20MHz Dual Trace Oscilloscope
with Function Generator
MODEL: GOS-620FG

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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

Frame or chassis
Terminal

FOR UNITED KINGDOM ONLY

NOTE

This lead/appliance must only be wired by competent persons

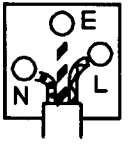
WARNING

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 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.

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-620FG

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:

EN 61326-1: Electrical equipment for measurement, control and laboratory use—EMC requirements (1997+A1:1998)					
Conducted Emission	EN 55022 class B	(1994)	Electrostatic Discharge	IEC 1000-4-2	(1995)
Radiated Emission	EN 55011 class B	(1991)	Radiated Immunity	IEC 1000-4-3	(1995)
Current Harmonics	EN 61000-3-2	(1996)	Electrical Fast Transients	IEC 1000-4-4	(1995)
Voltage Fluctuations	EN 61000-3-3	(1995)	Surge Immunity	IEC 1000-4-5	(1995)
----------	----------	----------	Conducted Susceptibility	EN 61000-4-6	(1996)
----------	----------	----------	Power Frequency Magnetic field	EN 61000-4-8	(1993)
----------	----------	----------	Voltage Dip/Interruption	EN 61000-4-11	(1994)

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

1. PRODUCT INTRODUCTION

1.1 Description

The GOS-620FG oscilloscope + Function Generator is a portable-type, dual-channel oscilloscope with function generator. Its bandwidth of DC is up to 20MHz, and its maximum sensitivity is 1mV/DIV. The time base provides a maximum sweep time of 0.2uS/DIV. The sweep speed becomes 100nS/DIV after magnifying 10 times. The oscilloscope uses a 6-inch rectangular type cathode-ray tube with red internal graticule. The Function Generator generates triangle wave, sine wave, and square wave with the frequency range from 0.1Hz to 1MHz.
The product is 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 and high intensity type with a high acceleration voltage of 2kV. It displays readable traces clearly even at high sweep speeds.

2) Wide bandwidth and sensitivity:
In addition to wide bandwidth, DC-20MHz (-3dB), the instrument provides high sensitivity of 5mV/DIV (1mV/DIV at ×5 MAG). A 20MHz frequency is obtained with improved triggering synchronization.

3) Alternate triggering:
Even with an observation of two different frequency waveforms, each waveform can be triggered stably.

4) TV sync triggering:
The oscilloscope has a sync separator circuit for TV-V and TV-H signals triggering.

5) CH1 Output:
A signal from 50Ω output terminal of CH1 located on rear panel can be applied to frequency counter or other instruments.

6) Z-Axis Input:
Intensity modulation capability permits time or frequency markers to be added. Trace blank with positive signal, TTL compatible.

7) X-Y operation:
Set the switch to X-Y to operate the instrument as an X-Y oscilloscope. CH1 can be applied as a horizontal deflection (X-axis) while CH2 provides vertical deflection (Y-axis).

8) Built-in Function Generator with BNC output of 50Ω.

9) Three kinds of waveforms are available with 50Ω output.

10)Waveform frequency is up to 1MHz.

2.TECHNICAL SPECIFICATIONS

SPECIFICATIONS \ MODEL		GOS-620FG 20MHz OSCILLOSCOPE + FUNCTION GENERATOR
1.OSCILLOSCOPE		
VERTICAL AXIS	Sensitivity	5mV ~ 5V/DIV, 10 steps in 1-2-5 sequence.
	Sensitivity Accuracy	≤3% (× 5 MAG : ≤5%).
	Vernier Vertical sensitivity	To 1/2.5 or less of panel-indicated value.
	Frequency bandwidth	DC~20MHz (× 5MAG: DC~7MHz). AC coupling: Low limit frequency of 10Hz. (With reference to 100kHz, 8DIV. Frequency response at -3dB).
	Rise time	Approx. 17.5nS (×5 MAG: Approx. 50nS).
	Input impedance	Approx. 1M ohm // Approx. 25pF.
	Square Wave Characteristics	Overshoot : ≤ 5% (At 10mV/DIV range). Other distortions and other ranges: 5% added to the above value.
	DC Balance Shift	Panel adjustable.
	Linearity	<±0.1DIV 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 : CH1 and CH2 are displayed. ALT or CHOP selectable at any sweep rate. ADD : CH1 + CH2 algebraic addition.
	Chopping Repetition Frequency	Approx. 250kHz.
	Input Coupling	AC, GND, DC.
	Maximum Input Voltage	300Vpeak (AC: frequency 1kHz or lower). Set probe switch at **1: 1**, the maximum effective readout is 40Vpp (14Vrms at Sine wave), set probe switch at **10: 1**, 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 (At 5mV/DIV range)	>1000:1 at 50kHz. >30:1 at 20MHz.
	CH1 signal output	At least 20 mV/div into a 50Ω terminal. Bandwidth is 50Hz to 5MHz at least.
	CH2 INV BAL.	Balanced point variation: ≤1 DIV (Reference at center graticule).

PECIFICATIONS \ MODELS		GOS-620FG 20MHz OSCILLOSOPE + FUNCTION GENERATOR
TRIGGERING	Triggering source	CH1, CH2, LINE, EXT (CH1 and CH2 can be selected only in the DUAL or ADD vertical mode). In ALT mode, if the TRIG. ALT switch is pushed in, it can alternate triggering of two different source.
	Coupling	AC: 20Hz to full bandwidth.
	Slope	+ / -.
	Sensitivity	20Hz ~ 2MHz : 0.5 DIV, TRIG-ALT:2 DIV, EXT : 200mV. 2 ~ 20MHz : 1.5 DIV, TRIG-ALT:3 DIV, EXT : 800mV. TV : Sync pulse more than 1 DIV (EXT: 1V).
	Triggering modes	AUTO : Sweeps run in the free mode when no triggering input signal is applied. (Applicable for repetitive signals of frequency 25Hz or over.). NORM : When no triggering signal is applied, the trace is in the ready state, but not displayed. TV-V : This setting is used when observing the entire vertical picture of television signal. TV-H : This setting is used when observing the entire horizontal picture of television signal. (Both TV-V and TV-H synchronize only when the synchronizing signal is negative)
	EXT Triggering Signal Input Input Impedance Max. Input Voltage	 Approx.: 1M ohm // approx. 25Pf. 300V (DC+AC peak), AC: Frequency not higher than 1kHz.
HORIZIONAL AXIS	Sweep Time	0.2 μ Sec ~ 0.5 Sec/DIV, 20 steps in 1-2-5 sequence.
	Sweep Time Accuracy	$\pm$3%.
	Vernier Sweep Time Control	$\leq$1/2.5 of panel-indicated value.
	Sweep Magnification	10 times (maximum sweep time 100nSec/DIV).
	x10MAG Sweep Time Accuracy	$\pm$5%, (20nSec~50nSec are uncalibrated).
	Linearity	$\pm$3%, x10MAG: $\pm$5% (20ns and 50ns are uncalibrated).
	Position shift caused by x10MAG	Within 2 div. at CRT screen center.
X-Y MODE	Sensitivity	Same as vertical axis (X-axis:CH1 input signal; Y-axis:CH2 input signal.).
	Frequency Bandwidth	DC to at least 500kHz.
	X-Y Phase Difference	$\leq 3^0$ at DC ~50kHz.

SPECIFICATION \ MODEL		GOS-620FG 20MHz OSCILLOSCOPE + FUNCTION GENERATOR
	Sensitivity	5 Vp-p (Positive-going signal decreases intensity).
Z AXIS	Frequency Bandwidth	DC ~ 2MHz.
	Input resistance	Approx. 47KΩ.
	Maximum Input Voltage	30V (DC+AC peak, AC frequency≤1kHz).
CALIBRATION VOLTAGE	Waveform	Positive-going Square wave.
	Frequency	Approx. 1 kHz.
	Duty Ratio	Within 48:52.
	Output Voltage	2 Vp-p ±2%.
	Output Impedance	Approx. 1 kΩ.
CRT	Type	6-inch rectangular type, internal graticule.
	Phosphor	P 31.
	Acceleration Voltage	Approx. 2kV.
	Effective Screen Size	8 x 10 DIV (1 DIV = 10mm (0.39in)).
	Graticule	Internal.
	Trace Rotation	Provided.
2.FUNCTION GENERATOR		
Output Function Range		0.1Hz ~ 1MHz (7 steps).
Output Waveform		Sine Wave, Square Wave and Triangle Wave.
Frequency Variable Range		10:1 or more.
Output Impedance		50Ω ± 10%.
Output Voltage		Over 20Vp-p (open circuit) continuous conversion. DC offset possible over ± 10V when opened.
Sine wave Distortion		1% Max. (10Hz ~ 20kHz). (Specification applied from Max to $\frac{1}{10}$ level)
Square wave Unsymmetry		±3% or less (in 1kHz maximum).
Square wave Rise/Fall Time		50Ω output: 120nS or less.

MODEL / SPECIFICATION	GOS-620FG 20MHz OSCILLOSCOPE + FUNCTION GENERATOR
3.GENERAL	
Power Source	AC115V, 230V ± 15% selectable, 50Hz or 60Hz.
Power Consumption	Approx. 45VA, 40W(max.)
Operation Environment	Indoor use Altitude up to 2000 m Ambient temperature : To satisfy specifications :10° to 35℃(50° 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
Storage Temperature & Humidity	-10° to 70℃, 70%RH(maximum).
Accessories	Power cord × 1 Instruction manual × 1 Probes × 2 GTL-101 × 1
Dimensions	310 (W) x 150 (H) x 455 (D) mm.
Weight	Approx.8kgs (17.6lbs).

3. PRECAUTIONS BEFORE OPERATION

3.1 Unpacking the instrument

The product has been fully inspected and tested before shipping from the factory. Upon receiving the instrument, please unpack and inspect it to check if there is any damages caused during transportation. If any sign of damage is found, notify the bearer and/or the dealer immediately.

3.2 Checking the Line Voltage

The product can be applied any kind of the line voltage shown in the table below. Before connecting the power plug to an AC line outlet, make sure the voltage selector of the rear panel is set to the correct position corresponding to the line voltage. It might be damaged the instrument if connected to the wrong AC line voltage.

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

The fuse must be changed following after the line voltage shown as below:

Line voltage	Range	Fuse
AC 115V	97~132V	T 0.63A 250V
AC 230V	195~250V	T 0.315A 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 from 0° to 40°C (32° to 104°F). To operate the instrument over this specific temperature range may cause damage to the circuits.

Do not operate the instrument in a place where strong magnetic or electric field exists as it may disturb the measurement.

3.4 Equipment Installation and Operation

Ensure there is proper ventilation for the vent of the instrument. If it is not according to the specification to operate the instrument, the protection provided by the instrument may be impaired.

3.5 CRT Intensity

To prevent permanent damage to the CRT phosphor, do not let the CRT trace brighten excessively or leave the spot stay for an unreasonable long time.

3.6 Withstanding Voltages of Input Terminals

The withstanding voltages of the instrument input terminals and probe input terminals are shown in the following table. Do not apply voltage higher than the specification. When set probe switch at **1: 1**, the maximum effective readout is 40Vp-p (14Vrms at Sine wave), set probe switch at **10: 1**, the maximum effective readout is 400Vp-p (140Vrms at Sine wave).

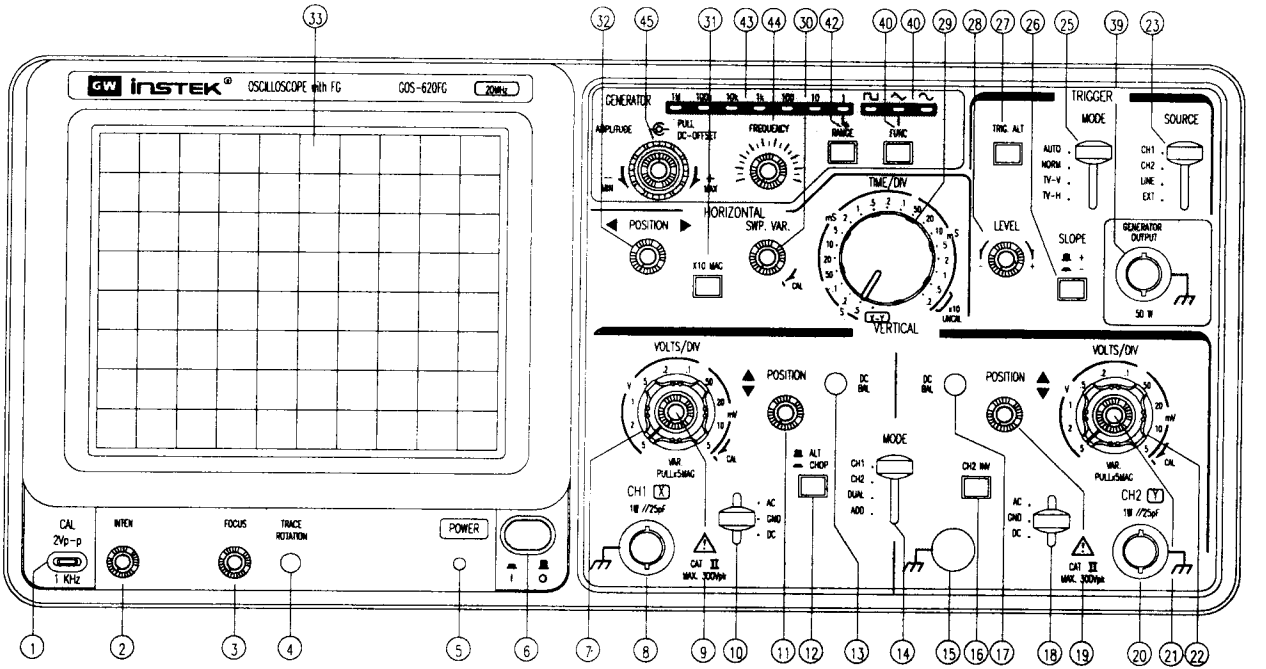
Input terminal	Maximum input voltage
CH1, CH2, inputs	300Vpeak
EXT TRIG IN input	300Vpeak
Probe inputs	600Vpeak
Z AXIS input	30Vpeak

CAUTION. **To avoid any damage, do not apply exceeding maximum input voltage of the frequency less than 1 kHz to the instrument.**

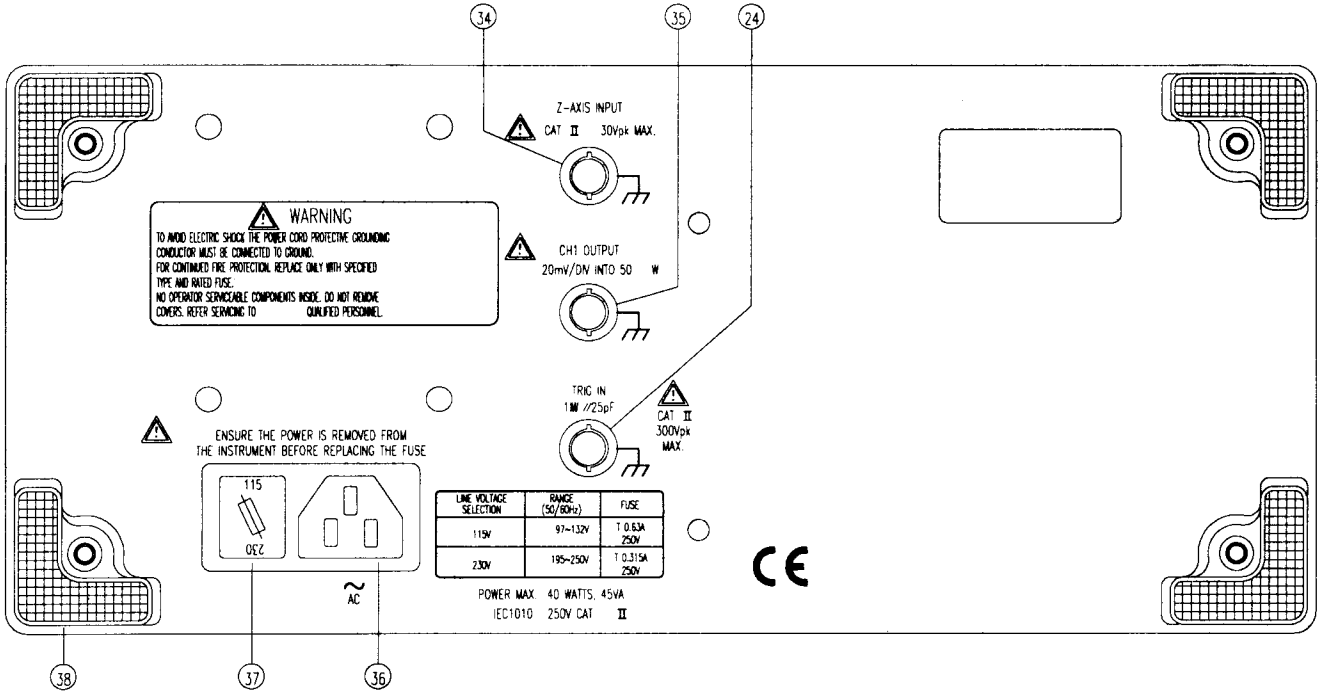
If an AC voltage which is superimposed on a DC voltage is applied, the maximum peak value of CH1and CH2 input voltages must not exceed ±300V, so is the AC voltages with a mean value of zero voltage, the maximum peak to peak value is 600Vp-p.

4.PANEL INTRODUCTION

- **Fig. 4-1. Front Panel**



- **Fig. 4-2 Rear Panel**



4-1.Front Panel

CRT :

(6) POWER

Main power switch of the instrument. Turn on the switch to light the LED (5).

(2).INTEN

Control the brightness of the spot or trace.

(3) FOCUS

Focus the trace to the sharpest image.

(4) TRACE ROTATION

Semi-fix potentiometer for aligning the horizontal trace in parallel with graticule lines.

(33)FILTER

The filter is easy for waveform viewing.

Vertical Axis:

(8) CH1 (X) input

The vertical input terminal of CH1 is X-axis in X-Y operation,

(20)CH 2 (Y) input

The vertical input terminal of CH2 is Y-axis in X-Y operation,

(10) &(18)AC-GND-DC

Select 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

(7) & (22)VOLTS/DIV

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

(9) & (21)VARIABLE

Fine adjustment of sensitivity with a factor of ≥1/2.5 of the indicated value. The sensitivity is calibrated to specific value in the CAL position. When this knob is pulled out (x5 MAG state), it will multiply 5 by the amplifier sensitivity.

(13) & (17)CH1 & CH2 DC BAL.

The knobs are used for adjusting the attenuator balance. See page 20 DC BAL adjustments for details.

(11)&(19)▲ ▼POSITION

Vertical positioning control of trace or spot.

(14)VERT MODE :Select operation modes of CH 1 and CH 2 amplifiers.

CH 1	Operate the oscilloscope as a single-channel instrument by selecting CH1 alone.
CH 2	Operate the oscilloscope as a single-channel instrument by selecting CH2 alone.
DUAL	Operate the oscilloscope as a dual-channel instrument by selecting CH1 and CH2.
ADD	The oscilloscope displays the algebraic sum (CH1 + CH2) or subtraction (CH1 - CH2) of the two signals (the subtraction function effects only when push in CH2 INV(16) button).

(12)ALT/CHOP

When this switch is released in the dual-trace mode, the CH1 and CH2 inputs are alternately displayed (normally used at faster sweep speeds).

When this switch is depressed in the dual-trace mode, the CH1 and CH2 inputs are chopped and displayed simultaneously. (normally used at slower sweep speeds).

(16)CH2 INV

When press CH2 INV button, it will inverts the CH2 input signal in CH2 and in ADD MODE, the CH2 trigger signal pickoff is also inverted.

(23)SOURCE

Select the internal triggering source signal, and the EXT TRIG IN input signal.

CH 1 Press key DUAL or ADD of VERT MODE (14), select CH1 to get internal triggering source signal

CH 2 Press key DUAL or ADD of VERT MODE (14), select CH2 to get internal triggering source signal

(27)TRIG.ALT

Set VERT MODE switch (14) in DUAL or ADD key, select the SOURCE switch (23) by pressing CH1 or CH2, then press TRIG.ALT switch(27), the internal triggering source signal will display alternately from CH1 and CH2.

LINE Display the triggering signal from AC power line frequency signal.

EXT Obtain the external triggering source signal by applying external signal to EXT TRIG IN input terminal (24).

(26)SLOPE

Triggering slope button.

"+" Triggering occurs when the trigger signal crosses the trigger level by positive-going course.

"- " Triggering occurs when the trigger signal crosses the trigger level by negative-going course

(28)LEVEL

Display a synchronized stationary waveform and set a start point for the waveform.

Toward "+" The trigger level moves upward on the display waveform.

Toward "-" The trigger level moves downward on the display waveform.

(25)TRIGGER MODE

Trigger mode selection.

AUTO If no trigger signal applied or the trigger signal frequency is less than 25Hz, the sweep will be in the free run mode.

NORM If no trigger signal applied and sweep is in a stand-by state, there will be no trace appear.

TV-V Used for observing entire vertical picture of television signal.

TV-H Used for observing entire horizontal picture of television signal.

(Both TV-V and TV-H synchronize only when the synchronizing signal is negative.)

Time Base:

(29)TIME/DIV

Provide sweep time ranges from 0.2 uS/div to 0.5 S/div with 20 steps totally.

X-Y Use the instrument as an X-Y oscilloscope by setting to X-Y position.

(30)SWP.VAR

Vernier control knob of the sweep time used when CAL and the sweep time is calibrated to the value preset in TIME/DIV. The sweep of TIME/DIV can be varied continuously when shaft is not in CAL position. Rotate the control knob to CAL position and the sweep time is calibrated to the preset value of the TIME/DIV. Counterclockwise rotate the control knob to the bottom to delay the sweep by 2.5 time or more.

(32)◀ ▶ POSITION

Adjust the trace or spot in horizontal position.

(31)×10 MAG

Magnify 10 by pressing this key.

Function Generator:

(39)GENERATOR OUTPUT

The main output terminal with 50Ω output impedance.

(40)WAVEFORM SELECTOR

The waveform change following after each button pushing in Sine wave, Triangle wave, and Square wave sequence.

(41)OUTPUT WAVEFORM DISPLAY

Display the current output waveform.

(42)FREQ RANGE Switch:

The frequency range changes following after each button pushing in 1M, 100k, 10k, 1k, 100, 10, and 1 sequence.

(43)FREQUENCY RANGE DISPLAY

Display the current frequency range.

(44)FREQUENCY Knob

Rotate the knob clockwise to get higher frequency and reverse the rotation of knob to get lower frequency.

(45)AMPLITUDE/DC LEVEL Adjustment Knob

Rotate outside knob clockwise to get higher amplitude and reverse the rotation of knob to get lower amplitude. The inside knob is for DC Level adjustment, it works only when the knob being pulled up. Pull up the knob and rotate it clockwise to get positive DC Level, and reverse the rotation of knob to get negative DC Level.

Others:

(1) CAL

This terminal delivers the calibration voltage of 2 Vp-p, 1kHz, positive square wave.

(15)GND

Ground terminal of oscilloscope mainframe.

4-2.Rear Panel

Triggering:

(24)EXT TRIG IN Input Terminal

Input Terminal is used for external triggering signal by setting SOURCE switch (23) to the EXT position.

(34)Z AXIS INPUT

Input terminal for external intensity modulation signal.

(35)CH1 SIGNAL OUTPUT

Delivers a voltage of approximately 20mV/DIV from the CH1 signal to 50Ω terminal for frequency counting.

AC POWER Input Circuit:

(36)AC Power input connector

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

(37)FUSE & line voltage selector

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

(38)Studs

Studs is not only used as a stand for laying the oscilloscope on its back to operate it in the upward posture, also used for winding up the power cord.

5.OPERATION METHOD

5-1.Basic Operation---Single-channel 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	(6)	Disengage position(OFF)
INTEN	(2)	Mid-position
FOCUS	(3)	Mid-position
VERT MODE	(14)	CH1
ALT/CHOP	(12)	Released(ALT)
CH 2 INV	(16)	Released
▲ ▼ POSITION	(11)(19)	Mid-position
VOLTS/DIV	(7)(22)	0.5V/DIV
VARIABLE	(9)(21)	CAL(clockwise position)
AC-GND-DC	(10)(18)	GND
SOURCE	(23)	CH1

Item	No	Setting
SLOPE	(26)	+
TRIG. ALT	(27)	Released
TRIGGER MODE	(25)	AUTO
TIME/DIV	(29)	0.5mSec/DIV
SWP.VER	(30)	CAL position
◀ ▶ POSITION	(32)	Mid-position
x10 MAG	(31)	Released

After setting the switches and control knobs as mentioned, connect the power cord to the AC line outlet, then follow the procedure describes as follows:

1) Press 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 INTEN and FOCUS control knob respectively.

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

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

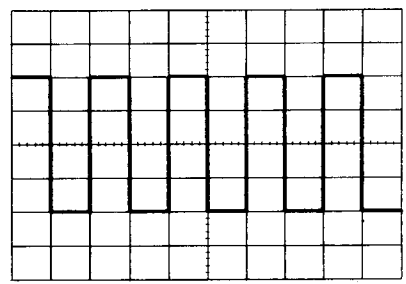
5) Set the AC-GND-DC switch to AC, a waveform will be displayed on the CRT screen as shown in the figure 5-1.

6) Adjust the FOCUS control knob to trace image sharply.

7) Display the signal waveform clearly by adjusting the VOLTS/DIV switch and TIME/DIV switch to appropriate position.

8) Adjust the ▲ ▼ POSITION and ◀ ▶ POSITION control knobs to appropriate position to align the waveform with the graticule, so that voltage (Vp-p) and period (T) can be read conveniently.

● **FIG. 5-1**



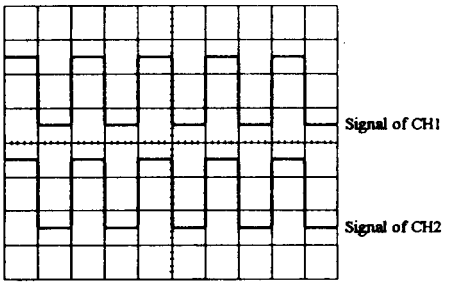
The descriptions above are the basic operating procedures for CH1 single-channel operation of oscilloscope. So is CH2 single-channel operation. For further operation methods will be explained in the subsequent paragraph.

5-2.Dual-channel Operation

Set the VERT MODE switch to DUAL to display trace in CH2 (The procedure is same as CH1 described in previous section). At this step, the calibrator signal appears in CH1 is Square wave, but it appears in CH2 is a straight line as no signal applied to this channel yet.

Now, apply the calibrator signal to the vertical input terminal of CH2 through the probe with the same procedure as for CH1. Set the AC-GND-DC switch to AC, and adjust vertical POSITION knobs (11) and (19), the signals will be displayed on both channels as shown in Figure 5-2.

● **Fig. 5-2**



When ALT/CHOP switch is released (ALT MODE), the input signals which applied respectively to CH1and CH2 appears on the screen alternately at each sweep. This setting is used when the sweep time is short in 2-channel observation.

When ALT/CHOP switch is pressed (CHOP MODE), the input signals which applied to CH1and CH2 are chopped and display on the screen at the same time with the frequency of 250kHz. This setting is used for low speed sweep.

Set to dual channel operation (DUAL or ADD mode), select CH1 or CH2 signal from SOURCE switch to get triggering source signal. If both CH1 and CH2 signals are in a synchronized relation, both waveforms will be displayed in stationary states. If not, only a signal stationary waveform will be appeared. If press TRIG. ALT push button, both waveforms can also be displayed in stationary states.

5-3 ADD Operation

An algebraic sum of the CH1 and CH2 signals can be displayed on the screen by setting the VERT MODE switch to ADD. The displayed signal will be difference between CH1 and CH2 if press CH2 INV push button. Adjust ▲ ▼ POSITION knob of CH1 or CH2 can make vertical position, to the advantage of the linearity of the vertical amplifiers, it's better to set ▲ ▼ POSITION knob of both channels in middle position.

5-4.Triggering

Proper triggering is essential for an efficient operation of the instrument. Users must make themselves familiar with the triggering functions and procedures thoroughly:

(1)Functions of MODE switch:

AUTO Select automatic sweep operation by setting to AUTO mode, the sweep generator will freely generate a sweep without a trigger signal. However, it will automatically switch to triggering sweep operation if an acceptable trigger source signal is preset. The AUTO mode is handy for observing the waveform when first set up the instrument, as it provides sweep function for waveform observation until properly set to other mode. Once starting to set the control mode, the operation often jumps back to the NORM trigger mode as it is much more sensitive. Automatic sweep must be used for DC measurements and signals with low amplitude in order not to trigger the sweep.

NORM The NORM mode provides normal triggering sweep operation. The sweep will not act until the selected trigger source signal crosses the threshold level set by TRIG LEVEL control knob. The triggering generate one sweep which will come to inactivate until another triggering occurs. In the NORM mode, there will be no trace unless an adequate trigger signal is present. In the ALT mode of dual trace operation with NORM sweep selected, there will be no trace unless both CH1 and CH2 signals are adequate for triggering.

TV-V Set the MODE switch to TV-V mode, select vertical sync pulses for sweep triggering to view composite video waveforms. Select vertical sync pulses as a triggering to view vertical fields and frames of video. A sweep time of 2 ms/div is appropriate for viewing fields of video and 5 ms/div for complete frames (two interlaced fields) of video.

TV-H Set the MODE switch to TV-H mode and select horizontal sync pulses for sweep triggering to view composite video waveforms. Select horizontal sync pulses as a triggering to view horizontal lines of video. A sweep time of about 10 us/div is appropriate for displaying lines of video. Display the exact number of desired waveforms by setting SWP VAR control knob.
This oscilloscope synchronizes with only (-) polarity, that is, the sync pulses are negative and the video is positive as shown in Fig. 5-3.

- **Fig. 5-3**

(2)Functions of SOURCE switch:

Apply the displayed signal itself or a trigger signal, which has a time relationship with the displayed signal, to the trigger circuit to display a stationary signal on the CRT screen. The SOURCE switch is used for selecting these trigger sources.

CH1 The internal trigger source is used most commonly.

CH2 The signal applied to the vertical input terminal is branched off away from the preamplifier and is fed to the trigger circuit through the VERT MODE switch. Since the trigger 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 selected signal through the SOURCE switch is used as a trigger source signal.

LINE The AC power line frequency signal is used as a trigger 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 by an external signal applied to the external trigger input terminal. An external signal which has a periodic relationship with the measured signal is used. Because the measured signal is not used as the triggering signal, the waveforms can be displayed more independent than the measured signal.

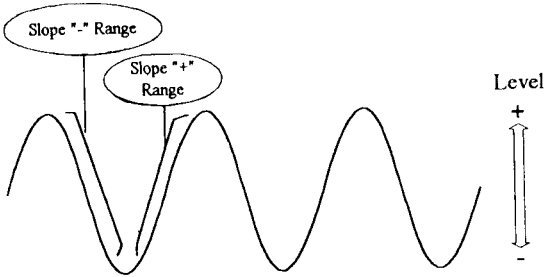
(3)Functions of TRIG LEVEL control knob and SLOPE button:

A sweep triggering is developed when the trigger source signal crosses a preset threshold level. Rotate TRIG LEVEL control knob to vary the threshold level. In the "+" direction, the trigger threshold shifts to a more positive value, and in the "-" direction, the trigger threshold shifts to a more negative value. When set the control knob in the center, the threshold level will be on the average of the signal used as the trigger source.

Adjust TRIG LEVEL control knob for the desired start point of sweep on a waveform. On sine wave signals, the phase at which sweep begins is variable. Note that if rotate TRIG LEVEL control knob toward its extreme "+" or "-", no sweep will be developed in the NORM trigger mode because the trigger threshold exceeds the peak amplitude of the sync signal.

When set TRIG SLOPE button to the (+) position (up), the sweep is developed form the trigger source waveform as it crosses the threshold level in a positive-going direction. When set TRIG SLOPE button to the (-) position (down), a sweep triggering is developed from the trigger source waveform as it crosses the threshold level in a negative-going direction. The slope (polarity) trigger signal as shown in Figure 5-4.

- **Fig. 5-4**



(4) Function of TRIG ALT button:

The TRIG ALT button is used to select alternate triggering and display the selected DUAL-trace of VERT MODE (the switch control knob CH1, CH2, DUAL and ADD modes). In the alternate trigger mode (when select dual-trace operation), the trigger source alternates between CH1 and CH2 with each sweep. This is convenient for checking amplitudes, wave-shape, or waveform period measurements, and even permits simultaneously observing two waveforms which are not related to frequency or period. However, this setting is not suitable for phase or timing comparison measurements. For such measurements, both traces must be triggered by the same sync signal.

If press both CHOP and TRIG ALT buttons during dual-trace operation, synchronization of the display is not possible because the chopping signal will be triggered. Use ALT mode itself, or select CH1 or CH2 as trigger source.

5-5.TIME/DIV Control

Set the TIME/DIV switch to display the desired number of cycles of the waveform. If there are too many cycles displayed with good resolution, set to increase the sweep speed. If only a line is displayed, try to slow down the sweep speed. When the sweep speed is faster than the observed waveform, only part of it will be displayed, which may appear as a straight line for a Square wave or Pulse waveform.

5-6.Sweep Magnification

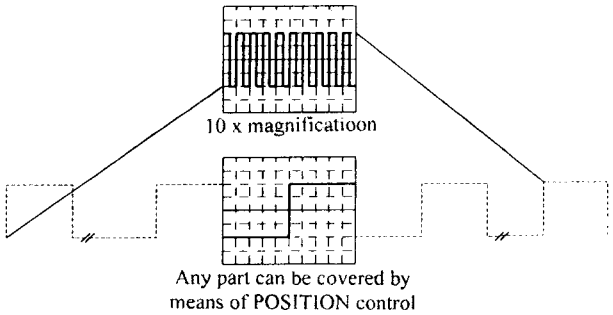
When a certain part of displayed waveform is needed to be expanded timewise, a faster sweep speed may be used. However, if the required portion is apart from the starting point of the sweep, it may run off the CRT screen. In this case, push the ×10MAG button to expand 10 times the displayed waveform from the right to the left in the center of screen. The sweep time with the magnification operation is as follows:

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

Thus, the unmagnified maximum sweep speed (1nSec/DIV) can be increased with the magnification as follows :

1 μSec/DIV x 1/10 = 100nSec/DIV

● **FIG. 5-5**

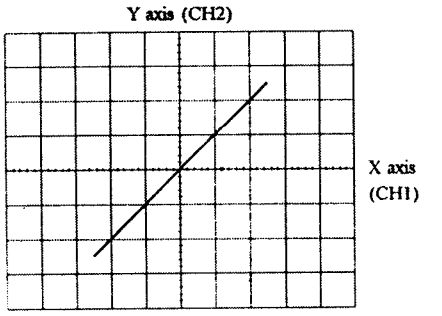


5-7.X-Y Operation

Set the TIME/DIV switch to X-Y position to operate the instrument as an X-Y oscilloscope. Each input is applied to the instrument as follows
X-axis signal (horizontal axis signal) : CH1 INPUT.
Y-axis signal (vertical axis signal) : CH2 INPUT.

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

● **FIG. 5-6**



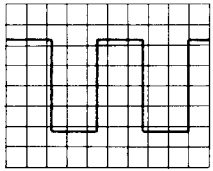
The X-Y operation permits the oscilloscope to perform many state-of-the-art measurements which the conventional sweep operation could not make. The CRT display becomes an electronic graph of two instantaneous voltages. The display may be a direct comparison of the two voltages such as a vectorscope display of video color bar patterns. However, the X-Y mode can almost be used in graph of any dynamic characteristic if a transducer is adopted to change the characteristic (frequency, temperature, velocity, etc.) of voltage. One common application is frequency response measurements that the Y-axis corresponds to signal amplitude and the X-axis corresponds to frequency.

1. Set the TIME/DIV control knob to the X-Y position (fully counterclockwise), CH1 becomes the X-axis input and CH2 becomes the Y-axis input.
2. Adjust X and Y positions by using the horizontal ◀ ▶ POSITION and CH2 ▲ ▼ POSITION control knobs respectively.
3. Adjust the amount of vertical (Y-axis) deflection by using CH2 VOLTS/DIV and VAR control knobs.
4. Adjust the amount of horizontal (X-axis) deflection by using CH1 VOLTS/DIV and VAR control knobs.

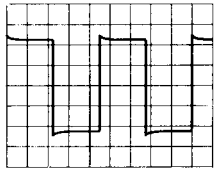
5-8.Calibration of Probe

As explained previously, the probe makes up a wide range attenuator. Unless phase compensation is properly done, the displayed waveform will be distortion causing measurement errors. Therefore, the probe must be properly compensated before use. Connect 10:1 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).

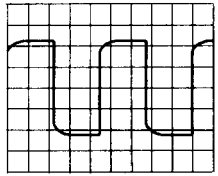
- **FIG. 5-7**



(a) Correct compensation



(b) Over compensation



(c) Insufficient compensation

5-9.DC BAL Adjustments

The ATT balance of the vertical axis can be adjusted easily.

(1)Set the input coupling switches of CH1 and CH2 to GND and set the TRIG MODE to AUTO, then position the base line to the center.

(2)Adjust the VLOTS/DIV switch to 5mV-10mV and fix the line does not move.

5-10.Function Generator

The instrument also provides the basic features of Function Generator to satisfy general demand with simply and intuitional operation method by adjusting the control knobs directly from front panel for output waveform, amplitude, DC level and etc. All the control knobs located in front panel are marked with the same color to prevent missetting.

6.MAINTENANCE

WARNING

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

6-1.Fuse Replacement

If the fuse blows, the power lamp indicators will not light and the instrument will not start. The fuse holder should not normally be opened unless a problem has been caused to the unit. Try to determine and correct the cause of the blown fuse and replace with a fuse of correct rating and type (see page 7) 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.**

6-2 Line Voltage Conversion

The primary winding of the power transformer is tapped to permit operation from 115V, 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)Adjust 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.

6-3 Cleaning

To clean the instrument, use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the unit 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.

7.BLOCK DIAGRAM