UNIT – 2

Q.1) Describe the functioning of standard signal generator

Ans.

STANDARD SIGNAL GENERATOR

A standard signal generator produces known and controllable voltages. It is used as power source for the measurement of gain, signal to noise ratio (SN), bandwidth standing wave ratio and other properties. It is extensively used in the measuring of radio receivers and transmitter instrument is provided with a means of modulating the carrier frequency, which is indicated by the dial setting on the front panel. The modulation is indicated by a meter. The output signal can be Amplitude Modulated (AM) or Frequency Modulated (FM). Modulation may be done by a sine wave, Square, rectangular, or a pulse wave. The elements of a conventional signal generator

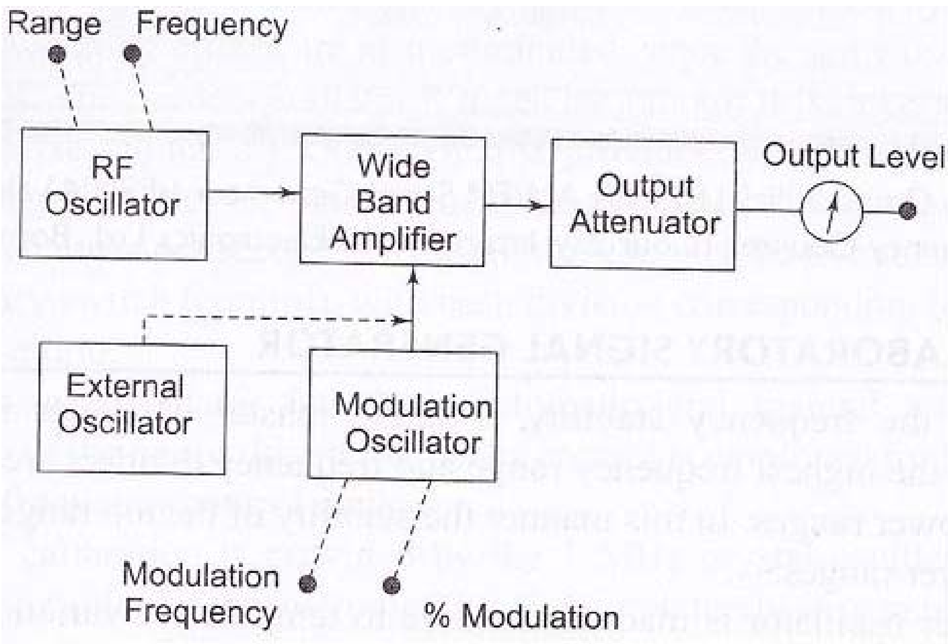

fig 1.1 Conventional standard signal generator

The carrier frequency is generated by a very stable RF oscillator using an LC tank circuit, having a constant output over any frequency range. The frequency of oscillations is indicated by the frequency range control and the venire dial setting. AM is provided by an internal sine wave generator or from an external source.

Q.2) how can a sine and square wave be generated using signal generator?

Ans.

The signal generator is called an oscillator. A Wien bridge oscillator is used in this generator. The Wien bridge oscillator is the best of the audio frequency range. The frequency of oscillations can be changed by varying the capacitance in the oscillator. The frequency can also be changed in steps by switching the resistors of different values. The output of the Wien bridge oscillator goes to the function switch. The function switch directs the oscillator output either to the sine wave amplifier or to the square wave shaper. At the output, we get either a square or sine wave. The output is varied by means of an attenuator.

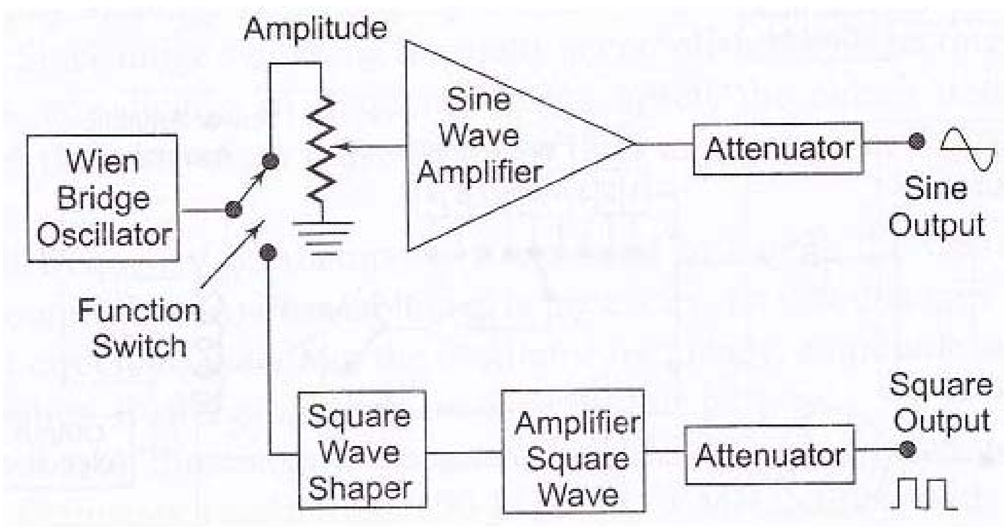

fig 2.1 AF sine and square wave generator

The instrument generates a frequency ranging from 10 Hz to 1 MHz continuously variable in 5 decades with overlapping ranges. The output sine wave amplitude can be varied from 5 mV to 5

V (rms).The output is taker through a push-pull amplifier. For low output, the impedance is 6000. The square wave amplitudes can be varied from 0 - 20 v (peak). It is possible to adjust the symmetry of the square wave from 30 -70%. The instrument requires only 7W of power at 220V 50Hz. The front panel of a signal generator consists of the following.

l. Frequency selector: It selects the frequency in different ranges and varies it continuously in a ratio of 1: 11. The scale is non-linear.
2. Frequency multiplier: It selects the frequency range over 5 decades from 10 Hz to 7 MHz
3. Amplitude multiplier: It attenuates the sine wave in 3 decades, x l x 0.1 and x 0.01.
4. Variable amplitude: It attenuates the sine wave amplitude continuously
5. Symmetry control: It varies the symmetry of the square wave from 30% to 70%.
6. Amplitude: It attenuates the square wave output continuously.
7. Function switch: It selects either sine wave or square output.
8. Output available: This provides sine wave or square wave output.
9. Sync: This terminal is used to provide synchronization of the internal signal with an external signal.
10. On-Off Switch

Q.3) Explain how a Function Generator works?

Ans:

FUNCTION GENERATOR

A function generator produces different waveforms of adjustable frequency. The common output waveforms are the sine, square, triangular and saw tooth waves. The frequency may be adjusted, from a fraction of a Hertz to several hundred kHz lie various outputs of the generator can be made available at the same time. For example, the generator can provide a square wave to test the linearity of a rectifier and simultaneously provide a saw tooth to drive the horizontal deflection amplifier of the CRO to provide a visual display. Capability of Phase Lock the

function generator can be phase locked to an external source. One function generator can be used to lock a second function generator, and the two output signals can be displaced in phase by adjustable amount. In addition, the fundamental frequency of one generator can be phase locked to a harmonic of another generator, by adjusting the amplitude and phase of the harmonic; almost any waveform can be generated by addition.
The function generator can also be phase locked to a frequency standard and its output waveforms will then have the same accuracy and stability as the standard source. The block diagram of a function generator is illustrated in fig. Usually the frequency is controlled by varying the capacitor in the LC or RC circuit. In the instrument the frequency is controlled by varying the magnitude of current which drives the integrator. The instrument produces sine, triangular and square waves with a frequency range of 0.01 Hz to 100 kHz.

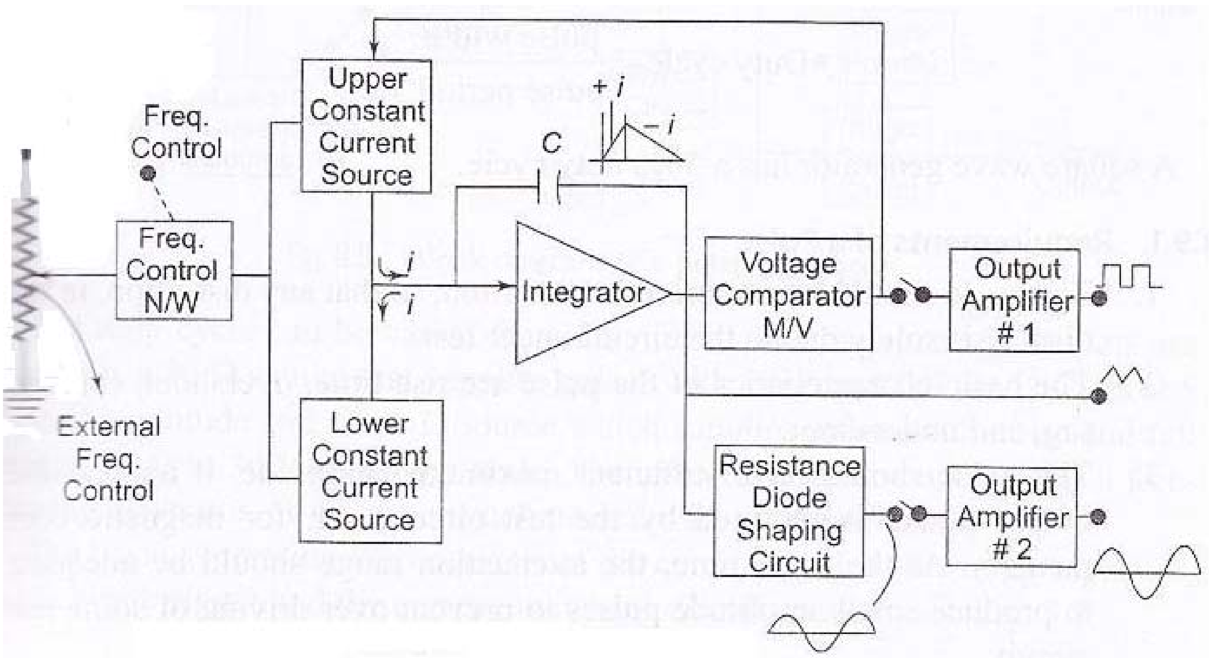

fig 3.1 Function Generator

The frequency controlled voltage regulates two current sources. The upper current source supplies constant current to the integrator whose output voltage increases linearly with time, according to the equation of the output signal voltage. An increase or decrease in the current increases or decreases the slope of the output voltage and hence controls the frequency. The voltage comparator multi-vibrator changes states at a pre-determined maximum level of the integrator output voltage. This change cuts off the upper current supply and switches on the lower current supply. The lower current source supplies a reverse current to the integrator, so that its output decreases linearly with time. When the output reaches a pre-determined minimum level, the voltage comparator again changes state and switches on the Lower current source. The output of the integrator is a triangular waveform whose frequency is determined by the magnitude of the current supplied by the constant current sources. The comparator output delivers a square wave voltage of the same frequency.

$$e = -\frac{1}{C}\int_0^t i\,dt$$

The resistance diode network alters the slope of the triangular wave as its amplitude changes and produces a sine wave with less than 1% distortion.

Q.4) Explain the functioning of Random Noise Generator and explain the parameters of noise?

Ans:

RANDOM NOISE GENERATOR

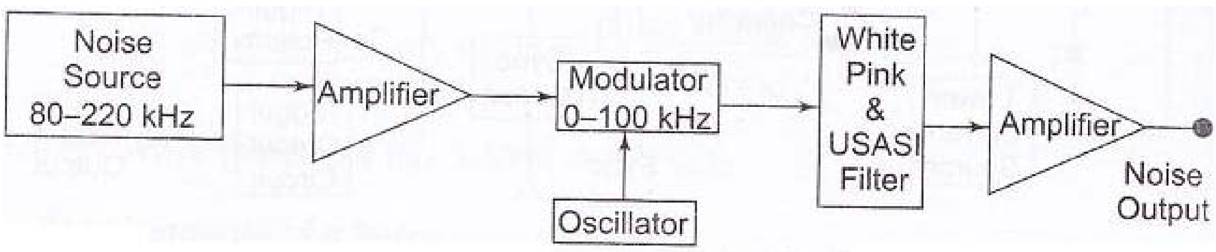

fig 4.1 Random noise Generator

The spectrum of random noise covers all frequencies the lower density spectrum tells us how the energy of the signal is distributed in frequency, but it does not specify the signal uniquely nor does it tell us very much about how the amplitude of the signal varies with time

The spectrum does not specify the signal uniquely because it contains no phase information. The method of generating noise is usually to use a semi conductor noise which delivers frequencies in a band roughly extending from 80 – 220 KHz The output from the noise diode is amplified and heterodyned down to audio frequency band by means of a balanced symmetrical modulator. The filter arrangement controls the bandwidth and supplies an output signal in three spectrum choices, white noise, pink noise and Usasi noise. From the Fig 4.2 it is seen that white noise is flat from 20Hz to 20 KHz and has upper cutoff frequency of 50 kHz with a cutoff slope of -12 dbs/ octave. Pink noise is so called because the lower frequencies have larger amplitude, similar to red light. Pink noise has a voltage spectrum which is inversely proportional to the square root of frequency and is used in band analysis. Usasi noise ranging simulates the energy distribution of speech and music frequencies and is used for testing audio amplifiers and loud speakers.

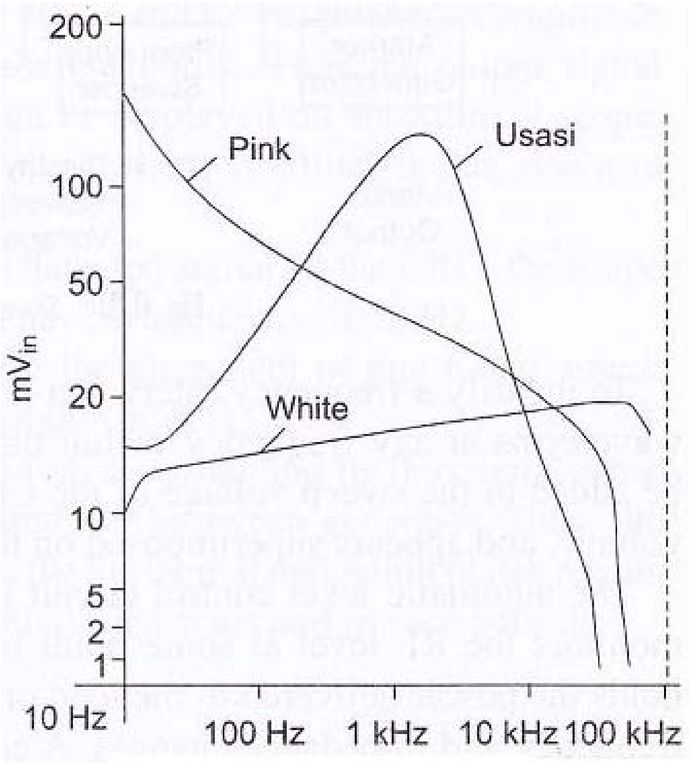

fig 4.2 Random Noise Generator

Q.5 what is a Sweep Generator, explain its functioning?

Ans:

It provides a sinusoidal output voltage whose frequency varies smoothly and continuously over an entire frequency band, usually at an audio rate. The process of frequency modulation may be accomplished electronically or mechanically. It is done electronically by using the modulating voltage to vary the reactance of the oscillator tank circuit component, and mechanically by means of a motor driven capacitor, as provided for in a modern laboratory type signal generator. Figure shows a basic block diagram of a sweep generator. The frequency sweeper provides a variable modulating voltage which causes the capacitance of the master oscillator to vary. A representative sweep rate could be of the order of 20 sweeps/second. A manual control allows independent adjustment of the oscillator resonant frequency. The frequency sweeper provides a

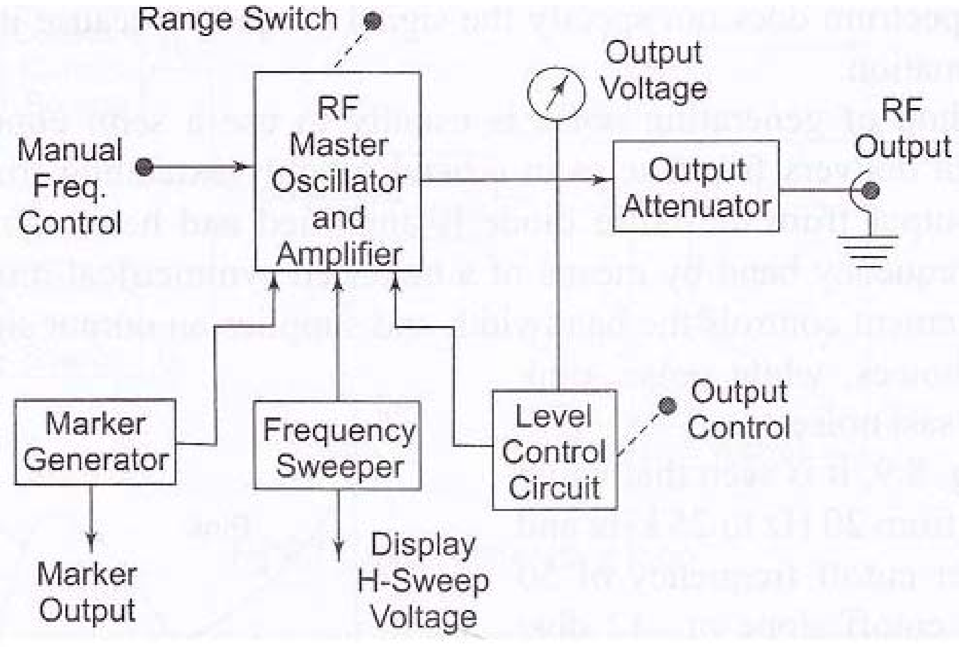

fig 5.1 Sweep Generator

varying sweep voltage for synchronization to drive the horizontal deflection plates of the CRO. Thus the amplitude of the response of a test device will be locked and displayed on the screen.

To identify a frequency interval, a marker generator provides half sinusoidal waveforms at any frequency within the sweep range. The marker voltage can be added to the sweep voltage of the CRO during alternate cycles of the sweep voltage, and appears superimposed on the response curve. The automatic level control circuit is a closed loop feedback system which monitors the RF level at some point in the measurement system. This circuit holds the power delivered to the load or test circuit constant and independent o frequency and impedance changes. A constant power level prevents any source mismatch and also provides a constant readout calibration with frequency.

6. Explain Square and Pulse Generator?

ANS:

SQUARE AND PULSE GENERATOR:

These generators are used as measuring devices in combination with a CRO. They provide both quantitative and qualitative information of the system under test. They are made use of in transient response testing of amplifiers. The fundamental difference between a pulse generator and a square wave generator is in the duty cycle.

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

A square wave generator has a 500/o duty cycle.

Requirements of a Pulse

1. The pulse should have minimum distortion, so that any distortion, in the display is solely due to the circuit under test.

2. The basic characteristics of the pulse are rise time, overshoot, ringing, sag, and undershoot.

3. The pulse should have sufficient maximum amplitude, if appreciable output power is required by the test circuit, e.g. for magnetic core memory. At the same time, the attenuation range should be adequate to produce small amplitude pulses to prevent over driving of some test circuit.

4. The range of frequency control of the pulse repetition rate (PRR) should meet the needs of the experiment. For example, a repetition frequency of 100 MHz is required for testing fast circuits.

Other generators have a pulse-burst feature which allows a train of pulses rather than a continuous output.

5. Some pulse generators can be triggered by an externally applied trigger signal; conversely, pulse generators can be used to produce trigger signals, when this output is passed through a differentiator circuit.

6. The output impedance of the pulse generator is another important consideration. In a fast pulse system, the generator should be matched to the cable and the cable to the test circuit. A mismatch would cause energy to be reflected back to the generator by the test circuit, and this may be re-reflected by the generator, causing distortion of the pulses.

7. DC coupling of the output circuit is needed, when dc bias level is to be maintained.

The basic circuit for pulse generation is the asymmetrical multi-vibrator. A laboratory type square wave and pulse generator is shown in Fig 6.1

The frequency range of the instrument is covered in seven decade steps from 1Hz to 10 MHz, with a linearly calibrated dial for continuous adjustment on all ranges.

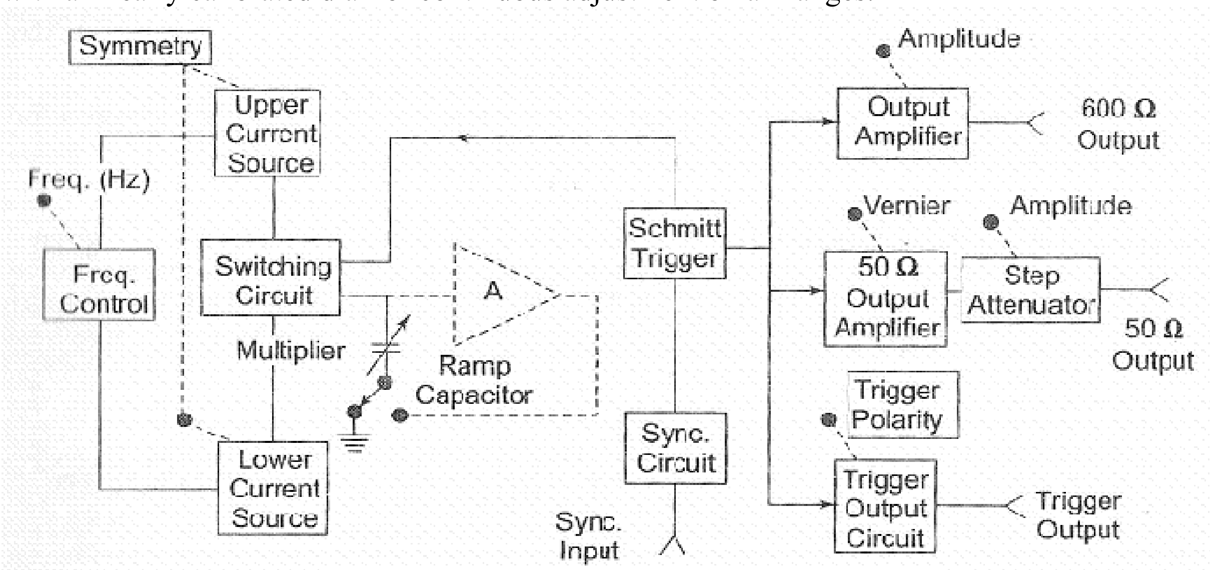

fig 6.1 Block Diagram of Pulse Generator

The duty cycle can be varied from 25 - 75%. Two independent outputs are available, a 50Ω source that supplies pulses with a rise and fall time of 5 ns at 5V peak amplitude and a 600Ω source which supplies pulses with a rise and fall tme of 70 ns at 30 V peak amplitude. The instrument can be operated as a freerunning genenrator or, it can be synchronized with external signals.

The basic generating loop consists of the current sources, the ramp capacitor, the Schmitt trigger and the current switching circuit as shown in the fig 6.2

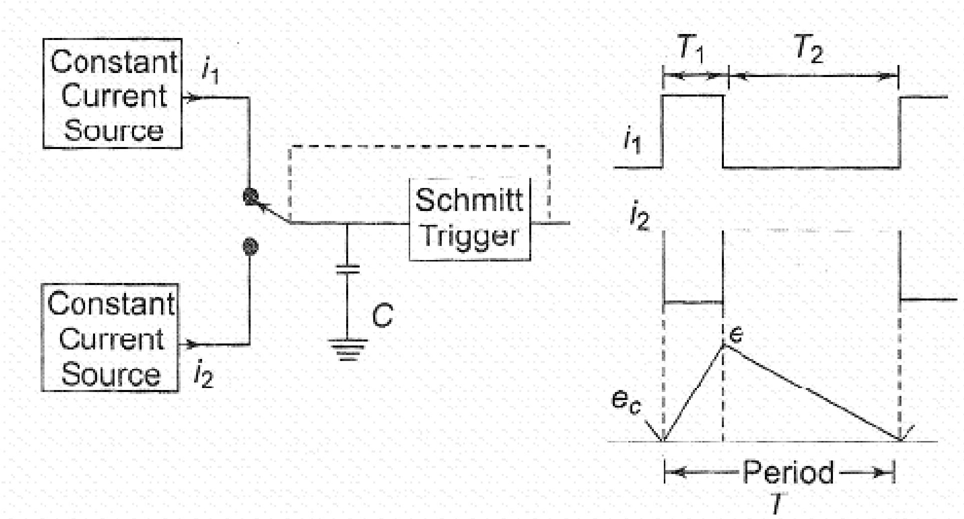

fig 6.2 Basic Generating Loop

The upper current source supplies a constant current to the capacitor and the capacitor voltage increases linearly. When the positive slope of the ramp voltage reaches the upper limit set by the internal circuit components, the Schmitt trigger changes state. The trigger circuit output becomes negative and reverses the condition of the current switch. The capacitor discharges linearly, controlled by the lower current source. When the negative ramp reaches a predetermined lower level, the Schmitt trigger switches back to its original state. The entire process is then repeated. The ratio i_1/i_2 determines the duty cycle, and is controlled by symmetry control. The sum of i_1 and i_2 determines the frequency. The size of the capacitor is selected by the multiplier switch. The unit is powered by an intenal supply that provides regulated voltages for all stages of the instrument.

7. What is the basic difference between a signal generator and an oscillator? Discuss fixed and variable AF oscillator?

Ans:

Signal generators are the sources of electrical signals used for the purpose of testing and operating different kinds of electrical equipment. A signal generator provides different types of waveforms such as sine, triangular, square, pulse etc., whereas an oscillator provides only sinusoidal signal at the output.

The AF oscillators are divided into two types. They are as follows,

1. Fixed frequency AF oscillator
2. Variable frequency AF oscillator.

1. Fixed Frequency AF Oscillator

Many instrument circuits contain oscillator as one of its integral parts to provide output signal within the specified fixed audio frequency range. This specified audio frequency range can be 1 kHz signal or 400 Hz signal.
The 1 kHz frequency signal is used to execute a bridge circuit and 400 Hz frequency signal is used for audio testing. A fixed frequency AF oscillator employs an iron core transformer. Due to this a positive feedback is obtained through the inductive coupling placed between the primary winding and secondary winding of the transformer and hence fixed frequency oscillations are generated.

2. Variable Frequency AF Oscillator

It is a general purpose oscillator used in laboratory. It generates oscillations within the entire audio frequency range i.e. from 2O Hz to 20 kHz. This oscillator provides a pure, constant sine wave output throughout this AF range. The examples of variable AF oscillators used in laboratory are RC feedback oscillator, beat frequency oscillator.

8. With a neat block diagram discuss about an AF sine wave generator?

Ans: As the name suggest an AF sine and square wave generator produces either sine wave or square wave output. It employee a Wein bridge oscillator, sine wave amplifier, square wave shaper, square wave amplifier and attenuator. The schematic arrangement of these blocks is shown below.

The Wien bridge oscillator operates effectively in audio frequency ranges. It produces oscillations whose frequency can be varied by varying the capacitance value of the capacitor of the oscillator. Also the frequency value can be varied in steps by switching in different values of resistors. The oscillations of Wien bridge oscillator are applied to either sine wave amplifier or sine wave shaper through function key. When the key is connected to position 1, the output oscillations are connected to sine wave amplifier and then to attenuator. Therefore, the oscillations are amplified and then attenuated and a pure sine wave is available at the output. Depending on the requirement the amplitude of this sine wave can be varied from 5 mV to 5 V (r.m.s value).

When the key is connected to position 2, the oscillations are applied to square wave shaper which converts the oscillations into square wave. The square wave signal is amplified and then attenuated and finally appears as pure square wave at the output. The amplitude of the square wave can be varied from 0 V to 20 V (peak value).

This generator produces output in the frequency range of 1 0 Hz to I MHz and it requires power of 7 W at 220V, 50 Hz. The front panel of the instrument contains

(i) ON/OFF switch.

(ii)FrequencyMultip1ier: To choose the frequency range over 5 decades (from10Hz to1MHz).

(iii) Amplitude Multiplier: To attenuate sine wave output in 3 decades (x 1; x 0.1 and x 0.01).

(iv) Amplitude: To continuously attenuate the amplitude of square wave output.

(v) Variable Amplitude: To continuously attenuate the amplitude of sine wave output.
(vi) Frequency Selector: To select different ranges of frequencies and to vary the frequency in a ratio of 1: 11.

(vii) Function Key: To select either square wave or sine wave output.

(viii) Symmetry Control: To adjust the symmetry of square wave from 30% to 70%

(ix) Sync: To synchronize the internal signal with external signal.

8. What is need for inserting isolation between the signal generator output and oscillator in a simple signal generator? What are the difference ways in which this can be achieved?
Ans:

An oscillator of a simple signal generator needs to be isolated from the output of the signal generator because any variations in the load (output circuit of signal generator) will affect the output characteristic (i.e., amplitude, frequency, etc) of an oscillator. Usually, the frequency of an oscillator should be very stable when the oscillator is operating at high frequencies of the order of MHz, because even a small variation in the frequency will give rise to errors. Hence, an isolation of 20 dB or more (based upon the type of oscillator circuit) should be introduced between oscillator and signal generator output.

The different ways to achieve an isolation of 20 dB or more between oscillator and signal generator output are,
1. Setting the attenuation of attenuator to 20 dB or more.
2. Introducing an isolation amplifier between oscillator and attenuator

1. Setting the Attenuation of Attenuator to 20 dB or More

In a signal generator the output of the oscillator is attenuate d by feeding it to variable attenuator, in order to obtain a signal of desired amplitude (or power level). So, if the attenuator is set to provide and attenuate the oscillator output by 20 dB or more, an isolation of 20 dB will be produced between the oscillator and the load.

2. Introducing an Isolation Amplifier between oscillator and Attenuator

In this method of achieving isolation, the oscillator output is amplified by certain amount using a buffer amplifier. Consecutively, it is attenuated by same amount by a fixed attenuator before feeding the oscillator output to the variable attenuator of the signal generator. In this way isolation is achieved without any change in the signal level of oscillator output. To achieve an isolation of 20 dB or more, a 10 dB gain isolation amplifier followed by a 10 dB fixed attenuator is introduced between the oscillator and variable attenuator as shown in the following figure. The gain of the isolation amplifier and thus the attenuation of a fixed attenuator depend on the amount of isolation required and also on the attenuation of the variable attenuator

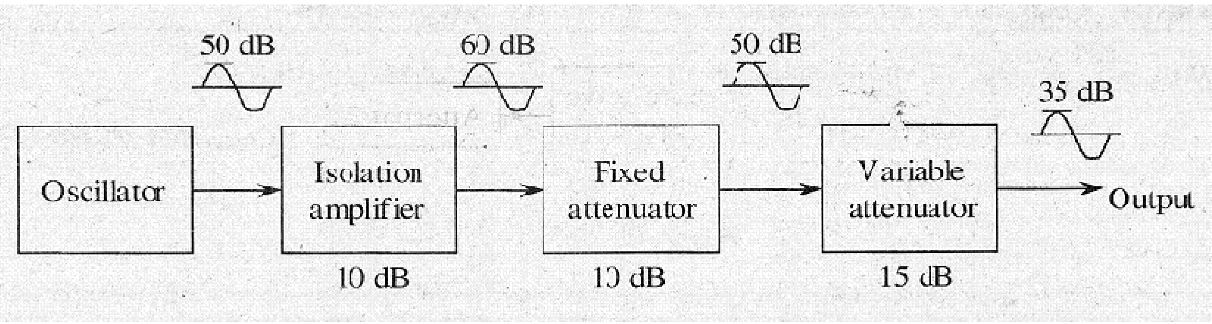

fig 8 steps involved in isolation pattern

9. with respect to construction and circuit configuration, explain how a square wave generator differs from sine wave generator?
Ans:

Sine Wave Generator

The circuit configuration of a sine wave generator consists of Wien bridge oscillator, sine wave amplifier and attenuator. The block diagram of a sine wave generator is shown in figure 9.1

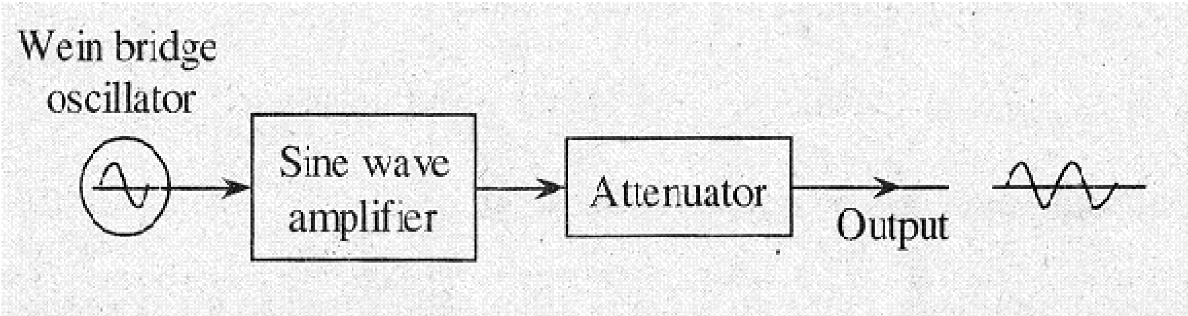

fig 9.1 Block Diagram of Sine Wave Generator

Wein bridge oscillator produces an oscillating output which is usually a sinusoidal (sine) wave. Thus, half of the operation of a sine wave generator is done by the Wein bridge oscillator. The frequency of oscillations of this oscillator can be varied by varying its capacitance and thus a sine wave of desired frequency can be generated. The remaining elements of sine wave generator i.e., amplifier, and attenuator are used as signal conditioners to condition the output of Wien bridge oscillator in order to obtain a sine wave of desired amplitude.

Square Wave Generator

The circuit configuration of a square wave generator consists of the basic elements of a sine wave generator (i.e., Wien bridge oscillator, attenuator) and square wave shaper and square wave amplifier. Figure 9.2 shows the block diagram of a square wave generator.

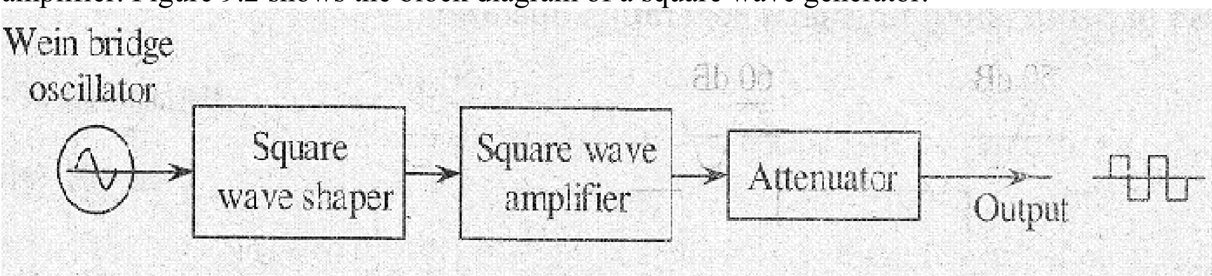

fig 9.2 Block Diagram of Square Wave Generator

A square wave is obtained by feeding the sinusoidal output of the Wein bridge oscillator to the square wave Shaper circuit. The square wave shaper is usually a sine-to-square wave converter. The square wave is further processed through square wave amplifier and attenuator in order to obtain a square wave of desired amplitude. The frequency of the square wave can be varied by varying the oscillation frequency of Wein bridge oscillator.

10. What are the precautionary measures to bee taken in a signal generator application?

Ans;
A signal generator is an instrument, which can produce various types of wave forms such as sine wave, square wave, triangular wave, saw tooth wave, pulse trains etc. As it can generate a variety of waveforms it is widely used in applications like electronic troubleshooting anti development, testing the performance of electronic equipments etc. In such applications a signal generator is used to provide known test conditions (i.e., desired signals of known amplitude and frequency

Hence, the following precautionary measures should be taken while using a signal generator for an application.

1. The amplitude and frequency of the output of the signal generator should be made stable and well known.

2. There should be provision for controlling the amplitude of signal generator output from very small to relatively large values.

3. The output signal of generator should not contain any distortion and thus, it should possess very low harmonic contents.

4. Also, the output of the signal generator should be less spurious.