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

Task 4: Cortex-M0 Connected to External Components

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Outlook

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- Task 4: Cortex-M0 Connected to External Components
  - Last digital part of the embedded systems fundamentals
  - 2 weeks
- Task 5: Analog and Digital Filters
  - 2 weeks
- Task 6: Analog Output
  - 1 week
- Task 7: Project
  - Think about possible ideas

Orga

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- Register for exam!
- Deadline for Task 1-6: 26.7.

Task 4:
Cortex-M0 Connected to External Components

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- Using the ChibiOS HAL
- UART communication between the Cortex-A53 and the Cortex-M0
- Sensor control via I^2C and ADC

Typical Communication Interfaces in Embedded Systems

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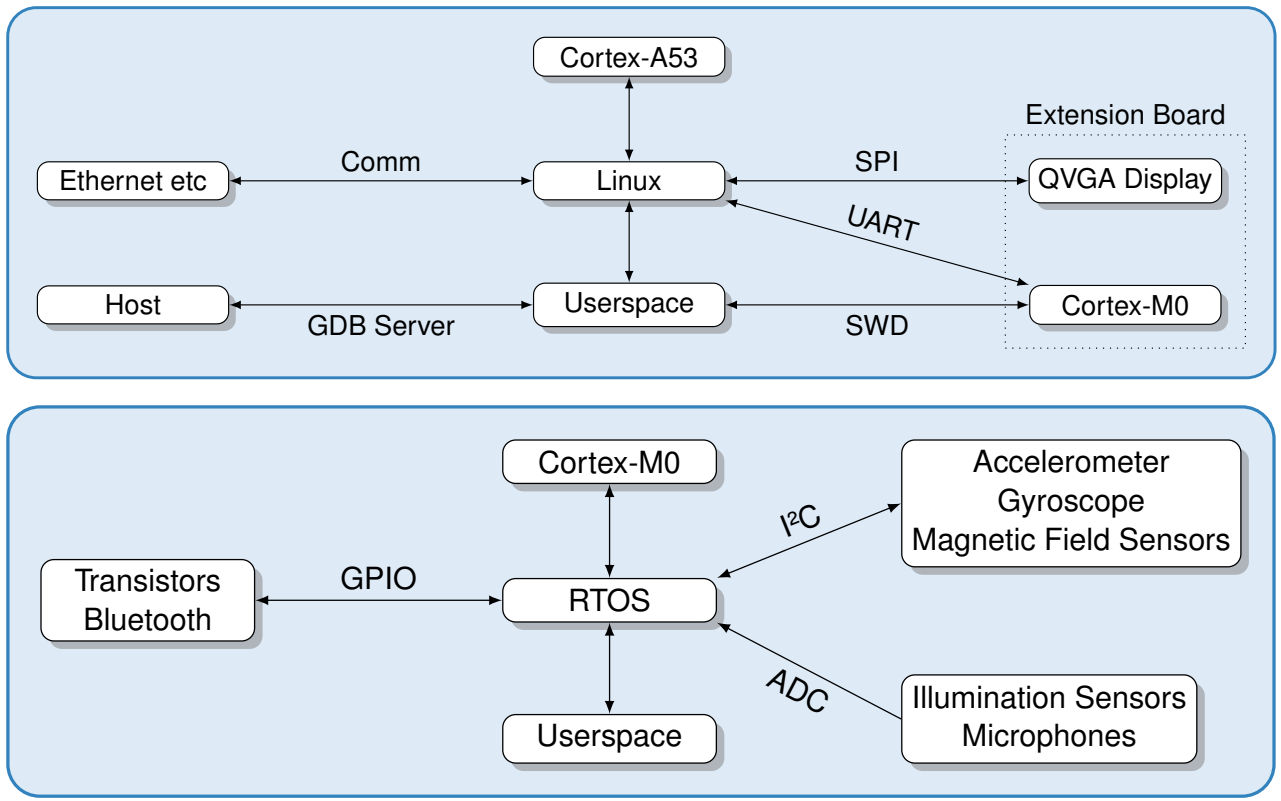
- Test ChibiOS HAL
- Interfaces handled in this task:
  - UART
  - I²C
  - ADC
- Not handled here:
  - USB
  - CAN
  - SPI
  - 1-Wire
  - etc.



Serial Peripheral Interface

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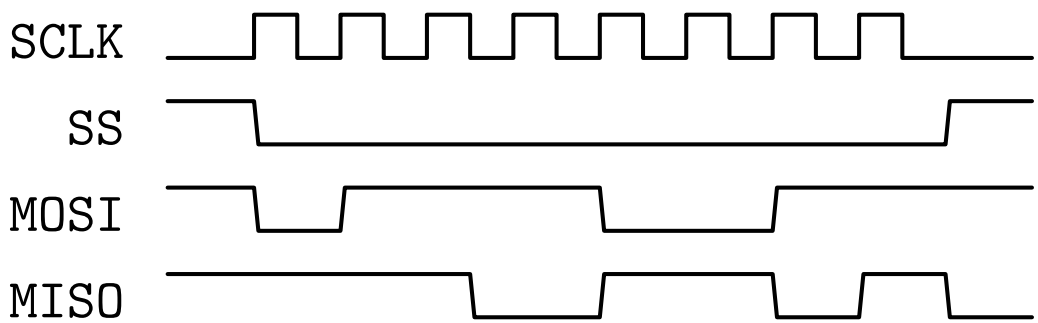
- Very simple protocol developed by Motorola
- Only a few features are fixed by specification

$\Rightarrow$ See device datasheets

- Master generates clock
- Bidirectional data transfer

$\Rightarrow$ Master has to write (dummy data) to read from slave



SPI Modes

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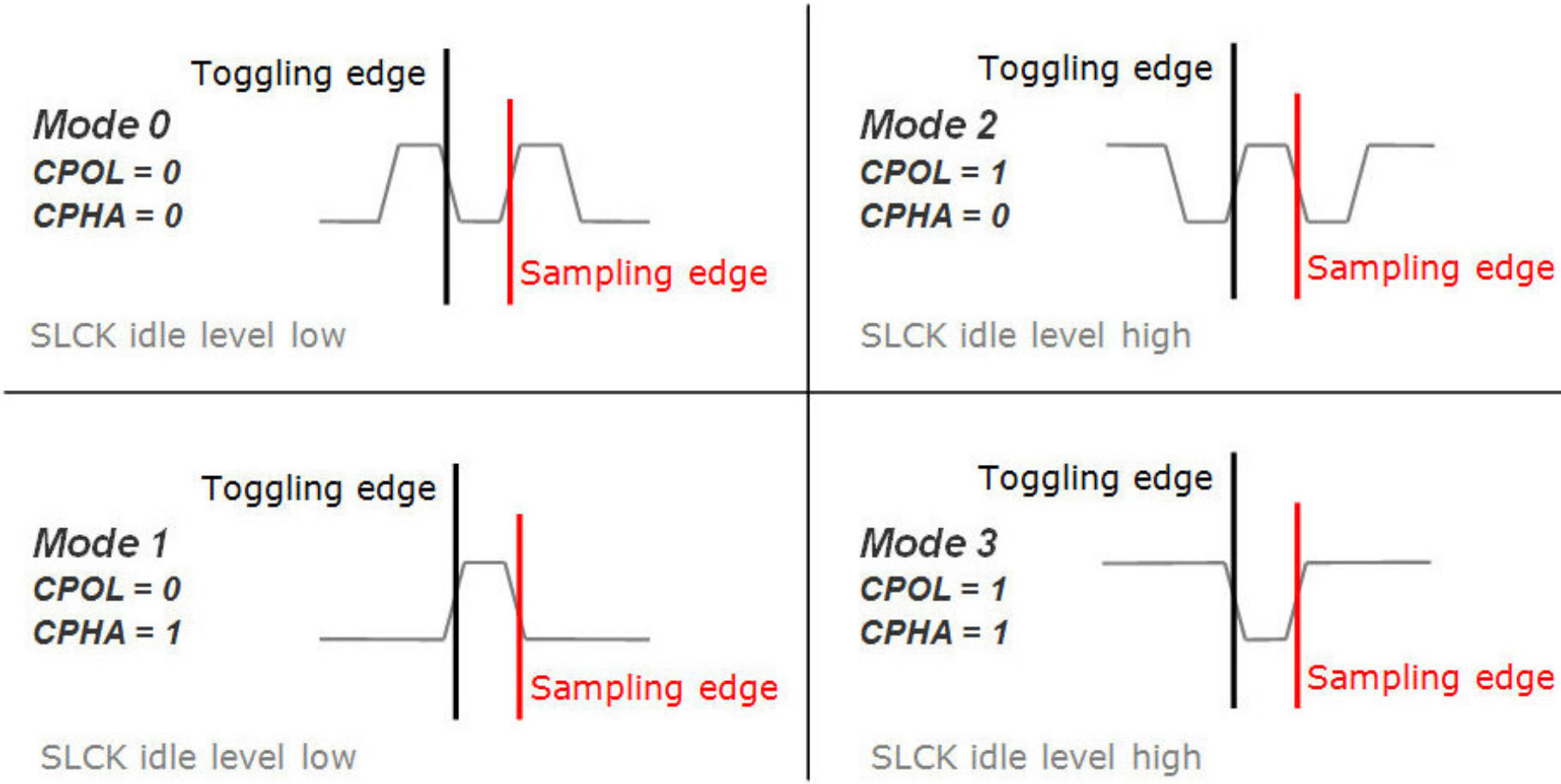

Inter-Integrated Circuit

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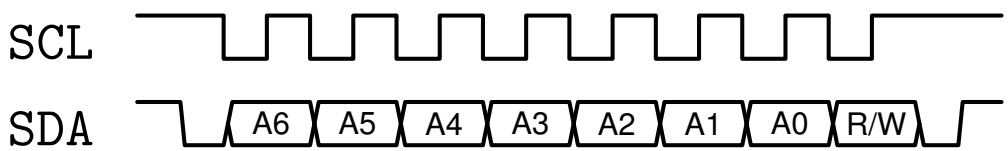
- More complex than SPI
- Developed by Philips
- Requires only two signals
- Master generates clock
- Pull-Up at data line
- Slaves are addressed (no slave select signal)
- Base for higher level protocols like PMBus and SMBus



Inter-Integrated Circuit

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- Supports enhanced (optional) features, e.g.
  - Clock stretching (slave may slow down master)
  - Multiple masters
  - 10 bit addressing
- More properties are actually specified than for SPI
- Some uncertainty remaining:
  - How to read registers?
  - How to write to successive Registers?

$\Rightarrow$ See datasheets

Universal Asynchronous Receiver Transmitter

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- In contrast to SPI and I²C not synchronized to clock signal
- Sender and receiver have to meet the selected timing requirements
- One signal per (independent) transfer direction
- RX of one device is TX of the other device
- Extension:
  - Hardware flow control
  - Parity
  - More stop bits

Analog to Digital Converter

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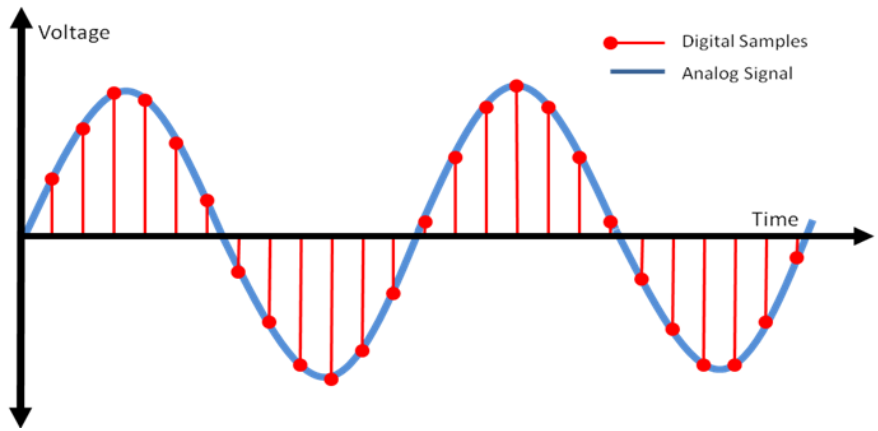
- Some sensors only provide analog outputs (current, voltage)
- Some microcontrollers include (simple) ADCs

$\Rightarrow$ controlled via CMSIS or HAL drivers

- Compares input voltage to reference voltage
  - Analog signal has to be converted to voltage
  - Reference voltage often provided on-chip
- Some kind of calibration required anyway



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