DIGITAL COMMUNICATION LAB THIRD STAGE

Eng: Shaymaa Fakhir

Experiment:5

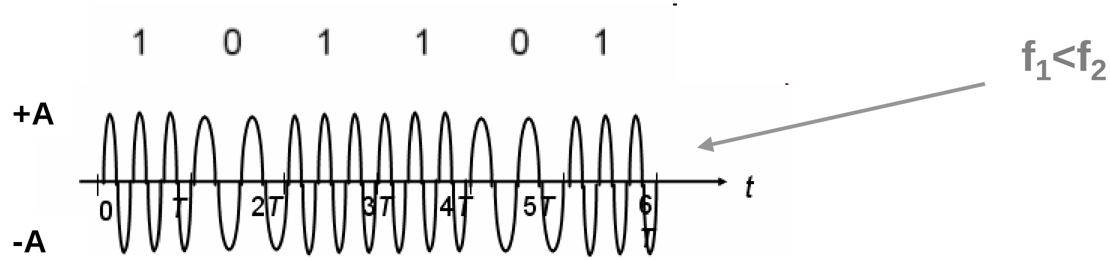
Frequency Shift Key Modulation & Demodulation (FSK)

Object: To study the generation of the frequency shift keyed output and also to demodulate the FSK output.

FSK – **frequency of carrier signal is varied to represent binary 1 or 0**

- **peak amplitude & phase remain constant during each bit interval**

$$s(t) = \begin{cases} A\cos(2\pi f_1 t), & \text{binary } 0 \\ A\cos(2\pi f_2 t), & \text{binary } 1 \end{cases}$$



- **demodulation**: **demodulator must be able to determine which of two possible frequencies is present at a given time**
- **advantage**: **FSK is less susceptible to errors than ASK – receiver looks for specific frequency changes over a number of intervals, so voltage (noise) spikes can be ignored**
- **disadvantage**: **<u>FSK spectrum is 2 x ASK spectrum</u>**
- **application**: **over voice lines, in high-freq. radio transmission, etc.**

Features & procedure :

The board consists of the following built-in parts :
1. ± 5V D.C. at 100mA IC regulated power supply internally connected
2. Op-Amp IC.
3. Decade counter IC.
4. Quad Op-Amp. IC
5. Multiplexer IC.
6. Quad, 2-input EX-OR gate IC
7. Mains ON/OFF switch, fuse and jewel light.

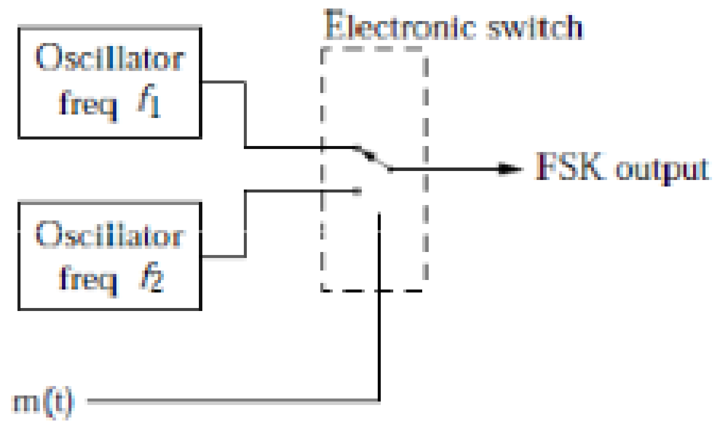
* The unit is operative on 230V ±10% at 50Hz A.C. Mains.
* Adequate no. of patch cords stackable from rear both ends 4mm spring loaded plug length ½ meter.
* Good Quality, reliable terminal/sockets are provided at appropriate places on panel for connections /observation of waveforms.
* Strongly supported by detailed Operating Instructions, giving details of Object, Theory, Design procedures, Report Suggestions and Book References.

THEORY:-

In frequency-shift keying, the signals transmitted for marks (binary ones) and spaces (binary zeros) are respectively.

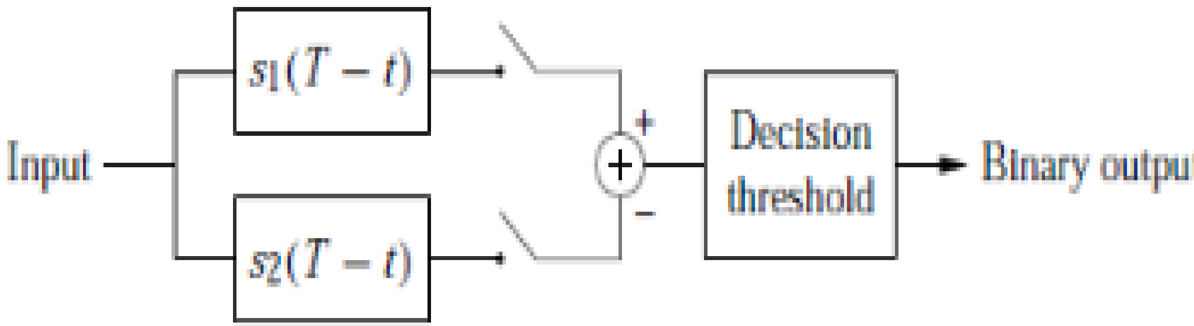
$$s_1(t) = A\cos(\omega_1 t + \theta_c), \qquad 0 < t \leq T$$
$$s_2(t) = A\cos(\omega_2 t + \theta_c), \qquad 0 < t \leq T$$

This is called a **discontinuous phase** FSK system, because the phase of the signal is discontinuous at the switching times. A signal of this form can be generated by the following system.



If the bit intervals and the phases of the signals can be determined (usually by the use of a phase-lock loop), then the signal can be decoded by two separate matched filters:

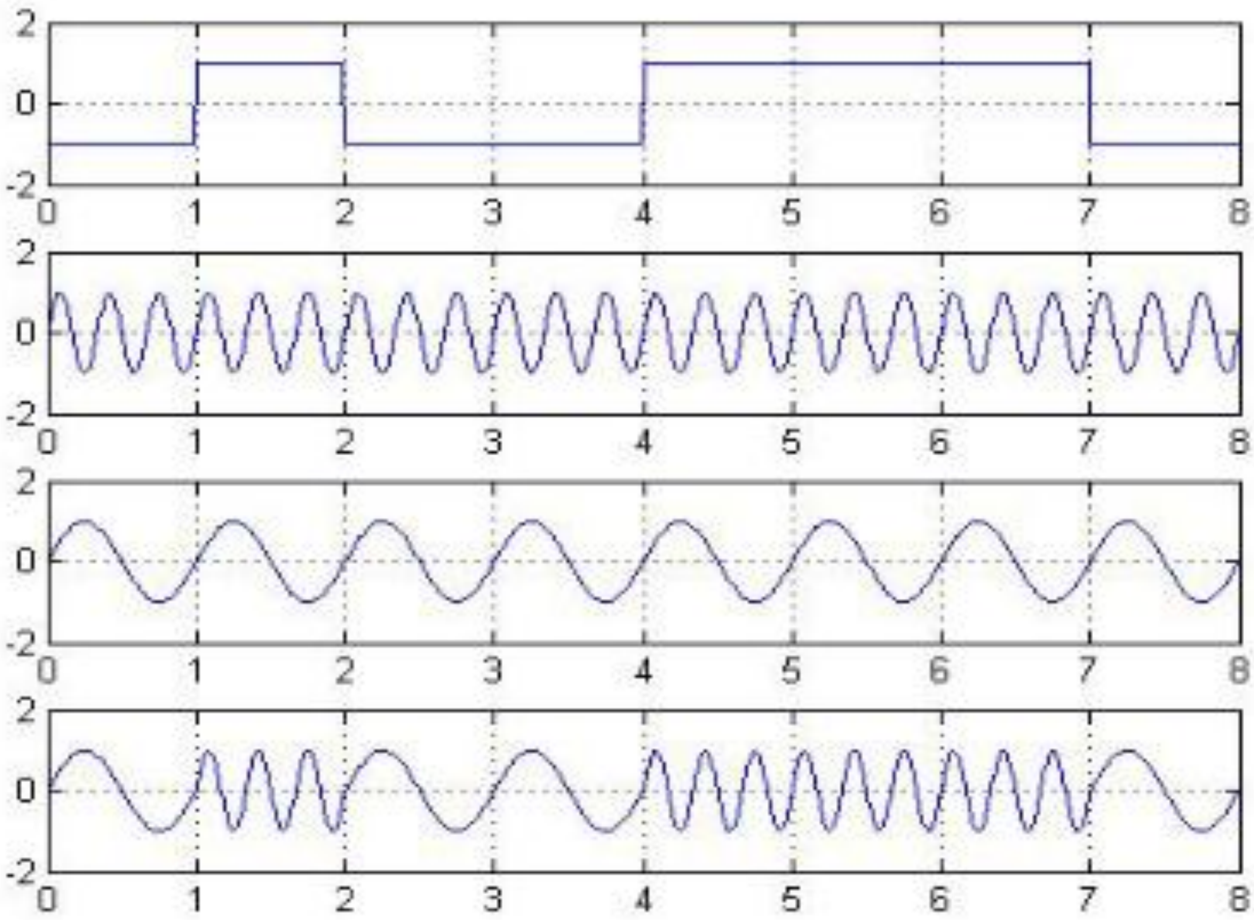
FSK-Modulated Signal:



The first filter is matched to the signal S1(t)and the second to S2(t) Under the assumption that the signals are mutually orthogonal, the output of one of the matched filters will be E and the other zero (where E is the energy of the signal). Decoding of the bandpass signal can therefore be achieved by subtracting the outputs of the two filters, and comparing the result to a threshold. If the signal S1(t) is present then the resulting output will be +E, and if S2(t) is present it will be –E. Since the noise variance at each filter output is $E\eta/2$, the noise in the difference signal will be doubled, namely ^{2}=En. Since the overall output variation is $2E$, the probability of error is:

$$P_e = \text{erfc}\left(\frac{2E}{2\sqrt{E\eta}}\right) = \text{erfc}\sqrt{\frac{E}{\eta}}.$$

Example **[FSK]**



NOTES:-

Digital Bandpass Modulation Techniques

Link Budget Analysis: Digital Modulation, Part 1

In digital communications, the modulating baseband message signal: $m(t)$ is a binary or M-ary digital data stream. The carrier is usually a sinusoidal signal.

1. **Baseband digital message signal**: $m(t)$
2. **Analog sinusoidal carrier signal**:
   A. Carrier signal: $A_c \cos(2\pi f_c t + \phi_c)$
3. **ASK: Amplitude Shift Keying.**
   A. Message signal changes the carrier's **amplitude** : $A_i(t)$.
4. **FSK: Frequency Shift Keying.**
   A. Message signal changes the carrier's **frequency** : $f_i(t)$.
5. **PSK: Phase Shift Keying.**
   A. Message signal changes the carrier's **phase** : $\phi_i(t)$.