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GOS-6xxG Family
Dual Trace Oscilloscope

Members Of The Family

50MHz	Cursor Readout With Delayed Sweep ……	GOS-658G
20MHz	Cursor Readout ……..……..……	GOS-626G
50MHz	Basic With Delayed Sweep ……..……	GOS-653G
50MHz	Basic ……..……..……..……	GOS-652G
35MHz	Basic ……..……..……..……	GOS-635G
20MHz	Basic ……..……..……..……	GOS-622G

82OS-658G0MC

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SAFETY TERMS AND SYMBOLS

These terms may appear in this manual or on the product:



WARNING. Warning statements identify condition or practices that could result in injury or loss of life.



CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

The following symbols may appear in this manual or on the product:



DANGER
High Voltage



ATTENTION
refer to Manual



Protective
Conductor
Terminal



Earth(ground)
Terminal



Frame or chassis
Terminal

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FOR UNITED KINGDOM ONLY

NOTE

This lead/appliance must only be wired by competent persons

WARNING

THIS APPLIANCE MUST BE EARTHED

IMPORTANT

The wires in this lead are coloured in accordance with the following code:

Green/ Yellow: Earth
Blue: Neutral
Brown: Live(Phase)



As the colours of the wires in main leads may not correspond with the colours marking identified in your plug/appliance, proceed as follows:

The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with the letter E or by the earth symbol ⏚ or coloured Green or Green & Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse : refer to the rating information on the equipment and/or user instructions for details. As a guide, cable of 0.75mm^2 should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any moulded mains connector that requires removal/replacement must be destroyed by removal of any fuse & fuse carrier and disposed of immediately, as a plug with bared wires is hazardous if a engaged in live socket. Any re-wiring must be carried out in accordance with the information detailed on this label.

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EC Declaration of Conformity

We

GOOD WILL INSTRUMENT CO.,LTD.

(1) NO. 95 - 11, Pao Chung Rd., Hsin-Tien City, Taipei Hsien, Taiwan

(2) Plot 522, Lorong Perusahaan Baru 3, Prai Industrial Estate, 13600 Prai, Penang, Malaysia

declare, that the below mentioned product

GOS-622G,GOS-626G,GOS-635G,GOS-652G,GOS-653G,GOS-658G

are herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to Electromagnetic Compatibility (89/336/EEC,92/31/EEC,93/68/EEC) and Low Voltage Equipment Directive(73/23/EEC).

For the evaluation regarding the Electromagnetic Compatibility and Low Voltage Equipment Directive, the following standards were applied:

EN50081-1: Electromagnetic compatibility - **(1992)** Generic emission standard Part 1: Residential, commercial and light industry		
Conducted Emission	EN 55022	class B
Radiated Emission		(1994)
Current Harmonics	EN 61000-3-2	(1995)
Voltage Fluctuations	EN 61000-3-3	(1995)
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EN50082-1: Electromagnetic compatibility - **(1992)** Generic immunity standard Part 1: Residential, commercial and light industry		
Electrostatic Discharge	IEC 1000-4-2	(1995)
Radiated Immunity	IEC 1000-4-3	(1995)
Electrical Fast Transients	IEC 1000-4-4	(1995)
Surge Immunity	IEC 1000-4-5	(1995)
Voltage Dip/Interruption	EN 61000-4-11	(1994)

EN50081-2: Electromagnetic compatibility - **(1993)** Generic emission standard Part 2: Industrial Environment		
Conducted Emission	EN 55011	class B
Radiated Emission		(1991)

Low Voltage Equipment Directive 73/23/EEC	
Low Voltage Directive	EN 61010-1:(1993)+A2:(1995)

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1. GENERAL

1.1 Description

The 6xxG family oscilloscopes are dual-channel oscilloscopes with maximum sensitivity of 1 mV/DIV, and maximum sweep time of 10 nSec/DIV. Each of these oscilloscopes employs a 6-inch rectangular type cathode-ray tube with red internal graticule. 653G and 658G each has a sweep magnification feature with B sweep whereas 626G and 658G provide the read-out function which enables 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 2kV for models 622G ,635G and 626G ,and 12KV for models 652G, 653G and 658G. 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.
6) Cursor readout measurement:
   The unique easy-to-use cursor and numerical readouts make waveform observations and measurement faster and accurate.
   The on- screen cursors provide seven functions (ΔV, ΔV%, ΔVdB, ΔT, 1/ΔT, DUTY, PHASE).(626G, 658G only)

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2.TECHNICAL SPECIFICATIONS

SPECIFICATIONS \ MODEL		20MHz OSCILLOSCOPE 622G	626G	35MHz 635G	50MHz OSCILLOSCOPE 652G	653G	658G
VERTICAL AXIS	Sensitivity	1mV ～ 5V/DIV, 12 steps in 1-2-5 sequence					
	Sensitivity accuracy	5mV ～ 5V/DIV:≤3%, 1mV ～ 2mV/DIV: ≤5% (10℃ to 35℃(50℉ to 95℉)) << 5 DIV at the center of display>>					
	Vernier vertical sensitivity	To 1/2.5 or less of panel-indicated value.					
	Frequency bandwidth (－3dB)	5mV～5V/DIV:DC～20MHz,(622G,626G) 5mV～5V/DIV:DC～35MHz,(635G) 1mV～2mV/DIV:DC～10MHz			5mV～5V/DIV : DC～50MHz, 1mV～2mV/DIV:DC～15MHz		
		AC coupling: Low limit frequency 10Hz. (With reference to 100kHz,8DIV. Frequency response with -3dB.)					
	Rise time	5mV～5V/DIV:≈ 17.5ns(622G,626G) 5mV～5V/DIV:≈ 100ns(635G) 1mV～2mV/DIV: ≈ 35ns			5mV～5V/DIV:≈ 7ns, 1mV～2mV/DIV: ≈ 23ns		
	Input impedance	1M ohm ±2% // Approx. 25pF					
	Square wave characteristics	Overshoot : ≤ 5% (At 10mV/DIV range) << 5 DIV at the center of display>> Other distortions and other ranges : 5% added to the above value. (10℃ to 35℃ (50℉ to 95℉))					
	DC balance shift	5mV ～5V/DIV: ±0.5DIV, 1mV ～ 2mV/DIV: ±2.0DIV					
	Linearity	< ±0.1 DIV of amplitude change when waveform of 2 DIV at graticule center is moved vertically.					
	Vertical modes	CH1 : CH1 single channel. CH2 : CH2 single channel. DUAL : CHOP/ALT are auto-set by TIME/DIV switch.(CHOP:0.5s～5ms/DIV, ALT:2ms～0.1 μs/DIV) When CHOP switch is pushed in, the two traces are displayed in the CHOP mode at all range. ADD : CH1 + CH2 algebraic addition.					
	Chopping repetition frequency	Approx. 250kHz					
	Input coupling	AC, DC, GND					
	Maximum input voltage	400V (DC+AC peak), AC: frequency 1kHz or lower. When set probe switch at 1:1, the maximum effective readout is 40Vpp(14Vrms at sine wave), or set probe switch at 1:10, the maximum effective readout is 400Vpp(140Vrms at sine wave).					
	Common mode rejection ratio	50:1 or better at 50kHz sinusoidal wave. (When sensitivities of CH1 and CH2 are set equally)					
	Isolation between channels	> 1000:1 at 50kHz , >30:1 at 20MHz(622G,626G) > 1000:1 at 50kHz , >30:1 at 35MHz(635G) (At 5mV/DIV range)			> 1000:1 at 50kHz > 30:1 at 50MHz (At 5mV/DIV range)		
VERTICAL AXIS	CH1 signal output	Approx. 100mV/DIV without termination, 50mV/DIV with 50 ohm termination. Bandwidth(-3dB) : 622G/626G/635G : 20MHz 652G/653G/658G : 40MHz					
	CH2 INV BAL.	Balanced point variation : ≤ 1 DIV (Reference at center graticule.)					
	Dynamic range	>8DIV at 20MHz >5DIV at 35MHz(635G only)			>8DIV at 50MHz		
	Signal delay	—	—	—	—	Leading edge can be monitored.	
TRIGGERING	Triggering source	CH1, CH2, LINE, EXT (CH1 and CH2 can be selected only when the vertical mode is DUAL or ADD. In ALT mode, if the TRIG. ALT switch is pushed in, it can be use for alternate triggering of two different source.)					
	Coupling	AC, HF-REJ, TV, DC (TV-V/TV-H can be auto-set by TIME/DIV range. TV-V: 0.5s-0.1ms/DIV; TV-H: 50 μs-0.1 μs/DIV)					
	Polarity	+ / －					
	Sensitivity	DC～5MHz : 0.5 DIV (EXT: 0.1V) 5～20MHz : 1.5 DIV (EXT: 0.2V)(622G,626G) 5～35MHz : 1.5 DIV (EXT: 0.2V)(635G)			DC～10MHz : 0.5 DIV (EXT: 0.1V) 10～50MHz : 1.5 DIV (EXT: 0.2V)		
		TV(video signal): 2.0 DIV (EXT: 0.2V) AC coupling : Attenuate signal components of lower than 10Hz. HF-REJ: Attenuate signal components of higher than 50kHz.					
	Triggering modes	AUTO : Sweeps run in the free mode when no triggering input signal is applied. (Applicable for repetitive signals of frequency 50Hz or over.) 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 RESET switch. The READY lamp(LED) turns on when in the READY state or in the sweep operation. (626G,652G,653G and 658G only)					
	LEVEL LOCK and ALT triggering	Satisfies the value of the above trigger sensitivity plus 0.5 DIV (EXT: 0.05V) for signal of duty cycle 20:80.					
		Repetition frequency : 50Hz ～20MHz (622G,626G) Repetition frequency : 50Hz ～35MHz (635G)			Repetition frequency : 50Hz ～40MHz		
	EXT triggering signal input Input impedance Max. input voltage	EXT HOR input terminal is used in common. 1M ohm ±2% // approx. 35pF 100V (DC+AC peak), AC: Frequency not higher than 1kHz					
	B triggering signal.	—	—	—	—	The A triggering signal of main sweep is used as the B triggering signal.	

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SPECIFICATIONS \ MODEL		20MHz OSCILLOSCOPE		35MHz	50MHz OSCILLOSCOPE		
		622G	626G	635G	652G	653G	658G
HORIZONTAL AXIS	Horizontal axis display	A				A, A INT, B, B TRIG'D	
	A sweep(main sweep) time	0.1 μs ～ 0.5s/DIV, 21 steps in 1-2-5 sequence					
	Sweep time accuracy	±3%, (10℃ to 35℃ (50℉ to 95°F))					
	Vernier sweep time control	≤ 1/2.5 of panel-indicated value					
	Hold off time	Continuous variable >= twice sweep length (time) at 0.1μSec~1mSec/DIV ranges.					
	B sweep delay system B sweep(delay sweep) time Sweep time accuracy Delay time Delay jitter	—	—	—	—	Continuous delay and triggered delay 0.1 μs～0.5ms/DIV, 12 steps ±3%, (10℃ to 35℃(50℉ to 95 ℉)) 1 μs ～ 5ms ≤ 1/10000	
	Sweep magnification	10 times (maximum sweep time 10ns/DIV)					
	x10MAG sweep time accuracy	0.1 μs～50ms/DIV ±5%, 10ns～50ns/DIV ±8% (10℃ to 35℃(50℉ to 95℉))					
	Linearity	NORM:±3%, x10MAG:±5% (±8% for 10ns～50ns/DIV)					
	Position shift caused by x10MAG	Within 2 div. at CRT screen center					
X-Y MODE X-Y MODE	Sensitivity	Same as vertical axis.(X-axis:CH1 input signal; Y-axis:CH2 input signal.)					
	Sensitivity accuracy	NORM:±4%, x10MAG:±6% (10℃ to 35℃(50℉ to 95℉))					
	Frequency bandwidth	DC ～ 1MHz (-3dB)			DC ～ 2MHz (-3dB)		
	X-Y phase difference	≤3º at DC ～50kHz				≤3º at DC ～100kHz	
EXT HOR MODE	Sensitivity	Approx. 0.1V/DIV(Trace swept by an external horizontal signal applied to the EXT TRIG IN terminal. Vertical axis modes are CH1,CH2,DUAL and ADD modes in the CHOP mode.)					
	Frequency bandwidth	DC ～ 1MHz (-3dB)			DC ～ 2MHz (-3dB)		
	Phase difference between vertical axis	≤ 3º at DC ～50kHz				≤ 3º at DC ～100kHz	
Z AXIS	Sensitivity	3 Vp-p (Trace becomes brighter with negative input.)					
	Frequency bandwidth	DC ～5MHz					
	Input resistance	Approx. 5k ohm					
	Maximum input voltage	50 V (DC+AC peak, 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 kV			Approx. 12 kV		
	Effective screen size	8 x 10 DIV (1 DIV = 10mm(0.39in))					
	Graticule	Internal; continuous adjustable illumination (626G,652G,653G,658G only)					
CURSOR READOUT (626G,658G)	Cursor measurement functions	△V ,△V% ,△VdB, △T ,1/△T ,DUTY ,PHASE					
	Cursor display format	▽(DELTA), ▼(REF)					
	Cursor resolution	1/25 DIV					
	Effective cursor range from center graticule	Vertical: ±3 DIV Horizontal: ±4 DIV					
	Panel setting display	V/DIV,V-MODE, INV, ALT/CHOP, UNCAL, ADD(SUB), x10MAG, PROBE(x1/x10), X-Y, A T/D, TV-V/H, B T/D(for 658G only)					

Line Power Requirements

Voltage : AC 100V, 120V, 220V, 230V ±10% selectable
Frequency : 50Hz or 60Hz
Power consumption : Approx. 70VA, 60W(max.)

Operating Environment

Indoor use
Altitude up to 2000 m
Ambient temperature :
To satisfy specifications : 5° to 35℃ (41° to 95° F)
Maximum operating ranges: 0° to 40℃(32 °to 104° F)
Relative humidity:85% RH(max.) non condensing
Installation Category II
Pollution degree 2

Accessories

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

Mechanical Specifications

Dimensions : 310 W x 150 H x 455 D (mm)
Weight : Approx.8.2Kg (18 lbs)

Storage Temperature & Humidity

-10° to 70℃,70%RH(maximum)

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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 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 voltage 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 correct position corresponding to the line voltage. Note the oscilloscope may be damaged if it is connected to the wrong AC line voltage.



WARNING. To avoid electrical shock the power cord protective grounding conductor must be connected to ground.

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

Line voltage	Range	Fuse	Line voltage	Range	Fuse
100V	90-110V	T 0.63A 250V	220V	198-242V	T 0.315A 250V
120V	108-132V		230V	207-250V	



WARNING. To avoid personal injury, disconnect the power cord before removing the fuse holder.

3.3 Environment

The normal ambient temperature range of this instrument is 0° to 40°C (32° to 104°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 Equipment Installation, and Operation

Ensure there is proper ventilation for the hole vents in the oscilloscope case.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

3.5 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.

3.6 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)

Voltage w.r.t. Earth



CAUTION. To avoid instrument damage, do not exceed maximum input voltages. Maximum input voltages must have frequencies less than 1 kHz.

If an AC voltage which is superimposed on a DC voltage is applied, the maximum peak of CH1 and CH2 input voltage must exceed + or – 400V. So for voltages with a mean value of zero volt the maximum peak to peak value is 800Vpp.

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Figure 4-1(a)

Model 622G

Model 635G

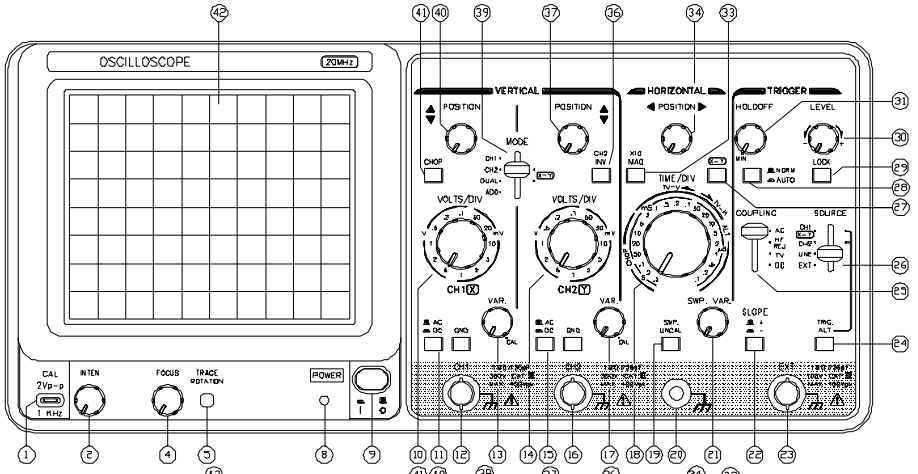


Figure 4-1(b)

Model 652G

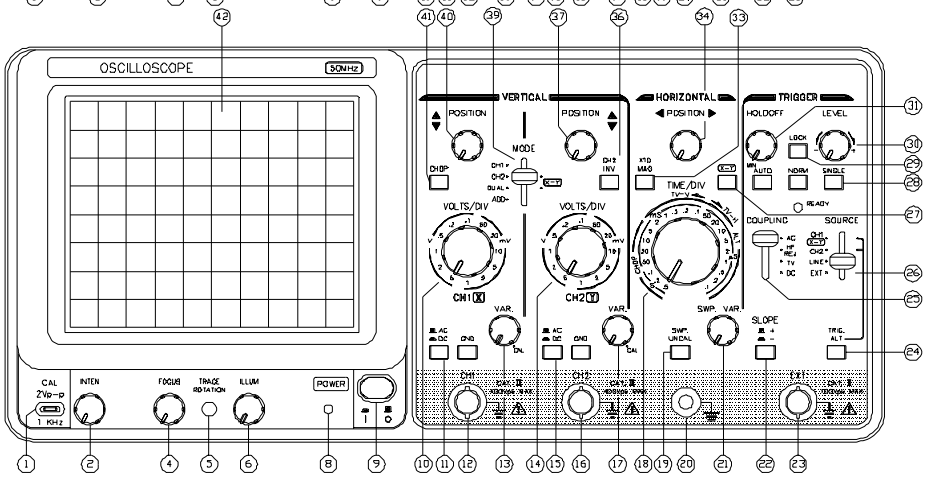
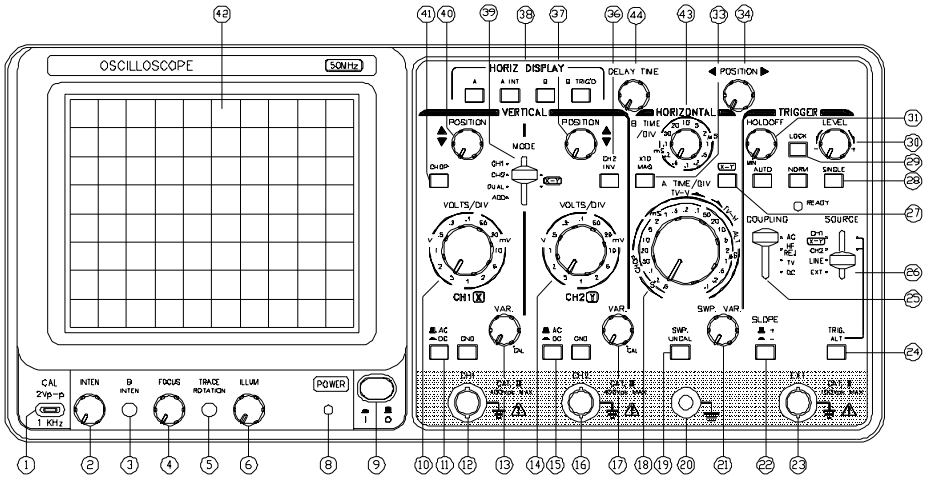


Figure 4-1(c)

Model 653G



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Figure 4-1(d)

Model 626G

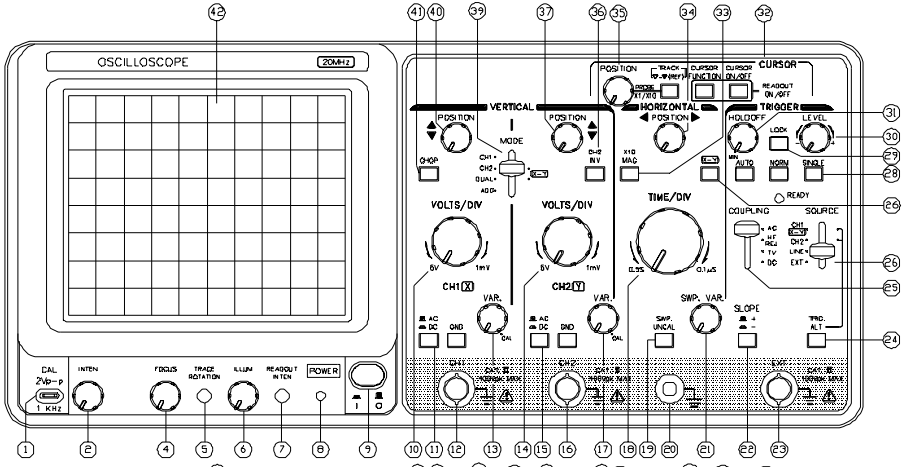
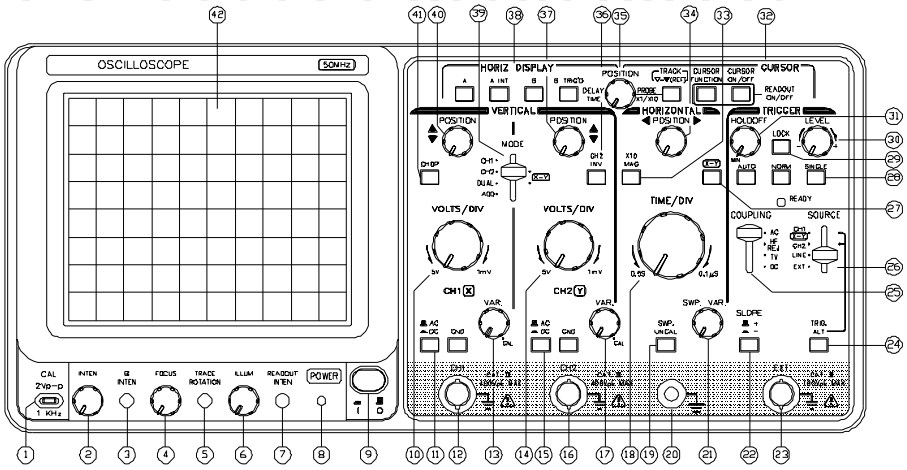


Figure 4-1(e)

Model 658G



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4. OPERATION METHOD

4.1 Introduction of Front Panel

CRT :

POWER.....(9)
Main power switch of the instrument. When this switch is turned on, the LED (8) is also turned on.

INTEN.....(2)
Controls the brightness of the spot or trace.

B INTEN.....(3)(653G & 658G only)
Semi-fixed potentiometer for adjusting trace intensity when in B sweep mode.

READOUT INTEN.....(7)(626G & 658G only)
Semi-fixed potentiometer for adjusting intensity of the readout and cursors.

FOCUS.....(4)
For focusing the trace to the sharpest image.

ILLUM.....(6)(Except 622G & 635G)
Graticule illumination adjustment.

TRACE ROTATION....(5)
Semi-fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.

FILTER.....(42)
Filter for ease of waveform viewing.

Vertical Axis:

CH 1 (X) input.....(12)
Vertical input terminal of CH 1. When in X-Y operation, X-axis input terminal.

CH 2 (Y) input.....(16)
Vertical input terminal of CH 2. When in X-Y operation, Y-axis input terminal.

AC-DC-GND.....(11)(15)
Switch for selecting connection mode between input signal and vertical amplifier.
AC : AC coupling
DC : DC coupling
GND : Vertical amplifier input is grounded and input terminals are disconnected.

VOLTS/DIV.....(10)(14)
Select the vertical axis sensitivity, from 1mV/DIV to 5V/DIV in 12 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.

POSITION.....(40)(37)
Vertical positioning control of trace or spot.

VERT MODE.....(39)
Select operation modes of CH 1 and CH 2 amplifiers.
CH 1 : The oscilloscope operates as a single-channel instrument with CH 1 alone.
CH 2 : The oscilloscope operates as a single-channel instruments with CH 2 alone.
DUAL : The oscilloscope operates as a dual-channel instrument both CH 1 and CH 2. CHOP/ALT are automatic changed by TIME/DIV switch(18). When CHOP (41) button is pushed in, the two traces are displayed in the CHOP mode at all ranges.
ADD : The oscilloscope displays the algebraic sum (CH 1 + CH 2) or difference (CH 1 - CH 2) of the two signals. The pushed in state of CH 2 INV(36) button is for the difference (CH 1 - CH 2).

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)
Select the internal triggering source signal, and the EXT HOR input signal.
CH 1 (X-Y) : When the VERT MODE switch(39) is set in the DUAL or ADD state, select CH 1 for the internal triggering source signal. When in the X-Y mode, select CH 1 for the X-axis signal.
CH 2 : When the VERT MODE switch(39) is set in the DUAL or ADD state, select CH 2 for the internal triggering source signal.
TRIG.ALT(24): When the VERT MODE switch(39) is set in the DUAL or ADD state, and the SOURCE switch(26) is selected at CH 1 or CH 2, with the engagement of the TRIG.ALT switch(24), it will alternately select CH 1 & CH 2 for the internal triggering source signal.

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LINE : To select the AC power line frequency signal as the triggering 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

COUPLING.....(25)

Select COUPLING mode(25) between triggering source signal and trigger circuit; select connection of TV sync trigger circuit.
AC : AC coupling
DC : DC coupling
HF REJ : Removes signal components above 50kHz(-3dB).
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(18)
TV-V: 0.5 s/DIV - 0.1ms/DIV
TV-H: 50μs/DIV - 0.1μs/DIV

SLOPE.....(22)

Select 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.

LEVEL.....(30)

To display a synchronized stationary waveform and set a start point for the waveform.
Toward "+": The triggering level moves upward on the display waveform.
Toward "–" : The triggering level moves downward on the display waveform.
LOCK(29) : 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.....(31)

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

TRIGGER MODE...……..(28)

Select 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 ≤ 50 Hz.
SINGLE: Use for single sweep.(Except 622G & 635G)
Push to RESET: Operation(one-short triggering operation), and in common as the reset switch. When these three buttons are disengaged, the circuit is in the single trigger mode. The circuits is reset as this button is pressed. When the circuit is reset, the READY lamp turns on. The lamp goes out when the single sweep operation is over.

Time Base

(A) TIME/DIV.....…….....(18)

Select the sweep time of the A sweep. (A and B sweep in common for 658G only, B TIME/DIV < A TIME/DIV)

B TIME/DIV.....……..(43) (653G only)

Select the sweep time of delayed sweep (B sweep).

SWP.VAR.....……..(21)

Vernier control of sweep time. When SWP.UNCAL(19) button is pushed in, the sweep time can be made slower by a factor ≥2.5 of the indicated value. The indicated values are calibrated when this button is not pushed in.

POSITION.....……..(34)

Horizontal positioning control of the trace or spot.

×10 MAG.....……..(33)

When the button is pushed in, a magnification of 10 occurs.

DELAY TIME.....… .....(44)(653G only)

Vernier control of the delay time selected by the A TIME/DIV(18) and B TIME/DIV(43) switch to finely select the portion of the A sweep waveform to be magnified.

HORIZ. DISPLAY MODE.....(38)(653G & 658G only)

Select 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 : Select 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 B TIME/DIV switch and DELAY .TIME knob 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 and B TIME/DIV switch and DELAY TIME knob has elapsed. (The triggering signal is used in common for both A sweep and B sweep).

X-Y.....…….....(27)

Press the X-Y button to enable X-Y operation.

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Others

CAL…….....…….....(1)

This terminal delivers the calibration voltage of 2 Vp-p, 1kHz, positive square wave. The output resistance is 2k ohm see page 5 technical specification for tolerance.

GND.....……....(20)

Ground terminal of oscilloscope mainframe.

Readout Function(Only available in 626G & 658G)

CURSOR measurement.....(32)

CURSOR ON/OFF : Press the button to turn on/off the cursor measurement.

CURSOR FUNCTION : Press the button to select the measurement functions.

- ΔV : Voltage difference measurement.
- ΔV% : Voltage difference measurement in percentage(5 div =100% ref.)
- ΔVdB : Voltage gain measurement(5 div = 0dB ref. , ΔVdB = 20 logΔdiv/5div)
- ΔT : Time difference measurement.
- 1/ΔT : Frequency measurement.
- DUTY : Duty cycle or time difference percent(ΔT%) measurement(5 div =100% ref.)
- PHASE : Phase measurement(5 div = 360° ref.)

TRACK-▽-▼(REF) : Press the button to select the cursor(s) to be moved. The selected cursor is indicated by either a ▽ or ▼ symbol. When both symbols are displayed, the two cursors can be shifted simultaneously.

POSITION(35) : Rotate the cursor POSITION control to position the selected cursor(s). When HORZ.DISPLAY mode is set A INT or B state and CURSOR ON/OFF is set off, the POSITION control is used in common as the DELAY TIME (For 658G only).

READOUT ON/OFF : To turn on/off the readout status on the CRT, press the CURSOR ON/OFF and CURSOR FUNCTION buttons at the same time.

PROBE ×1/×10 To indicate the voltage readout is scaled for ×1 or×10 probe, press the TRACK-▽-▼(REF) button and rotate the cursor POSITION(35) at the same time.

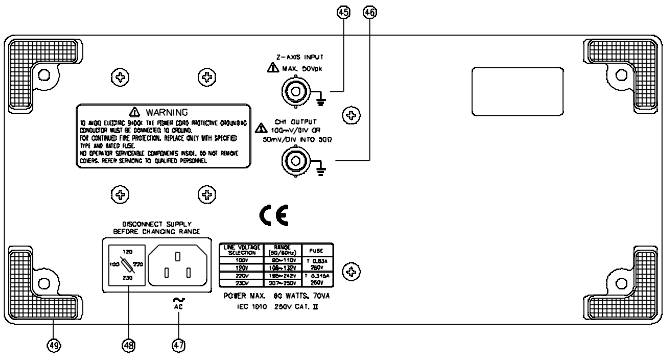
4.2 Introduction of Rear Panel

Z AXIS INPUT.....…...(45)

Input terminal for external intensity modulation signal.

CH 1 SIGNAL OUTPUT.....(46)

Delivers the CH 1 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

Figure 4-2

AC Power input connector.....(47)

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

FUSE & line voltage selector.....(48)

Fuse rating is shown in Page 7. Line voltage selector: to select power sources.

Studs.....….....….(49)

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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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 below:

Item	No	Setting
POWER	(9)	Disengage position(OFF)
INTEN	(2)	Clockwise(3-o'clock position)
FOCUS	(4)	Mid-position
ILLUM	(6)	Full anti-clockwise Position (Except 622G & 635G)
VERT MODE	(39)	CH 1
CHOP	(41)	Released
CH 2 INV	(36)	Released
POSITION	(40)(37)	Mid-position
VOLTS/DIV	(10)(14)	0.5V/DIV
VARIABLE	(13)(17)	CAL(clockwise position)
AC-DC-GND	(11)(15)	GND
SOURCE	(26)	Set to CH 1
COUPLING	(25)	AC

Item	No	Setting
SLOPE	(22)	+
TRIG ALT	(24)	Released
LEVEL LOCK	(29)	Pushed in
HOLDOFF	(31)	MIN(anti-clockwise)
TRIGGER MODE	(28)	AUTO
HORIZ DISPLAY MODE	(38)	A (653G &658Gonly)
TIME/DIV	(18)	0.5mSec/DIV
SWP.UNCAL	(19)	Released
POSITION	(34)	Mid-position
x10 MAG	(33)	Released
X-Y	(27)	Released

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 setting.
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 CH 1 POSITION control and TRACE ROTATION control(adjustable by screwdriver).
4) Connect the probe to the CH 1 INPUT terminal and apply the 2Vp-p CALIBRATOR signal to the probe tip.
5) Set the AC-DC-GND 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 signal waveform is displayed clearly.
8) Adjust the ΔV 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 CH 1. Single-channel operation with CH 2 can also be achieved in a similar manner. Further operation methods are explained in the subsequent paragraph.

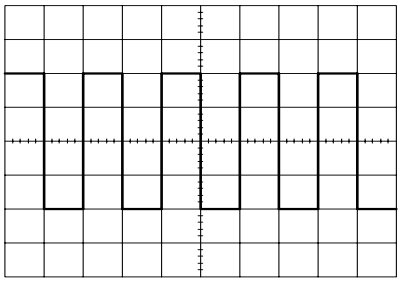


Figure 4-3

4.4 Dual-channel Operation

Change the VERT MODE switch to the DUAL states so that trace(CH 2) is also displayed(The explanation in the proceeding section is of CH 1). At this state of procedure, the CH 1 trace is the square wave of the calibrator signal and the CH 2 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 CH 2 with the probe as is the case for CH 1. Set the AC-DC-GND switch to the AC state. Adjust vertical POSITION knobs(40) and (37) so that both channel signals are displayed as shown in Figure4-4.

When in the dual channel operation(DUAL or ADD mode), the CH 1 or CH 2 signal must be selected for the triggering source signal by means of the SOURCE switch. If both CH 1 and CH 2 signals are in a synchronized relationship, both waveforms can be displayed stationary; if not, only the signal selected by the SOURCE switch can be stationary. If the TRIG. ALT push switch is engaged, both waveforms can be stationary(Do not use "CHOP" and "ALT" triggering source switch at the same time).

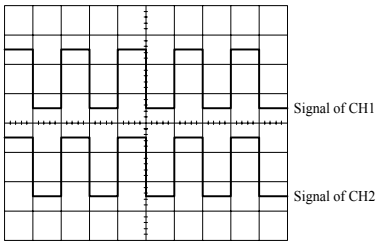


Figure 4-4

Selection between CHOP mode and ALT mode is automatically made by the TIME/DIV switch shown in Figure 4-5. The 5mSec/DIV and lower ranges are used in the CHOP mode and the 2ms/DIV and higher ranges are used in the ALT mode.

When the CHOP push switch is engaged, the two traces are displayed in the CHOP operation at all ranges. The CHOP operation has priority over the ALT operation.

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4.5 ADD Operation

An algebraic sum of the CH 1 and CH 2 signals can be displayed on the screen by setting the VERT MODE switch to the ADD state. The displayed signal is the difference between CH 1 and CH 2 signals if the CH 2 INV push switch is engaged.

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 ΔV POSITION knob of either channel. In view of the linearity 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 CH 1 X-Y position, the oscilloscope operates as an X-Y scope with the CH 1 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 CH 1 as X-axis and CH 2 as Y-axis. The bandwidth of the X-axis becomes DC to 1MHz(-3dB)(or DC to 2MHz for 652G, 653G, 658G) and the horizontal POSITION control is directly used as the X-axis POSITION control. For the Y-axis, the CH 2(X-Y) should be selected by the VERT MODE switch.

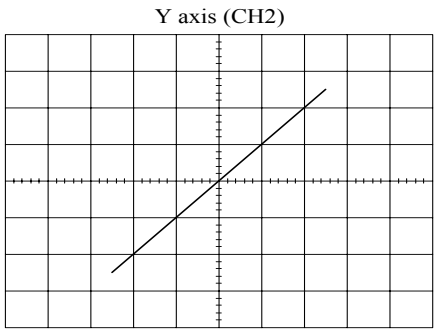
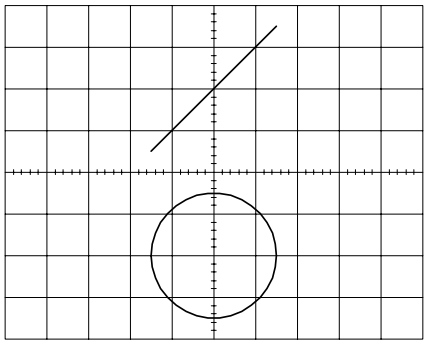


Figure 4-6



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 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 CH 1 and CH 2 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.

CH 1 : The internal trigger method which is used most commonly.

CH 2 : 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 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 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, the waveforms can be displayed more independent than the measured signal.

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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			
CH2	Triggered by CH2 signal			
ALT	Alternately triggered by CH1 & CH2			
LINE	Trigged by LINE signal			
EXT	Trigged 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 (-3dB).
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 s - 0.1 ms
TV-H : 50 μs - 0.1 μs

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

(3) Function 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 lever in the positive-going direction.

“-“ : When set in the “-” state, triggering occurs as the triggering signal crosses the triggering lever in the negative-going direction.

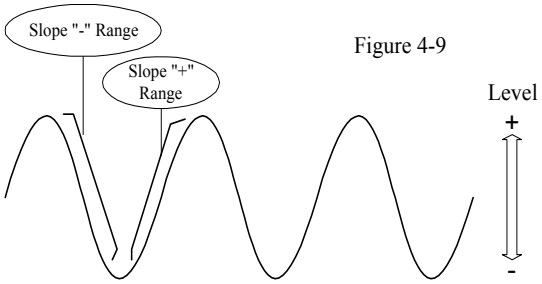


Figure 4-9

(4) Function 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 counter clockwise. The characteristic changes are as shown in Figure 4-10.

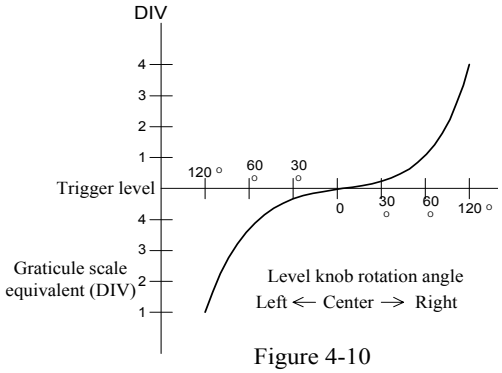


Figure 4-10

LEVEL LOCK:

When LEVEL LOCK push switch is engaged, 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:

622G / 626G :
50 Hz- 5MHz : 1.0DIV (0.15V) or less
5MHz- 20MHz : 2.0DIV (0.25V) or less

635G: 50 Hz- 5MHz : 1.0DIV (0.15V) or less
5MHz- 35MHz : 2.0DIV (0.25V) or less

652G / 653G / 658G :
50 Hz- 10MHz : 1.0DIV (0.15V) or less
10 MHz- 40MHz : 2.0DIV (0.25V) or less

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(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 stable 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 0.2s/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 MIN 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.

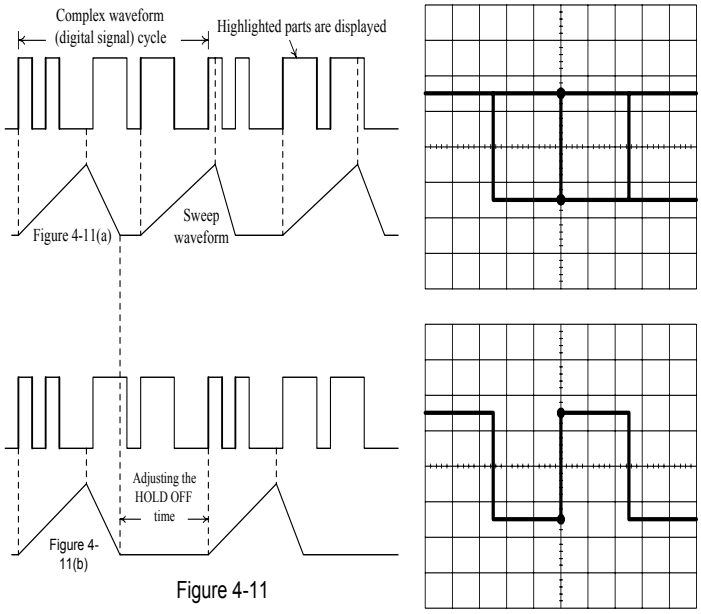


Figure 4-11

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: (Except 622G & 635G)

(1) Set the TRIGGER MODE to the NORM state.

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

(3) Set the TRIGGER MODE to the SINGLE state. Apply the measured signal instead of the calibration 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 .

(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, push in the × 10MAG button.

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

The sweep time during the magnification operation is as follows：

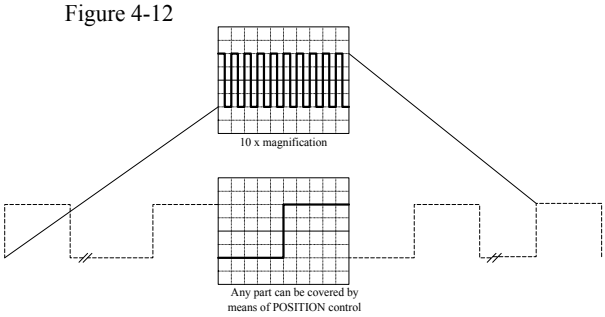
(Value indicated by TIME/DIV switch)×1/10

Thus, the unmagnified maximum sweep speed (0.1 μs/DIV) can be increased with the magnification as follows：

0.1 μs/DIV×1/10 = 10 μs/DIV

When the sweep is magnified and the sweep speed is above 0.1 μs/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.

Figure 4-12



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4.10 Waveform Magnification with Delayed Sweep(653G / 658G only)

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 continuously variable delay circuit and a triggering delay circuit are incorporated into the oscilloscope.

(1) Continuous variable delay

Set the HORIZ. 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 HORIZ. DISPLAY MODE switch is disengaged, engage the HORIZ. 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 continuously variable by means of the DELAY TIME POSITION knob. Next, change the HORIZ.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：

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

(2) Triggering delay：

When the display 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.

Figure 4-13

HORIZ DISPLAY
A INTEN

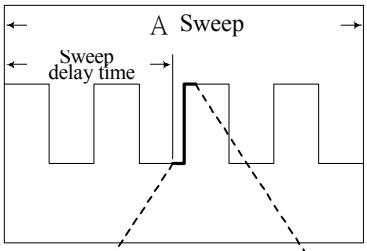
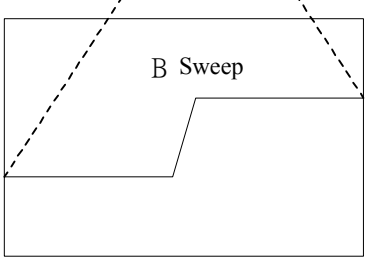


Figure 4-14

HORIZ DISPLAY
B INTEN



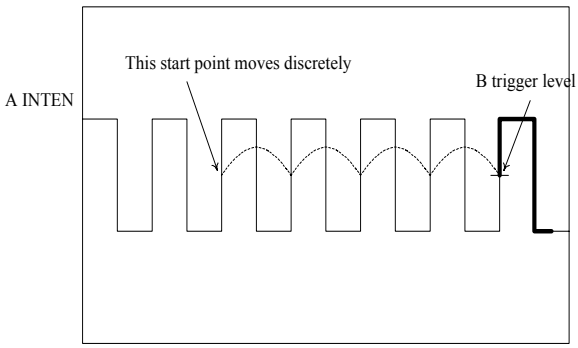


Figure 4-15

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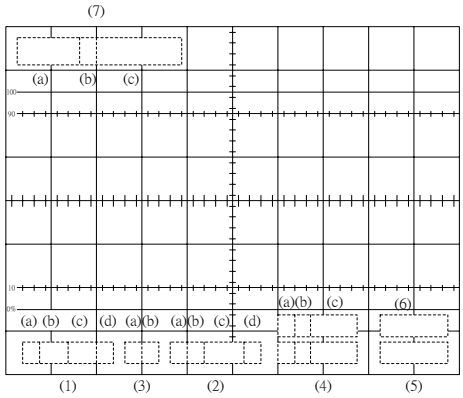
4.11 Readout Function (626G and 658G)

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 TRIGGER MODE is in NORM state. To observe the signals, depress the AUTO button.

CH1 Display

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)……“ P10 ” sign is shown when the probe ×10 is setted.
(b)……“> ” sign is shown when the V/DIV VAR. is at UNCAL position.
(c)…… Display the selected sensitivity from 1mV to 5V. (Probe x10 from 10mV to 50V)
(d)……“x ” sign is displayed when the X-Y button is set and the VERT MODE is at CH2. At DUAL X-Y mode, “y1 ”is displayed.

Figure 4-16



CH2 Displayed

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)……“P10 ” sign is shown when the probe ×10 is setted.
(b)……“> ” sign is shown when the V/DIV is at UNCAL position.
(c)…… Display the selected sensitivity from 1mV to 5V. (Probe x10 from 10mV to 50V)
(d)……“y ” sign is shown at X-Y mode.“y2 ” sign is shown at DUAL X-Y mode.

ADD(SUB) & CH2 INV Display

The ADD, SUB and INV functions are displayed at (3).
(a)……“+ ” is shown when the VERT MODE is at ADD position, then the inputs CH1 & CH2 are algebraically summed.
(b)…… A “ ↓ ” sign is displayed when the VERT MODE is at CH2 or DUAL and the CH2 INV button is engaged. When the CH2 INV button is pushed in, the subtraction of CH2 from CH1 is in function.

TIME Display

The sweep time is displayed at (4). The A sweep time is shown at the under row, the B sweep time is shown at the upper row. (B sweep for 658G only)
(a)……“A ” and “B ” are shown at A and B sweep time.
(b)……“ = ” is shown normally. “ * ” sign is displayed when the x10 MAG button is pushed in. “ > ” sign is displayed when the SWP. UNCAL button is engaged.
(c)…… shows the selected sweep time from 10ns to 0.5s. An “X-Y ” is displayed when the X-Y button is pushed in.

CHOP / ALT Display

The “CHOP ” or “ALT ” are displayed at (5) when the VERT MODE is set to DUAL. When X-Y button is engaged, an “X_{EXT} ” is displayed.

TV-V / TV-H Display

The “TV-V ” or “TV-H ” are displayed at (6) when the TRIG. COUPLING is set to TV position.

Cursor Measured Value Display

The relative measured values of the seven functions are displayed at (7).
(a)……Shows each of seven functions (△V, △V%, △VdB, △T, 1/△T, DUTY, PHASE) which may be selected by the CURSOR FUNCTION button. The △V function provide different △V (△V1, △V2, △V12, $\triangle V_y$, $\triangle V_{y1}$) according to the following table：

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">VERT. MODE</td></tr>
<tr><td>CH1</td><td>CH2</td><td>DUAL</td><td>ADD</td></tr>
<tr><td rowspan="4">TRIG.
SOURCE</td><td>CH1</td><td rowspan="4">△V1</td><td rowspan="4">△V2</td><td>△V1</td><td rowspan="4">△V12</td></tr>
<tr><td>CH2</td><td rowspan="3">△V2</td></tr>
<tr><td>LINE</td></tr>
<tr><td>EXT</td></tr>
<tr><td colspan="2">X-Y</td><td>*1</td><td>△ V_y</td><td>$\triangle V_{y1}$</td><td>*1</td></tr>
</table>

NOTE： *1：When X-Y mode is not set at correct position, the error message “X-Y mode error ”is shown.

(b)……In the △V function, a “ + ” or “ - ” polarity is shown. “+ ”when the ▽(delta) cursor is above the ▼ (REF.) cursor; “- ”when the ▽(delta) cursor is below the ▼ (REF.) cursor.

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(c)……Display the measured value and units of the seven cursor measurement functions.

△V ： 0.0V~40.0V (400V for PROBE x10)
NOTE：When the V/DIV VAR. 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 measuring unit will be value is displayed in division(0.00 to 8.00 div.) instead.

△V% ： 0.0%~160% (5 div. = 100% reference)

△VdB： -41.9dB~+4.08dB (5 div. = 0dB reference)
△VdB = 20 log △V(div.) / 5 div.
△V(div.)：measured difference division value.

△T ： 0.0nS~5.00S
NOTE：When the SWP UNCAL button is pushed in, the measured value is displayed in divisions (0.00 to 10.00 div.).

1/△T ： 200.0mHz~2.500GHz
NOTE： When the SWP UNCAL button is pushed in or two cursors are overlap, the unknow value displays " ???? ".

DUTY ： 0.0%~200.0% (5 div. = 100% reference)

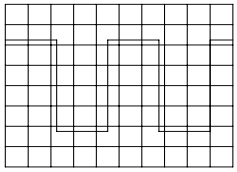
PHASE： 0.0°~720° (5 div. = 360° reference)
NOTE：Except △V(%,dB), the other functions (△T, 1/△T, DUTY, PHASE) are selected and then the X-Y button is engaged, the unknown value displays "???? ".

4.12 Calibration of Probe

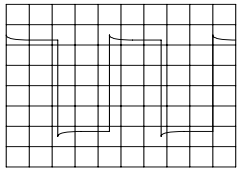
As explained previously, the probe makes up a wide range attenuator. Unless phase compensation is properly done, the displayed waveform is distorted causing measurement errors. Therefore, the probe must be properly compensated before use.

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 4-18 ：

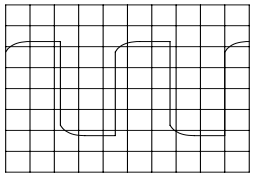
Figure 4-18



(a) Correct compensation



(b) Over compensation



(c) Insufficient compensation

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5.MAINTENANCE

WARNING

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

5.1 Fuse Replacement

If the fuse blows, the power lamp indicators will not light and the oscilloscope will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse. The replace only with a fuse of the correct rating and type(see page 7)

The fuse is located on the rear panel (see fig. 4-2).



WARNING. For continued fire protection. Replace fuse only with 250V fuse of the specified type and rating ,and disconnect power cord before replacing fuse.

5.2 Line Voltage Conversion

The primary winding of the power transformer is tapped to permit operation from 100,120,220,or 230VAC 50/60Hz line voltage. Conversion from one line voltage to another is done by changing the line voltage selector switch as shown in Fig. 4.2.

The rear panel identifies the line voltage to which the unit was factory set. To convert to a different line voltage, perform the following procedure:

(1)Make sure the power cord is unplugged.

(2)Change the line voltage selector switch to the desired line voltage position.

(3)A change in line voltage may also require a corresponding change of fuse value. Install the correct fuse value as listed on rear panel.

5.3 Cleaning

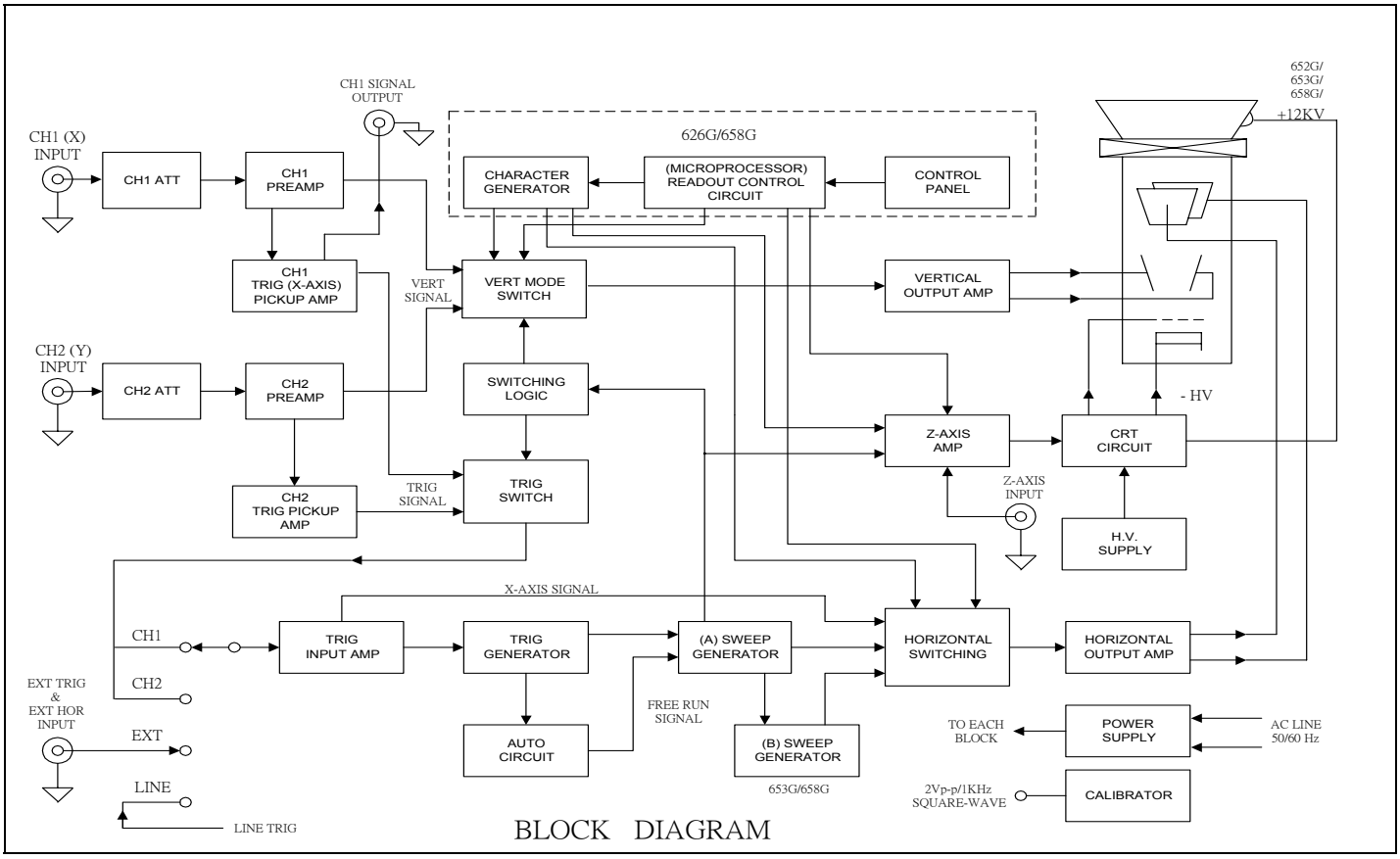
To clean the oscilloscope, use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the oscilloscope because it may leak into the cabinet and cause damage.

Do not use chemicals containing benzine, benzene, toluene, xylene, acetone, or similar solvents.

Do not use abrasive cleaners on any portion of the oscilloscope.

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6.BLOCK DIAGRAM



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