Microprocessors & Interfacing

Analog Input/Output (II)

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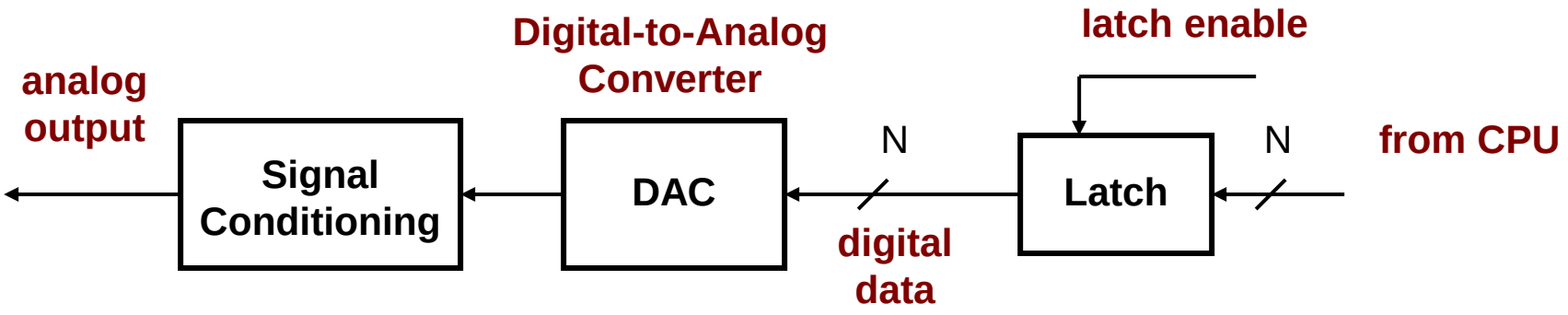
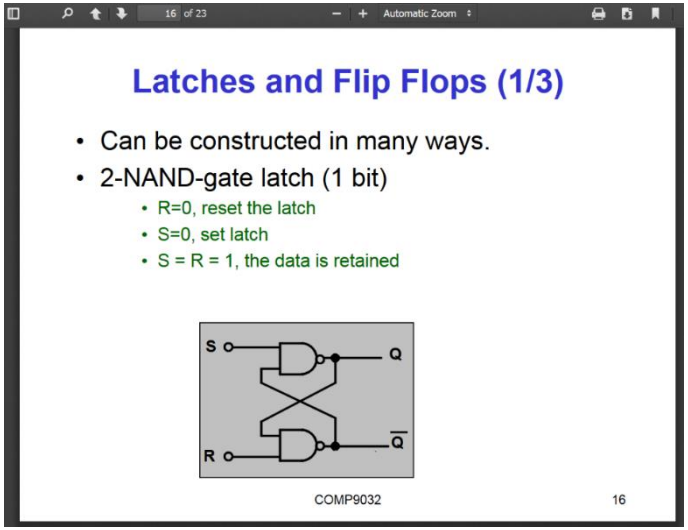
Lecture Overview

- Analog output
  - DAC

Digital-to-Analog Conversion (DAC)

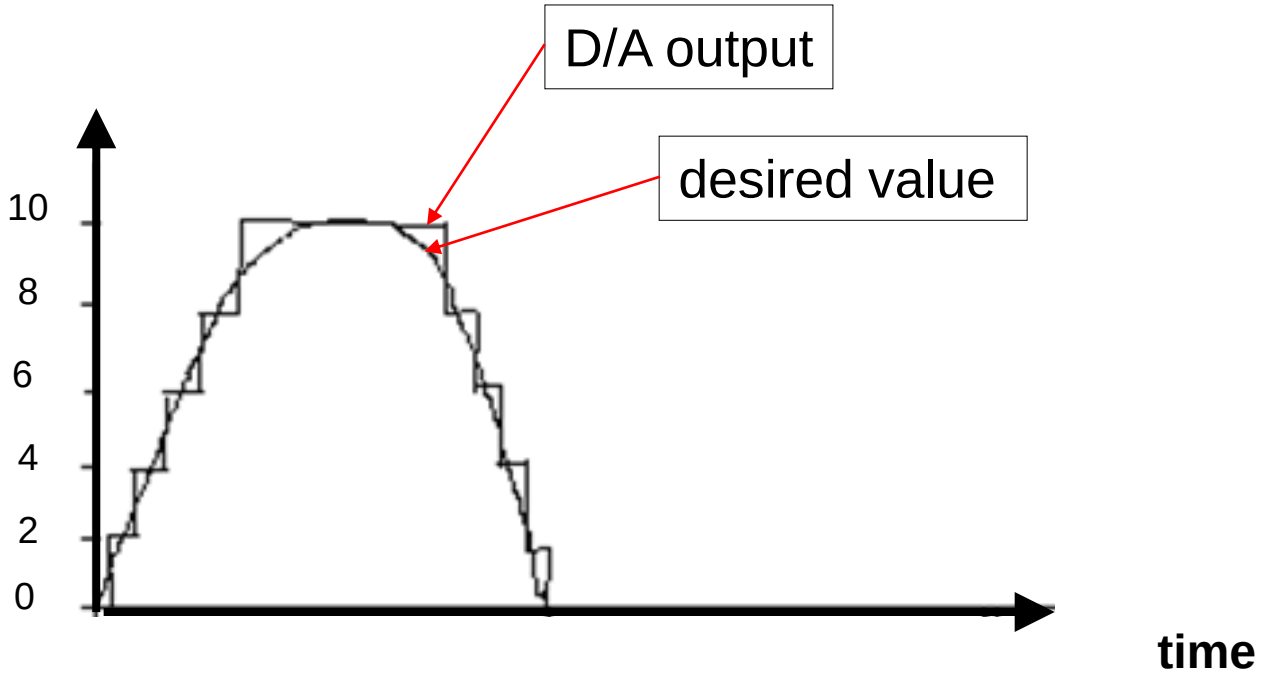




Digital-to-Analog Conversion (cont.)

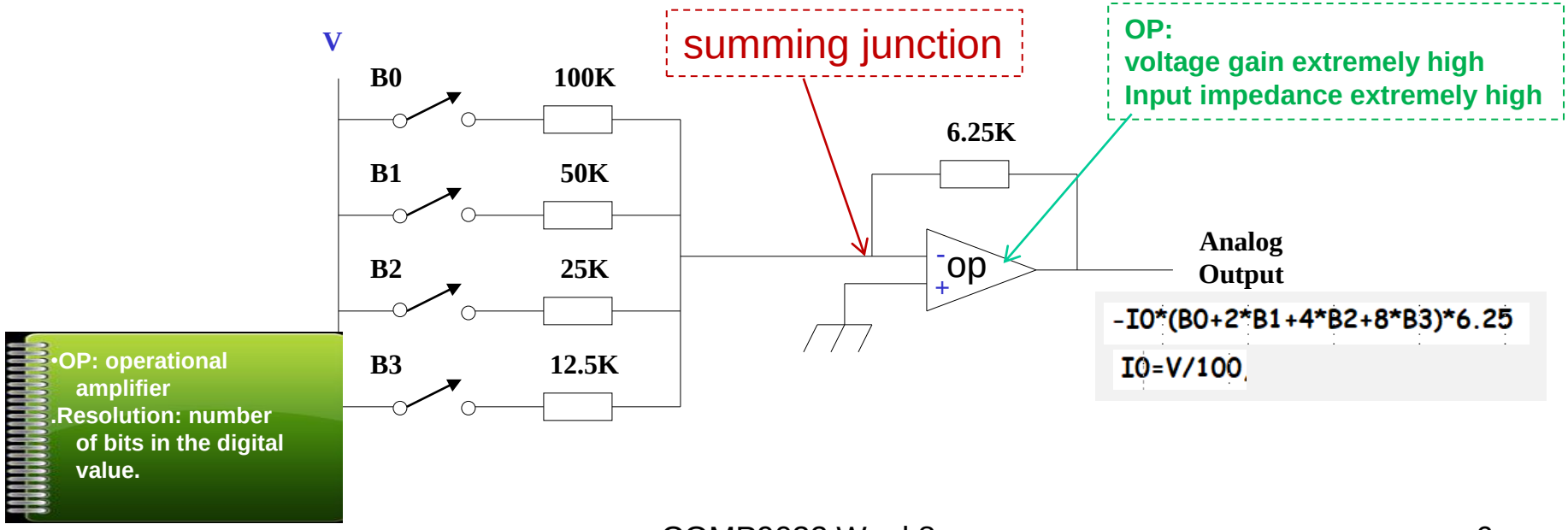
- A parallel output interface connects the Digital-to-Analog converter (**DAC**) to CPU.
- The latches may be part of the DAC or the output interface.
- **Digital value is converted into "continuous" value.**
  - **Quantized**
- A signal conditioning block may be used as a filter to smooth the quantized nature of the output.
  - The signal conditioning block also provides isolation, buffering and voltage amplification if needed.

Quantized D/A Output



Binary-Weighted D/A Converter

- Example: 4-bit DAC
  - As a switch for a bit is closed, a *weighted current* is supplied to the *summing junction* of the amplifier (OP).
  - For high-resolution D/A converters, the binary-weighted type must have a wide range of resistors. This may affect the output accuracy.



R-2R Ladder D/A Converter

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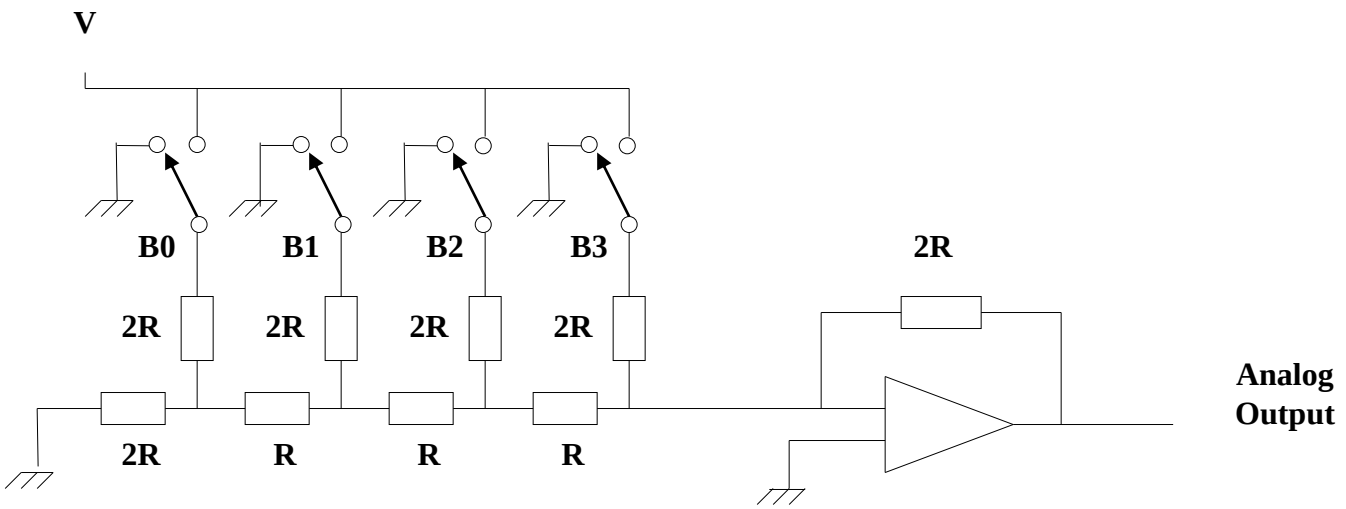
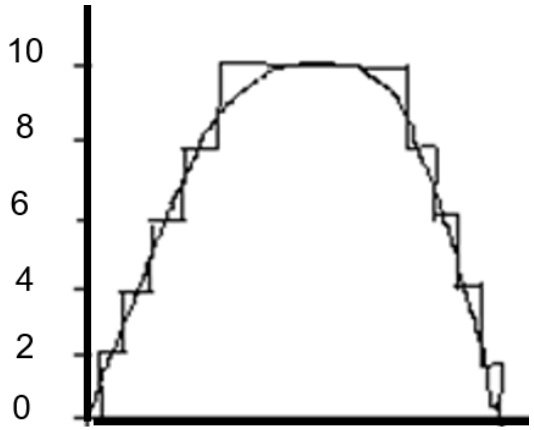
- As a switch changes from the grounded position to the reference position, a binary-weighted current is supplied to the summing junction.
- For high-resolution D/A converters, a wide range of resistors are not required, providing better accuracy for the output.



D/A Converter Specifications

- **Resolution**
  - The resolution is determined by the number of bits and is given as the output voltage corresponding to the smallest digital step, i.e. 1 LSB.

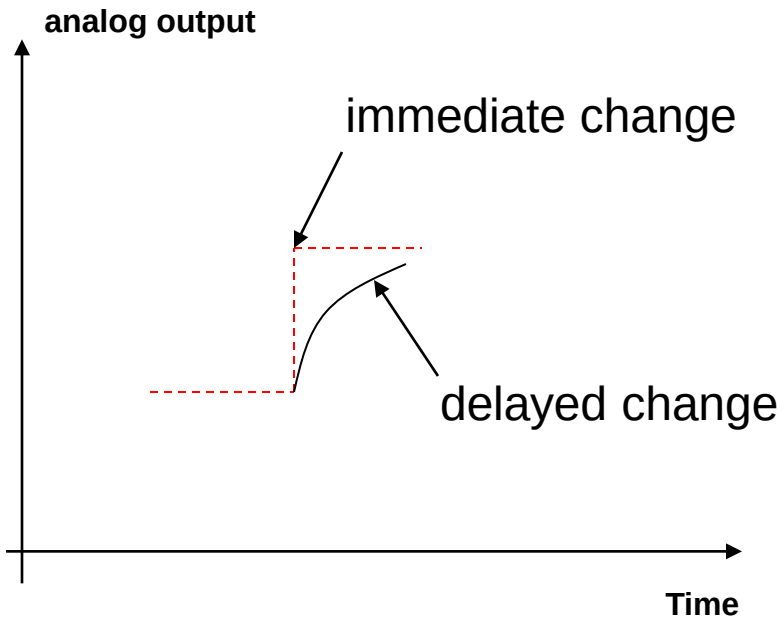


D/A Converter Specifications

- **Linearity**
  - Linearity shows how closely the output voltage to the idea values (a straight line drawn through zero and full-scale).
    - A way of measuring accuracy of DAC
      - Ideally, any two adjacent digital codes correspond to output analog voltages that are exactly one LSB apart.

D/A Converter Specifications

- **Settling Time**
  - The time taken for the output voltage to settle to within a specified error band, usually ± ½ LSB.



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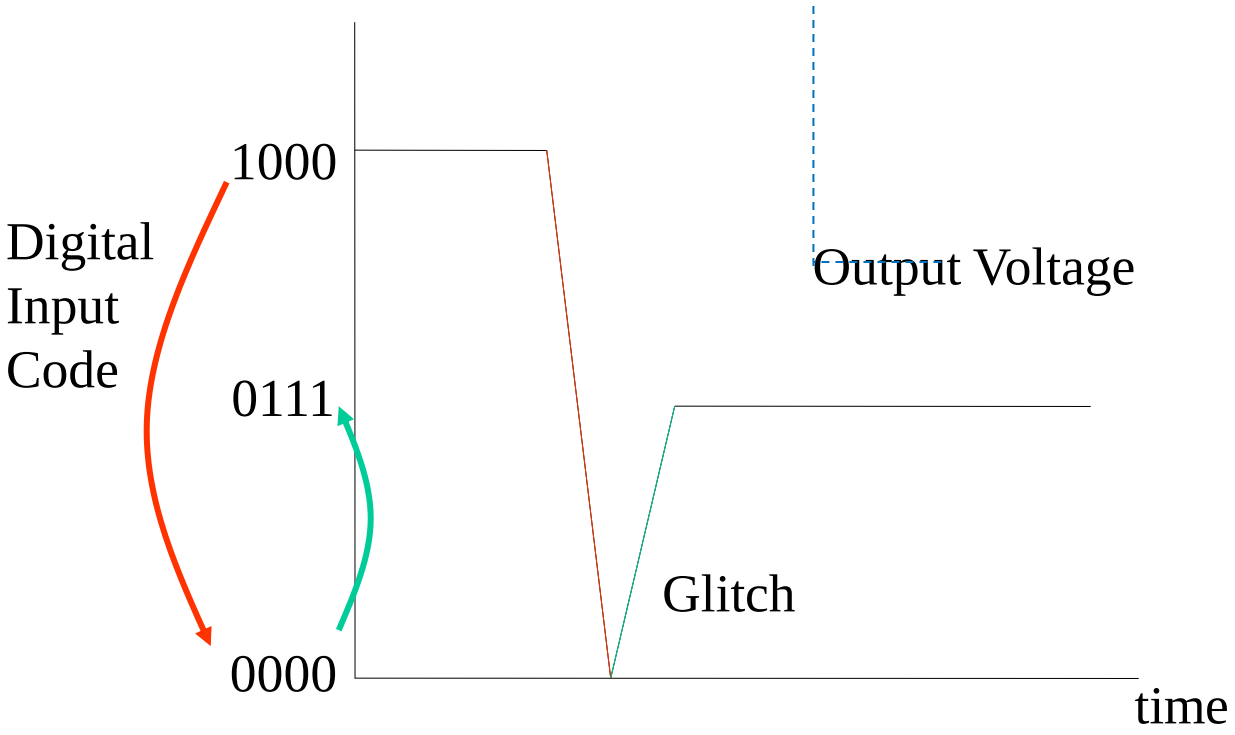
Glitches

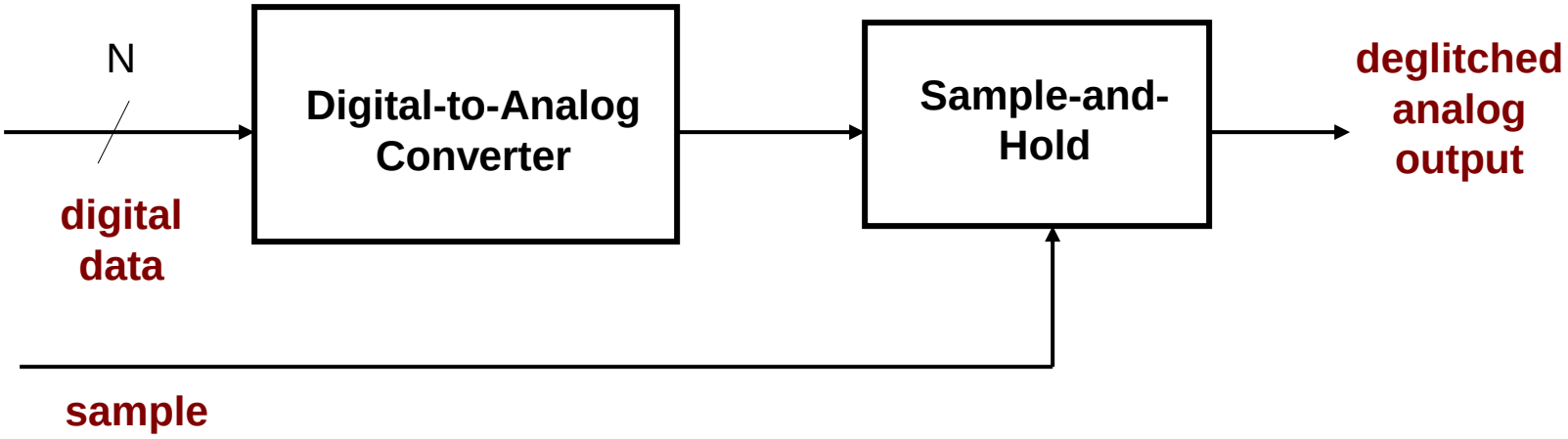
不对称

- A glitch is caused by asymmetrical switching in the D/A switches. If a switch changes from 1 to 0 faster than from 0 to 1, a glitch may occur.
  - Consider changing the output code of a 4-bit D/A from 1000 to 0111 in the next slide.
- The D/A converter glitch can be eliminated by using a sample-and-hold.

D/A Output Glitch



Deglitched D/A



Reading Material

- Chapter 13: Analog Input and Output. Microcontrollers and Microcomputers by Fredrick M. Cady.