Chapter 3 Amplitude Modulation (III)

AM-Radio Broadcasting (1/6)

- Commercial AM-radio broadcasting utilizes the frequency band 535-1605 kHz for the transmission of voice and music
- The carrier-frequency allocations range from 540-1600 kHz with 10 kHz spacing
- Radio stations employ conventional AM for signal transmission. The baseband message signal $m(t)$ is limited to a bandwidth of approximately 5 kHz
- The major objective to use conventional AM for broadcast is to reduce the cost of implementing the receiver

AM-Radio Broadcasting (2/6)

- The receiver most commonly used in AM-radio broadcast is the so-called *superheterodyne receiver*

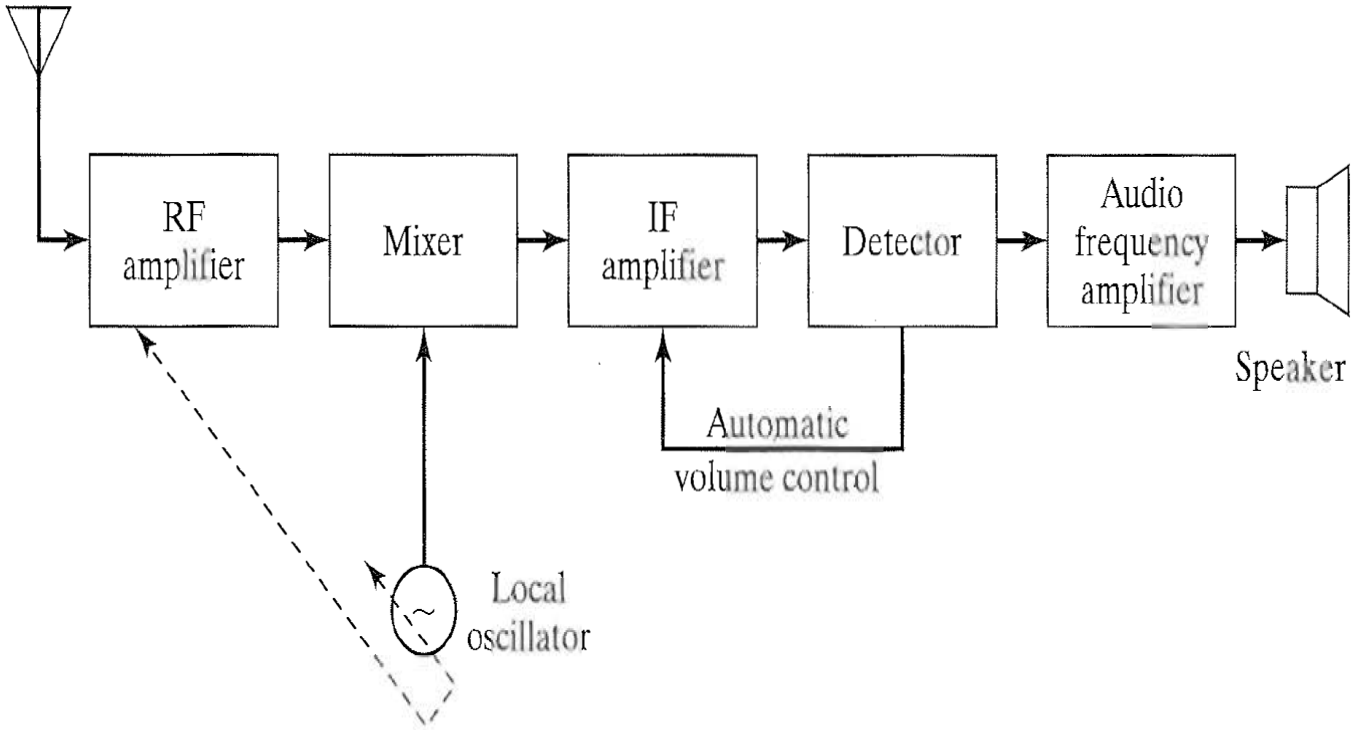

Figure 3.33 A superheterodyne receiver.

AM-Radio Broadcasting (3/6)

- In the superheterodyne receiver, every AM-radio signal is converted to a common IF frequency of f_{IF}=455 kHz
- This conversion allows the use of a single-tuned IF amplifier for signals from any radio station in the frequency band
- The IF amplifier is designed to have a bandwidth of 10 kHz, which matches the bandwidth of the transmitted signal
- The frequency of the local oscillator is

$$f_{LO}=f_c+f_{IF}$$

  f_c is the carrier frequency of the desired AM-radio signal
- The tuning range of the local oscillator is

  $f_{LO}=f_c+f_{IF}=(540\sim1600)+455 =995\sim2055$ kHz

AM-Radio Broadcasting (4/6)

- By tuning the RF amplifier to the frequency f_c and mixing its output with the local oscillator frequency f_{LO}, we obtain two signal components; one is centered at f_c and the other is centered at $f_{LO}+f_{IF}=f_c+2f_{IF}$
- Only the signal located at f_c is passed by the IF amplifier. The other one located at f_c+2f_{IF} is suppressed by the RF amplifier
- B_c is the bandwidth of the AM-radio signal (10 kHz)
- B_{RF} is the bandwidth of the RF amplifier
- The *image-frequency* signal is transmitted at $f_c'=f_{LO}+f_{IF}$

AM-Radio Broadcasting (5/6)

- If $\frac{B_c}{2} < \frac{B_{RF}}{2} < f_{IF}$, we can reject the radio signal transmitted at so-called *image frequency*. Hence $B_c < B_{RF} < 2f_{IF}$

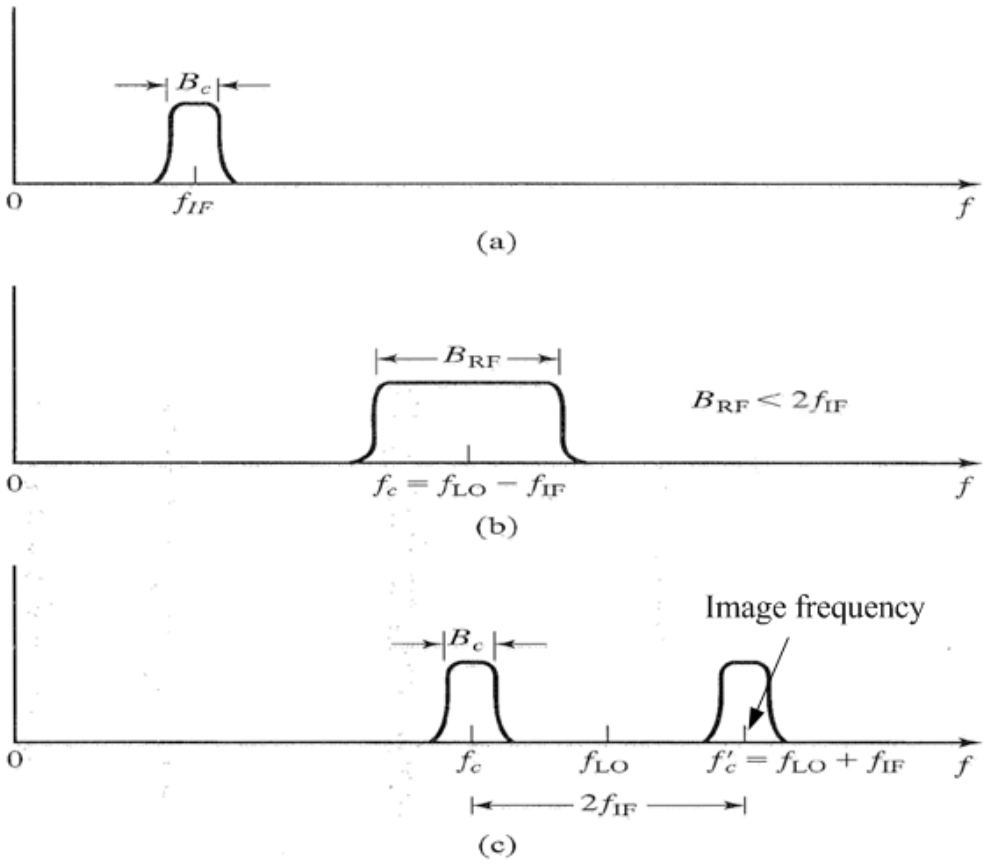

Figure 3.34 Frequency response characteristics of both IF and RF amplifiers.

AM-Radio Broadcasting (6/6)

- In other words, the bandwidth constraint of the RF amplifier is $B_c < B_{RF} < 2f_{IF}$; *i.e.*, $10 < B_{RF} < 910$ kHz. It is far from stringent
- The bandwidth of the RF amplifier is still considerably wider than the bandwidth of the IF amplifier
- The IF amplifier, with its narrow bandwidth, provides signal rejection from adjacent channels, and the RF amplifier provides signal rejection from image channels
- Automatic volume control (AVC) is provided by a feedback-control loop, which adjusts the gain of the IF amplifier based on the power level of the signal at the envelope detector