(iv) Image Frequency and its Rejection

Image Frequency

To understand image frequency, consider a receiver which is tuned to receive 1000 kHz frequency. Now, consider the following cases :

Case (i)

- The receiver is tuned to a frequency of 1000 kHz.

$$\therefore \quad f_s = 1000 \text{ kHz}$$

- As the IF frequency is set to 455 kHz, the local oscillator frequency is

$$f_o = f_s + f_i$$

$$\boxed{f_o = 1455 \text{ kHz}}$$

- Now, the receiver will work for input frequency (f_s = 1000 kHz), since the difference of f_s and f_o is equal to IF frequency. This is the normal operation and nothing is wrong. Now consider the second case.

Case (ii)

- Now consider another case with same value of f_o and f_i in the above case but f_s is now 1910 kHz.

$$\therefore \quad f_s = 1910 \text{ kHz}$$

- The difference of f_o and f_s is still equal to f_i i.e. 455 kHz

$$f_i = f_o - f_s = -455 \text{ kHz}$$

$$= 455 \text{ kHz} \qquad (\because \text{We cannot have -ve frequency})$$

- Since, the receiver will always work if the difference of f_s and f_o is f_i, the receiver will detect this signal also.
- The frequency of 1910 kHz in this case is called *image frequency* and it is given by

$$\boxed{f_{si} = f_s + 2f_i}$$

f_{si} = Image frequency

f_i = Intermediate frequency, normally f_i = 455 kHz

f_s = Signal frequency.

Image Frequency Rejection Ratio

- It is denoted by α
- It is the ratio of the gain of the receiver at signal frequency to the gain at image frequency.
- It is given by

$$\alpha = \frac{\text{Gain at signal frequency}}{\text{Gain at image frequency}}$$

- It depends on the quality factor Q in the following manner

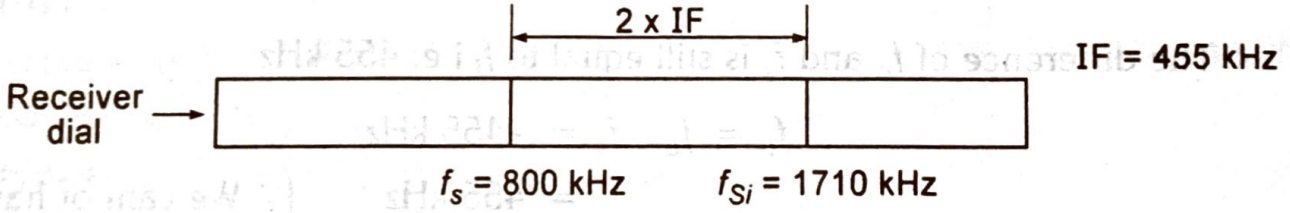
$$\alpha = \sqrt{1 + Q^2\rho^2}$$

where $$\rho = \frac{f_{Si}}{f_s} - \frac{f_s}{f_{Si}}$$

Double Spotting

Note : *Double spotting is not a receiver characteristic, it is just a problem faced in some receivers due to poor characteristics.*

- Double spotting means the same station gets picked up at two different points on the receiver dial.
- It can occur if a signal is stronger than the signal at its image frequency.



- Consider the figure above

$$f_s = 800 \text{ kHz}$$

$$f_{Si} = 2 \times \text{IF} + 800 \text{ kHz} = 1710 \text{ kHz}$$

Assume that the signal with frequency 800 kHz is of very high strength compared to the signal with frequency 1710 kHz.

Consider the following cases

Case (i) : Receiver Dial is Tuned to 800 kHz

- As the strength is very high, the signal is picked up and nothing is wrong. Problem occurs in the next case.

Case (ii) : Receiver Dial is Tuned to 1710 kHz

- As the signal at 1710 kHz is weak and also, as 1710 kHz is the image frequency of 800 kHz, the receiver can detect both the signals.
- Now, as the strength of original signal is less than the image signal, the image signal is selected.
- Thus, the same signal is selected at two points. This is called *double spotting*.

Blocking

- If a radio receiver is tuned to a weak signal, then the corresponding Automatic Gain Control (AGC) will be very low, and the gains of the RF and IF stages will be high. If a strong signal which is close in frequency to the weak signal is present then the AGC voltage may reduce due to its presence. This may suppress the wanted signal completely. Also if the strong signal is fluctuating then the AGC voltage will fluctuate.
- A receiver which has a very little reaction to the nearby unwanted signals is said to have good blocking. To have excellent blocking, high adjacent channel rejection should be there. For this the selectivity of the IF amplifier should be high.