

AQA A-Level Physics

13.2 Analogue and digital signals

Flashcards

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What is the difference between an analogue and a digital signal?



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Analogue signals are continuous, digital signals are discontinuous and have 2 states, high and low.



What is a bit? How many bits are in a byte?



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A bit is a basic information unit that can either be 1 or 0. A byte is 8 bits.



What is the difference between the value of a kB (kilobyte) in data transmission and the value in memory storage capacity?



What is the difference between the value of a kB (kilobyte) in data transmission and the value in memory storage capacity?

Data transmission: $1\text{kB} = 1000\text{B}$

Storage: $1\text{kB} = 2^{10} \text{ bytes} = 1024 \text{ bytes}$

This difference is because binary numbers represent digital signals numerically.



Represent 7 in binary form.



Represent 7 in binary form.

111

This is 3 bits, digital signals can be represented as bits.



What is noise and why does it arise?



What is noise and why does it arise?

Random fluctuations in a waveform at different frequencies caused by interference from external sources and the system processing the signal.



How can the signal to noise ratio (SNR) be calculated and why is amplification of analogue signals a problem?



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$$\text{SNR}_{\text{dB}} = 10 \log(P_{\text{signal}} / P_{\text{noise}}), \text{ where } P = \text{power}$$

Amplifying analogue signals also amplifies the noise in them, which distorts the signal.



Why is the reading of digital signals unaffected by noise?



Why is the reading of digital signals unaffected by noise?

The pattern of high and low is still recognisable so noise can be filtered out.



Define the sensitivity, resolution and response time of a sensor that produces an analogue output.



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Sensitivity: Change in output quantity / unit change in input quantity

Resolution: Smallest change in quantity that can be measured, given as a ratio of the change to the value measured

Response time: the time taken to completely respond to a change in input



Define the bandwidth of an analogue signal.



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The highest frequency in signal minus the lowest frequency in signal.



How does an analogue to digital converter (ADC) work?



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Sampling: analogue signal passes into a sampling gate which samples signal value in equal intervals determined by an external clock pulse. Each decimal sampled value is converted into binary form and the corresponding digital signal sent.



How often should samples be taken to obtain a digital signal recognisable as the original analogue signal?



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The sampling rate must be at least 2x the highest information frequency in the signal bandwidth.



How does quantisation affect analogue to digital conversion signal quality?



How does quantisation affect analogue to digital conversion signal quality?

Quantisation is the number of available voltage values. It's determined by the number of bits used for each sample. A sampled analogue value must be rounded and encoded to an integer digital value (introducing an approximation error). To increase the no. of values that can be recorded, use more bits.



What are the 3 stages of pulse code modulation (PCM)?



What are the 3 stages of pulse code modulation (PCM)?

Sampling: reading analogue signal values at constant sampling rate.

Quantisation: assigning a discrete value to each analogue value sampled.

Encoding: representing discrete values as binary numbers. The resultant signal is a pulse code modulated signal.



How is the bit rate of a PCM signal calculated?



How is the bit rate of a PCM signal calculated?

Bit rate = sampling frequency x number
of bits used in quantisation



What is a sensor?



What is a sensor?

A transducer that produces an analogue voltage output depending on the environment.



What are advantages of digital signals
over analogue signals?



What are advantages of digital signals over analogue signals?

- Digital signals have high immunity to noise, so they stay high quality over long distance transmissions
- Noise is easily removed
- More information can be sent at any one time
- Readily interfaced with digital systems
- Optical transmissions are possible



What are the disadvantages of digital signals compared to analogue signals?



What are the disadvantages of digital signals compared to analogue signals?

- Information is not as exact, as discrete values are used to form the signal
- Systems for transmission and processing are more complex to build than those for analogue

