YEDITEPE UNIVERSITY ENGINEERING FACULTY
COMMUNICATION SYSTEMS LABORATORY

EE 352 – COMMUNICATION SYSTEMS II

EXPERIMENT 5: ASK

Objective:

Generation and demodulation of ASK modulated signals.

Equipment:

- Sequence Generator Module
- Adder Module
- Tunable LPF Module
- Multiplier Module
- Phase Shifter Module
- Audio Oscillator Module
- Dual Analog Switch Module
- Master Signal Module
- Variable DC Module
- Utilities Module
- Oscilloscope

General Information:

ASK:

Amplitude Shift Keying (ASK) is a modulation process which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. Thus the modulated waveform consists of bursts of a sinusoid. **Figure 5.1** illustrates a binary ASK signal (lower), together with the binary sequence which initiated it (upper).

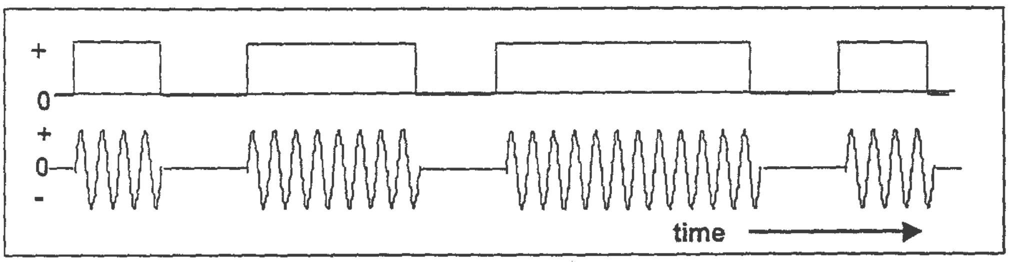

Figure 5.1 An ASK Signal (below) and The Message (above)

The data rate is often made a sub-multiple of the carrier frequency. This has been done in the waveform in **Figure 5.1**.

One of the disadvantages of ASK, compared with FSK and PSK, for example, is that it has not got a constant envelope. This makes its processing (e.g., power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector.

A block diagram of a basic ASK generator is shown in **Figure 5.2**. In this figure, the switch is opened and closed by the unipolar binary sequence.

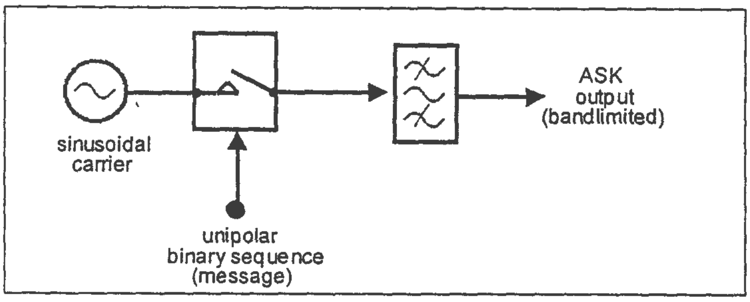

Figure 5.2 Principle of ASK Generation

There are sharp discontinuities shown at the transition points. These result in the signal having an unnecessarily wide bandwidth. Bandlimiting is generally introduced before transmission, in which case these discontinuities would be 'rounded off'. The bandlimiting may be applied to the digital message, or the modulated signal itself. A significant reduction can be accepted before errors at the receiver increase unacceptably. This can be brought about by bandlimiting (pulse shaping) the message *before* modulation, or bandlimiting the ASK signal itself *after* generation. Both of these options are illustrated in **Figure 5.3**.

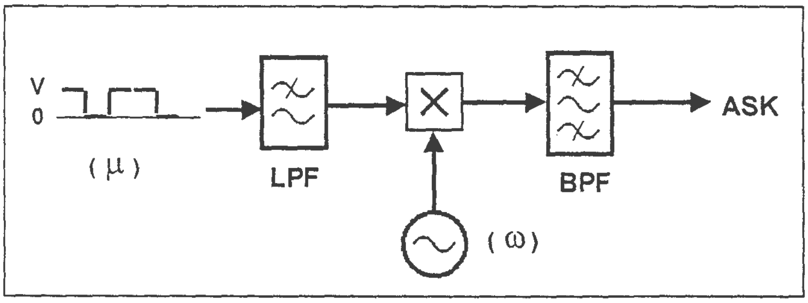

Figure 5.3 ASK Bandlimiting, with a LPF or a BPF

Figure 5.4 shows the signals present in a model of **Figure 5.3**, where the message has been bandlimited. The shape, after bandlimiting, depends naturally enough upon the amplitude and phase characteristics of the bandlimiting filter. These waveforms can be approximated with a SEQUENCE GENERATOR clocked at about 2 kHz, filter #3 of the BASEBAND CHANNEL FILTERS, and a 10 kHz carrier from a VCO.

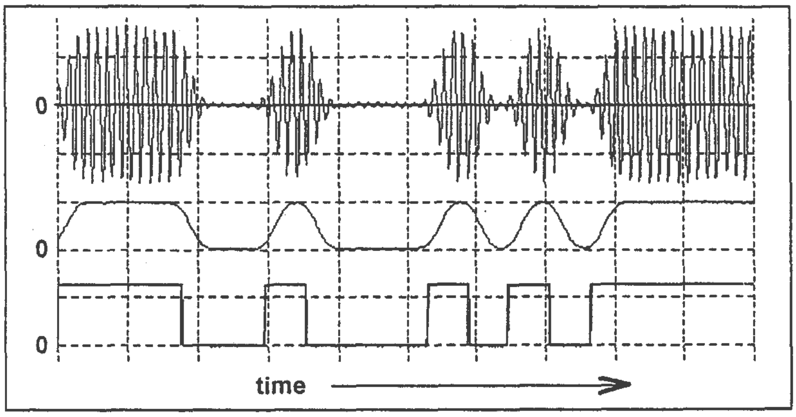

Figure 5.4 Original TTL Message (lower), Bandlimiting Message (centre), ASK (above)

It is easy to estimate the bandwidth of an ASK signal. Referring to the **Figure 5.3**, which is a DSB transmitter and example of linear modulation, the ASK bandwidth is twice the message bandwidth, centered on the carrier frequency. Using the analogy of the DSB generator, the binary sequence is the message (bit rate ‘μ’), and the sinewave being switched is the carrier (‘ω’). Even though we have not an analytical expression for the bandwidth of a pseudo random binary sequence, it will be of the same order as that of a square, or perhaps a rectangular, wave.

Considering the Fourier transform, for the special case of a binary sequence of alternate ones and zeros the spectrum will:

- be symmetrical about the frequency of the carrier ‘ω’
- have a component at ‘ω’, because there will be a DC term in the message
- have sidebands spaced at odd multiples of ‘μ’ either side of the carrier
- have sideband amplitudes which will decrease either side of the carrier (proportional to 1/n, where ‘n’ is the order of the term)

If the spectrum is accepted to be symmetrical around the carrier then its effective bandwidth can be measured by passing it through a tunable lowpass filter.

Demodulation of ASK:

It is apparent from **Figure 5.1** and **Figure 5.4** that the ASK signal has an inconstant but well defined envelope. Thus it is possible to demodulate it by an envelope detector. A synchronous demodulator would also be appropriate. However, envelope detection circuitry is simple, while the synchronous demodulation requires a phase-locked local carrier and therefore carrier acquisition circuitry.

With the bandlimiting of the transmitted ASK neither of these demodulation methods would recover the original binary sequence; instead, their outputs would be a bandlimited version. Further processing – by some sort of decision-making circuitry for example – would be necessary. Thus, demodulation is a two-stage process: recovery of the bandlimited bit stream, and regeneration of the binary bit stream. **Figure 5.5** illustrates these stages.

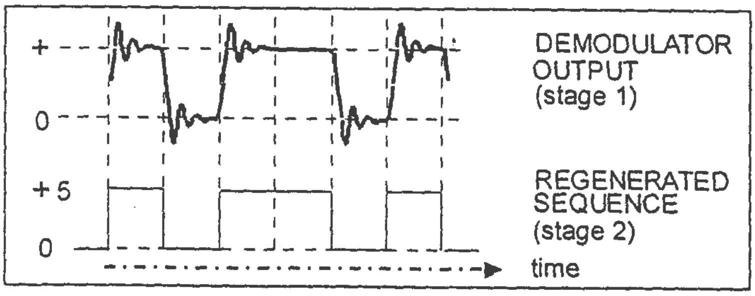

Figure 5.5 The Two Stages of The Demodulation Process

Procedure:

1. Build the circuit shown as a block diagram in **Figure 5.2**. To synchronize the sinusoidal carrier, use 8.333 kHz TTL. To produce the digital data, clock the SEQUENCE GENERATOR module with 2 kHz sine wave. Observe and sketch the ASK and its corresponding digital data on a scope sheet.
2. This step is about **envelope demodulation of ASK**. Observe and sketch the demodulated output on a scope sheet. Calculate the percentage of the maximum ripple level over the peak-to-peak signal level. What is the reason of these ripples? Give a short explanation.
3. Build the bandlimiting ASK circuit by just adding a DC level to the digital data. Now, use a 100 kHz sinusoidal as the carrier wave. Observe the effect of bandlimiting by comparing this signal shape with that found in **step1** and draw this new signal on a scope sheet.
4. This step is about **synchronous demodulation of ASK**. Observe and sketch the demodulated output on a scope sheet. Calculate the percentage of the maximum ripple level over the peak-to-peak signal level. Compare it with that found in step2, give a short explanation.