Electronic components

1 Passive components

1.1 Resistors

- Through Hole Resistors *More...*
  - Resistor values have a range between 1 Ohm and 1 Mega Ohm. Its good practice to use values between 1 KΩ and 10 KΩ.
  - The value of most resistors is coded by means of coloured bands on the resistor. More information can be found on this page. On line you can find some Java-applets for translating colour codes into resistor values.
- SMD resistors *More*
  - SMD devices are quite small and are used intensively
  - One can also use SMD (surface mount devices) to reduce the circuit area.
  - You are not allowed to use them in your design

1.2 Capacitors

- For electronic design use the capacitor values range between 100pF and 100μF.
- Large capacitors have the value printed on them. Smaller types often have just 2 or three numbers printed on them. You can find information about it on this page
- There are polar and non-polar types of capacitors
  - Some capacitor types (tantalum, electrolytic capacitors) are polar: the negative lead should be connected to the lowest potential, the positive to the highest. In case you bias them the other way around, the capacitor will be destroyed and this may (and probably will) damage your circuit.
  - The non-polar types are f.e. ceramic and mica-types

2 Active components[1]

2.1 Op amps (Operational Amplifiers)

- Opamps are used in filter design, control loop design and much more
- More information about Opamps is provided in a design manual for circuits containing opamps (in Cursus informatie > Hardware). This is a very useful manual and should be read carefully by all students who are designing opamp circuits!!
- The most important characteristics are:
  - Bandwidth
  - Gain
  - Maximum load
  - You can find all these specifications and example configurations in their data sheets (read them!)
- Some of the most common used types are:
  - **CA3140AE** Wideband OP AMP data sheet
  - **TL084A** Good general purpose opamp! data sheet
  - **OP27** Low offset opamp data sheet

Remark: Often multiple opamps are available in one package, if you need two equal opamps on the same board this can save area on your pcb.

2.2 DA-AD-converters

- AD-converters: used in analog-digital interfaces and turn analog measurements (from analog sensors for example) into digital data for FPGA or microprocessors. *More...*
  - The most important characteristics are
    - Sample rate
    - Accuracy - Number of Bits
  - One of the most common used types is:
    - **MCP3201** 12-bit data sheet
    - **TLC1549** 10-bit data sheet
- DA-converters are used in digital-analog interfaces. *More...*
  - One of the most common used types is:
    - **TLV5616** 12-bit data sheet
    - **DAC0808** 8-Bit data sheet

Most of the ADC's use serial communication with the fpga, so you have to design an FSMD to read out the data.

1 Most of these components are available at CDE, however do check this before you plan to use them.

2.3 Transistors

- Bipolar
  - High gain but needs base current
  - Examples
    - **BC547** NPN-bipolar data sheet
    - **BC557** PNP-bipolar data sheet
    - **BD138** PNP-bipolar data sheet
    - **BD139** NPN-bipolar data sheet
- MOSFET
  - Good switches and doesn't need continuous base/gate-current
  - Examples
    - **BS270** N-MOS data sheet
    - **BS170** N-MOS data sheet
    - **BS250** P-MOS data sheet

2.4 Digital logic

Nowadays most digital logic will be implemented by means of a microprocessor (for example PIC, AVR or many others). However if one needs some simple functionality[2] still discrete logic chips are used. The most frequently used *families* are:

- ✔ 74HC-family data sheet
  - Low power and high-speed Si-gate CMOS logic
  - High drive capability
  - Here you find a long list with the most important members of this family
    - **74HC00** Quad 2-input NAND Gate
    - **74HC02** Quad 2-input NOR Gate
    - **74HC04** Hex Inverter
    - **74HC244** 8 Buffers-non-inverting
    - **74HC240** 8 Buffers-inverting
- ✔ 4000-family data sheet
  - Standard digital logic functions
  - Here you find a long list with the most important members of this family
    - **HEF 4001B** 4 NOR gates 2 inputs
    - **HEF 40106B** 6 inverting Schmitt triggers
    - **HEF 4011B** 4 NAND gates 2 inputs

2 A logic function for example or level shifting or buffering of some critical circuitry

2.5 Printed Circuit Board *More...*

- **What?** "A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate." [3]
- **Designing**: Read carefully the Cadstar instructions document provided in Cursus informatie > Software > Cadstar *before* and *while* you are designing your pcb.
- **Testing**: During designing the pcb make sure that it is testable. This means: add connectors for measuring separate parts of your design. Or put jumpers between different parts of your system in order to isolate the subsystems during testing.
- **Decoupling:** Digital IC's introduce noise on the supply lines (Vdd and ground) of your pcb, this is undesirable. Therefore 100nF caps (more if necessary) have to be put between ground and Vdd. Put them as close as possible to the IC pins. This is called decoupling the IC's. The capacitors will damp the noise by creating a path to ground (only for AC/noise) and decreasing the AC-output impedance of the voltage supply.
- **Specialists**: Discuss your board layout with the specialists before handing it in.
- **Buffers:** Each signal from the FPGA board MUST be buffered before being used on the student board. **74HC244** and **74HC240** can be used for this purpose. The drivers on the FPGA board are in most cases not strong enough to drive the loads ons the student boards.

  Concerning these comments: they are not optional, your design will probably NOT work if you ignore them :-)

3 Source: Wikipedia