

SAMPO CORPORATION

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service and repair of this instrument. Operators must comply with these precautions and follow the normally operating procedures as mentioned in this manual. SAMPO CORPORATION assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. This instrument is equipped with a three-conductor AC power cord. The power cord must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the ground wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power cord and AC outlet meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cord connected. Under certain conditions, dangerous voltages may exist even with the power cord removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument.

X-RAY RADIATION NOTICE

MODEL: OSCILLOSCOPE SS2020

When operating this instrument emits x-rays; however, it is well shielded and meets safety and health requirements of IEC 348.

Radiation emitted by this instrument is less than 0.5mR/hr at a distance of Five (5) centimeters from the surface of the cathode-ray tube. The x-ray radiation primarily depends on the characteristics of the cathode-ray tube and its associated low voltage and high voltage circuitry. To ensure safe operation of the instrument, adjust both the low voltage and high voltage power supplies as mentioned in adjustments of this manual.

Replace the cathode-ray tube with an identical CRT only.

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1. GENERAL

1.1 Description:

2020 Oscilloscope is a dual – channel oscilloscope with frequency bandwidth DC – 20MHz (-3dB), Multitude operation modes. Trigger facilities and Maximum sweep time up 50ns/div. The oscilloscope employs an 140mm rectangular screen cathode ray tube with internal graticule. The Oscilloscope is rugged, ease to operate and high reliability. It is incorporated with sweep delay, single sweep, hold off, component tester and excellent functions, making itself an ideal instrument for diversified types of Research, Education, Production and Development work of electronic devices and Equipment.

1.2 Operating Mode:

The 2020 can be operated as a Single or Dual trace Oscilloscope. In single trace mode, it can perform CHI or CHII, in dual mode (ALT/ CHOP) the channels can be added or subtracted (differential measurement). In the CHOP operation, the trigger signal derived from one of the channels, in the ALT operation the trigger signal derived from both channels alternatively. X-Y operation is obtained by switching CHI into vertical system and CHII into horizontal system, the CHI (Vertical) and CHII (Horizontal) have the same input impedance and sensitivity ranges.

1.3 Vertical Deflection:

The preamplifiers in both channels of the 2020 have diodes protected FET inputs. Both channel's Signal are electronically switched by diode gates either individually or alternatively to the final Vertical amplifier in either CHOP or ALT mode. Control for CHOP mode is effected by a 500KHz square wave, which is generated by a bistable multivibrator, for ALT mode is controlled by a blanking pulse which derived from sweep generator, the pulses is divided by TWO then provided to switching diode gates. The preamplifiers input stages utilize Dual FET and Monolithic Integrated circuits to minimize drift which is caused by environmental conditions. The input attenuators have 10 - steps frequency compensated R - C network, it can be easily achieved exact

measurement of the displayed waveform.

1.4 Time base:

The Time base of 2020 has 20 calibrated sweep speeds from 0.1us to 0.2s with Variable control for continuously adjust sweep rate. The X10 Magnifier increase the displayed sweep rate by a factor of 10. The HOLD OFF controls the hold off time between sweeps is used for triggering an aperiodic signals which is complex and stable triggering can not be attained with LEVEL knob alone. A Single sweep and Reset function used to display non-recurrent events is possible, a LED indicated that sweep is ready to whit a trigger signal. A simple sweep delay has 6 decade ranges from 100ns to 0.1s for expansion of a signal interval by 100 Times, it is easy operation. The N.S.D is for selecting of sweep mode. Delay is for selection of proper delay time and multiplier is a fine adjust of delay time for shifting continuously of starting point of the expansion. When Delay Function is set completely then increase sweep rate for expanding the desired interval of signal. The triggering system has hiah reliability and sensitivity. Signal up to 40MHz at a display height 5mm ensure reliable triggering. The Trigger mode can be selected from Automatic Peak to Peak Level or Normal Triggering, Trigger Coupling and Source are switchable with many variants providing the stable waveform of even very complex signals. An LED indicates the trigger system received a trigger signal and sweep is running.

1.5 Miscellaneous

A filter in front of CRT can be easily removeable for cleaning with a soft cloth. A power source selector and Two BNC connector are provided on the rear panel, the power source selector combined with fuse holder is used to select correct Line Voltage. One of the BNC is for Z — modulation, the other is providing sweep ramp output (about 5Vp-p). The upper right corner of front panel has a built-in Calibrator with 0.2Vp-p Square wave about 1KHz for probe compensation. A trace rotation in the internal board On the right side is used to adjust timebase coincide to the CRT internal graticule.

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OSCILLOSCOPE

MODEL 2020 SPECIFICATIONS

1. VERTICAL DEFLECTION:

Bandwidth	:	DC –20MHz (–3dB)
Risetime	: :	Less than 17.5ns
Overshoot	:	Less than 3%
Deflection Factor	:	10 Calibrated steps
		5mV/div – 5V/div, 1–2–5 Sequence
Accuracy	:	+/- 3% (10°c - 35°c)
Variable Control	:	5:1, Max Clockwise Increase
		Sensitivity Five Times to 1mv/div, 10MHz(3dB)
		Approx. 5% error.
Input Impedance	:	1M ohm // 25PF, (2%)
Input Max. Voltage	; ;	400v (DC +peak AC) or 500Vp-pAC at 1KHz or Less
Operation Modes	:	CHI, CHII, CHI & CHII, Alternate, chopped (Approx. 500KHz)
Algebraic Addition	;	CHI + CHII, —CHI + CHII
Inverter	:	CHI only

2. TIMEBASE

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Deflection Factor	2	20 Calibrated Steps, 0.1us/div0.2s/div, 1-2-5 Sequence, Uncali-
		brated Continuously Control extend deflection factor at least to
		0.5s/div.
Accuracy	;	Less than 3% (10°c – 35°c)
Expansion	:	x10, Accuracy Less than 5%
		(0.2us, 0.1us Uncalibrated)
Single Sweep	:	Single – Reset buttons with LED
Holdoff	:	10:1, variable control increase Holdoff time.

3. TRIGGER

Triggering Modes	:	Peak (Auto) or Normal
Source	:	CHI, CHII, CHI/CHII, EXT.
Coupling	:	AC, DC, LF, HF
Slope	:	+/
Sensitivity	:	Internal 0.5div (20Hz – 20MHz), External 0.5Volts (min)
Bandwidth	:	DC — 30MHz
Trigger Action	:	Indicated by LED

4. SWEEP DELAY

Ranges	:	6 steps, 0.1us – 10ms, Decade Sequence
Mode :		N-S-D
		(Normal, Search, Delayed)
Multiplier	:	Delay Time Variable Adjust, (10 Turns)

5. X-Y OPERATION

X-Y Mode	:	Selected by $X-Y$ Push button switch
Bandwidth	:	DC – 2MHz (3dB), Y by CHI, X by CHII
Phase Shift	:	Less than 3°(100KHz)

6. COMPONENT TESTER

Test Voltage	:	8.6Vrms (Max., Open circuit)
Test Current	:	Max. 28mA (shorted)
Test Frequency	:	Same as Main Power Frequency (50Hz/60Hz)
Components	:	Capacitor, Inductor, Diode, Transistor, Zener, etc.

7. GENERAL

CRT	:	140mm Rectangular Screen with 8x10 div Internal graticule, Approxi- mately 2KV acceleration Potential, Phosphor P31.
Trace Rotation	:	Correct Tilt Trace, Adjust on Right side
Beam Finder	:	Returns trace to CRT viewing area regardless of setting horizontal,
		Vertical or intensity controls.
Z-Modulation	:	Positive TTL level, \geq 50ns width pulse blanks trace of any intensity.
Ramp Output	:	Sawtooth wave Appox. 5V p-p
Calibrator	:	1KHz (5%), 0.2V p-p (2%) Square Wave
Power Consumption	:	Appox, 35 Watts
Dimension (mm)	:	310 (w) x 160 (H) x 400 (D)
Weight	:	9Kg
Accessories	:	Power Cord, User's Manual
Option	:	Probe (1:10/1:1) Ordered.

Operation Condition:

Normal Range: $10^{\circ}C - 35^{\circ}C$, $\leq 10\% \sim 80\%$ R.H.

Limited Range: $0^{\circ}C - 50^{\circ}C$, $\leq 10\% \sim 80\%$ R.H.

PRECAUTIONS BEFORE OPERATING THE OSCILLOSCOPE

3.1 Unpacking The Oscilloscope

The oscilloscope is shipped from the factory after being fully inspected and tested upon receipt of the instrument immediately unpack and inspect it for any defect which might have been sustained when in transportation. If any sign of defect is found immediately notify the bearer and/or the dealer.

3.2 Checking The Line Voltage

The oscilloscope can operate on any one of the Line Voltages shown in the below table, by inserting the voltage selector plug in the corresponding position indicated on the receptacle frame. Before selecting line voltage, remove AC power cord out of receptacle. There is a square hole in the right side of voltage selector, use a small screw driver insert into the square hole, the Voltage selector plug can be easily pull out. Note the oscilloscope may not operate or may be defected if it is connected to a wrong Voltage AC Line. When Line voltages are changed, replace fuse is also required.

Voltage Indicated On Selector Plug	Voltage tolerance	Fuse
110 V	110V – 120V	0.63A
125V	112V – 135V	0.63A
220V	200V - 240V	0.315A
240∨	220V — 260V	0.315A

3.3 Environments

The normal ambient temperature range of this oscilloscope is 0° to 40° C (32° to 104° F).

Operation of the oscilloscope outside of this temperature range may cause defect to the circuits. Do not use the oscilloscope in a place where exists strong magnetic or electric field. Such fields may interfere the measurement.

3.4 CRT Intensity

In order to protect your eyes and CRT phosphor, do not increase the intensity of the spot or trace too much.

3.5 Maximum Input

The input maximum voltage of each input connector and probe input is shown as below. Never apply a voltage higher than specified.

Input Connector	Maximum Input Voltage		
CHI, CHII inputs	400Vp-p (DC+AC peak)		
EXT TRIG inputs	100Vp-p (DC+AC peak)		
Probe input	500Vp-p (DC+AC peak)		
Z - Modulation	30Vp-p (DC+AC peak)		

3.6 Handling

- Do not put a heavy objects on the instrument
- Do not apply a strong shock to the instrument
- Do not insert a wire, pin or metal, etc into the ventilation hole
- Do not put a hot soldering iron on the cabinet or screen
- Do not put a magnet near the cabinet
- Do not drag the set, when the probe and cable are attached.

INSTALLATION

4.1 Installation Site

The instrument should be placed in a clean and dry room and must not be put into operation in explosive, corrosive, dusty, or moist environments. The instrument is capable of operating in any position, but it must keep away from heating device, equipment generating strong magnetic force or vibrating location.

4.2 Power Requirements

The instrument requires a power sources of 110/120/220/240 Vrms (±10%) at a frequency of 50/60 Hz single phase. Power Source is mentioned in "Precaution" section.

4.3 Line Voltage Selection

Before switching on this instrument, make sure that the instrument is set to the local line voltage. Fig. 4.1 provides information for line voltage and fuse selection.



Fig. 4.1

code for the power cord. One of the illustrated type is equiped with the instrument. Other plug type (not illustrated) is available for option.



Fig. 4.2

4.5 Cushion

Additional cushions are packed with the manual's bag. The cushions, if necessary, can be attached fixedly on four conner of the right side of the oscilloscope as shown in Fig. 4.3



Fig. 4.3

4.4 Power Cord

Fig. 4.2 illustrates the configurations used for three contact Power Cord. The number directly above each drawing is the international part

CONTROLS AND CONNECTORS (Refer to Fig. 5.1, 5.2)

1. POWER

Turns instrument power on and off. LED light indicates instrument power on.

2. INTENSITY

The knob controls brightness of the display, the brightness is increased clockwise.

3. FOCUS

After obtaining an appropriate brightness by operating intensity then adjust focus until the bright line is clearest.

4. BEAM FIND

As the pushbotton is pressed, the beam trace can be limitted in the center area of screen, if the trace is out of the screen, press this button and the beam trace can be found.

5. COMP TEST

Component tester input banana jacks are used in component test function refer item 20. The black jack is connected to chassis ground.

6. CHI OR Y

Input BNC connector for channel I deflection signals or Y – axis deflection in the X – Y mode operation The input resistance is 1 megohm paralled with 25 picofarads capacitance.

7.8. DC-GND-AC: Input Coupling Switch

Selecting input connection mode for CHI(7), CHII(8)

- DC: dc coupling, all signal are directly connected to attenuator.
- GND: ground, the input signal is switched off and the attenuator is short to ground.
- AC: ac coupling, block the DC signal of input signal only AC signal pass into attenuator.

9. CHII OR X

Input BNC connector for channel II deflection signals or X-axis deflection in the x-y mode operation. The input resistance is 1 megohm paralled with 25 picofarads capacitance.

10.11. CHI VOLT/DIV. CHII VOLT/DIV

Attenuator for chl and chll The attenuator selects deflection factor from 5v/div to 5mv/div in 1-2-5 sequence. 10 positions. VAR control must be in the calibrated position.

12.14 VAR

VAR for CHI (12).CHII(14) provides continuously variable uncalibrated deflection factors between the calibrated setting of volt/div switch. Turns VAR knobs to maximum counterclockwise is in CAL position, to maximum clockwise will increase sensitivity five times. **13. 15 Y-POSI, Y-POSII**

Position adjusting for CHI (13). CHII (15) The X-Y mode of operation, the CHI controls y-axis (vertically), the X-POS controls x-axis (horizontally) position.

16. CHI/CHII

Selects CHI or CHII vertical operation, released pushbotton is CHI operation and pressed is CHII.

17. MONO/DUAL

Select dual traces or single trace of vertical operation mode

Released pushbotton: single trace (MONO) Pressed pushbotton: dual traces (DUAL)

18. ALT/CHOP

The ALT/CHOP pushbotton has two functions as pushbotton is pressed only others push botton in the vertical section are all released. CHI and CHII will be added this function is marked in the right side of button when push botton is used in dual trace of vartical operation mode (mono/dual pressed) the button selects the dual traces mode operating in alternative or chop form.

19. NORM/INVERT

Selects CHI operating in normal or inverted form, this combined with 1 + 11 can operate add or subtract for input signals.

20. C.T.

C.T. is the abbreviation of component test, it is an application of oscilloscope for testing FET, Transistor. Diode, Zener, Inductor, Capacitor etc. which are in working or damaged.

On this oscilloscope the tested component is connected in component test jacks(5), press C.T. button, the trace on CRT of tested component should be displayed the characteristic trace of components are listed in appendix.

21. TIME/DIV

Has 20 steps which ranges are from 0.2 sec/div to 0.1 us/div in 1:2:5 sequence.

22. X-Y

Pressing the X-Y button apply the vertical signal to the CHI or Y input connector and the horizontal signal to the CHII or X input connector and the positioning on the screen can been vertically controlled by CHI position control knob.

23. HOLD OFF

Provides controls of hold off time between sweep signals to obtain stable display when triggering an aperiodic signal. The control hold off time ranges is from 1 to 10 times of timebase.

24. VAR

1. Provides continuously variable sweep rate by a factor of 2.5.

2. Light is turned on when VAR is not at cal position.

25. X-POS (PULL X 10)

1. Positions the display horizontally.

2. Pull 10: increases the displayed sweep rate by a factor of 10.

26. CALIBRATION (CAL)

Provides about 1 KHz 0.2v square wave to calibrate probe frequency compensation.

27. SINGLE

Provides single sweep function after a sweep is displayed, further sweeps can't be presented until reset button is pressed again, during sweep is triggered.

28. RESET: (Reference item 27)

1. In single sweep waiting for a coming sweep and sweep is triggered, pressed reset button to obtain a single sweep.

2. An LED located above reset button indicate single sweep is operating.

29. EXT TRIG

From the connector the outside signal can be input which is taken for a trigger signal.

30. TRIG SELECTOR

1. I: A sample of the signal derived from the CHI input connector is used as a trig signal.

2. II: A sample of the signal derived from the CHII input connector is used as a trig signal.

3. I/II: Alternative trigger which can triggter I and II alternatively. The function is used in alternative dual trace of vertical mode operation.

4. EXT: Trigger signal is obtained from EXT TRIG connector.

31. TRIG COUPLE

1. AC – Rejects dc and attenuates signal about 100Hz, accepts signals above 100Hz.

2. LF – Accepts signals below about 10Hz.

3. HF – Accepts signals above 10Hz.

4. DC – Accepts all trigger signals from DC to 20MHz or greater.

32. AUTO/NORM

1. The button chooses trigger form. 2. AUTO: In the AUTO mode automatically operate trigger action. The trigger level is obtained from trig signal's peak to peak Value. Operating TRIG LEVEL knob can be adjusted it's level within signal's peak range.

3. NORM: The trigger level range is obtainned from +5v to -5v by adjust TRIG LEVEL knob.

33. +/--

The trigger level is chosen on trigger signal slope side when the button is pressed.

34. TRIG LEVEL

It chooses a level within signal peak range from which the sweep can be selected at a properly starting edge of the input signal.

35. DELAY SELECTOR

- 1. N (NORMAL) for main sweep.
- 2. S (SEARCH) searches a point at which the sweep will be delayed.
- D (DELAY) by way of item 36 delayed signal is displayed by increasing sweep rate of timebase.

36. DELAY TIME

Selected delay time after trigger point.

37. MULTIPLIER

Provides continuously variable delay time after trigger point.

38. CRT

140mm rectangular screen with internal graticule 8×10 div, a blue acric filter placed in front of CRT.

39. FRAME

A plastic frame placed on the front panel to hold acric filter, it can easily be removed by slightly pressing down the upper edge of the plastic frame and pull out, then the acric filter can be taken for cleaning the CRT screen.

40. Receptacle and Fuse Holder

Receptacle for AC power input. Fuse Holder is used as a power source selector.

41. S – output

Provide ramp (Sawtooth wave) output about 5Vp-p, which is internal sweep signal.

42. Z – Modulation

Input terminal for external intensity modulation signal.

43. Studs

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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Fig. 5.1 Front Panel



Fig. 5.2 Rear Panel

OPERATING INSTRUCTION

6.1 Initial Power-ON

Power ON the instrument into operation, perform the following steps: (All push button switches in OUT Position, except DUAL/ MONO)

- a. Make sure power supply voltage.
- b. Set INTENSITY fully counter clock wise.
- c. Set vert mode to DUAL, (ALT mode).
- d. Set TRIGGER SELECT to I/II
- e. Set vertical variable control to CAL
- f. Set vertical couple to GND
- g. Set Y-POS and X-POS to midrange
- h. Set TIME/DIV to .5ms/DIV
- i. Set DELAY N-S-D to N position
- j. Set sweep variable to CAL
- k. Set TRIGGER AUTO/NORM to AUTO
- I. SINGLE sweep switch in OUT position
- m. Power ON the Instrument
- n. Adjust INTENSITY control for just visible trace.
- **CAUTION:** If it can not be found base lines, push BEAM FIND button to relocate X, Y positions.

6.2 Operator Check.

Operation may be checked without additional test equipment by using the CAL .2V, 1KHz output as a signal source. The following procedures functionally check each display mode and operation of the front panel controls.

a. Set the instrument controls as follows

CHANNEL I

VOLT/DIV... 50mV/DIV DC-GND-AC.. AC VAR..... CAL Y-POS Center VERT MODE. I (push button all OUT) TIME BASE

X-POS Center (push IN) Sweep VAR .. CAL TIME/DIV ... 0.5ms/DIV HOLDOFF ... MIN SINGLE OUT Delay N-S-D .. N position

TRIGGER

AUTO/NORM AUTO Slope +/- + TRIG LEVEL Center SELECT I COUPLE AC

b. Power ON and set INTENSITY and FOCUS controls for desired baseline display.

c. Apply CAL .2V output directly to CHI Input.

d. Adjust TRIG LEVEL for stable display. (Adjust X-POS for sweep baseline starting at first graticule line)

Verify six pulses with leading edge of first and sixth pulse on first and eleventh vertical graticule lines respectively (\pm 10%), as shown in Fig. 6.1



e. Set Y-POS control for vertical amplitude about 4 divisions (± 5%) to coincide with horizontal graticule lines, as shown in Fig. 6.1

f. Rotate sweep variable control clockwise to stop.

Verify 12 or more pulses between first

and eleventh graticule lines. Then Rotate to CAL position.

g. Set VOLT/DIV to 0.2V/DIV.

Verify vertical amplitude in one division.

h. Rotate amplitude variable control clockwise to stop.

Verify amplitude about five divisions (± 10%). The amplitude Variable control increase sensitivity to five times. Then rotate variable control to CAL position, and set VOLT/DIV to 50 mV/DIV.

i. Set TRIG LEVEL control to fully clockwise position.

j. Set AUTO/NORM switch to NORM

(push IN).

k. Select SINGLE operation (SINGLE switch push IN).

Verify no sweep.

I. Press RESET pushbutton switch. Verify no sweep and RESET indicator (LED) is lit.

m. Rotate TRIG LEVEL fully counterclockwise.

Verify one sweep, RESET indicator (LED) goes off after sweep.

n. Set AUTO/NORM switch to AUTO and TRIG LEVEL to center position.

o. Press RESET push button, Verify one sweep.

p. Disable SINGLE sweep, (SINGLE switch in OUT position)

q. Set delay mode switch N-S-D to S position.

r. Select DELAY TIME switch to 1ms/ DIV.

Verify a portion of the displayed trace on the left screen is blanked, as shown in Fig. 6.2



FIG 6.2 LEFT PORTION OF THE WAVEFORM IS BLANKED

s. Rotate MULTIPLIER (10 Turns) to increase (or decrease) the blanked portion about $2\sim5$ divisions at a desired rising or falling edge.

CAUTION: If the DELAY TIME is set too short, the blanked portion will very short. If the the DELAY TIME is set too long, the waveform will be all blanked.

t. Set delay mode swith N-S-D to D position.

u. Set TIME/DIV to 50μ s/DIV (or higher sweep rate).

v. Slightly adjust MULTIPLIER to locating rise or fall edge in the center of the screen.

Verify waveform is expanded as shown in Fig. 6.3



FIG 6.3 SWEEP DELAY FUNCTION EXPAND A DESIRED INTERVAL OF THE INPUT SIGNAL

w. Set delay mode switch N-S-D to N position and TIME/DIV to 1 ms/DIV.

x. Pull out X-POS (magnify 10 times). Verify two pulses with leading edge of first and second pulse on first and eleventh vertical graticule lines respectively (±10%)

y. Push in X-POS

z. Channel II check procedures same as channel I.

aa. Dual trace, ALTernative operation performs as follows

Connect 0.2V CAL output to both channel input

MONO/DUAL DUAL (push IN) TRIG SELECT..... I/II

Operating Timebase function is same as mentioned above.

ab. Dual trace, CHOPped operation performs as follows

> Connect 0.2V CAL output to both channel input MONO/DUAL DUAL (push IN) ALT/CHOP CHOP (push IN) TRIG SELECT I or II

cc. Component Tester (C. T.) check procedures, Push IN C.T. pushbutton switch on Vert mode. Disconnects CHI and CHII input connectors. Insert a diode (or zener diode, LED, capacitor . . .) to the COMP-TEST banana jack.

Verify the displayed waveform is similar to the Test Patterns shown in Page

dd. Disable C.T.

6.3. Operation Information.

6.3.1 AC/DC/LF/HF Coupling

AC coupling removes the DC level from trigger signals and attenuates signals below 10Hz. DC coupling connects input signals directly to the input amplifier. With DC coupling selected, a large DC voltage component in an input signal can offset the input signal outside the trigger level range of the instrument and cause the oscilloscope to lose trigger. HF and LF coupling are both ac coupling function. In an occasion when AC coupling is difficult to get stable waveform by rotating TRIG LE-VEL, either HF or LF must be selected to block low frequency or bypass high frequency of trigger signal, that can easily achieve a stable triggering operation.

6.3.2 AUTO/NORM

In AUTO operation, the trig level is automatically set within the signal's peak to peak range, a bright baseline will be displayed in the absence of a trigger signal. A trigger of 30Hz or higher overrides AUTO operation and produces a presentation. Adjustment of TRIG LEVEL control may be necessary for a stable display. If the trigger is less than 30Hz, NORM operation must be used. A trigger signal is always needed in NORM operation to generate sweep.

6.3.3 TRIG SELECT I, II, I/II, EXT

Trigger select switch selects trigger source from CHI, CHII, CHI/CHII alternatively or external. The mark I/II is an ALT (alternative) trigger, it derive trigger source from both channel alternatively. When dual trace ALT is selected in vertical mode, in order to obtain both channel's signal are stable display, the TRIG SELECT must be set to I/II position.

> **CAUTION:** In the I/II trigger operation, if input frequency of CHI is different from CHII's frequency very much. The displayed waveforms may be dim or unstable.

6.3.4 HOLDOFF

When trigger signal is a complex or an aperiodic waveform, the stably displayed wave-

form can not be obtained by TRIG LEVEL only. Rotate HOLDOFF control to get a more stable waveform.

6.3.5 Sweep Delay

With the sweep delay the start of the sweep can be delayed from the trigger instant by a selectable time from $.1\mu$ sto maximum 10ms. It is therefore possible to start the sweep at practically any point of a waveform. The interval, which follows the start of the sweep, can be greatly expanded by the increase of the sweep speed. It can expand of at least 100 times, and with the aid of the X-MAGN. (X10), expansion of even 1000 times. However, with increasing the expansion, the display brightness decreases.

> CAUTION: If the input signal exists inherent jitter, it is some difficulties with higher expansions.

Operation of the sweep delay is easy, only three controls in the DELAY section need to be operated: the delay mode slide switch N-S-D (Normal-search-Delay), the Delay time rotary switch (selection of delay time range), and the MULTIPLIER variable control (10 Turns, fine control).

6.3.6 Component Tester

With the built-in component-Tester, semiconductor, capacitors, inductors, resistors; R-L-C network or even combination of R.L.C and semiconductors can be every easily tested. Also, integrated circuits may be checked to some extend. The tested result is displayed on the screen of the oscilloscope. The device under test can be either in or out of a circuit. When the device under test is situated in highly complex circuitry the test result may not be clear, this is due to the effects of the components, and the stray capacitance in the test circuit. This problem may be overcome by comparing the result obtained from the circuit under test with the result obtained from a similar circuit which is known to be fully operative.

MEASURING INSTRUCTION

7.1 Preparation

Before pushing ON the power, make sure the power supply voltage is within the selected voltage range. The rated voltage and fuse are labelled on rear panel. Then insert the plug of the power cord into the outlet and set controls as follows:

POWER	OFF
INTENSITY	midrange
FOCUS	midrange
AC-GND-DC	GND
Y-POS	midrange
VERT MODE	CHI (buttons all OUT)
TRIG	AUTO
SELECT	1
COUPLE	AC
TIME/DIV	50µs/DIV
X-POS	midrange (push IN)
VAR	CAL
DELAY N-S-D	N

All push buttons in OUT position.

After setting the controls as above mentioned, then pushing ON the power and, 30 second later, rotate INTENSITY control for proper brightness, and set FOCUS control at a position where the bright baseline is clearest.

7.2 DC Voltage Measurement

Measuring DC voltage perform as follows:

- a. Connect DC voltage direct to CHI input.
- b. Set AC-GND-DC to GND.
- c. Adjust Y-POS let the baseline coincide to one of the horizontal graticule line which is used for the zero level (reference level).
- d. Set VOLT/DIV to an appropriate range.

e. Set AC-GND-DC to DC

Since the bright baseline shifts here by



FIG. 7.2 DC VOLTAGE MEASUREMENT

the amount of DC voltage, the DC voltage of the input signal can be obtained by multiplying the shift division by the indicated value of VOLT/DIV. For example, shown in Fig. 7.2, when VOLT/DIV is 50mV/DIV, the shift division is 4.1DIV, then the DC voltage is: $50mV/DIV \times 4.1DIV = 205 mVdc$.

If the X10 attenuation probe is in use, the true value of the signal becomes 10 times the calculated value, or $50mV/DIV \times 4.1 DIV \times 10 = 2.05 Vdc$.

7.3 AC Voltage Measurement:

- a. Connect signal direct to channel input.
- b. Set VOLT/DIV to an appropriate range.
- c. Set AC-GND-DC to AC.
- d. Adjust Y-POS, let the lowest waveform to coincide with one of the horizontal graticule line which is used for scale line.

The AC peak to peak voltage (Vp-p) can be obtained. For example, showning Fig. 7.3, when VOLT/DIV is 0.1V/DIV, the amplitude of waveform is 4.5 DIV, then Vp-p = $0.1V/DIV \times 4.5DIV = 0.45Vp-p$



FIG 7.3 AC MEASUREMENT

7.4 Period Measurement

The duration of a signal period or a portion of the waveform is ascertained by multiplying the relevant division (horizontal distance in division) by the time coefficient selected on the TIME/DIV switch. This will be explained by the example, shown in Fig. 7.4



FIG 7.4 PERIOD MEASUREMENT

In Fig. 7.4, the waveform which starts from A to B is equal to one period. From A point to B point covers 2.0 division on the screen. When TIME/DIV is 0.5 ms/DIV, then the period (or A to B interval) is calculated by $0.5 \text{ ms/DIV} \times 2.0 \text{ DIV} = 1.0 \text{ mS} = 1.0 \times 10^{-3} \text{ S}$. Accordingly, the signal's frequency is

 $1/1.0 \times 10^{-3}$ S = 1000Hz = 1 KHz

7.5 Time Difference Measurmenet

This oscilloscope can perform the time difference measurement in dual trace operation. Trigger source selecting switch SELECT is selected as offering reference signal, when measuring the time difference between two signals. Assume that signals as shown in Fig. 7.5.a.









In Fig. 7.5.b. illustrates an expanded waveform of Fig. 7.5.a., which trigger source is CHI. Therefore, it can easily ascertained the horizontal divisions from A point to B point shown in Fig. 7.5.b.. The time difference is obtained by multiplying the interval of A to B by sweep speed. Fig. 7.4.c. illustrates the waveform that is trigged by CHII signal which is not reference signal. However, it is not possible to measure time difference.



FIG. 7.5.C. INADEQUATELY EXPANDED WAVEFORM, THE TRIG SELECT IS SET TO CHII

A more precise method to measure time difference is shown in Fig. 7.5.d and 7.5.e., Fig. 7.5.d is the equal amplitude measuring method, by rotating amplitude variable controls and Y-POS to equalize amplitude for both channels. Fig. 7.5.e. is the superposition measuring method, by adjusting the Y-POS of the smaller amplitude to the center of the larger amplitude.







FIG 7.5.e SUPPERPOSITION MEASURING METHOD

7.6 Rise (Fall) Time Measurement

When investigating pulse or square waveforms, the critical feature is the risetime of the voltage step. The rise time is generally measured between 10% and 90% of the vertical pulse height. For setting signal peak to peak amplitudes in six division height, which are symmetrically adjusted to the horizontal center line, match the internal graticule of the CRT'S two horizontal dotted lines with ± 2.4 division from center line. The CRT graticule is shown in Fig. 7.6.

To measure the rise time, adjust the VOLT/ DIV switch with Variable control and Y-POS control so that the waveform amplitude is precisely coincided with 0% and 100% lines on CRT gratidule, as shown in Fig. 7.6.



FIG 7.6. RISE(FALL) TIME MEASUREMENT

The risetime is defined by the product of the horizontal divisions between the waveform intersection to 10% and 90% dotted lines and the sweep time. If the magnification is used, this product must be divided by 10. The fall time of a square wave can also be measured by using this method.

The risetime contained two parameters when it is measured directly from the displayed waveform on the screen. One of the parameter is the true risetime of the measured signal, the other is the risetime of the oscilloscope. For example, as shown in Fig. 7.6, tro is the measured risetime from the screen, to is the risetime of the oscilloscope, tr is the risetime of the measured signal.

The risetime displayed on Fig. 7.6. tro has following relationship,

tro =
$$\sqrt{tr^2 + to^2}$$

Actually, the signal's true risetime is given by

$$tr = \sqrt{tro^2 - to^2}$$

7.7 How to Get Stable Display

7.7.1 Synchronization of complex waveform

In the case shown in the Fig. 7.7.1, the waveform containes two peaks that greatly different in amplitude alternate, that waveform will display double peak on the screen, if the trigger level is not set properly.

In Fig. 7.7.1, if the TRIG LEVEL is set to L1, the waveform maybe doubled, or even unstable. Operators should adjust TRIG LEVEL control until the trigger level comes to L2 line, then the display on the screen will synchronize.



FIG 7.7.1 DOUBLE PEAK WAVEFORM, IF TRIG LEVEL SET TO L1, DISPLAYED WAVEFORM WILL BE DOUBLE PEAK. IF TRIG LEVEL SET TO L2, DISPLAYED WAVEFORM IS SAME AS FIGURE SHOWN.

7.7.2 Aperiodic Waveform

In the case shown in the Fig. 7.7.2, where waveforms greatly different in width alternate. In such waveform, obtaining a stable display is difficult to adjust TRIG LEVEL

only, the HOLD OFF function will improve synchronization.



FIG 7.7.2 APERIODIC SQUARE WAVE, PROPELY ADJUSTING HOLD OFF CAN IMPROVE TRIGGERRING OPERATION

When input signal is an aperiodic waveform, adjusting HOLDOFF control is necessary that will increase hold off time between two sweeps. If the hold off time is increased to a proper range, the undesired trig action can not generate sweep, therefore, the synchronized waveform can be attained. If rotation HOLD-OFF and TRIG LEVEL controls can not get stable display, it requires to set TRIG COUPLE to HF position that may be an improvement.

7.8 Selection of Trigger

In order to attain easy operation and and obtain stable display. There is a recommended instruction as shown in the table.

VERT MODE	TRIG SELECT	TRIG COUPLE	AUTO NORM	HOLDOFF	TRIG LEVEL
СНІ	1	AC	AUTO	Complex , Jitter	Complex
СНП	11	AC	AUTO	Complex , Jitter	Complex
DUAL ALT	1/11	AC, HF	AUTO NORM	if unstable	Complex
DUAL CHOP	1, 11	AC, HF	AUTO		-
ADD	1, 11	AC	AUTO		

ADJUSTMENTS

8.1 DC Balance Adjustments

Each vertical amplifier contains an FET input amplifier, it is possible that over a long period of time the characteristics of the FET may drift. This occasion drifts the DC-balance of the vertical amplifier. If the vertical baseline position shifts considerably when the variable control on the input attenuator is rotated. It should be noted that if the shift is less than 1mm after a 30 minute warm-up interval then the instrument is within specification. Larger shifts than this can be corrected by adjusting the potentialmeter which is located on the bottom side where DC BALANCE is marked on each channel. Operator can use a nonmetallic alignment tool to adjust the DC balance, the variable control should be continuously rotated while the potentialmeter is adjusted. [CAUTION.] Before adjusting, set VOLT/DIV to 5mV/DIV, set input coupling to GND. The correct DC balance is obtained when the vertical baseline position remains steady while the variable control is varied. Channel I and channel II have the same procedures of the adjustments.

8.2 Trace Rotation Adjustments

The trace rotation adjustment compensates for external magnetic fields that may affect alignment of the horizontal baseline with respect to the CRT graticule. When the oscilloscope is moved to a new location, trace rotation adjustment should be checked and adjusted if necessary. To adjust the trace, proceed as follows:

- a. Set input coupling to GND
- b. Adjust Y-POS control until baseline is on the center of the horizontal graticule line.

c. Using a non-metallic alignment tool, adjust TRACE ROTATION control (which is located on the Right Side) until baseline aligns with horizontal graticule line.

8.3 Focus And Astigmatism Adjustments

Normally, the CRT of the Oscilloscope has very good brightness and sharpness. Any reduction of the brightness or sharpness can be corrected by the FOCUS and ASTIGMA-TISM controls. Adjustments of focus and astigmatism can perform as follows:

- **CAUTION:** The brightness and sharpness can be lasting for very long interval. Do not adjust ASTIGMATISM, except necessary.
- a. Turn INTENSITY control fully counterclockwise
- b. Set vertical and timebase controls as follows

VOLT/DIV 10mV/DIV

AC-GND-DC GND

Vert Mode I (push buttons all in OUT position)

VARiable CAL

TRIGGER I, AC couple

LEVEL Center

X-Y deflection . . X-Y button push IN

- c. Set INTENSITY to observe spot.
- d. Adjust FOCUS and ASTG controls for best defined spot. ASTG control is located on the Power Supply Board as shown in Fig. 8.1.

CAUTION: High Voltage exist near ASTG control. Carefully adjust.

8.4 Power Supply Adjustments

There are seven stably regulatted DC operating voltages which are +24V, +5V, -12V,

+140V, +260V, -1900V and 33V for the unblanking circuit. The +24V +5V, -12V and 33V are fixed voltage within \pm 5% tolerance. The test points and adjust potentialmeters are shown in Fig. 8.4.

8.5 Probe Adjustments

Adjust probe frequency compensation, perform the following procedures: (Probe is in x 10 attenuation)

- a. Connect the tip of the probe to the output of CAL 0.2V, 1KHz
- b. Set VOLT/DIV to 5mV/DIV
- c. Set AC-GND-DC to DC
- d. Adjust frequency compensating trimmer on the probe until the displayed square wave is in optimum state as shown in Fig. 8.5.



FIG 8.5 PROBE COMPENSATION 8.6 Calibration

To maintain the oscilloscope accuracy, perform the calibration of the oscilloscope at least every 1000 hours of operation, or every six months if used infrequently. **CAUTION:** To avoid ELECTRIC HA-ZARD. It is recommended for safety that an isolation transformer be connected between the AC power source and the oscilloscope.



Fig. 8.1 Power Supply and Astigmatism Layout.

MAINTENANCE

- Since semiconductors, precision components, static-sensitive device, etc. are employed in this oscilloscope, use at most care for operation and storage.
- 2. Clean the scale with soft tissue periodically.
- 3. Removing CRT filter should be careful.
- 4. Store this oscilloscope in the ambient temperature from -10°C to +60°C. and keep away from moisture.

10. TEST PATTERNS (NEW)







Capacitor 47µf



Power transformer primary



Single diode (with cathode grounded)



Short circuit



Resistor 680n



B-E junction

E-C barrier

Zener diode under 8V

FET (between gate and source, with source grounded)



Zener diode beyond



Silicone diode



Germanium diode

Rectifier

In-circuit component





Diode#680n



B-E junction // 0.1µf



2 diodes antiparallel





12V



Capacitor 1µf#1Kn



EXTERNAL VIEW



FRONT PANEL



BOTTOM VIEW











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 $\sim 26 \sim$



 ~ 27





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 ~ 30 \sim

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 $\sim 31 \sim$

13. ALIGNMENT LOCATION

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