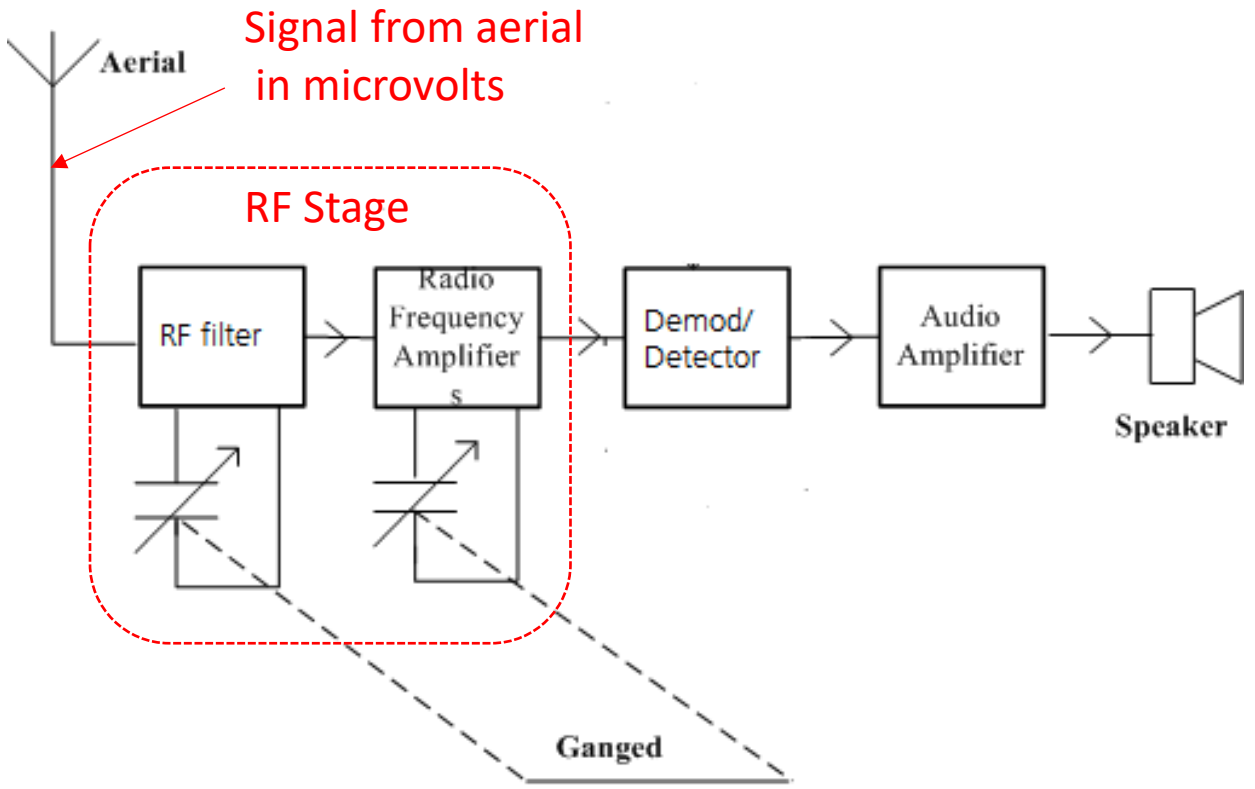
TRF, HOMODYNE, HETERODYNE & SUPERHETERODYNE

EEEN 462 – ANALOGUE COMMUNICATION SYSTEMS

Monday, June 30, 2025

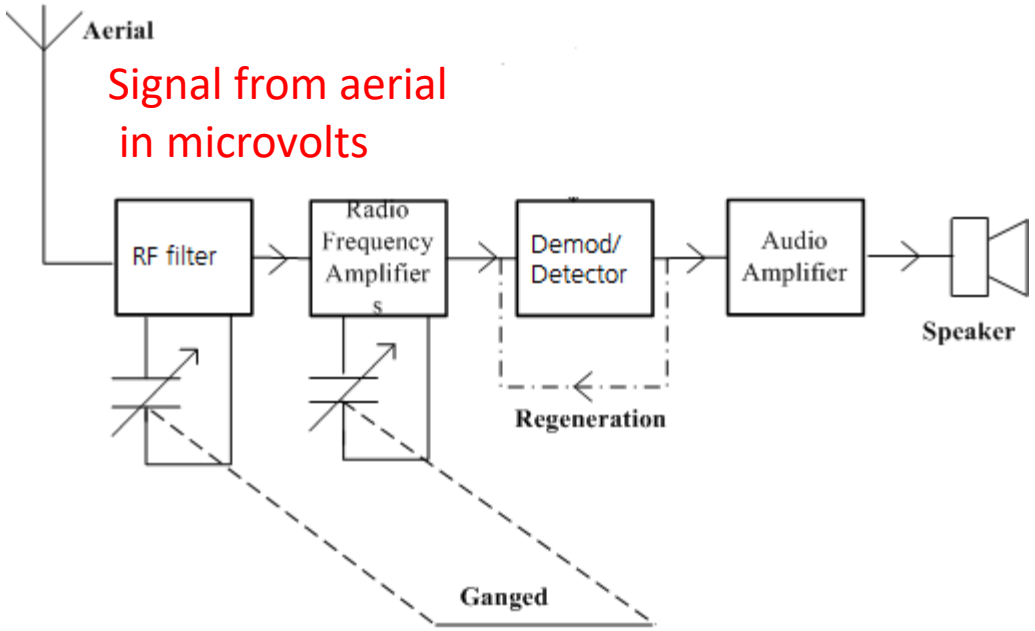
TUNED RADIO FREQUENCY (TRF) RECEIVER

1. A tuned Radio Frequency (TFR) receiver consists of:
   a) **RF Stage** – a tuned Radio Frequency amplifier
   b) **Demodulator or detector** which demodulates the signal
   c) **Audio Amplifier** amplifies the demodulated signal
2. Receiver was widely used in the 1920s but was replaced in the 1930s with the superhetrodyne receiver



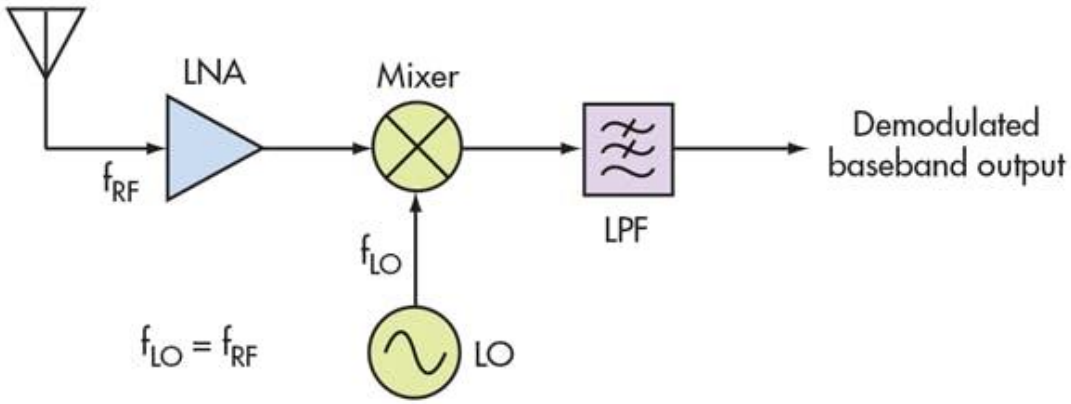
REGENERATIVE TFR RECEIVERS

1. **Regenerative Receiver** is a TRF receiver with positive feedback from its output to increase the gain of that stage.
2. The inclusion of regeneration or “reaction” increases the sensitivity of the receiver.
3. However, if too much regeneration is applied, the set may go into self-oscillation and “howl.
4. It is possible under these circumstances (depending on the design of the receiver) that the set will re-transmit a radio signal from the aerial, possibly causing interference to other users.



HOMODYNE RECEIVER

1. **Homodyne (also called synchrodyne, or zero-IF receiver)** is a radio receiver design that demodulates the incoming radio signal using synchronous detection driven by a local oscillator whose frequency is identical to, or very close to the carrier frequency of the intended signal.
2. This is in contrast to the standard superheterodyne receiver where this is accomplished only after an initial conversion to an intermediate frequency.



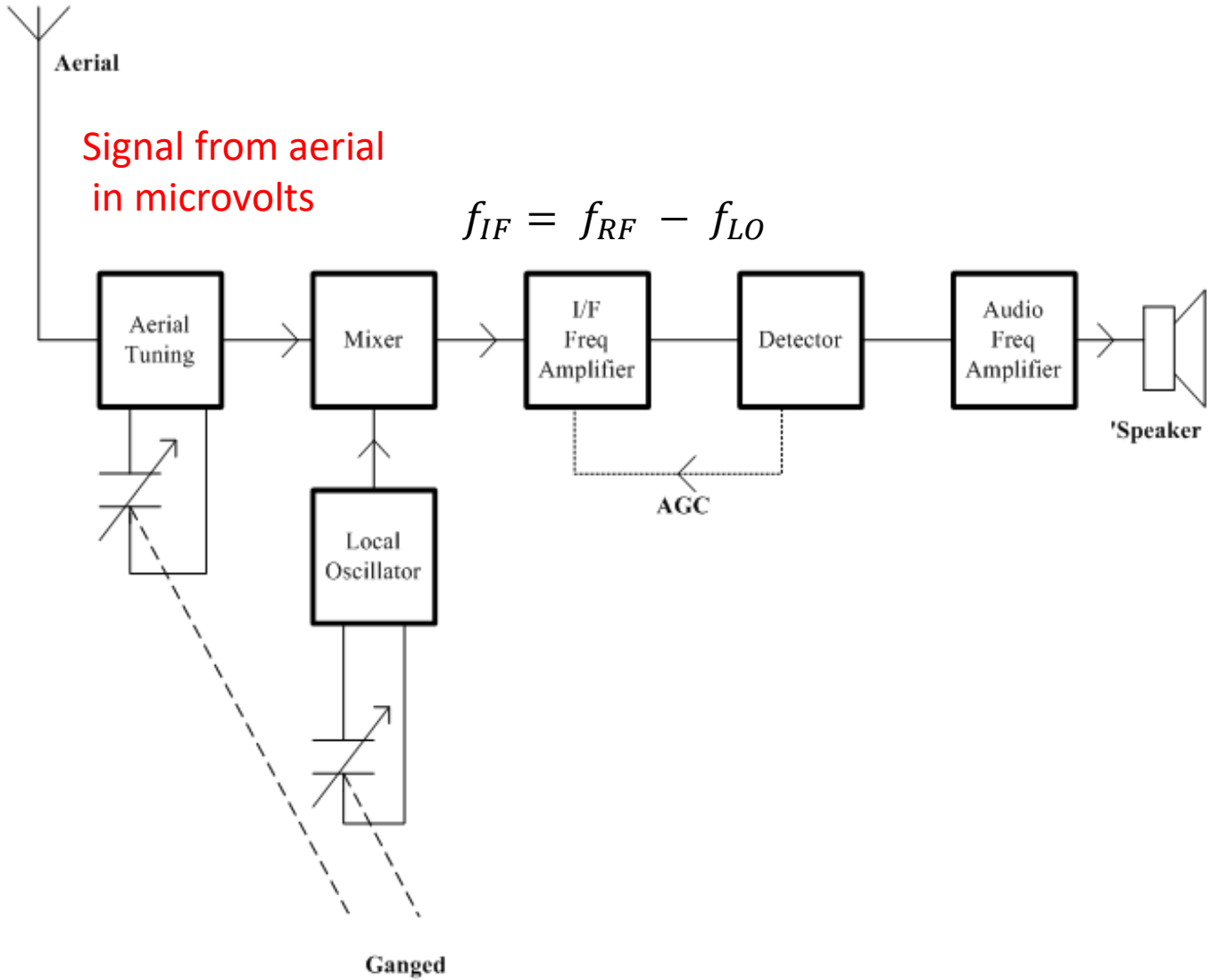
WHY DO WE NEED INTERMEDIATE FREQUENCY?

1. **All radio receivers require an amplifier** at the Radio Frequency (RF) stage.
2. The problem is designing an amplifiers that has a flat response in the whole tunable RF band.
3. One solution is to have multiple amplifiers covering the entire band, but that would be expensive.
4. The **superheterodyne receiver** converts all signals in the tunable frequency range to one frequency called the Intermediate frequency (IF).

Further Reading:
The Evolution And Importance Of Intermediate Frequency

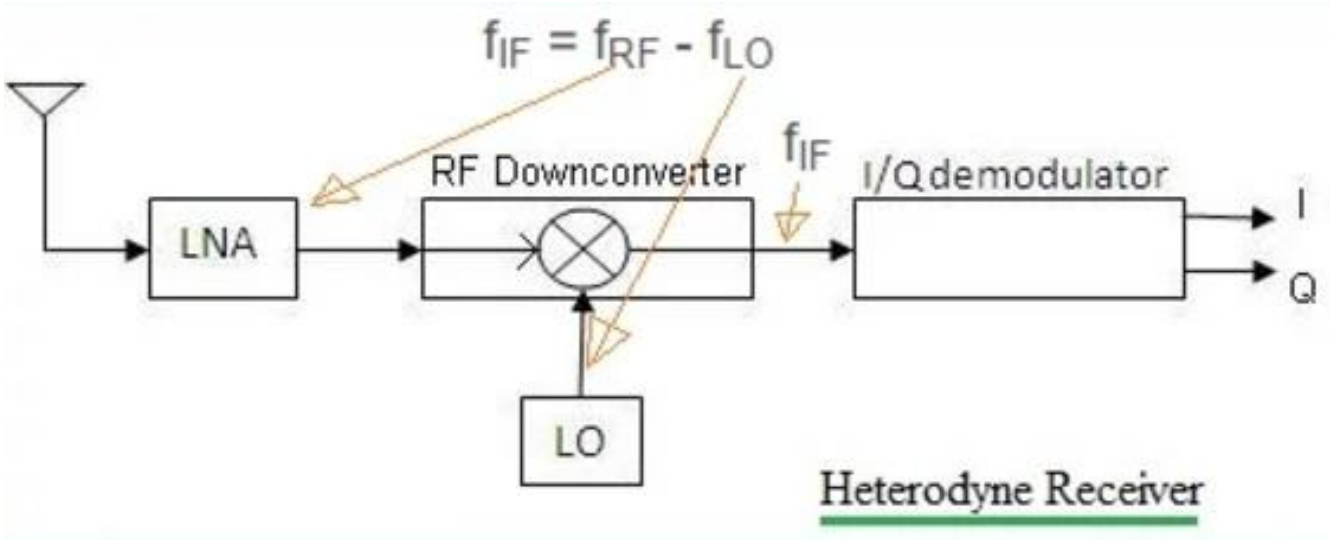
HETERODYNE RECEIVER

1. **Heterodyne receiver** uses frequency mixing to convert a received signal to a fixed Intermediate Frequency (IF), which can be more conveniently processed than the original radio carrier frequency.
2. **heterodyne** is derived from the Greek roots hetero- "different", and -dyne "power".



HETERODYNE RECEIVER /02

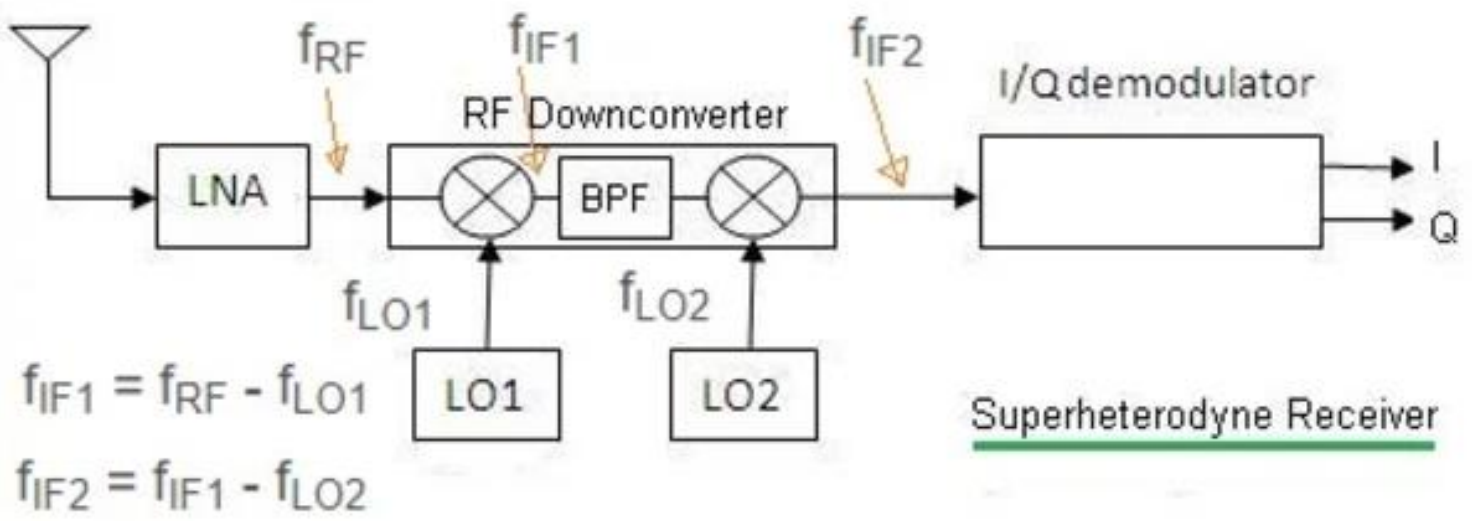
Heterodyne receiver uses single RF mixer for conversion of modulated RF signal to baseband I/Q signals.



SUPERHETERODYNE RECEIVER

Superheterodyne receiver uses dual RF mixers for conversion of modulated RF signal to baseband signals.

1. **Superheterodyne** is a contraction of "supersonic heterodyne", where:
   a) **supersonic** indicates frequencies above the range of human hearing.
   b) **heterodyne** is derived from the Greek roots hetero- "different", and -dyne "power".



ADVANTAGES OF SUPERHETERODYNE RECEIVER

The advantages of superheterodyne receiver are:

1. All processing takes place at lower frequencies. The devices are cheaper at such lower frequencies compare to higher frequencies.
2. It is easy to filter IF signal compared to RF signal.
3. It offers better sensitivity compare to homodyne receiver architecture.
4. Heterodyne uses single conversion and Superheterodyne uses double conversion. This prevents image noise fold-over due to use of two IF frequencies before conversion to baseband.

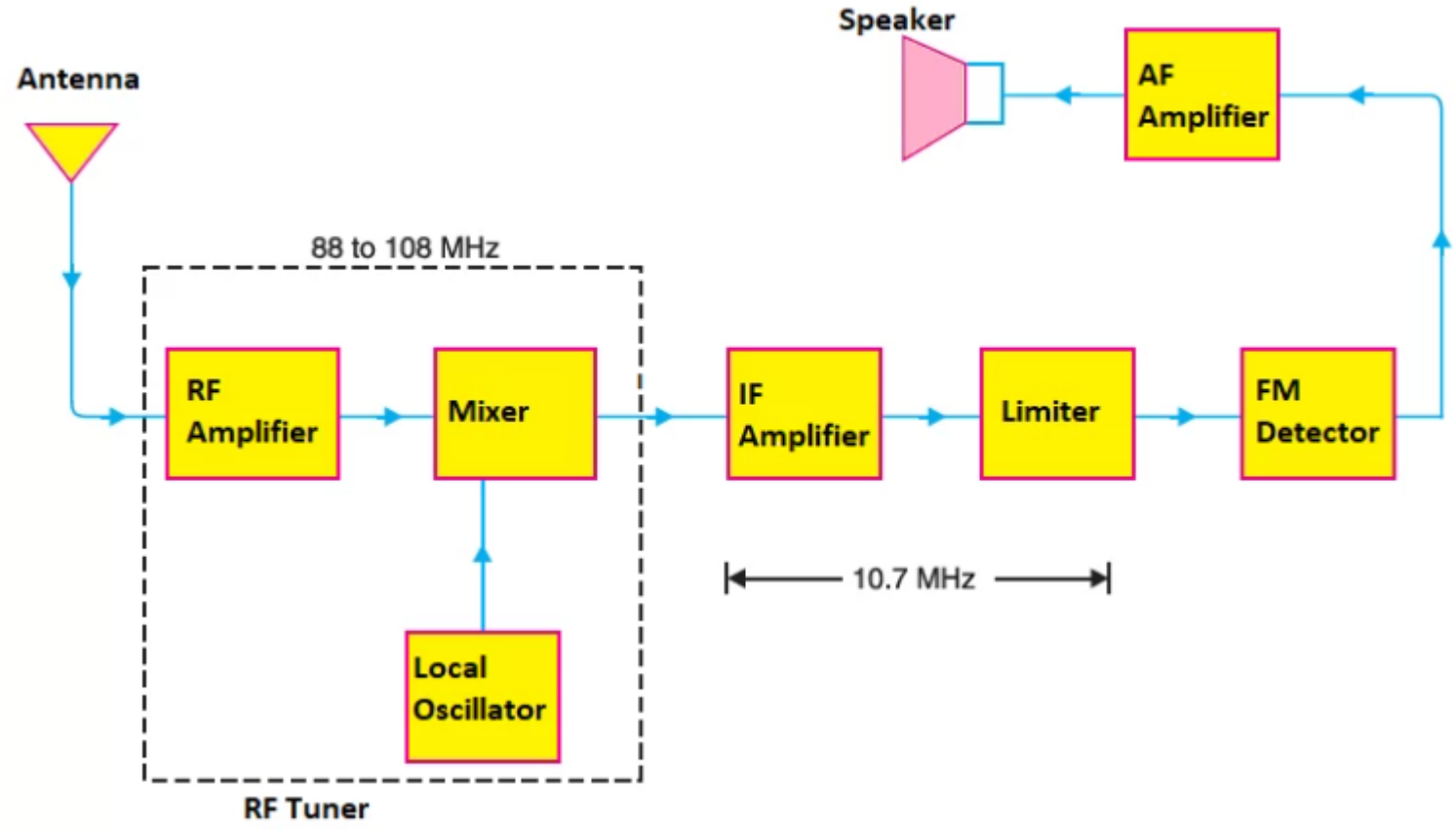
DISADVANTAGES OF HETERODYNE ARCHITECTURES

The disadvantages of superheterodyne Receiver and heterodyne receiver architecture types are:

1. It requires additional LOs (Local Oscillators) and RF Mixers to convert signal from RF to IF before conversion to baseband. This increases cost of overall receiver.
2. Filters are needed to remove any LO leakage as well as undesired frequency components to prevent image frequencies. This also increases cost as well as complexity of the receiver.

FM RECEIVER

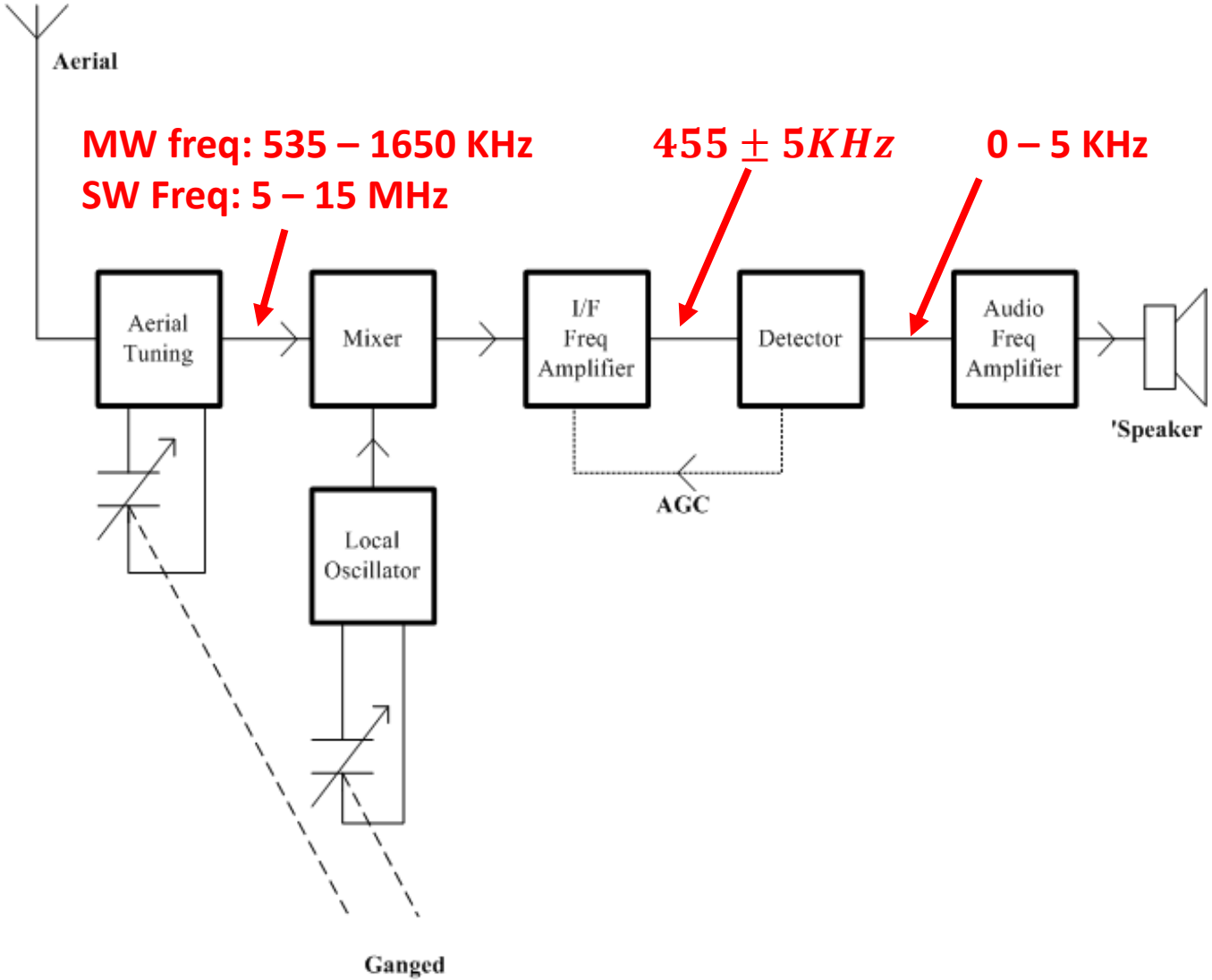
1. The FM receiver is a heterodyne receiver.
2. The intermediate frequency (IF) of an FM receiver is around 10.7 MHz.



MW & SHORTWAVE RECEIVER

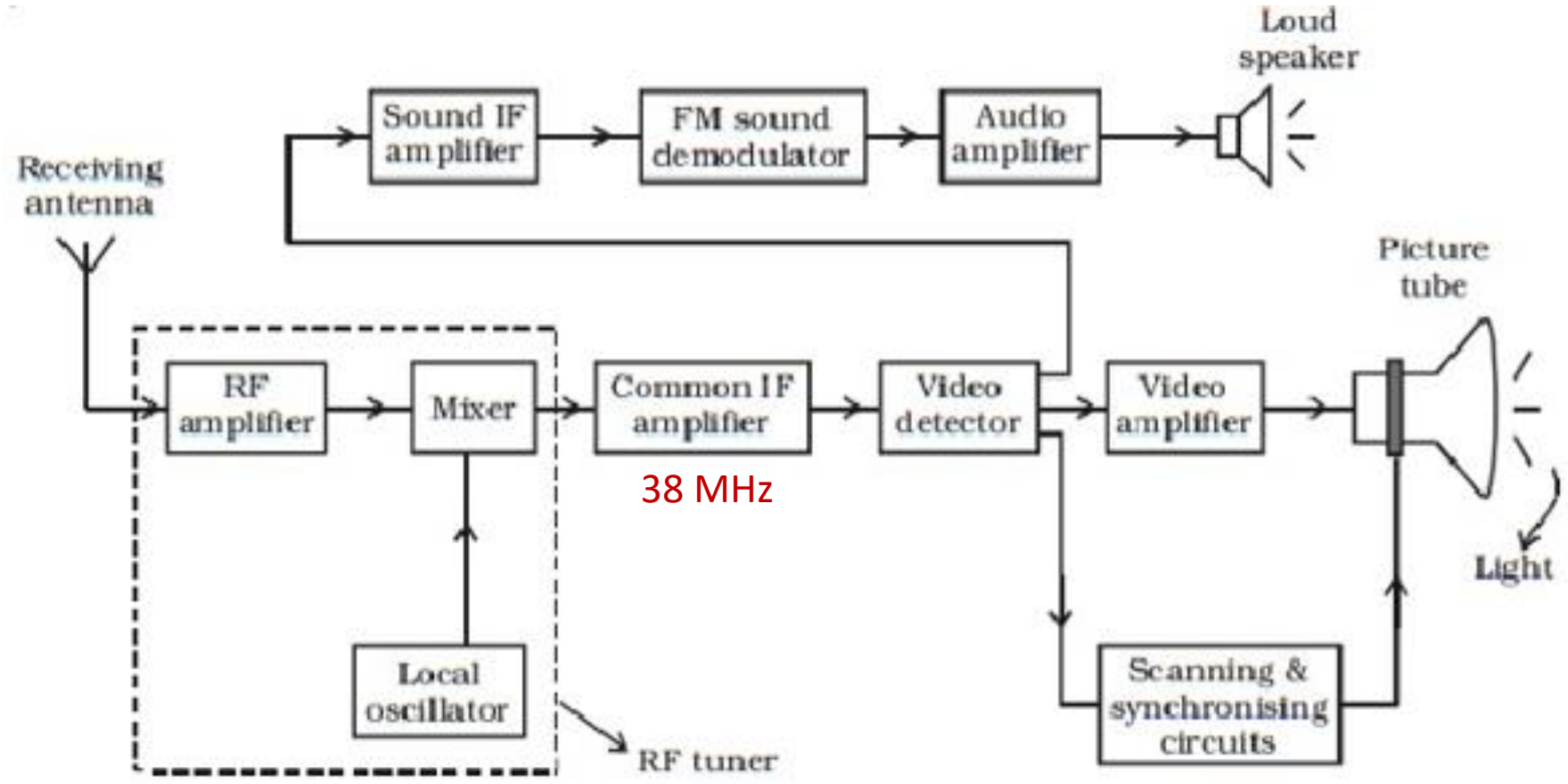
MW and shortwave receivers use heterodyne architecture.

1. Two frequency bands:
   a) Medium Wave – 535 kHz – 1650 KHz
   b) Short Wave – 5 – 15 MHz
2. Intermediate Frequency of 455 KHz



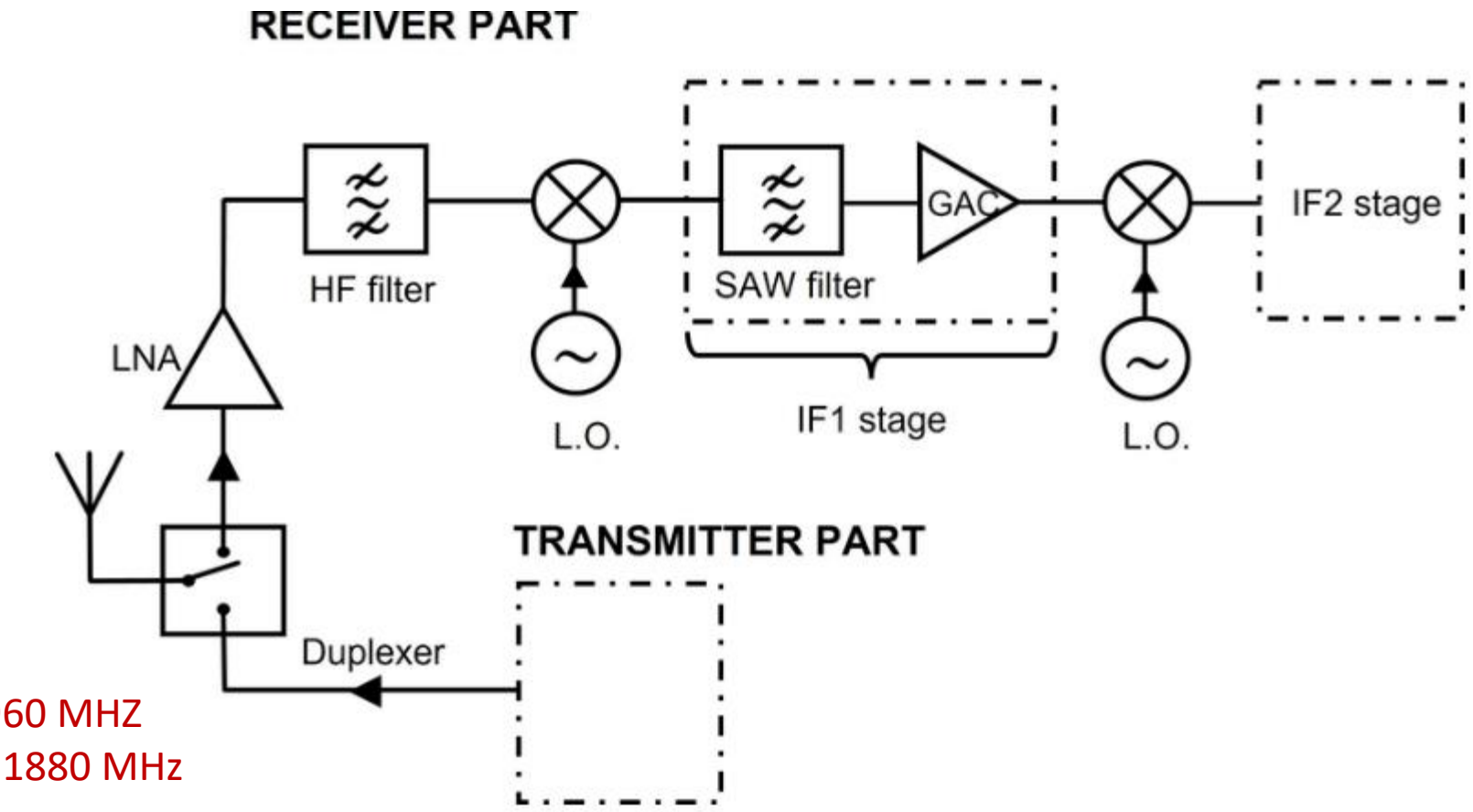
ANALOG TV RECEIVER

1. Analogue TV receiver uses superheterodyne receivers.
2. The Intermediate frequency is 38 MHz.



RECEIVER IN GSM PHONE

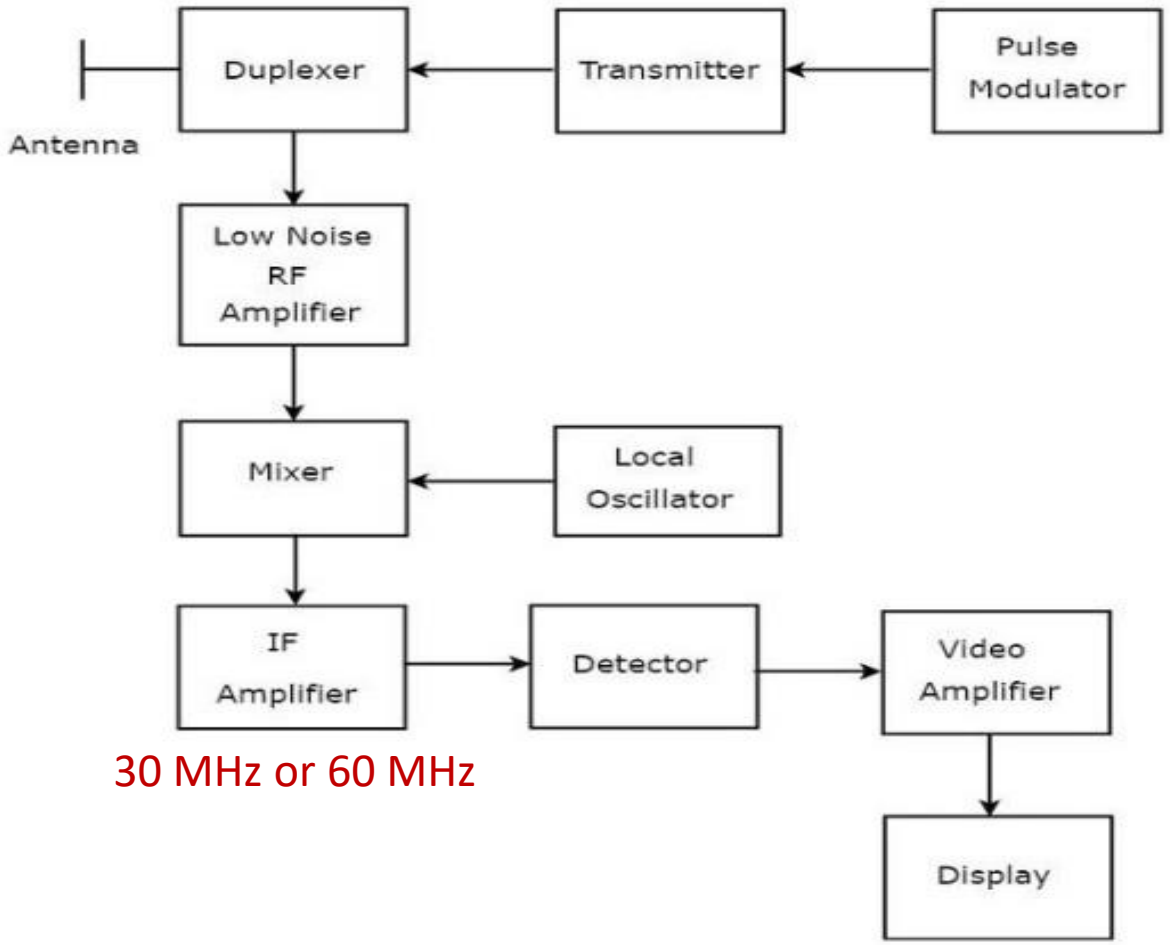
GSM phone uses a superheterodyne architecture.



880 – 960 MHZ
1710 – 1880 MHz

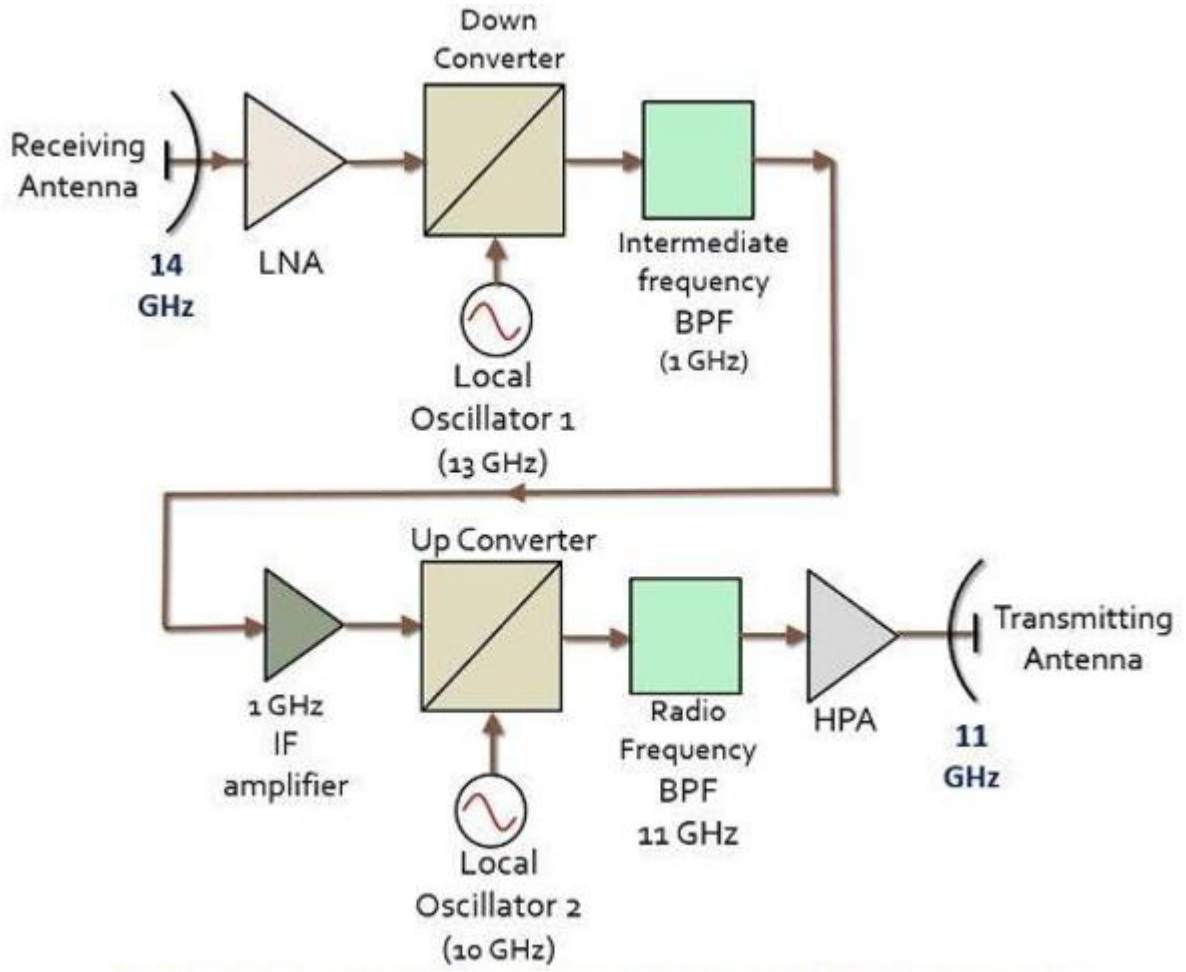
PULSE RADAR RECEIVER

The intermediate frequency of a radar system is usually 30 MHz or 60 MHz.



SATELLITE TRANSPONDER

1. **A satellite transponder** is a series of interconnections that form a communication channel between the transmitting antenna and the receiving antenna.
2. A typical communication satellite contains about 15-30 transponders.



(a) Block diagram of a 14/11 GHz Ku-Band Transponder