UNIT III

SIGNAL GENERATORS

Introduction:

Signal generator provides variety of different signals for testing various electronic circuits at low powers. The signal generator is an instrument which provides several different output waveforms including sine wave, square wave, triangular wave, pulse train and an amplitude modulated waveform.

Requirements of Laboratory Type Signal Generator:

There are different types of signal generator. But the requirements are common to all the types.

i) The output frequency of signal generator should be very stable.

ii) The amplitude of output signal of signal generator should be controllable from low values to relatively largevalues.

iii) The amplitude of output signal must be stable. the harmonic contents in the output should be as low as possible. The output signal should be distortionfree.

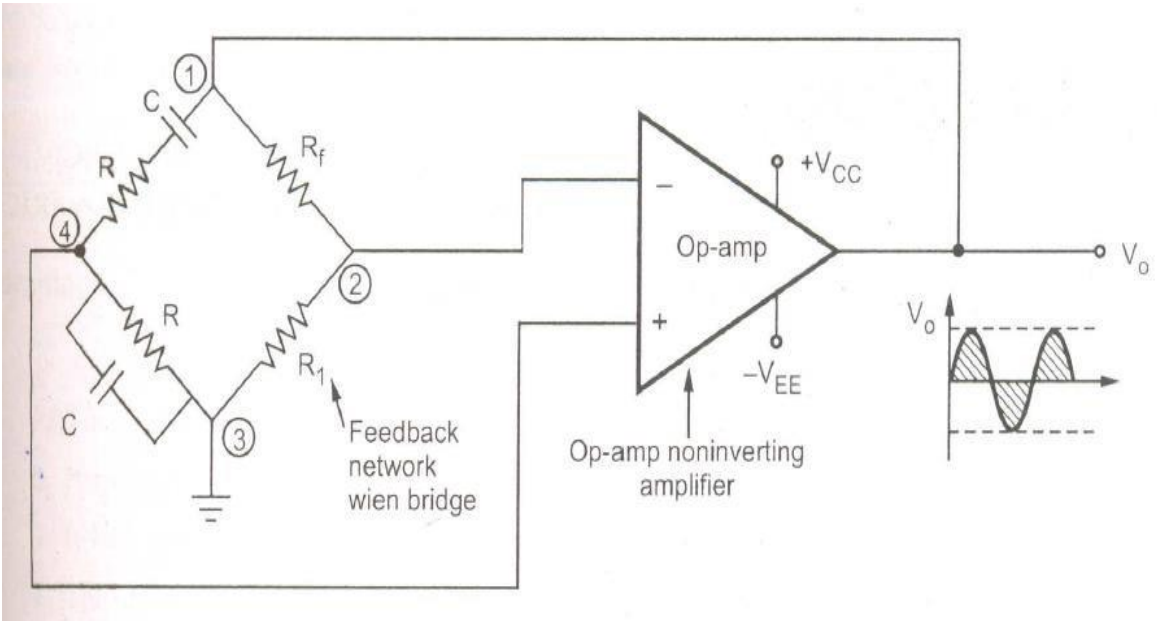
v) The signal generator should provide very low spurious output; that means effect of hum, noise, jitter and modulation should be negligible.

A F oscillator:

The signal generators which provide sinusoidal waveforms in the frequency range of 20 Hz to 20 kHz are called audio frequency(A.F.) signal generator. Depending upon the load, in modern AF signal generators a provision is made to select output impedance either 50 n or 600 n. To generate audio frequency signals, in practice RC feedback oscillators are used. The most commonly used RC feedback oscillators are Wien Bridge oscillator and RC phase shift oscillator. Let us discuss both the types of oscillators indetail.

Wien Bridge Oscillator using Op-amp:

The Fig shows the Wien bridge oscillator using an op-amp.



*nle*resistance R and capacitor C are the components of frequency sensitive arms of the bridge. The resistance Rf and R1 form the part of the feedback path. The gain of noninverting op-amp can be adjusted using the resistance Rf and R1. The gain of op-amp is,

$$A = 1 + \frac{R_f}{R_1}$$

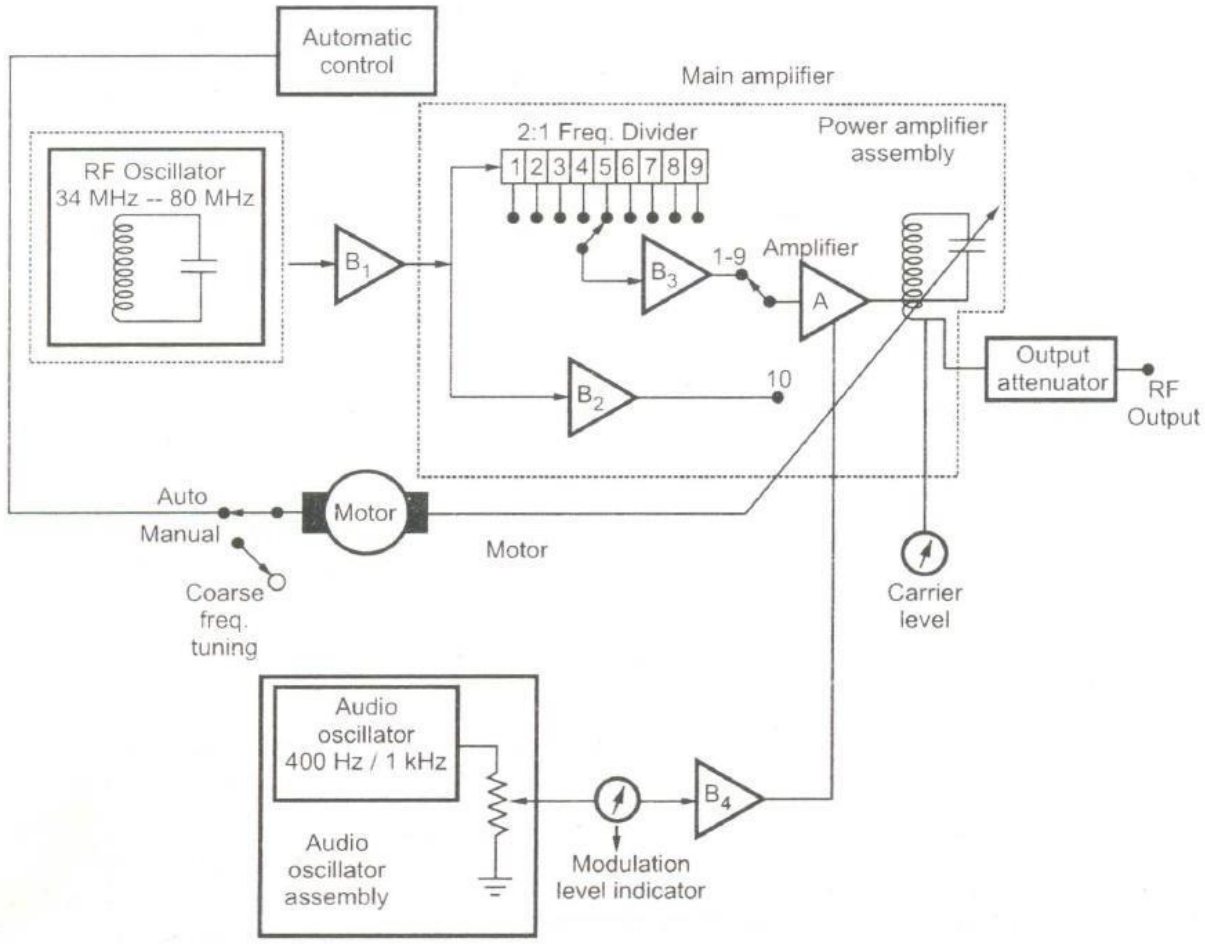
Standard signal generator:

It is extensively used in the testing of radio receivers and transmitters. This is basically a radio frequency (RF) signal generator. The standard signal generator produces**known and controllablevoltages.**

Principle of working:

The output of the generator is amplitude modulated or frequency modulated. The frequency modulation is possible using a carrier signal from RF oscillator. The amplitude modulation can be done using internal sine wave oscillator. The modulation may be done by a sine wave, square wave, triangular wave or a pulse also. The setting on the front pane1 indicates the carrier frequency to be used for modulation.

Block Diagram:



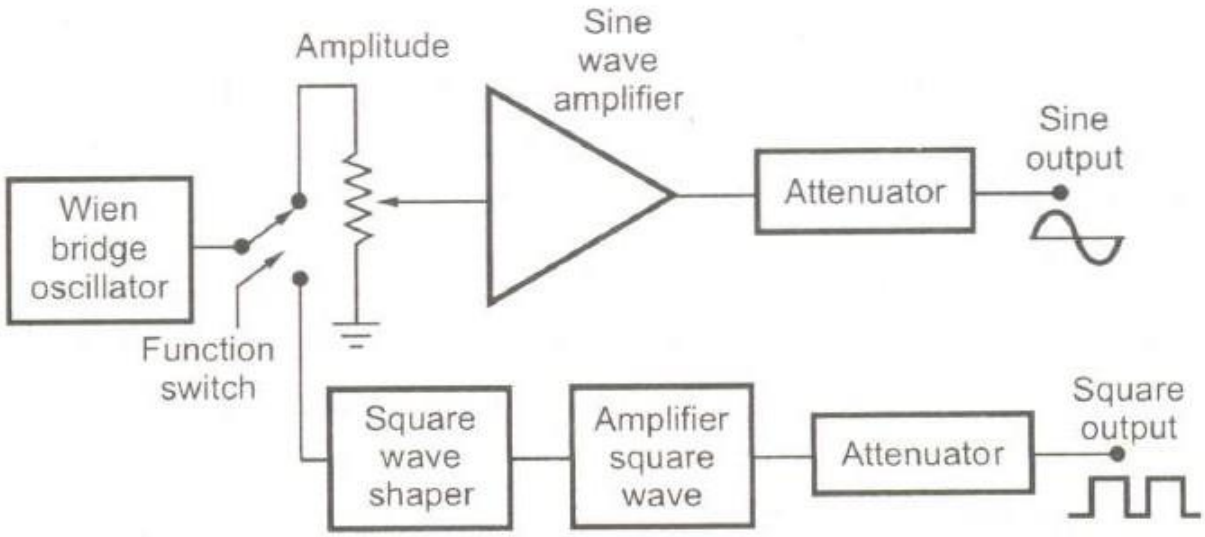
Signal for modulation is provided by anaudio oscillator. The frequency given by thisoscillator is in the range of 400 Hz to 1 kHz The modulation takes place in main amplifier, in power amplifier stage. The level of modulation can be adjusted upto 95% by using control devices.

The lowest frequency range obtained by using frequency divider is the highest frequency range divided 29 or 512. Thus, frequency stability of highest range is imparted to the lowest frequency range. The effects of frequency range selection is eliminated as same oscillator is used for all frequency bands. The master oscillator is tuned automatically or manually. **In** automatic controller for tuning master oscillator, a motor driven variable capacitor used. This system is extensively used in programmable automatic frequency control devices. The oscillator can be fine tuned by means of a large rotary switch with each division corresponding to 0.01 % of main dial setting.

The supply voltage of the master oscillator is regulated by temperature compensated reference circuit. The output of the main amplifier is given to an output attenuator. The attenuator controls the amplitude level and provides the required stable **RF**output.

AF sine and square wave generator:

The block diagram of an AF sine-square wave generator is as shown in the Fig



As per our previous discussion, Wien bridge oscillator is the heart of an AF sine-square wave generator. Depending upon the position of switch, we get output as square wave output or sine wave output. The Wien bridge oscillator generates a sine

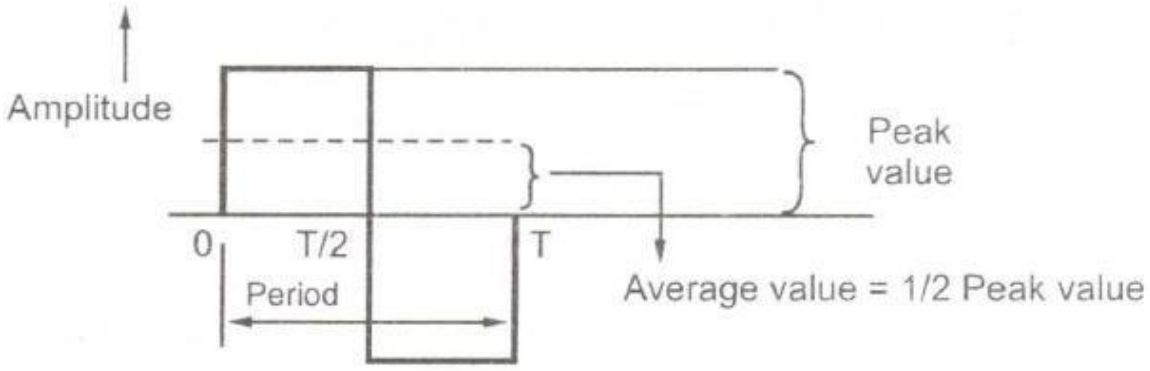
wave. Depending upon the position of switch, it is switched to either circuit. In the square wave generation section, the output of the Wi en bridge oscillator is fed to square wave shaper circuit which uses schmitt trigger circuit. The attenuators in both the sections are used to control output signal level. Before attenuation, the signal level is made very high using sine wave amplifier and square wave amplifier.

Square wave and pulse generator:

The square wave generator and pulse generator are generally used as measuring devices in combination with the oscilloscope. The basic difference between square wave generator and pulse generator is in the duty cycle. The duty cycle is defined as the ratio of average value of a pulse over one cycle to the peak value. It is also defined as ratio of the

pulse width to the period of one cycle.

$$\text{Duty cycle} = \frac{\text{Pulse width}}{\text{Pulse period}}$$



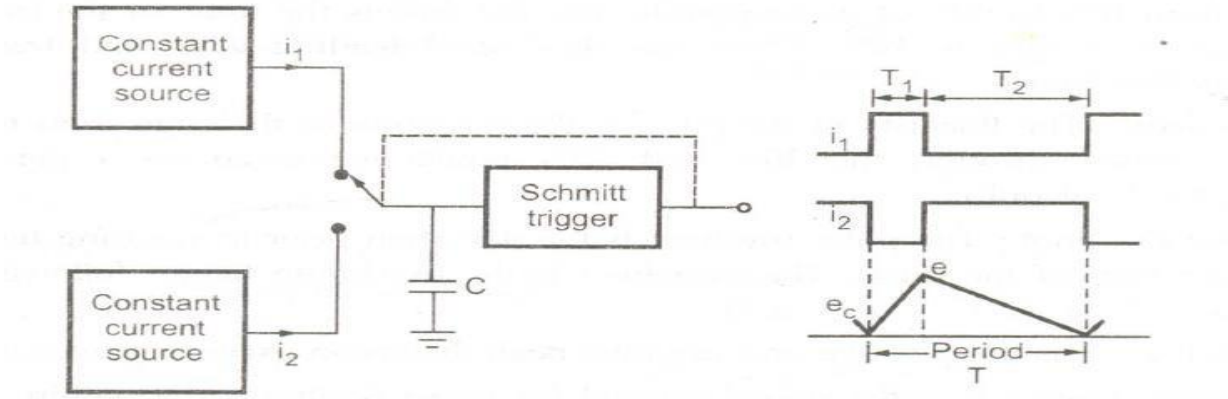
The average value is half of peak value. Both the average value and peak value are inversely proportional to time duration. The average value of a pulse is given as,

1

Average value = 1/2 Peak value Duty cycle of square wave = 0.5

Thus square wave generator produces an output voltage with equal ON andOFF periods as duty cycle is 0.5 or 50% as the frequency of oscillation is varied. Then we can state that irrespective of the frequency of operation, the positive and negative half cycles extend over half of the totalperiod

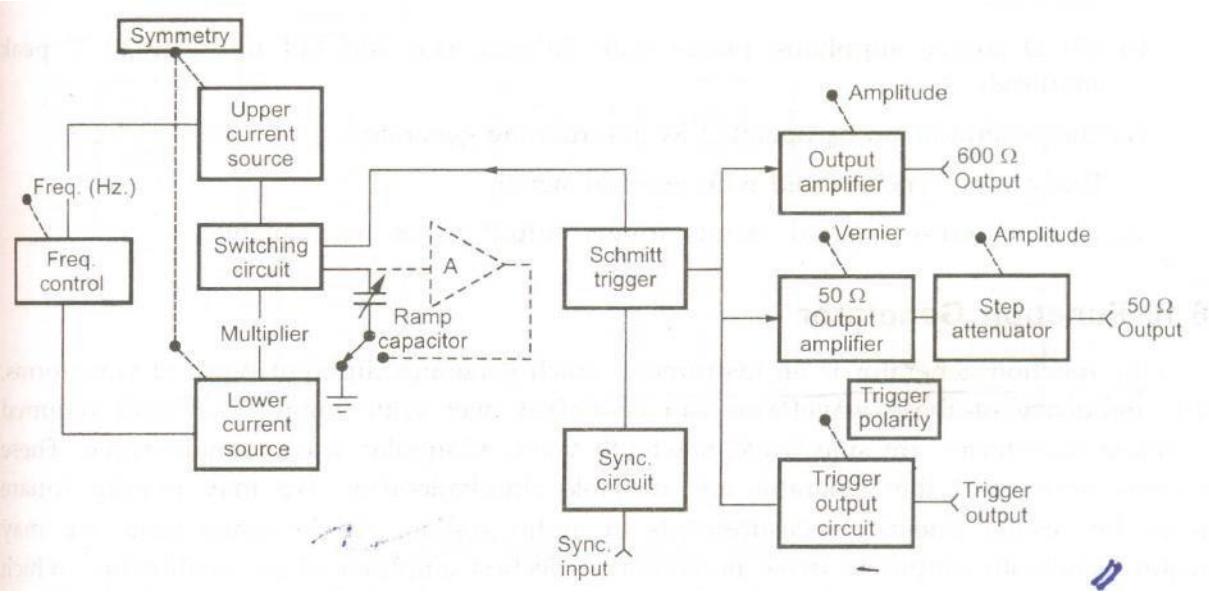
Laboratory type square wave and pulse generator:



The circuit consists of two current *sourcesJ*a ramp capacitor, and schmitt triggercircuit as well as curr~wit~ht!!g 9,rcuit. The two current sources provide a constanCllr.ITn~toaJamp c:apaci tor for charging and discharging. The ratio of tnese charging and discharging current is' determined by setting of symmetry control. The symmetry control determines duty cycle of output waveform. In the current source, an appropriate control voltage is applied to current control transistors which controls the frequency i.e. sum of twocurrents.

The multiplier switch provides decade switching control output frequency. While frequency dial provi.des continuous vernier control of output frequency.

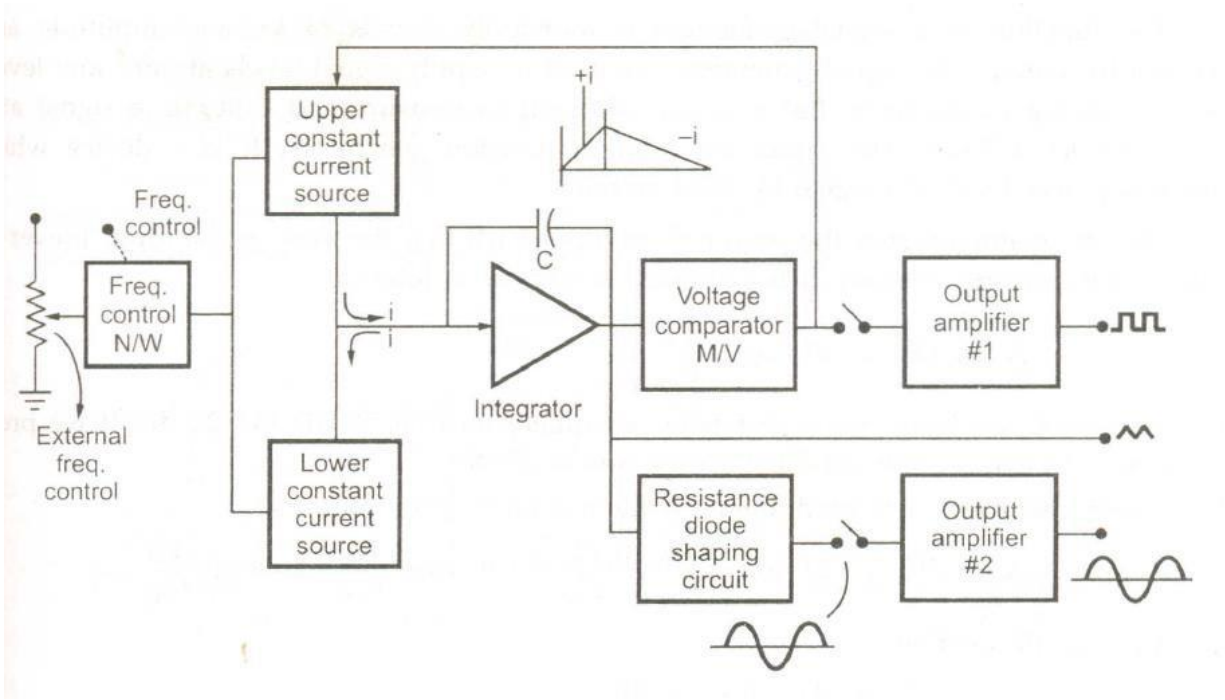
The block diagram of laboratory type square wave and pulse generator is as shown in fig:



Function generator:

The function generator is an instrument which generates different types of waveforms The frequency of these wave orms can be vane over wide range. le most required common waveforms are sine wave, sawtooth wave, triangular wave, square *wave.* These various OlltputS of the generator are available simultaneously. We may require square wave for testing linearity measurements in audio system. At the same time, we mal' require!"~awtooth output to drive horizontal deflection amplifier of an oscilloscopewhich gives visual display of the measurements. The purpose of providing simultaneous**.**

Block Diagram:



The frequency controlled voltage is used to regulate two current sources namely upper current source and lower current source. The upper current source supplies constant current to an integrator. The output voltage of integrator then increases linearly with time. If the current, charging the capacitor increases or decreases, the slope of output voltage increases or decreases respectively. Hence this controls frequency. The voltage comparator multivibrator circuit changes the state of the network when the output voltage of integrator equals the maximum predetermined upper level. Because of this change in state, the upper current source is removed and the lower current source is switched ON. This lower current source supplies opposite current to the integrator circuit. The output of integrator decreases linearly with time. When this output voltage equals maximum predetermined upper level on negative side, the voltage comparator multivibrator again changes the condition of the network by switching OFF the lower current source and switching ON the upper current source.

The output voltage of the integrator has triangular waveform. The frequency of this triangular waveform is determined by the magnitudes of the currents supplied by upper current source and lower current source. To get square wave, the output of the integrator

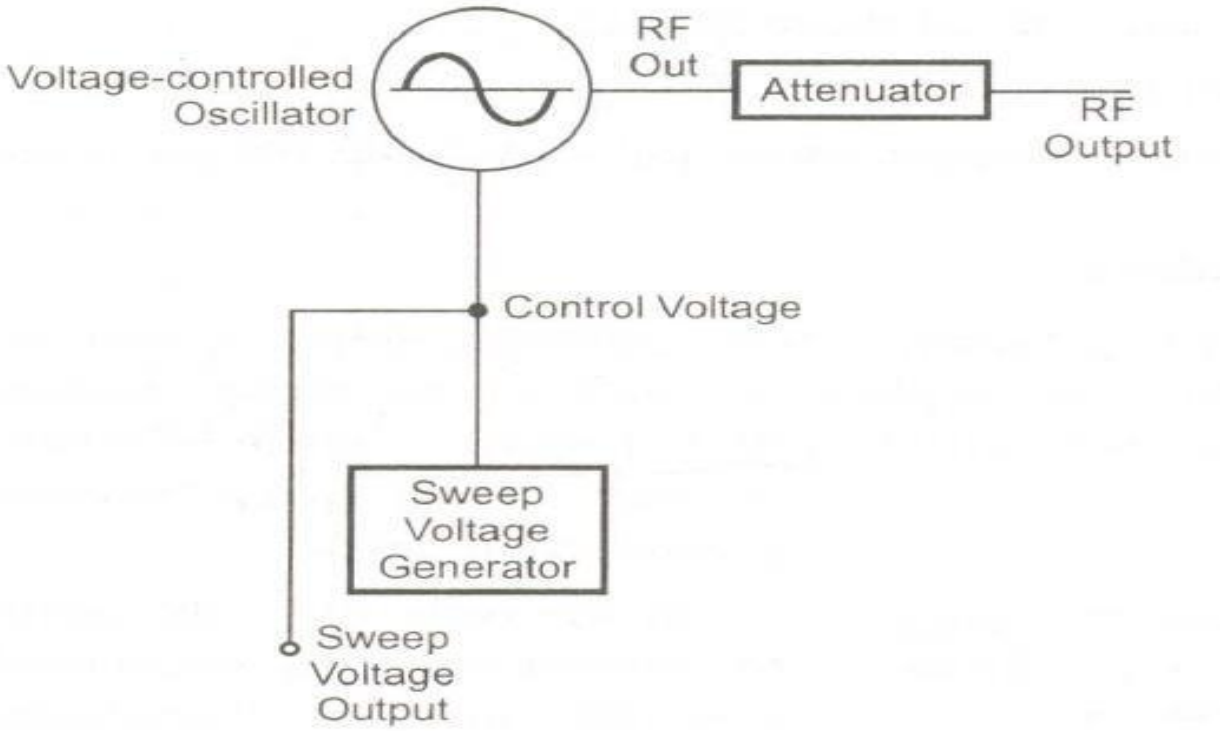
is passed through comparator. The voltage comparator delivers square wave output voltage·of same frequency as that of input triangular waveform. The sine wave is derived from triangular wave. The triangular wave is synthesised into sine wave using diode resistance network. **In** this shaper circuit, the slope of triangular wave is changed as its arr'plitude changes. This results in a sine wave with less than 1% distortion.

The two output amplifiers provide two simultaneous, individually selected outputs of any of the waveform functions.

The function of a signal generators is to supply signals of known amplitude and known frequency. The signal generators are used to supply signal levels at very low levels for the testing of receivers. But it is very difficult to measure and calibrate a signal at a very low level. Thus attenuators are used in function generators. It is a device which reduces power level of a signal by fixed amount.

Sweep-Frequency Generators:

The sine wave generator discussed in earlier sections generates output voltage at a known and stable frequency.


Voltage-controlled
Oscillator
RF
Out
Attenuator
RF
Output
Control Voltage
Sweep
Voltage
Generator
Sweep
Voltage
Output

The development of solid state variable capacitance diode (varicap diode) helps in building sweep frequency genera tors. These are extensively used than any other electronic devices. These varicap diodes provide the method of electronically tunning an oscillator. The block diagram of simple sweep frequency generator is as shown in Fig

The sweep generator is very much similar to the simple signal generator. Tn the simple signal genera tor, an oscilla tor is tuned to fixed single frequency.

Tn the sweep generator, an oscillator is electronically tuned and by using voltage controlled oscillator variable frequency is obtained. As name indicates, a sweep voltage generator provides voltage, known as control voltage, to the voltage controlled oscillator (VeO). The function of voltage controlled oscillator is to provide various frequency sweeps according to voltage provide by sweep voltage generator.

Frequency Synthesizers:

The frequency generators are of two types.

1. One is free running frequency generators in which the output can be tuned continuously either electronically or mechanically over a wide frequency range. The generators discussed uptill now are of thistype.
2. The second is frequency generator with frequency synthesis technique. The synthesis means to use a fixed frequency oscillator called reference oscillator or *clock* and to derive the wide frequency range in steps from the output of the reference oscillator.

The stability and accuracy of free running frequency generator is poor while frequency synthesizers provide output which is arbitrarily selectable, stable and accurate frequency. The reference oscillator used in frequency synthesizers is generally precision crystal oscillator with an output at some cardinal frequency such as 10 MH. Various signal processing circuits then operate in synchronism to provide a large choice of the output frequencies.