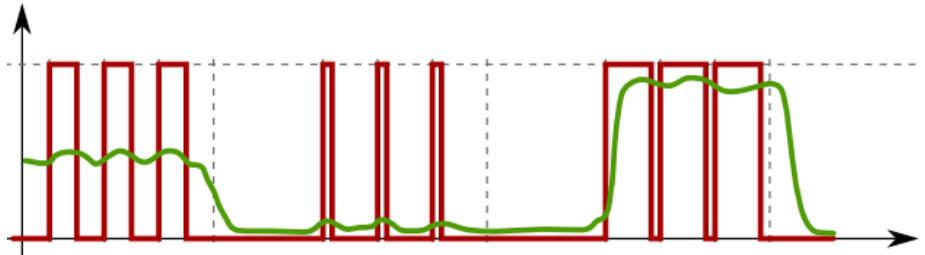


Embedded Systems Hands-On 1: Design and Implementation of Hardware/Software Systems

Task 6: Analog Output



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Task 6: Analog Output



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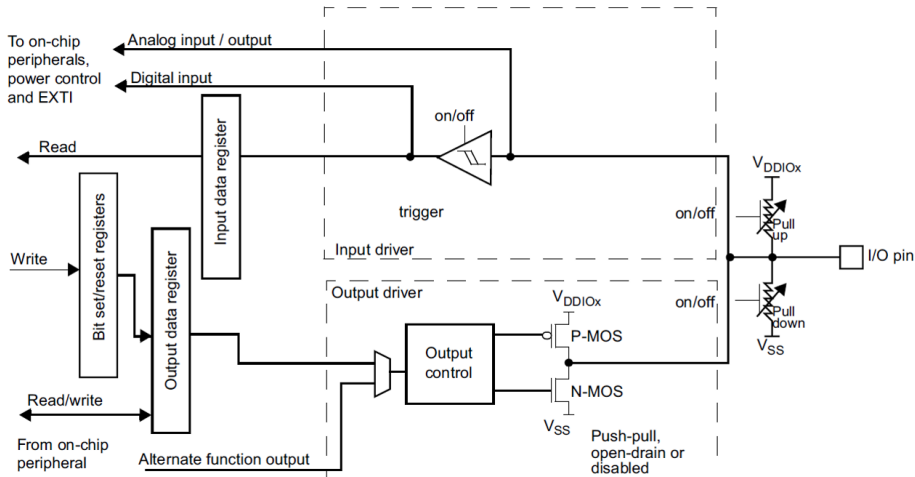
- ▶ Generating and filtering PWM signals
- ▶ Controlling bipolar transistors

Cortex-M GPIO

Source: RM0360



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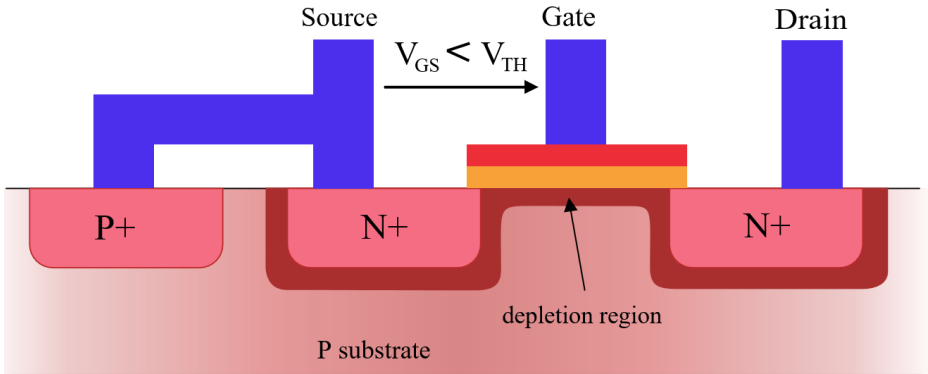


N-Channel MOSFET: Off

Source: wikipedia.org



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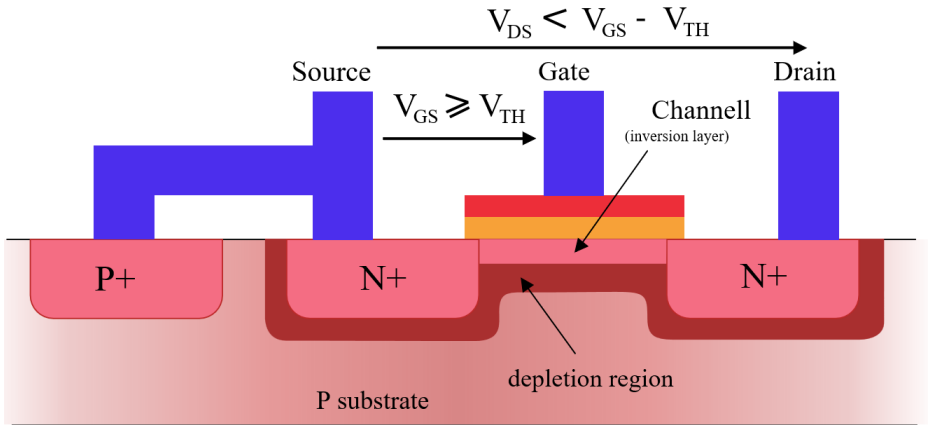


N-Channel MOSFET: Linear

Source: wikipedia.org



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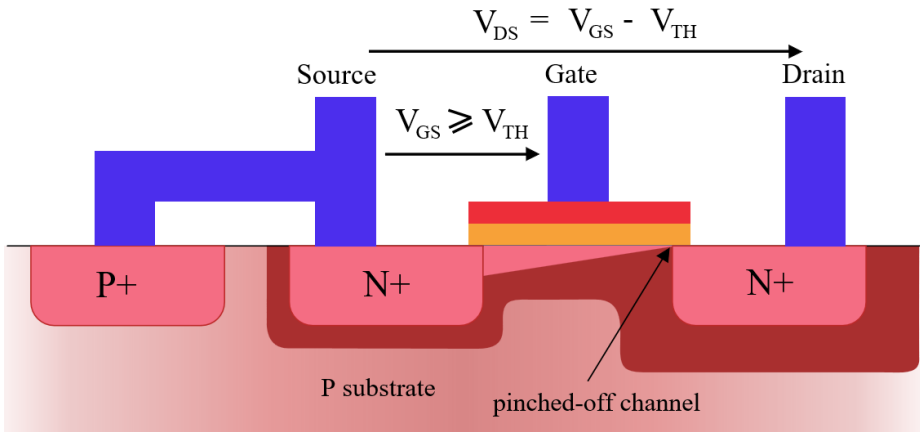


N-Channel MOSFET: Pinch-Off

Source: wikipedia.org



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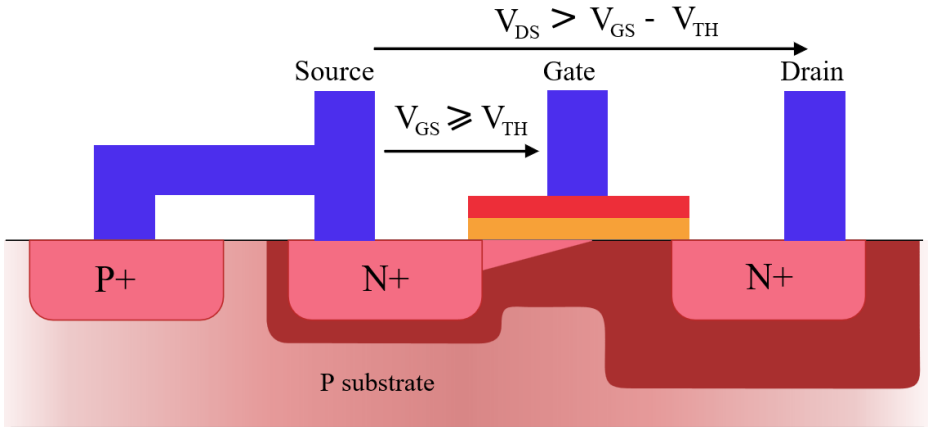


N-Channel MOSFET: Saturation

Source: wikipedia.org

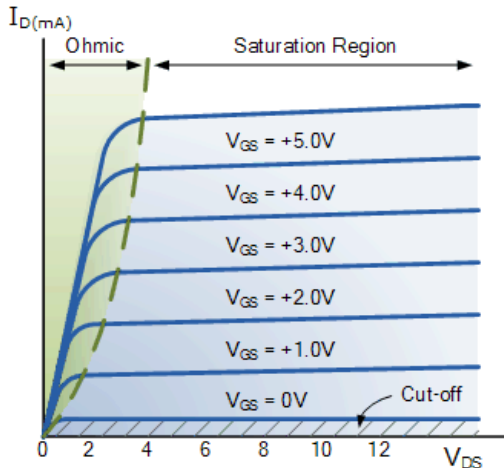


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N-Channel MOSFET: Characteristic

Source: wikipedia.org





- ▶ Digital (General Purpose) Outputs
 - ▶ Binary output levels (GND, VDD)
 - ▶ Limited output current (about 20 mA for Cortex-M)



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 - ▶ Analog actuators (e.g., piezo modules)
 - ▶ High load (e.g., bright LEDs)

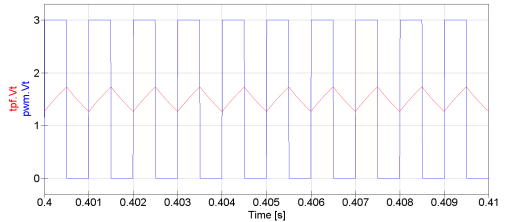
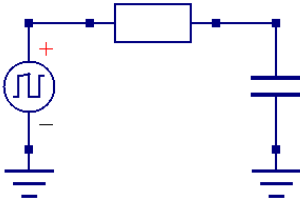


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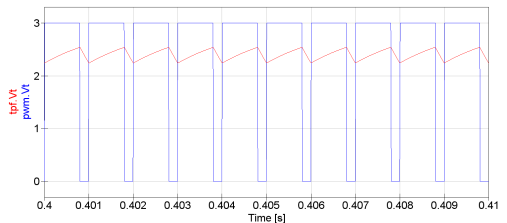
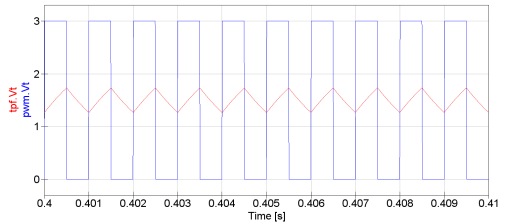
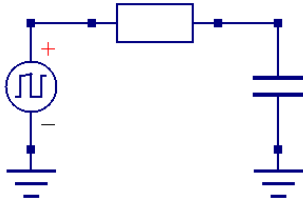
⇒ Alternatives required

- ▶ Digital to Analog Converter ICs
- ▶ Filtered PWM
- ▶ Power transistors

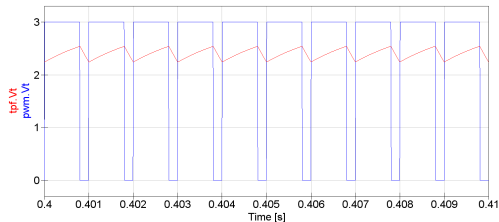
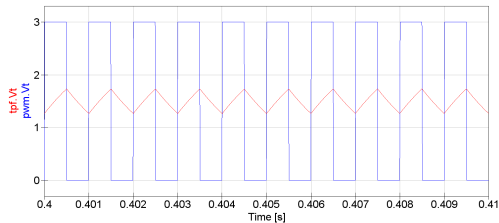
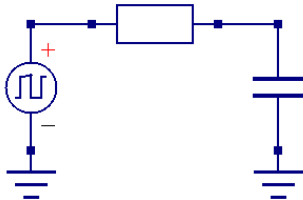
Subtask 6.1: Filtered PWM Signal



Subtask 6.1: Filtered PWM Signal



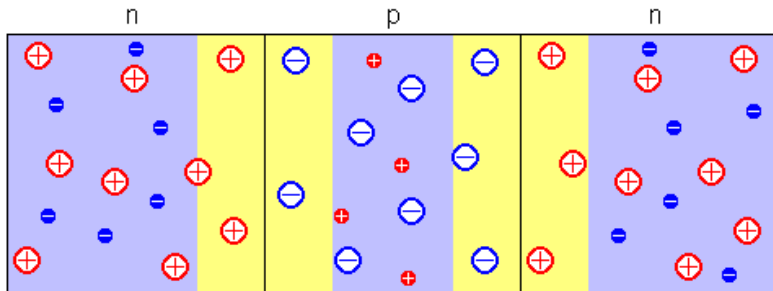
Subtask 6.1: Filtered PWM Signal



- ▶ LPF dimensioning
- ▶ PWM generation on Cortex M0
- ▶ Generating ramp signals

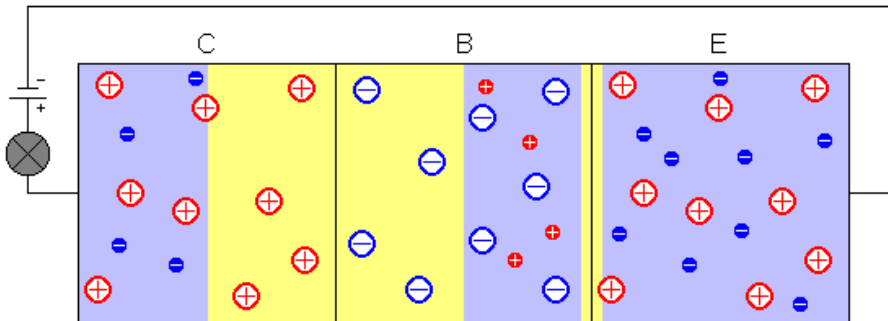
Bipolar Junction Transistor

Source: wikipedia.org



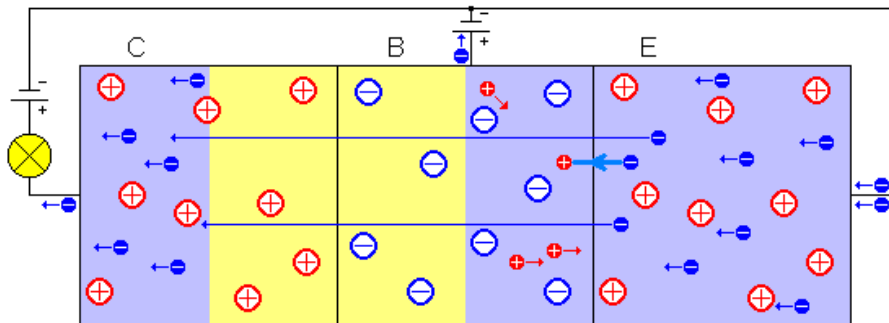
Bipolar Junction Transistor

Source: wikipedia.org



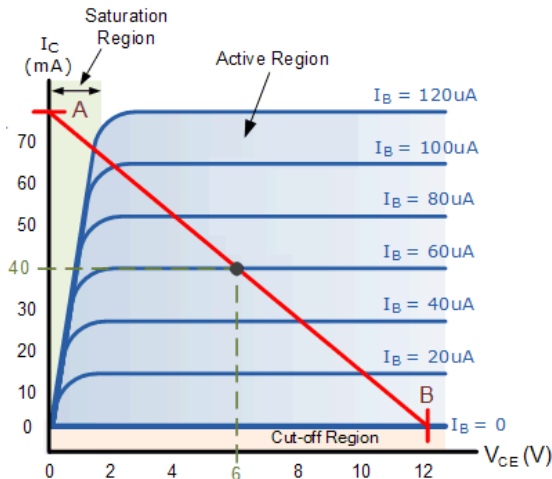
Bipolar Junction Transistor

Source: wikipedia.org



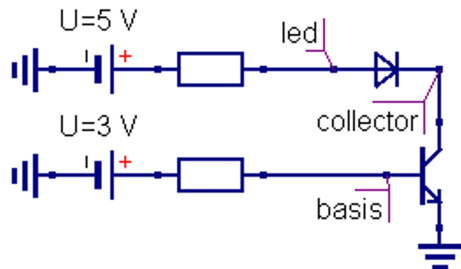
Bipolar Junction Transistor

Source: wikipedia.org



Subtask 6.2: BJT driving LED

- ▶ Advantages of MOSFETs and BJTs
- ▶ Parameterize simulation model of diode and transistor
- ▶ Dimensioning series resistors
- ▶ Compare LED current and brightness for different resistors



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