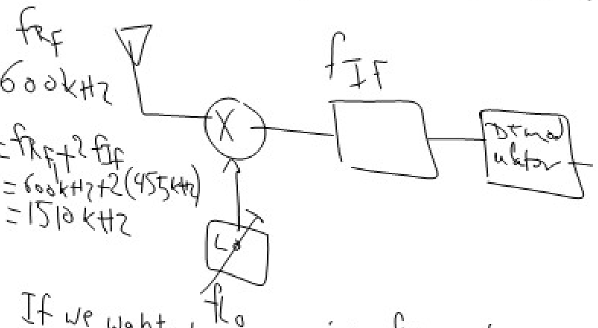
* The disadvantage of the Superheterodyne receiver is the presence of an image frequency

$f_{RF_1} = 600\,kHz$

$f_{RF_2} = f_{RF_1} + 2f_{IF}$
$= 600\,kHz + 2(455\,kHz)$
$= 1510\,kHz$



If we want to receive f_{RF_1}, then

$f_{LO} = f_{RF_1} + f_{IF}$
$= 600 + 455 = 1055\,kHz$

Similarly at this local oscillator frequency, we have

$f_{RF_2} - f_{LO} = 1510 - 1055 = 455\,kHz$

* The above analysis shows that the receiver will receive both channels at the simultaneously
* Therefore f_{RF_2} is known as an image for f_{RF_1}
* The image frequency for any signal can be defined mathematically by

$$f_{image} = f_{RF_1} + 2f_{IF}$$

* The image frequency can be eliminated by
  a) using an image reject filter at the receiver
  b) choose your intermediate frequency according to

$$f_{IF} \geq \frac{f_{max} - f_{min}}{2}$$

for example we can eliminate the image problem completely in AM If we choose the IF to be

$$f_{IF} \geq \frac{1600 - 540}{2} = 530\,kHz$$

In FM system

$$f_{IF} \geq \frac{108 - 88}{2}\,MHz = 10\,MHz$$

c) To eliminate the image problem, we can let each transmitter on the assigned frequency and omits image

EX A given radar receiver operating at an RF frequency $f_{RF_1} = 2.8\,GHz$ using the superheterodyne receiver with local frequency $f_{LO} = 2.86\,GHz$. A second radar receiver operating at an RF frequency of f_{RF_2} which is the image for the first radar receiver

a) Determine the IF frequency for the first receiver
b) what is f_{RF_2}
c) what is the minimum value for the IF frequency that eliminates the image problem in the frequency range 2.8-3 GHz

Solution

a) $f_{LO} = f_{RF} + f_{IF}$

$2.86 = 2.8 + f_{IF} \Rightarrow f_{IF} = 0.06\,GHz$

b) $f_{RF_2} = f_{image} = f_{RF_1} + 2f_{IF}$

$= 2.8 + 2(0.06) = 2.92\,GHz$

c) $f_{IF} \geq \frac{f_{RF_{max}} - f_{RF_{min}}}{2}$

$\geq \frac{3 - 2.8}{2} = 0.1\,GHz$