OPERATION MANUAL

SWEEP GENERATOR

MODEL 4600

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.

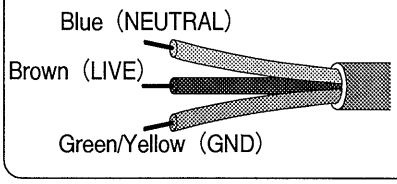
☐ AC power cable

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.

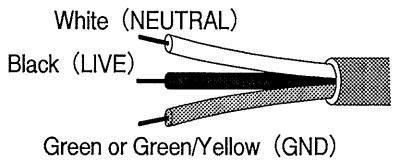
WARNING

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

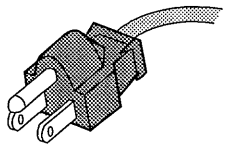
☐ Without a power plug



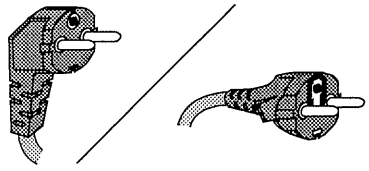
☐ Without a power plug



☐ 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

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1. GENERAL DESCRIPTION:

Model 4600 Sweep Generator is Sine Wave Generator with Output Voltage of 10Vrms and with Oscillating Frequency from 0.02Hz to 200kHz.

It is provided with two kinds of Sweep Width Modes: Wide Range Sweep Mode(WIDE MODE) and Narrow Range Sweep Mode(DEVIATION MODE). Each of Sweep Modes has in turn following 5 Sweep Modes:

1. Continous Sweep Mode
2. One Side Trigger Sweep Mode
3. One Shot Trigger Sweep Mode
4. Manual Sweep Mode
5. DIAL Oscillating Adjustable Function

WIDE MODE Provides Logalithmic Sweep Mode settled by Upper and Lower Limit Dials of Frequency from 0.02Hz to 200kHz. The Frequency Range is devided into 4 ranges. Among the ranges of Frequency, Maximum Sweep Width is adjustable by 10000 times ratio than ratio of minimum one.

DEVIATION MODE is Linear Sweep Mode for Frequency Deviation settled by Center Dial concerning plus/minus of Frequency. Center Frequency is obtained from 4 ranges between 20Hz to 200kHz. Sweep Width can be adjustable from 1 to 1/100 - 1/1000 at the minimum.

Sweep Speed can be adjustable freely as follows:

WIDE MODE: 4 DECADE/(1000 - 0.1 second)

DEVIATION MODE: 1000 - 0.1 second

This model 4600 can settle Standard Frequency for Auto Level Operation to provide Sweep Mode for our Frequency Characteristic and Response Display Eqipment additionally.

2. SPECIFICATIONS:

NAME	Sweep Generator
MODEL:	4600
SWEEP WIDTH MODES:	Wide/Deviation(Narrow Band Use)

SWEEP MODES
1) Dial(Lower Center Dial)
2) Manual Sweep(Upper and Lower Limit Level available by another Dial Operation)
3) Continous Sweep
4) One Shot Sweep
5) One Side Sweep Operation(UP)

WIDE MODE(Logarithmic Sweep Operation)

OSCILLATION FREQUENCY:	0.02Hz - 200kHz
ADJUSTABLE RANGE:	1/1, 1/10, 1/100 and 1/1000

DIAL CALIBRATION: Equal Ratio Graduation for 20 - 200k on both Upper and Lower Limit Level

ACCURACY FOR DIAL ADJUSTMENT: ±(8% + 0.005% of F.S.) when "LF ADJ" operated for both Upper and Lower Limit Level.

STABILITY: ±0.1% against Power Supply Voltage Fluctuation of ±10%

DEVIATION MODE(Linear)

CENTER FREQUENCY: 20Hz - 200kHz

ADJUSTABLE RANGE: x10/. x100/, x1k and x10k

DIAL CALIBRATION: Linear Graduation for 2 - 20

DIAL ACCURACY: ±(2% + 0.25% of F.S.)

STABILITY: ±0.01% Max. against Input Voltage Fluctuation of ±10%

±0.5% Max. after one hour of Power Input against stability after 8 hours at ambient temperature of constant 25 C.

DEVIATION

ADJUSTABLE RANGE: 1/ , 1/10 , 1/100

DIAL: 2 - 20

DIAL ACCURACY: ±(2% + 0.25% of F.S.)

STABILITY: ±0.02% Max. against Input Power Fluctuation of ±10%

LF ADJ(Frequency Fine Adjustable Range): Abt. ±0.01% for Full Scale

SWEEP TIME: 0.1 - 1000 seconds

ADJUSTABLE RANGE: 0.1 - 1/1 - 10/10 - 100/100 - 1000
(with Variable Dial for 10 times within ranges.)

OUTPUT WAVE FORM: Sine Wave

MAXIMUM OUTPUT VOLTAGE (OPEN CONDITION): 10Vrms Min.

OUTPUT IMPEADANCE: 600 ohm ±20%

FREQUENCY CHARACTERISTIC: ±0.3dB at 1kHz

STABILITY: ±0.5% Max. against Input Voltage Fluctuation of ±10%

SINE WAVE DISTORTION RATIO:

WIDE MODE:	2% Max.	less than 20 - 100Hz
(LOWER DIAL):	1% Max.	less than 100 - 70kHz
	1.5% Max.	70k - 200kHz
DEVIATION MODE:	0.6 Max.	less than 20 - 20kHz
(CENTER DIAL)	1.5% Max.	for 20k - 200kHz

AUTO LEVEL CONTROL (at ON for display Part)

FREQUENCY SET:	Continously adjustable in each range Checking for Frequency available when Push Switch will be operated.
SQUARE WAVE OUTPUT:	This Output is synchronized at the Main Output.
VOLTAGE:	20Vp-p Min. Fixed.
OUTPUT IMPEADANCE:	600 ohm ±20%

CONTROL SIGNAL FOR DISPLAY EQUIPMENT is provided by 24 Pins Connector.

TIME BASE:	DEVI	-4 - +4V
	WIDE	0 - +8V
BLANKING SIGNAL:	TTL Level(H Level at Reset)	
SWEEP STOP SIGNAL:	TTL Level(H Level at Stop) but except Auto Level Time	
DEVI/WIDE SWITCHING SIGNAL:	TTL Level(DEVI L Level)	
AUTO LEVEL SIGNAL:	TTL Level(L Level operation)	
AUTO LEVEL OPERATING INPUT SIGNAL:	TTL Level(L Level operation)	
ONE SHOT TRIGGER INPUT SIGNAL:	TTL Level(Operation by switching from H to L)	

INPUT POWER SOURCE:	VAC 50/60Hz
POWER CONSUMPTION:	About 16VA
DIMENSIONS:	430(W) x 100(H) x 370(D)mm
Max.	431(W) x 113(H) x 430(D)mm
WEIGHT:	About 10kg.
ACCESSORIES:	Operation Manual x 1

3. OPERATION METHOD:

3-1 DETAILS OF FRONT PANEL:

(1) POWER: Power is provised in the condition of Locking of Push Type Power Switch and at the same time L.E.D. is lighted.

(2) MODE: Exchanging Switch for Oscillation Modes Inside Red Colour Switch is for Exchanging one for WIDE and DEVIATION. Outside Switch is for Change-over Use of UP, ONE SHOT, CONT., MANUAL and DIAL.

WIDE(Wide Sweep Use): For Logalithmic Sweeping Mode Between Frequencies settled by Upper and Lower Limit Dial. The Frequency is of value(the dial graduation X range).
Letter Colour for special function is marked by Blue.

DEVI(DEVIATION, Narrow Sweep Use) For plus and minus Frequency Sweeping Mode against Center Frequency. The Center Frequency is of value(dial X range).
Deviation Frequency is(dial X range X deviation range).
Letter Colour for special function us illustrated by Green.

UP: By depressing UP Trigger Switch, WIDE and DEVIATION MODES is swept from lower limited Frequency to upper limited Frequency and then, the sweep mode is stopped at the upper limited Frequency. Switch OFF of UP Trigger Switch provide lower limit Frequency.

ONE SHOT: ONE SHOT Trigger Switch provide Trigger Input for One Sweeping in the condition of ON. And then, the Sweeping is stopped. ONE SHOT Trigger Switch and EXT Trigger Input on the rear Panel are connected in parallel.

CONT: For Continous Sweeping operation

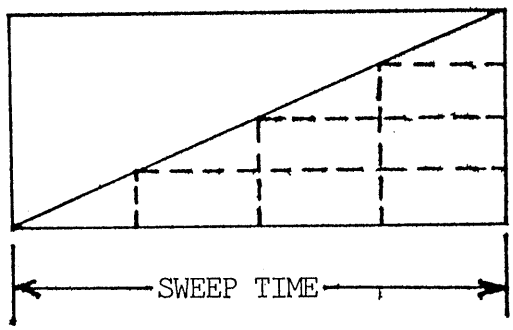
MANUAL: For Manual Adjustment of Setting Ranges by Knob

DIAL: Frequency within ranges is adjusted freely by lower limited frequency Setting Dial on the WIDE MODE. On the Contrary, Center Frequency is freely selected by the same Dial on the DEVIATION MODE.
(Checking of Center Frequency is available on the DEVIATION MODE).

(3) SWEEP TIME: Sweep Repeat Setting Knob provide 4 ranges of 1000 - 100, 100 - 10, 10 - 1 and 1 - 0.1 second against 1000 - 0.1 second. Construction of Double Knob provide continous variable operating among above 4 ranges.

(3) SWEEP TIME

Clockwise rotation gives shorter periodic time, and period is caliblated when the dial is fully turned toward clockwise direction.
SWEEP TIME is constant without any ralation of Sweep Width in the condition of DEVIATION MODE. But on WIDE MODE, SWEEP TIME is caliblated by Maximum Sweep Width and the relation between aboves is shown in below figure:



MAx. Frequency
" X 1/10
" X 1/100
" X 1/1000
Min. Frequency

(4) FREQUENCY RANGE: For Selection Switch of Frequency Range. Value of Set Frequency is obtained by multiplying value of FREQUENCY RANGE Switch by value of Dial.

(5) DEVIATION RANGE: For Setting of Frequency Deviation on DEVIATION MODE. Deviation Frequency is obtained by Multiplier on Deviation Range X dial reading X Multiplier on Frequency Range.

Sweep Width is given from (Center Frequency - Deviation Frequency.) to (Center Frequency + Deviation Frequency) but the actual usage recommendable under below mentioned condition:

(Max. Frequency in range/10000 $<$ (Center Freq. - Deviation Freq.)

(Max. Frequency in range) $\geq$ (Center Freq. + Deviation Freq.)

(Sweeping Time) $<<$ (Center Freq. - Deviation Freq.)

(6) UPPER FREQ. /DEVIATION: Inside Blue Coloured Logalithmic Graduation from 20 to 200k on Upper Limit Freq. Dial on WIDE MODE is used.
On DEVIATION MODE, Outside Green Coloured Linear Graduation from 2 to 20 is applied on Center Freq. Setting Dial.

(7) LOWER FREQ. /CENTER: On WIDE MODE, Inside Blue Coloured Logalithmic Scale from 20 to 200k is used. Outside Green Coloured Linear Caliblation is used at Center Freq. Dial on DEVIATION MODE.

(8) LF ADJ.: Fine Adjustment Dial for Freq. By this Dial, variation of about 1/10000 is available against Max. Freq. in the ranges.
Freq. Dials are calibrated when this ADJ Dial is at the center.

(9) SWEEP STOP: L.E.D. Lighting
When Sweep Action is stopped, this L.E.D. is illuminated for marking of SWEEP STOP.

(10) MANUAL: For Manual Sweep Operation within the ranges between Freq. dials in MANUAL position on MODE Switch.

(11) AUTO LEVEL: This Switch is applied in the condition of Auto Level operation when our Display Eqipment is operated together.

When Auto Level Operation Signal is given from outside, Output of Oscillating Freq. set by dial (12) and Switch (13) is obtained in the period when this Switch is depressed.

(12) FREQ. SET: For Standard Freq. Setting Knob in operation of Auto Level, which knob can mechanically be locked and can be turned by 10 rotations. Freq. Change is linear variation. Maximum Freq. in the ranges meets with graduation of 10 and also, Setting of 1/10 Times is available by operatiom of switch (13).

(13) 1/10: Range Switch of Freq. Set Dial(12), and 1/ and 1/10 is obtained by this Switch exchange. 1/10 Time is given in the condition of depressed and locked.

(14) L.E.D. which is lighted when Oscillation is made in Auto Level Operation.

(15) ONE SHOT: Trigger Switch when Sweep Mode Switch is at ONE SHOT.

(16) UP: When Sweep Mode Switch Mode at UP, this Trigger Switch is pushed to get Sweep Operation from Lower Limit Freq. to Upper Limit Freq. and then, to stop the Sweep Operation.

(17) (18) Output Voltage Variation Knob to get continous change from 0 to 10Vrms. Clockwise rotation for this Knob give Output Voltage increase.

Output Terminal is consisted of BNC Type Receptacle which Connector has impedance of 600 ohm at lower position.

3-2 DETAILLS OF REAR PANEL:

(19) CONNECTOR: 24 Pins AMPHENOL Connector which is used to connection with our Display Equipment.

Pin Arrangement:

1 - 5	No connection
6	WIDE/DEVI Switching Signal
7	No connection
8	Time Base Voltage(LOW)
9 - 10	No connection
11	N.C.
12	Auto Level Action Signal Input
13	No connection
14	Blanking Signal
15	Sweep Stop Signal
16	No connection
17	Blanking Signal
18	Sweep Stop Signal
19	No connection
20	Time Base Voltage(HIGH)
21	No connection
22	Auto Level Signal Output
23	No connection
24	Ground

WIDE/DEVI SWITCHING SIGNAL OUTPUT: WIDE MODE - TTL Level "H"
DEVI MODE - TTL Level "L"

AUTO LEVEL ACTION SIGNAL INPUT: TTL Level "H" - AUTO Level Operation

AUTO LEVEL SIGNAL OUTPUT: TTL Level "L" - AUTO Level Oscillation

SWEEP STOP SIGNAL OUTPUT: TTL Level "H" - Sweep Operation Stop but except Operation of AUTO Level

BLANKING SIGNAL OUTPUT: TTL Level "H" - Blanking Operation

TIME BASE SIGNAL OUTPUT: WIDE MODE - 0 - +8V
DEVI MODE - -4 - +4V

(20) EXT TRIGGER: External Trigger Signal Input Terminal in operation of ONE SHOT MODE

(21)  Square Wave Output Terminal from which Fixed Output Voltage more than 20Vp-p is provided.

(22) FUSE: Fuse for AC Power Source

(23) AC Power Supply Cord: For AC Power Supply Voltage VAC 50/60Hz

(24) GND: Ground Terminal

Fig. 3-1 Front Panel View

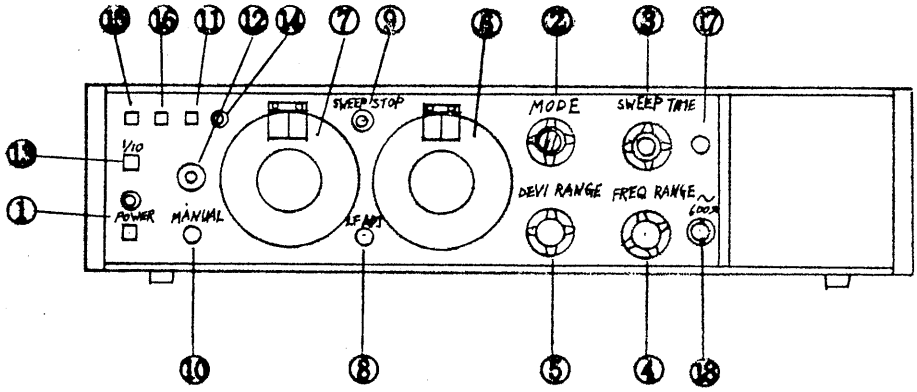
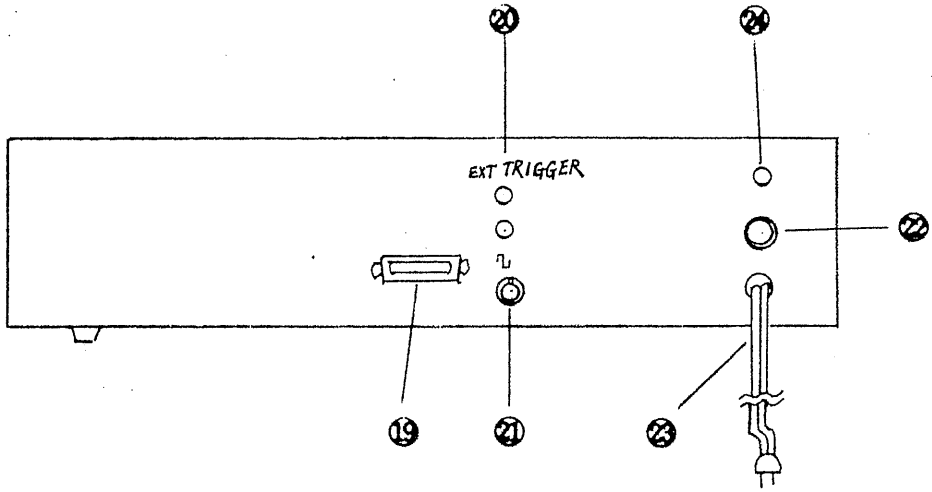


Fig. 3-2 Rear Panel View



3-3 APPLICATION

This 4600 Sweep Generator has much wide application. However, some basical applications are stated hereafter:

3-3-1 Continous Logalithmic Sweep with 1 second Sweep Period from 20Hz to 200kHz:

1) Set Sweep Width Mode Switch (2) to WIDE, and after that, Sweep Mode Switch to CONT.

2) Set Frequency Range Switch to WIDE "1".

3) Set Lower Frequency Dial to "20".

4) Set Upper Frequency Dial to "200k".

5) Under the above condition, when more accurate Frequency limits both on Upper and Lower side is required, connect FREQUENCY COUNTER to output of Oscillator on this 4600. Then, set the Sweep Mode to UP.

   For accurate frequency adjustmant, Trigger Switch must be made to OFF for adjustment of lower frequency limit and UP Trigger Switch is depressed for Upper frequency limit, so that you can adjust both frequency accurately through FREQUENCY COUNTER.

6) After Sweep Time Switch is set to 1 - 0.1 second, adjust turning Knob to get 1 second:

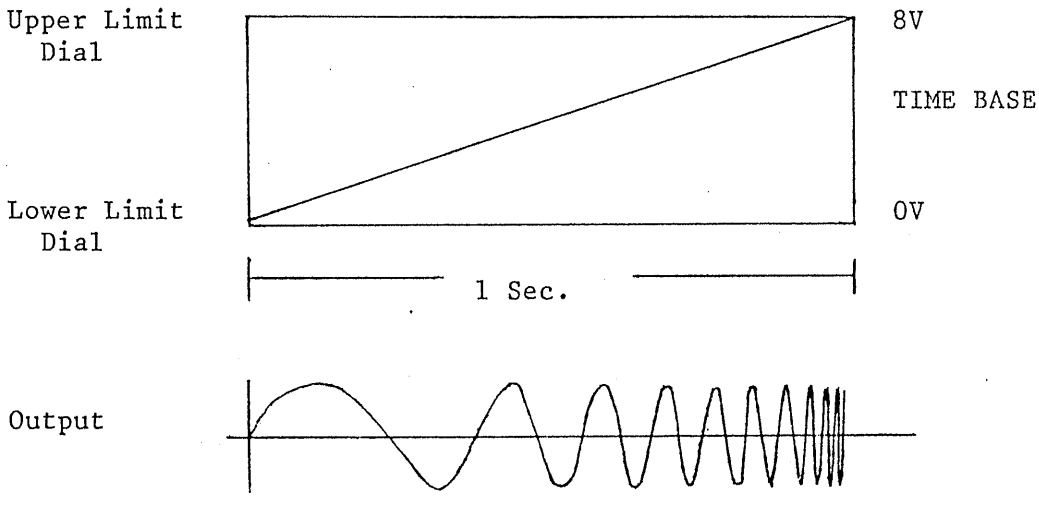


Fig. 3-3

3-3-2 Continous Linear Sweep Action with repeated period of 1 second and with frequency deviation of ±100Hz at center frequency of 1kHz.

1) Set Sweep Width Mode Switch to DEVI, and then, Sweep Mode to CONT.

2) Set Frequency Range Switch to DEVI " X 100"

3) Set Center Dial to "10"

4) Set DEVI RANGE Switch to "1/10"

5) Set DEVI Dial to "10"

6) In a case to get more accurate center frequency and deviation frequency adjustment, connect FREQUENCY COUNTER to output of this 4600 and then, Set Sweep Mode to Dial. And then, Center Frequency is accurately adjustable by FREQUENCY COUNTER.

After that, set the Sweep Mode to UP and depress UP Trigger Switch, so that you can measure(Center Frequency + Deviation Frequency) through FREQUENCY COUNTER. Under the same condition, turn UP Trigger Switch to OFF, so that you can lock at(Center Frequency - Deviation Frequency). Therefore, accurate Sweep Width Frequency measurement is available.

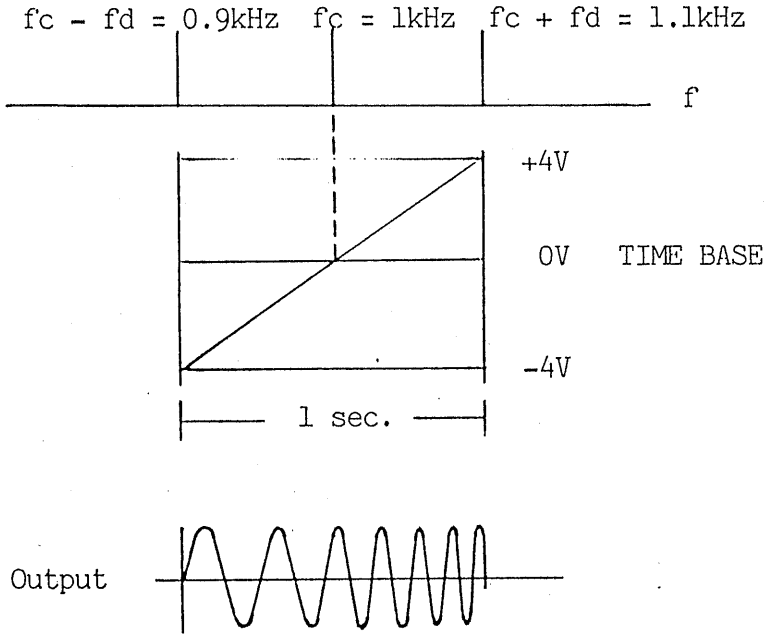


Fig. 3-4

3-3-3 Auto Level Operation but coupled with our Display Equipment:

1) Turn on the Auto Level Switch of the Display Equipment after operation of applications 3-3-1 or 3-3-2.

2) While AUTO LEVEL Switch is being depressed, set Standard Frequency with FREQUENCY SET Knob and 1/10 Switch.

   Frequency Setting must be done by following method:

   a) FREQUENCY COUNTER isconnected to this 4600.

   or

   b) By F-V Convertor of INT. Sweeping on Direct Display Equipment, measure Frequency Setting on C.R.T. Display's X Axis(Horizontal Axis). In this case, Oscillating Output must be inputted to Direct Display Equipment.

      * In a case of Direct Display Equipment Measurement, please take care for C.R.T. Display X Axis Calibration of Logalithmic 20Hz - 200kHz (or 20Hz - 20kHz).

Standard Oscillation is performed at the starting of each Sweep per Fig. 3-5:

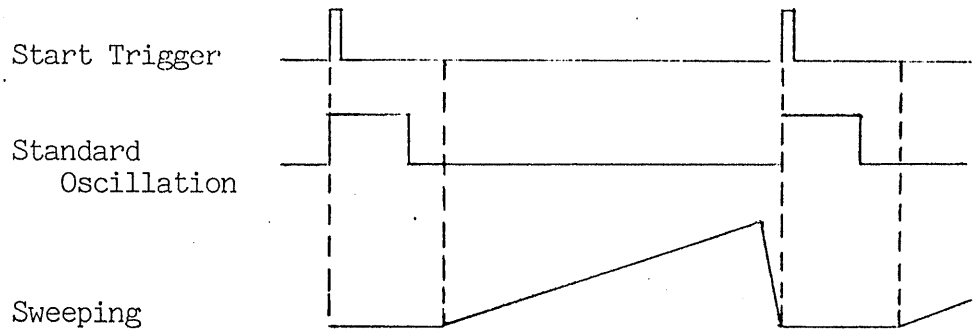


Fig. 3-5

4. PRINCIPLES OF OPERATION:

4-1 BASIC STRUCTURE:

BAsical structure of this 4600 Sweep Generator is consisted of

1. TIME BASE OSCILLATOR
2. INVERSE LOGALITHMIC CONVERTER
3. VOLTAGE CONTROLLED GENERATOR
4. VOLTAGE/CURRENT CONVERTER
5. SINE WAVE MIXER
6. OUTPUT AMPLIFIER
7. ATTENUATOR

Fig. 4-1 illustrate above mentioned main basical function on this 4600 Sweep Generator.

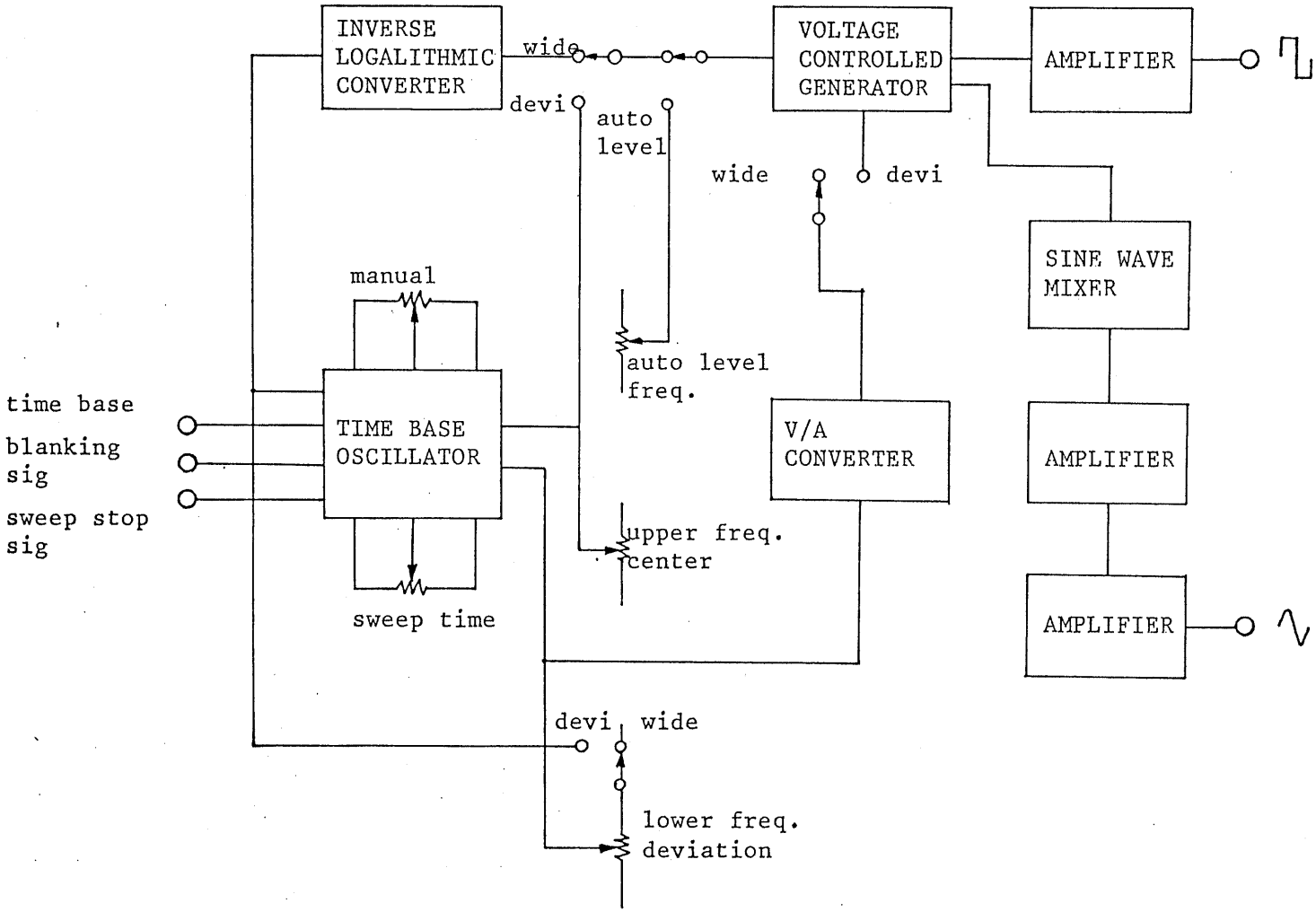


Fig. 4-1

4-2 INVERSE LOGALITHMIC CONVERTER:

In Voltage Controlled Generator, Oscillating Frequency is proportional to Input Voltage. Inverse Logalithmic Converter is necessary to give Input Voltage to be in proportionable to Logalithmic value of Oscillating Freq. On this 4600, the Converter employ followingcircuit per Fig. 4-2:

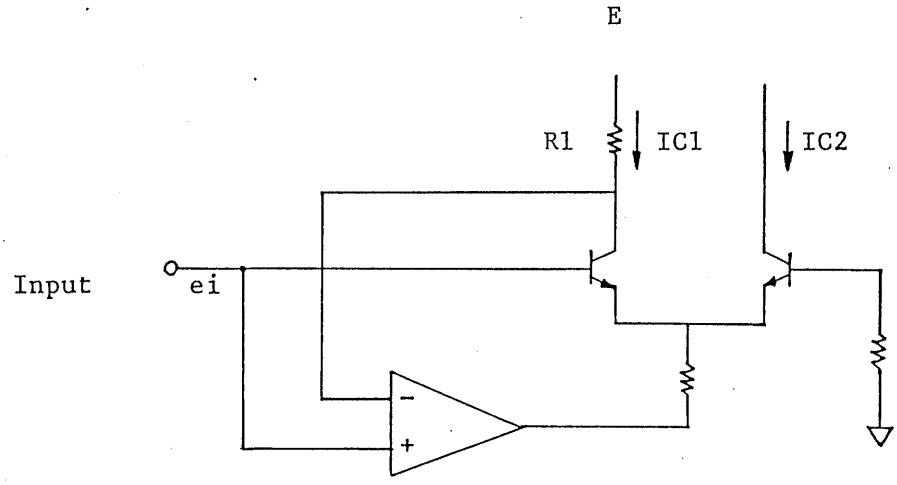


Fig. 4-2

To get Inverse Logalithmic value, Non-Linear Element employ herewith the relation between voltage of Base-Emitter and Current flowed into Transistor.

You can understand the situation from following formula that show Inverse Log. Changenable Output Current by change of Input Voltage:

Collector Current of Transistor:	IC
Base-Emitter Voltage:	Vbe
Fixed Voltage:	E

$$IC2 = IC1 \exp \frac{-q}{kT} Vbe$$

$$IC2 = \frac{E}{R1}, \quad Vbe = ei$$

$$IC2 = \frac{E}{R1} \exp \frac{-q}{kT} \cdot ei$$

4-3 VOLTAGE CONTROLLED GENERATOR:

This is circuit to decide the Oscillating Frequency and is consisted of following diagram per Fig. 4-3

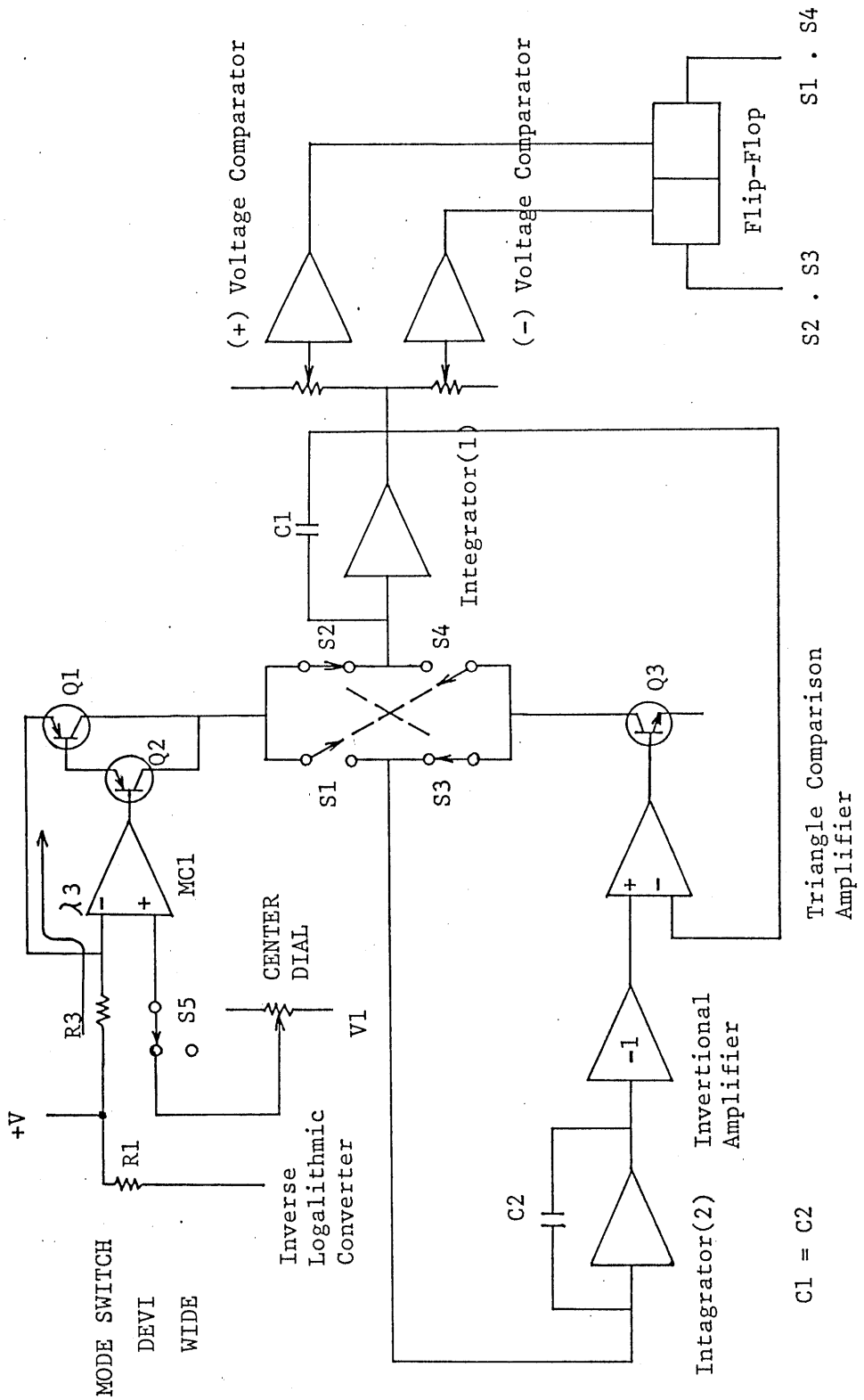


Fig. 4-3

Referring to Fig. 4-3, operation is made as follows:

In a case of Switch S5 of DEVI Side, Voltage V1 provide to MC1. Operation of MC1 supply (V - V1)/R3 = λ 3 Current to Emitter of Q1 Transistor.

Now, Switch S2 and S3 is closed, and S1 and S4 is opened(Those Switches have relation each other). Current of 3 is flowed into Integrator (1) after through Switch S2. And then, this Integrator start calculating minus integration.

On the other hand, Output of Integrator is connected to terminal of Inverse Input on Triangle Wave Comparison Amplifier. Terminal of Inverse Input on Triangle Wave Comparison Amp. is connected to Output of Integrator (2) via. Invertional Amp. The loop is designed to get Zero Level between both Input Terminals.

If there may be Voltage difference between both Input Terminals, for example, Output Voltage from Integrator (1) is lower than that of Integrator (2), the current is increased by Transistor Q3 ON Switching. Therfore, The current flowed into Integrator (2) is increased through Switch S3 and the Output of Integrator (2) is powered up. Output of Invertional Amp is adjusted to be equal Output Level to Integrator (1).

Under this condition, Output of Integrator (1) is decreased. When the Output reachs to registered voltage, minus voltaeg comparator begin operating. Then, Flip-Flop circuit is inversed by Trigger Signal from Comparator to close Switch of S1 and S4 and to open Switches of S2 and S3.

Accordingly, Current of λ 3 is flowed into Integrator (2) through Switch of S1 and then, Integration Output is beginning to go down to minus direction. On the contrary, Input of Triangle Wave Comparison Amp is going upward by inversion of λ 3 through Invertional Amp.

On the other hand, Output of Integrator (1) is increased by integration operated by minus current of Q3 as Switch of S4 is closed. And Triangle Wave Comparison Amp. works evertime to give Zero Level between both terminals of Integrators (1) and (2). Therefore, Current of λ 3 is becoming equal to Q3. Keeping these balance condition, Output of Integrator (1) is raised and is reached to registered value. After that, plus Voltage Comparator will begin working and output Trigger Signal to inverse Flip-Flop circuit. After these operation, the balanced condition is obtained.

Oscillation is continously repeated by the above mentioned operation. Minus current follows plus current adjusted. Accordingly, better synmetrical Wave is obtained.

4-4 SINE WAVE MIXER:

Sine Wave is formed from Triangle Wave that is given from Integrators by Sine Wave Mixer. Fig. 4-4 show the principle consisting of Diodes of D1 - D6 and D1' - D6'. Each Diode has Series Connected Resistor to get most suitable Sine Wave Mixing operation. It is decided to get suitable Sine Wave Operation by Bias Voltage of E1 - E6 supplied by the Series Resistor.

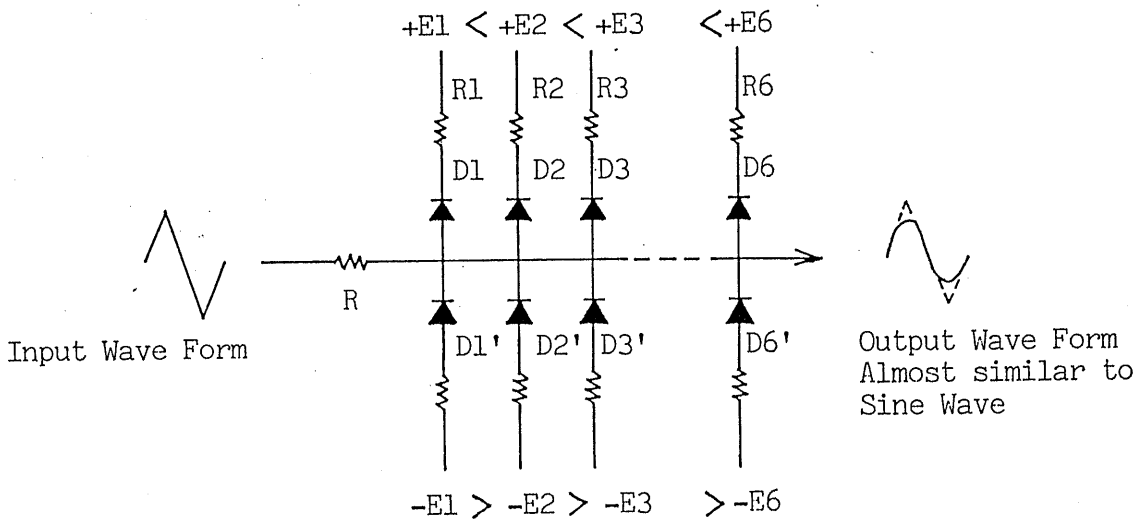


Fig. 4-4

In a case that Triangle Wave Input Momentary Value of "e" is $0 < e < +E1$, all Diodes are in OFF condition. Therefore, Input Wave Form is supplied to Output. In the next time, if the momentary value become as $+E1 < e < +E2$, Diode of D1 is turned to ON and then, Gradient of Output is decreased to $R/(R1 + R)$ against Input Waveform. Furthermore, if D3 and D4 is turned to ON, R2 and R3 become in turn to parallel. Therefore, Gradient of Output is looser against Input.

For minus Voltage, D1' - D6' Diodes will enter into ON situation in turn as well as above mentioned phenomenon. And then, almost similar to Sine Wave is obtained at Output from Triangle Wave Form.