Al-Mustaqbal University
College of Engineering & Technology
Computer Techniques Engineering Department

Digital Communication

Lecture 13

Quadrature Phase Shift Keying (QPSK)

Principles, Generation, Bandwidth, and Advantages/Disadvantages

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Learning Objectives

By the end of this lecture, you will:

- Understand what QPSK is and how it works
- Learn how QPSK signals are generated and represented
- Study the advantages and disadvantages of QPSK
- Recognize QPSK in real-world communication systems

What is QPSK?

- **QPSK** = *Quadrature Phase Shift Keying*
- It is a **digital modulation technique**
- It sends **2 bits per symbol** (unlike BPSK, which sends only 1)

🧠 **Why QPSK?**

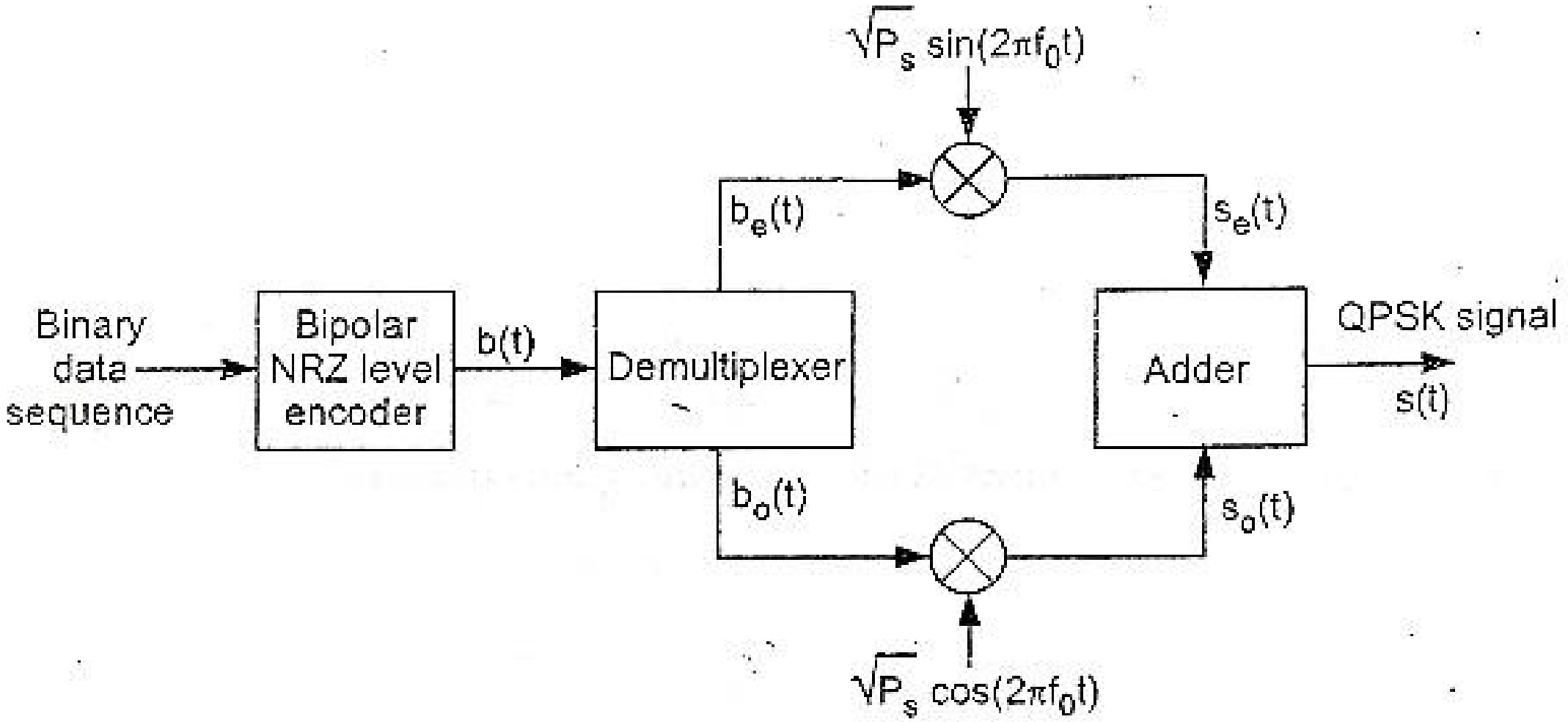
To **increase the data rate** without needing more bandwidth.

Offset QPSK (OQPSK) Generation

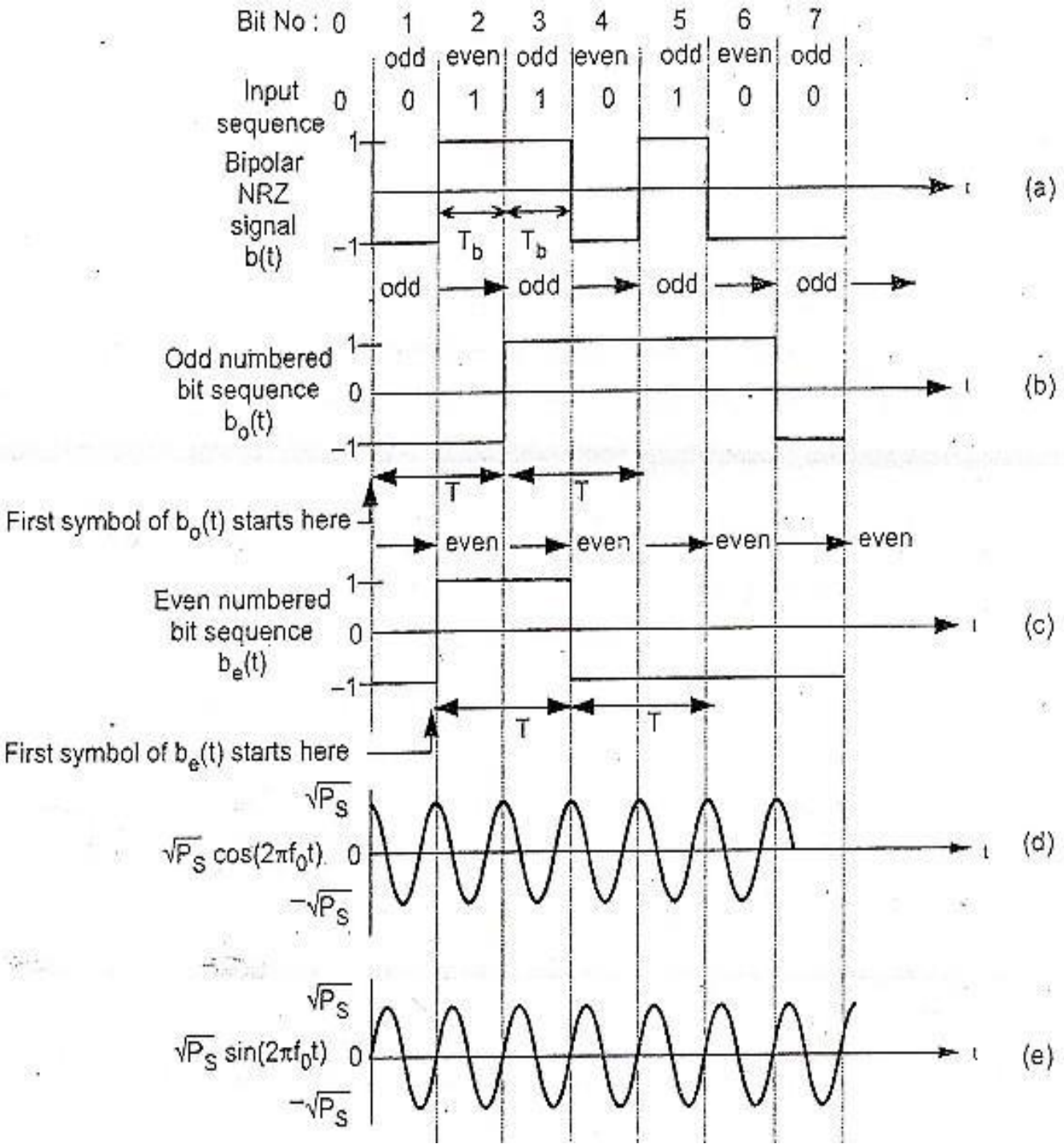
📊 **Steps:**

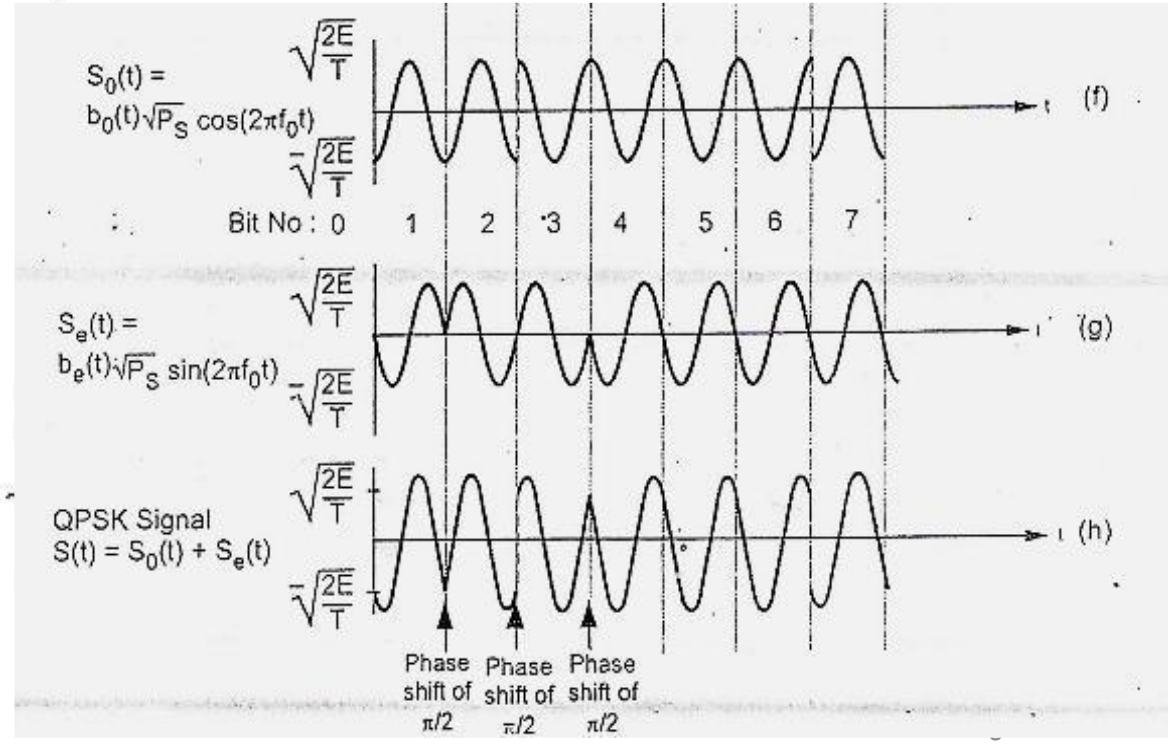
1. Split input data into **even and odd bits**.
2. Use two carriers:
    1. Cosine wave (I-channel)
    2. Sine wave (Q-channel)
3. Modulate both separately.
4. Combine them.

OQPSK Generator Block Diagram

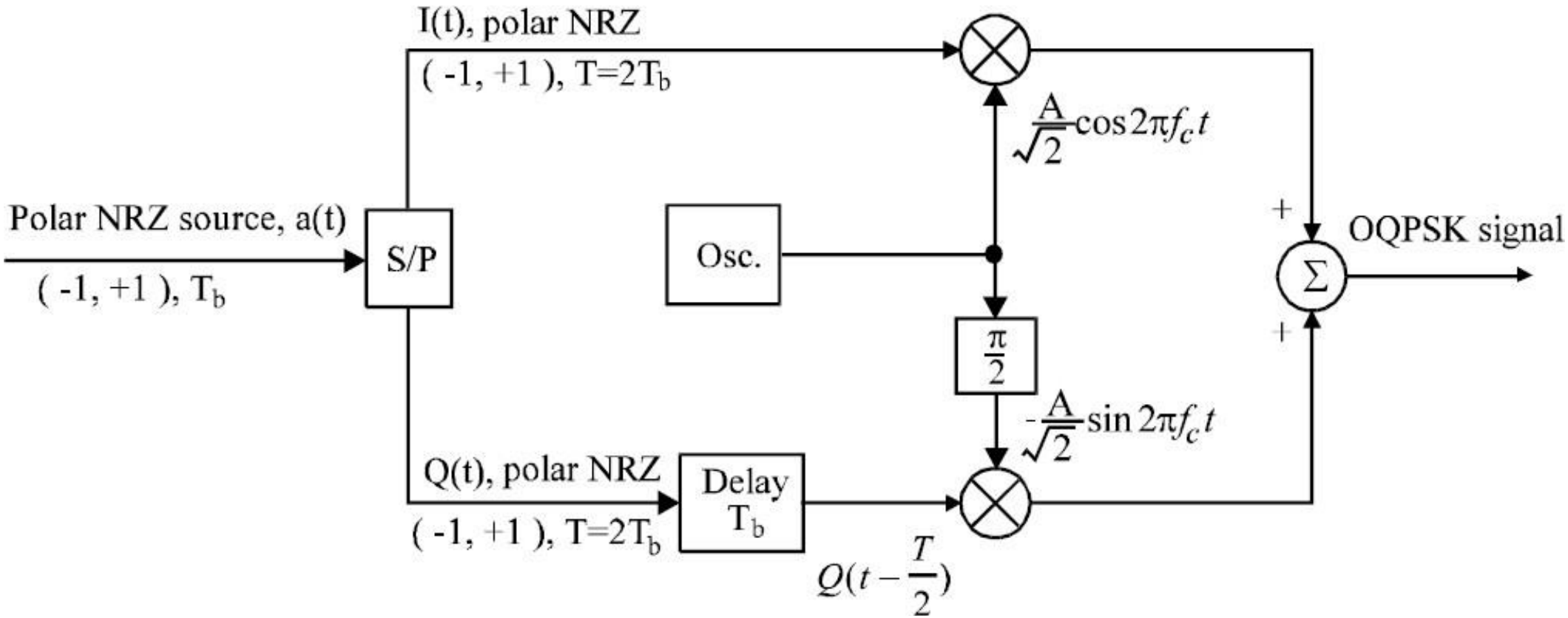


OQPSK Waveform Representation

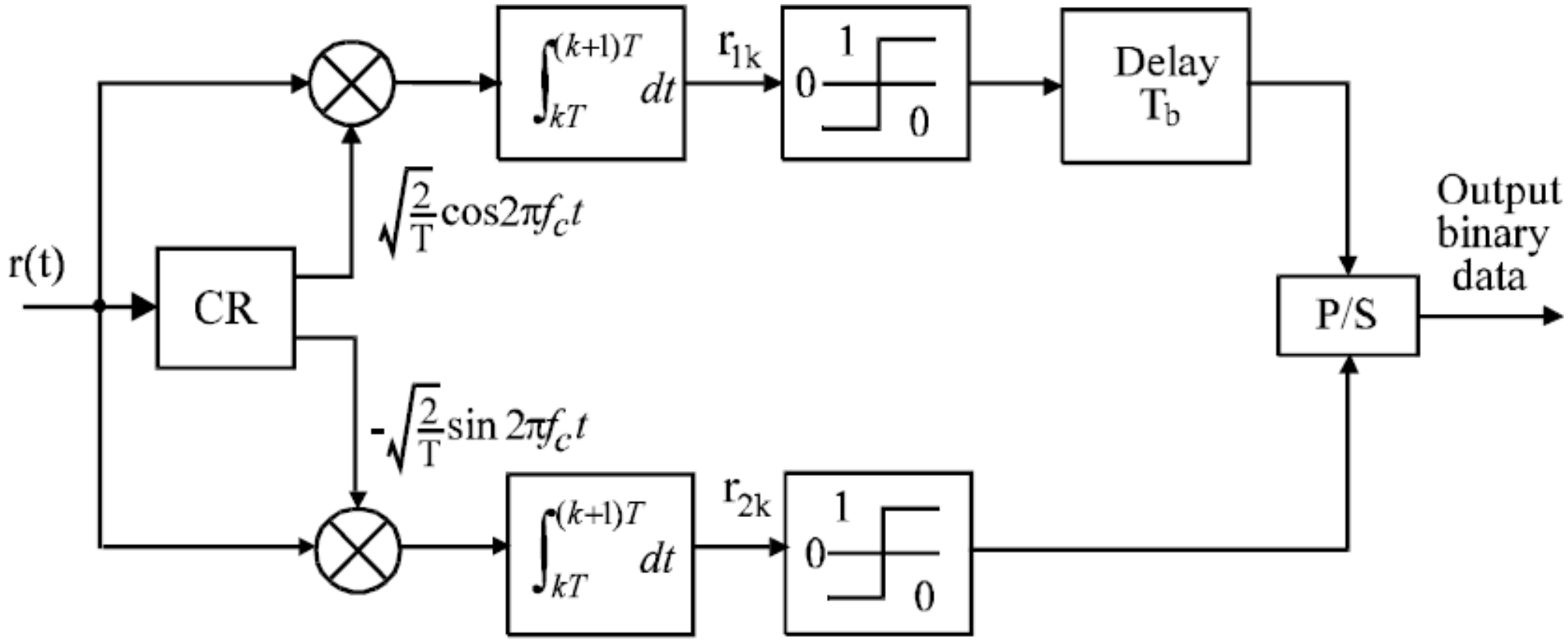




Block Diagram of OQPSK (Modulator)



Block Diagram of OQPSK (Demodulator)



(b)

Bandwidth of DPSK

- ✅ QPSK uses **the same bandwidth** as BPSK
- ✅ But it sends **twice the data**
- ✅ More efficient use of available frequency space

🧠 **Conclusion**:

Better **bandwidth efficiency** without increasing frequency range.

Advantages of QPSK

- ✅ **Bandwidth efficient** – 2 bits per symbol
- ✅ **Good power efficiency**
- ✅ **Less susceptible to noise** than higher-level modulations
- ✅ **Widely used** in real systems: Wi-Fi, satellite, 4G

Disadvantages of QPSK

⚠️ More complex than BPSK (needs phase synchronization)

⚠️ Needs accurate phase tracking at the receiver

⚠️ Performance degrades in channels with **phase noise**

Real-World Applications

🌐 **QPSK is used in**:

- ✓Satellite communication systems
- ✓Mobile systems (3G, 4G LTE)
- ✓Wi-Fi routers
- ✓Digital TV broadcasting

🧠 It provides a **balance of speed and reliability**.

Summary

- QPSK = sends 2 bits per symbol using 4 different phases
- Doubles data rate compared to BPSK
- Needs two orthogonal carriers (I and Q)
- Commonly used in modern communication systems

Thank You