ECE202 Analog Communication

Unit – 3
FM Transmitters

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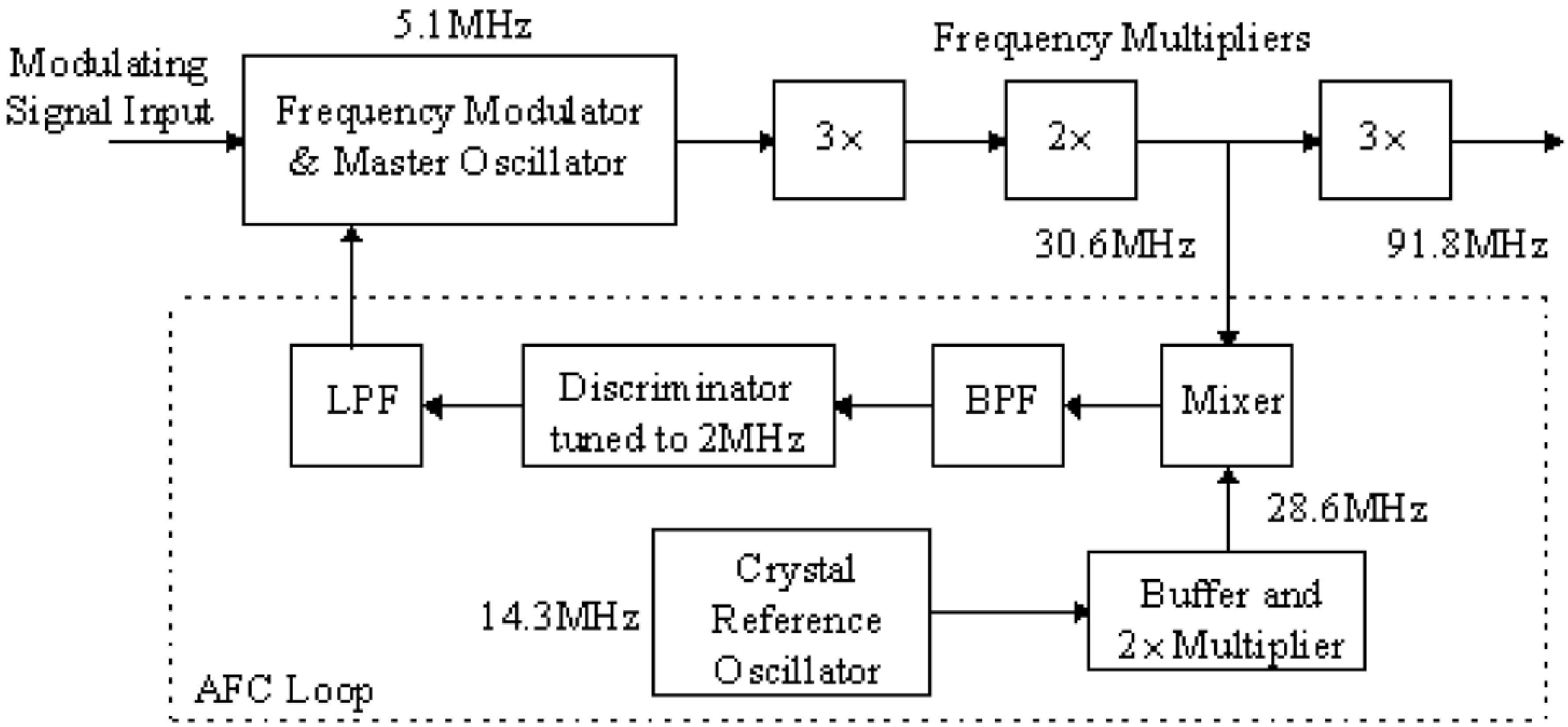
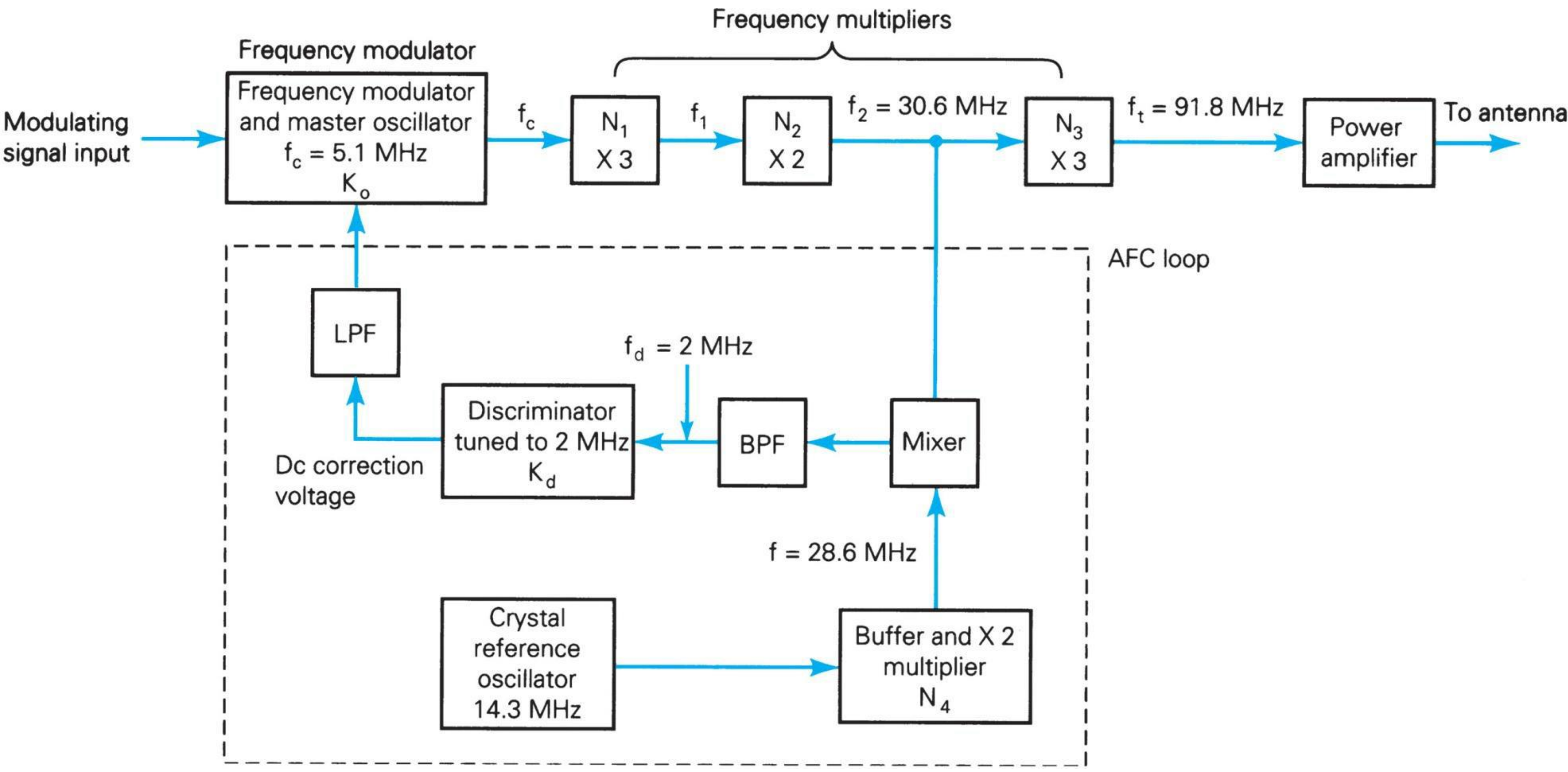
Crosby Direct FM Transmitter

- If a crystal oscillator is used to provide the carrier signal, the frequency cannot be varied too much (this is a characteristic of crystal oscillators)
- Crystal oscillators cannot be used in broadcast FM, but other oscillators can suffer from frequency drift
- An automatic frequency control (AFC) circuit is used in conjunction with a non-crystal oscillator to ensure that the frequency drift is minimal
- Figure shows a Crosby direct FM transmitter which contains an AFC loop
- The frequency modulator shown can be a VCO since the oscillator frequency as much lower than the actual transmission frequency
- In this example, the oscillator centre frequency is 5.1MHz which is multiplied by 18 before transmission to give ft = 91.8MHz

Crosby Direct FM Transmitter



Crosby Direct FM Transmitter



Crosby Direct FM Transmitter

When the frequency is multiplied, so are the frequency and phase deviations. However, the modulating input frequency is obviously unchanged, so the modulation index is multiplied by 18. The maximum frequency deviation at the output is 75kHz, so the maximum allowed deviation at the modulator output is

$$\Delta f = \frac{75\,\mathrm{kHz}}{18} = 4166.7\,\mathrm{Hz}$$

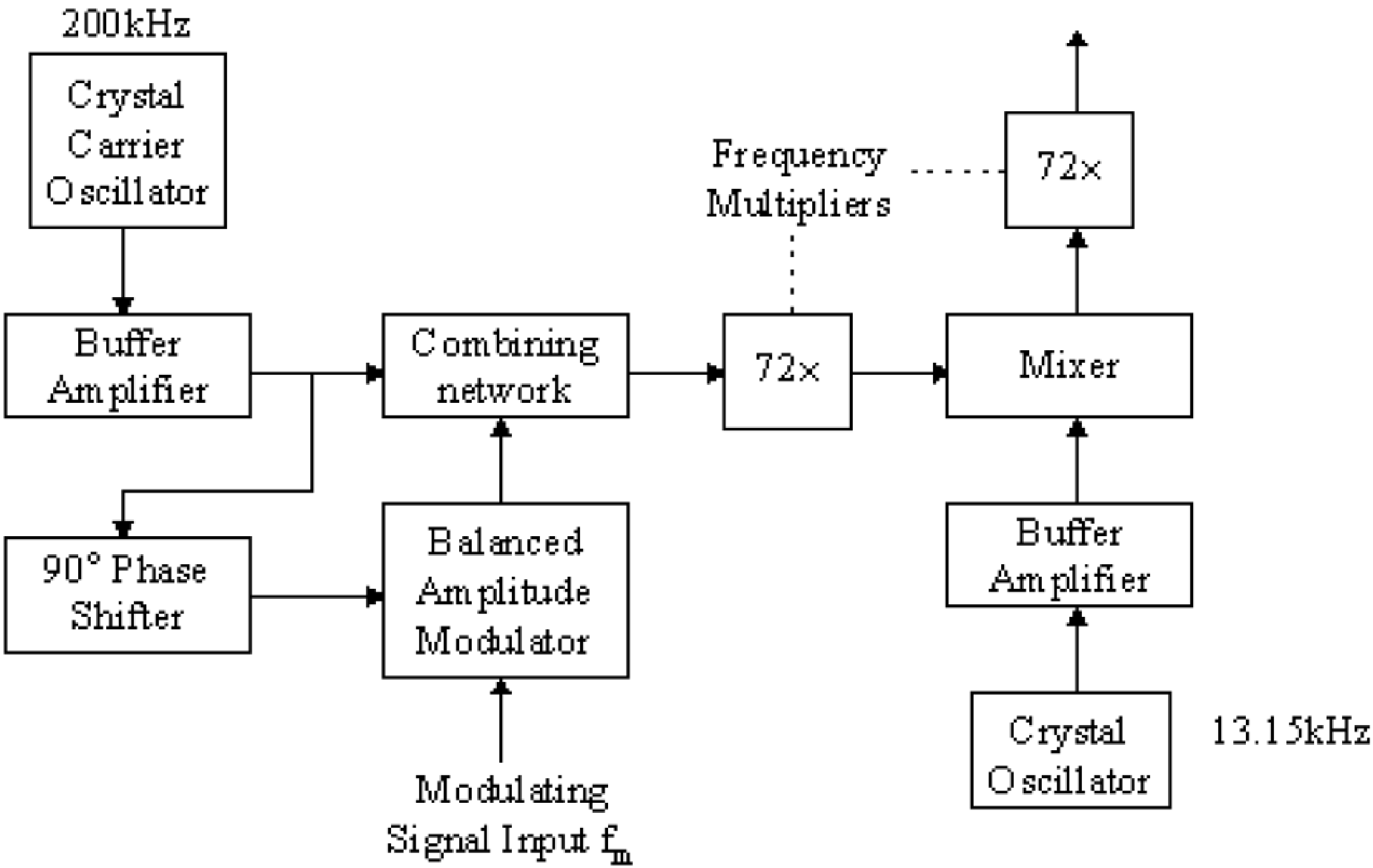
Since the maximum input frequency is fm = 15kHz for broadcast FM, the modulation index must be

$$\beta = \frac{\Delta f}{f_m} = 0.2778$$

The modulation index at the antenna then is $\beta = 0.2778 \times 18 = 5$.

The AFC loop aims to increase the stability of the output without using a crystal oscillator in the modulator.

Armstrong In-direct FM Transmitter



Armstrong In-direct FM Transmitter

- Figure shows the block diagram for an Armstrong indirect FM transmitter
- This works by using a suppressed carrier amplitude modulator and adding a phase shifted carrier to this signal
- The effect of this is shown in figure 6, where the pink signal is the output and the blue signal the AM input.
- The output experiences both phase and amplitude modulation. The amplitude modulation can be reduced by using a carrier much larger than the peak signal amplitude, as in Figure 7
- However, this reduces the amount of phase variation.

Armstrong In-direct FM Transmitter

Figure 6 Phase modulation using amplitude

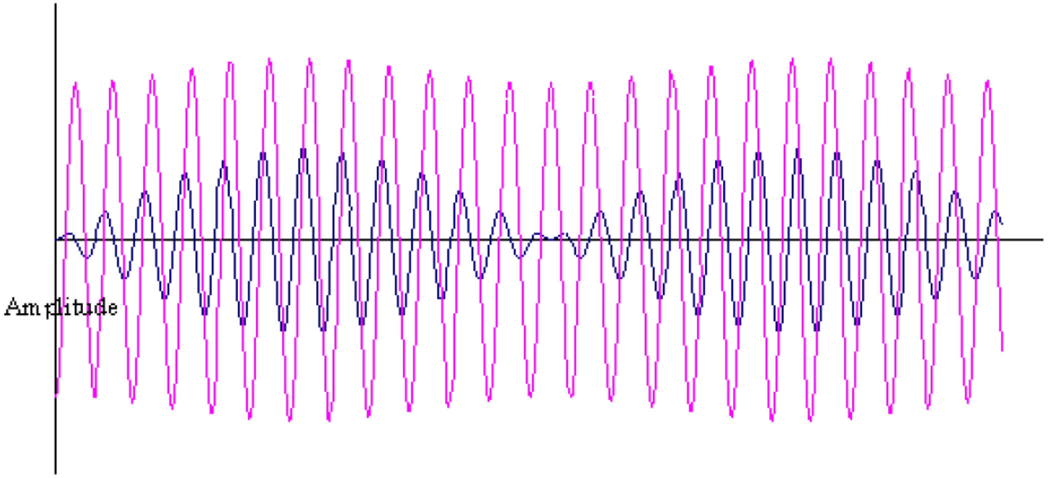
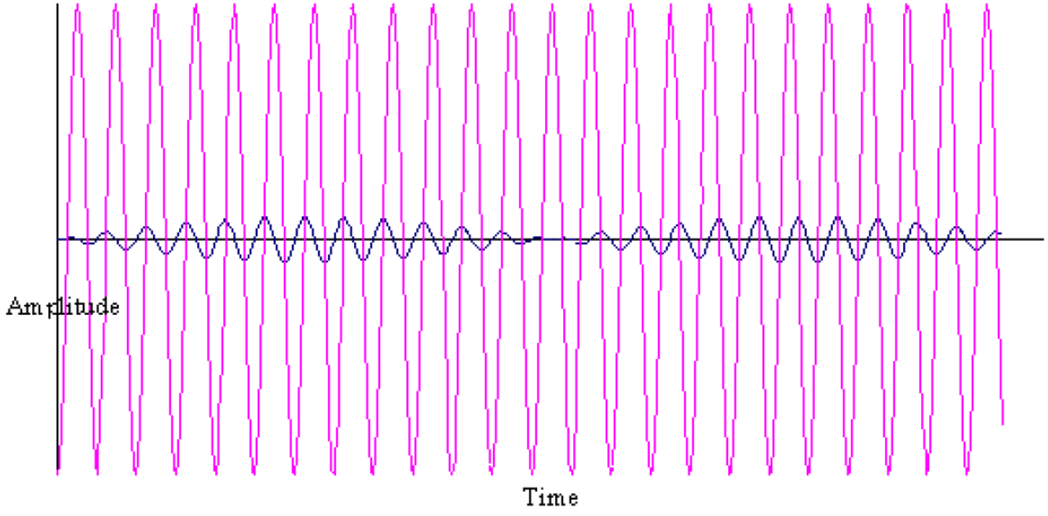
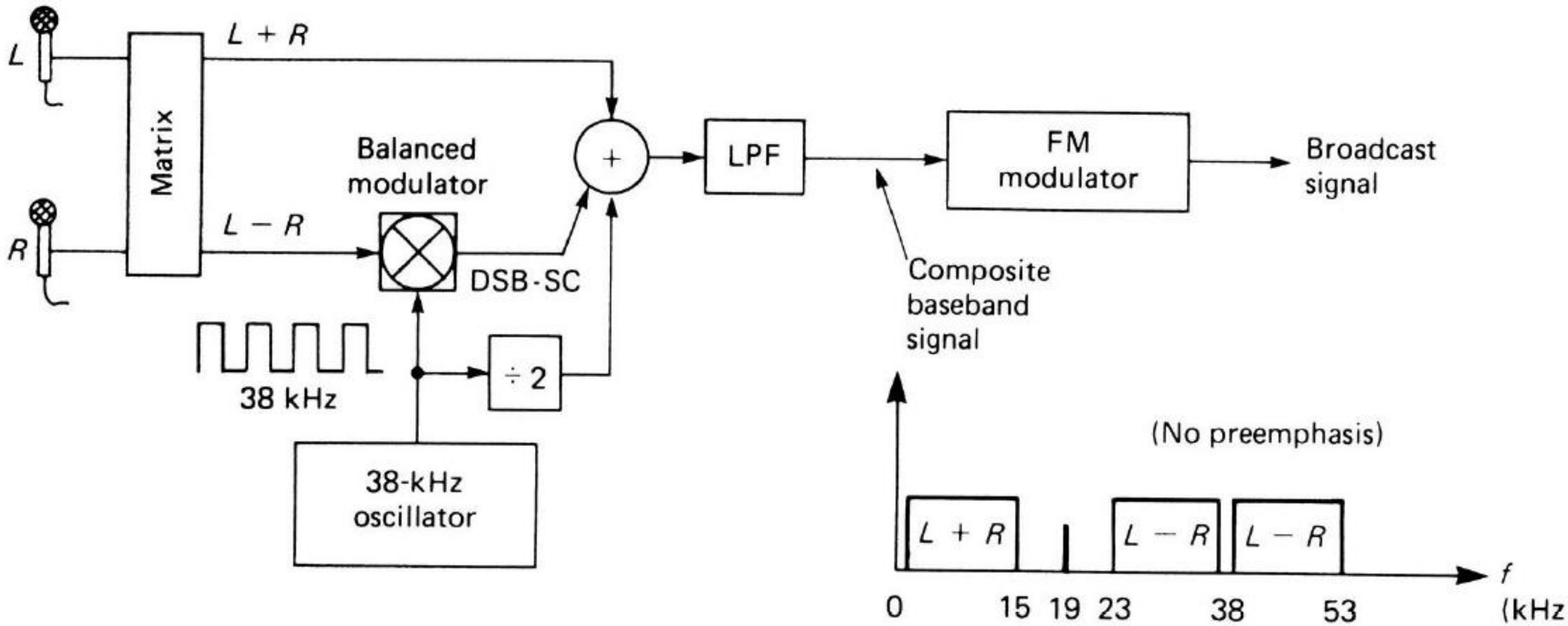


Figure 7 Better phase modulation with less amplitude



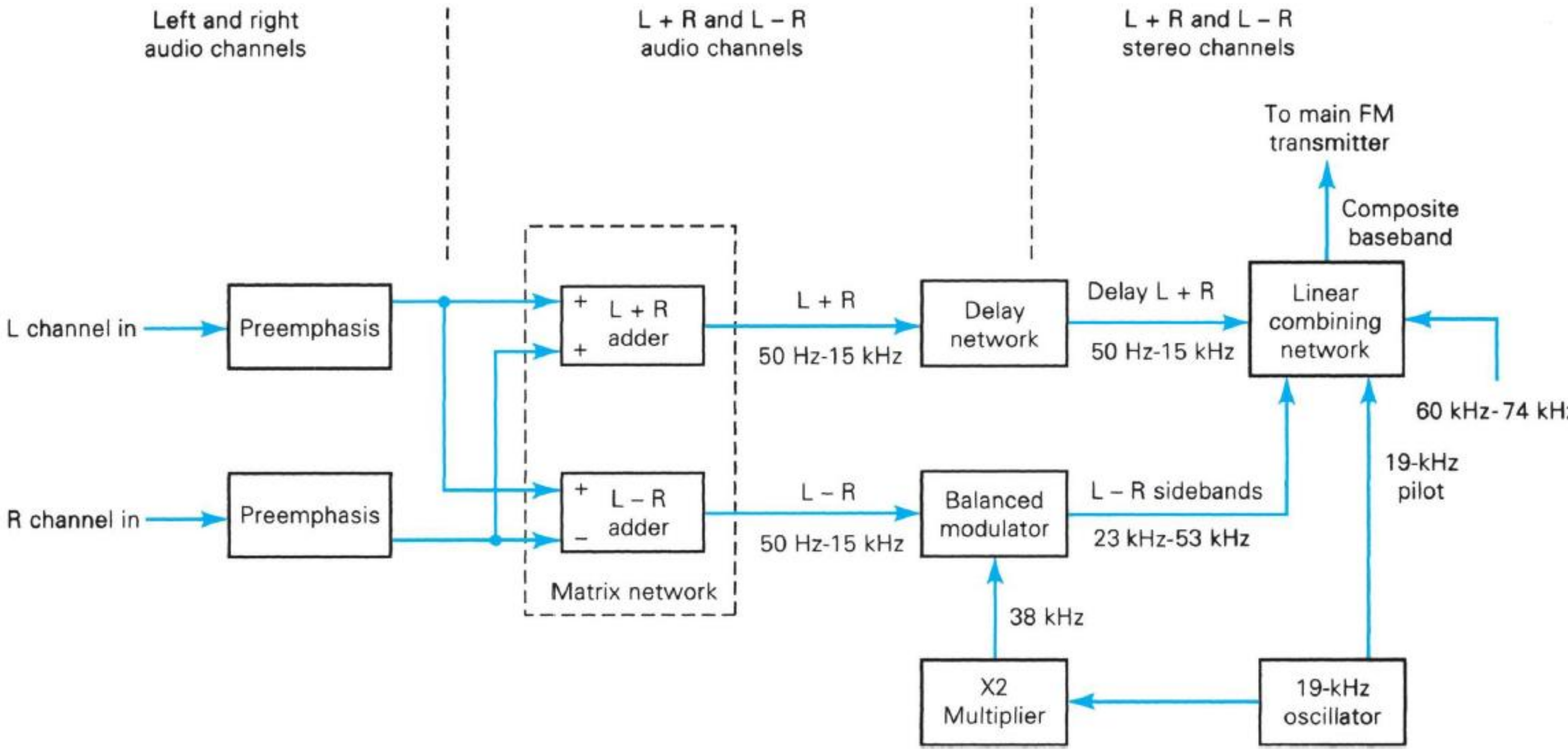
Stereo FM



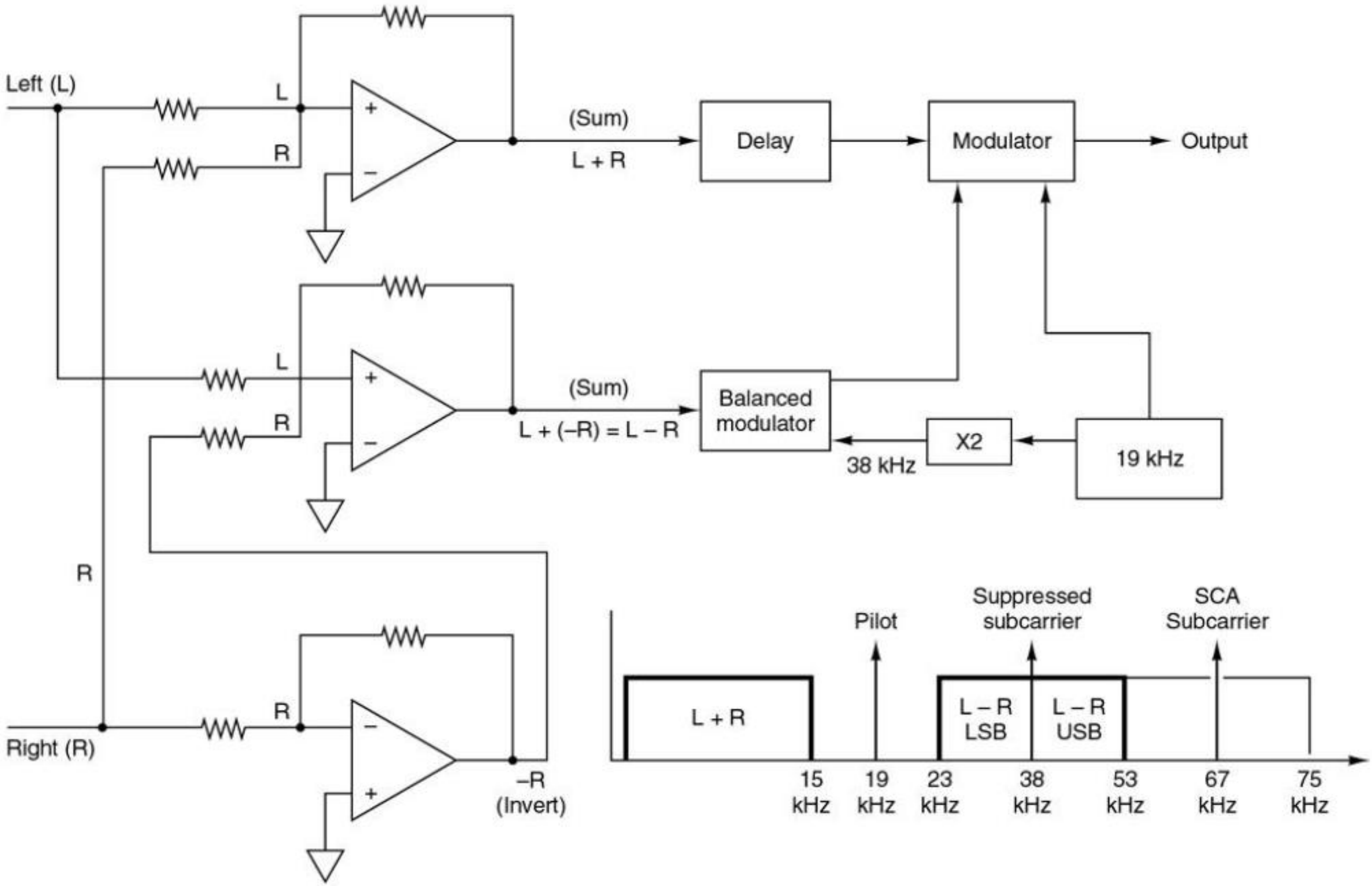
- In Figure 9-40, audio signals from both left and right mircrophones are combined in an linear matrixing network to produce an *L*+*R* signal and an *L*-*R* signal.
- Both *L*+*R* and *L*-*R* are signals in the audio band and must be separated before modulating the carrier for transmission. This is accomplished by translating the *L*-*R* audio signal up in the spectrum.
- As seen in Figure 9-40, the frequency translation is achieved by amplitude-modulating a 38-kHz subsidiary carrier in a balanced modulator to produce DSB-SC.

	Mono	**Stereo**
Definition	Monaural or monophonic sound reproduction is intended to be heard as if it were a single channel of sound perceived as coming from one position.	Stereophonic sound or, more commonly, stereo, is a method of sound reproduction that creates an illusion of multi-directional audible perspective.
Cost	Less expensive for recording and reproduction	More expensive for recording and reproduction
Recording	Easy to record, requires only basic equipment	Requires technical knowledge and skill to record, apart from equipment. It's important to know the relative position of the objects and events.
Key feature	Audio signals are routed through a single channel	Audio signals are routed through 2 or more channels to simulate depth/direction perception, like in the real world.
Stands for	Monaural or monophonic sound	Stereophonic sound
Usage	Public address system, radio talk shows, hearing aid, telephone and mobile communication, some AM radio stations	Movies, Television, Music players, FM radio stations
Channels	1	2

Stereo FM Transmitter



Stereo FM Transmitter



(a)

(b)

Stereo FM Receiver

- The stereo receiver will need a frequency-coherent 38-kHz reference signal to demodulate the DSB-SC.
- To simplify the receiver, a frequency- and phase-coherent signal is derived from the subcarrier oscillator by frequency division (÷2) to produce a pilot.
- The 19-kHz pilot fits nicely between the $L+R$ and DSB-SC $L-R$ signals in the baseband frequency spectrum.

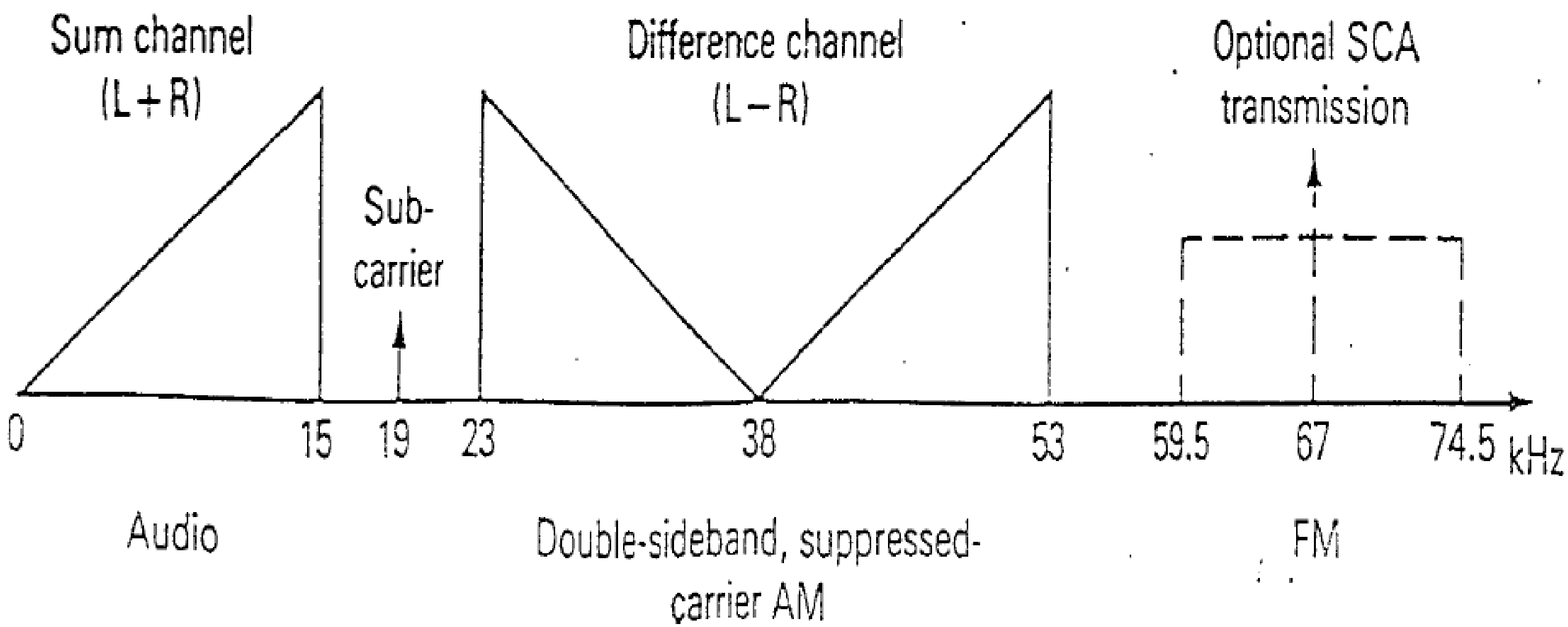
Stereo FM Receiver

- As indicated by its relative amplitude in the baseband composite signal, the pilot is made small enough so that its FM deviation of the carrier is only about 10% of the total 75-kHz maximum deviation.

- After the FM stereo signal is received and demodulated to baseband, the 19-kHz pilot is used to phase-lock an oscillator, which provides the 38-kHz subcarrier for demodulation of the *L-R* signal.

- A simple example using equal frequency but unequal amplitude audio toned in the *L* and *R* microphones is used to illustrate the formation of the composite stereo (without pilot) in Figure 9-41.

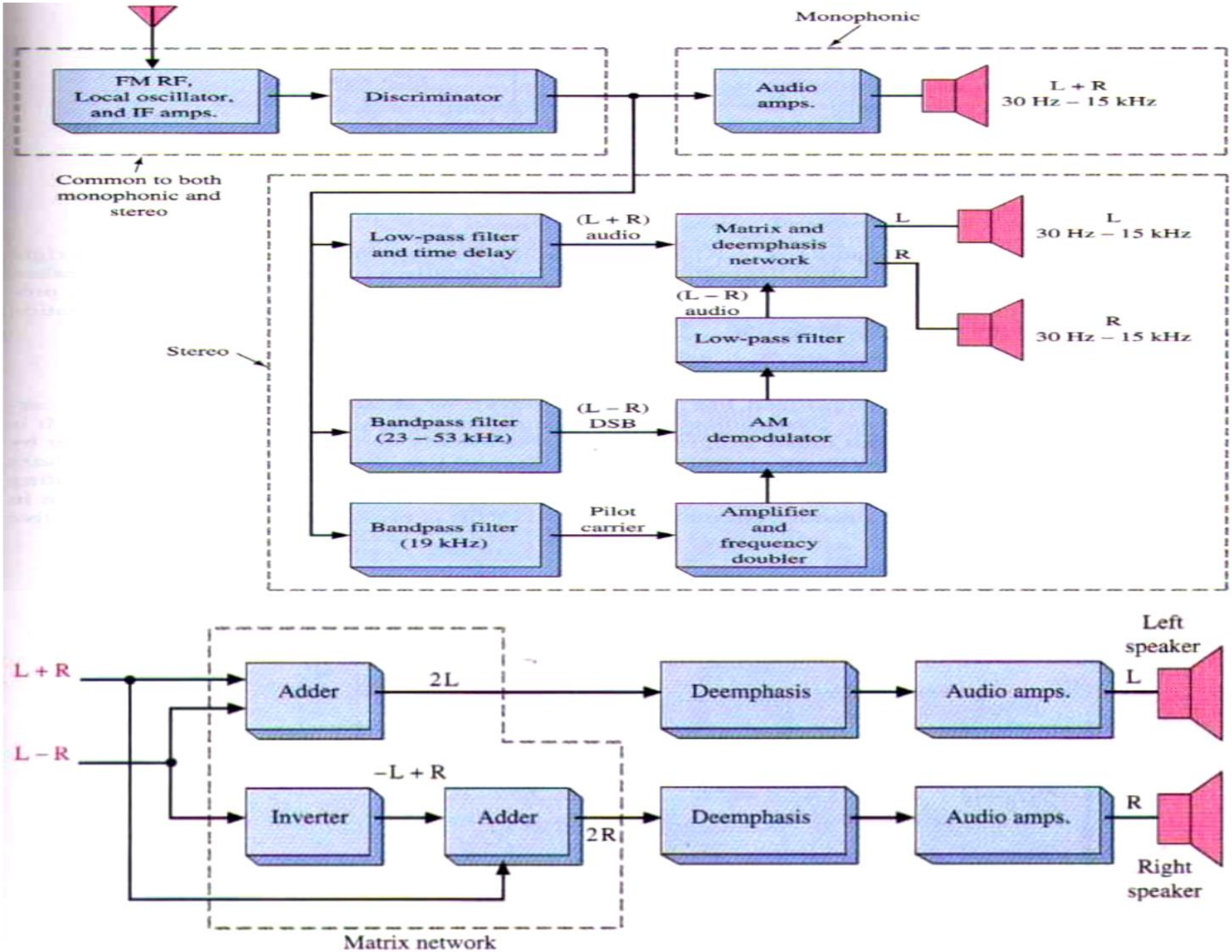
Stereo FM Receiver



Spectrum of stereo FM signal.

SCA: Subsidiary communication authorization (commercial-free program)

Stereo FM Receiver



FM Receiver - Superheterodyne Receiver & Amplitude Limiter