O P E R A T I N G M A N U A L

C A T H O D E R A Y O S C I L L O S C O P E

O P - 5 1 G

Kikusui Electronics Corporation

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

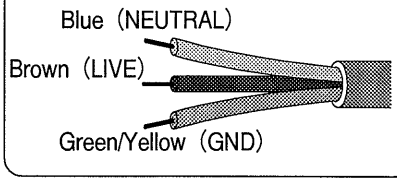
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

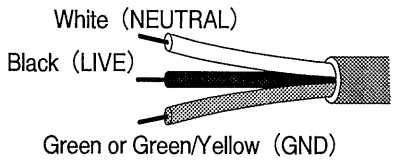
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

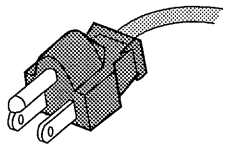
☐ Without a power plug



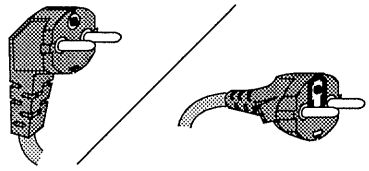
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

OPERATION MANUAL

Specifications

MODEL OP-51G OSCILLOSCOPE

SPECIFICATIONS

POWER SOURCE:	100V, 50/60 cps. about 78VA
DIMENSION (MAX):	230 (234)W x 350 (362)H x 395 (420) Dmm^3
WEIGHT:	About 12 Kgs.
ACCESSORIES:	Testing Record ..... 1 Operation Manual ..... 1 Scale plate and green colored plate .... 1 set Tipe ~~G-6B~~ 453C Low capacitance probe ..... 1 Terminal adapter 1
BRAUN TUBE :	5UP1 ... Accelerative Voltage: about 1450V
ELECTRON TUBE:	6C4 ..... 2 6U8 ..... 1 12BH7 ..... 1 6DT6 ..... 1 12AU7 ..... 3 6CA4 ..... 1 1X2 1

VERTICAL AXIS

DEFLECTION SENSITIVITY:	Amplification terminal.... range x1, 1KC..35m V_{p-p}/cm_{p-p} & up. Use of ~~G-6B~~ 753C Low capacitance probe .. 1/10 at amplification terminal
FREQUENCY FEATURES:	1KC basis....3cps...4MC ≠ 2, - 3dB & less
POTENTIAL DIVIDER:	Frequency features compensated....1/10 and 1/100 Reliability of ratio of potential divided..within ≠ 0.5dB
GAIN REGULATOR FREQUENCY FEATURES:	Against Max. Gain at 4MC .... -2dB & Less
MAX. INPUT VOLTAGE:	Range: x1... D.C. part ≠ 350V. AC. part *$11V_{p-p}$ & less Range: x1/10.. D.C. part ≠ 350V. AC. part *$110V_{p-p}$ & less Range: x1/100.. D.C. part ≠ 350V. AC. part *$1000V_{p-p}$ & less Use of G-6B ... D.C. part ≠ 250V. AC. part *$700V_{p-p}$ & less
INPUT IMPEDANCE:	Amplification terminal... all range... 3M ohms. 19≠ 3pF Use of ~~G-6B~~ 453C ..... 10M ohms. 8pF & less
DIRECTION OF MOCEMENT OF EMISSION:	Moves upward against signal in positive direction.
CALIBRATION VOLTAGE:	1V p-p and 0.2Vp-p are slectable by vertical attenuator ...ng potentional) Switch. Reliability: when power source Voltage is 100V..within≠10%

HORIZONTAL AXIS

DEFLECTION SENSITIVITY:	Amplification terminal... 0.65Vp-p/cm p-p up.
FREQUENCY FEATURES:	1KC basis ..... 1CPS ... 350KC ≠1, -3dB and less
GAIN REGULATOR FREQUENCY FEATURES:	Against Max. Gain at 350KC...within -3dB.
MAX. INPUT VOLTAGE:	D.C. part ≠ 350V, AC. part * 40Vp-p and less
INPUT IMPEDANCE:	3.3M ohms 24 ≠ 3pF
DIRECTION OF MOVEMENT OF EMISSION:	Amplidication terminal...Moves left against positive signal. Timer Axis ... Moves from left to reight.
TIMER AXIS OSCILLATOR SWEEPING FREQUENCY:	5 Range ..... 10 ... 100cps 100cps.. 1KC 1 .... 10kC 10 .... 100KC 100 .... 500KC Continuously vary

OUT LINE

KIKUSUI OP-51G Oscilloscope has Vertical Axis Amplifiers of broad-band. Timer Axis Oscillator is electron tube-type which easily synchronizes with signal and is available up to 500 KC for the sweeping Frequency. It makes possiblity of good observation of waveform for high frequency even several hundred K.C. together with blanking circuit.

By easily fixing Low capacitance probe, to search high impedance circuit is available. Green colored Soale panel on flourescent face asist our observation, and we can measure peak to peak voltage of observed waveform because two kinds of calibration voltage can be selected by switch changing vertical part sensitivity. Main part of circuit is fixed on two printed circuit board, and this oscilloscope has excellency of uniformity and stability in charactristics. Light weight help us to carry it.

The following is a block diagram of this Oscilloscope which has push-pull circuit that both of Vertical and Horizontal Amplifier Connector with Braun Tube.

Therefore, it causes no distortion and ~~emission~~ trace moves quickly without any delay. Gain adjustment is done by output circuit of Cathode-follower. Especially, vertical axis get even response of frequency up to rather high frequency by compensation of frequency futures of input potential devider and series and paralles peaking of each stage of amplifier.

Block Diagram.

Vertical and Horizontal amplifiers Frequency Features.

EXPLANATION OF PANEL

~~emission~~ Spot of Braun Tube

INTEN (OFF): It is a knob for adjusting brightness of ~~emission~~ spot, and is also serving as a power supply switch. When it is revolved clockwise, electricity is turned on and pilot lamp is lighted. And it begins to operate after about 30 sec.

Brightness increases in proportion to clockwise revolving, however, of it is externaly brighter beyond of necessity, halation occurs and emission becomes larger, shortening the life of Braun Tube.

FOCUS: It is a knob for focussing electron beams and making ~~emission~~ spot distinct near the central part of which, it becomes the smallest ~~emission~~ spot.

VERT POSITION

HOR POSITION: It is a knob for moving stationary position of emission in the vertical or horizontal direction. It moves to the right individually when the knob is revolved clockwise, However, it is better to move emission within ≦ 30mm from center to avoid occurence of distorted wave and shortening the life.

INPUT TERMINAL

VERT INPUT: It is Input Terminal of vertical amplifier. In case of using ordinaly lead, terminal adaptor is to be fixed to connector on panel face and put signal between the terminal and GND terminal. In case of using Low capacitance probe ~~G-6B~~ 953C, it dos not need to use GND Terminal on Panel face, because by connecting with connector of ~~G-6B~~ 953C to VERT INPUT, GND Clip can be connected with ~~Shash~~ chassis of OP-51G electrically.

HOR INPUT: Input Terminal of Horizontal amplifier.

INTEN MOD: Input Terminal of brightness variation signal. It is able to increase brightness of ~~emission b~~ trace with signal in positive direction.

EXT SYNC: Input terminal of outside synchronous signal.

SCALE PLATE

The scale is composed of graph graduation in 10mm and auxiliary scale graduated in 2mm on the center line. It is utilized for the measurement of amplitude of ~~emission~~ trace. Black triangle cut on the both ends, right and left of scale plate is dB scale, which is indicating -3dB, -6dB, -10dB and 20dB as illustrated.

VERTICAL AXIS AMPLIFIER

VERT GAIN: Gain-regulator vertical part amplifier. It can be continuously changed from 0 until max.

In case of such high Input Voltage as that this knob must be revolved up to first graduation, it is feared that distortion may occur by reason of saturation of ~~V1A~~, therefore Input Voltage must be decreased by the next VERT ATTEN. V1A

CAL/VERT ATTEN: Switch for input of vertical part amplifier.

1Vp-p
0.2V p-p: The signal of frequency of power supply for calibration is given to amplifier in these position. The Figures show peak-to-peak Voltage of calibrating voltage.

1/100
1/10
1: In these positions, input signal given to VERT INPUT Terminal, is connected with amplifier. The figures show ratio of divided potentical.

HORIZONTAL AXIS AMPLIFIER

HOR GAIN: Gain regulator of horizontal part amplifier. It can be continuously changed from 0 to maximum. In case of such high Input Voltage (40Vp-p) as that this knob must be revolved under the first two graduation, it is feared that distortion may occur by reason of the saturation of V6A.

HOR SEL/SWEEP RANGE: Switch Knob for changing Horizontal Axis Amplifier and oscillatio (Sweep) frequency band of timer axis amplifier. For the position AMP. LINE SWEEP, Timer axis Oscillator can not be operated.

AMP: In this position, the signal given to HOR INPUT Terminal becomes Input of Horizontal Axis amplifier.

LINE SWEEP: A part of power source of this Oscillator becomes input of Horizontal Axis, sweep is made by sinusoidal wave of power source frequency. Phase of Voltage can be changed by PHASE knob as per followings.

10-100

100K-500K: In these position frequency band indicated by knob can be variable by SWEEP VERNIER KNOB. Oscillation Frequency of each range is overlaped.

SWEEP VERNIER: Knob for micro-adjustment against oscillation frequency of Timer Axis. It can change frequency band indicated by SWEEP RANGE continuously, and when it is revolved clockwise, frequency becomes high accordingly.

PHASE: By this knob, phase of power source of LINE SWEEP can be shifted from 0° to about 130°.

SYNCHRONISM OF TIMER AXIS

SYNC ADJUST: Dial for regulating the amplitude of synchronous signal of timer part Oscillator. It happens sometimes that the output waveform is remarkably tranformed when too synchronous signal is given to oscillator. It is recommended, therefore, to use it at the minimum within the limit of stable synchronization. It is quite often enough to use it at the first graduation approximately in case of + INT and - INT synchronization.

SYNC SELECTOR: Switch for synchronizing Input of Timer Axis oscillator have four positions as following.

SYNCHRONOUS INPUT:	Interior (Plus) Interior (Minus) Exterior and Power Source.
BRIGHTNESS OF EMISSION MODULATION:	Possible.

Note: * In case that plus wave and minus wave Values are equal.

** In case of using x1 Range 110Vp-p and less.

CIRCUIT

1. Resistance

Without indication ..... ± 5%

G..... ± 2%

Unit ..... ohm.

★ R 7, R 40 is adjusted in works.

2. Capacitance

△ ..... ± 10%

Without indication of Unit..... mF

ex: 0.1 -0.1 mF.

3. A revolving arrow of variable Resistor and switch is shown direction of clockwise.

4. D.C. Voltage measured by KIKUSUI 107A VTVM (use of G-1 and HV-2 of high capacitance probe) under the condition as bellow.

Power Source 100V 50 cps.
Input signal 0

INTNSITY, FOCUS } Position of knob is half-revolving

VERT POSITION, HOR POSITION } Put Emission on center of scale plate.

VERT GAIN, HOR GAIN, SWEEP VERNIER, SYNC ADJUST, PHASE } Full-revolved position to counter-clockwise.

CAL/VERT ATTEN 1/100

HOR SEL/SWEEP RANGE 1K-10k

SYNC SELECTOR ≠ INT

5. Measuring point of Saw-Tooth wave-form for adjustment against compensating capacitance of ~~C-1~~ C1, C3 and ~~C-2~~ 953C.

OBSERVATION OF WAVEFORM

Waveforms which are to be observed by this instrument under the voltage of sine wave are as follows:

Frequency.....Abt. 10cps.....4MC
Voltage.....Abt. 10mV.....350VRMS

The range of frequency is more narrow than the above, when pulse wave, rectangular wave, triangular wave or high pitch wave are observed.

Incase that there is a remarkable difference between the positive amplitude of signal and the negative amplitude, the only signals which have voltage smaller than that of the above can be used.

Adjustment of Knobs

The methode of waveform observation is explained as follows in due order:

1. VERT INPUT terminal is given observation-voltage.
2. Adjust knob of CAL/VERT ATTEN and VERT GAIN, and then regulate adequately amplitude of vertical direction.
3. By SYNC SELECTOR, -INT or +INT is selected according to waveform observed. If there is a power supply with uniform amplitude in as well as knob is desired to be changed to EXT.
4. SYNC ADJ knob to be changed to 0---------1.
5. Adjust HOR SEL/SWEEP range and SWEEP VERNIER, and keep waveform almost stationary.
6. Keep it stationary exactly be SYNC ADJ.

P-P Measurement of Voltage: As input voltage is proportioned to amplitude of trace, peak to peak voltage(Vp-p) of observation voltage can be measured by utilization of voltage for calibration in the inside of this instrument.

Utilization of Decibel(db) Scale: Triangle mark on the both end, right and left of scale plate is graduated as per "EXPLANATION OF PANEL ". Therefore, we can read voltage ratio in decibel. In case of using Decibel Scale, utilize VERT and HOR POSITION and move waveform to the position which can be read easily.

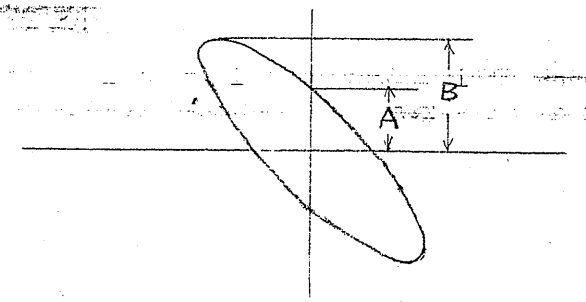
LISSAJOU'S FIGURE

When vertical and horizontal of deflecting plate of CRT is given signal individually we can get Lissajou's Figure indicating mutual relation on the Fluorescent plate. By this we can measure phase difference and frequency ratio. Besides, if we give third signal to INTENMOD terminal, we can know mutual relation among three waveform. In order to obtain Lissajou's Figure, change HOR SEL/SWEEP range to AMP. then give two signals to VERT INPUT and HOR INPUT terminal individually.

Measurement of Phase Difference: To measure phase difference between two signals with same frequencies experimenter ought to calculate from

$$\sin\theta = \frac{A}{B}$$

After making vertical amplitude and horizontal one equal and measuring A and B of figure shows the angle that horizontal part goes ahead or behind in comparison with vertical part.



Measurement of Frequecy:

Lissajous's Figure of 2 signals with mutually different frequency comes to a standstill when the ratio of the two frequencies is an integer ratio. From Lissajous's Figure the numbers of loops, touching with the vertical line of lattice (Nv) and those of loops touching with horizontal one (Nh) are obtainable, and then, vertical input frequency (Fv) and horizontal one (Fh) can be calculated as under.

$$\frac{Fv}{Fh} = \frac{Nh}{Nv} \qquad Fv = Fh \frac{Nh}{Nv}$$

Attention must be paid to the point that Nv is lyed upon Nh, and it is apt to misread the number due to phase relation between the two signals.

HOR/SEL/SWEEP are switched from horizontal axis to timer axis and INTEN MOD terminal is given signal. Then signal comes to a standstill when the ratio of the two frequencies is an integer ratio. When the ratio of them is shifted a little, the figure begins to revolve to direction of couter clockwise in case of phase leading of vertical than horizontal. therefore, we can judge leading or lagging of phase.

MAINTENANCE

Every experimenter ought to avoid strong vibration and shock, high temperature of 40° C or more and low temperature of 0° C or less, water deops and high humidity as well as direct sunshine, dusty place, etc. for the maintenance of this Oscilloscope.

It is also desireable to keep the voltage of power supply within the regular limits of ± 5%.

When transport this oscilloscope, it is better to remove Braun Tube and other electron tubes from the set, and to utilize the packing materiables which were used at shipment from our plant.

Be cautious not to damage printed circuit board while vacuum tubes on which printed circuit board is fitten up, are dismantled or fitted.

Inspection of Interior:

First of all, total nine pieces of screws on the panel and the base must be takenoff, then chassis is pulled out while panel is lifted slightly upward. Of course plug must be taken off from power supply unit.

Because high voltage (max. 1500V) is exposed, it is quite necessary to pay close attention to electric shock.

V2B Grid Bias: In case that vertical amplifier V2 is changed, it needs to do V2B first Grid Bias voltage into optimum value after adjustment half fixed resistor R82 on high-tension circuit of Braun Tube. In actual method, put vertical axis on condition of no signal (VERT GAIN..O.) and adjust R82 so as to became D.C. Voltage of both side of load resistance of V2B plate into about 18V.

Astigmatism: The variable resistance of the right side of case the asigmatic aborration of Braun Tube smallest. Sweep vertical by calibration voltage and horizontal by LINE SWEEP, and adjust thickness of circumference of a circle, which is made by regulation of PHASE, on fluorescent face like phto showned at the bottom of Page 9.

Regulation of Cl and C3: Variable condenser for compensating the frequency features of vertical potential divider circuit is put in high grade rectangular wave, and regulated after taking off a rubber lid on the left side of case so as to let horizontal part level.

Or please give the output (about 1KC and regarding Position of taking out refer to Circuit Diagram) of timer part oscillator to VERT INPUT terminal as illustrated below, and regulated so that emission line (sweeping fron left to reght of fluorescent face) may be in a straight line.

Frequency of Timer Axis Oscillator: If the frequency of timer part oscillator becomes lower or higher on the whole by reason of excahnge V4 —— V5, Value of R40 must be regulated. If R40 is connected with high resistance in parallel from the back of printed circuit board, we can increase frequency a little.

Low Capacitance Probe: In case of use this probe, you must check regulation of trimmer condenser for conpensation of charactristic of frequency. Methode of regulation is same to regulation of C1 and C3.

- INT: Negative part of observing waveform
/ INT: Positive part of observing waveform
LINE: Power Source Frequency.
EXT: Outside signal given to EXT SYNC Terminal the above four forms synchronise each other.