Frequency-shift keying

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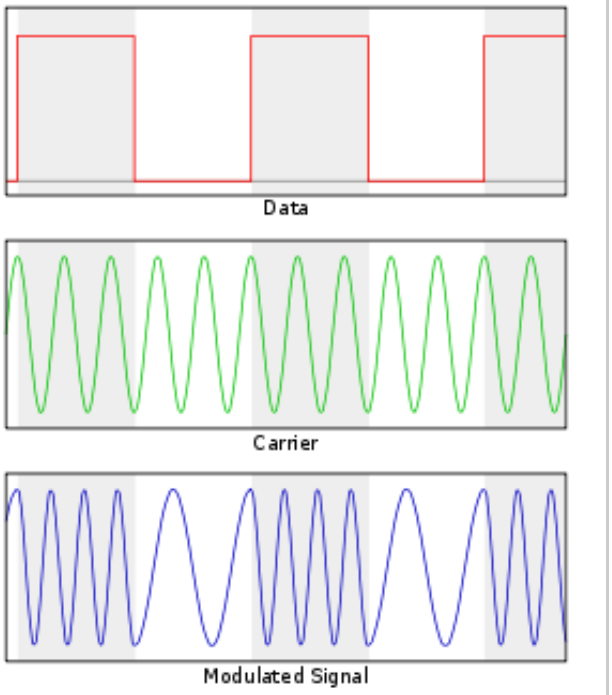
Frequency-shift keying (**FSK**) is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier wave.[1] The simplest FSK is **binary FSK** (**BFSK**). BFSK uses a pair of discrete frequencies to transmit binary (0s and 1s) information.[2] With this scheme, the "1" is called the mark frequency and the "0" is called the space frequency. The time domain of an FSK modulated carrier is illustrated in the figures to the right.



An example of binary FSK

Contents

Implementations of FSK Modems

Reference implementations of FSK modems exist and are documented in detail.[3] The demodulation of a binary FSK signal can be done using the Goertzel algorithm very efficiently, even on low-power microcontrollers.[4]

Other forms of FSK

Minimum-shift keying

Main article: Minimum-shift keying

Minimum frequency-shift keying or minimum-shift keying (MSK) is a particular spectrally efficient form of coherent FSK. In MSK, the difference between the higher and lower frequency is identical to half the bit rate. Consequently, the waveforms that represent a 0 and a 1 bit differ by exactly half a carrier period. The maximum frequency deviation is $\delta = 0.25\, f_m$, where f_m is the maximum modulating frequency. As a result, the modulation index m is 0.5. This is the smallest FSK modulation index that can be chosen such that the waveforms for 0 and 1 are orthogonal. A variant of MSK called GMSK is used in the GSM mobile phone standard.

Audio FSK

Audio frequency-shift keying (AFSK) is a modulation technique by which digital data is represented by changes in the frequency (pitch) of an audio tone, yielding an encoded signal suitable for transmission via radio or telephone. Normally, the transmitted audio alternates between two tones: one, the "mark", represents a binary one; the other, the "space", represents a binary zero.

AFSK differs from regular frequency-shift keying in performing the modulation at baseband frequencies. In radio applications, the AFSK-modulated signal normally is being used to modulate an RF carrier (using a conventional technique, such as AM or FM) for transmission.

AFSK is not always used for high-speed data communications, since it is far less efficient in both power and bandwidth than most other modulation modes. In addition to its simplicity, however, AFSK has the advantage that encoded signals will pass through AC-coupled links, including most equipment originally designed to carry music or speech.

AFSK is used in the U.S. based Emergency Alert System to notify stations of the type of emergency, locations affected, and the time of issue without actually hearing the text of the alert.

Applications

In 1910, Reginald Fessenden invented a two-tone method of transmitting Morse code. Dots and dashes were different tones of equal length.[5] The intent was to minimize transmission time.

1200 baud AFSK signal

0:00 MENU

Listen to an example of a 1200 baud AFSK-modulated signal.

Problems playing this file? See media help.

Some early CW transmitters employed an arc converter that could not be conveniently keyed. Instead of turning the arc on and off, the key slightly changed the transmitter frequency in a technique known as the *compensation-wave method*.[6] The compensation-wave was not used at the receiver. The method consumed a lot of bandwidth and caused interference, so it was discouraged by 1921.[7]

Most early telephone-line modems used audio frequency-shift keying (AFSK) to send and receive data at rates up to about 1200 bits per second. The common Bell 103 and Bell 202 modems used this technique.[8] Even today, North American caller ID uses 1200 baud AFSK in the form of the Bell 202 standard. Some early microcomputers used a specific form of AFSK modulation, the Kansas City standard, to store data on audio cassettes[*citation needed*] . AFSK is still widely used in amateur radio, as it allows data transmission through unmodified voiceband equipment. Radio control gear uses FSK, but calls it FM and PPM instead.

AFSK is also used in the United States' Emergency Alert System to transmit warning information[*citation needed*] . It is used at higher bitrates for Weathercopy used on Weatheradio by NOAA in the U.S.

The CHU shortwave radio station in Ottawa, Canada broadcasts an exclusive digital time signal encoded using AFSK modulation.[*citation needed*]

FSK is commonly used[*citation needed*] in Caller ID and remote metering applications: see FSK standards for use in Caller ID and remote metering for more details

See also

- Amplitude-shift keying (ASK)
- Continuous-phase frequency-shift keying (CPFSK)
- Dual-tone multi-frequency (DTMF), another encoding technique representing data by pairs of audio frequencies
- Frequency-change signaling
- Multiple frequency-shift keying (MFSK)
- Orthogonal frequency division multiplexing (OFDM)
- Phase-shift keying (PSK)
- Federal Standard 1037C
- MIL-STD-188

References

1. ^ Kennedy, G.; Davis, B. (1992). *Electronic Communication Systems* (4th ed.). McGraw-Hill International. ISBN 0-07-112672-4., p 509
2. ^ FSK: Signals and Demodulation (B. Watson) http://www.xn--sten-cpa.se/share/text/tektext/digital-modulation/FSK_signals_demod.pdf
3. ^ Teaching DSP through the Practical Case Study of an FSK Modem (TI) http://www.ti.com/lit/an/spra347/spra347.pdf
4. ^ FSK Modulation and Demodulation With the MSP430 Microcontroller (TI) http://www.ti.com/lit/an/slaa037/slaa037.pdf
5. ^ Morse 1925, p. 44; Morse cites British patent 2,617/11.
6. ^ Bureau of Standards 1922, pp. 415–416
7. ^ Little 1921, p. 125
8. ^ Kennedy & Davis 1992, pp. 549–550

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External links

- dFSK: Distributed Frequency Shift Keying Modulation in Dense Sensor Networks (http://cn.ece.cornell.edu/publications/papers/icc2004/pp.pdf)

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