Grade 12 A/L ICT · Lesson 6

6.3 Digital Data Encoding and Parity

Syllabus 6.3. Digital bits are sent as agreed **signal elements** (e.g. two voltages). You meet **Manchester encoding**, the need for **synchronization**, and **parity** for detecting bit errors.

1. Signal elements and protocols

Sender and receiver must **agree** what voltage (or frequency/phase change) means 0 or 1 – that agreement is part of a **protocol**.

2. Manchester and sync

Manchester encoding puts a transition in the middle of each bit so the receiver can recover timing. Without sync, bits are misread.



Manchester mid-bit transitions

Simple two-voltage coding can change once per bit; Manchester often needs about **twice** the signal-element rate for the same bit rate.

3. Parity

An extra **parity bit** makes the number of 1s even (or odd). One flipped data bit changes parity and can be **detected** (not always corrected).

🧱 **Worked example: Bits 1011001 (four 1s). Even parity bit?**
Already even → parity bit **0**.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* Modern links use CRC and FEC; parity still teaches the exam idea of an extra check bit.

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Key Words

Signal element – Physical change that stands for a bit.

Protocol – Agreed rules for communication.

Manchester encoding – Mid-bit transition coding.

Synchronization – Keeping sender and receiver clocks aligned.

Parity bit – Extra bit for even/odd check.

Even parity – Total number of 1s made even.

Odd parity – Total number of 1s made odd.

Bit rate – Bits sent per second.

Baud – Signal-element changes per second.

Error detection – Finding that a bit error occurred.

Voltage level – Common two-level signal element.

Clock – Timing reference for sampling bits.

Sample Q&A

1. What is a signal element?

> **Answer:** Physical representation of a bit (e.g. voltage).

2. Why Manchester helps sync?

> **Answer:** Mid-bit transition recovers timing.

3. What if clocks disagree?

> **Answer:** Bits are sampled wrongly.

4. Even parity for 1011001?

> **Answer:** 0 (already even).

5. Parity detects what?

> **Answer:** Many single-bit errors.

6. Manchester vs simple 2-level rate?

> **Answer:** Often ~2× signal changes per bit.

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MCQ

1. Manchester places a transition

A. never
B. in the middle of each bit
C. only in DNS
D. only at dawn
E. only in IP headers

2. Parity bit is used to

A. paint cables
B. charge batteries
C. help detect bit errors
D. name folders
E. set GUI themes

3. Even parity for 1011001

A. undefined
B. parity 11
C. 1
D. 0
E. 2

4. Without synchronization

A. DNS vanishes
B. bits may be misread
C. cables paint themselves
D. printers invent ink
E. OSI deletes layer 1

5. A protocol here means

A. a school bell only
B. a lunch break
C. a textbook cover
D. a chair
E. agreed rules including signal meanings

6. Bit rate measures

A. cows per farm
B. tabs per browser
C. metres per bit
D. icons per desktop
E. bits per second

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7. Two voltage levels can encode

A. binary 0 and 1
B. only temperatures of tea
C. only font sizes
D. only colours
E. only smells

8. Odd parity makes

A. the MAC empty
B. the IP private
C. the count of 1s odd
D. the fiber dark
E. the port 80 only

9. Which term means: “Physical change that stands for a bit”?

A. Signal element
B. Manchester encoding
C. Even parity
D. Voltage level
E. Bit rate

10. Which term means: “Agreed rules for communication”?

A. Odd parity
B. Protocol
C. Clock
D. Baud
E. Synchronization

11. Which term means: “Mid-bit transition coding”?

A. Manchester encoding
B. Bit rate
C. Parity bit
D. Signal element
E. Error detection

12. Which term means: “Keeping sender and receiver clocks aligned”?

A. Voltage level
B. Even parity
C. Baud
D. Protocol
E. Synchronization

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13. Which term means: “Extra bit for even/odd check”?

A. Odd parity
B. Manchester encoding
C. Error detection
D. Parity bit
E. Clock

14. Which term means: “Total number of 1s made even”?

A. Voltage level
B. Bit rate
C. Synchronization
D. Even parity
E. Signal element

15. Which term means: “Total number of 1s made odd”?

A. Clock
B. Protocol
C. Odd parity
D. Baud
E. Parity bit

16. Which term means: “Bits sent per second”?

A. Bit rate
B. Signal element
C. Error detection
D. Manchester encoding
E. Even parity

17. Which term means: “Signal-element changes per second”?

A. Synchronization
B. Voltage level
C. Baud
D. Odd parity
E. Protocol

18. Which term means: “Finding that a bit error occurred”?

A. Parity bit
B. Manchester encoding
C. Bit rate
D. Error detection
E. Clock

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19. Which term means: “Common two-level signal element”?

A. Signal element
B. Voltage level
C. Even parity
D. Synchronization
E. Baud

20. Which term means: “Timing reference for sampling bits”?

A. Odd parity
B. Protocol
C. Parity bit
D. Error detection
E. Clock

Structured Questions

1. Explain two-voltage encoding. *(2 marks)*

> Agree which level is 0/1; send levels as bits.

2. Describe Manchester encoding. *(2 marks)*

> Transition in middle of each bit for timing.

3. Why is synchronization needed? *(2 marks)*

> Receiver must sample at correct times.

4. Compute even parity for 1011001. *(2 marks)*

> Parity bit 0.

5. Compare bit rate and Manchester baud idea. *(2 marks)*

> Manchester often needs ~2 signal changes per bit.

Summary

- Signal elements represent bits.
- Manchester aids synchronization.
- Clocks must stay aligned.
- Parity detects many single-bit errors.
- Protocols agree meanings of signals.

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MCQ answer key – 6.3

1. **B** – Mid-bit.
2. **C** – Error detect.
3. **D** – Four 1s → 0.
4. **B** – Misread bits.
5. **E** – Agreed rules.
6. **E** – bits/s.
7. **A** – 0 and 1.
8. **C** – Odd count.
9. **A** – Signal element – Physical change that stands for a bit.
10. **B** – Protocol – Agreed rules for communication.
11. **A** – Manchester encoding – Mid-bit transition coding.
12. **E** – Synchronization – Keeping sender and receiver clocks aligned.
13. **D** – Parity bit – Extra bit for even/odd check.
14. **D** – Even parity – Total number of 1s made even.
15. **C** – Odd parity – Total number of 1s made odd.
16. **A** – Bit rate – Bits sent per second.
17. **C** – Baud – Signal-element changes per second.
18. **D** – Error detection – Finding that a bit error occurred.
19. **B** – Voltage level – Common two-level signal element.
20. **E** – Clock – Timing reference for sampling bits.

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