INSTRUCTION MANUAL

OSCILLOSCOPE

MODEL COS5041-DM

83.2.27

KIKUSUI ELECTRONICS CORPORATION

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1. GENERAL

1.1 Description

Kikusui Model COS5041-DM Oscilloscope is a dual-trace oscilloscope with a digital multimeter built in. It has a 6-inch rectangular CRT with a red internal graticule, covering a frequency bandwidth of DC - 40 MHz (-3 dB). It provides the maximum sensitivity of 1 mV/DIV, the maximum sweep time of 20 nsec/DIV, and a B-sweep function.

Since the digital multimeter is integrally built in, the oscilloscope can be used as an integral test and measuring instrument for maintenance service, production, and research and development.

1.2 Features

(1) Built-in digital multimeter:

Both waveform monitoring and resistance measurement can be done with this instrument. The CH1 signal of the oscilloscope can be applied as an input signal for the multimeter, for waveform observation and voltage measurement at the same time.

(2) Compact, light, but sturdy:

The oscilliscope is mode of aluminium diecast and therefor it is compact and light, but sturdy.

(3) 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.

(4) High-brightness Domed-mesh post acceleration CRT:

The high acceleration voltage (12 kV) and high contrast of CRT ensures a bright trace for high speed sweep observation.

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(5) High stability with less drift:

The oscilloscope employs a newly-developed temperature conpensation circuit, thereby greatly reducing drift of base line and DC balance distrubance caused by temperature change.

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

A new 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.

(7) TV sync triggering:

The oscilloscope has a sync separator circuit which automatically triggers on either the TV V or TV H signal according to the setting of the TIME/DIV switch.

(8) Linear focus:

Once the beam focus is adjusted to the optimum position, it is automatically maintained irrespective of intensity change, even for such waveforms with brightness variation displayed in the A INTEN mode.

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2. SPECIFICATIONS

2.1 Oscilloscope

Vertical axis

Item	Specification	Remarks
Sensitivity	NORM: 5 mV - 5 V/DIV ×5 MAG: 1 mV - 1 /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), at 1 kHz, 4 or 5 DIV
Vernier vertical sensitivity	To 1/2.5 or less of panel-indicated value	
Frequency bandwidth	NORM: DC - 40 MHz, within -3 dB ×5 MAG: DC - 20 MHz, within -3 dB AC coupling: Low limit frequency 10 Hz	With reference to 50 kHz, 8 DIV
Rise time	NORM: Approx. 8.75 nsec ×5 MAG: Approx. 17.5 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	
Linearity	±0.1 DIV or less of amplitude change when waveform of 2 DIV at graticule center is moved vertically.	

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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 at the CHOP mode over all ranges.
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	At least 1000: 1 at 50 kHz At least 50: 1 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, 1 DIV or less	PULL CH2 POSITION (Reference at center of graticule)
Signal delay time	Approx. 40 nsec (with delay cable of approx. 120 nsec)	The displayed portion preceding the triggering point

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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 (0.2 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 operation.
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.	
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 − 40 MHz.	

Item	Specification	Remarks
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
B triggering signal	The A triggering signal of main sweep is used as the B triggering signal.	

Horizontal axis (Time base)

Item	Specification	Remarks
Horizontal axis display	A, A INT, B, B TRIG'D	
A sweep (main sweep) Sweep time	NORM: 0.2 µsec/DIV – 0.5 sec/DIV ×10 MAG: 20 nsec/DIV – 50 msec/DIV	1-2-5 sequence, 20 ranges
Sweep time accuracy	NORM: ±3%	10 to 35°C (50 to 95°F)
Venier sweep time control	To 1/2.5 or slower of the panel-indicated value	
Holdoff time	Continuously variable to 2 times or higher of the sweep length (time) at 0.2 µsec/DIV to 1 msec/DIV	

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Item	Specification	Remarks
B sweep Delay system	Continuous delay and triggered delay	Triggered by A triggering signal
Sweep time	NORM: 0.2 µsec/DIV - 0.5 msec/DIV ×10 MAG: 20 nsec/DIV - 50 µsec/DIV	
Sweep time accuracy	NORM: ±3%	10 to 30°C (50 to 95°F)
Delay time	2 µsec - 5.0 sec/DIV	
Delay time accuracy	±4% of the value read on CRT	
Delay jitter	1/100,000 or less $\left(\frac{\text{B sweep time}}{\text{A sweep time}} \times \frac{\text{Jitter width}}{\text{10 DIV}}\right)$	Jitter width 1.0 DIV or less at A: 1 msec/DIV B: 1 µsec/DIV
Sweep magnification	10 times (maximum sweep time 20 nsec/DIV)	
Magnified sweep time accuracy	0.1 µsec/DIV - 0.5 sec/DIV ranges: ±5% 0.2 µsec/DIV - 0.5 µsec/DIV ranges: ±8%	10 to 35°C (50 to 95°F)
Linearity	NORM: ±3% ×10 MAG: ±5% (±8% for 0.2 µsec and 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	
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 - 2 MHz (-3 dB)	
X-Y phase difference	Not greater tnan 3° at DC - 100 kHz	

Item	Specification	Remarks
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 with CHOP operation.	
Sensitivity	Approx. 0.1 V/DIV	
Frequency bandwidth	DC - 2 MHz (-3 dB)	
Phase difference between vertical axes	Within 3° (at DC - 100 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 Vp-p (DC + AC peak)	AC frequency not higher than 1 kHz

Calibration voltage

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

CRT

Item	Specification	Remarks
Type	6-inch rectangular type, internal graticule	
Phosphor	P31	
Acceleration voltage	Approx. 12 KV	
Effective screen size	8 × 10 DIV	1 DIV = 10 mm (0.39 in.)
Graticule	Internal graticule; continuously adjustable illumination	

2.2 Digital Multimeter

Functions

Item	Specification	Remarks
Measuring functions	DC voltage, AC voltage, resistance	
A/D conversion system	Double integration system	
Sampling period	Approx. 2.5 times/sec	
Range select system	Auto-range system	

Display

Item	Specification	Remarks
Readout	7-segment LED's (red)	
Maximum display	3-1/2 digits, 1999 display	
Polarity display	+ and −, with dots	
Unit display	mV Ω, V kΩ, with dots	
Overrange display	Blinking of 1999	

Input Terminals for Measurement

Item	Specification	Remarks
EXT input	DC/AC voltage, or resistance	Floating input
INT input	DC/AC voltage of CH1 input	Decimal point moves in conformity with CH1 range.
Input selector	Selectable with the selector switch on front panel	When the function selector is set to the Ω position, the input circuit is automatically set to the EXT state.

DC Voltage Measurement

(i) EXT Input

Range	Accuracy	Resolution	Input resistance	Maximum input voltage
200 mV	±0.5% of rdg ±0.4% of fs	100 µV	100 MΩ or over	700 V
2 V		1 mV		
20 V	±0.7% of rdg ±0.4% of fs	10 mv	Approx. 10 MΩ	
200 V		100 mV		
2000 V	±2% of rdg ±0.4% of fs	1 V		

Full scale (fs): 2000 digits

(ii) INT Input

CH1 range	Range	Accuray	DC offset	Remarks
5 mV - 50 mV/DIV	200 mV	±2% of rdg ±0.4% of fs	±10 dgts	Accuracy is guaranteed within effective measuring range. When the probe (10:1) is used, error of ±2% is added to the accuracy.
	2 V		±1 dgt	
	20 V		±0 dgts	
0.1 V - 0.5 V/DIV	2 V	±2.5% of rdg ±0.4% of fs	±10 dgts	
	20 V		±1 dgt	
	200 V		±0 dgts	
1 V - 5 V/DIV	20 V		±10 dgts	
	200 V		±1 dgt	
	2000 V		±0 dgts	

Effective voltage measuring range: See Section 4.15.

Full scale (fs): 2000 digits

AC Voltage Measurement

(i) EXT Input

Range	Accuracy	Resolution	Input resistance	Maximum Input Voltage
200 mV	±1.3% of rdg ±0.4% of fs	100 µV	100 MΩ or over	500 Vrms
2 V	±1.3% of rdg ±0.3% of fs	1 mV		
20 V		10 mV	Approx. 10 MΩ	
200 V		100 mV		
2000 V	±2.5% of rdg ±0.3% of fs	1 V		

Full scale (fs): 2000 digits

(ii) INT range

CH1 range	Range	Accuracy	Remarks
5 mV - 50 mV/DIV	200 mV	±2.5% of rdg ±0.4% of fs	The accuracy is applicable within the effective voltage measuring range and with DC coupling for CH1.
	2 V		
0.1 V - 0.5 V/DIV	2 V		
	20 V		
1 V - 5 V/DIV	20 V		
	200 V		

Effective voltage measuring range: See Section 4.15.

Full scale (fs): 2000 digits

AC Frequency Measurement

Frequency	Accuracy	Remarks
50 Hz and over, less than 400 Hz	Satisfies the afore-mentioned accuracy.	
400 Hz and over, less than 500 Hz	Satisfies the afore-mentioned accuracy plus 2% for reading error.	

Resistance Measurement

Range	Accuracy	Resolution	Measuring current	Open terminal voltage
200 Ω	±1% of rdg ±0.3% of fs	0.1 Ω	1 mA	Approx. 4 V
2 kΩ		1 Ω		
20 kΩ		10 Ω	100 μA	
200 kΩ		100 Ω	10 μA	
2 MΩ	±2.5% of rdg ±0.3% of fs	1 kΩ	1 μA	

Full scale (fs): 2000 digits

Maximum Voltage Applied for Resistance Measurement

Item	Specification	Remarks
Maximum application voltage	DC: ±50 V AC: 50 Vrms (within 30 sec)	

2.3 Common Specification

Line power requirements

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

Frequency: 50 Hz or 60 Hz

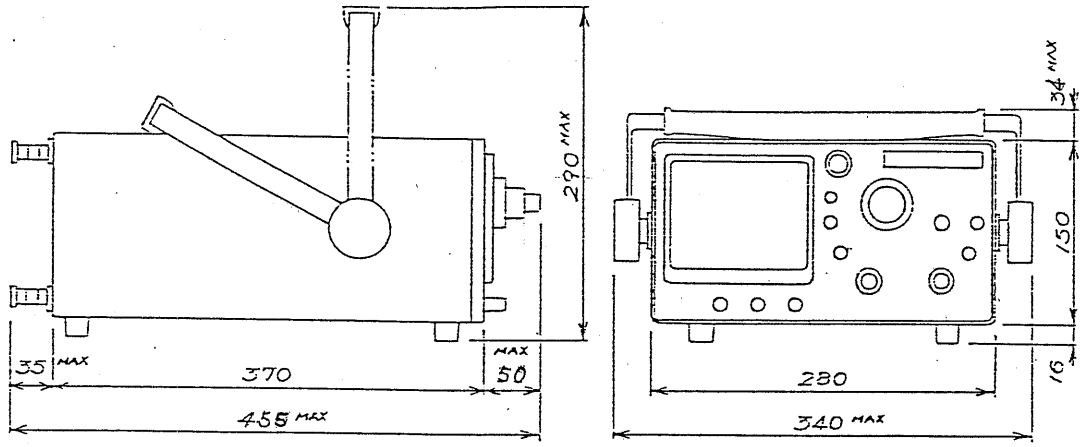
Power consumption: Approx. 37 VA

Mechanical specifictions

Mainframe dimensions: 280 W × 150 H × 370 D mm
(11.02 W × 5.91 H × 14.57 D in.)

Maximum dimensions: 340 W × 200 H × 455 D mm
(13.39 W × 7.87 H × 17.91 D in.)

Weight: Approx. 7 kg (15 lbs.)



Operating environments

To satisfy the specifications os oscilloscope

Temperature: 5 to 35°C (41 to 95°F)

Humidity: 85% RH or less

To satisfy the specifications of multimeter

Temperature: 23° ±5°C (41.4 ±9°F)

Humidity: 80% RH or less

Maximum operating ranges

Temperature: 0 to 40°C (32 to 104°F)

Humidity: 90% or less

Accessories

P060-S BNC Probes (10:1, 1:1) ...	(89-03-0300)	2
PW-1 Test Leads	(89-04-0030)	1
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 cord to an AC line outlet, be sure to check that the voltage selector plug is set in the correct position corresponding to the line. Note that the oscilloscope may not properly operate or may be damaged if it is connected to a wrong voltage AC line. When line voltages are changed, replace fuses also as required.

Selector plug position	Nominal voltage	Voltage tolerance	Fuse
A	100 V	90 - 110 V	0.5 A
B	115 V	104 - 126 V	
C	215 V	194 - 236 V	0.3 A
D	230 V	207 - 253 V	

3.3 Environments

The normal ambient temperature range of this instrument is 0 to 40°C (33 to 104°F). If the instrument is operated or stored in abnormally high ambient temperature and humidity for a long time, failure or shortening of the longevity of the instrument may result.

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

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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.

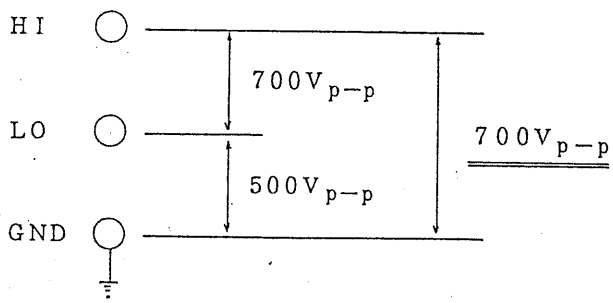
3.5 Withstanding Voltages of Input Terminals

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

Input terminal	Maximum allowable input voltage
CH1, CH2, inputs	400 Vp-p (DC + AC peak)
EXT TRIG input	100 Vp-p (DC + AC peak)
Probe inputs	600 Vp-p (DC + AC peak)
Z AXIS input	50 Vp-p (DC + AC peak)
Between DMM HI and LOW terminals	700 Vp-p (DC + AC peak)
Between DMM HI and GND terminals	700 Vp-p (DC + AC peak)
Between DMM LO and GND terminals	500 Vp-p (DC + AC peak)

AC frequency not higher than 1 kHz.

Precautions: When a voltage is applied between the LO terminal of DMM (digital multimeter) and the GND terminal of oscilloscope, it should be noted that the voltage applied between the HI terminal and the GND terminal shall not exceed the withstanding voltage.



4. OPERATION METHOD

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

CRT circuits:

POWER ..... (3) Main power switch of the instrument. When this switch is turned on, the LED (2) above the switch will light on.

INTEN ..... (4) Controls the brightness of the spot or trace.

B INTEN ..... (5) Semi-fixed potentiometer for adjusting trace intensity during B sweep mode operation.

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 ..... (38) For installing a camera mount in one-touch operation.

Filter ..... (39) Blue filter for ease of waveform viewing. Can be removed in one-touch operation.

Vertical Axis:

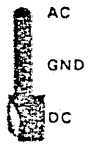
CH1 (X) input .. (11) Vertical input terminal of CH1. During X-Y operation, this terminal is used as an X-axis (abscissa) input terminal.

If DMM input selector switch (14) is set to the INT positon, the input voltage of this terminal can be measured with the DMM.

CH2 (Y) input .. (19) Vertical input terminal of CH2. During X-Y operation, this terminal is used as a Y-axis (ordinate) input terminal.

AC-GND-DC ... ⑩ ㉑

Switch for selecting connection mode between input signal and vertical amplifier.



AC: AC coupling

GND: Vertical amplifier input is grounded and input terminals are made open.

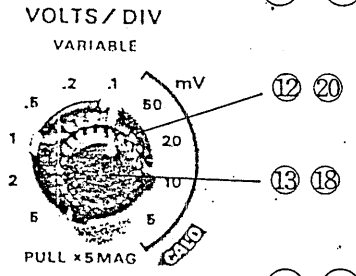
DC: DC coupling

VOLTS/DIV .. ⑫ ⑳

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

VARIABLE ... ⑬ ⑱

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

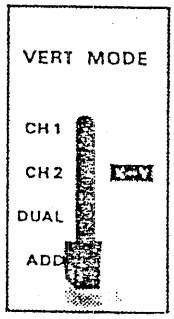


POSITION .... ⑨ ㉓

Vertical positioning control of trace or spot.

VERT MODE ..... ⑯

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 an internal triggering source signal.

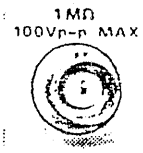
CH2: The oscilloscope operates as a single-channel instrument with CH2 alone. The CH2 signal is used as an internal triggering source signal.

DUAL: The oscilloscope operates as a dual-channel instrument with both CH1 and CH2 in the CHOP or ALT mode.
The internal triggering source signal is selected by SOURCE switch ㉗.

ADD: The oscilloscope displays the algebraic sum (CH1 + CH2) or difference (CH1 - CH2) of the two signals. The pulled out position of CH2 POSITION knob (23) is for the difference (CH1 - CH2). The internal triggering source signal is selected by SOURCE switch (27).

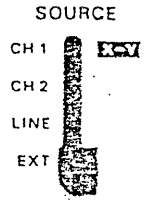
Triggering

EXT TRIG (EXT HOR) (26) INPUT TERMINAL



This terminal is used in common for external triggering signal and external horizontal signal. To use this terminal, set SOURCE switch (27) to the EXT position.

SOURCE ..... (27) Selects the internal triggering source signal. Also selects the EXT HOR input signal.



CH1 X-Y; When the VERT MODE switch (16) 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 (16) is set at the DUAL or ADD position, selects CH2 for the internal triggering source signal.

LINE: The AC line signal is used for the triggering signal.

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

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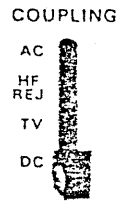
Note: When the VERT MODE switch is set to the CH1 or CH2 position, internal triggering source signal selection cannot be done with the SOURCE switch. That is, the internal triggering signal source is set with the VERT MODE switch.

COUPLING ..... (28) Selects coupling mode between triggering signal source and trigger circuit; selects connection of TV sync trigger circuit.



AC: AC coupling.

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

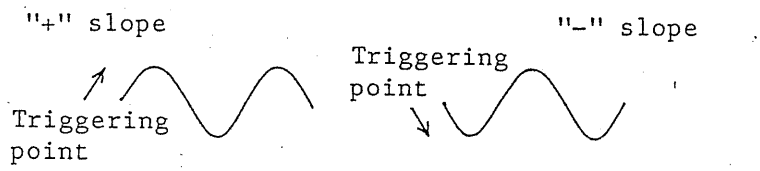
DC: DC coupling

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 (33).
TV V: 0.5 sec/DIV - 0.1 msec/DIV.
TV H: 50 µsec/DIV - 0.2 µsec/DIV.

SLOPE ..... (29) 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).



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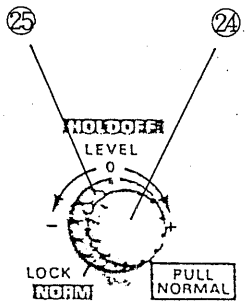
HOLDOFF ..... (25)
LEVEL, SWEEP MODE (24)



These double-knob controls are for holdoff time adjustment and triggering level adjustment with sweep mode switch.

The HOLDOFF time control is used when the signal waveform is complex so that stable triggering cannot be attained with the LEVEL knobe 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 "- +", the triggering level moves downward. When the knob is set in 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.

When the LEVEL knob is in the normal position (not pulled out), sweep is in the AUTO mode; when it is pulled out, sweep is in the NORMAL mode.

AUTO: When no triggering signal is applied or the triggering signal frequency is lower than 50 Hz, sweep runs in the FREE RUN mode.

NORMAL: When no triggering signal is applied, sweep is in the STANDBY state and not displayed on the screen. This mode is used primarily for measurement of signals of 50 Hz or less.

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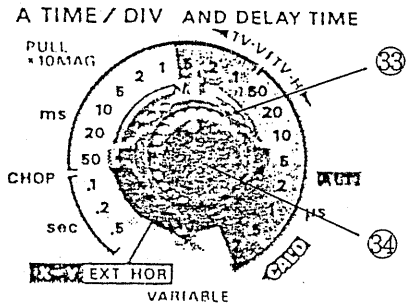
Time Base

A TIME/DIV ..... (33)
AND DELAY TIME



Selects the sweep time for the A sweep or the delay time for the delayed sweep mode. 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 horizontal signal.

(For details, see Sections 4.4 - 4.6.)

VARIABLE ..... (34)
PULL ×10 MAG

Vernier control of sweep time (A sweep). 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 in the CAL'D position.

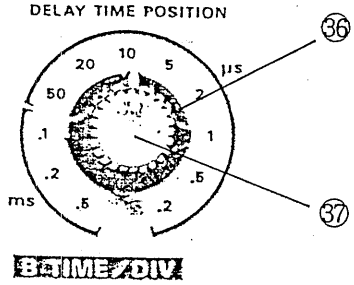
The pulled out position of this knob is for the ×10 MAG state.

POSITION ..... (35)

Vertical adjustment of the trace or spot.

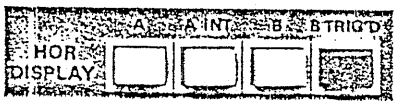
B TIME/DIV ..... (36)

Selects the sweep time for delayed sweep (B sweep).



DELAY TIME POSITION ..... (37) Vernier control of the delay time selected by the A TIME/DIV AND DELAY TIME switch (33), to finely select the portion of the A sweep waveform to be magnified.

HOR DISPLAY (22) Selects A or B sweep mode as follows:



A: Main sweep (A sweep) mode for general waveform observation.

A INT: This sweep mode is used when selecting the section of the A sweep which is to be magnified and prepared for delayed sweep (B sweep) observation. The B sweep is the high brightness portion of ths A sweep.

B: Displays the delayed sweep (B sweep) alone.

B TRIG'D: Selects continuous delay or triggered delay as follows;

 : Used for continuous delay. The B sweep starts immediately after the sweep delay time set by DELAY TIME switch (33) and DELAY TIME POSITION knob (37) has elapsed.

 : Used for triggered delay. The B sweep starts when the triggering pulse is applied after the sweep delay time set by DELAY TIME switch and DELAY TIME POSITION knob has elapsed.

(The triggering signal is used in common for both A sweep and B sweep.)

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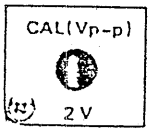
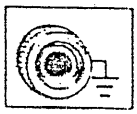
Others

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.



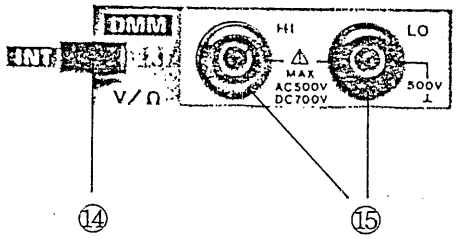
... (17)

Ground terminal of instrument mainframe.

DMM INT-EXT ... (14)

This switch is to select the input of the digital multimeter (DMM).

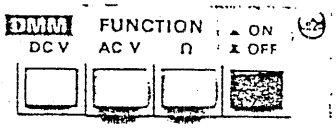
EXT input ..... (15) terminal



EXT: EXT input terminal (15) is used as input terminal for DMM. Voltage and resistance measurement can be made by using the test leads supplied. The input circuit is floated.

INT: The CH1 input (11) is connected to the DMM through internal circuit of the instrument. Both waveform observation and voltage measurement of the CH1 signal can be made.

DMM FUNCTION, .. (30)
DMM ON/OFF



The DMM FUNCTION buttons select the functions of the DMM.

DC V: DC voltage measurement.

AC V: AC voltage measurement.

Ω: Resistance measurement.
The input circuit is automatically switched to the EXT circuit.

The DMM ON/OFF switch turns on/off the DMM DISPLAYS ALONE. When the switch is on (⊓⊓), displays (31) and (32) light; when the switch is off (⊔⊔), displays (31) and (32) go off.

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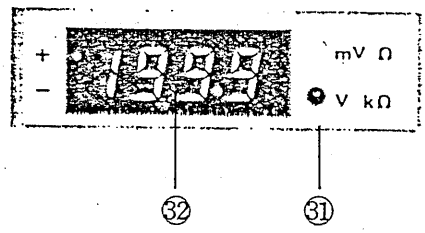
UNIT DISPLAY .... (31) These indicator lamps denote mV or V for voltage measurement and Ω or kΩ for resistance measurement.

DMM DISPLAY ..... (32) This readout indicates the value measured by the digital multimeter. When the measured value exceeds the display range, '1999' blinks.



4.2 Explanation of Rear Panel

Z-AXIS INPUT .... (40) Input terminals for external intensity modulation signal.

CH1 SIGNAL OUTPUT ..... (41) Delivers the CH1 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 ... (43) Input connector for the AC power of the instrument. Connect the AC power cord (supplied) to this connector.

FUSE ..... (44) Fuse in the primary circuit of the power transformer. Fuse rating is shown in Table (47).

AC voltage selecting connector ..... (45) For selecting the AC voltage of the instrument.

AC voltage selector plug ..... (46) For selecting the AC voltage of the instrument by aligning its arrowhead mark in the corresponding position as shown in Table (44).

Studs ..... (42) Studs for laying the oscilloscope on its back to operate it in the upward posture. Also used to take up the power cord.

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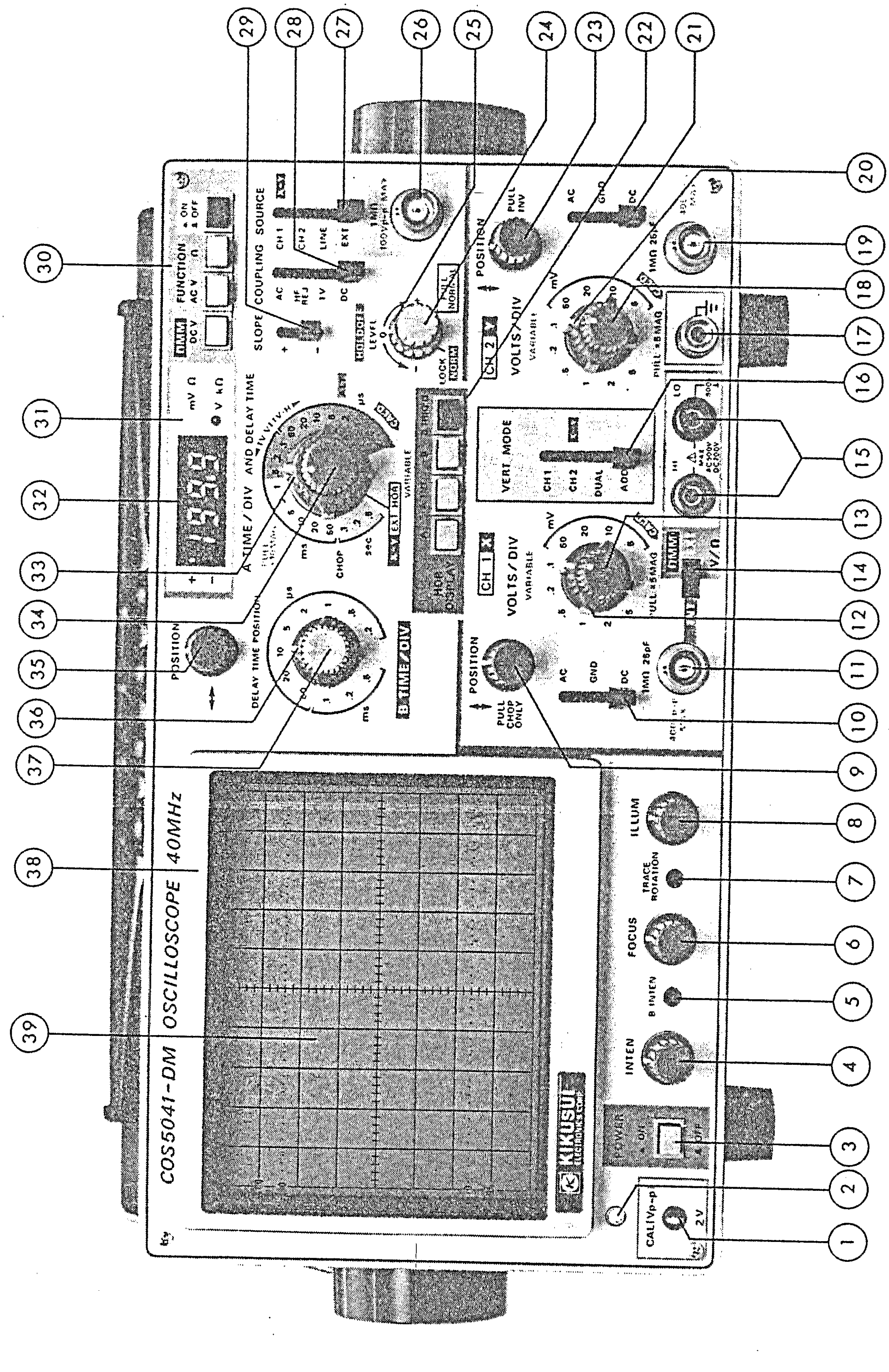

COS5041-DM OSCILLOSCOPE 40MHz
KIKUSUI
POWER
INTEN
B INTEN
FOCUS
TRACE ROTATION
ILLUM
CAL 1Vp-p
POSITION
DELAY TIME POSITION
A TIME / DIV AND DELAY TIME
B TIME / DIV
VOLTS / DIV
VARIABLE
CH 1 X
CH 2 Y
VERT MODE
CH1
CH2
DUAL
ADD
SLOPE
COUPLING
SOURCE
LEVEL
FUNCTION
DCV
AC V
V/Ω
1
2
3
4
5
6
7
8
9
10
11
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13
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Figure 4-1

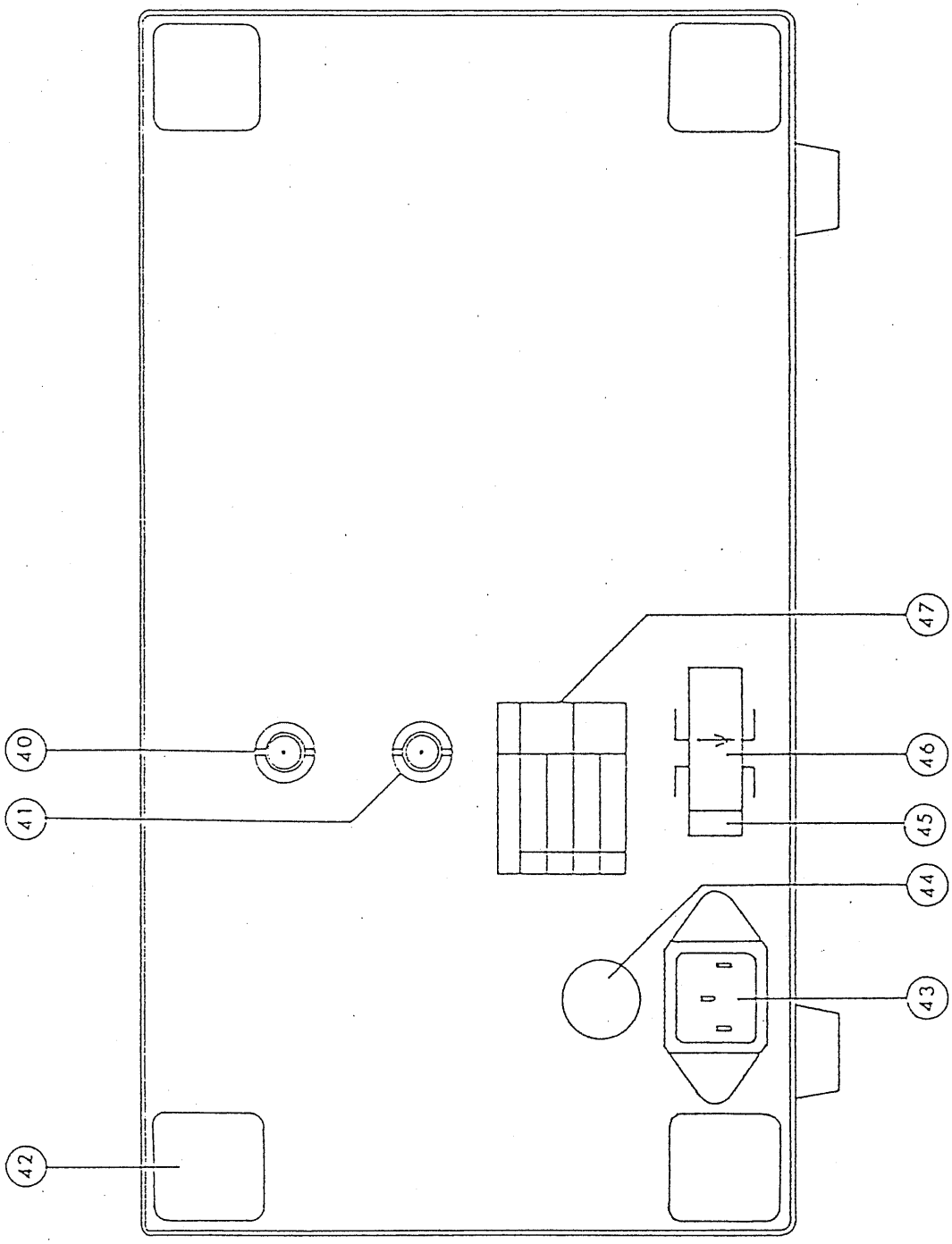

Figure 4-2

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 be 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	⑯	CH1
↕ POSITION	⑨ ㉓	Mid-position, pushed in
VOLTS/DIV	⑫ ⑳	50 mV/DIV
VARIABLE	⑬ ⑱	CAL'D (clockwise position), pushed in
AC-GND-DC	⑩ ㉑	GND
SOURCE	㉗	CH1
COUPLING	㉘	AC
SLOPE	㉙	+
LEVEL	㉔	LOCK (counterclockwise)
HOLDOFF	㉕	NORM (counterclockwise)
HOR DISPLAY	㉒	A
TIME/DIV	㉝	0.5 msec/DIV
VARIABLE	㉞	CAL'D (clockwise), pushed in
↔ POSITION	㉟	Mid-position

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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.

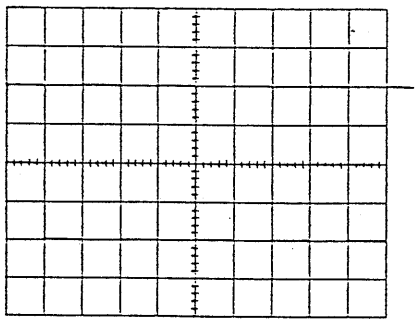


Figure 4-3

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.

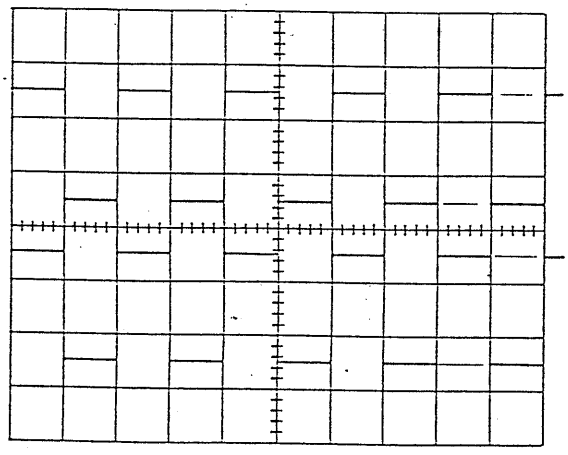
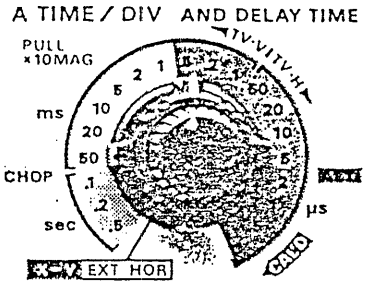


Figure 4-4

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 1 MHz (-3 dB).

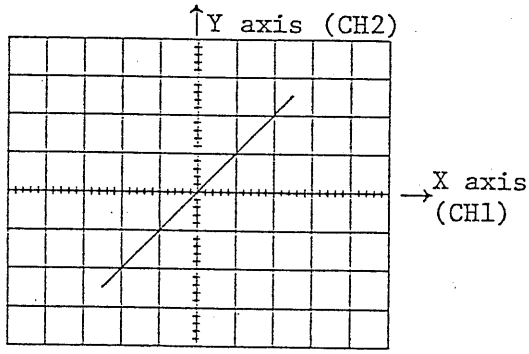


Figure 4-6

o EXT HOR (external sweep) operation

The external signal applied through the EXT HOR terminal (26) 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.

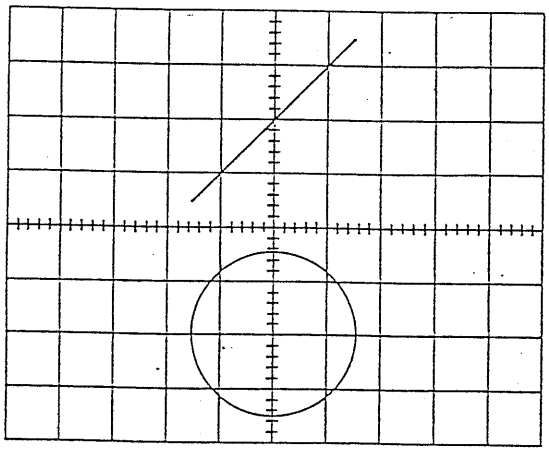


Figure 4-7. Dual-channel X-Y operation

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.

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

VERT MODE / SOURCE	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: 0.5 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 4-8.

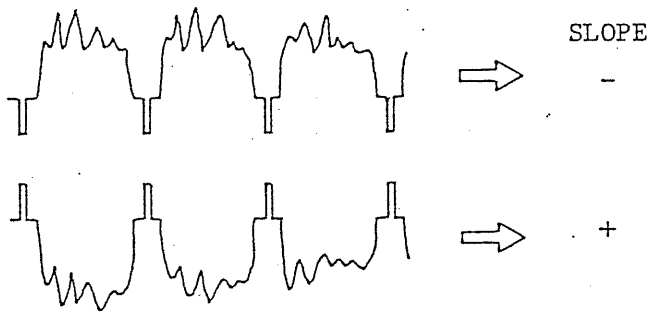

Figure 4-8

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).

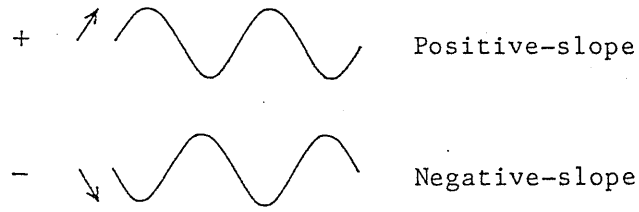

Figure 4-9

(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.

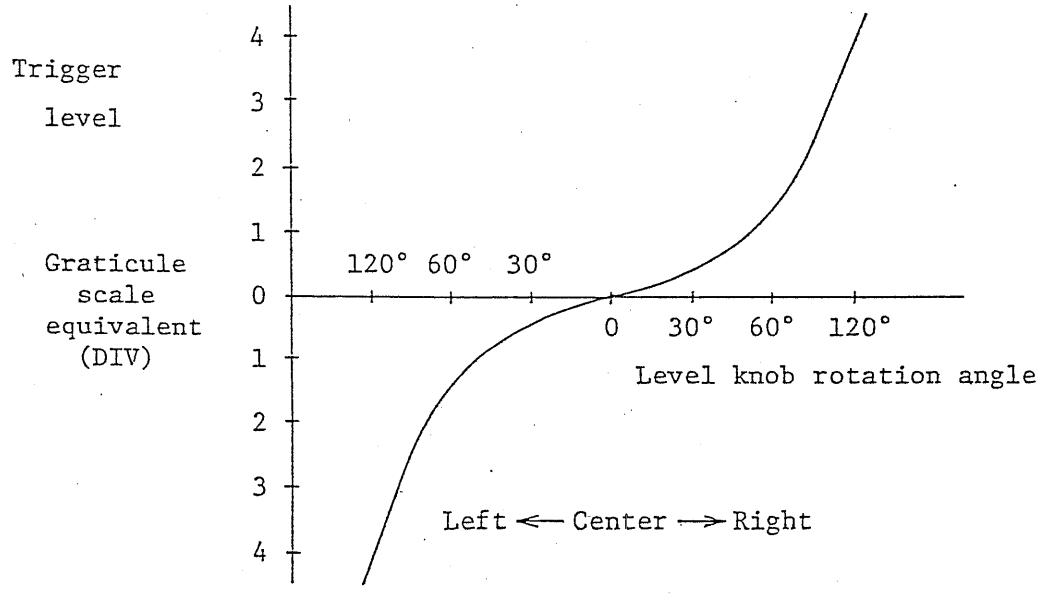

Figure 4-10

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 - 40 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 0.2 sec/DIV.

Figure 4-11 (1) shows a case for the 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.

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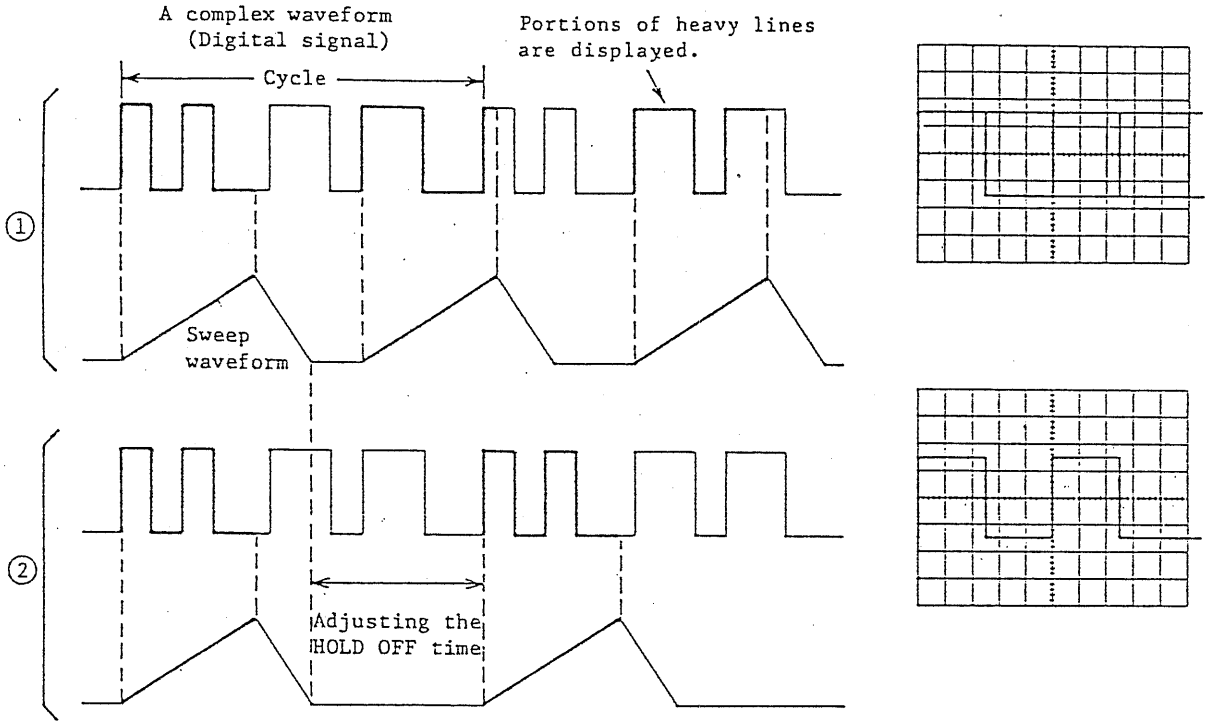

Figure 4-11

4.8 Sweep Magnification

When a certain portion 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 (34) . 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.

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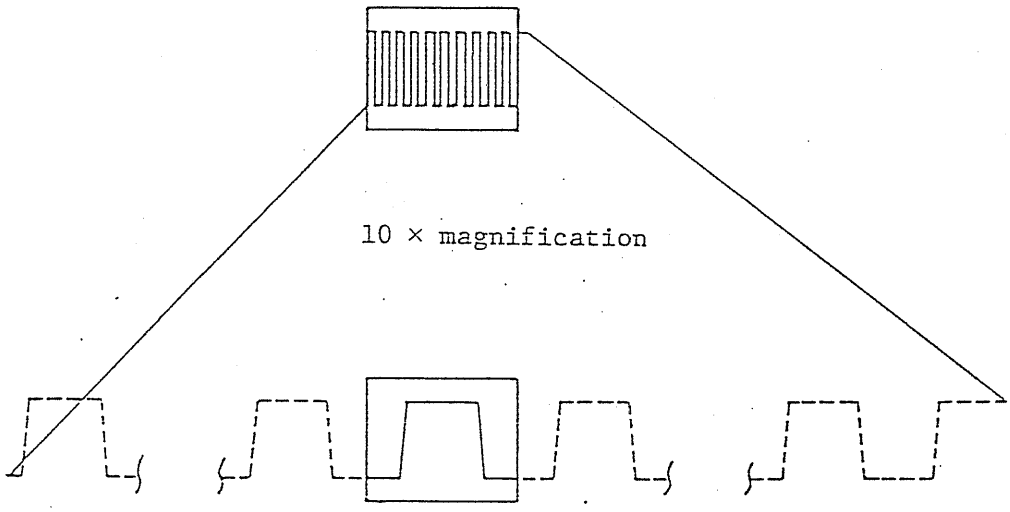

Any portion can be covered by means of POSITION control.

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:

0.2 μsec/DIV × 1/10 = 20 nsec/DIV

When the sweep is magnified and the sweep speed has become faster than 0.2 μsec/DIV, the trace may become darker. In such a case, the displayed waveform should be expanded in the B sweep mode as will be explained in the subsequent paragraphs.

4.9 Waveform Magnification with Delayed Sweep

With the sweep magnification of the preceding paragraph, although the magnification method is simple, the magnification ratio is limited to 10. With the delayed sweep method of this paragraph, on the other hand, the sweep can be expanded for a wide range from several times to several thousand times according to the ratio between A sweep time and B sweep time.

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As the measured signal frequency becomes high and the A sweep range for the non-expanded signal becomes higher, the available expansion ratio becomes smaller. Furthermore, as the magnification ratio becomes larger, the trace intensity becomes lower and the delay jitter increases. To cope with these situations, a continuously-variable delay circuit and a triggered delay circuit are incorporated into the oscilloscope.

(1) Continuously-variably delay:

Set the HOR DISPLAY switch to A and display the signal waveform with the A sweep in the regular operation method.

Next, set the B TIME/DIV switch at a position faster by several steps than the A TIME/DIV switch.

After ensuring that the B TRIG'D button of the HOR DISPLAY switch is at the pushed out position (□), turn the HOR DISPLAY switch to the A INTEN position. A portion of the displayed waveform will be accentuated as shown in Figure 4-14, indicating the state ready for delayed sweep. The portion of the accentuated brightness indicates the section corresponding to the B sweep time (DELAYED SWEEP). This portion is expanded on the B sweep.

The period from the start of the A sweep to that of the B sweep (the period to the start of trace accentuation) is called "SEEP DELAY TIME." This period is continuously variable by means of the DELAY TIME POSITION knob.

Next, change the HOR DISPLAY switch to the B position. The B sweep time will be expanded for the full span of the CRT screen as shown in Figure 4-15.

The B sweep time is set by the B TIME/DIV switch and the magnification ratio becomes as follows:

$$\text{Magnification ratio} = \frac{\text{A TIME/DIV indication}}{\text{B TIME/DIV indication}}$$

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The sweep delay time can be read on the CRT screen. For more accurate determination, the DELAY TIME MULTI dial should be used.

$$\text{Sweep delay time} = \frac{\text{A TIME/DIV indication}}{\text{DELAY TIME MULTI dial setting}} \times$$

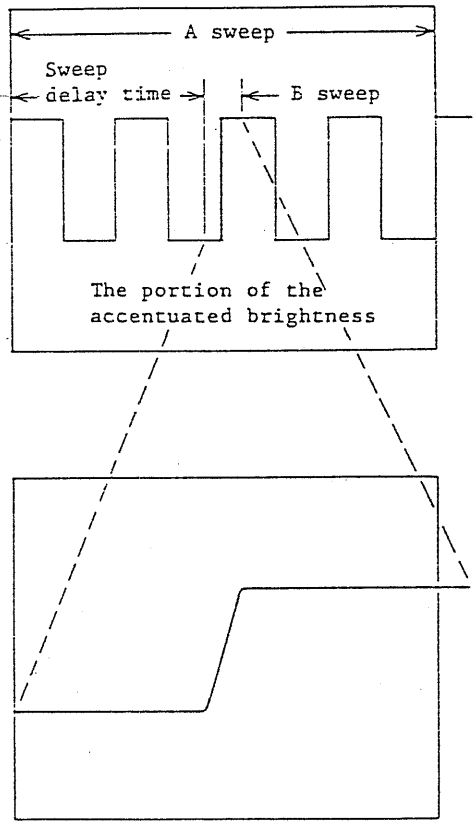

Figure 4-13

Figure 4-14

(2) Triggered delay:

When the displayed waveform is magnified by 100 times or higher in the above-mentioned continuous delay method, delay jitter is produced. To suppress the jitter, the triggered delay method may be used.

With the triggered delay, delay jitter is reduced by triggering the B sweep again after a sweep delay time as effected by the continuous delay method has elapsed.

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For this operation the A trigger circuit continues to operate even after the B TRIG'D button is pushed in (⊓) and the B sweep is triggered by the triggering pulse. Therefore, even when the delay time is continuously varied by turning the TIME DELAY POSITION knob, the starting point of the sweep moves discretely, not continuously. In the A INTEN mode, this operation is characterized by discrete shifts of the brightness-accentuated section of the sweep across the CRT screen; while in the B mode this section remains stationary.

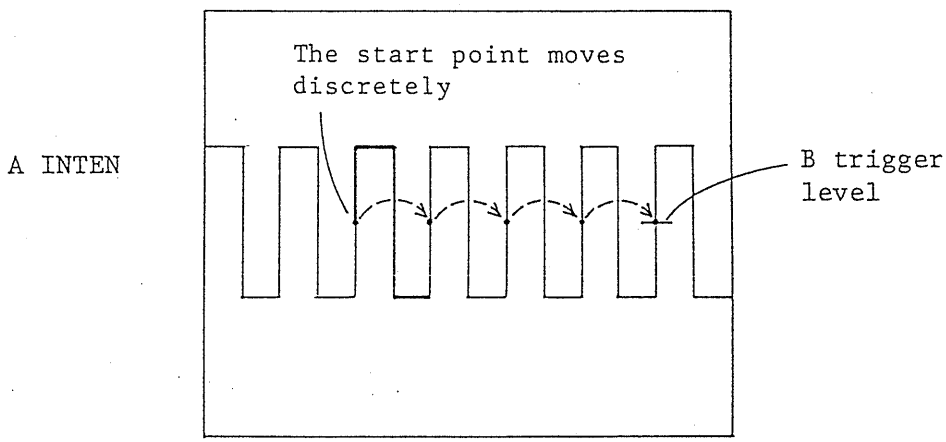

Figure 4-15

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4.10 Calibration of Probe

As explained previously, the probe makes up a wide-range attenuator. Unless phase compensation is properly done, the displayed waveform is distorted causing measurement errors. Therefore, the probe must be properly compensated before use.

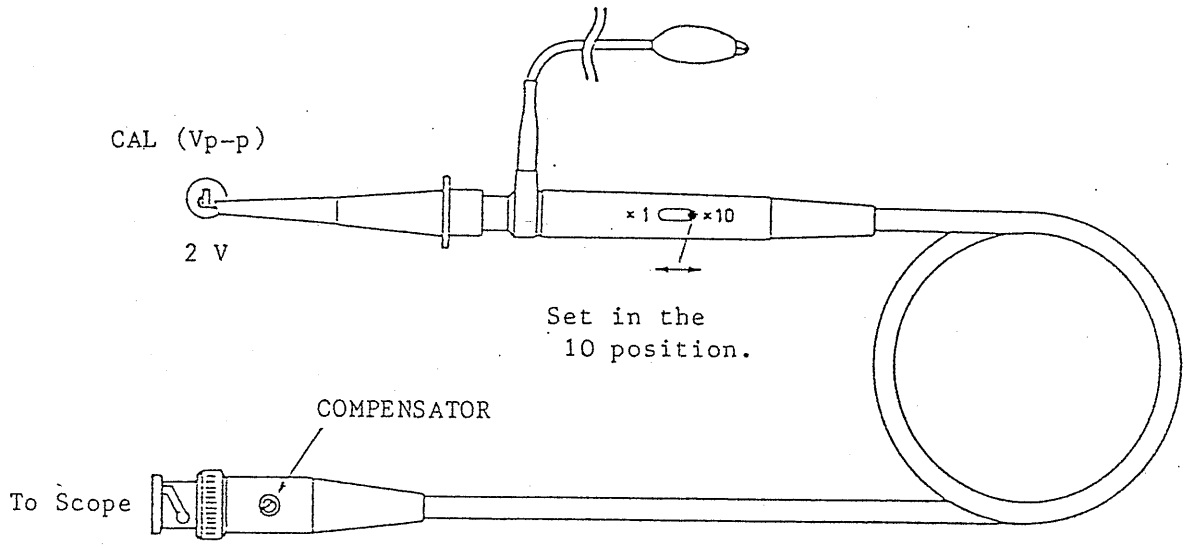

Figure 4-16

Connect the probe BNC to the INPUT terminal of CH1 or CH2 and set VOLTS/DIV switch at 50 mV. Connect the probe tip to the calibration voltage output terminal and adjust the COMPENSATOR control with an insulated screwdriver so that an ideal waveform as illustrated below is obtained.

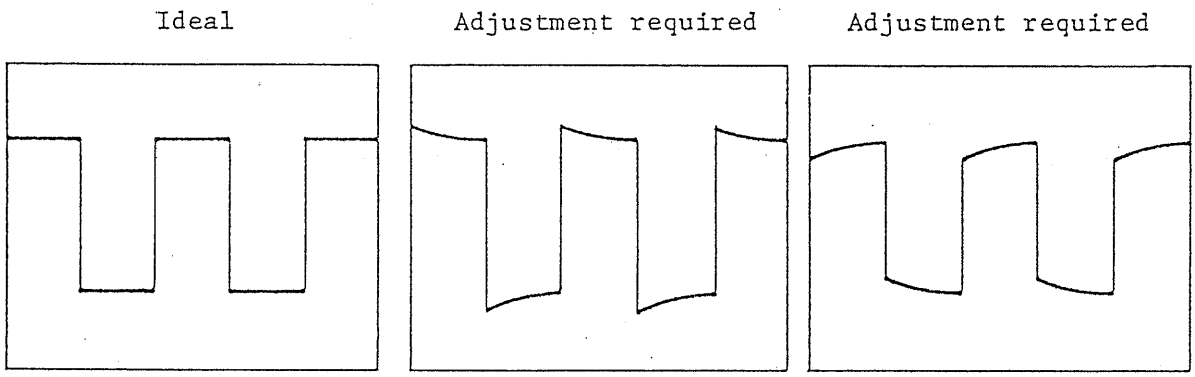

Figure 4-17

4.11 Operation of Digital Multimeter

(1) The power switch of the oscilloscope is used in common with the digital multimeter (DMM). When the power switch of the oscilloscope is turned on, the power of the digital multimeter also is turned on.

(2) As you press the DMM ON/OFF switch, the LED displays of the DMM light on. When the DMM is not required to be used, keep the switch at the OFF positon.

Note: The DMM becomes ready for use when its power is turned on. For more reliable measurement, however, allow a stabilization time of 15 minutes or longer after turning on its power. The DMM ON/OFF switch is only for the displays of the DMM and therefore it may be kept at the off position during the stabilization period.

4.12 Voltage Measurement

(1) For DC voltage measurement, press the DC V button of the DMM FUNCTION selector. For AC voltage measurement, press the AC V button.

(2) Select an input terminal. To use the HI-LO terminals, set the DMM input selector to the EXT position. To use the CH1 input, set it to the INT position.

(3) Connect the test leadwires (accessory) or the probe to the input terminals.

Warning: Do not reposition the DMM input selector switch when a voltage is already applied to the input terminals. Repositioning this switch while a voltage is present can deteriorate the switching contacts of the internal circuit.

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4.13 Resistance Measurement

(1) Press the Ω button of the DMM FUNCTION selector. Even if the DMM INPUT selector switch is set at the INT positon, the input circuit is switched to the EXT circuit internally and automatically.

(2) Connect the test leadwires to the HI-LO terminals for resistance measurement.

4.14. Description of EXT Input and INT Input

The DMM has two input modes for voltage measurement: One is the EXT input mode with which the voltage applied to the HI-LO terminals is measured and the other is the INT input mode with which the voltage of the signal applied to the CH1 input terminal of the oscilloscope is measured. Either input mode is selectable with the DMM INPUT selector switch.

(1) EXT Input (HI-LO)

The HI-LO terminals are used for voltage measurement and resistance measurement. The input circuit is isolated DC-wise from the oscillosope circuit for floating input. Consequently, measurement of a voltage with a DC componenet can be made as well as measurement of a regular voltage.

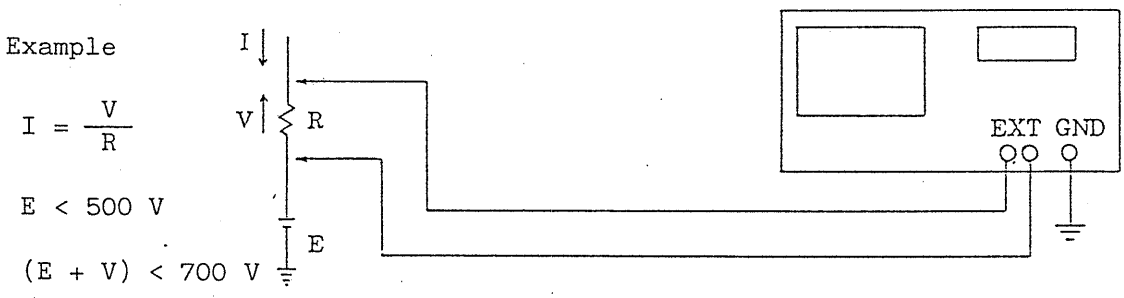

Figure 4-18

(2) INT Input (CH1)

The voltage of the signal applied to the CHI input can be measured, while observing its waveform on the CRT screen. A signal flow circuit for the case of the INT input mode is shown in Figure 4-19. The voltage applied to the CH1 input terminal is fed through the AC-GND-DC switch, CH1 attenuator, and the CH1 preamplifier to the digital multimeter. Although the input voltage of the digital multimeter varies as the setting of the CH1 VOLTS/DIV switch is changed, the digital multimeter automatically corrects the display and consequently the voltage can be directly read. The settings of the CH1 VARIABLE, ×5 MAG, and POSITION controls do not affect measurement of the digital multimeter.

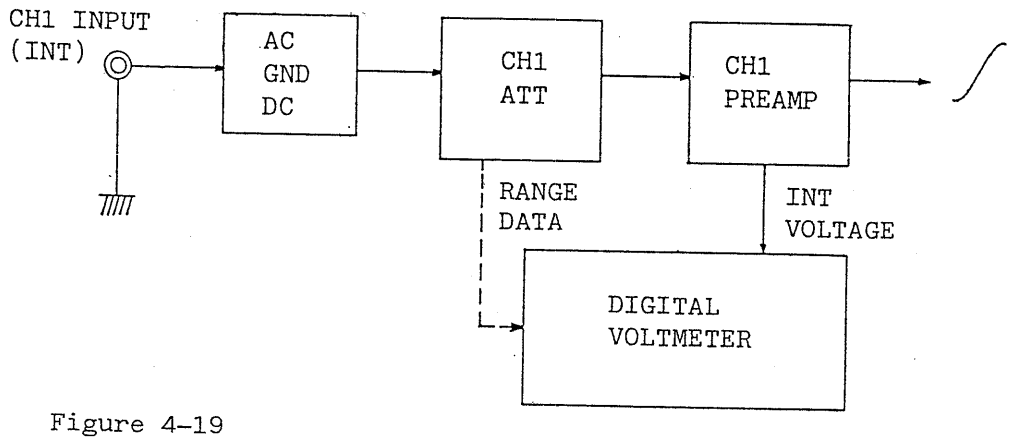

Figure 4-19

4.15 Notes for INT INPUT Mode Operation

(1) Effective Voltage Measuring Range

During the INT INPUT mode operation, the effective voltage measuring range is limited, depending on the setting of the CH1 VOLTS/DIV switch. When the measured voltage exceeds the effective measuring range, the value indicated by the digital voltmeter will not satisfy the specification accuracy. The effective measuring range at each range setting for the CH1 VOLTS/DIV switch covers the waveform displayed on the CRT screen within the graticule when the VARIABLE and POSITION controls are adjusted properly.

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In the case of AC voltage measurement, both positive and negative peaks should be within this range. See Figure 4-20.

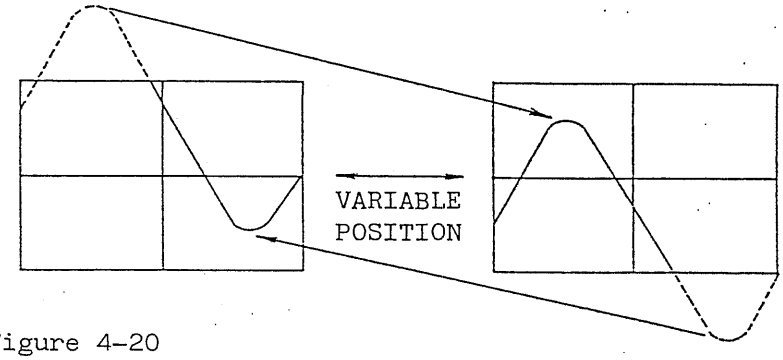

Figure 4-20

Confirm the effective measuring range with the instrument set in the NORMAL mode. The measured value is effective also when the measuring range is exceeded by setting the instrument to the ×5 MAG state.

(2) Errors Introduced When Probe Is Used

If the 10:1 probe (accessory) is used when the instrument is set in the INT INPUT mode, additional errors are caused by the attenuation of the probe. Thus, an error of approximately 2% needs to be added to the specification accuracy. No additional errors are caused when it is used at the 1:1 ratio.

(3) Notes For Operation With AC Coupling

When the CH1 is operated in the AC coupling mode, the output impedance of the measured voltage source will cause measurment errors. In such a case, use the probe of 10:1 ratio.

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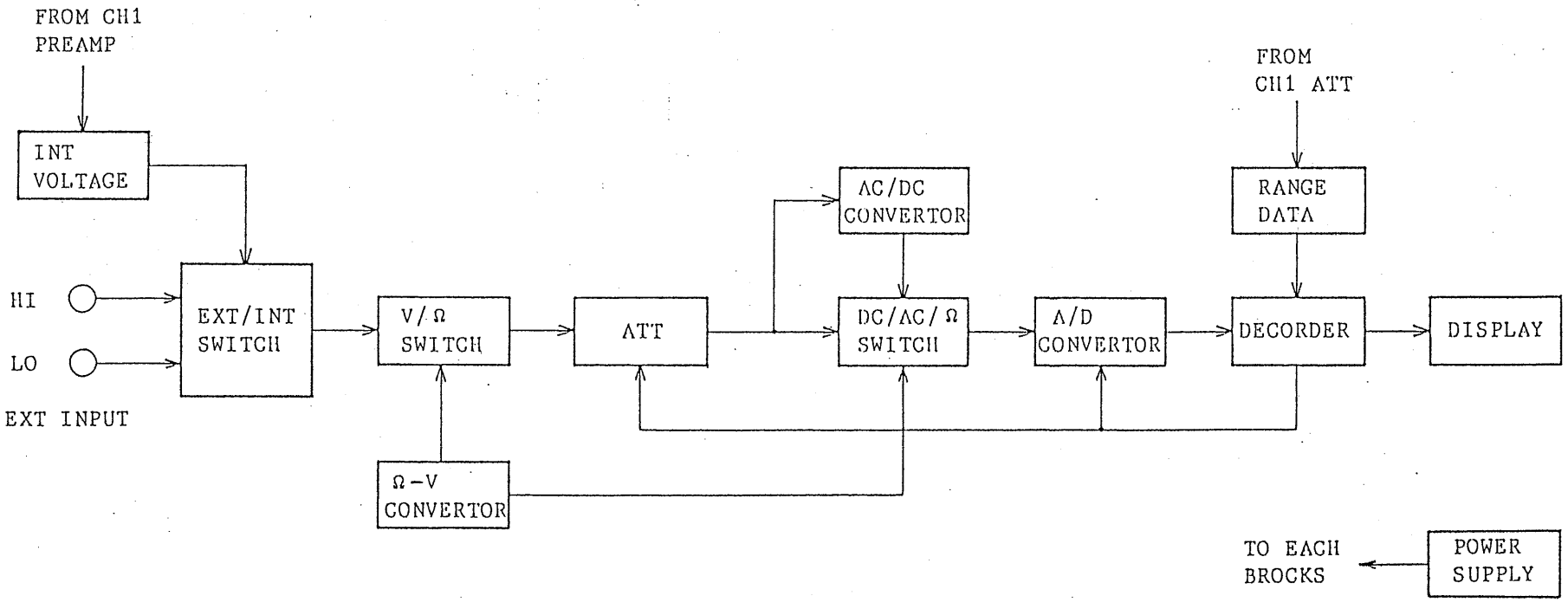

DIGITAL MULTIMETER BLOCK DIAGRAM

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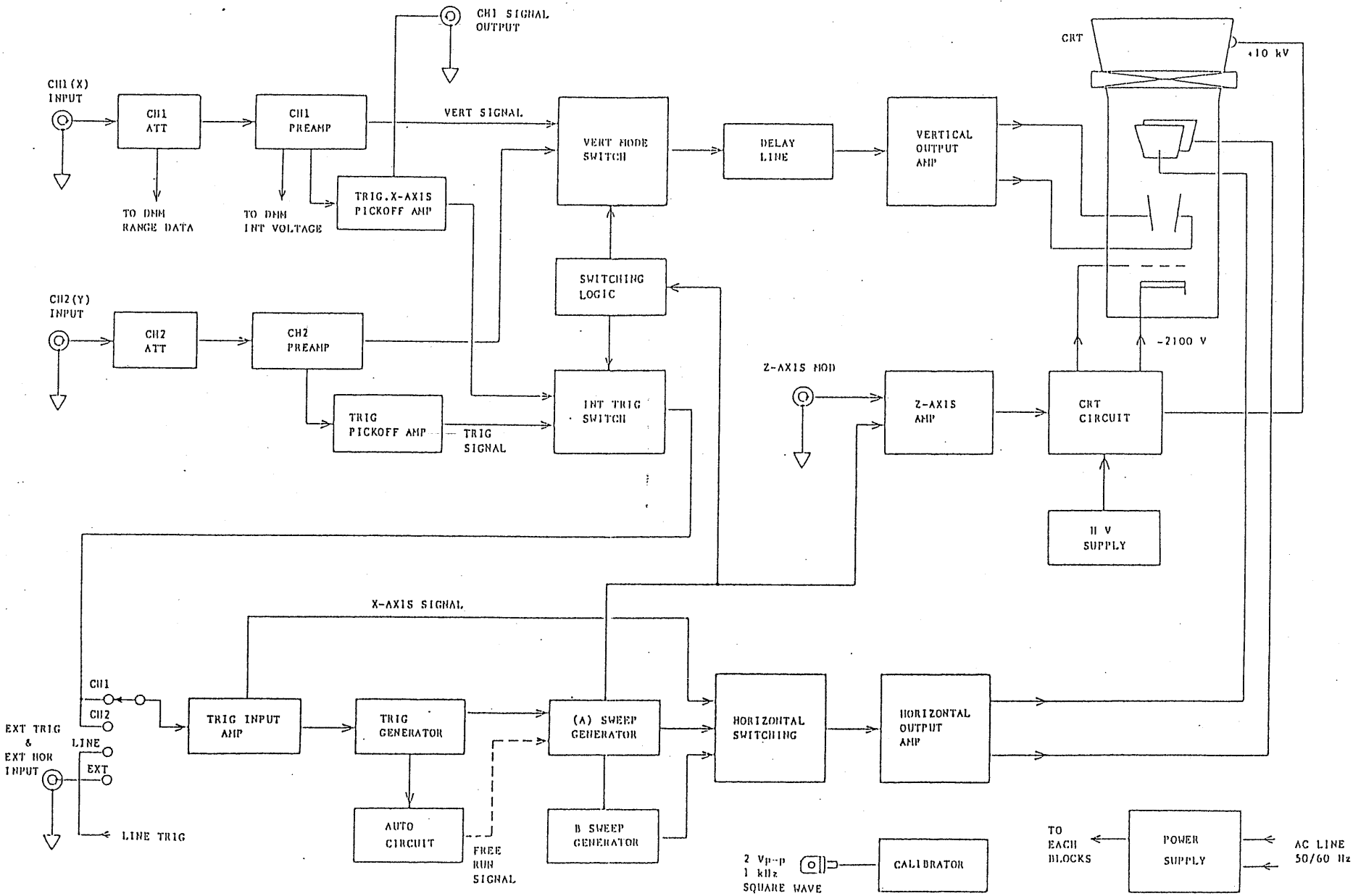

BLOCK DIAGRAM