GAUSSIAN MINIMUM SHIFT KEYING (GMSK)

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GOAL OF TODAY'S LECTURE

- Introduction to GMSK.
- Overview of MSK .
- Generation of GMSK & its Waveform.
- Pulse shaping.
- Summing , Integration , I & Q signals.
- GMSK Receiver
- Power spectrum of GMSK
- Properties.
- Advantages.
- Disadvantages.
- Applications.

INTRODUCTION TO GMSK

- Gaussian Minimum Shift Keying (GMSK) is a form of continuous-phase FSK in which the phase change is changed between symbols to provide a constant envelope. Consequently it is a popular alternative to QPSK.
- The RF bandwidth is controlled by the Gaussian low-pass filter. The degree of filtering is expressed by multiplying the filter 3dB bandwidth (B) by the bit period of the transmission (T), i.e. by BT (BT = 0.3 for GSM networks) .
- GMSK allows efficient class C non-linear amplifiers to be used.

INTRODUCTION TO GMSK (CONT….)

- Gaussian Minimum Shift Keying.
- Modulation scheme used in GSM.
- Bandwidth-time product.
  - Describes the amount the symbols overlap
  - BT = 0.3 for GSM networks
  - Good spectral efficiency
  - At the expense of some inter-symbol interference (ISI)
- Data rate: 270.8 kbps.

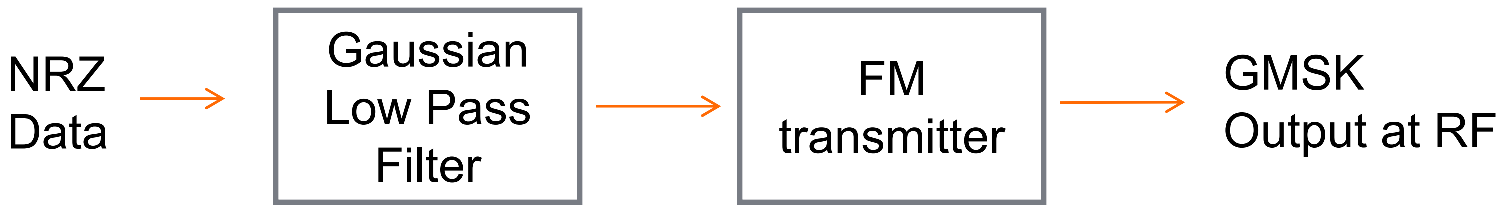
MSK

- GMSK is based on MSK.
- Minimum Shift Keying.
  - Linear phase changes
  - Spectrally efficient
- At baseband, bit transitions are represented by ½ sinusoidal cycle.

GENERATION OF GMSK

- 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.
- However, the Gaussian filter increases the modulation memory in the system and causes intersymbol interference, making it more difficult to discriminate between different transmitted data values and requiring more complex channel equalization algorithms such as an adaptive equalizer at the receiver.

GENERATING A GMSK WAVEFORM

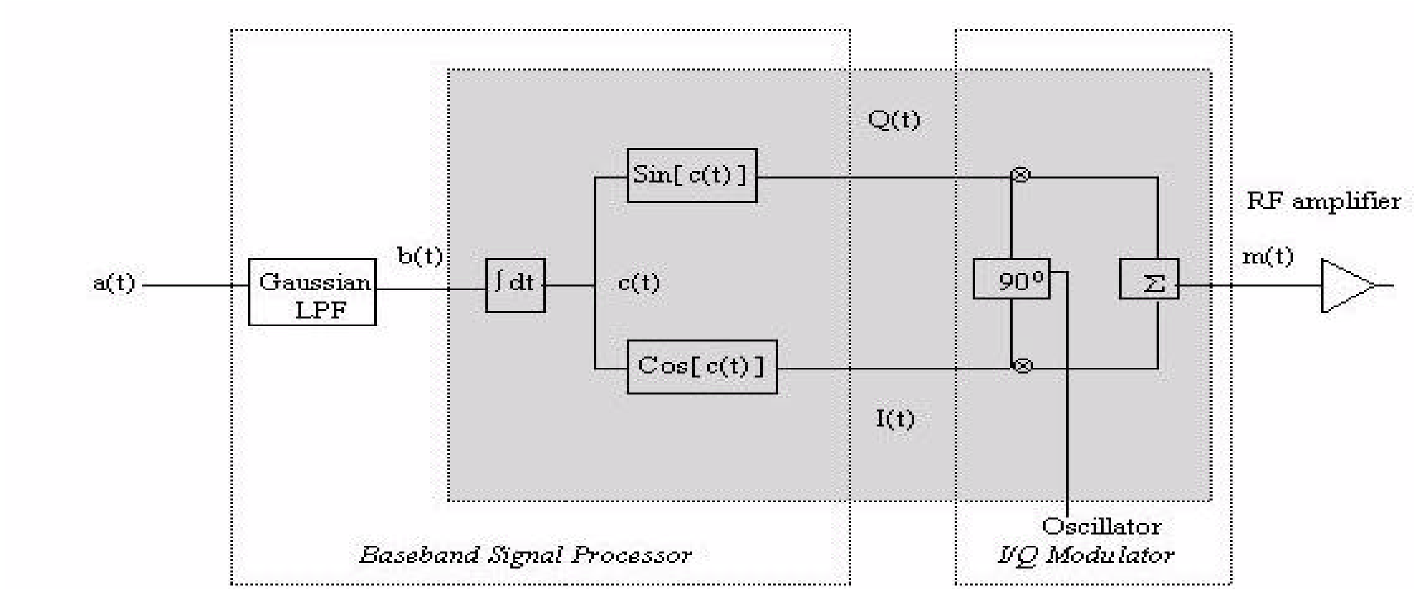


$H_G f = \exp(-\alpha^2 f^2)$

Where , α <=> B = 3 dB Bandwidth
= 0.5887/B
F = frequency in Hz.

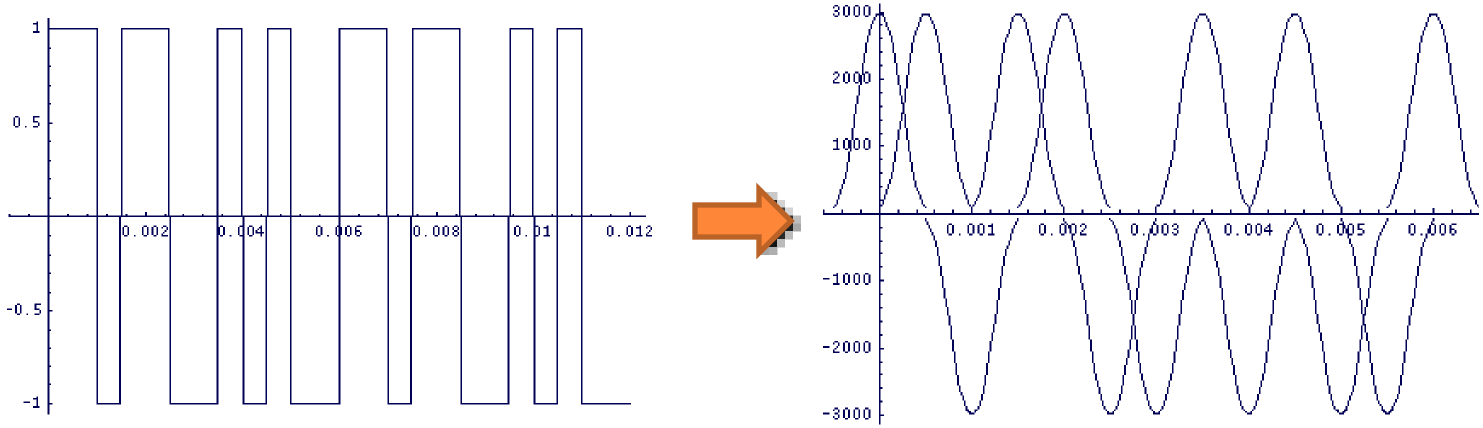
- GMSK as implemented by quadrature signal processing at baseband followed by a quadrature modulator

GENERATING A GMSK WAVEFORM (CONT….)



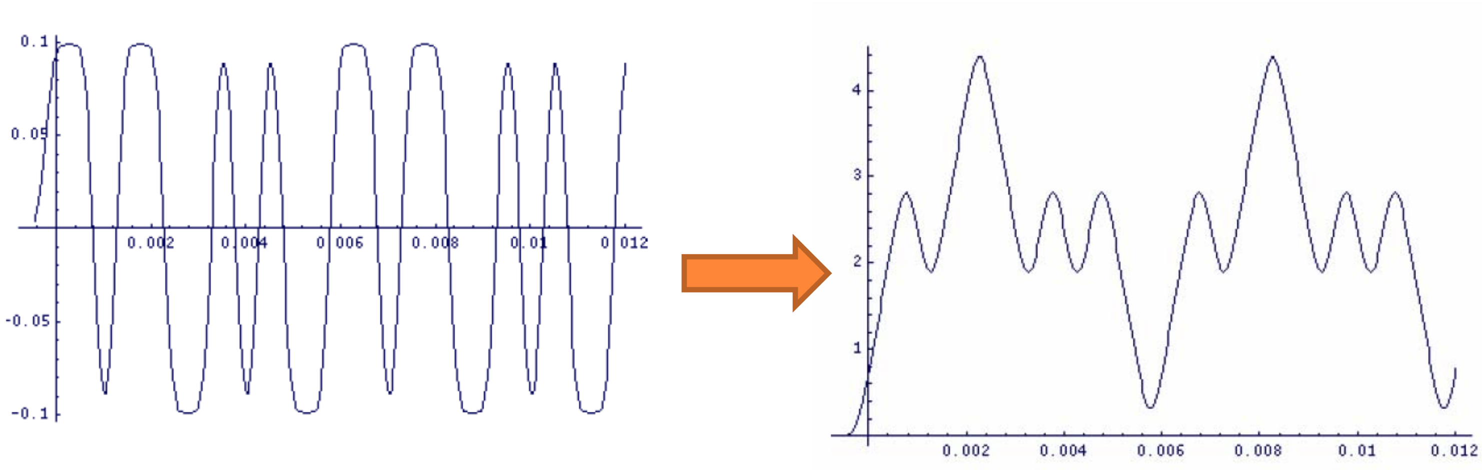
- GMSK as implemented by quadrature signal processing at baseband followed by a quadrature modulator

PULSE SHAPING



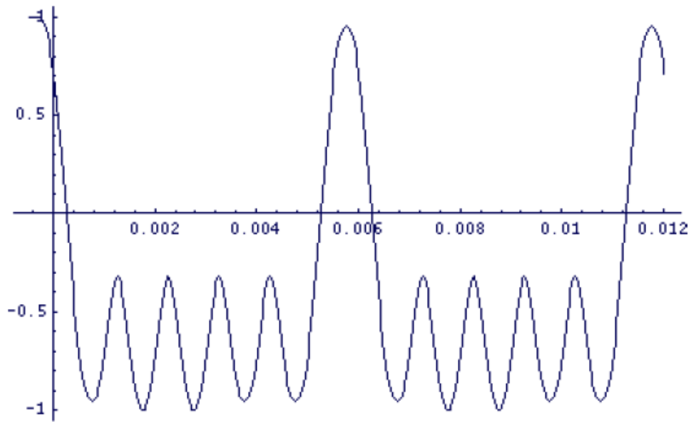
- Input: Binary pulse train (+1/-1).
- Each binary pulse goes through a LPF with a Gaussian impulse response.
  - The filter smoothes the binary pulses
  - The filter output is truncated and scaled
- This process results in a train of Gaussian shaped pulses

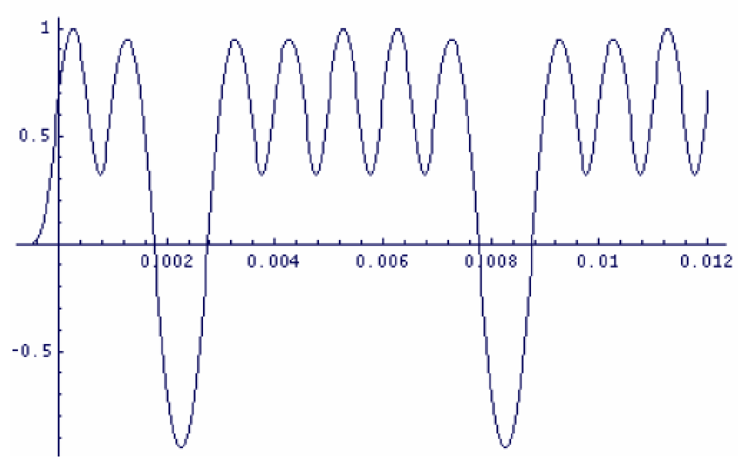
SUMMING AND INTEGRATION



- The pulses are summed together (left).
- The signal is integrated over time to obtain a continuous waveform which captures the bit transition information (right).

I&Q SIGNALS





- The resulting waveform is divided into In-Phase and Quadrature components.
  - In-phase: Left
  - Quadrature: Right
- The two signal components are then up-converted to the carrier frequency.

GMSK RECEIVER

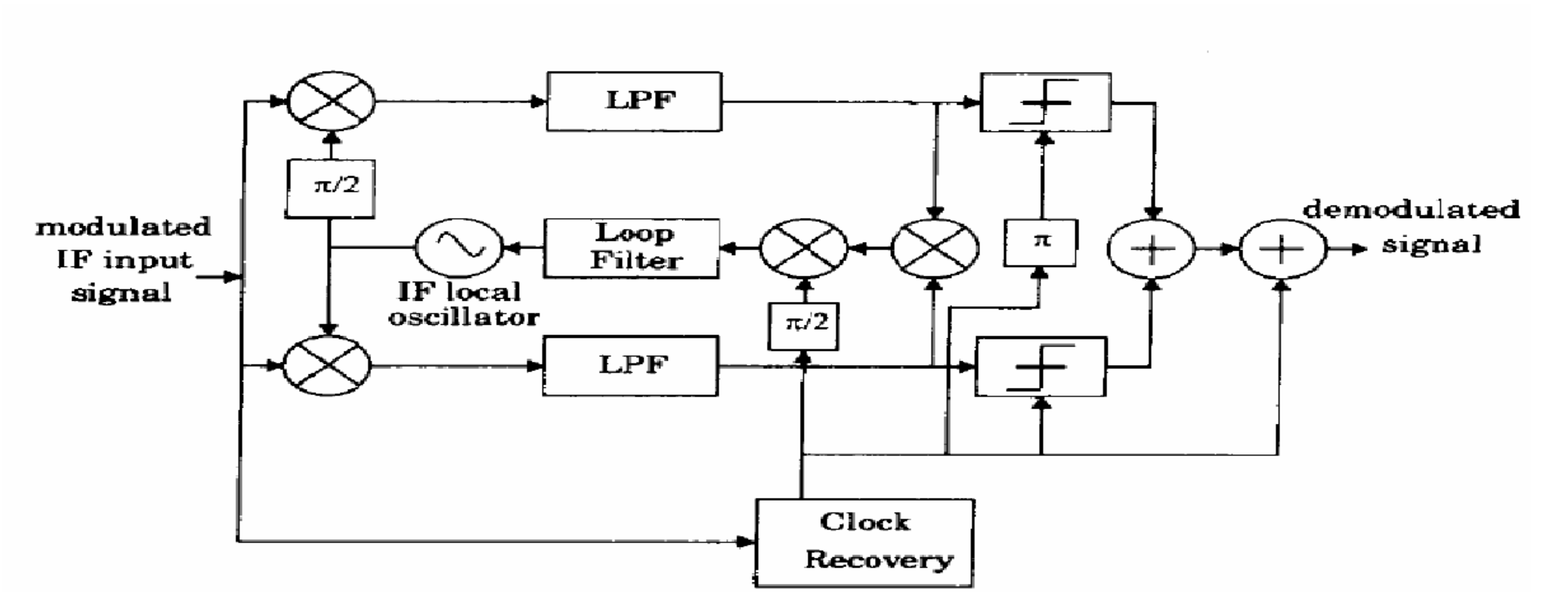


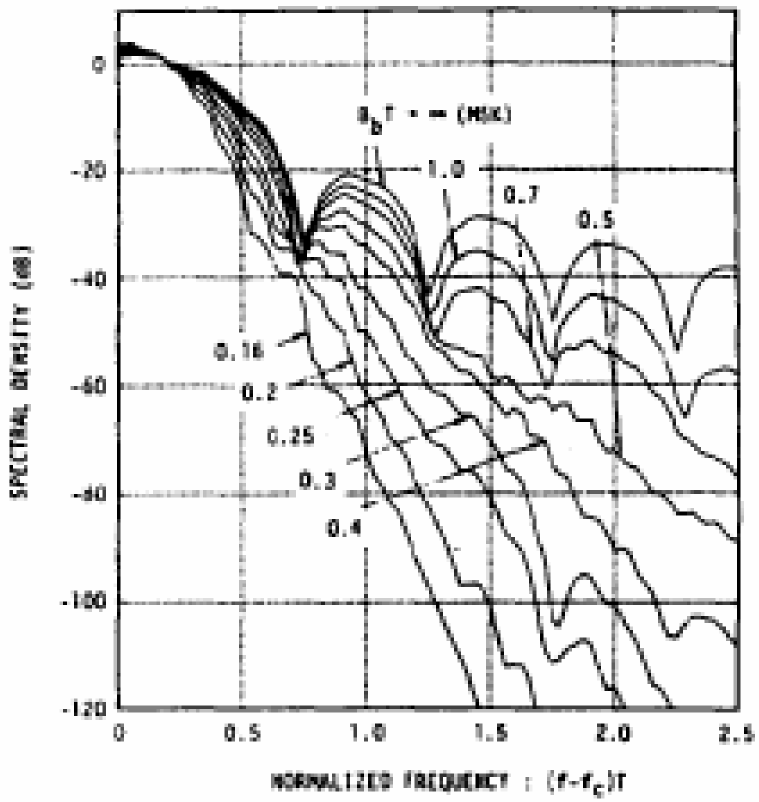
Figure 5.43
Block diagram of a GMSK receiver.

- Two D flip-flops acts as a quadrature product demodulator generate mutually orthogonal ref careers.
- X-OR gates acts as a baseband multipliers.

GMSK PROPERTIES

- Improved spectral efficiency.
- Power Spectral Density.
  - Reduced main lobe over MSK
- Requires more power to transmit data than many comparable modulation schemes.
- Self synchronizing capability
- Constant envelope over entire B.W
- Good BER performance

POWER SPECTRUM OF GMSK



- ➢ BT Decreases , side lobe falls rapidly.
- ➢ increases irreducible error rate.
- ➢Gives more power (%) with BT of 0.5 = BT of MSK

GMSK BIT ERROR RATE

- Function of BT.
- Bit error probability for GMSK is

$$P_e = Q\left\{\sqrt{\frac{2\gamma E_b}{N_0}}\right\}$$

where γ is a constant related to BT by

$$\gamma \cong \begin{cases} 0.68 & \text{for GMSK with } BT = 0.25 \\ 0.85 & \text{for simple MSK } (BT = \infty) \end{cases}$$

ADVANTAGES

- High spectral efficiency.
- Reducing sideband power.
- Excellent power efficiency due to constant envelope.
- Good choice for voice modulation.

DISADVANTAGES

- Higher power level than QPSK.
- Requiring more complex channel equalization algorithms such as an adaptive equalizer at the receiver.

APPLICATION

- Most widely used in the Global System for Mobile Communications (GSM).
- Used for CDPD (cellular digital packet data) overlay network.
- Used for GPRS & EDGE systems.

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- Ke-Lin Du & M.N.S.Swamy. *Wireless Communication Systems*, Cambridge University Press

Thank You