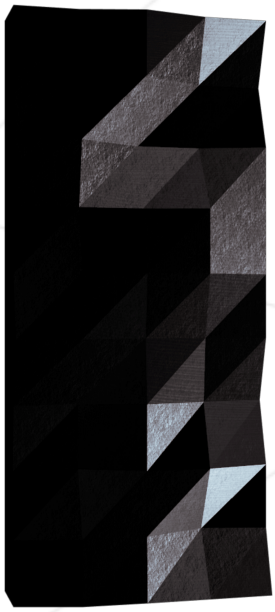

Module Electronics

Free project in embedded electronics

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Summary: Team-based project where students design, prototype, manufacture, solder and test a complete electronic system around an Atmega MCU.

Version:

Did you know?

Every electronic product you use began with a **specification**, was then prototyped to reduce design risk, and finally was turned into a **manufacturable PCB**. In this module you will follow that journey, step by step, as a team. From idea to soldered board, it will challenge not only your technical skills but also your ability to work in teams and make disciplined engineering decisions.

Chapter I

Objectives

By the end of this module you will:

- Define a clear and testable **CDC (Cahier des Charges)**.
- Design a system around an **Atmega MCU**.
- Use at least **3 distinct protocols** between components (e.g. UART, SPI, I^2C, analog).
- Hand-solder a complete **custom PCB**.
- Write embedded firmware in **C only**, with no libraries, fully covering your spec. Any build system is allowed.
- Document your project with a user manual inside your spec.

Teams of 3–5 students will work together, reporting progress in weekly mentoring sessions.

Chapter II

General Rules

- **Team size**: 3 to 5 students.
- **Freedom of topic**: any functional idea is valid, provided the CDC is clear and meets the minimum requirements.
- All components must be **hand-soldered** (THT or SMD).
- Custom PCBs must be manufactured externally (bare boards only).
- You must create your own symbol and footprint libraries. No pre-made libraries.
- Firmware must be written in **C**, using any make/build system, but without external libraries. Only registers and datasheets are allowed.
- All deliverables must be managed under version control and stored in your group Git repository.
- **Mentoring**: weekly check-ins with staff to track progress and team health.

Chapter III

Mandatory Deliverables

III.1 Specifications

Your specifications document must contain, at a minimum:

- **Functional schema**: modules and their interactions, down to individual chips.
- **Feature list**.
- **User guide**: how the end user interacts with the product.
- **Protocols**: which ones are used, why, and how they work.
- **Pinout**: for every chip, sensor and the MCU.
- **Power budget**: How much power chips draw.

Delivered as a PDF.

III.2 Prototypes

Prove each functionality independently first, e.g. comms links, sensors, actuators. Demonstrate understanding of each protocol used.

III.3 PCB Design + BOM

Your own schematic + footprints, routed PCB ready for manufacturing, plus a complete BOM with order links and alternates.

III.4 Assembly

Hand-solder your manufactured PCB and validate it through bring-up.

III.5 Firmware

C firmware covering 100% of the CDC features. Show complete integration of all required protocols.

III.6 Final Delivery

Working PCB running firmware, validated against the CDC. Documentation (repository + spec PDF + README). Short presentation & demo.

Chapter IV

Grading

Your project grade evolves with the maturity of your work:

60% Proofs of Concept: each function works in isolation.

80% Functional prototype on breadboard: all functions integrated, no PCB yet.

100% Functional PCB: fully working board matching the CDC.

125% Complete project: extra hardware/firmware features, better usability, enclosure, strong documentation.

150% Product-like finish: ready-to-sell quality, impeccable documentation, enclosure, and a product video.

On top of that, **individual questions** will be asked during final evaluation. This can bring up to +15 points to engaged students. Team grade is shared, individual grade differs only by these questions.

Chapter V

Bonus

Not mandatory but may increase your grade:

- Enclosure design and integration.
- Low-power modes and battery optimisation.
- Advanced PCB features: impedance control, EMC care, thermal vias.
- Automated testing and continuous integration of firmware.
- Thorough, user-friendly documentation.

Chapter VI

Deliverables Recap

The repository must contain:

- CDC PDF (functional schema, feature list, user manual, pinouts, protocols, power).
- Prototype notes and proofs with measurements/photos.
- KiCad project files (symbols, footprints, schematic, PCB).
- PCB manufacturing package (Gerbers, drills, BOM).
- Assembled board photos.
- C firmware source code.
- README with quickstart and pinout.