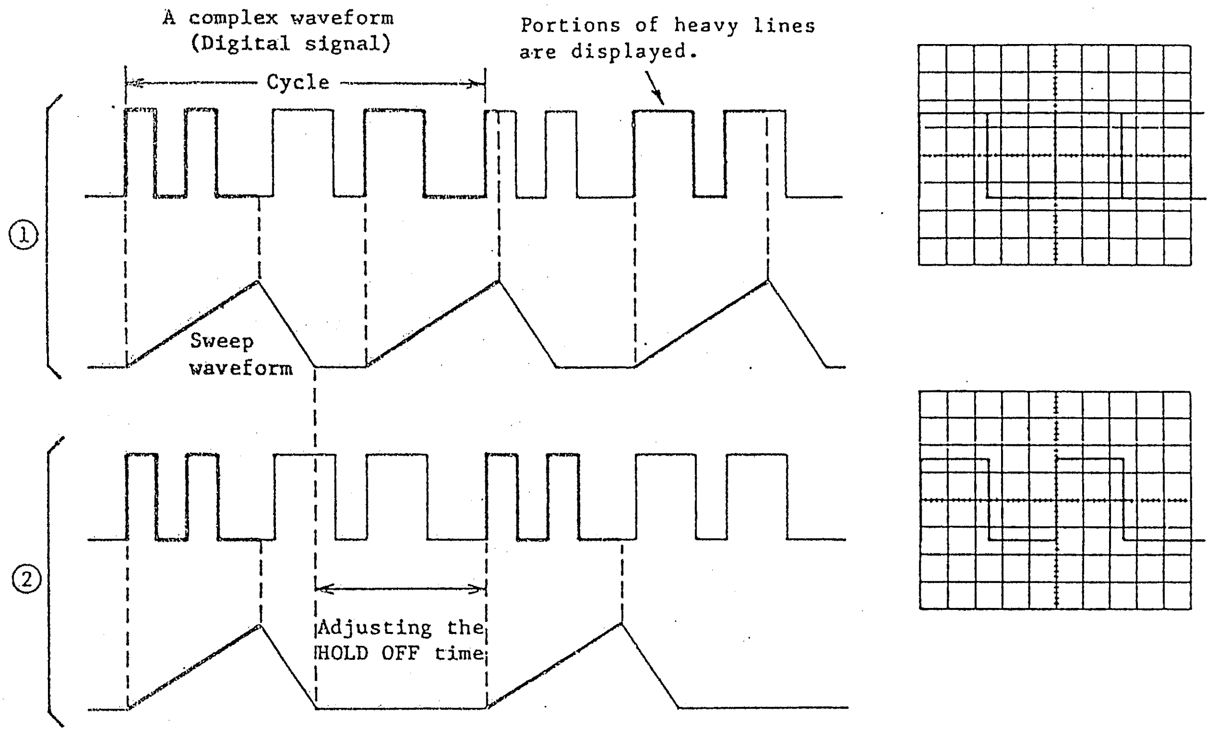


Figure 4-11

4.8 Single-sweep Operation

Non-repetitive signals and one-shot transiential signals can hardly be observed on the screen with the regular repetitive sweep operation. Such signals can be measured by displaying them in the single-sweep mode on the screen and photographing them.

o Measurement of non-repetitive signal:

(1) Set the SWEEP MODE at the NORM position.

(2) Apply the measured signal to the vertical input terminal and adjust the triggering level.

(3) Set the SWEEP MODE at the SINGLE position (the three pushbutton switches are pushed out).

(4) Press the RESET button. The sweep will run only for one cycle and measured signal will be displayed only once on the screen.

o Measurement of one-shot signal:

(1) Set the SWEEP MODE at the NORM position.

(2) Apply the calibration output signal to the vertical input terminal, and adjust the triggering level at a value corresponding to the predicted amplitude of the measured signal.

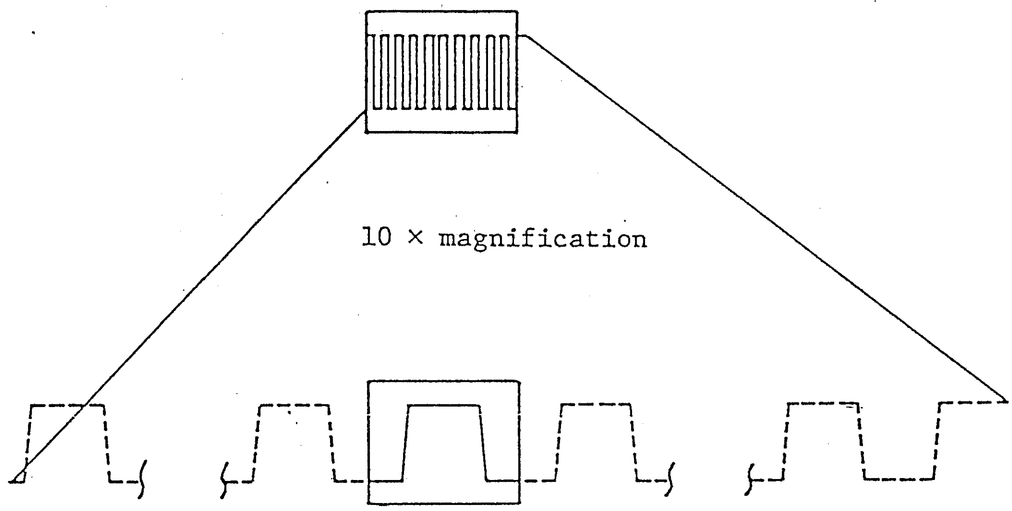
(3) Set the SWEEP MODE at the SINGLE position. Apply the measuted signal, instead of the calibration signal, to the vertical input terminal.

(4) Depress the RESET button. The sweep circuit will become in the ready state and the READY lamp will light on.

(5) As the one-shot signal occurs in the input circuit, the sweep runs only for one cycle and the one-shot signal is displayed on the CRT screen.

4.9 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 portion 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 sweep VARIABLE KNOB (29) . 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 portion can be covered by means of POSITION control.

Figure 4-12

The sweep time during the magnification operation is obtained as follows:

(Value indicated by TIME/DIV switch) × 1/10

Thus, the unmagnified maximum sweep speed (0.2 μsec/DIV) can be made faster with magnification as follows:

0.5 μsec/DIV × 1/10 = 50 nsec/DIV

4.10 STORAGE Operation

Even when the sweep speed is very low and no stable signal waveform can be displayed with the regular oscilloscope mode or even when the signal is of a one-shot phenomenon and no repetitive traces can be displayed, a stational signal waveform can be displayed with the STORAGE mode of operation. Notes and precautions for storage mode of operation are given in the following.

(1) Longevity of Storage CRT

The longevity of the CRT during the STORAGE mode operation is defined in terms of the period for which the read intensity becomes a half of the initial read intensity. The longevity of the CRT of this oscilloscope is approximately 1000 hours as shown in Figure 4-13.

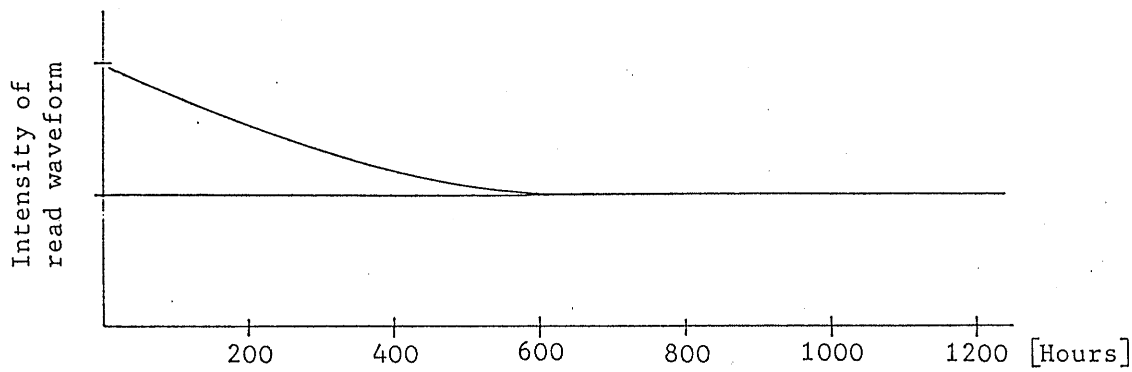


Figure 4-13

The writing speed also will be degraded by aging. The maximum writing speed can be maintained by adjusting the voltage of the storage target backing electrode of the CRT to compensate for writing speed degradation, as shown in Figure 4-14.

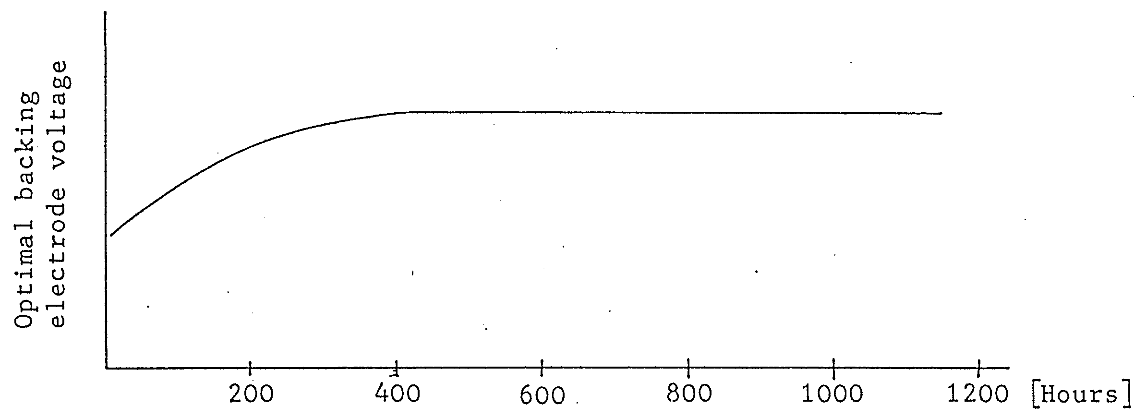


Figure 4-14

(2) ENHANCE Operation

The maximum writing speed of this oscilloscope is 40 μsec/DIV (25 DIV/msec) during the normal mode operation. During the ENHANCE mode opration, however, the maximum writing speed can be increased to 20 μsec/DIV (50 DIV/msec) or faster with the ENHANCE LEVEL control.

During the ENHANCE mode operation, at the instant when a sweep is over, an electron shower is applied for about 10 msec to the phosphor screen which also acts as a storage target, thereby fostering the storing action and enhancing the wriring speed. The ENHANCE LEVEL control adjusts the level of the electron shower applied to the screen.

The ENHANCE mode is used primarily for measurement of high-speed one-shot signals.

(3) ERASE Operation

During the ERASE mode operation, the waveform stored on the CRT screen is erased and the screen is reset to the write state. In order to avoid partial or uneven erasure, the entire screen is set once to the write state and then it is erased and reset to the write state.

If the oscilloscope is set in the SINGLE SWEEP mode, the sweep is automatically reset to the READY state after the ERASE operation is over, without requiring manual press of the RESET button.

(4) HOLD Operation

At the instant of this button pressed, the waveform stored on the CRT screen is held and displayed continuously in the read state. This state cannot be altered unless the STORAGE mode is changed to the NORM mode or the power switch is turned off.

If waveforms are held for prolonged periods on the CRT, the longevity of the CRT will be adversely affected. See Section 3.6 "Precautions for Storage Mode of Operation."

(5) Maximum Writing Speed

The maximum writing speed (WS) is determined by the travelling speed of the electron beam on the CRT screen with successful werting of a trace. The writing speed is a function of amplitude A and frequency F of the input signal (sinusoidal signal) and it can be sxpressed as follows:

$$WS = \pi \cdot F \cdot A \text{ [DIV/msec]}$$

The writing speed of this oscilloscope is as follows:

$$WS = 50 \text{ DIV/msec} = 50 \times 10^3 \text{ DIV/sec (when in ENHANCE mode)}$$

Example:

Assuming that the waveform is to be displayed with an amplitude of 4 DIV, the maximum signal frequency for successful trace writing is calculated as follows:

$$F = \frac{WS}{\pi \cdot A} = \frac{50 \times 10^3}{\pi \cdot 4} \doteq 4 \text{ [kHz]}$$

Thus, it can be known that a sinusoidal wave with an amplitude of 4 DIV on the CRT screen can be written up to approximately 4 kHz.

The relationships between the amplitude and the frequency, with the writing speed as a parameter, are shown in Figure 4-15.

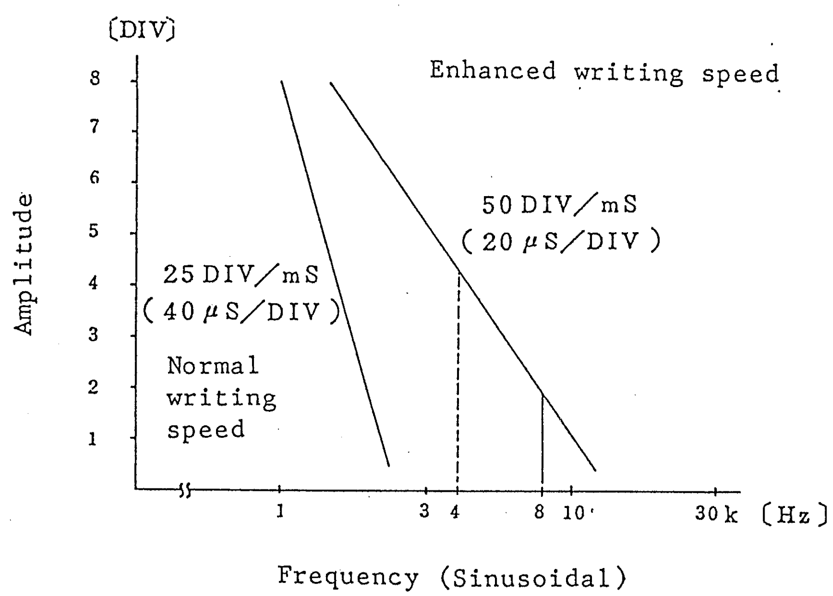

〔DIV〕
8
7
6
5
4
3
2
1
Amplitude
Enhanced writing speed
50 DIV/mS
(20 μS/DIV)
25 DIV/mS
(40 μS/DIV)
Normal
writing
speed
1
3
4
8
10
30 k
〔Hz〕
Frequency (Sinusoidal)

Figure 4-15

5. MEASURING METHODS

5.1 Connection Method of Input Signal

The input impedance of the oscilloscope as viewed from the vertical input terminal is 1 MΩ with capacitance approximately 25 pF in parallel. When the probe is used, the impedance increases to resistance of 10 MΩ with capacitance approximately 22 pF in parallel.

There are various methods of connection between measured signal source and oscilloscope. The most popular methods are with regular covered wires, with shielded wires, with a probe, or with a coaxial cable. The suitable one must be selected by taking the following factors into consideration.

Output impedance of input signal source

Level and frequency of input signal

External induction noise

Distance between input signal source and oscilloscope

Types of input signals and connection methods are tabulated in the following:

Type of input signal \ Connection method			Covered wire	Shielded wire	Probe	Coaxial cable	Others
Low frequency	Low impedance	Near	○	○	○	○	
		Far		○		○	
	High impedance	Near		▨	○	▨	
		Far		▨		▨	
High frequency	Low impedance	Near			○	○	
		Far				○	
	High impedance	Near			○	▨	
		Far					

(○ : Good, ▨: Fair)

o Connection with regular covered wires:

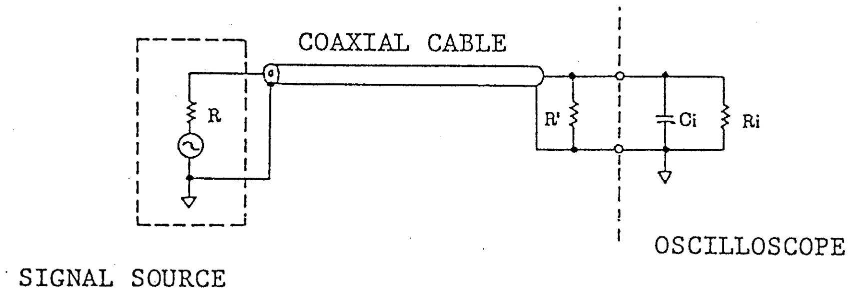
Set a BNC Type Adaptor (Type 942A, accessory) to the vertical input terminal and connect regular covered wires to the adaptor. This method is simple and the input signal is not attenuated. However it is susceptible to induction noise when the used wires are long or when the signal source impedance is high. Another disadvantage lies in a large stray capacity with respect to the ground. As compared with the case of using 10:1 probe, even larger effects are caused by this stray capacity.

o Connection with shielded wires:

The use of a shielded wire prevents external induction noise. However, the shielded wire has stray capacitance as much as 50 pF/m - 100 pF/m and therefore this method is not suitable when the signal source impedance is high or the measured signal frequency is high.

o Connection with coaxial cables:

When the output impedance of the signal source is 50 Ω or 75 Ω, the input signal can be fed without attenuation up to relatively high frequencies by using a coaxial cable which enables impedance matching. For impedance matching, terminate the coaxial cable with a 50 Ω or 75 Ω pure-resistive resistor corresponding to the characteristic impedance of the coaxial cable, as shown in Figure 5-1.

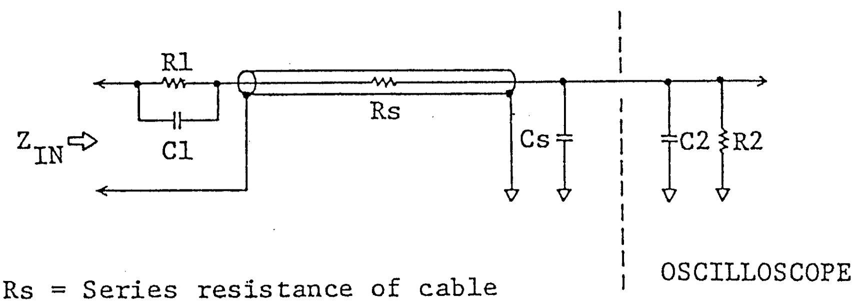


R = R'
When R = 50 Ω, use a 50 Ω coaxial cable.
When R = 75 Ω, use a 75 Ω coaxial cable.

Figure 5-1

o Connection with a probe:

The 10:1 probe supplied as an accessory of the oscilloscope has a probe circuit and a probe cable shielded to prevent induction noise. The probe circuit makes up a wide-range attenuator in conjunction with the input circuit of the oscilloscope, thereby enabling a distortionless connection from DC to high frequencies. When the probe is used, although the signal level is attenuated to 1/10, the input impedance becomes very-high (resistance 10 MΩ, capacitance approx. 22 pF) and the loading effect on the measured signal source is greatly reduced. Details of the probe are as follows:



Rs = Series resistance of cable

Cs = Stray capacitance plus cable capacitance

Figure 5-2

The probe, with its resistor R1, makes up a wide-range attenuator circuit with respect to the osilloscope's input resistor R2. In addition, the probe capacitor C1 compensates for the oscilloscope's input capacitance C2 and the stray capacitance of the cable (Cs)!

The input impedance Z_{IN} is expressed as follows:

$$Z_{IN} = \frac{R1 + R2}{\omega C\ (R1 + R2) + 1}$$

$$C = \frac{C1 \times (C2 + Cs)}{C1 + C2 + Cs}$$

Attenuation factor A is expressed as follows:

$$A = \frac{R2}{R1 + R2} \quad \left(= \frac{1\ M\Omega}{9M\Omega + 1M\Omega} = \frac{1}{10} \right)$$

The values enclosed in the parentheses are those for the probe supplied as an accessory of the oscilloscope.

Precautions:

- o Observe the maximum allowable input voltages mentioned in Section 3.1 "Precautions for Operation."
- o Be sure to use the ground lead wire which accompanies the probe. When used in the dual-channel mode, also be sure to use the ground lead wires for individual channels.
- o Before commencing measurement, be sure to accurately adjust the phase of the probe without fail.
- o Do not apply unreasonably large machanical shocks or vibration to the probe. Do not sharply bend or strongly pull the probe cable.
- o The probe unit and tip are not highly heat resistant. Do not apply a soldering iron to a circuit close to the point where the probe is left hooked up.

5.2 Voltage Measurement

To measure an AC signal which has no DC component or to measure the AC component alone of a signal which has a DC component superimposed on the AC component, set the vertical input AC/DC selector switch (⑩ , ⑲) at the AC position. To measure a signal which has a DC component, set the switch at the DC position.

Before commencing voltage measurement, set the VARIABLE attenuator knob (⑬ , ⑰) to the CAL'D position and calibrate the sensitivity to the value indicated by the VOLTS/DIV selector (⑫ , ⑯).

Apply the signal to be measured, display the signal with an appropriate amplitude on the screen, and determine the amplitude on the graticule. (For DC voltage measurement, determine the shifted distance of the trace.) The voltage can be known as follows:

(1) When measured signal is directly applied to input terminal:

Voltage (V) = Deflection amplitude (DIV) × Indication of VOLTS/DIV switch

(2) When the 10 : 1 probe is used:

Voltage (V) = Deflection amplitude (DIV) × Indication of VOLTS/DIV switch × 10

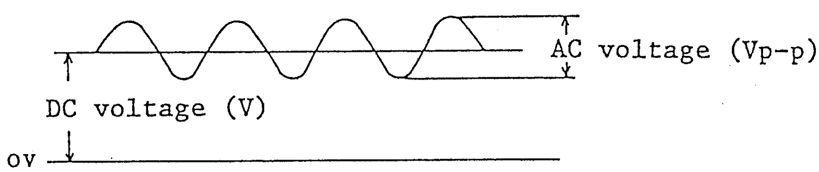


Figure 5-3

5.3 Current Measurement (Voltage Drop Method)

Connect a small-resistance resistor (R) in series in the circuit in which the current (I) to be measured flows and measure the voltage drop across the resistor with the oscilloscope. The current can be known from Ohm's law as follows:

$$I = \frac{E}{R} \quad (A)$$

The resistance should be as small as possible so that it does not cause any change to the measured signal source.

In the above method, currents from DC to high frequencies can be measured quite accurately.

5.4 Measurement of Time Interval

The time interval between any two points on the displayed waveform can be measured by setting the TIME/DIV VARIABLE knob (29) at the CAL'D position and referring to the indication of the TIME/DIV switch (31).

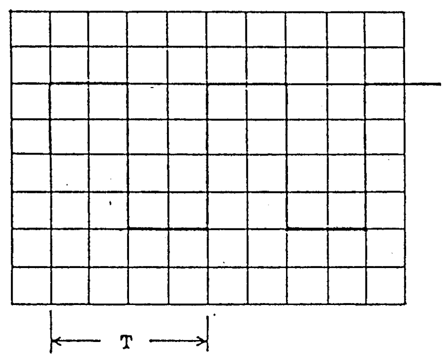


Figure 5-4

Time T (sec) = Indication of TIME/DIV × Horizontal span (DIV)

When the sweep is magnified (×10 MAG (47)), the time is 1/10 of the value determined as above.

5.5 Frequency Measurement

- o Frequency measurement by determining time (T) per one cycle of the displayed waveform:

  Time T (period) is measured as explained in Section 5.4 and the frequency is calculated by using the following formula.

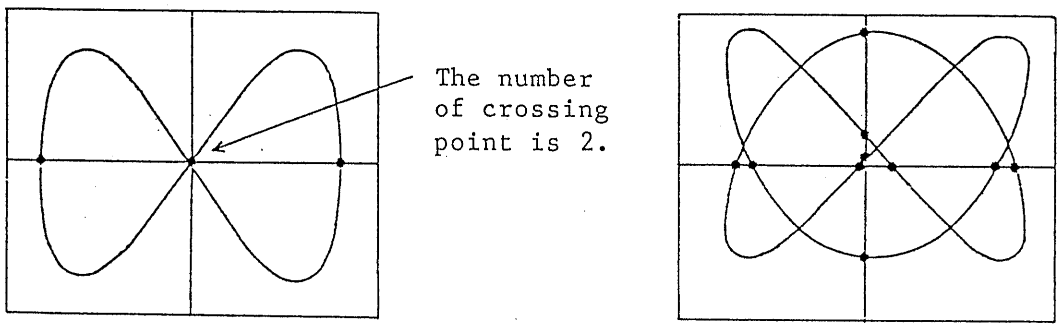
$$\text{Frequency of (Hz)} = \frac{1}{\text{Period T (sec)}}$$

- o Frequency measurement with Lissajous figure (See Figures 5-5 and 5-6):

  Set the MODE switch at the X-Y position so that the instrument operates as an X-Y scope. (See Section 5.3 "X-Y Operation.")

  Apply to the X-axis a known frequency from a signal generator (SG) and to the Y-axis the frequency to be measured. Adjust the required controls in such a way that a pattern is displayed on the overall surface of the CRT screen. Then adjust the frequency of the signal generator so that the displayed pattern becomes stationary as shown in Figure 5-5. From the displayed waveform, the unknown frequency can be calculated as follows:

$$\text{Unknown frequency (Hz)} = \frac{\text{The number of crossing points over horizontal scale line}}{\text{The number of crossing points over vertical scale line}} \times \text{Frequency of signal generator (Hz)}$$



$\frac{4}{2} = \frac{2}{1} \frac{(H)}{(V)}$ $\qquad$ $\frac{6}{4} = \frac{3}{2} \frac{(H)}{(V)}$

figure 5-5

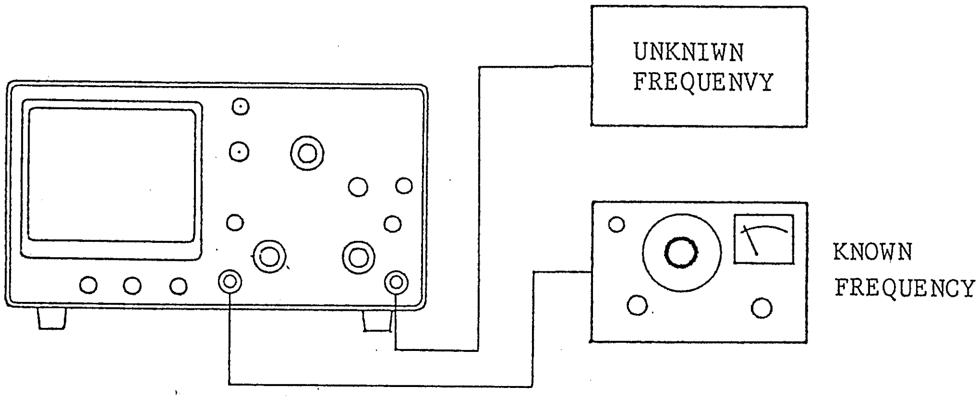


Figure 5-6

5.6 Measurement of Phase Difference

o Measurement of phase difference with Lissajous figure (See Figures 5-6, 7 and 8):

Operate the oscilloscope in the X-Y mode as explained in the paragraph for frequency measurement, and apply two signals of the same frequency (such as stereophonic signals) to the X and Y axes so that a Lissajous figure is displayed on the CRT screen. The phase difference between the two signals can be known by measuring the displayed waveform and employing the following equation:

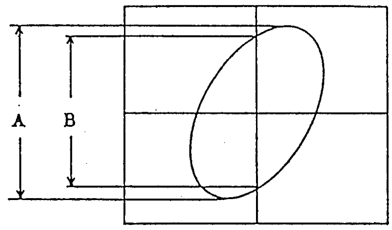
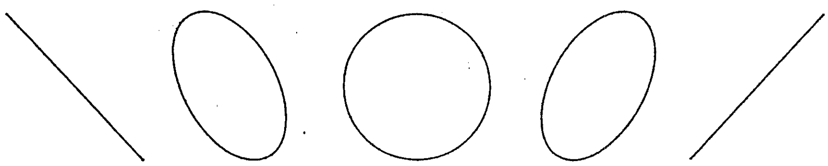


Figure 5-7



180° 150°(240°) 90°(270°) 60°(300°) 0°(360°)

Figure 5-8

o Measurement of phase difference with dual-trace operation:

Set the MODE switch at the DUAL position (10), and connect to CH1 the signal to be used for reference and to CH2 the signal to be measured. Adjust the oscilloscope so that it displays signals as shown in Fig. 5-9.

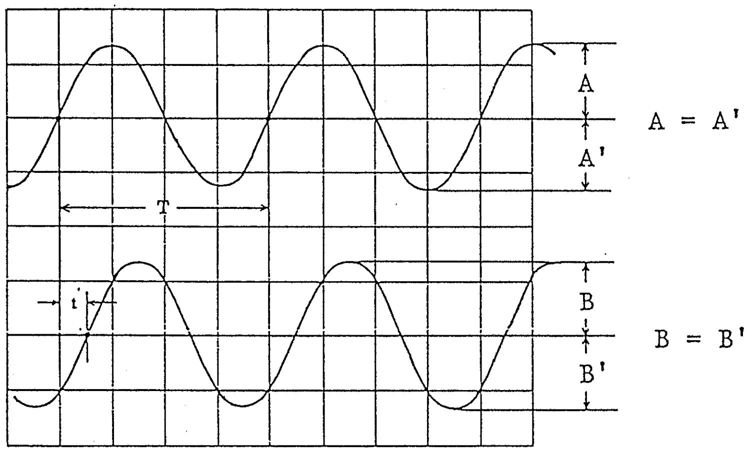


Figure 5-9

The phase difference (θ) can be calculated as follows:

$$\theta = \frac{t}{T} \times 360°$$

In this dual-trace method, very small values of t can be measured. Another advantage exists in that the phase can be known at a glance, whether it is leading or lagging.

5.7 Measurement of Pulse Waveform Characteristics

A theoretically ideal pulse waveform is the one in which the signal changes instantaneously from a certain level to another level, held in this level for a certain period, and returns instantaneously to the original level. However, actual pulse waves are distorted. Nomenclature of distortions is given in Figure 5-10.

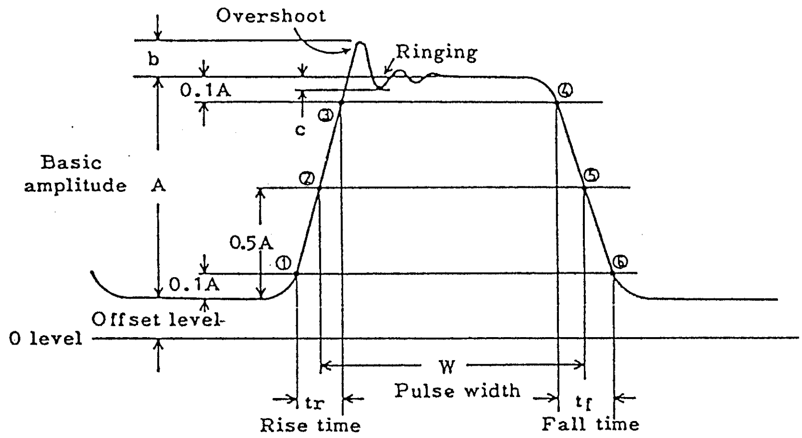


Figure 5-10

Pulse amplitude: Basic amplitude (A) of pulse

Pulse width: Time between points ② and ⑤ where signal amplitude is 50% of basic amplitude

Rise time: Time between 10% basic amplitude point ① and 90% basic amplitude point ③

Fall time: Time between 90% basic amplitude point ④ and 10% basic amplitude point ⑥

Overshoot: Amplitude of the first maximum excursion beyond basic amplitude. Expressed in terms of b/A × 100 (%)

Ringing: Oscillation which follows the first maximum excursion. Expressed in terms of c/A × 100 (%)

o Measurement of rise time:

The rise time of a pulse can be determined by measuring the value of t_r on the CRT screen in the method of "Time Measurement." It must be noted that t_r determined on the CRT screen includes the rise time of the oscilloscope itself. The closer the rise time of the oscilloscope (t_o) to the rise time of the measured pulse (t_n), the larger is the error introduced. To eliminate this error, calculation should be done as follows:

$$\text{True rise time } t_n = \sqrt{(t_r)^2 - (t_o)^2}$$

where, tr: Rise time measured on CRT screen

t_o: Rise time of oscilloscope itself (approx. 17.5 nsec when at 20 MHz band with this oscilloscope)

For example, when a pulse wave with rise time 100 nsec is measured on the CRT screen, the error is approximately 1.5%.

o Measurement of Sag

Pulse waveforms may have slanted-sections as shown in Figure 5-11, other than those distortions mentioned in Figure 5-10. (For example, slants are caused when the signal is amplified with an amplifier which has poor low-frequency characteristics, resulting from attenuation of the low frequency component.) The slanted section (d or d') is called "sag," which is calculated as follows:

$$\text{Sag} = \frac{d}{A} \quad (\text{or } \frac{d'}{A'}) \times 100 \ (\%)$$

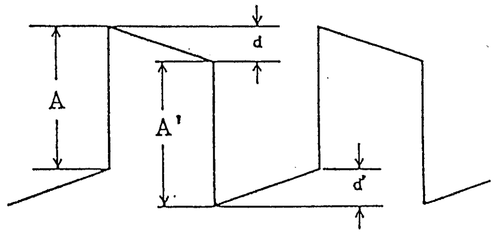


Figure 5-11

Note: If the AC-coupling mode is used for measurement of a low frequency pulse, sags are caused. For measurement of low frequency pulses, use always the DC-coupling mode.

6. CALIBRATION

6.1 General

After the oscilloscope is used for a period of time, it should be calibrated. Although the calibration of overall performances is recommended, partial calibration may serve the purpose. This includes the calibration for the time axis alone when the time measuring accuracy is especially important or that for the vertical axis alone when the vertical sensitivity accuracy is of prime importance. After the oscilloscope is repaired, the overall calibration is suggested although it depends on the type of repair.

Calibration task requires a reliable measuring installation and a qualified service engineer. It is most recommendable to order your Kikusui agent for calibration.

However, it is recommended to adjust the writing speed of the oscilloscope for yourself as it varies largely by time. (See Figure 4-14.) It should be adjusted at every 100 hours or thereabout, until approximately 400 hours of total run from the start of the use of the oscilloscope.

6.2 Removing the Case

To remove the case, remove the four screws (Figure 6-1) and pull out the chassis forward.

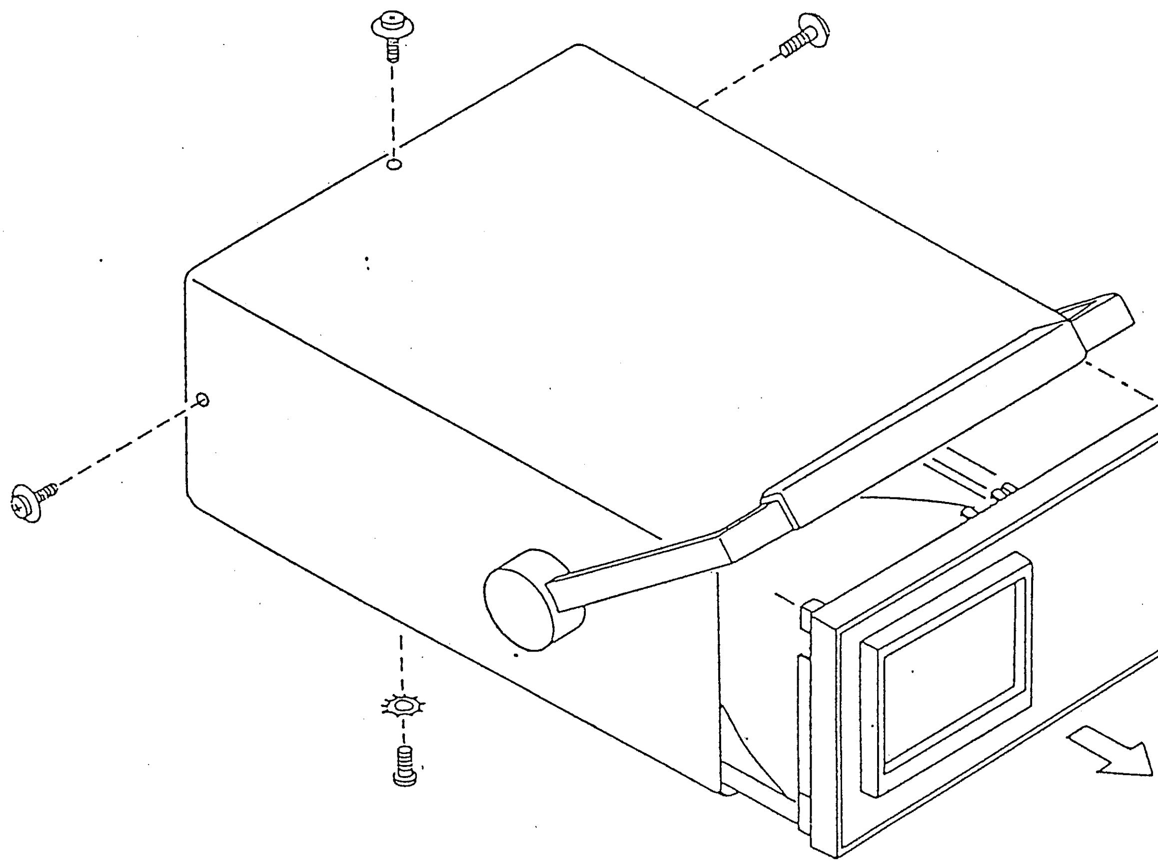


Figure 6-1

6.3 Adjustment of Backing Electrode Voltage (Writing Speed)

In order that the maximum writing speed in the storage mode is maintained, the voltage of the storage target backing electrode of the CRT should be adjusted at every 100 hours or thereabout until the total run hour of the oscilloscope reaches approximately 400 hours.

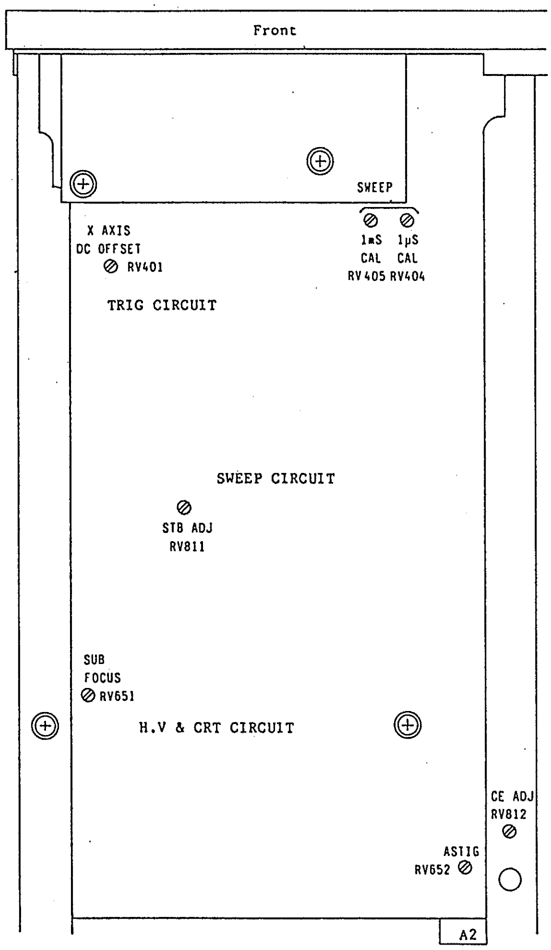


Figure 6-2

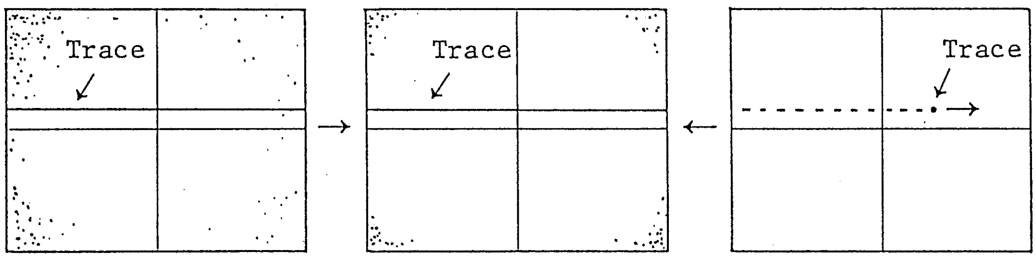
(1) Set the TIME/DIV switch at 0.1 S/DIV and display the trace in the free run mode.

(2) Of the STORAGE MODE selector buttons, set the STORAGE button to the pushed-in position (⊓) and the ENHANCE and HOLD buttons to the pushed-out position (⊓).

(3) Set the AUTO ERASE INTERVAL control at approximately 0.5 seconds.

(4) Adjust the backing electrode voltage with the backing electrode voltage adjustment potentiometer (RV811) to a voltage immediately before the pheriphery of the CRT screen starts glowing (see Figure 6-3).

(5) Set the TIME/DIV switch to the 20 µS/DIV and confirm that the trace line is stored.

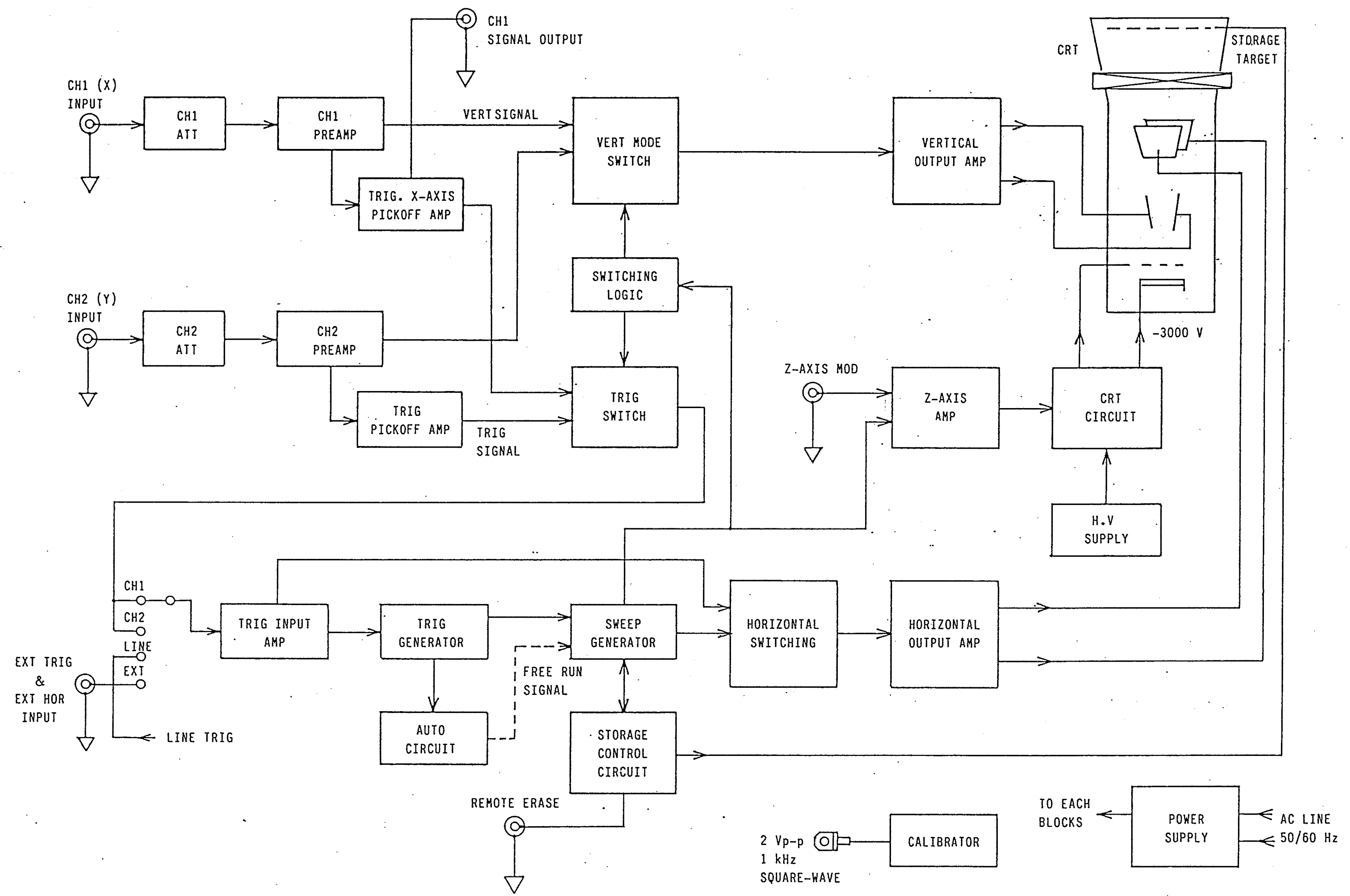


The backing electrode voltage is too high and the periphery glows.

Ideal

The backing electrode voltage is too low and the trace is not stored successfully.

Figure 6-3



BLOCK DIAGRAM