AVR Multi Motor Control

Paolo Lucchesi

What is ammc?

AVR Multi Motor Control is an electrical motor management hardware/software ecosystem composed of:

- A text-based **client** application
- One **master** controller
- One or more **slave** controllers

Features

- Text-based client application for POSIX environments
- Master and Slave(s) controller firmware
- Fully binary Client-Master communication protocol on top of the serial interface
- Fully binary Master-Slave communication protocol on top of the I2C interface
- Up to 126 DC motors (limited by 7-bit I2C Slave addressing, 0x00 is reserved)
- Ability to get and set the DC motors speed, individually
- Software defined PID controller embedded in each Slave controller

Development

- Focus on **modularity**
- Keeping *SOLID* principles in mind
  - Extensibility through the Open-Close Principle
  - Attention on module call directions following the Single Responsability Principle
- Exhaustive **documentation** on multiple depths
  - README.md file in the git repository
  - Source code documentation generated with *doxygen*
  - Client application's man page
  - Bachelor degree thesis
- GNU Make build system
- Absence of third-party non-standard libraries

Features

- Granular handling for getting and setting motors' speed
- Terminal User Interface implemented as a command shell
- Support for non-interactive use (i.e. scripting)
- Communication with master controller using the serial protocol
- Compatible with POSIX-compliant environments
- Comes with a man page

Software modules

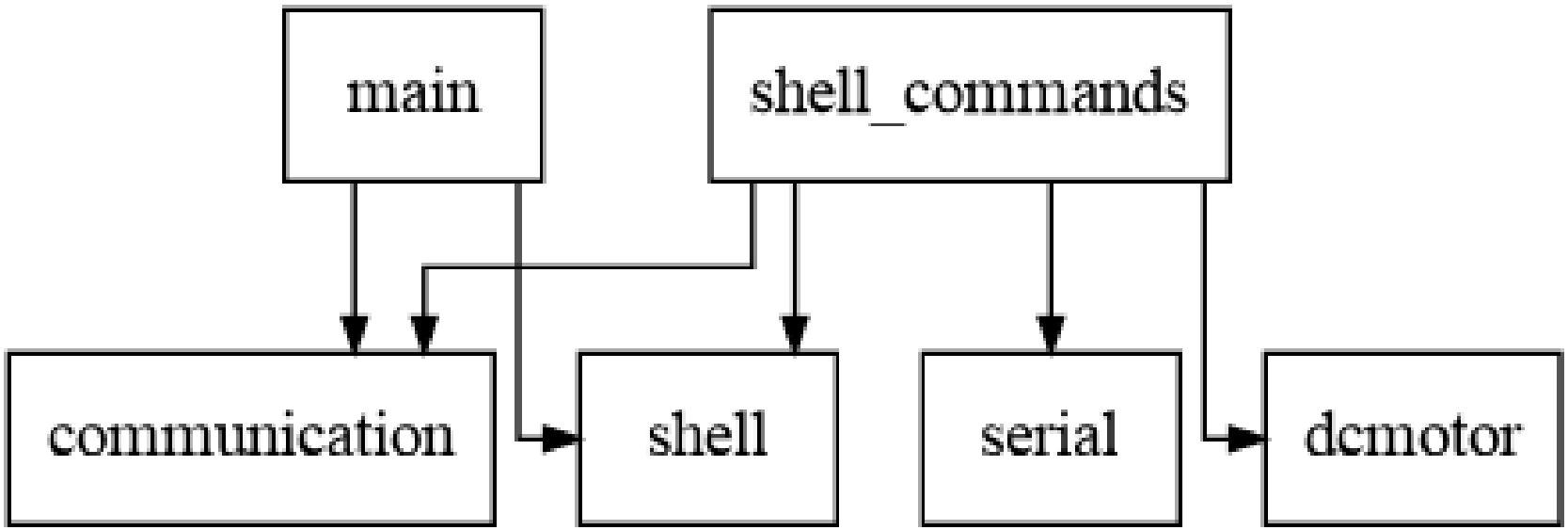

Figure: Client application modules dependency graph

User Interface

External commands allow to interface the master controller:

- `connect <device-path>`
- `ping <motor-id>`
- `get-speed <motor-id>`
- `set-speed <motor-id>=<speed>`
- `apply`
- `set-slave-addr`

Features

- Is itself an **ATMega2560** microcontroller unit
- Interfaces the client applications with the slave controllers
- Communicates with the client via serial
- Communicates with slaves via I2C
- Interrupt-driven communication
- Comes with a power saving policy

Hardware setup

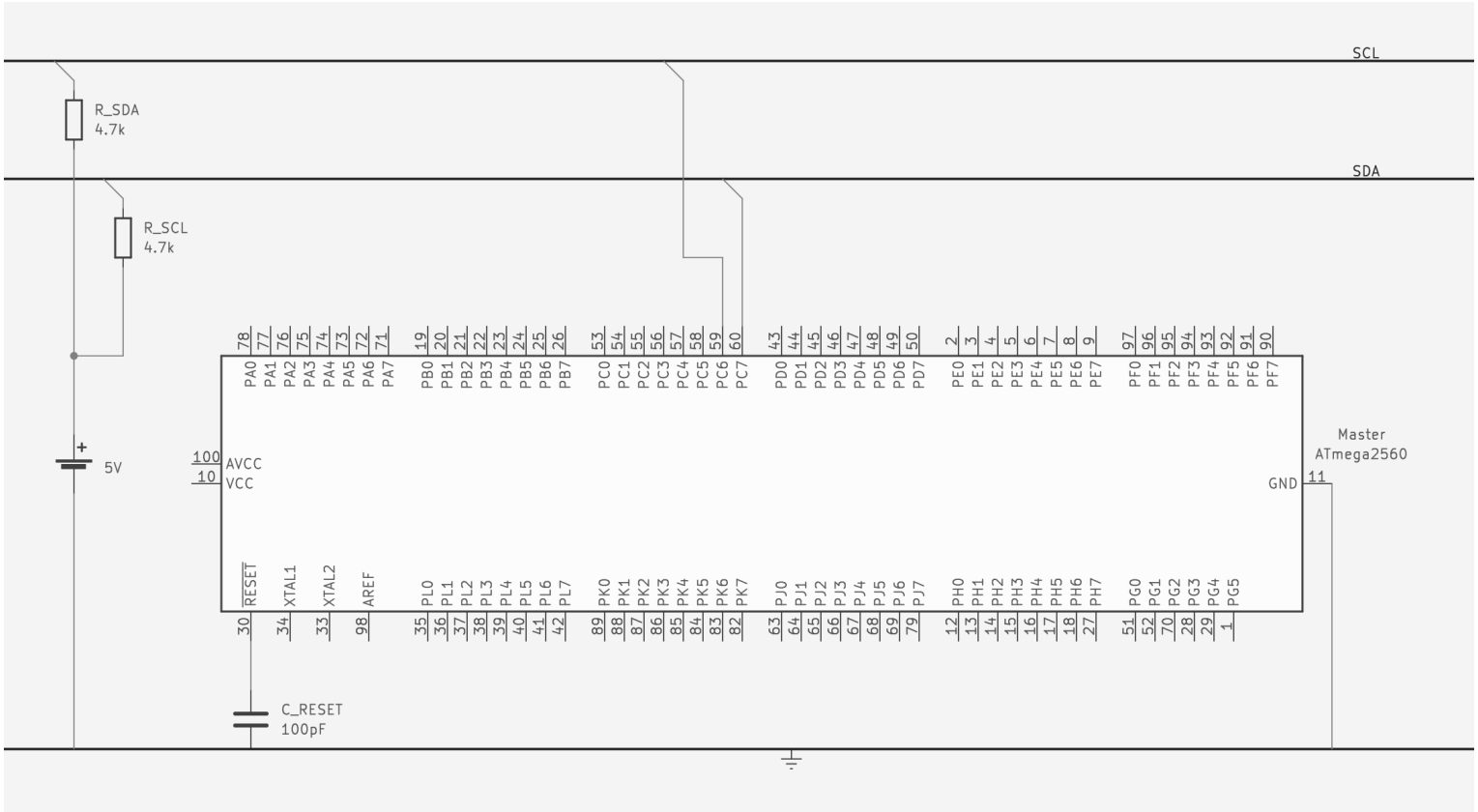

Figure: Master controller schematics

Software modules

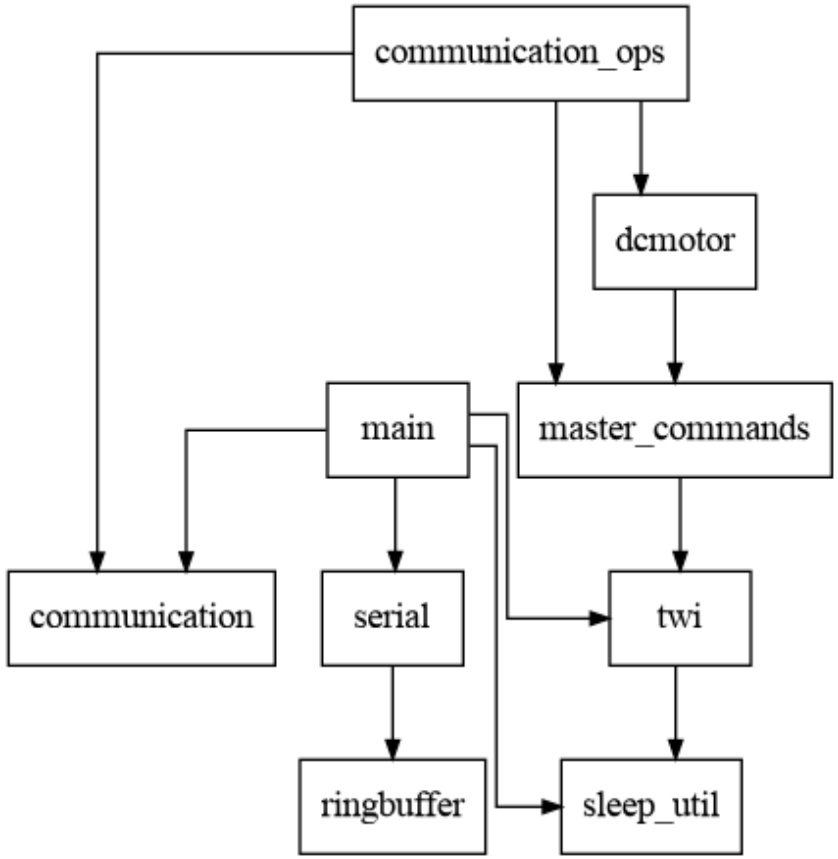

Figure: Master controller firmware modules dependency graph

Features

- Is itself an **ATMega2560** microcontroller unit
- Manages a single dc motor
- Communicates with the master controller using the **I2C** interface
- Execute commands issued by the master controller
- Embedded software-defined **Proportional-Integral-Derivative** controller

Hardware setup

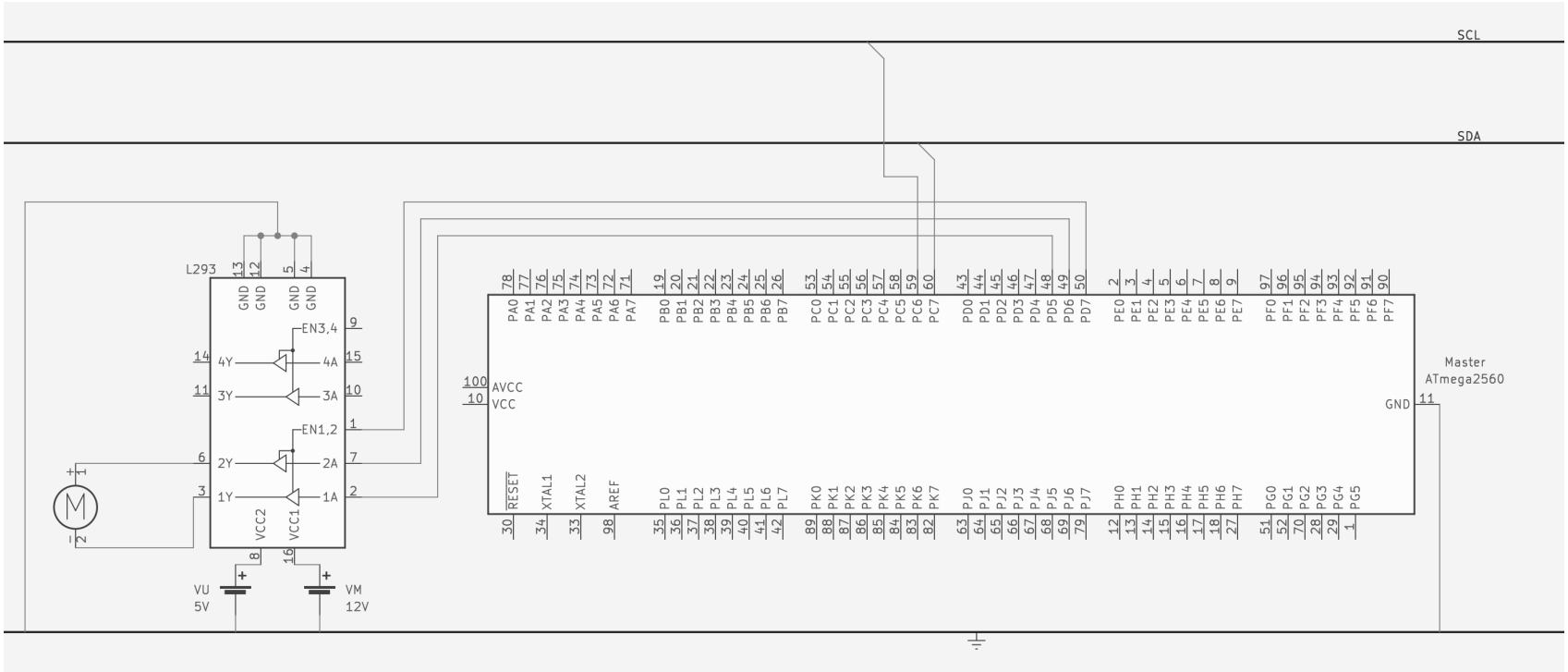

Figure: Slave controller schematics

Software modules

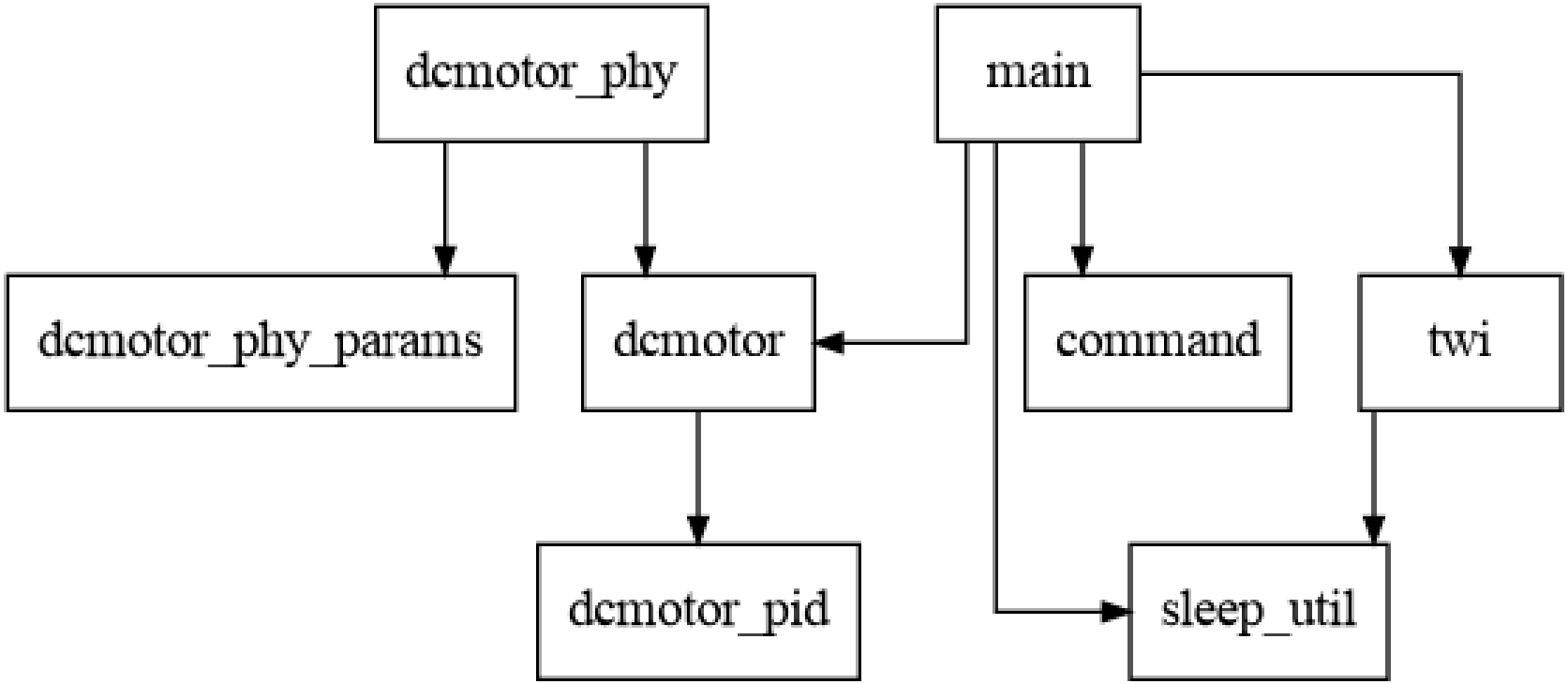

Figure: Slave controller firmware modules dependency graph

Characteristics

- Built on top of the **serial** interface
- Completely binary
- **Packet**-based
- Packet integrity is checked via **CRC-8** checksum
- Interrupt-driven for the master controller

Packets

Each packet is composed of:

- A **header** containing:
  - Packet id
  - Packet type
  - Whole packet size
  - DC motor selector
- An eventual **body**
- A trailing CRC-8 **checksum**

Packet types

Type	Actual value
COM_TYPE_NULL	0x00
COM_TYPE_HND	0x01
COM_TYPE_ACK	0x02
COM_TYPE_NAK	0x03
COM_TYPE_ECHO	0x04
COM_TYPE_PING	0x05
COM_TYPE_GET_SPEED	0x06
COM_TYPE_SET_SPEED	0x07
COM_TYPE_APPLY	0x08
COM_TYPE_DAT	0x09
COM_TYPE_SET_ADDR	0x0A
COM_TYPE_LIMIT	0x0B

Features

- Master-Slave architecture
- Completely binary
- **Interrupt-driven** for both master and slaves
- **Broadcasting** capabilities through the *general-call address* `0x00`
- Follows the original Philips I2C specification (year 2000)

Communication Frames

The communication frames is composed of two parts:

- A heading byte representing the master **command**
- An optional command **argument**

Command	Code
CMD_GET	0x00
CMD_SET	0x01
CMD_APPLY	0x02
CMD_PING	0x03
CMD_SET_ADDR	0x04