Superheterodyne Receiver

Some of the performance parameter of a good receivers are

i) Sensitivity, which may be defined as ~~its~~ ability of radio receiver to amplify weak signals.

ii) Selectivity, which may be defined as the ability of radio receivers to reject unwanted signals.

iii) Feidlity i.e how accurately receiver is capable of producing exact replica of the message signal which was modulated & transmitted at the transmitter end.

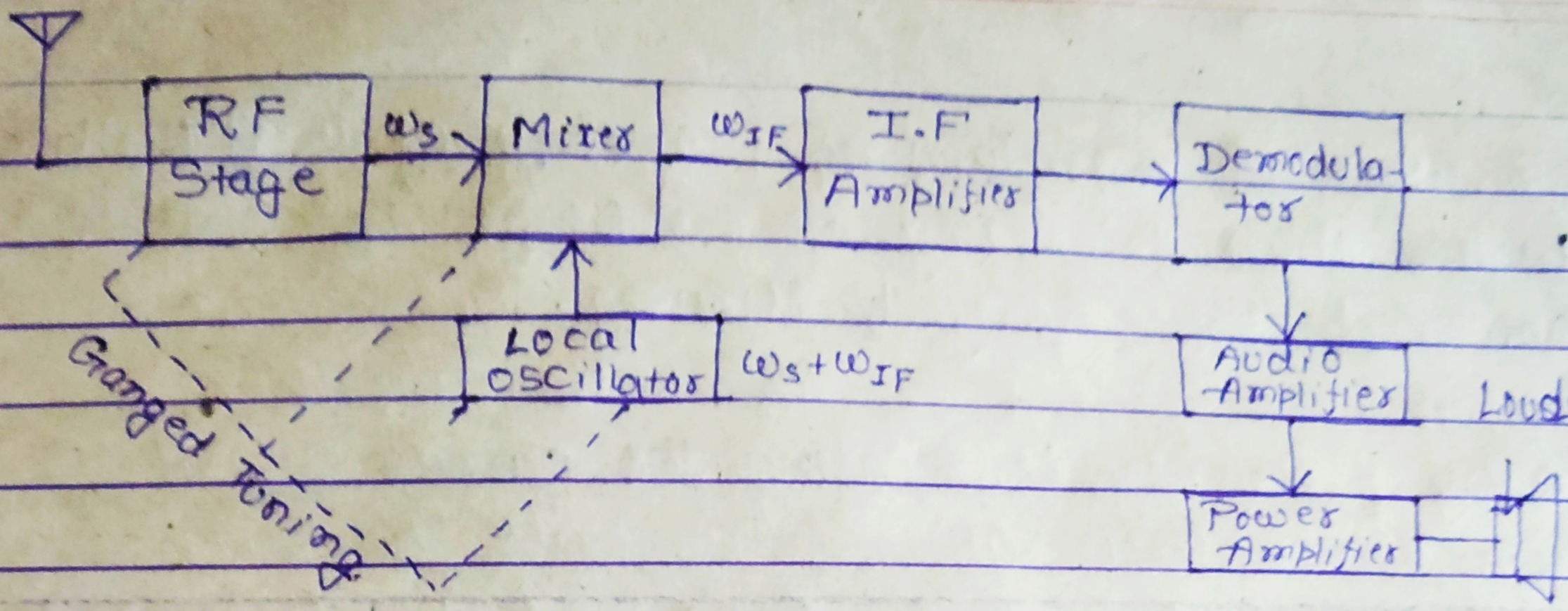
It is easy to design a receiver which has high sensitivity, high selectivity and high fiedility for a <u>particular frequency signal.</u>

Where as it is very difficult to design a receiver which has high sensitivity, selectivity and fiedility to a range of frequency signal.

It is this junction where frequency translation or heterodyne concept becomes very important. And it is the basis of designing & working principle of Superheterodyne receiver.

In a superheterodyne receiver, the incoming RF signal frequency is ~~the~~ frequency translated to a signal of lower fixed frequency called Intermediate frequency.

This intermediate frequency signal contains the same modulation as the original signal. Since signal has been translated to Intermediate frequency which is a fixed frequency. So receiver can be designed to have high selectivity, sensitivity and fiedility at this fixed frequency called Intermediate frequency.



Block diagram of Superheterodyne receiver

Intermediate frequency has been set fixed (for commercial purpose it is 455 KHz).

Since IF is fixed, IF amplifier which is designed specifically for this fixed frequency will have high selectivity, sensitivity and fiedility.

RF stage picks up the incoming signal and do some amplification. Let RF stage picks up the signal whose frequency is ω_s.

The frequency of local oscillator is always kept ω_{IF} higher than the frequency of the signal that RF stage picks up. So that after mixing the signal at the i/p of IF amplifier is always of fixed frequency ω_{IF}.

This work of maintaining frequency of local oscillator higher than frequency of RF stage by ω_{IF} is achieved by Ganged tuning.

So by frequency translating the ~~carries~~ signal from ω_s to ω_{IF} all requirements has been met and now it is this Intermediate frequency signal which will now be demodulated ~~and~~ to reproduce the original signal.

Since heterodyne (mixing) action is performed by local oscillator whose frequency is higher than incoming signal frequency by ω_{IF}, hence the name given Superheterodyne receiver.

The IF amplifier provide most of the gain and bandwidth requirement (selectivity) of the receiver. This means that IF amplifier determines the sensitivity and selectivity of the superheterodyne receiver.

Also, Since the characteristics of the IF amplifier are independent of the incoming frequency to which the receiver is tuned, the selectivity and sensitivity of the superheterodyne receiver are

quite uniform throughout its tuning range and not subject to the variations like a TRF receiver. Further Since the IF amplifier works at a fixed IF frequency, the design of this system is quite easy to provide high gain and ~~cost~~ constant bandwidth.

Because of its narrow bandwidth, the IF amplifier rejects all other frequencies except IF. Actually, this rejection process reduces the risk of interference from other station or sources.

However, ~~the~~ problem of Image frequency which is inherent to Superheterodyne receiver is taken care by tuning of RF Stage.

If ω_s is the frequency of incoming signal & ω_{IF} is the intermediate frequency, the Image frequency will be $\omega_s + 2\omega_{IF}$.

RF stage is designed & so that it ~~the~~ may allow ω_s and some other near by signal but it stop any signal with frequency as high as $\omega_s + 2\omega_{IF}$. Hence through this mechanism Image frequency rejection has been achieved.

The rejection of an image frequency signal by single tuned circuit is defined as gain at signal frequency to the gain at the image frequency. This is given as

$$\alpha = [1 + Q^2\rho^2]^{1/2}$$

$$\rho = \frac{\omega_{si}}{\omega_s} - \frac{\omega_s}{\omega_{si}}$$

Q = Quality factor

ω_{si} = image frequency

After the IF amplifier, the signal is applied at the input of demodulator which extracts the original modulating signal. This audio signal is amplified by an audio amplifier to get a particular voltage level.

This amplified audio signal is further amplified by a power amplifier to get a specified power level so that it may activate the loudspeaker.

The loudspeaker is a transducer which converts this audio electrical signal into audio sound signal and thus the original signal is reproduc

The advantages of the superheterodyne receiver make it the most suitable for the majority of radio receiver applications like AM, FM, Communi-cations, Single-sideband, television and even radar receiver all uses superheterodyne principle.