

# Image-Frequency Interferences

## The Appearance of the Image-Frequency

Heterodyning is the combining of the incoming signal with the local oscillator signal. When heterodyning the incoming signal and the local oscillator signal in the mixer stage, four frequencies are produced. They are the two basic input frequencies and the sum and the difference of those two frequencies. It is possible for superheterodyne receivers to receive two different stations at the same point of the dial therefore.

$$f_{IF} = f_{rx} - f_{local\ oscillator}$$

$$f_{IF} = f_{local\ oscillator} - f_{rx}$$

There aren't any components which can distinguish a negative frequency of a positive frequency. We can measure the magnitude of the frequency only therefore:

$$f_{IF} = | f_{local\ oscillator} - f_{rx} |$$

The result is a second reception frequency as a „mirror image“ around the intermediate frequency. Assuming an intermediate frequency of 60 MHz, the local oscillator will track at a frequency of 60 MHz higher than the incoming signal. For example, suppose the receiver is tuned to pick up a signal on a frequency of 1030 MHz. The local oscillator will be operating at a frequency of 1090 MHz. The received and local oscillator signals are mixed, or heterodyned, in the converter stage and one of the frequencies resulting from this mixing action is the difference between the two signals, or 60 MHz, the IF frequency. This IF frequency is then amplified in the IF stages and sent on to the detector and audio stages.

Any signal at a frequency of 60 MHz that appears on the plate of the converter circuit will be accepted by the IF amplifier and passed on. So on a receiver with no RF amplifier, the input to the converter is rather broadly tuned and some signals other than the desired signal will get through to the input jack of the converter stage. Normally these other signals will mix with the local oscillator signal and produce frequencies that are outside the bandpass of the 60 MHz IF amplifier and will be rejected. However, if there is a station operating on a frequency of 1150 MHz, and this signal passes

through the rather broad tuned input circuit and appears on the input jack of the converter stage, it too will mix with the local oscillator and produce a frequency of 60 MHz ( $1150 - 1090 = 60$ ). This signal will also be accepted by the IF amplifier stage and passed on, thus both signals will be indicated on the screen.

### Calculation of the Image-Frequency

at the example of the FM radio frequencies (87,5 - 108 MHz):

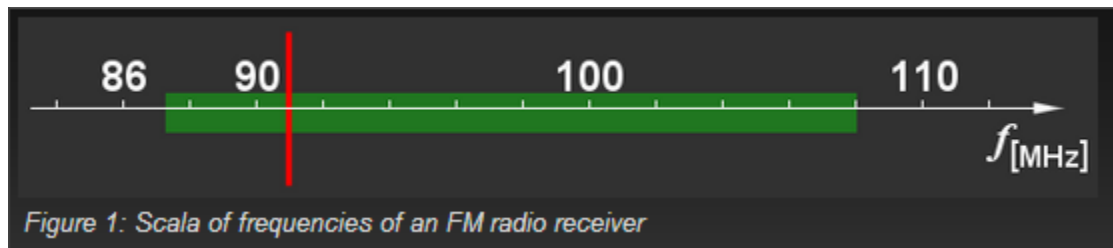


Figure 1: Scala of frequencies of an FM radio receiver

If an oscillator frequency is assumed above the reception frequency, then intermediate frequencies have to be expected from two reception frequencies at the exit of the mixer stage.

$$f_1 = f_{\text{oscillator}} + f_{\text{IF}}$$

$$f_2 = f_{\text{oscillator}} - f_{\text{IF}}$$

(Only the algebraic sign would change at an oscillator frequency below the reception frequency here.)

If I want to receive the highest frequency, then the image frequency must be below the receiving frequency more than the bandwidth (and reversed). Well, if I want to receive a frequency of 108 MHz, then a strange transmitter may send at approximately 87 MHz without to disturb.

I insert these two frequencies into the equations and transpose the oscillator frequency:

- $108,5 \text{ MHz} = f_{\text{oscillator}} + f_{\text{IF}}$

- $87,0 \text{ MHz} = f_{\text{oscillator}} - f_{\text{IF}}$
- $f_{\text{oscillator}} = 108,5 \text{ MHz} - f_{\text{IF}}$
- $f_{\text{oscillator}} = 87,0 \text{ MHz} + f_{\text{IF}}$

I can convict both relations in one equation now:

$$108,5 \text{ MHz} - f_{\text{IF}} = 87,0 \text{ MHz} + f_{\text{IF}}$$

...and can transpose to the IF:

$$2f_{\text{IF}} = (108,5 - 87,0) \text{ MHz}$$

$$f_{\text{IF}} = 10,75 \text{ MHz}$$

By a fluke: All the radio sets for this FM-waveband work on the intermediate frequency of 10,7 MHz!

If  $f_{\text{rx}} > f_{\text{Local Oscillator}}$  then:  $f_{\text{image}} = f_{\text{rx}} - 2 \cdot f_{\text{IF}}$

if  $f_{\text{rx}} < f_{\text{Local Oscillator}}$  then:  $f_{\text{image}} = f_{\text{rx}} + 2 \cdot f_{\text{IF}}$

**Source: <http://www.radartutorial.eu/09.receivers/rx06.en.html>**