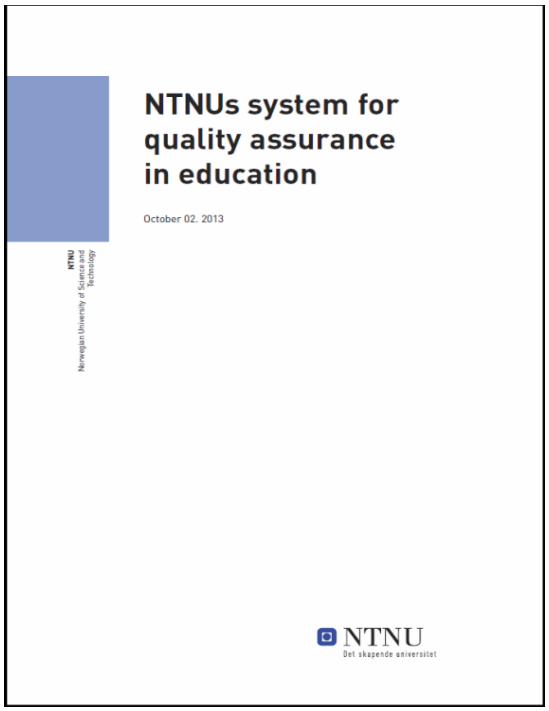
TTK 4155
Industrial and embedded computer systems design

Lecture #2

- Some highlights from last lecture
- Brush-up of some basic concepts in electronics
- Power supplies
  - Sources, AC and DC
  - Voltage regulators

Quality assurance in education at NTNU



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NTNU has revised the system for quality assurance of education

- New elements:
  - **Survey** among all students at least each third year.
  - **3 reference group meetings each semester the subject is taught.**
  - The course report and the reports from the reference group meetings are entered into a **database** which is accessible for all students and staff at NTNU.
  - All study programs are evaluated at least each 5th year.
  - Plans of action for development of all programs of study and the teaching of all departments are approved by the dean based on input from the study programs and departments.
  - Report problems – **New problem report page** for students. If you discover that the normal quality assurance system for education does not work as intended, you can report the problem directly.

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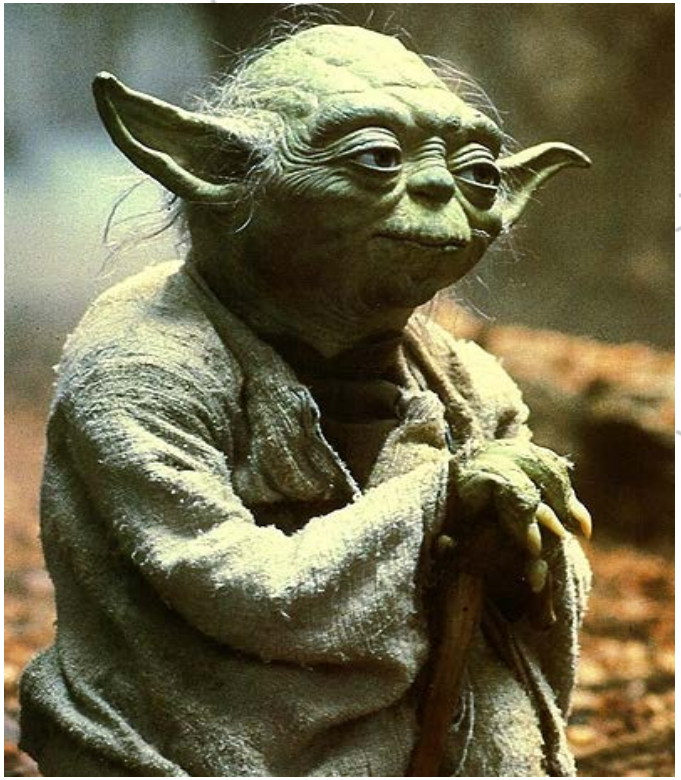
Roles: The course coordinator

- Establish a **reference group** and arrange three meetings.
- Write a **course report** after the teaching semester and exam are finished.
- Make sure the course report and reference group reports are **available** for the current and next group of students..
- Make sure the program coordinator and head of department obtain the evaluation report.
- Do a **survey** among all the students taking the course at least each third year.
- **Develop** the course on the basis for the evaluation report.



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Roles - Students

- Join reference groups, write the reference group report and give input to the members in the reference group.
- Elect student members in program boards, management teams and boards at different levels at NTNU.
- Be updated on the learning objectives of the various courses and the study program you follow as a student.

Student and professor cooperating ?

Roles – The reference group

- The group represents the students in three meetings during the semester.
- Writes an independent report after each meeting which is attached to the course report.
- At least three students take part, but there should be at least one student representative of each study program taking the course.
- In courses with few student, all the students may constitute the reference group.
- The reference group shall be in contact with the rest of the students and represent them in the reference group meetings.
- The students in the reference group write the reference group reports.

Links to the education quality assurance system

- Description of the system at www: http://www.ntnu.no/utdanningskvalitet/
- All details can be found on the internal pages: https://innsida.ntnu.no/wiki/-/wiki/English/Quality+assurance+of+education
- Page for reporting problems : https://innsida.ntnu.no/avvik
- Database for course reports etc.: https://irom.ivt.ntnu.no/ivt/adm/kvalitetssikring-utdanning/

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- The next pages shows some selected information about roles, evaluation of courses and reference group work, all taken form the quality assurance system of NTNU. **The following pages are not supposed to be shown during the lecture,** but to be used by students and course coordinator during the reference group meetings.

Additional information

Summary of roles, responsibilities and tasks

Students	Tasks	Reporting
Responsibility for being involved in the development of education programmes, teaching, and the learning environment.	The individual student is expected to participate actively in evaluation through reference groups, questionnaire surveys, meetings, etc., and to provide continuous feedback to the reference groups for his or her courses. Students in reference groups must have an ongoing dialogue with all the students taking the course and must represent the students at reference group meetings. Students in student democracy are to represent the students at all levels in the organization.	The reference group must write a reference group report with proposals for measures, which are submitted to the course coordinator.

Teaching staff	Tasks	Reporting
Are to implement teaching and learning activities that help students to achieve their learning outcomes.	Are to discuss any academic, pedagogical and practical aspects with the course coordinator that could improve the quality of the course.	

Course coordinator	Tasks	Reporting
Is responsible for planning, coordination and implementation of the course.	Leads the course team. Conducts an evaluation during each course. Follows up the plan of action as decided by the Head of Department.	Each time the course is completed, prepares a course report with proposals for a plan of action. Submits the course report to the students currently taking the course, the Head of Department and the head(s) of programme.

Head of Department	Tasks	Reporting
Ensures that quality assurance of the department's courses is performed in accordance with the requirements.	Ensures that heads of the programmes of study receive a relevant basis for evaluation from the department. Decides on the plan of action and follows it up through resource allocation and personnel management.	Ensures that quality assurance processes are documented and are included in the annual quality reporting process.

Head of programme	Tasks	Reporting
Heads the council for the programme of study and provides recommendations to the Dean.	In consultation with the council, continuously evaluates the quality of the programme of study. Follow up the plan of action as decided by the Dean.	Prepares an annual report on the programme of study with a proposal for the plan of action. The report is submitted to the Dean and is included in the quality reporting process.

Additional information

Dean	Task	Reporting
Responsible for ensuring that quality assurance of the faculty's programmes of study is carried out in accordance with the requirements.	Is responsible for assigning resources for implementation of the programme of study and the quality assurance processes. Decides and follows up on the plan of action.	Communicates the plan of action to the heads of programme and Heads of Departments who are involved. Reports to Rector through the annual quality reporting process.

Learning Environment Committee	Task	Reporting
Is an advisory body for NTNU's Board and management.	In cooperation with management, helps the university to develop a favourable study environment, improved student welfare and a sound working environment for the students.	Reports to the Board in the form of an annual report on the institution's work concerning the learning environment, with recommendations to Rector regarding measures and follow up.

Executive Committees (FUS/FUL)	Task	Reporting
Ensure that there is inter-faculty coordination of engineering and teacher education.	Develop common quality requirements for the programmes In accordance with their mandates, ensure that the quality assurance processes are followed up.	Through the quality assurance report, the committees report annually to Rector on the quality assurance work and implemented measures, and propose measures to Rector.

The Education Committee and the Research Committee	Task	Reporting
Are Rector's consultative committees in the areas of education and research.	Advise Rector on quality assurance of the education activities and on the annual quality assurance report.	

Rektor	Task	Reporting
Responsible for quality assurance of the education at NTNU.	Decides and follows up on the plan of action.	Reports to the Board through the annual quality assurance report.

The Board	Task	Reporting
Responsible for ensuring that NTNU has a system for quality assurance of education.	Approves NTNU's quality assurance report each year. At least every fifth year, ensures that NTNU's system for quality assurance in education is evaluated.	

Course evaluation
Requirements
During each course, the course coordinator is to carry out an evaluation.
All course evaluations are to include a student evaluation, normally based on the reference group method. At least every third time the course is completed, the course coordinator must actively ask for feedback from all the students in the course to ensure that there is representative information.

Each time the course is completed, the course coordinator is to prepare a course report (see Appendix 5 for template) with proposals for a plan of action. The report is sent to students currently taking the course, the Head of Department and The head of programme. The report is to be made available to the student representatives at the department, the faculty and the programme of study, and for the reference groups for the next three times that the course is completed.

Subject
Learning outcomes: Are they up to date and relevant? Have they been clearly communicated to the students? Is there consistency and coherence between the learning outcomes for the course and parallel and previous courses?
Teaching and learning activities: How do they help students to achieve the learning outcome for the course? Is the type of learning activity, the level and progression appropriate? What about the students' own efforts and motivation? What is the learning environment like?
Form of assessment: Is this consistent with the learning outcomes and with the teaching and learning activities, so that the students are tested in an appropriate way that contributes to their learning?

Basis
The basis for the course evaluations is previous course and programme reports with plans of action, the reference group's feedback, feedback obtained from individual students and relevant statistics. Examples of these are: percentage of fails, dropout rate, distribution of grades.

Definitions: Embedded computer system

A computer system:

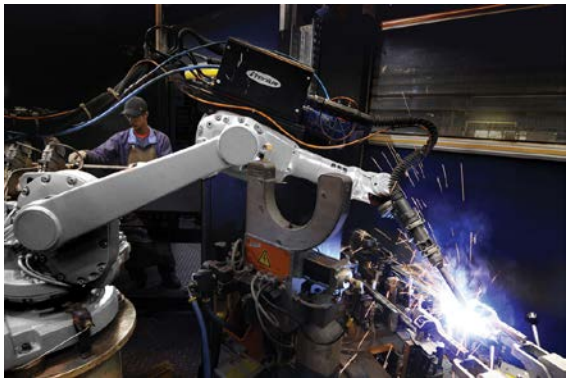
- that is designed and optimized to execute a dedicated task
- that is embedded as a part of a larger system, which typically consists other types of components (mechanical, electrical) than computers
- where the computer itself is not necessarily the “purpose” of the system
- where hard or soft real-time requirements often are part of the specification

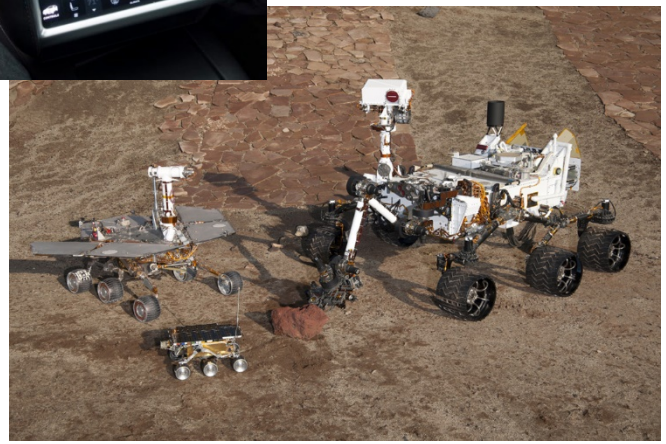
Types of computer systems

- Open systems
  - General purpose computing
  - Purpose-loaded functions
  - Flexible, high performance, no limitations on energy
- Embedded systems
  - Fixed-function, optimized, high/low performance
  - Part of larger system
  - Computer not the «purpose» of the system
- Deeply embedded systems
  - Devices of a single purpose
  - Not «visible», highly optimized wrt. application
  - Typically sense -> process -> act

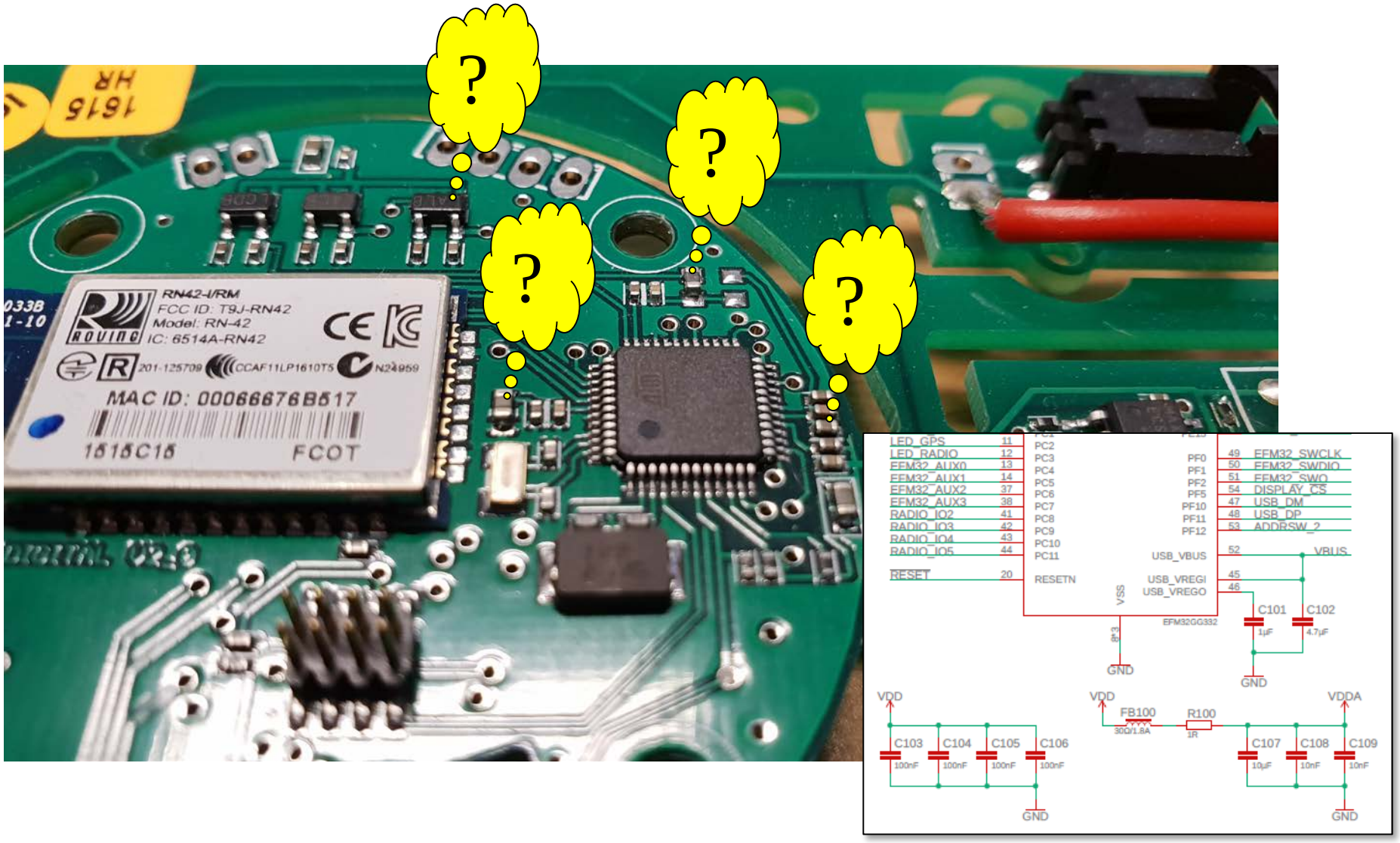
Embedded systems development – a diversity of requirements

- Simple/complex algorithms
- Simple/complex interfaces
- Real-time requirements
- Multi-rate systems
- Safety and security requirements
- Requirements to energy consumption
- Requirements to physical size/shape
- Requirements to operating environment
- Requirements to serviceability
- Cost sensitivity
- Typically small development teams and tight deadlines
- Complex development tools and test requirements



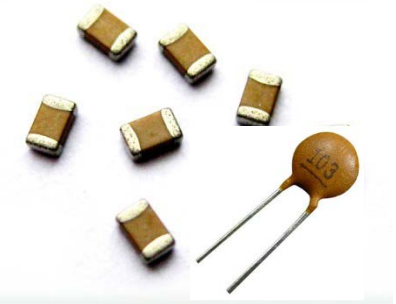


Brush-up of some useful concepts in electronics…



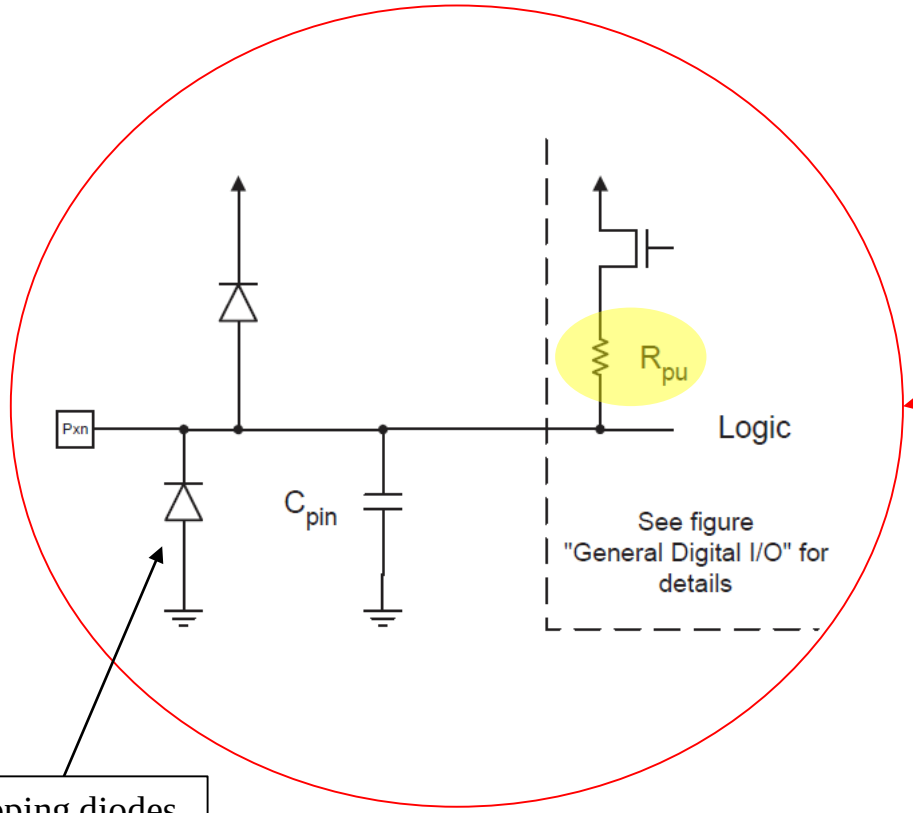
Decoupling of digital circuits: recommendations

- One 22uF bulk electrolyte per board
- One 1uF tantalum per 10 SSI/MSI
- One 1uF tantalum per 2-3 LSI
- One 10-100nF ceramic per supply pin per LSI
- One 10-100nF ceramic per octal IC/MSI
- One 10-100nF ceramic per 4 SSI logic Ics

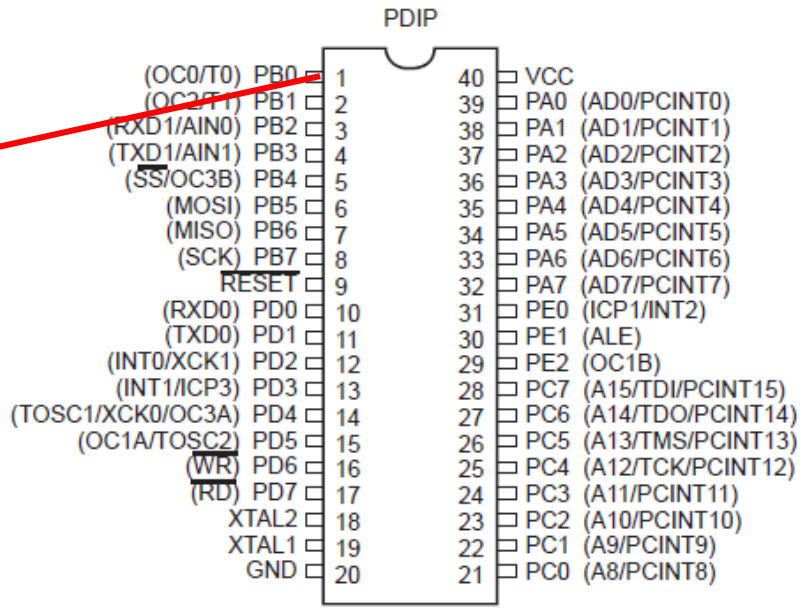


(T. Williams, *The Circuit Designer's Companion*)

Pull-up resistors on AVR ATmega microcontroller input ports



Clipping diodes (protection)

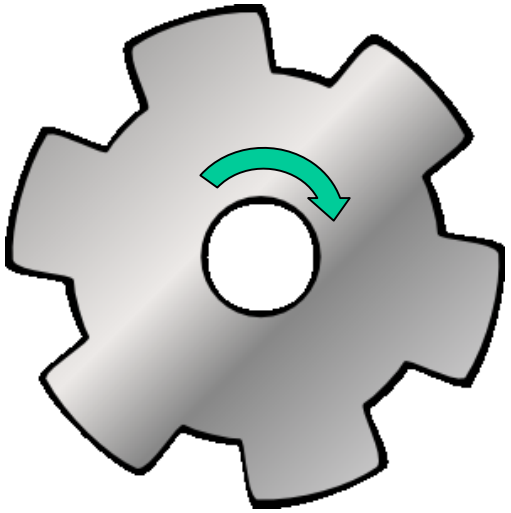


DC Characteristics

T_A = -40°C to 85°C, V_{CC} = 1.8V to 5.5V (unless otherwise noted)

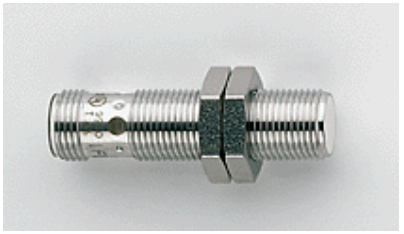
Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IL}	Input Low Voltage, Except XTAL1 and $\overline{\text{RESET}}$pin	V_{CC} = 1.8 - 2.4V V_{CC} = 2.4 - 5.5V	-0.5 -0.5		0.2 V_{CC}[1] 0.3 V_{CC}[1]	V
V_{IH}	Input High Voltage, Except XTAL1 and $\overline{\text{RESET}}$ pin	V_{CC} = 1.8 - 2.4V V_{CC} = 2.4 - 5.5V	0.7 V_{CC}[2] 0.6 V_{CC}[2]		V_{CC} + 0.5 V_{CC} + 0.5	V
V_{IL1}	Input Low Voltage, XTAL1 pin	V_{CC} = 1.8 - 5.5V	-0.5		0.1 V_{CC}[1]	V
V_{IH1}	Input High Voltage, XTAL1 pin	V_{CC} = 1.8 - 2.4V V_{CC} = 2.4 - 5.5V	0.8 V_{CC}[2] 0.7 V_{CC}[2]		V_{CC} + 0.5 V_{CC} + 0.5	V
V_{IL2}	Input Low Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8 - 5.5V	-0.5		0.2 V_{CC}	V
V_{IH2}	Input High Voltage, $\overline{\text{RESET}}$ pin	V_{CC} = 1.8 - 5.5V	0.9 V_{CC}[2]		V_{CC} + 0.5	V
V_{OL}	Output Low Voltage[3], Ports A, B, C, D, and E	I_{OL} = 20 mA, V_{CC} = 5V I_{OL} = 10 mA, V_{CC} = 3V			0.7 0.5	V V
V_{OH}	Output High Voltage[4], Ports A, B, C, D, and E	I_{OL} = -20 mA, V_{CC} = 5V I_{OL} = -10 mA, V_{CC} = 3V	4.2 2.3			V V
I_{IL}	Input Leakage Current I/O Pin	Vcc = 5.5V, pin low (absolute value)			1	µA
I_{IH}	Input Leakage Current I/O Pin	Vcc = 5.5V, pin high (absolute value)			1	µA
R_{RST}	Reset Pull-up Resistor		30		60	kΩ
R_{pu}	I/O Pin Pull-up Resistor		20		50	kΩ

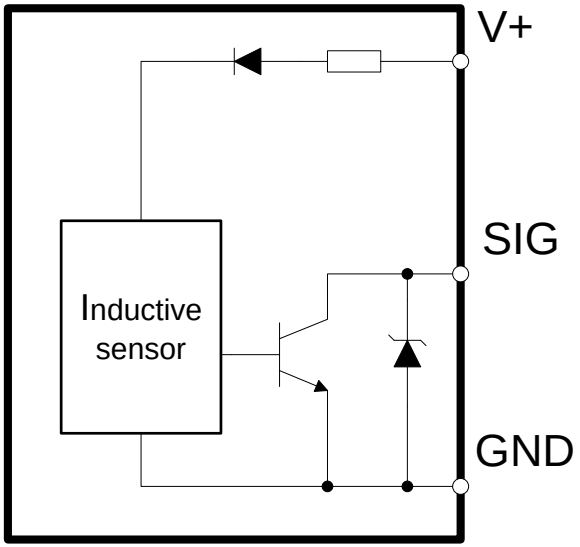
Ex: Sensor (transmitter) with *open collector output*



Inductive proximity sensor
(for ferrous metals)

Magnetic field





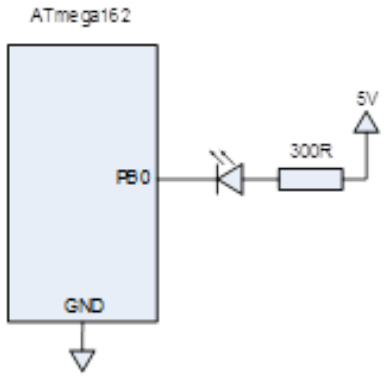
How to drive a LED from an MCU
- example from an exam…

Problem 1. (30 %)

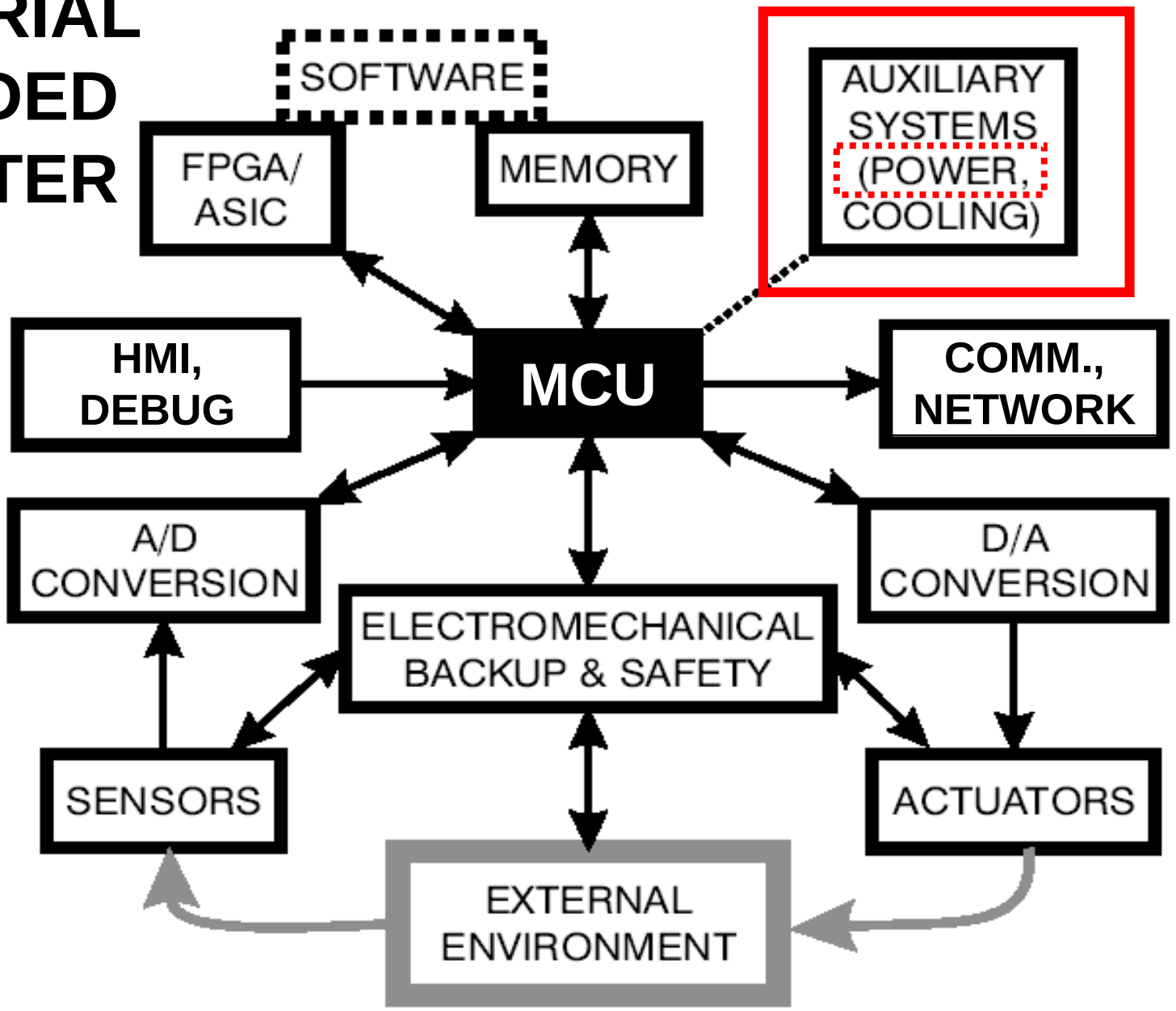
a. Figure 1 shows the diagram of the 16 bit Timer/Counter unit of the Atmel AVR ATmega162 microcontroller. Assume that the system clock is driven by a 4.194304MHz external crystal oscillator and that Timer/Counter 1 is set to normal mode and clocked (clk_{T1}) by the system clock prescaled by a value of 64.
Calculate the frequency of the TOV1 interrupt f_{TOV1} (timer overflow).

b. A blinking LED is frequently used to show the "heart beat" of an embedded computer indicating that the system runs normally. Show with a simple circuit diagram how a heart beat LED can be connected to pin PB0 of the Atmel AVR ATmega162 enabling the microcontroller to alternatingly sink a 10mA current through the LED. The supply voltage of the microcontroller is 5V and the forward voltage drop of the LED is 2V. See Figure 4 for the pinout of the ATmega162.

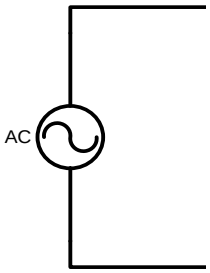
c. Use the TOV1 interrupt from a) and write a simple program in C/pseudo-code that implements the heart beat LED from b) and a mechanism that keeps track of how many hours and days the system has been running since last reset.



INDUSTRIAL EMBEDDED COMPUTER



Power supply



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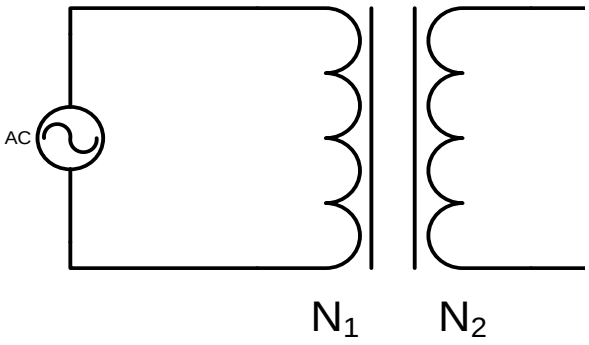

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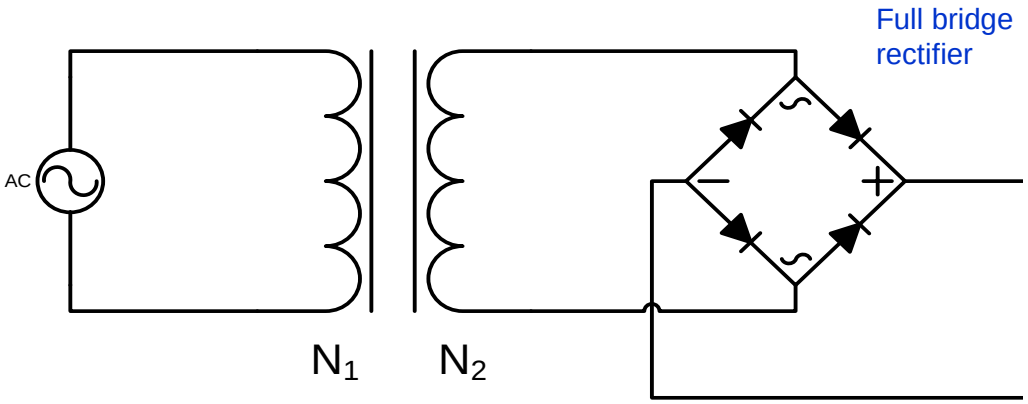

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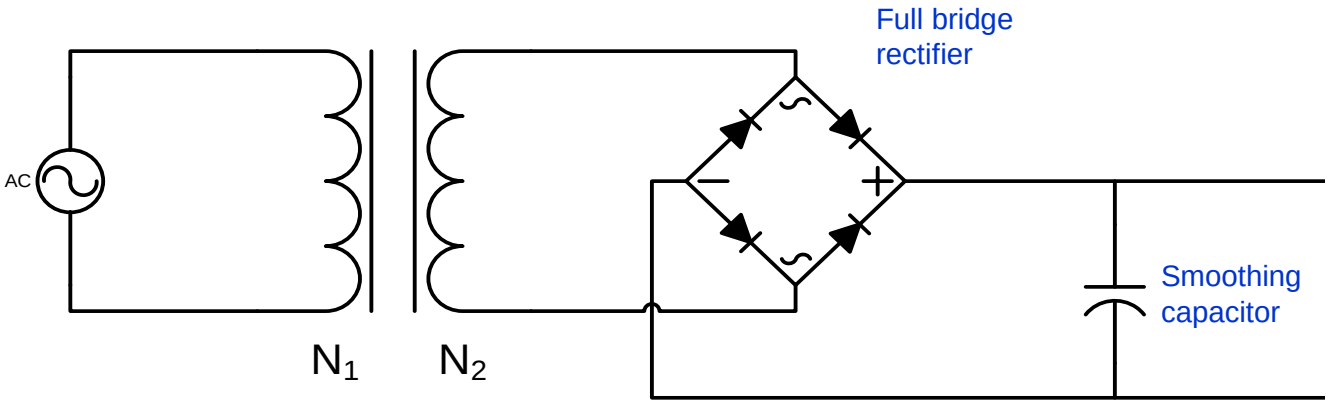

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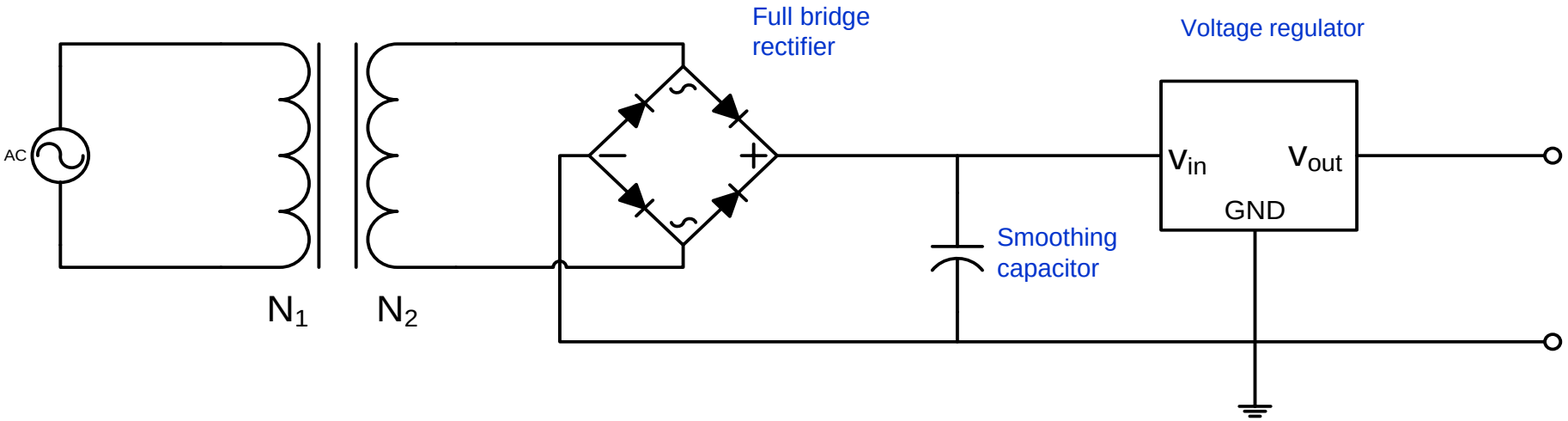

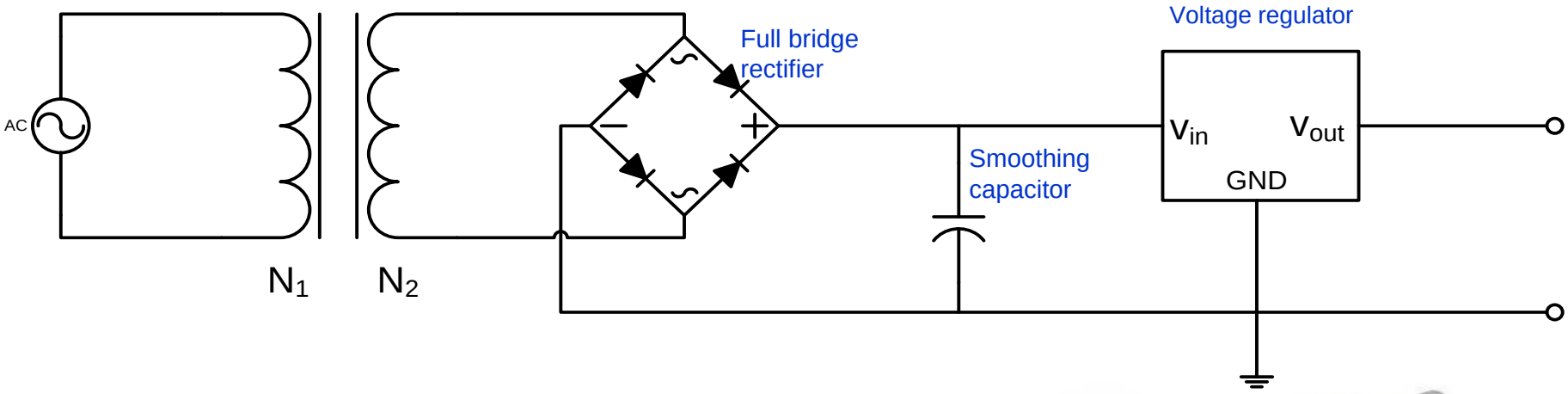

Voltage regulator

- provides a *stable, noise-free supply voltage…*
- at the *desired level…*
- and with *sufficient power capacity…*
- independent of variations in input voltage and load current:
  - Line regulation (= 100 * $\Delta V_{out}/\Delta V_{in}$ [%])
  - Load regulation (= 100 * ($V_{out\text{-}maxload}$ - $V_{out\text{-}minload}$)/$V_{out\text{-}nomload}$ [%])

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