GOS-6xx Family
Dual Trace Oscilloscope

INSTRUCTION MANUAL

GW GOOD WILL INSTRUMENT CO., LTD.

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Dual Trace Oscilloscope

INSTRUCTION MANUAL

.....GOS-645
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1. GENERAL

1.1 Description

The GOS-6xx Family oscilloscopes are dual-channel oscilloscopes with maximum sensitivity of 1mV/DIV, and maximum sweep time of 20 [illegible]c/DIV. Each of these oscilloscopes employs a 6-inch rectangular type cathode-ray tube with red internal graticule. GOS-623B and GOS-653 each has a sweep magnification feature with B sweep whereas GOS-625 and GOS-645 provide the read-out function which enable an easy read out for settings and cursor measured values.

These oscilloscopes are sturdy, easy to operate and exhibits high operational reliability.

1.2 Features

1). High intensity CRT with high acceleration voltage :
The CRT is a high beam transmission, high intensity type with a high acceleration voltage of 2.2KV for models GOS-622B, GOS-623B and GOS-625 (and 12 KV for models GOS-652, GOS-653 and GOS-645). It displays clear readable traces even at high sweep speeds.

2). High stability with less drift :
The oscilloscope employs a temperature compensation circuit which is newly developed to reduce the drift of base lines and DC balance disturbance caused by temperature change.

3). A trigger level lock function which makes the triggering adjustment unnecessary :
A new trigger level lock circuit is incorporated. This circuit eliminates the procedures of the troublesome triggering adjustment not only for displaying signals but also for that of video signals and large duty-cycle signals.

4). TV sync triggering :
The oscilloscope has a sync separator circuit incorporated within the TIME/DIV switch for automatic triggering of TV-V and TV-H signals.

5). Linear focus :
Once the beam focus is adjusted to the optimum position, it is automatically maintained regardless to the intensity change.

2. TECHNICAL SPECIFICATIONS

	Specifications \ Model		GOS 622B	GOS 623B	GOS 652	GOS 653	GOS 625	GOS 645
Vertical Axis	Sensitivity		NORM : 5mV - 5 V/DIV , X 5 MAG : 1mV - 1 V/DIV (Remark: 1-2-5 sequence, 10 ranges)					
	Sensitivity accuracy		NORM : <= ± 3% , X 5 Mag : <= ± 5% (Remark : 10^0 to 35^0C (50^0 to 95^0F), 1 kHz, at 8 DIV)					
	Vernier vertical sensitivity		To 1/2.5 or less of panel-indicated value.					
	Frequency bandwidth	NORM	DC - 20 MHz DC - 15 MHz		DC - 50 MHz DC - 20MHz		DC - 20 MHz DC - 15 MHz	DC - 40 MHz DC - 20 MHz
		x 5 Mag	AC coupling : Low limit frequency 10 Hz (Remark : With reference to 100kHz, 8 DIV. Frequency response within -3 dB.)					
	Rise time	NORM	Approx. 17.5 nSec		Approx. 7 nSec		Approx 17.5 nSec	Approx. 8.75 nSec
		x 5 Mag	Approx. 23 nSec		Approx. 17.5nSec		Approx 23 nSec	Approx. 17.5 nSec
	Input impedance		1 M ohm ± 2%. Approx. 30 pF.					
	Square wave characteristics		Overshoot : <= 3%, Other distortions : <=2% (At 10m V/DIV range). (Remarks : Other ranges : 3% added to the left value. 10^0 to 35^0C (50^0 to 95^0F)					
	DC balance shift		NORM : ± 0.5 DIV, x 5 Mag : ± 2.0 DIV					
	Linearity		< ± 0.1 DIV of amplitude change when waveform of 2 DIV at graticule center is moved vertically.					
	Display modes		CH1 : Single channel, CH2 : Single channel, DUAL : (a) CHOP : 0.5 Sec - 1 mSec/DIV, (b) ALT : 0.5 mSec - 0.2 uSec/DIV, (c) ADD : CH1 + CH2 algebraic addition. (Remarks : When CH1 POSITION knob is pulled out(CHOP ONLY position), the two traces are displayed in the CHOP mode.When ALT push switch is pushed in, the two traces are in the ALT mode at all ranges, but the priority is given to chop only statement.)					
	Chopping repetition frequency		Approx. 250kHz					
	Input coupling		AC / GND / DC					
	Maximum input voltage		400 V (DC + AC peak) (Remark : AC : <=1kHz)					
	Common mode rejection ratio		50 : 1 or better at 50 kHz sinusoidal wave (Remarks : When sensitivities of CH1 and CH2 are set equally)					
	Isolation between channels	< 30 : 1	at 20 MHz		at 50 MHz		at 20MHz	at 40 MHz
			< 1000 :1 at 50KHz (Remarks : At 5 mV/ DIV range)					
	CH1 signal output		Approx. 100mV/DIV without termination , approx. 50mV/DIV with 50 ohms termination.					
	CH2 INV BAL		Balanced point variation : <= 1 DIV (Remarks : Pull CH2 position. Reference at center graticule.)					

	Specifications \ Model		GOS 622B	GOS 623B	GOS 652	GOS653	GOS 625	GOS 645
Triggering	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.) (Remarks : In DUAL or ADD mode, if the ALT switch is pushed in, it can be used for alternate triggering of two different source signals.)					
	Coupling		AC, HF, REJ, TV, DC.					
	Polarity		+ / -					
	Sensitivity	0.5DIV(0.1V) 1.5DIV(0.2V)	DC-5MHz 5-20MHz		DC-10MHz 10-50MHZ		DC-5MHz 5-20MHz	DC-10MHz 10-40MHz
			Video signal : 2.0DIV (0.2V) AC coupling : Attenuate signal components of <= 10 Hz HF REJ : Attenuate signal components of >= 50kHz (Remarks : The values stated in the parenthesis are the input sensitivities when it is in the EXT triggering mode.)					
	Triggering modes		AUTO : Sweeps run in the free mode when no triggering input signal is applied. (Remarks : Applicable for repetitive signals of frequency >= 50 Hz.) 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 the READY switch. The READY lamp(LED) turns on when in the READY state or in the sweep operation.					
	LEVEL LOCK		Satisfies the value of the above trigger sensitivity plus 0.5 DIV(0.05V) for signal of duty cycle 20 : 80 and repetition frequency.					
	ALT Triggering		50Hz - 20MHz		50Hz - 40MHz		50Hz - 20 MHz	50Hz - 40MHz
	EXT Triggering signal input		EXT HOR input terminal is used.					
	Input impedance		1 Mohm ±2%, approx. 30pF.					
	Maximum input voltage		100 V (DC + AC peak) (Remarks : AC frequency < = 1 kHz.)					
	B triggering signal			The A triggering signal of main sweep is used as the B triggering signal.		The A triggering signal of main sweep is used as the B triggering signal.		

	Model / Specifications	GOS 622B	GOS623B	GOS 652	GOS653	GOS 625	GOS 645
	Horizontal axis display		A, A INT, B, B TRIG'D		A, A INT, B, B TRIG'D		
	A sweep (main sweep) time	0.2 uSec - 0.5 Sec/DIV. (Remarks : 1 - 2 - 5 sequence, 20 ranges)					
	Sweep time accuracy	± 3% (Remarks : 10^0 to 35^0C (50^0 to 95^0F))					
	Vernier sweep time control	< = 1/2.5 of panel-indicated value.					
	Hold off time	Continuous variable >= twice sweep length (time) at 0.2 uSec/DIV - 1 mSec/DIV ranges.					
	B sweep delay system (Remarks : Triggered by A triggering signal.)		Continuous delay and triggered delay		Continuous delay and triggered delay		
Horizontal axis	Sweep time accuracy	NORM : ± 3% (Remarks : 10^0 to 35^0C(50^0 to 95^0F))					
	Delay time	2 uSec-5 mSec/DIV					
	Delay jitter	<= 1/10000					
	Sweep magnification	10 times (maximum sweep time), 20nSec/DIV.					
	Magnified sweep time accuracy	Range : 1 uSec/DIV - 0.5 Sec/DIV, ± 5% Range : 0.2 uSec/DIV- 0.5 uSec/DIV, ± 8%. (Remarks : 10^0 to 35^0C (50^0 to 95^0F)).					
	Linearity	NORM : ± 3%, x 10 Mag : ± 5% (± 8% for 0.2 uSec - 0.5 uSec/ DIV)					
	Position shift caused by sweep magnification	Within 2 DIV at CRT screen center.					
	Sensitivity	Same as vertical axis. (X - axis CH1 input signal, Y - axis CH2 input signal.)					
X-Y mode	Sensitivity accuracy	NORM : ± 4%, x 5 Mag : ± 6% (Remarks : 10^0 to 35^0C(50^0 to 95^0F))					
	Frequency bandwidth	DC - 1 MHz (-3dB)		DC - 2 MHz(-3dB)		DC - 1 MHz (-3dB)	DC - 2 MHz (-3dB)
	X-Y phase difference	<= 3^0 at DC - 50 kHz			<=3^0 at DC - 100kHz.	<=3^0 at DC-50KHz	<=3^0 at DC-100KHz
	Sensitivity	Approx. 0.1 V/DIV. (Trace swept by an external horizontal signal applied to the EXT TRIG IN terminal. Vertical axis modes CH1, CH2, DUAL and ADD modes in the CHOP mode.)					
EXT HOR mode	Frequency bandwidth	DC-1MHz(-3dB).		DC-2MHz(-3dB)		DC-1MHz(-3dB)	DC-2MHz(-3dB)
	Phase difference between vertical axis	<= 3^0 (at DC - 50 kHz)		<= 3^0 (at DC - 100kHz)		<= 3^0 (at DC - 50 kHz)	<= 3^0 (at DC - 100 kHz)

	Model / Specifications	GOS 622B	GOS 623B	GOS 652	GOS 653	GOS 625	GOS 645
[illegible]is	Sensitivity	3 Vp-p (Trace becomes brighter with negative input).					
	Frequency bandwidth	DC - 5 MHz					
	Input resistance	Approx. 5 K ohm.					
	Maximum input voltage	50 V (DC + AC peak) (Remark : AC frequency <= 1KHz)					
Calibration voltage	Waveform	Positive-going square wave					
	Frequency	1 kHz+ 5%					
	Duty ratio	Within 48 : 52					
	Output voltage	2 Vp-p, ± 2%					
	Output impedance	Approx. 2 K ohm.					
CRT	Type	6-inch rectangular type, internal graticule.					
	Phosphor	P 31					
	Acceleration voltage	Approx. 2.2kV		Approx.12kV		Approx. 2kV	Approx. 12kV
	Effective screen size	8 x 10 DIV (Remark : 1 DIV = 10mm (0.39in))					
	Graticule	Internal	Internal ; continuous adjustable illumination.				
Readout	Cursor readout					Simultaneous to measure voltage difference (△V) and time difference (△ T)	
	Cursor display format					+ cursor (△), x cursor (REF)	
	Readout resolution					1/25 DIV	
	Panel setting display					V /DIV, ADD(SUB), UNCAL, MAG , T/DIV, CH2 INV, X - Y, DUAL X - Y, 1 /△ T, △ T, △V (△V1 or △V2 can be selected when Vert Mode switch is at DUAL, except X - Y mode).	
	Effective cursor range from center graticule					Vertical : Within ± 3 DIV Horizontal : Within ± 4 DIV	

Line Power Requirements

Voltage : AC 100V, 120V, 220V, 240V
±10% selectable
Frequency : 50Hz or 60Hz
Power consumption : Approx. 35VA
Approx. 40VA(GOS625/645)

Operating Environment

To satisfy specifications : 5° to 35°C (41°to 95°F), 85% RH non condensing.
Maximum operating ranges : 0° to 40°C (32° to 104°F), 90% RH non condensing.

Mechanical Specifications

Dimensions : 310W x 165H x 450D (mm)
Weight : Approx. 7.1kg (16 lbs)
Approx. 9.0kg (19.8 lbs) (GOS-625/645)

Accessories

Power cord.....1
Instruction manual.....1
Probes.....2

3. PRECAUTIONS BEFORE OPERATING THE OSCILLOSCOPE

3.1 Unpacking the Oscilloscope

The oscilloscope is shipped from the factory after being fully inspected and tested. Upon receiving of the instrument, immediately unpack and inspect it for any damages that might have been sustained during transportation. If any sign of damage is found, immediately notify the bearer and/or the dealer.

3.2 Checking the Line Voltage

These oscilloscopes will 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, make sure the voltage selector is set to the co position corresponding to the line voltage. Note the oscilloscope may be damaged if it is connected to the wrong AC line voltage.

When line voltages are changed, replace the required fuses as shown.

Line voltage	Range	Fuse	Line voltage	Range	Fuse
100V	90 - 110V	T 0.5A	220V	198 - 242V	T 0.3A
120V	108 - 132V		240V	216 - 264V	

3.3 Environment

The normal ambient temperature range of this instrument is 0^0 to 40^0 C (32^0 to 104^0 F). Operation of the instrument above 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

To prevent permanent damage to the CRT phosphor, do not make the CRT trace excessively bright or 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 as shown in the following table. Do not apply voltages higher than these limits.

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

Note : AC frequency <= 1 kHz.

Figure 4-1(a)

Model GOS-622B

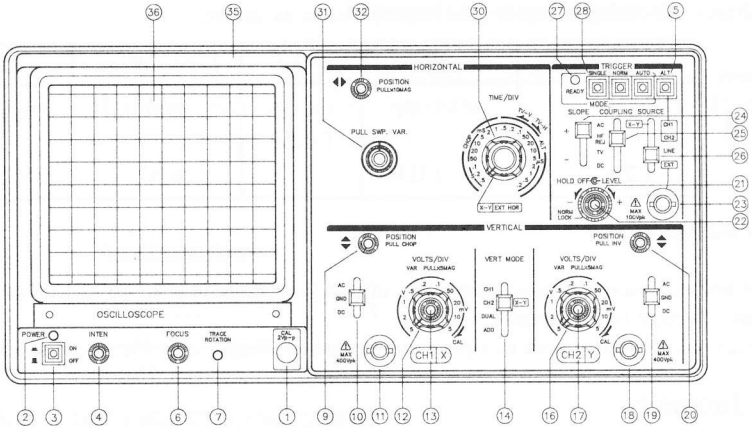


Figure 4-1(b)

Model GOS-652

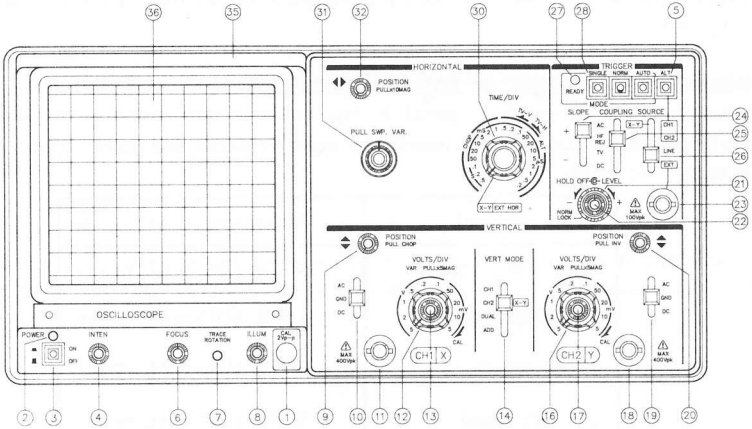


Figure 4-1(c)

Model GOS-623B &
GOS-653

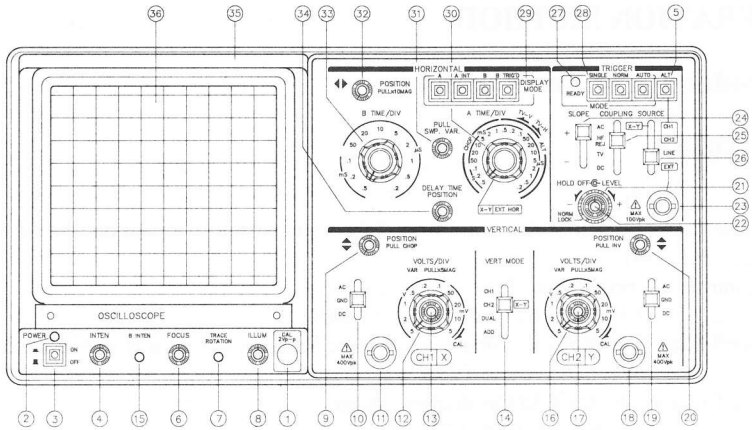
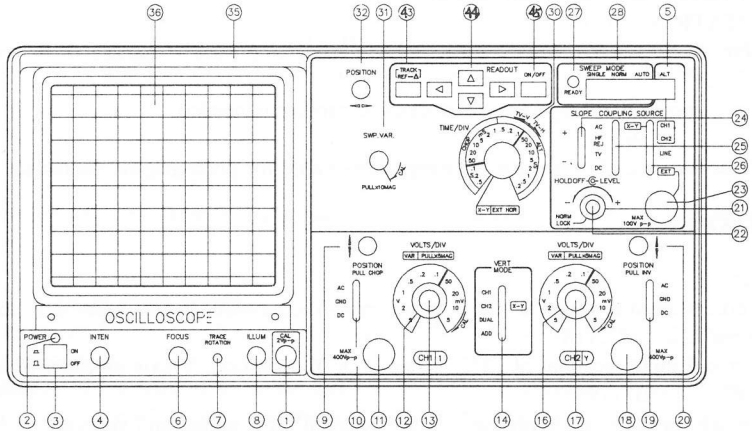


Figure 4-1(d)

Model GOS-625 &
GOS-645



4. OPERATION METHOD

4.1 Introduction of Front panel

CRT Circuits :

POWER .....(3)
Main power switch of the instrument. When this switch is turned on, the LED (2) is also turned on.
INTEN .....(4)
Controls the brightness of the spot or trace.
B INTEN .....(15) (GOS-623B & GOS-653 only)
Semi-fixed potentiometer for adjusting trace intensity when in B sweep mode.
FOCUS.....(6)
For focusing the trace to the sharpest image.
ILLUM.....(8) (Except GOS-622B)
Graticule illumination adjustment.
TRACE ROTATION.....(7)
Semi-fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.
Bezel.....(35)
For camera mounting when photographic capture is needed.
Filter .....(36)
Filter for ease of waveform viewing. Removable for photographic capturing.

Vertical Axis:

CH1 (X) input .....(11)
Vertical input terminal of CH1. When in X-Y operation, X-axis input terminal.
CH2 (Y) input .....(18)
Vertical input terminal of CH2. When in X-Y operation, Y-axis input terminal.
AC-GND-DC .....(10) (19)
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.....(12) (16)

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

VARIABLE .....(13) (17)

Fine adjustment of sensitivity, with a factor of >= 1/2.5 of the indicated value. When in the CAL position, sensitivity is calibrated to indicated value. When this knob is pulled out (x5 MAG state), the amplifier sensitivity is multiplied by 5.

POSITION .....(9) (20)

Vertical positioning control of trace or spot.

VERT MODE .....(14)

Selects operation modes of CH1 and CH2 amplifiers and 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.

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

DUAL: The oscilloscope operates as a dual-channel instrument both CH1 and CH2. The internal triggering source signal is selected by SOURCE switch (26) and ALT push switch (5).

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) is for the difference (CH1-CH2). The internal triggering source signal is as selected by SOURCE switch (26).

Triggering

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

Input 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. And the EXT HOR input signal.

CH1 (X-Y): When the VERT MODE switch (14) is set in the DUAL or ADD state, select CH1 for the internal triggering source signal. When in the X-Y mode, select CH1 for the X-axis signal.

CH2: When the VERT MODE switch (14) is set in the DUAL or ADD state, select CH2 for the internal triggering source signal.

ALT: When the VERT MODE switch (14) is set in the DUAL or ADD state, and the SOURCE switch (26) is selected at CH1 or CH2, with the engagement of the ALT switch, it will alternately select CH1 & 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. When in the X-Y, EXT HOR mode, the X-axis operates with the external sweep signal.

Note: When the VERT MODE switch (14) is set to the CH1 or CH2 position, selection of internal triggering source signal cannot be made by the SOURCE switch. In such case, a triggering source signal is to be set by the VERT MODE switch (14)

COUPLING.....(25)

Selects COUPLING mode (25) between triggering source signal and trigger circuit; select connection of TV sync trigger circuit.

AC: AC coupling

DC: DC coupling

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

TV-V: 0.5Sec/DIV - 0.1mSec/DIV

TV-H: 50uSec/DIV - 0.2uSec/DIV

SLOPE.....(24)

Selects the triggering slope.

"+" : Triggering occurs when the triggering signal crosses the triggering level in positive-going direction.

"-" : Triggering occurs when the triggering signal crosses the triggering level in negative-going direction.

HOLDOFF .....(21)

LEVEL .....(22)

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

LEVEL : To display a synchronized stationary waveform and set a start point for the waveform.

Towards "+" : The triggering level moves upward on the display waveform.

Towards "-" : The triggering level moves downward on the display waveform.

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

HOLDOFF : Used when the signal waveform is complex and stable triggering cannot be attained with the LEVEL knob alone.

Time Base

A TIME/DIV AND DELAY TIME.....(30)

Selects the sweep time for the A sweep or the delay time when in the delayed sweep mode.

B TIME/DIV .....(33) (GOS623B & GOS-653 only)

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

VARIABLE .....(31)

Vernier control of sweep time. The sweep time can be made slower by a factor >= 2.5 of the indicated value. The indicated values are calibrated when this knob is pushed in for CAL position.

POSITION .....(32)

Horizontal positioning control of the trace or spot.

PULL x 10 MAG.....(32)

When the knob is pulled out, a magnification of 10 occurs.

DELAY TIME POSITION.....(34) (GOS-623B & GOS-653 only)

Vernier control of the delay time selected by the A TIME/DIV and DELAY TIME switch (30) to finely select the portion of the A sweep waveform to be magnified.

TRIGGER MODE .....(28)

Selects the desired trigger 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 signal <= 50Hz.

SINGLE : Used for single sweep.

PUSH TO RESET Operation (one-shot triggering operation), and in common as the reset switch. When these three buttons are disengaged, the circuit is in the single trigger mode. The circuit is reset as this button is pressed. When the circuit is reset, the READY lamp (27) turns on. The lamp goes off when the single sweep operation is over.

DISPLAY MODE.....(29) (GOS-623B & GOS-653 only)

Selects A and B sweep modes as follows:

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

A INT : This sweep mode is used when selecting the section to be magnified of A sweep, in preparation for delayed sweep. The B sweep section (delayed sweep) corresponding to the A sweep is displayed with a high intensity beam.

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

B TRIG'D : Selects between continuous delay and triggered delay.

Disengaged : For continuous delay. The B sweep starts immediately after the sweep delay time set by A TIME/DIV and DELAY TIME switch (30) and DELAY TIME POSITION knob (34) has elapsed.

Engaged : For triggered delay. The B sweep starts when the triggering pulse is applied after the sweep delay time set by A TIME/DIV DELAY TIME switch and DELAY TIME POSITION knob has elapsed. (The triggering signal is used in common for both A sweep and B sweep.)

Others

CAL (Vp-p).....(1)

This terminal delivers the calibration voltage of 2Vp-p, 1kHz, positive square wave. The output resistance is 2k ohm see technical specification for tolerance.

Readout Function (Only applicable for GOS 625 & GOS 645)

REF△TRACK cursor select switch.....(43)

The cursor REF(x), △(+) or TRACK (both REF & △) can be selected sequentially by every short pressing of the select switch, and the intensity of the selected cursor will glow whereas the other becomes dim.

To select the number of cursor lines between cursor △(+) and REF(x) (two cursor lines or four cursor lines), press the switch until the CRT shows the desired figure.

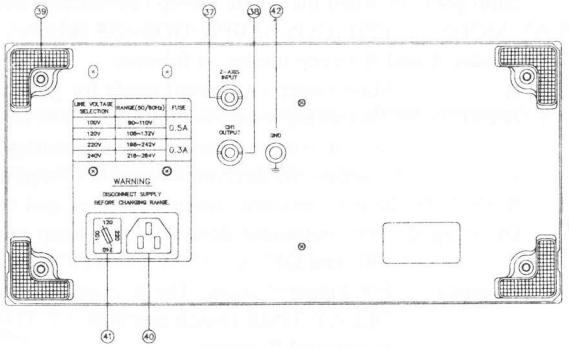
Cursor Shift Switch.....(44)

To shift the selected cursor to relative directions as the marked arrows on the switches.

READOUT ON / OFF switch.....(45)

To ON or OFF the readout function, press the switch a little longer. A short pressing of this switch enable the user to select the Readout △T or 1/△T function.

4.2 Introduction of Rear Panel



GND .....(42)

Ground terminal of oscilloscope mainframe.

Z AXIS INPUT .....(37)

Input terminal for external intensity modulation signal.

CH1 SIGNAL OUTPUT.....(38)

Delivers the CH1 signal with a voltage of approximately 100mV per 1 DIV of graticule. When terminated with 50 ohms, the signal is attenuated to about one half. Suitable for frequency counting, etc.

AC POWER Input Circuit

AC Power input connector ....(40)

AC Power input socket. Connect the AC power cord (supplied) to this connector.

E & line voltage selector ..... (41)

Fuse rating is as shown in Page 7.

Line voltage selector: to select power sources.

Studs .....(39)

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

4.3 Basic Operation

Before connecting the power cord to an AC line outlet, make sure that the AC line voltage input switch 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:

Item	No	Setting
POWER	(3)	Disengage position (OFF)
INTEN	(4)	Clockwise (3-o'clock position)
FOCUS	(6)	Mid-position
ILLUM	(8)	Full anticlockwise position (Except GOS-622B)
VERT MODE	(14)	CH1
POSITION	(9) (20)	Mid-position, pushed in
VOLTS/DIV	(12)(16)	.5V/DIV
VARIABLE	(13)(17)	CAL (clockwise position), pushed in
AC-GND-DC	(10)(19)	GND
SOURCE	(26)	Set to CH1
COUPLING	(25)	AC
SLOPE	(24)	+

Item	No	Setting
LEVEL	(22)	LOCK (anticlockwise)
HOLDOFF	(21)	NORM (anticlockwise)
TRIGGER	(28)	AUTO
DISPLAY MODE	(29)	A (GOS-623B & GOS-653 only)
TIME/DIV	(30)	0.5mSec/DIV
VARIABLE	(31)	CAL, pushed in
POSITION	(32)	Mid-position, pushed in

After setting the switches and controls as mentioned, connect the power cord to the AC line outlet, and then, continue as follows:

1) Engage the POWER switch and make sure that the power LED is turned on. In about 20 seconds, a trace will appear on the CRT screen. If no trace appears in about 60 seconds, counter check the switch and control settings.
2) Adjust the trace to an appropriate brightness and image with the INTEN control and FOCUS control respectively.
3) Align the trace with the horizontal center line of the graticule by adjusting the CH1 POSITION control and TRACE ROTATION control (adjustable by screwdriver).
4) Connect the probe to the CH1 INPUT terminal and apply the 2Vp-p CALIBRATOR signal to the probe tip.
5) Set the AC-GND-DC switch to the AC state. A waveform as shown in the figure 4.3 will be displayed on the CRT screen.
6) Adjust the FOCUS control so that the trace image appears sharply.
7) For signal viewing, set the VOLTS / DIV switch and TIME / DIV switch in appropriate positions so that the signal waveform is displayed clearly.
8) Adjust the △▽ POSITION and ◁▷ POSITION controls in appropriate positions so that the displayed waveform is aligned with the graticule and voltage (Vp-p) and period (T) can be read conveniently. The above are the basic operating procedures of the oscilloscope. The above procedures are for single-channel operation with CH1. Single-channel operation with CH2 can also be achieved in a similar manner. Further operation methods are explained in the subsequent paragraph.

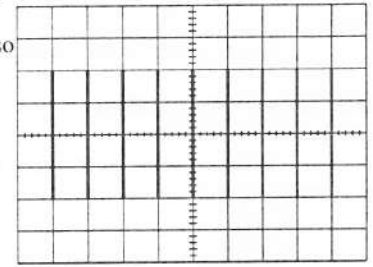


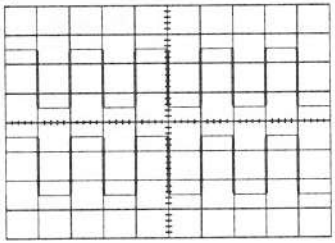
Figure 4-3

4.4 Dual-channel Operation

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

Now, apply the calibrator signal to the vertical input terminal of CH2 with the probe as is the case for CH1. Set the AC-GND-DC switch to the AC state. Adjust vertical POSITION knobs (9) and (20) so that both channel signals are displayed as shown in Figure 4-4.

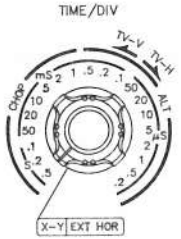
Figure 4-4



Signal of CH1

Signal of CH2

Figure 4-5



When in the dual channel operation (DUAL or ADD mode), the CH1 or CH2 signal must be selected for the triggering source signal by means of the SOURCE switch. If both CH1 and CH2 signals are in a synchronized relationship, both waveforms can be displayed stationary; if not, only the signal selected by the SOURCE switch can be displayed stationary. If the ALT push switch is engaged, both waveforms can be displayed stationary. (Do not use "CHOP" and "ALT" triggering source switch at the same time.)

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

When the ALT push switch is engaged, the two traces are displayed in the ALT operation at all ranges. Whereas, when the CH1 POSITION knob is pulled out, the two traces are displayed in the CHOP operation at all ranges. The CHOP operation has better priority compare to the ALT operation.

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 to the ADD state. The displayed signal is the difference between CH1 and CH2 signals if the CH2 POSITION knob is pulled out.

For accurate addition or subtraction, it is a prerequisite that the sensitivities of the two channels are 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 advantage to set both knobs in their mid-positions.

4.6 X-Y Operation and EXT HOR Operation

When the TIME / DIV switch is set in the X-Y / EXT HOR state, 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 SOURCE 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.

X-Y Operation

The X-Y operation is with CH1 as X-axis and Ch2 as Y-axis. The bandwidth of the X-axis becomes DC to 1MHz (-3dB) (or DC to 2MHz for GOS-652, GOS 653 & GOS-625) and the horizontal POSITION control is directly used as the X-axis POSITION control. For the Y-axis, the CH2 (X-Y) should be selected by the VERT MODE switch.

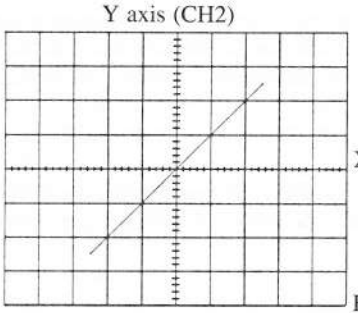
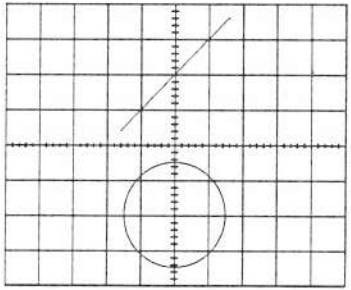


Figure 4-6



Dual-Channel
X-Y Operation

Figure 4-7

Note : When high frequency signals are displayed in the X-Y operation, pay attention to the frequency bandwidths of and phase difference between X and Y-axis.

EXT HOR (external sweep) Operation

The external signal applied through the EXT HOR terminal (23) drives the X-axis. The Y-axis is with any 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.

4.7 Triggering

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

(1) Functions of SOURCE switch :

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 to display a stationary signal on the CRT screen. The SOURCE switch is used for selecting such a triggering source.

CH1: The internal trigger method which is used most commonly.

CH2: 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 stable waveform can be readily displayed on the CRT screen.

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

When in 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 is used as the triggering signal. This method is effective when the measured signal has a relation ship 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, the waveforms can be displayed more independent than the measured signal.

The above triggering source signal selection functions are shown collectively 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	
ALT			Alternately triggered by CH1 & CH2.	
LINE	Triggered by LINE signal			
EXT	Triggered by EXT TRIG input signal			

(2) Functions of COUPLING switch:

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

AC: This coupling is 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 10Hz (-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 50kHz, -3dB). The higher components of the trigger signal are rejected and only the lower components are applied to the trigger circuit.

TV: This coupling is for TV triggering, for observation of TV video signals. The triggering signal is AC-coupled and fed through the triggering 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 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-0.1mSec
TV-H: 0.5 uSec-0.1uSec

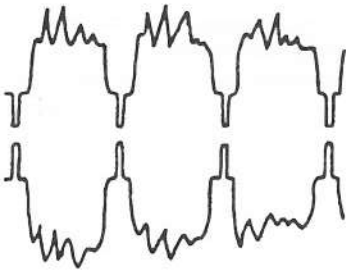


Figure 4-8

SLOPE The SLOPE switch should be set to conform to the video signal as shown in 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 signal with very low frequency or a signal with large duty cycle ratio is needed to be displayed.

(3) Functions of SLOPE switch:

This switch selects the slope (polarity) of the triggering signal as shown in Figure 4-9.

"+": When set in the "+" state, triggering occurs as the triggering signal crosses the triggering level in the positive-going direction.

"-": When set in the "-" state, triggering occurs as the triggering signal crosses the triggering level in the negative-going direction.

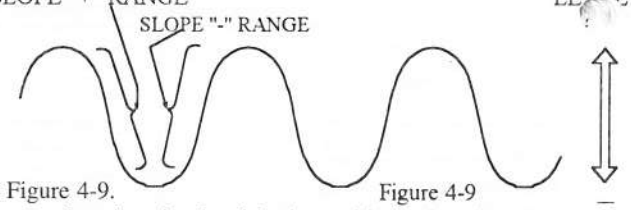


Figure 4-9

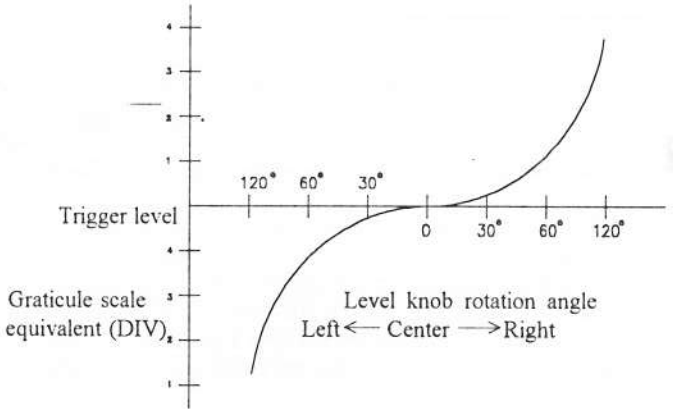


Figure 4-10

(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, the triggering signal has crossed the triggering level set by the 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 counterclock wise. The characteristic changes are as shown in Figure 4-10.

LEVEL LOCK

When the LEVEL knob is set in 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 when in the ALT mode). 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:

GOS-622B / GOS-623B / GOS-625	GOS-652 / GOS-653 / GOS-645
50Hz-5MHz :1.0DIV(0.15V) or less	50Hz-10MHz:1.0DIV(0.15V) or less
10Hz-20MHz:2.0DIV(0.25V) or less	10Hz-40MHz:2.0DIV(0.25V) or less

(5) Functions of HOLD OFF control:

When the measured signal is a complex waveform with two or more repetition frequencies (periods), triggering with the above mentioned LEVEL control alone may not be sufficient to attain 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 one full sweep time for sweeps faster than 0.2 Sec/DIV.

Figure 4-11(a) shows several different waveforms which overlapped on the screen, making the signal observation unsuccessful when the HOLD OFF knob is in the NORM state. Figure 4-11 (b) shows the undesirable portion of the signal is held off. The same waveforms are displayed on the screen without overlapping.

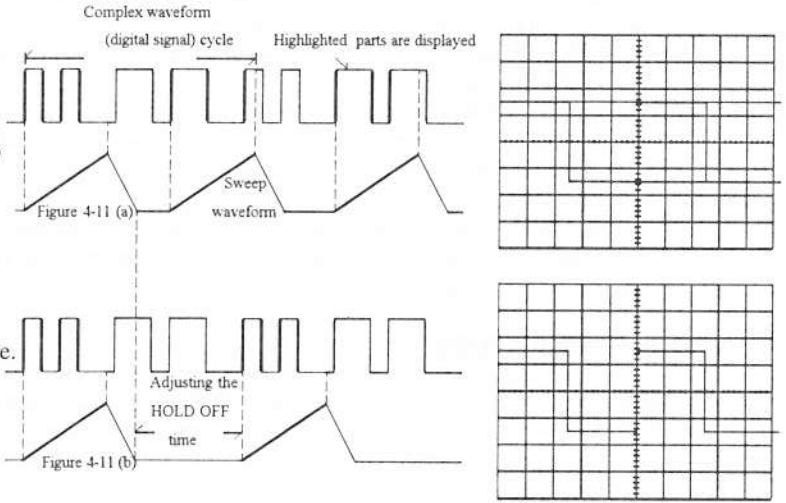


Figure 4-11

4.8 Single-sweep Operation

Non-repetitive signals and one-shot transient 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.

Measurement of non-repetitive signal:

(1) Set the TRIGGER MODE to the NORM state.
(2) Apply the measured signal to the vertical input terminal and adjust the triggering level.
(3) Set the TRIGGER MODE to the SINGLE state (the three push-button switches are pushed out).
(4) Press the SINGLE button. The sweep will run only for one cycle and the measured signal will be displayed only once on the screen.

Measurement of single-shot signal:

(1) Set the TRIGGER MODE to the NORM state.
(2) Apply the calibrator 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 TRIGGER MODE to the SINGLE state. Apply the measured signal instead of the calibrator signal to the vertical input.
(4) Depress the SINGLE button. The sweep circuit is now in the ready state and the READY indicator lamp will be turned on. However, this cannot be done when the dual-channel ALT mode is in operation. For the dual-channel one-sweep operation, use the CHOP mode instead.
(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. However, this cannot be done when the dual-channel ALT mode is in operation. For the dual-channel one-sweep operation, use the CHOP mode instead.

4.9 Sweep magnification

When a certain part of the displayed waveform is needed to be expanded timewise, a faster sweep speed may be used. However, if the required portion is apart from the starting point of the sweep, the required portion may run off the CRT screen. In such a case, pull out the POSITION knob(32) (set in the x10 MAG state).

When this is done, the displayed waveform is expanded 10 times to the right and left with the center of screen as the center of expansion.

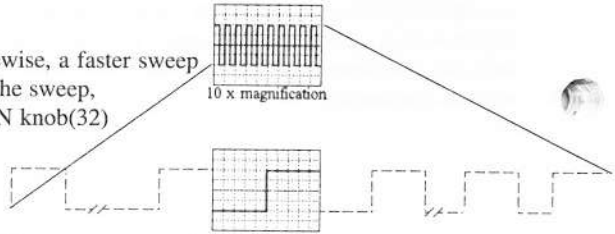


Figure 4-12 Any part can be covered by means of POSITION control

The sweep time during the magnification operation is as follows :

(Value indicated by TIME/DIV switch) x 1/10.

Thus, the unmagnified maximum sweep speed (0.2uSec/DIV) can be increased with the magnification as follows:

0.2 uSec/DIV x 1/10 = 20 nSec/DIV

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

4.10 Waveform Magnification with Delayed Sweep

With 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, the sweep can be expanded for a wider range from several times to several thousand times according to the ratio between A sweep time and B sweep time.

As the measured signal frequency increases, the A sweep range for the non-expanded signal becomes higher whereas 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 continuous variable delay circuit and a triggering delay circuit are incorporated into the oscilloscope.

(1) Continuous variable delay:

Set the DISPLAY MODE switch to A and display the signal waveform with the A sweep in the regular operation mode. Next, set the B TIME/DIV switch to a position several steps faster than that of the A TIME/DIV switch. After ensuring the B TRIG'D button of the DISPLAY MODE switch is disengaged, engage the DISPLAY MODE 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 trade accentuation) is called "SWEEP DELAY TIME". This period is a continuous variable by means of the DELAY TIME POSITION knob. Next, change the DISPLAY MODE 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, the magnification ratio becomes :

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

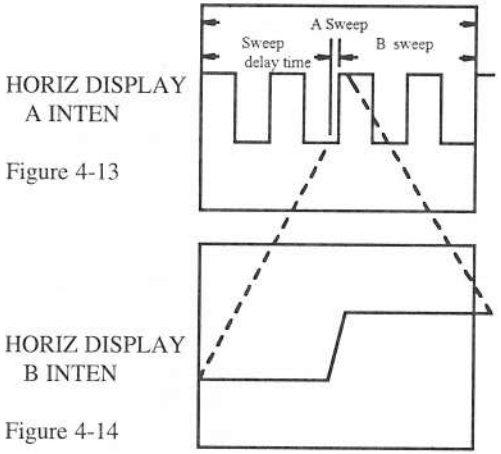


Figure 4-13

Figure 4-14

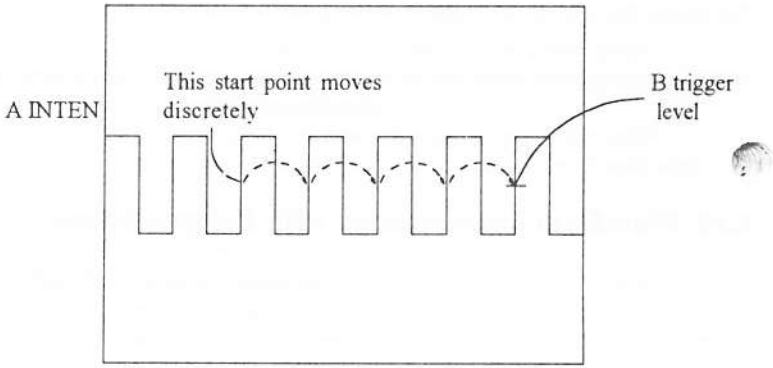


Figure 4-15

(2) Triggering delay:

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

For this operation, the A trigger circuit continues to operate even after the B TRIG'D button is engaged 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 the discrete shifts of the brightness-accentuated section of sweep across the CRT screen; while in the B mode this section remains stationary.

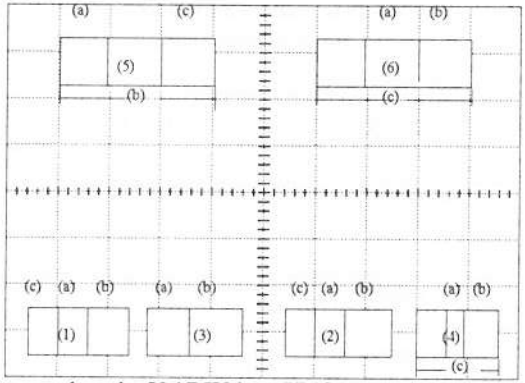
4.11 Readout Function

The selected sensitivity, input, sweep time, etc.. are displayed in the positions as shown in Figure 4-16.

NOTE : The CRT will not show any trace or spot when the SWEEP MODE is in NORM state. To observe the signals, depress the AUTO button.

CH1 Display

Figure 4-16



When the VERT MODE switch is at CH1, DUAL or ADD state, the set values of CH1 are displayed at (1). However, these values are not shown when the VERT MODE is at CH2.

(a)..... "*" sign is shown when the VAR x 5 Mag knob is pulled out. When the V / DIV is at UNCAL position, a ">" sign is shown instead.

(b)..... Display the selected sensitivity from 1mV to 5V.

(c)..... CH1x is displayed when the V / DIV knob is at X-Y mode and the VERT MODE is at CH1. At DUAL X-Y mode, CH1y is displayed.

CH2 Display

Set values of CH2 signal are displayed at (2) when the VERT MODE is at CH2, DUAL or ADD. They are not displayed in the CH1 mode.

(a)..... "*" sign is shown when the VAR x 5 Mag knob is pulled out. ">" sign is shown when the V / DIV is at UNCAL position.

(b)..... Display the selected sensitivity from 1mV to 5V.

(c)..... CH2y is shown at X-Y & DUAL X-Y mode.

ADD(SUB) & CH2 INV Display

The ADD, SUB and INV functions are displayed at (3).

(a)..... Shows whether ADD or SUB is in function.
"+" is shown when the VERT MODE is at ADD position, then the inputs CH1 & CH2 are algebraically summed. "-" is shown when the CH2 INV knob is pulled out and the subtraction of CH2 from CH1 is in function.

(b)..... A"$\downarrow$" sign is displayed when the VERT MODE is at CH2 or DUAL and the CH2 INV control is pulled out.

TIME Display

The sweep time is displayed at (4) only when the TIME / DIV switch is set to a position other than X-Y mode.

(a)..... "*" sign is shown when the x 10 Mag knob is pulled out. ">" is displayed when the TIME / DIV is at the UNCAL position.

(b)..... Shows the selected sweep time from 20ns to 0.5s.

(c)..... Not displayed at all when the TIME / DIV switch is at X-Y mode. An "EXTx 0.1V" is displayed when the TIME / DIV remain unchanged and the VERT MODE is at DUAL.

△V Cursor Measured Value Display

The relative measured values are displayed at (5).

(a).....Shows different △V (ΔV_1, ΔV_2 or ΔV_{12}) which may be displayed according to the following table :

SOURCE \ VERT MODE	CH 1	CH 2	DUAL	ADD
CH 1	ΔV_1	ΔV_2	ΔV_1	ΔV_{12}
CH 2			ΔV_2	
LINE				
EXT				
X-Y	ΔV_2		ΔV_1	ΔV_2

(b)....."+" or "-" polarity displays which depend on the position of the △(+) cursor: "+" when the △(+) cursor is above the REF(x) cursor; "-" when the △(+) cursor is below the REF (x) cursor.

(c)..... Measured value from 0.00mV to 40.0V is displayed.

NOTE : When the V / DIV is set to uncalibrated position, or when the VERT MODE is at ADD but the CH1 & CH2 sensitivities on V / DIV are not the same, the measured value is displayed in divisions (0.00 to 8.00 div) instead.

△T Cursor Measured Value Display

Position(6) shows the relative measured values of △T cursor.

(a)..... "+" or "-" polarity displayed. "+" when the △(+) cursor is on the right of the REF(x) cursor; "-" when the △(+) cursor is on the left of the REF(x) cursor.

(b)..... Displays the measured value from 0.00ns to 5.00s.

NOTE : When the SWP VAR control is at UNCAL, the measured value is displayed in divisions (0.00 to 10.00 div).

(c)..... Shows "X-Y" when the TIME / DIV is at X-Y mode. "DUAL X-Y" when the VERT MODE is at DUAL and TIME / DIV is at X-Y mode.

NOTES :

1). The △V and △T measured values are displayed in divisions when the SWP VAR and V / DIV switch are set to their respective uncalibrated positions.

2). When the power is turned off, and then turned on, the initial set values are set as shown below :

Item	Initial setting
cursor	TRACK
cursor value	△V = 1.00div △T = 1.00div

3). When all the four cursor shift buttons are pressed simultaneously, the △V and △T values are set to 6.00 divisions and 8.00 divisions respectively. To reset the initial set values, press any one of the four buttons.

Application

The voltage difference (△V) and time difference (△T) are simultaneously measured by the REF(x) cursor and the △(+) cursor, and the measured values are then displayed on the screen.

a). Cursor Selection

The REF(x) cursor and △(+) cursor is selected by the REF TRACK select button. Once the button is pressed, the intensity of the selected cursor is made brighter, then press the cursor shift button to shift it to the desired position. When TRACK (both cursors are in the same brightness) the two cursors can be shifted simultaneously.

b). Cursor Shifting

Every pressing of the cursor shift button shifts the cursor by one resolution and continuous pressing makes the cursor to shift continuously. If any two of the cursor shift buttons are pressed simultaneously, the cursor shifts at an angle of 45^0.

Measured value display

When the cursor is shifted at an angle of 45^0, the △V and △T display are simultaneously changed (only when the REF(x) or △(+) cursor is tracked).

Cursors at channel 1

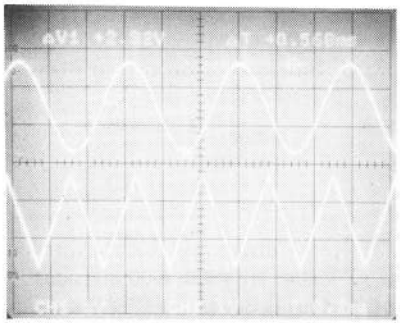
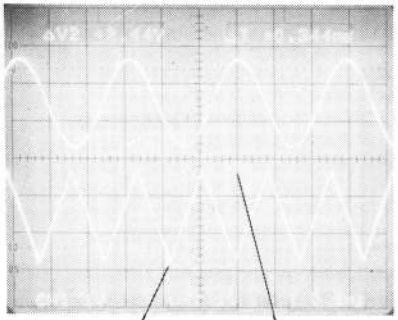


Figure 4-17

Cursors at channel 2



The measured values are changed automatically with respect to the selected values of the V / DIV and TIME/DIV switches. In the x 5 Mag and the x 10 Mag modes, the conversation is performed automatically.

The measurement can be easily made by the exclusive two cursor lines, A, or four cursor lines, B, as follows :

This unique feature eliminates the visual lining up waveforms and the screen graticules on the conventional oscilloscopes.

4.12 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.

Connect the probe BNC to the INPUT terminal of CH1 or CH2 and set VOLTS/DIV switch at 50mV. Connect the probe tip to the calibration voltage output terminal and adjust the compensation trimmer on probe for optimum square wave (minimum overshoot, rounding off and tilt). Refer to Figure 4-18 & 4-19 :

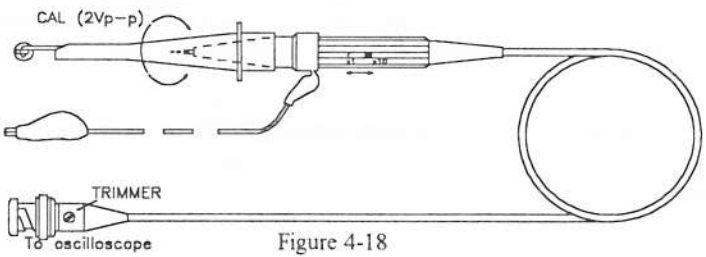
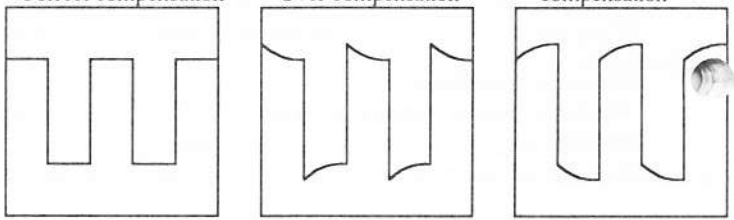
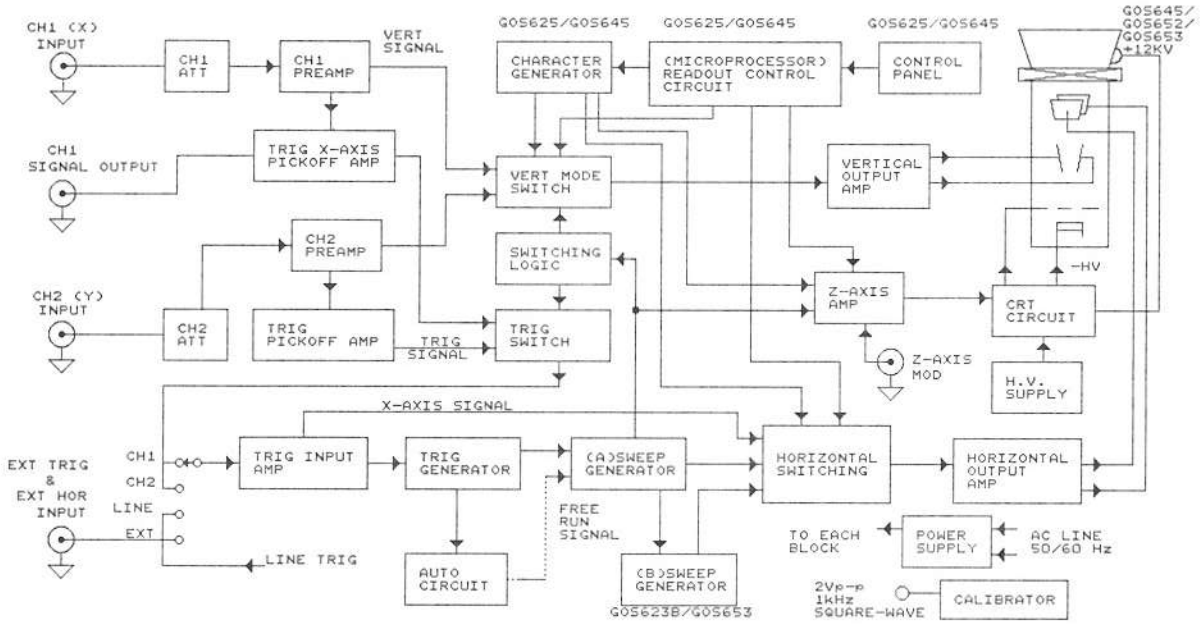


Figure 4-18

Figure 4-19





BLOCK DIAGRAM

GOOD WILL INSTRUMENT CO., LTD

NO. 18, LANE 54, CHUNG CHENG ROAD, HSIN TIEN CITY,
TAIPEI HSIEN, TAIWAN
TEL : 886-2-9179188 (15 LINES)
TELEX : 32518 GWINST
FAX : 886-2-9179189