FM Receiver, Modulators and Descriminators

FM Receiver

An FM waveform carries its information in the form of frequency, so the amplitude is constant. Thus the information is held in the zero crossings. The FM waveform can be clipped at a low level without the loss of information. Additive noise has less of an effect on zero crossings than the amplitude. Receivers therefore often clip, or limit the amplitude of the received waveform prior to frequency detection.

This produces a constant waveform as an input to the discriminator. This clipping has the effect of introducing higher harmonic terms which are rejected by a pos-detection low-pass filter. A simplified FM receiver is shown in figure 1a, a more sophisticated system is shown in figure 1b.

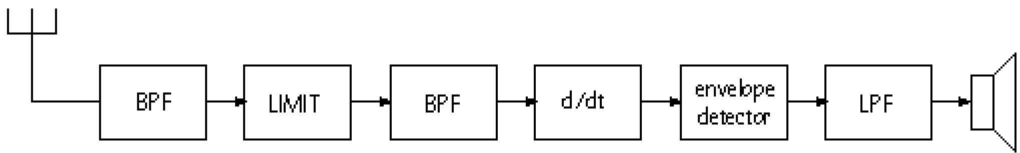

Figure 1a Simplified FM Reciever

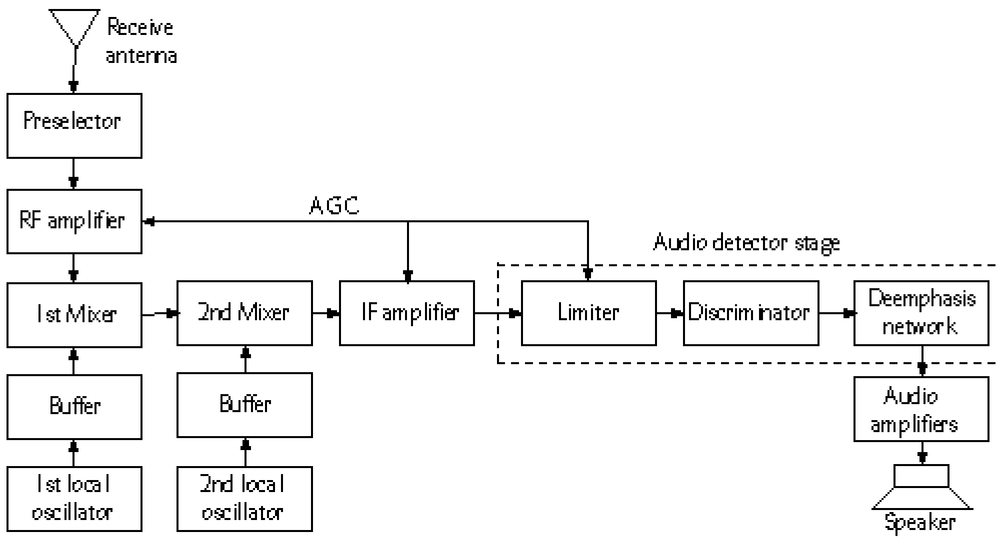

Figure 1b Double-conversion FM Receiver

<u>DEMODULATORS</u>

FM demodulators are frequency-dependant circuits that produce an output voltage that is directly proportional to the instantaneous frequency at its input. The signal received is lfm(t) and is known to the receiver in the form,

$$\lambda fm(t) = A \cos 2\pi \left(fct + kf \int_0^t s(\tau)\, d\tau \right)$$

Several circuits are used for demodulating FM signals slope detector, Foster-Seeley disciminator, ratio detector, PLL demodulator and quadrature detector. The first three are tuned circuit frequency discriminators, they work by converting the FM signal to AM then demodulate using conventional peak detectors.

Descriminators

A block diagram of a descriminator is shown in figure 2.

Figure 2

The differentiator effectively converts the FM signal into an AM signal. The differentiated FM signal is,

$$\frac{d\lambda}{dt} = -2\pi A[f_c + k_f s(t)]\sin 2\pi\left(f_c t + k_f \int_0^t s(\tau)d\tau\right)$$

The envelope detector removes the sine term, this is possible because the slight changes in frequency are not detected by the envelope detector. The envelope is given by

$$2\pi|A[f_c + k_f s(t)]|$$

from which the signal s(t) can be found.

When a differentiator is used like this it is called a slope detector or discriminator. A requirement for a descriminator is that the transfer function be linear throughout the range of frequencies of the FM wave. This is the simplest type of decriminator. Two descriminators can be used by subtracting the characteristic of one from a shifted version of itself, see figure 3.

This method is called a balanced slope detector. It has several disadvantages like poor linearity and difficulty in tuning. Another way is to approximate the derivative by using the difference between two adjacent sample values of the waveform, see figure 4, the Foster-Seeley discriminator or also known as a phase shift demodulator.

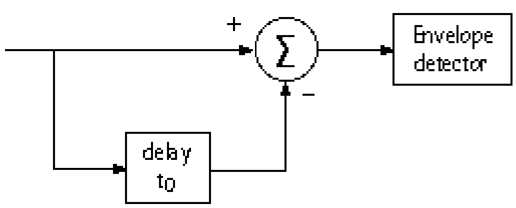

Figure 4

The Foster-Seeley circuit is easier to tune but must be preceeded by a separate limiter circuit to clip the amplitude before demodulating. The ratio detector has the property that it is immune to amplitude variations in its input signal, so a preceeding limiter is not required.