Volume 4, Issue 6, June 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An Overview of Improved Spectral Efficiency of GMSK over MSK

Monika sharma(Mtech Student)
Electronics and Communication
Eternal University
Baru Sahib, HP India

Abhilasha Sharma(Assistant Professor)
Electronics and communication
Eternal University
Baru Sahib, HP India

Abstract- CPFSK is continuous frequency shift keying. The primary drawback of CPFSK is the high implementation complexity required for an optimal receiver. CPFSK with non-coherent envelope detection adaptive channel equalization are investigated to improve the bit error rate (BER) performance of microcellular digital wireless communications systems. CPFSK requires synchronization circuit therefore more expensive to implement. In this paper we are describing how GMSK is providing improved spectral efficiency over MSK.

Index Terms- Bit Error Rate (BER), Continuous frequency shift keying (CPFSK), Minimum shift keying (MSK), Gaussian minimum shift keying (GMSK).

I. INTRODUCTION

CPFSK has a higher quality bit error performance than traditional binary FSK for a given signal to noise ratio. Continuous-phase frequency-shift keying (CPFSK) is a commonly used variation of frequency-shift keying (FSK), which is itself a special case of analog frequency modulation. FSK is a method of modulating digital data onto a sinusoidal carrier wave, encoding the information present in the data to variations in the carrier's instantaneous frequency between one of two frequencies. In general, a standard FSK signal does not have continuous phase, as the modulated waveform switches instantaneously between two sinusoids with different frequencies. Minimum shift keying, MSK, is a type of continuous-phase frequency-shift keying, that is used in a number of applications. GMSK, is used for GSM cellular telecommunications system. The main attributes of MSK are constant envelope, spectral efficiency, error rate performance of binary PSK, and self- synchronizing capability. Gaussian minimum shift keying or GMSK is a continuous-phase frequency shift keying. It is similar to standard minimum-shift keying (MSK); however the digital data stream is first shaped with a Gaussian filter before being applied to a frequency modulator. This has the advantage of reducing sideband power.

II. CPFSK

CPFSK maintains a persistent amplitude signal, which is appropriate for nonlinear channels. It will occurrence fewer adverse effects than a non-constant envelope signal. Hence, a non-linear high power amplifier in the signal path is acceptable. Second, the information in a CPFSK signal can be retrieved via non-coherent demodulation, which is appropriate for multipath fading channels. The continuous phase frequency shift keying processor receives as input an incoming data stream. It includes a timer for toggling its output between a first predetermined frequency and a second predetermined frequency on a period basis based on the logical state of each bit in the incoming data stream. The CPFSK processor is counting down the predetermined time period associated with the detected logic state of a particular bit of the incoming data signal at least some of the other circuitry, preferably all of the other circuitry of the processor, is toggled to a sleep mode in which power is cut off thereby minimizing power consumption by the processor during this interim state. The use of zero phase crossover CFSK is particularly advantageous during wireless transmissions between devices in a closed system in that it (i) provides smoother transitions from high (e.g.,"1") to low (e.g., "0") bits, (ii) limits the radiated harmonics, and (iii) ensures proper demodulation of the received coded signal by improving the robustness of wireless transmissions. Continuous-phase frequency-shift keying (CPFSK) is a type of full-response continuous-phase modulation (CPM) that is characterized by the use of rectangular phase- shaping function. CPFSK has attractive spectral Characteristics because the smooth phase transitions between adjacent symbols minimize out-of-band power. A key convenience of CPFSK is that it can be non -coherently detected, which can Produce significant complexity savings and improved robustness relative to coherent detection. Continuous-phase frequency shift keying (FSK) is often used to transmit digital data faithfully over wire line and wireless links at low data rates.

III. MINIMUM SHIFT KEYING (MSK)

MSK the differentiation between the higher and lower frequency is identical to half the bit rate. MSK is encoded with bits alternating between quadrature components, with the Q component delayed by half the symbol period. However, instead of square pulses as OQPSK uses, MSK encodes each bit as a half sinusoidal. This results in a constant-modulus signal, which reduces problems caused by non-linear distortion. Minimum Shift Keying (MSK) is a continuous phase (CP) Frequency Shift Keying (FSK) binary modulation format. MSK is a form of FSK, with modulation index h = 0.5. In MSK two generic techniques for modulation and demodulation of MSK are referred to as parallel and serial methods. In direct synthesis method of realization, MSK is derived as ordinary FSK with the modulation index set to 0.5. The modulation index of 0.5 corresponds to minimum frequency spacing that allows two FSK signals to be coherently orthogonal, and the name minimum shift keying implies the minimum frequency separation that allows orthogonal detection. MSK is a spectrally efficient modulation scheme and is particularly attractive for use in mobile communication systems. An MSK signal with I-Q components is formed by passing the modulation signal through a half-sine shaper before modulation MSK produces an FSK with the minimum difference between the frequencies of the two FSK signals such that the signal do not interfere with each other. MSK can operate in a smaller bandwidth.

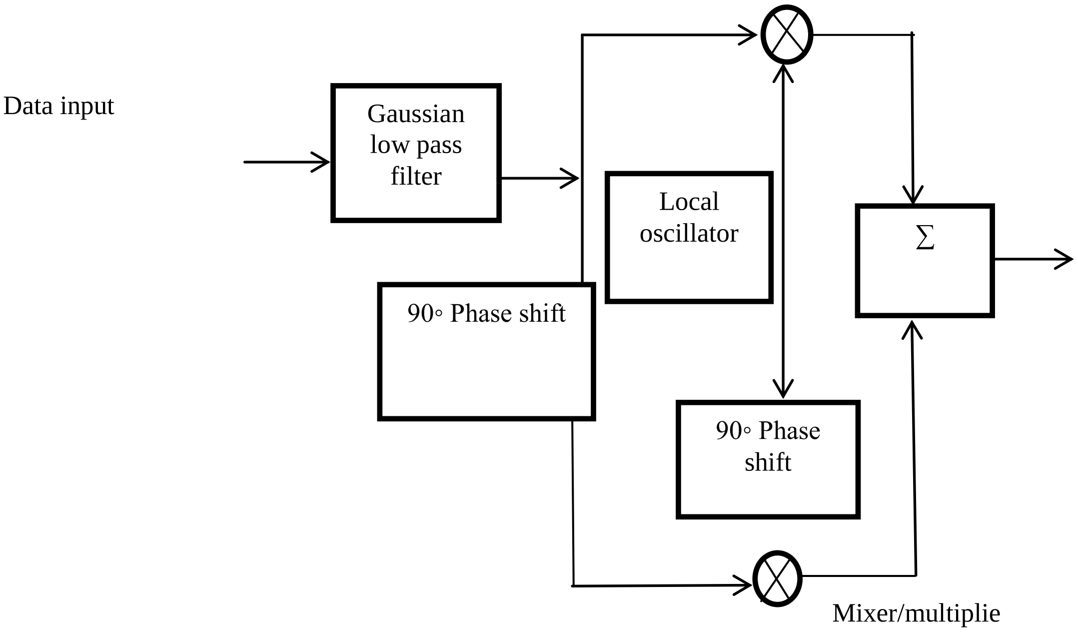

Figure No. 1 Block diagram of I-Q modulator used to create MSK

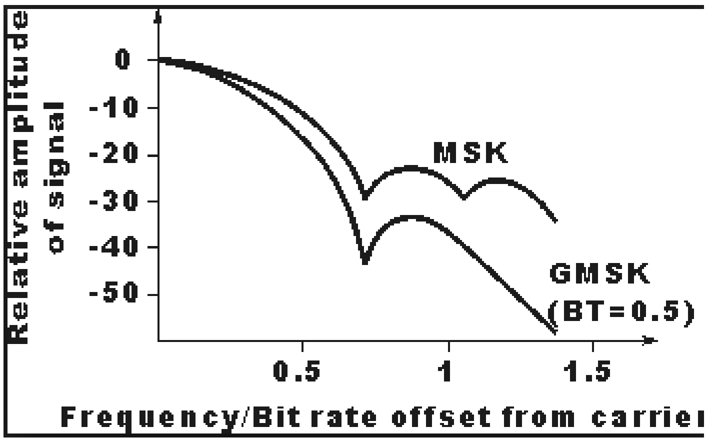

Figure No.2 Graph of Relative amplitude of signal versus Bit Rate

The above figure shows the relation between Relative Amplitude of Signal and Frequency Bit rate offset from carrier.

IV. GAUSSIAN MINIMUM SHIFT KEYING (GMSK)

Gaussian Minimum Shift Keying, are provide to its full title Gaussian filtered Minimum shift Keying. It has benefit of being able to carry digital modulation while still using the spectrum efficiently. GMSK modulation is based on MSK, which is itself a form of phase shift keying. One of the problems with standard forms of Phase Shift Keying (PSK) is that sidebands extend out from the carrier. To overcome this, MSK and its derivative GMSK can be used. Gaussian minimum shift keying or GMSK is a continuous-phase frequency shift keying, It is similar to standard minimum-shift keying (MSK); however the digital data stream is first shaped with a Gaussian filter before being applied to a frequency modulator. This has the advantage of reducing sideband power, which in turn reduces out-of-band interference between signal carriers in adjacent frequency channels. GMSK has spectral efficiency but it needs a higher power level than QPSK, for instance, in order to reliably transmit the same amount of data GMSK is most notably used in the Global system for mobile communication (GSM) and the Automatic Identification. GMSK is most prominent standards around the world. Global System for Mobile communication (GSM), Digital European Cordless Telephone (DECT), Cellular

Digital Packet Data (CDPD), Digital communications system in the 1800 MHz band Personal communications services in the 1900 MHz band (PCS1900) in U.S., all use GMSK as their modulation format. The reason GMSK is used for GSM is its High spectral efficiency, MSK uses phase variation for modulation so better immune to noise. Non- linear amplifiers are used to give better response and consumes less power so low battery usage which is an important parameter in cellular technologies. Gaussian Minimum Shift keying modulation scheme is a derivative of MSK. In GMSK, side lobe levels of the spectrum introduced in MSK are further reduced by passing the modulating NRZ data waveform. GSM spectrum is divided into 200 kHz channel for multiple accesses; there is very little interference between channels. It cannot go faster, since that would cause inter-symbol interference.

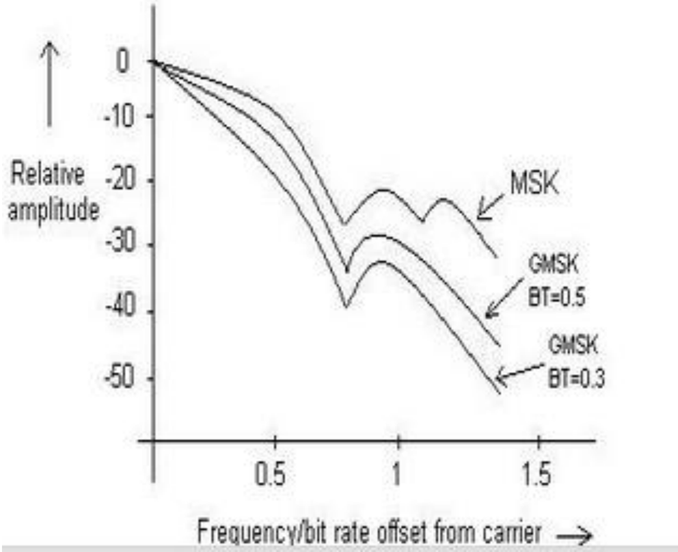

Figure no.3 Graph of Relative Amplitude and Bit rate of different modulating techniques

V. CONCLUSION

Gaussian minimum shift keying provides improved spectral efficiency and reduces side lobes over MSK. Power consumption is less. Bit rate and side lobe are directly proportional to each other. As bit rate increases side lobes are also increase and vice-versa. The main drawback of MSK is that increasing in side lobe causes information loss. Although MSKs power spectrum density falls quite fast. But it does not falls fast enough that it can reduce inference between adjacent signals in the frequency band. To overcome from this problem, we passes original binary signal through a Gaussian shaped Filter. Therefore GMSK have better spectral efficiency in comparison of MSK.

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