Unit-II

Signal generator provides different kind of Waveform Such as Sine, Square, triangular, Sweep, pulse etc

The requirements of Signal generator are:—

→ The frequency of the Signal must be known and stabl

→ The amplitude of the Signal Can be Varied from small Value to relatively large Value

→ The Signal must be distortion field.

Applications of Signal generator :—

→ Signal generator are used to measure frequency response, gain signal-to Noise ratio

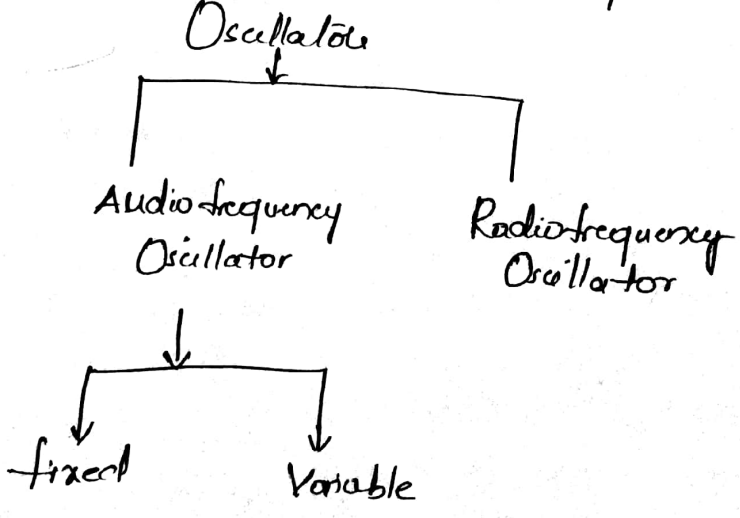
→ Electronic troubleshooting and development

→ To test and operate Various Electronic Equipment.

→ Alignment of radio reciever.

Oscillator:—

Oscillator is used to indicate the instrument which produces Sinusoidal output. Whereas Signal generator provides wave-forms Such as Sine, square &le etc.



Fixed Audio frequency Oscillator:—

→ Some instrument Contain internal oscillator which produce Sinusoidal output with a fixed frequency. Such fixed frequency may be 400Hz, Signal used for audio testing.

→ May be 1000Hz signal is used for exiting bridge ckt

→ Such Oscillations are easily generated by using an iron core transformer to obtain the positive feedback through inductive Coupling b/n primary and secondary windings.

Variable AF Oscillator:—

→ It is the general purpose Oscillator used in Laboratory.

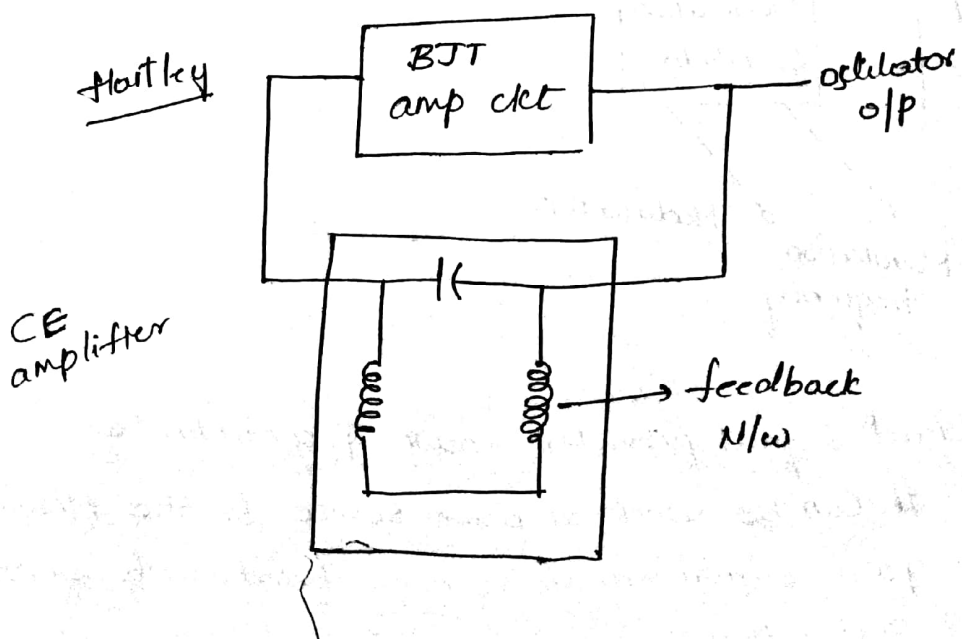
→ It provides Oscillations with AF range i.e 20Hz to 20KHz.

Ex:- Wein bridge, RC phase shift, beat frequency

RF oscillators:—

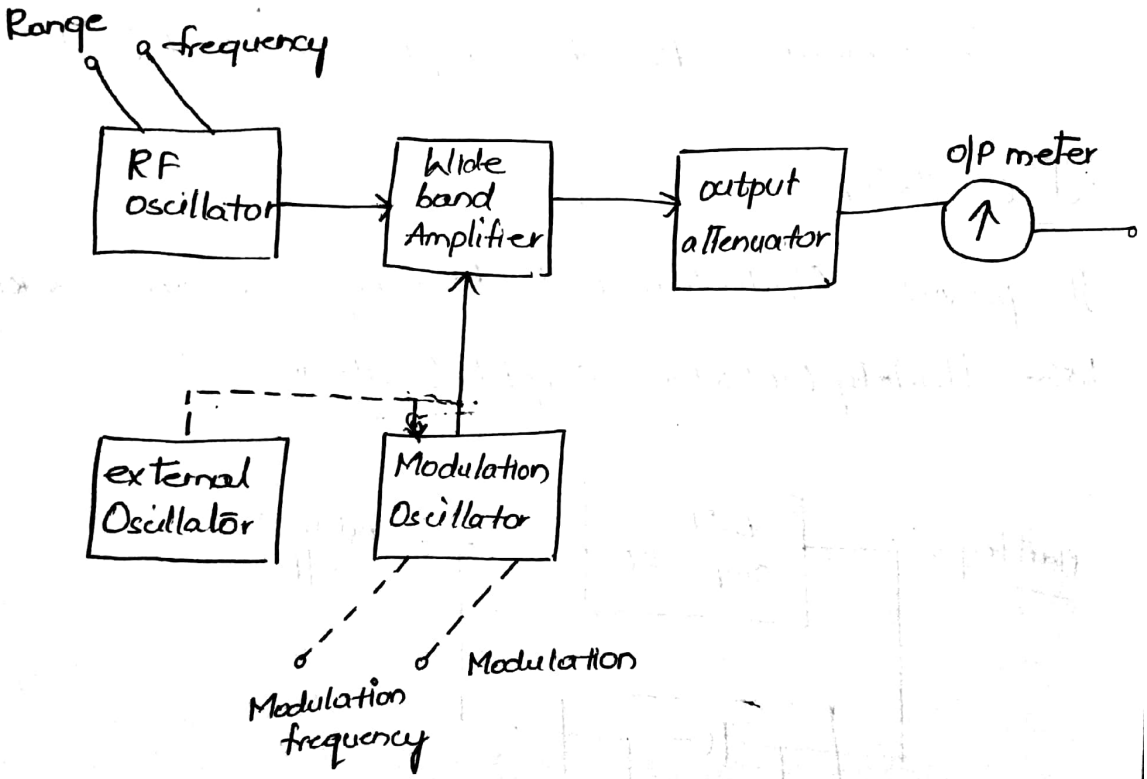
It provides Oscillations with Rf range i.e above 30KHz.

Ex:- Hartley Oscillator, Colpitts Oscillator



Standard Signal Generator:-

Band	Approximate range
Audio	20Hz - 20MHz
Radio	above 30kHz
VLF	15kHz - 100kHz
LF	100k - 500kHz
Broadcast	500k - 1500kHz
Video	DC - 5MHz
HF	1.5M - 30MHz
VHF	30M - 300MHz
UHF	300M - 3GHz
Microwave	above 3GHz



A standard signal provides known & controlable voltage. It can be used as power source for the measurement of gain, signal to Noise ratio, bandwidth, wave ratio and other

It is extensively used in testing of radio reciever and transmitter

Operation:—

→ The Carrier signal (sine wave) is generated by a stable RF oscillator by using LC tank ckt having constant o/p over any frequency range.

→ The Carrier freq is modulated with sine, square, Δle wave or pulse

→ The AM and FM modulated signal obtained at the o/p of the generator through a Oscillator (external oscillator) Modulator Oscillator)

→ The Modulated Carrier is fed to o/p attenuation finally the level of o/p voltage read through o/p meter.

Advantages:—

→ The o/p Voltage can be Controlled as for our requirement.

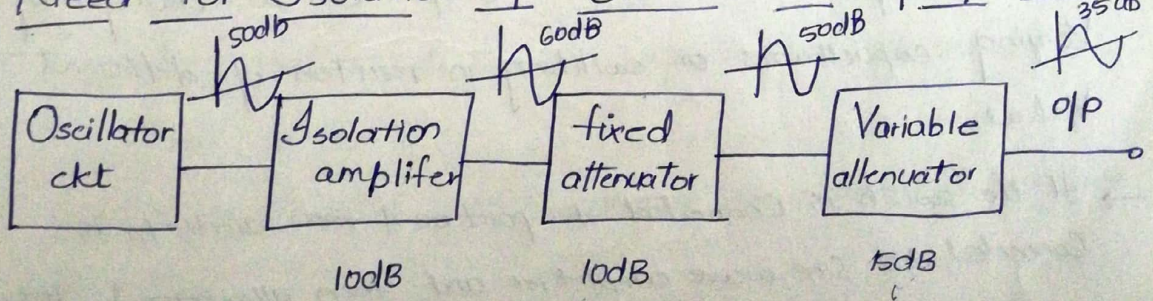
→ Stable o/p

DisAdvantage:—

→ The frequency stablity depends on design of LC tank ckt of RF Oscillator

→ At high frequencies it is essential to Isolate Oscillator ckt from o/p ckt.

Need for Isolation b/n Oscillator ckt & o/p ckt:—



This Isolation is necessary so that the changes occurring in load dont effect the Oscillator Signal frequency, amplitude and distortion charcteristics.

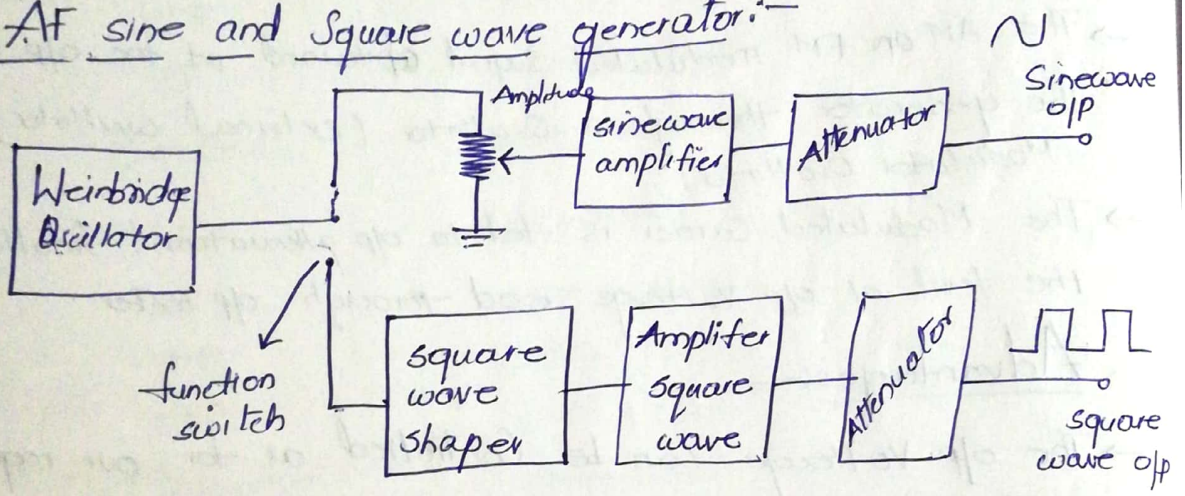
Generally a buffer amplifier is used to Isolate

Oscillator ckt from the o/p ckt.

→ The oscillator o/p is amplified by certain amount by Isolation amplifier Consequently the same amount can be attenuated by a fixed attenuator.

→ In this way the oscillation is achieve without changing the signal level of Oscillating o/p.

AF sine and Square wave generator:-



→ As Name indicate it generates AF sine and square wave.

→ It employees the Wienbridge Oscillator. It is the best in audio freq range.

→ The function switch is used to connect the oscillator o/p to either Sine amplifier (or) square wave shapper.

→ The Square wave shaper Converts the Sinusoidal Oscillation into a square wave.

→ The frequency of the oscillator output can be change by Varying capacitance or switching in resistors of different Values.

→ If the switch is Connected to position 1 then oscillator is Connected to Sine wave amplifier and then attenuator & the amplitude can be Varied from 5mv to 5V which gives pure sinusoidal o/p.

→ If the switch is connected to position 2 the Oscillator o/p is

Connected to square wave shaper which Converts the Sinosoidal Oscillator into Square wave. After that the Signal is applied to Square wave amplifier and attenuate

It provides a Square wave of amplitude 0V to 20V with a duty cycle from 30% to 70%.

Specification:—

Sinewave Amplitude = 5mV to 5V

Squarewave Amplitude = 0 to 20V

Duty cycle = 30 to 70%

Frequency = 10HZ to 1MHz.

power required = 7Watts (at 220V, 50Hz)

Standard signal generator:—

The frontend of the signal generator Consists of

1) frequency selector:— It select the frequency in different ranges

2) frequency multiplier:— It select the frequency range over 5decades from 10HZ to 1MHz i.e 10HZ, 100HZ, 1KHZ, 10KHZ, 100KHZ

3) Amplitude Multiplier:— It attenuates the sinewave in 3decades ie multiplier x1, x0.1, x0.01.

4) Variable amplitude:— It attenuates the sine wave Continuosly

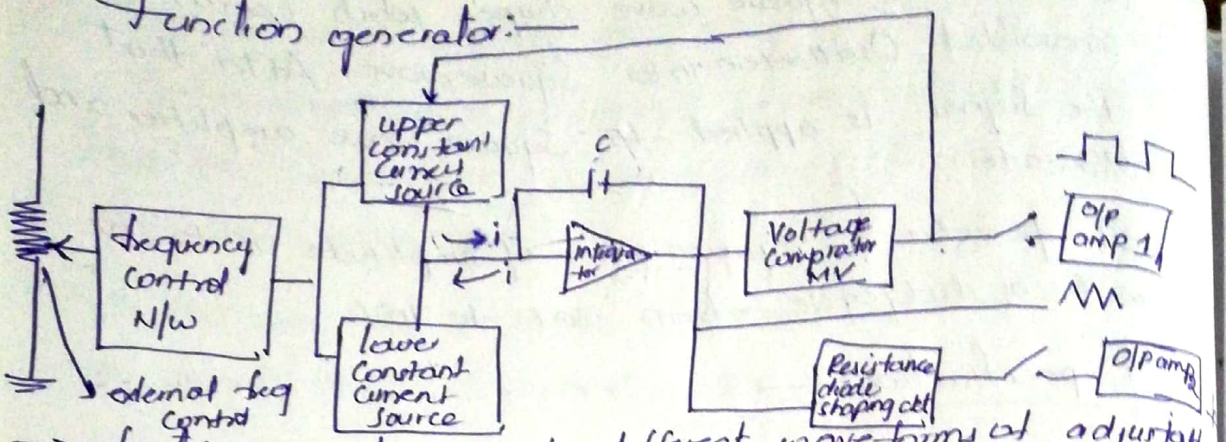
5) Symetry Control:— It provides symetry of square wave Varies from 30% to 70%.

6) function switch:— It select either a sinewave or a square-wave

7) sync:— It provides synchronization of input signal ie the external signal.

8) ON/OFF switch:—

function generator:-



→ function generator provides different waveforms of adjustable frequency

→ The common output waveforms are sine, square Triangular and sawtooth Waveform

→ The frequency may be adjusted from the fraction of ~~edge~~ to several

→ Usually the frequency is control by varying capacitance in LC (or) RC ckt

→ In function generator the frequencies control by Varying magnitude of current.

Which drives the integrator

The frequency control n/w regulates two constant current sources

→ The upper current source supplies a constant current through the integrator. The o/p of integrator is given by

Square $e_0 = \frac{1}{C}\int i\,dt$

$\left(\frac{i}{C}\right)t$

→ Where i & C are constant. Hence the o/p of integrator is a +ve going ON. Now the o/p of Voltage Comparator is high. When this Voltage reaches ~~exceeds~~ predefined max Value. the Voltage Comparator multivibrator change the o/p Voltage to low and lower current source connected to the integrator

→ The lower Current source supplies reverse current to the integrator when the o/p of integrator is a -ve going on when this Voltage Comparator multivibrator change the o/p Voltage is high and the upper Current Source Connected to the integrator then is known as reverse Current

→ Hence the o/p of integrator is a Triangular wave whose freq depends on magnitude of Current supplies by Current source

→ The o/p of Voltage Comparator is a square wave of same freq

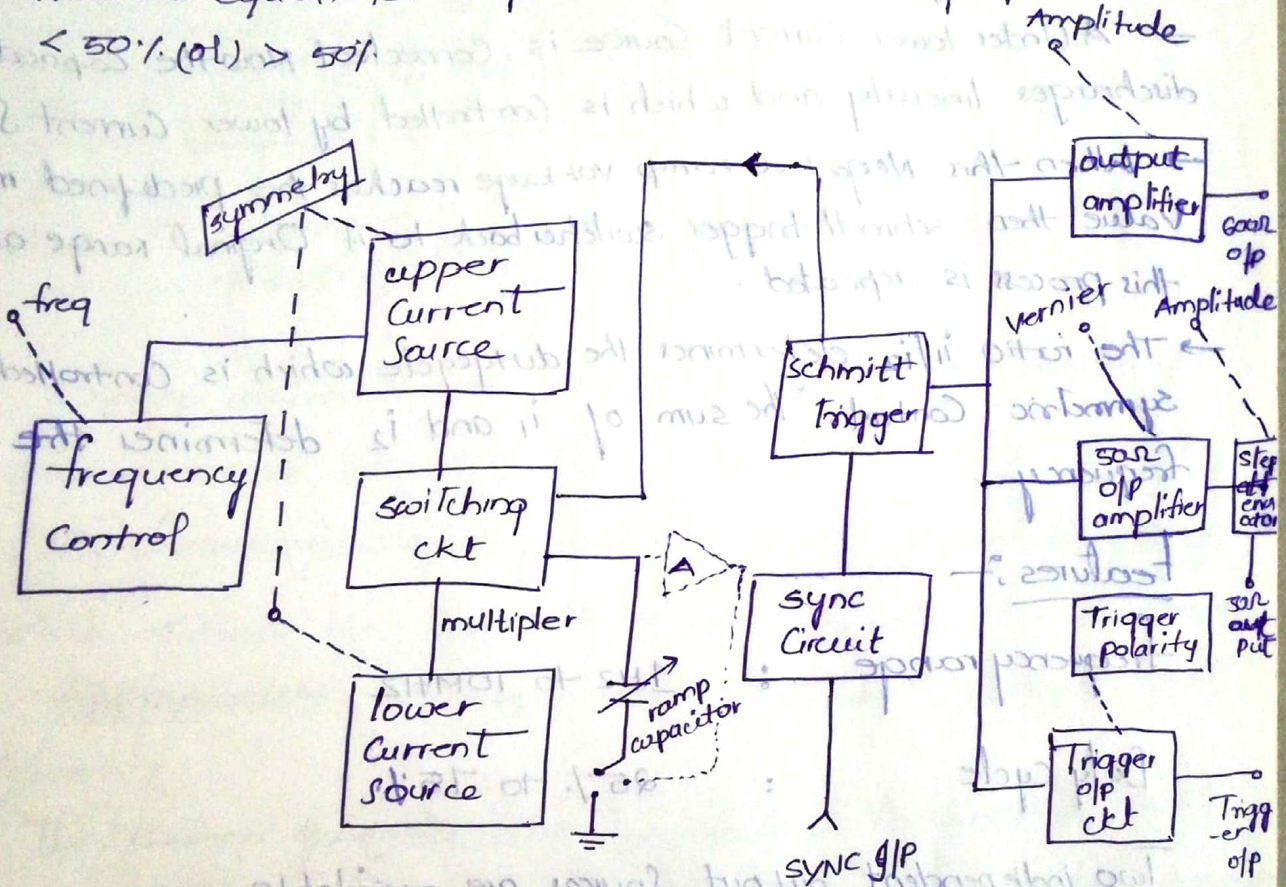
→ The resistance diode shaping ckt allows that the slope of triangular wave accordingly to the amplitude and produce a Sine wave less than 1% distortion

Square and pulse Generator :—

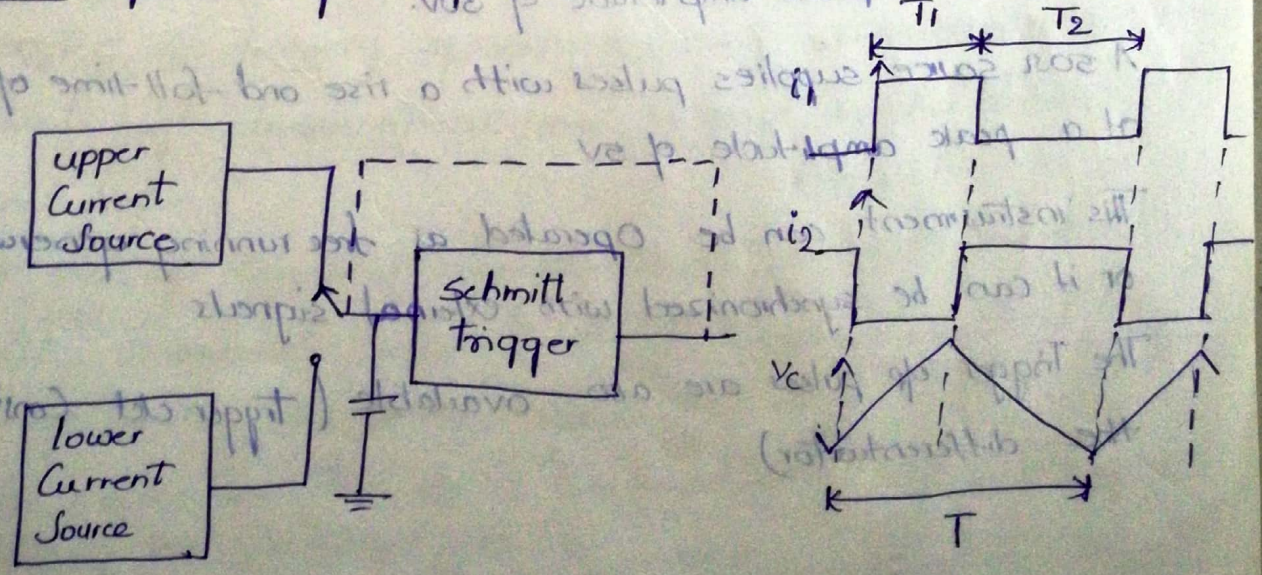
→ The square and pulse generator along with CRO can be used as a Measuring instrument.

→ The fundamental difference b/n pulse wave-form and square wave is duty cycle

→ For a square wave the duty cycle is 50% (ON and OFF times are equal) for a pulse wave the duty cycle is < 50% (or) > 50%



Basic generating loop :—



→ The basic generator loop consists of two current source one ramp capacitor, shmitttrigger and current switching ckt as show in fig

→ The upper current source supplies constant current for charging ramp capacitor

→ As ramp capacitor charges the voltage across the capacitor increases linearly

→ At this +ve ramp voltage reaches a predefined maximum value then Schmitttrigger changes the o/p state

→ A Under lower current source is connected Now the capacitor discharges linearly and which is controlled by lower current source

→ When this Negative ramp voltage reaches the predefined min value then schmitt trigger switches back to it Orginal range and this process is repeated.

→ The ratio i_1/i_2 determines the dutycycle which is controlled by symmetric control. The sum of i_1 and i_2 determines the frequency

Features:-

frequency range : 1Hz to 10MHz

Duty cycle : 25% to 75%

Two independent output sources are available.

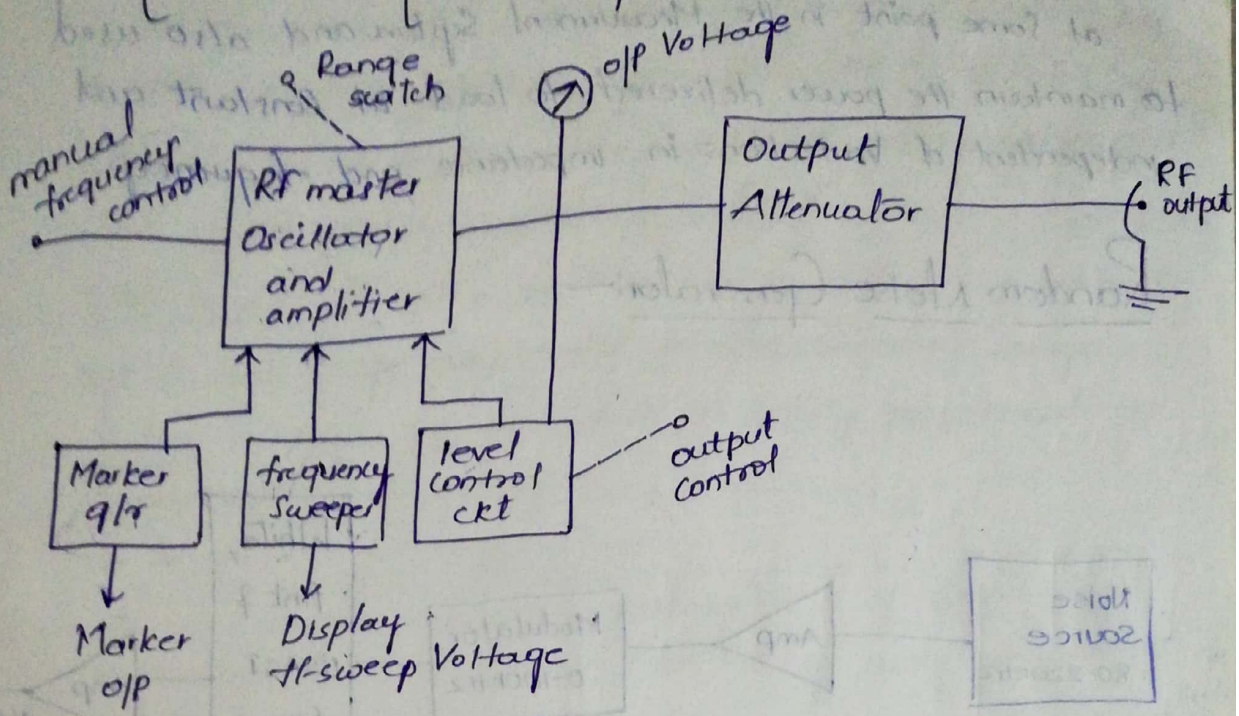
A 600Ω source supplies pulses with raise and fall time of 70nsec at a peak amplitude of 30V.

A 50Ω source supplies pulses with a rise and fall time of 5ns at a peak amplitude of 5V

This instrusiment can be operated as free running generator or it can be synchronized with external signals

The Trigger op pulses are also available (trygger ckt consists the differentiator)

Standard Sweep Generator :—



→ Sweep generators are generally sweeps in frequency in a linear manner but also offers logarithmic sweep frequency.

→ The frequency sweeper provides Variable modulating voltage which causes the capacitances of Oscillator to be Varied.

→ Approximately the sweep rate is around 20 sweeps per second.

→ The sweep generator also provides a Vary sweep Voltage to the horizontal deflection plates of CRO for synchronization

→ A ramp signal is applied to Voltage tuned oscillator then the o/p frequency of Voltage tuned oscillator sweeps from low to high frequency as ramp Voltage reaches from 0 to final Value.

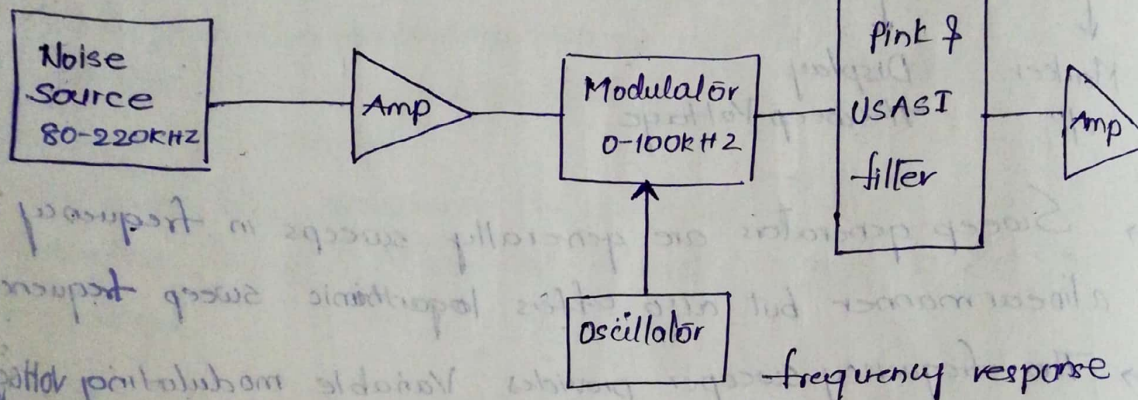
→ To identify frequency interval Marker generator provides a half Sinosoidal Signal to the oscillator at any frequency range within the sweep range.

→ The marker generator o/p is Combined with sweep Voltage of the CRO at alternate cycle of sweep

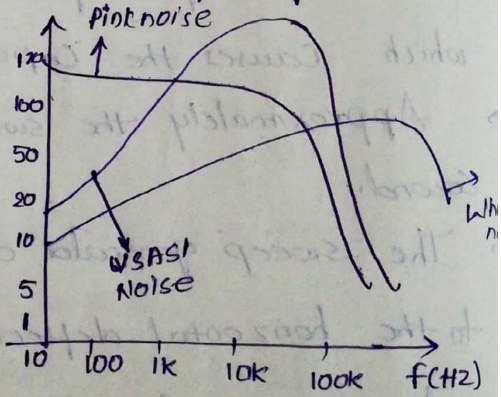
→ The Manual frequency Control is used to adjust the resonant frequency of Oscillator

→ The level Control circuit is used to maintain the RF l
at some point in the Measurment System and also used to maintain the power delivered to load at Constant and independent of Variations in impedance and frequency.

Random Noise Generator:-



frequency response



→ A random noise generator generates a o/p signal whose amplitude Varies randomly and doesn't contain any perodic frequency Component

→ This instrument offers the possiblity of using a single measurm to indicate the performance over entire frequency band.

→ The Noise source can be a semiconductor noise diode which supplies noise frequency in range of 80 to 220KHz

→ The o/p from noise diode Can be amplified and given to balanced symmetrical modulator Where it is mixed down to

→ Where a band of audio frequency range.

→ The filter arrangment is used to control the bandwidth and the o/p signal supplies a spectrum of 3 choices while pink and usnsi Noise.

White Noise:— It Covers the all the frequency range and has equal power spectral density

Pink Noise:— It has a spectrum same as that of red light ~~wave~~ It has large amplitude at low frequency range

→ It has Voltage spectrum which is invesly proportional to square root of frequency.

It is similar USASI Noise:—

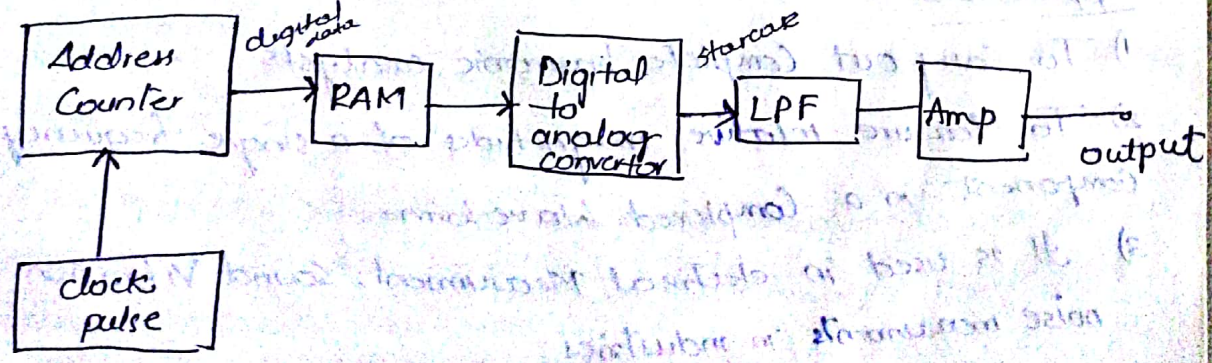
It is similar to energy distribution of speech and music signal. and it is used for testing audio amplifiers and loud speakers.

Arbitary Waveform Generator:—

→ Arbitary wave-form doesn't contain any predefined particular shape or characteristic. the amplitude or frequency of arbitary wave-form varies in a random manner.

→ The arbitary wave-form may be perodic or may a nonperodic. It may also include Transitions and noise components. etc

→ The arbitary wave-form can be used as test signal to determine whether the testing equipment is functioning properly are not and also use to determine the false present in the equipment



→ The arbitary Waveform generator produces an o/p signal based on the digital data stored in Ram

→ The digital data samples stored in RAM gives the detailed information about the desired waveform.

→ The digital-to analog convertor produces voltage proportional to digital data supplied to it.

→ The address counter is incremented for every clock pulse is applied.

→ The digital to analog convertor o/p is staircase wavefo and a Lowpass filter is used for smooting the staircase waveform by removing higher frequency component

According to sampling theorem the sampling frequency must be taken at nyquist frequency = $f_s \geq 2f_m$ inorder to preserve the information of the signal.

f_m = maximum frequency of signal component

f_s = sampling frequency.

Wave Analyzer:—

→ It can be show mathematically that any complex wavefo can be made up of a fundamental and its harmonic

→ Wave analyses are used to measure the magnitude of a single frequency component

→ Basically wave analyser is a frequency selective voltmeter which is tuned to frequency of one signal component while rejecting all other frequency signal Component

→ These are used in frequency range 10Hz to 40MHz

Applications:—

1) To Carry out Complete harmonic analysis

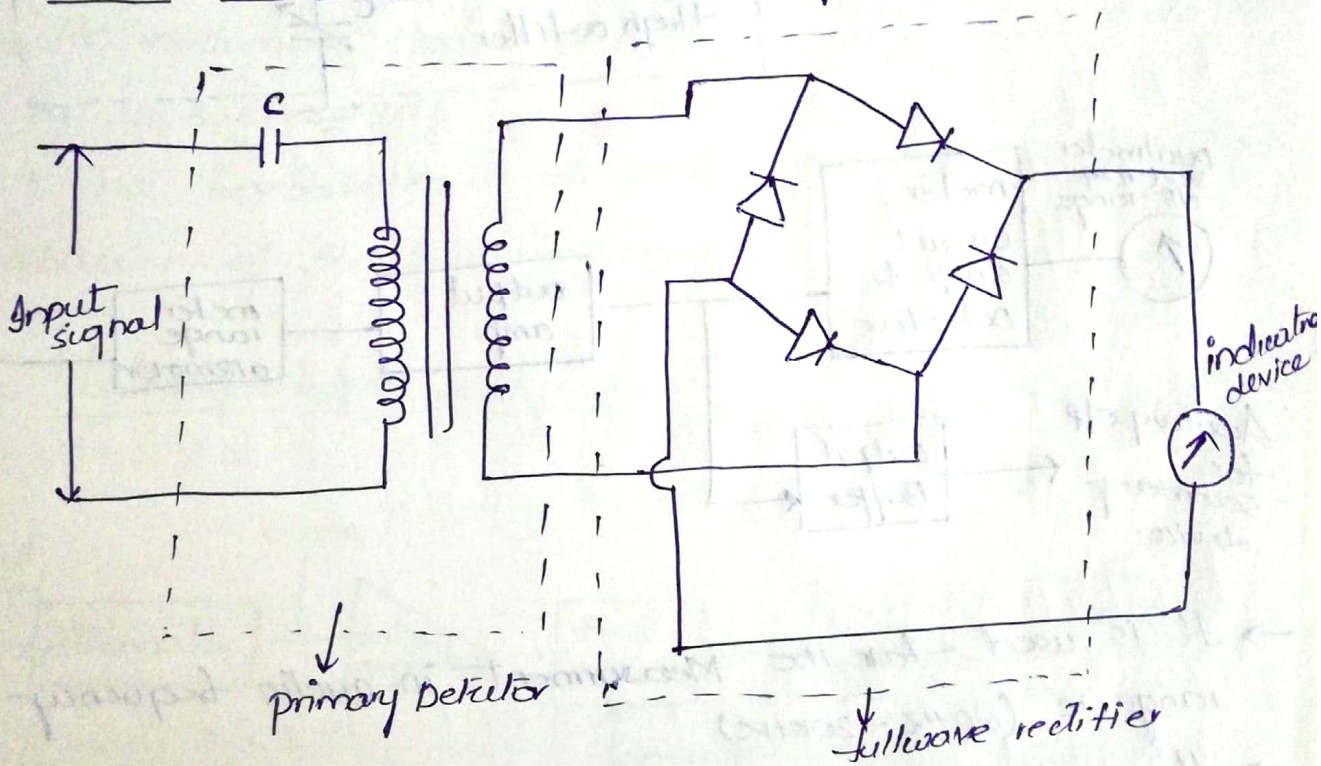
2) To Measure relative magnitude of a single frequency Component in a Complexed Waveform.

3) It is used in electrical Measurment, sound Vibration noise measurments in industries.

Types of Wave Analyzer:-

1) Basic (or) Resonant wave analyzer.
2) frequency selective Analyser.
3) Heterodyne wave analyser.

Basic (or) Resonant Wave Analyzer:-



The basic wave analyser consists of primary detector full wave rectifier and an indicating device.

primary Detector is a simple LC circuit.

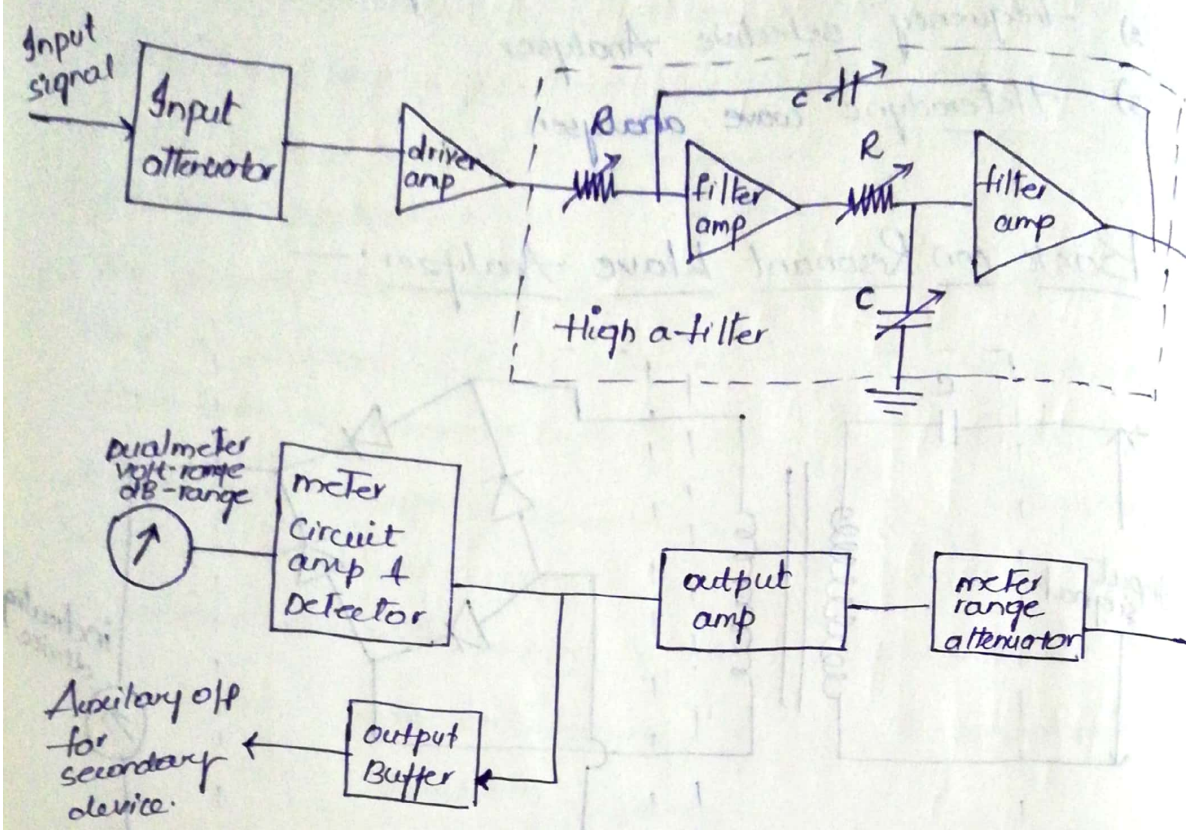
Since LC circuit is tuned to a simple frequency and reject

full Wave rectifier is used to obtain the average value of the Input

Indicator:- It is a DC voltmeter that is calculate to read the peak value of Input signal.

A No: of tuned circuits are connected to indicating device through a selected switch for a useful wave analyser.

Frequency Selective Wave Analyzer :—



→ It is used for the Measurment in audio frequency range ie (20Hz – 20kHz)

→ It consists of a Narrow band pass section which transmits a single frequency and reject remaining rang

→ The complex signal to be analysed can be given to a adjustable attenuator which serves as range multiplier her large signal amplitude can be analyzed with out loadin to amplifier

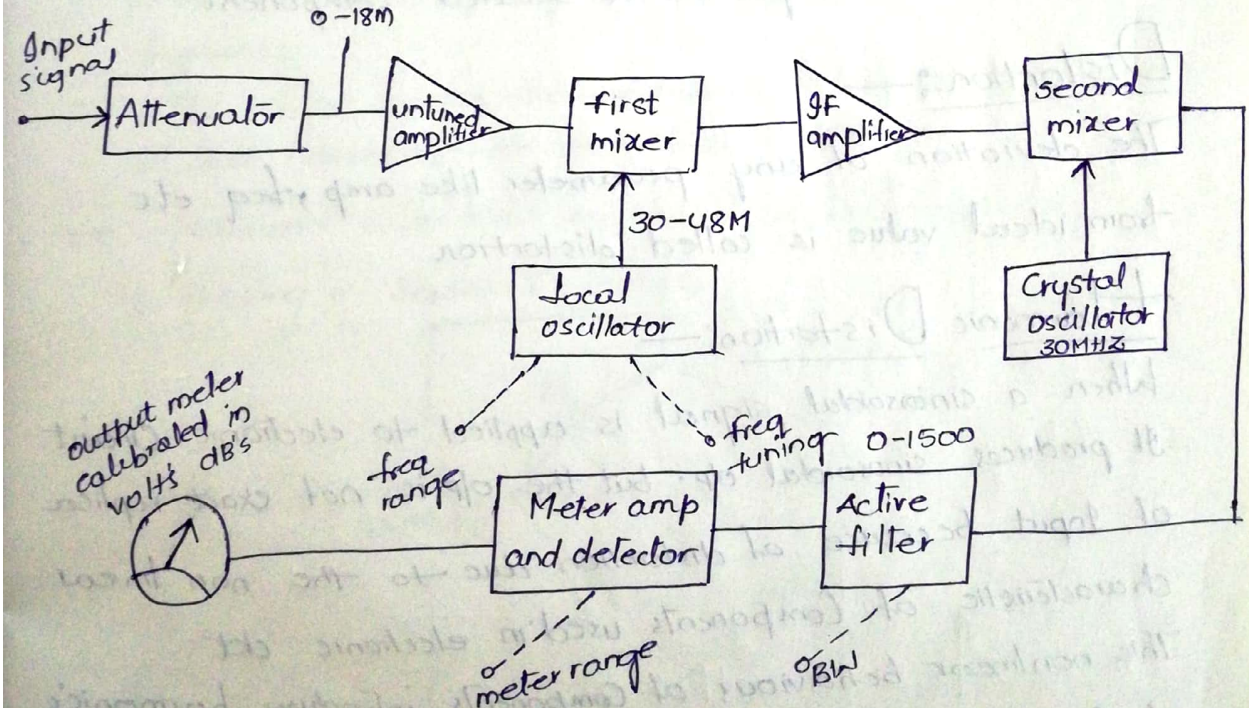
→ The attenuated dp signal is given to active high Q filter section through a driver amplifier.

→ The high Q-filter section is tuned to a single frequency Component. It Consist of cascaded resonance ckt & amplifier

→ The capacitor is used to selects the frequency range and the precision potentio meter is used to select the desired frequency in a selected band.

→ The entire Af range is covered in decade steps by switching the capacitor in RC circuit.
→ The selected signal from output amplifier can be given to meter circuit and untuned buffer amplifier.
→ The buffer amplifier is used to drive output device such as recorders and electronic counters.
→ The Meter is calibrated in volts and dB to measure the magnitude of selected frequency component
→ The instrument should have less distortion which is undetectable by instrument itself.
→ The bandwidth of this instrument is very low typically above 1% of selected frequency.

Hetrodyne Wave analyzer :—



→ Hetrodyne wave analyzers are designed for measurments in radio frequency range and above MHz range.
→ Its operation depends on the principle of heterodynamic or mixer
→ The signal to be analysed is given to attenuator and untuned amplifier
→ The output of attenuator is heterodyne in first stage mixer with the signal from local oscillator having the frequency

30-40MHz.

→ The first stage mixer produce output as If signal, which is the difference btn input signal frequency and local oscillator frequency. This If signal is uniformly amplified by If amplifier

→ The amplitude of If signal is given to second mixture where it is again heterodyne with Crystal oscillator frequency and produce a difference frequency or If signal of zero frequency

→ The selected Component is passed through meter amplifier and detector through active filter having a controlled Bandwidth and o/p meter is calculated in Volts and dB to indicate the magnitude of selected Component

Distortion:—

The deviation of any parameter like amp, freq etc from ideal value is called distortion

Harmonic Distortion:—

When a sinusoidal signal is applied to electronic Circuit it produces sinosoidal o/p. but the o/p is not exact replica of Input because of distortion due to the non linear characteristic of Components used in electronic ckt

This nonlinear behaviour of Components introduces harmonics of fundamental frequency. this distortion is called Harmonic distortion. The total harmonic distortion or distortion factor is given by $D = \sqrt{D_2^2 + D_3^2 + \cdots + D_n^2}$

$$D_2 = \frac{E_2}{E_1}$$

$$D_3 = \frac{E_3}{E_1}$$

$$D_n = \frac{E_n}{E_1} \qquad D = \frac{\sqrt{E_2^2 + E_3^2 + \cdots + E_n^2}}{E_1}$$

where D_n = distortion due to n^{th} harmonic

E_n = amplitude of n^{th} distortion

Harmonic Distortion Analyzer:-

→ To Measure Various distortion in the signal, we use distortion analyzer

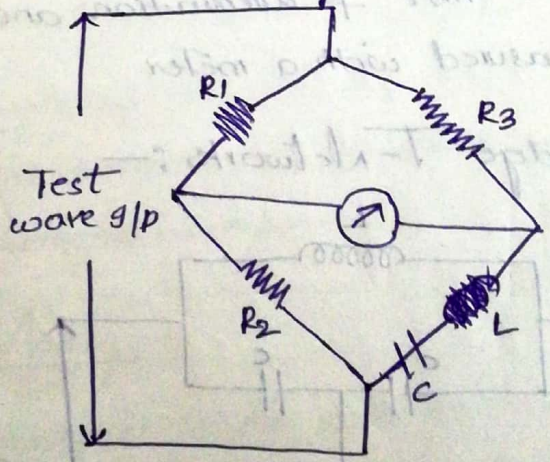
→ Harmonic distortion analyzer measures the total harmonic distortion without indicating amplitude & frequency of each Component

→ To Measure total harmonic distortion the o/p signal passes through a narrow band reject filter whose cut off frequency is the fundamental frequency or a high pass filter whose cutoff frequency is little above the fundamental frequency.

→ The filter supress the fundamental frequency & transmitts all over harmonics for the Measurment

→ Harmonic Distortion Analyzer Can be designed by

i) using a Resonant bridge



→ The bridge is tuned to a fundamental frequency & the bridge is balanced for fundamental frequency

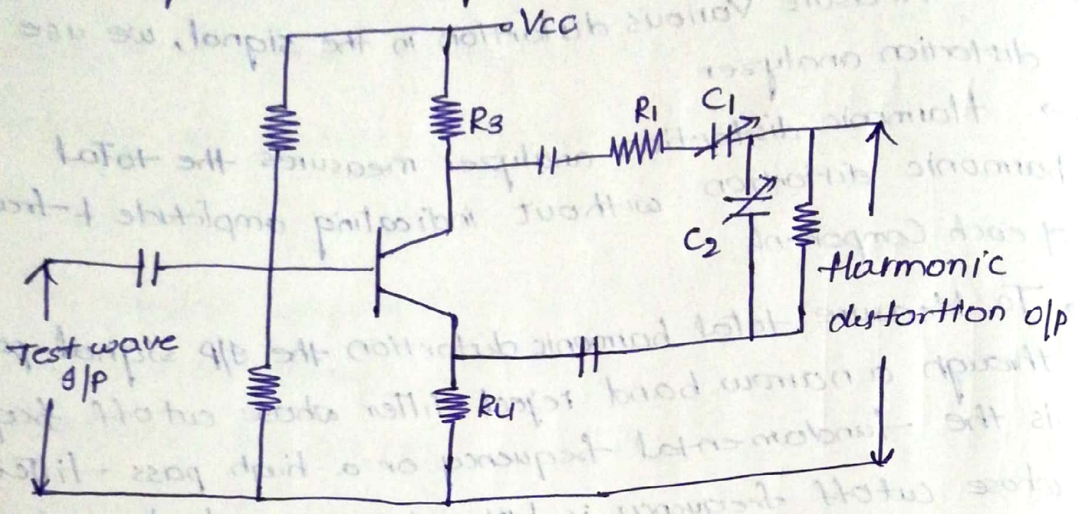
→ The bridge is not balanced for harmonics i.e the harmonic power will be available at the o/p for the measurment

→ If the fundamental frequency is changed then the bridge must be balanced again

→ for a fixed values of L & C this bridge is used for test wave with a fixed frequency

→ When a continuous adjustment of fundamental freq is desired then weinbridge circuit is used

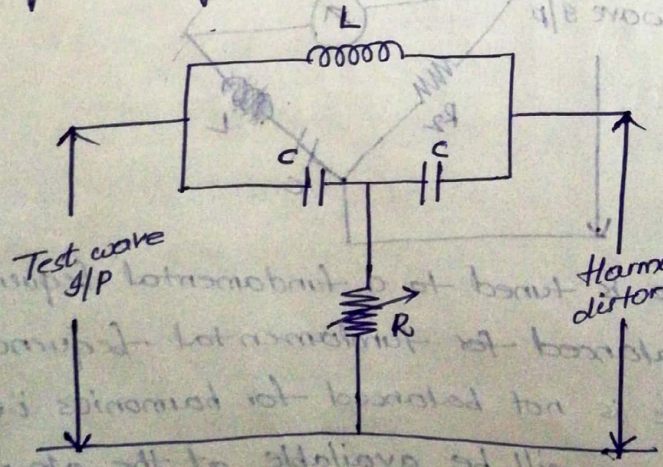
ii) Using a Wein Bridge :—



→ The Wein bridge ckt can be used as rejection filter for the fundamental frequency & the bridge is balanced for fundamental freq by setting proper values of R_1 & R_2

→ for all other frequencies weinbridge offer varying degrees of phase shift & attenuation and the distorted o/p can be measured with a meter

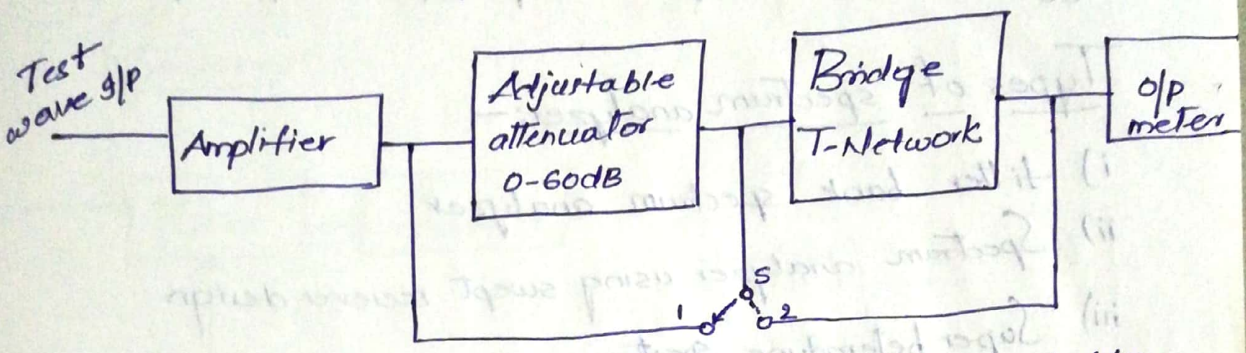
iii) Using a Bridge T-Networks :—



→ The bridge T-N/w reject the fundamental frequency & transmits all other harmonic component to the o/p the distorted o/p can be measured in meter

→ for a better performance, high quality factor resonance Circuit is used

→ The harmonic distortion analyzer using bridge T-N/w is shown in fig



→ first the switch is connected to position 1 adjustable attenuator is not included in the ckt.

→ At this time, the bridge T-N/w is turned to a fundamental frequency (min o/p). This minimum o/p indicates the bridge is balanced for fundamental frequency.

→ The switch is connected to position 2, then bridge T-N/w is not included in the ckt and the adjustable attenuator is varied until the same o/p obtained on the meter

→ At this time, the meter reading gives total RMS distortion

→ The Harmonic distortion Analyzer works on the principle of fundamental frequency seperation & it is easy to design & low cost than wave Analyzer

Disadvantages:-

It gives total distortion & does not gives amplitude of individual distortion components

Spectrum Analyzer:-

→ spectrum Analyzer is an instrument design to produce graphical display of spectrum of frequencies on the CRT screen with frequency is X-axis & amplitude in Y-axis.

→ In Ordinary CRO, the signal is plotted as a function of time i.e amplitude Vs time such analysis called as Time domain analyzer

→ In spectrum analyzer the signal is plotted as a function of frequency i.e amp Vs freq Such analysis is called

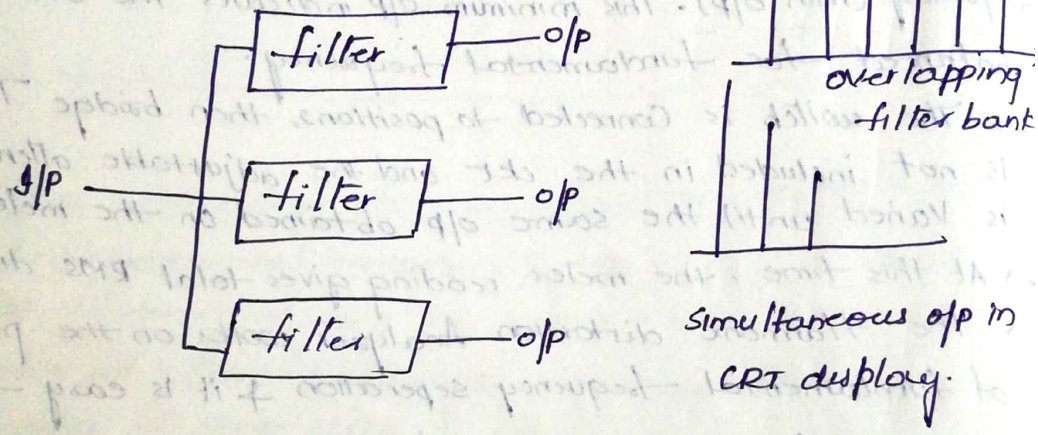
as frequency domain analyzer.

→ The spectrum of a signal gives the information about Bandwidth, frequency stability & spectral purity. atte etc

Types of spectrum analyzer:-

i) filter bank spectrum analyzer
ii) Spectrum analyzer using swept reciever design
iii) Super heterodyne spectrum analyzer

Filter bank spectrum analyzer:-

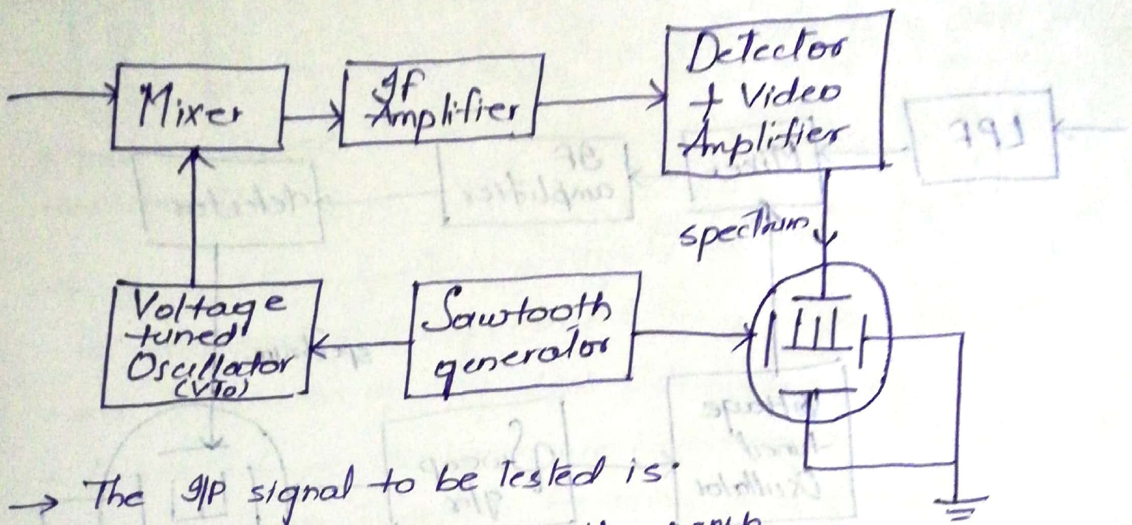


→ In case of fillerbank spectrum analyzer, the freq rang is Covered by a series of filter whose Central freq choos such away that the filter are overlapping as shown in fi
→ the parallel filter bank analyzer uses 'n' no: of filters
→ Each filter is tuned to different frequencies and ea filter removes the all the frequencies Component except a particular frequencies that the frequencies was designe to measure
→ The filter o/p's are detected and displayed to the CRT screen
→ In the analyzer the frequency resolution of bank of filt depends on the bandwidth of individual filters
→ By increasing the no: of filters we can increase the freq

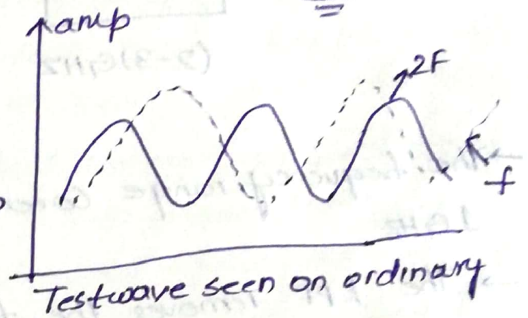
range + frequency resolution.

This is not suitable for white bandwidth measurement

Spectrum Analyzer Design Using Swept Reciever:-

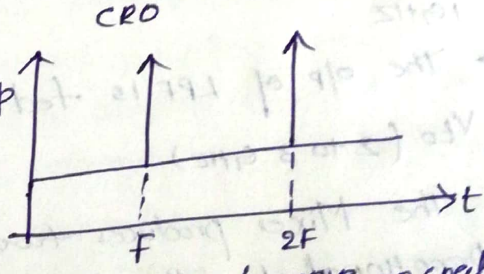


→ The I/P signal to be tested is applied to mixer the sawtooth generator generates a sawtooth voltage signal is given to voltage tuned Oscillator and to horizontal deflection plates of the CRT



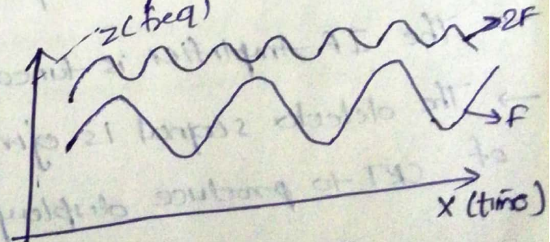
Test wave seen on ordinary CRO

→ As VTO frequency sweeps from fmin to fmax of its frequency band width at a linear rate and beats with the input signal frequencies generates an IF signal Component.



Display of wave on spectrum analyzer

→ The resulting IF signal is filter and amplified by IF amplifier and rectified by amp detector ckt and this detected signal is given to Vertical deflection planes of CRT.

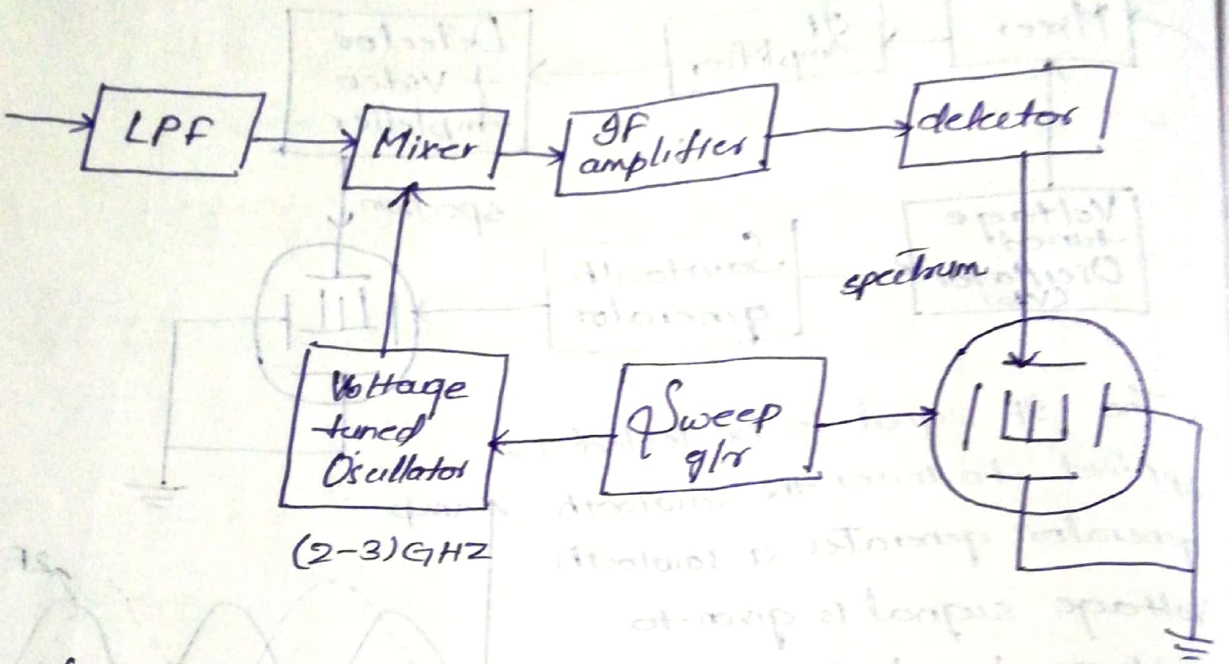


→ As Vto frequency sweeps the amplitude of different freq Components appears on the screen one by one in horizontal directions

→ By using this instrument we can measure the freq. in the range of 1MHz to 40GHz

Super Heterodyne Spectrum Analyzer:—

(RF spectrum Analyzer)



→ The frequency range covered by this ckt is 500MHz to 1GHz.

→ The LPF removes the frequencies components higher than 1GHz

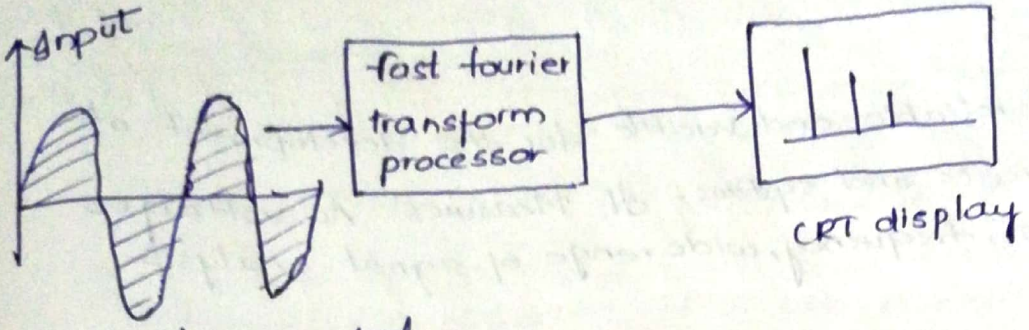
→ The o/p of LPF is fed to mixture which is driven by Vto (2 to 3 GHz)

→ The Mixer produces two o/p signals whose amplitudes are proportional to i/p signal and their frequencies are sum and difference frequencies components of i/p signals and Vto sig

→ The IF Amplifier is tuned to a narrowband around 2GHz

→ The detecto signal is given to Vertical deflections plate of CRT to produce display of amplitude Vs freq.

Digital fourier Analyzer :— (FFT spectrum Analyzer)



signal is sampled for time T

→ In realtime spectrum analyzer the signal is analyze by bandpass filtering, Notch filtering, frequency Transulation and Combination of any these Techniques

→ Digital fourier Analyzers are based on the calculation of discrete fourier transform by using an algorithm. this algorithm calculates amplitude, phase of each signal component from a set of time domain samples of Input

→ FFT is very efficient mathematical technique for Computing the spectrum of waveform from its time domain samples.

→ The Input signal is sampled and turned into digital by using an appropriate analog to digital Convertion method the rate at which sampling occurs is called sampling rate. According to sampling theorem the sampling should be done at nyquist rate to preserve the information of Signal

→ The output of ADC is a set of digital numbers representing the amplitudes of Input waveform. These set of samples are called data record and stored in ram.

The FFT processor performs certain series of Calculation and record data to obtain frequency domain results. These results Can be displayed on CRT.