Elektronische Schaltungen und Systeme
Electronic Circuits and Systems

1 Introduction and Overview

1.1 Organization of the Course *ESS*

Course ***ESS*** [1] teaches ***E****lektronische* ***S****chaltungen und* ***S****ysteme* (***E****lectronic* ***C****ircuit and* ***S****ystems*) in the master degree program *Elektro- und Informationstechnik* of *OTH Regensburg*.

Spoken Language German, English offered on demand, Documentation English.

Organization: approximately…
- 50% theory and its application using software (*Matlab/Simulink* and other software tools),
- 50% practical training in the laboratory,

Focus of Course *ESS*
- Unified system level design and application of mixed analog and digital circuitry.
- Fundamentals of modeling linear analog / digital control loops, short: Fuzzy example.
- Main application example is a digitally controlled DC/DC buck converter.
- We will do some model-based design (*MBD*); however, understanding what we do!

Assumed model is linear linear and time-invariant (LTI) control loop featuring a single input (*X*), a single output (*Y*) and a single interferer (*I*), as illustrated in Fig. 1.1.

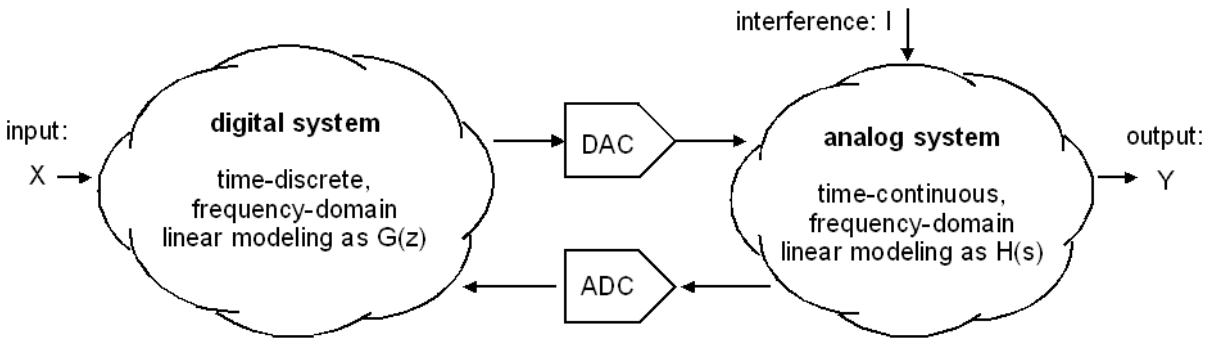
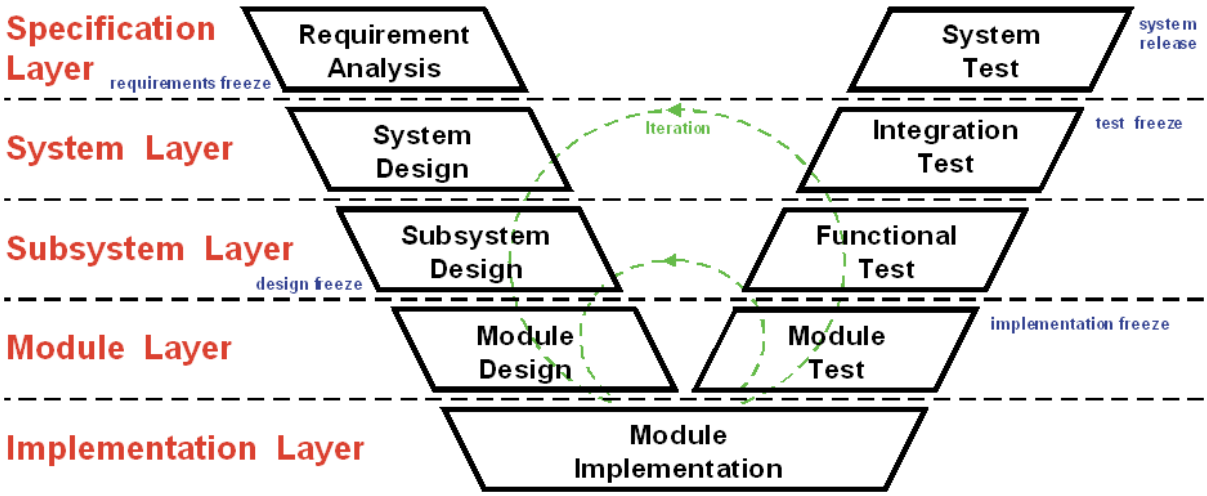


Fig. 1.1: System model assumed: linear analog/digital with single input, output and interferer

1.2 Project Management Methodologies

1.2.1 *V-Model* Oriented Project Management & Design Flow



(a) *V-Model* design flow according to [2]

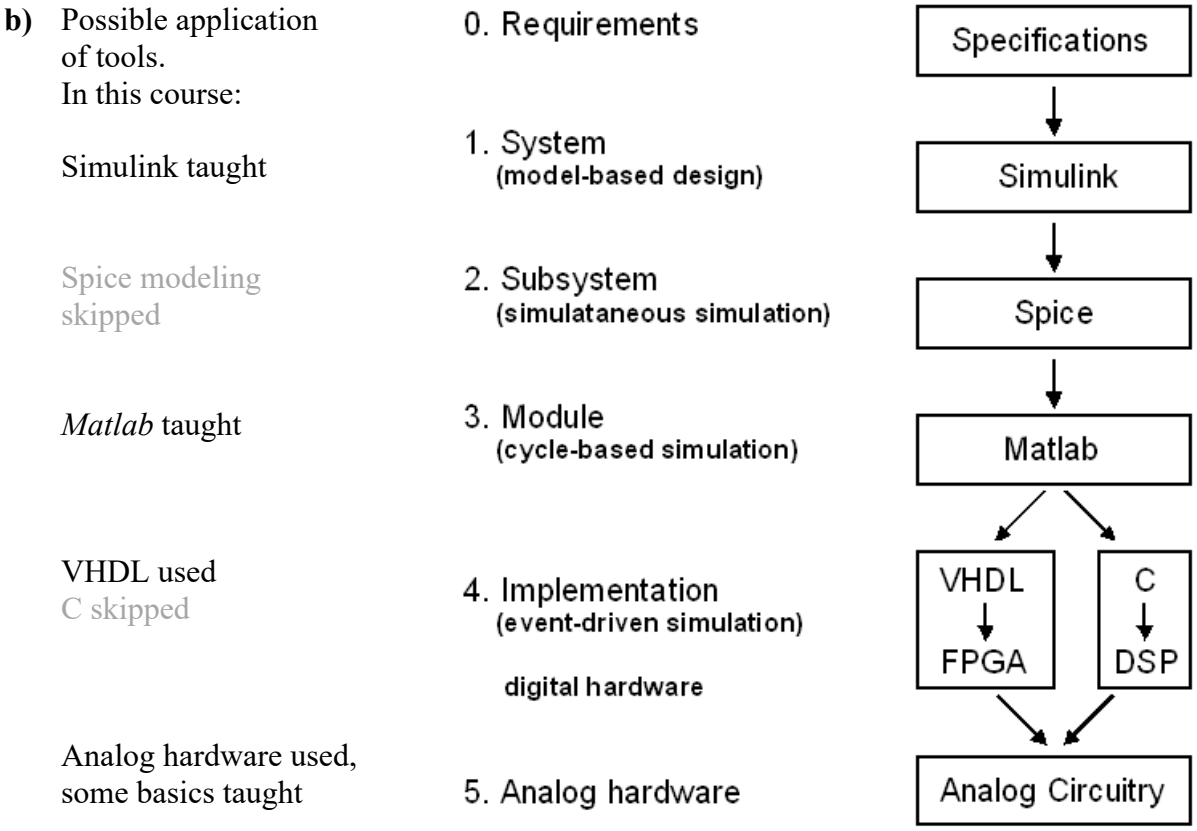


Fig. 1.2.1: V-Model design flow, (b) Possible selection of tools deployed on different levels

1.2.2 *Agile* Software Development

Software developers intentionally do not work as illustrated by *V-Model*. They intentionally try a new idea, test and analyze its strengths and weaknesses, improve the code, test again, etc. This kind of development process was formalized as *Agile* [3] method or Scrum [4].

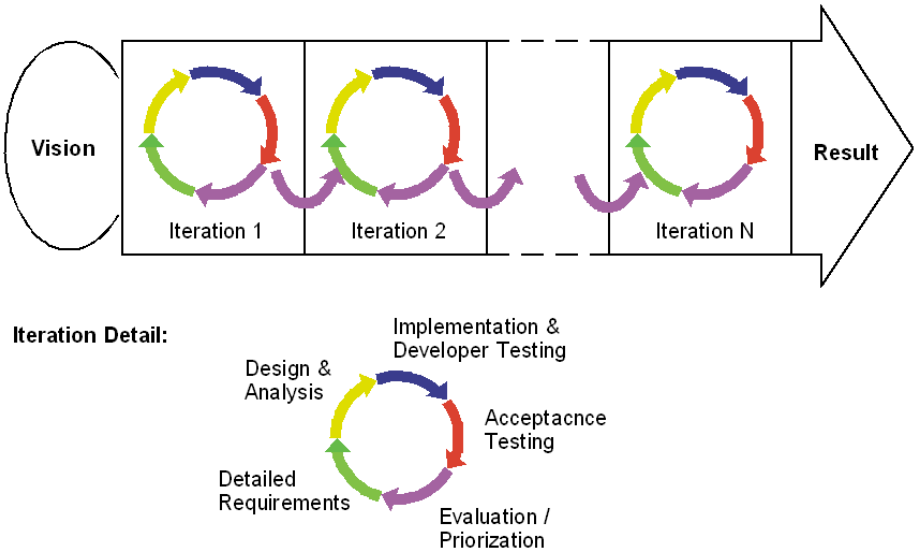
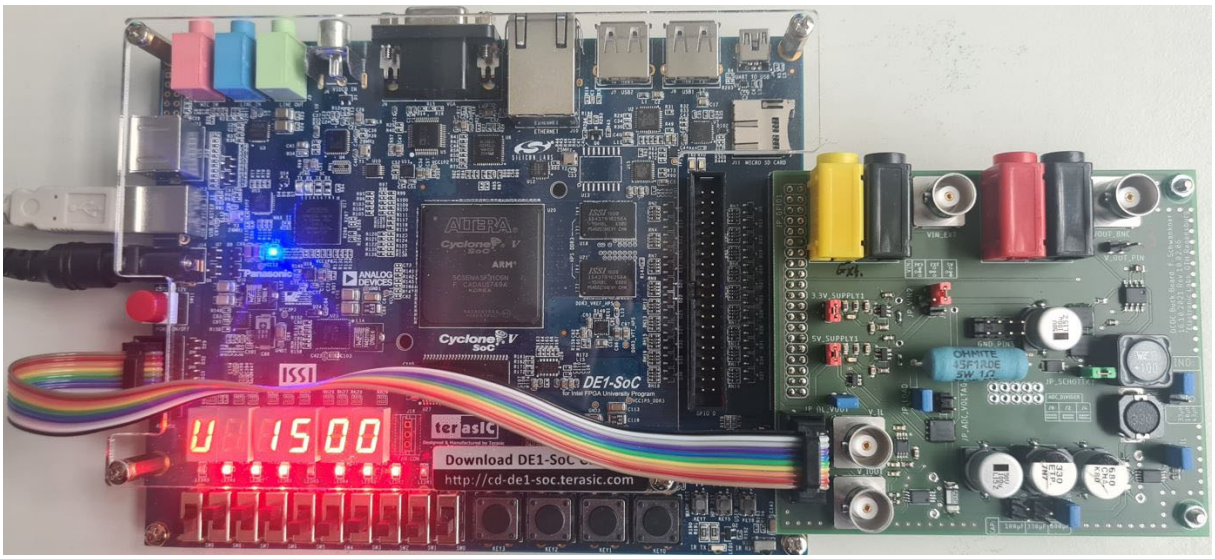


Fig. 1.2.2: Software development according to *Agile* methods [3] or Scrum [4]

1.3 Main Example: Digitally Controlled DC/DC Buck Converter

(a) Boards photo



(b) Schematics overview

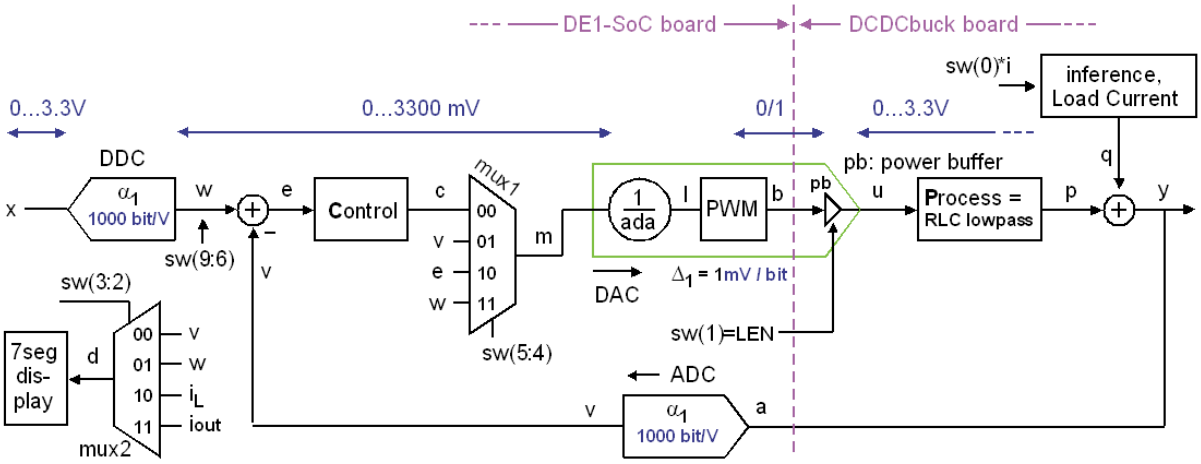


Fig. 1.3.1: *DE1-SoC* board [5] used as main example [6]

Fig. 1.3.1(a) shows the *DE1-SoC* board (left) [5] carrying the *DCDCbuck* daughter board (right) [6]. The 10 wire ribbon cable connects VCC5=5V, gnd=0V and the 8 inputs of the ADC input multiplexer to different voltages of the *DCDCbuck_Rev10.02* board.

Fig. 1.3.1(b) illustrates block diagrams: Left of the vertical, pink dashed line we see the digital system (*Terasic's DE1-SoC* baord with *Intel Cyclone FPGA*), on the right hand side the analg (selfmade) *DCDCbuck_Rev10.02* daughter board. The box labeled "*process*" in Fig. 1.3.1(b) is basically an RLC lowpass.

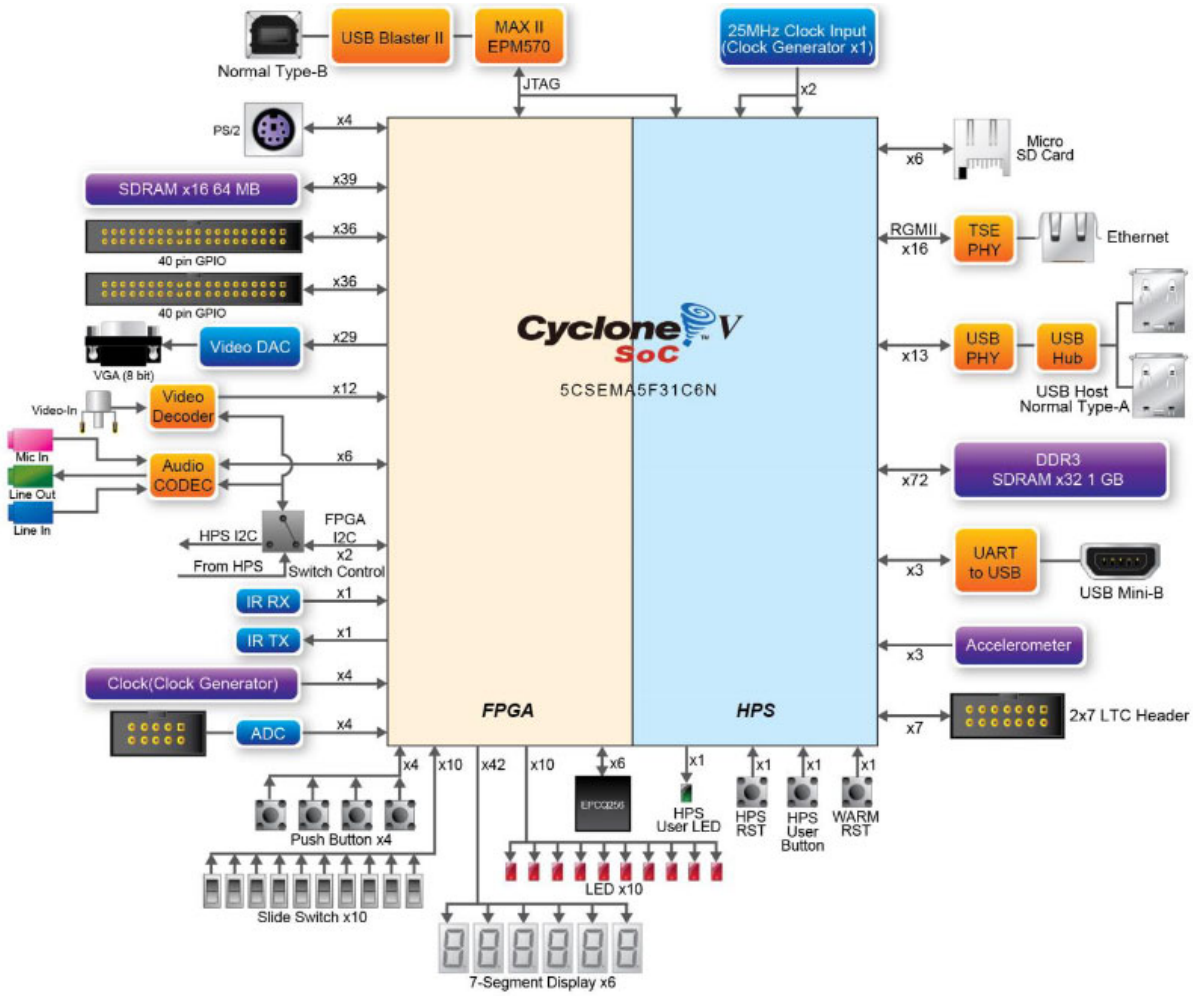


Fig. 1.3.2:: Block diagram of the DE1-SoC board, copied from Fig 2-3 in [5].

Fig. 1.3.2 illustrates the block diagram of the *DE1-SoC* board, copied from Fig 2-3 in [5]. The *CycloneV FPGA* consists of 2 parts: the *Field Programmable Gate Array* (*FPGA*) programmed with *VHDL* [9] and the *Hard Processor System* (*HPS*), which is a *Dual Core ARM ARM Cortex-A9 MPCore* [10] programmed with the *C* programming languae [11]. An *Advanced eXtensible Interface* (*AXI*) [12] allows for communication between the two parts.

1.4 Model Based Design (*MBD*) Example Using *Simulink*

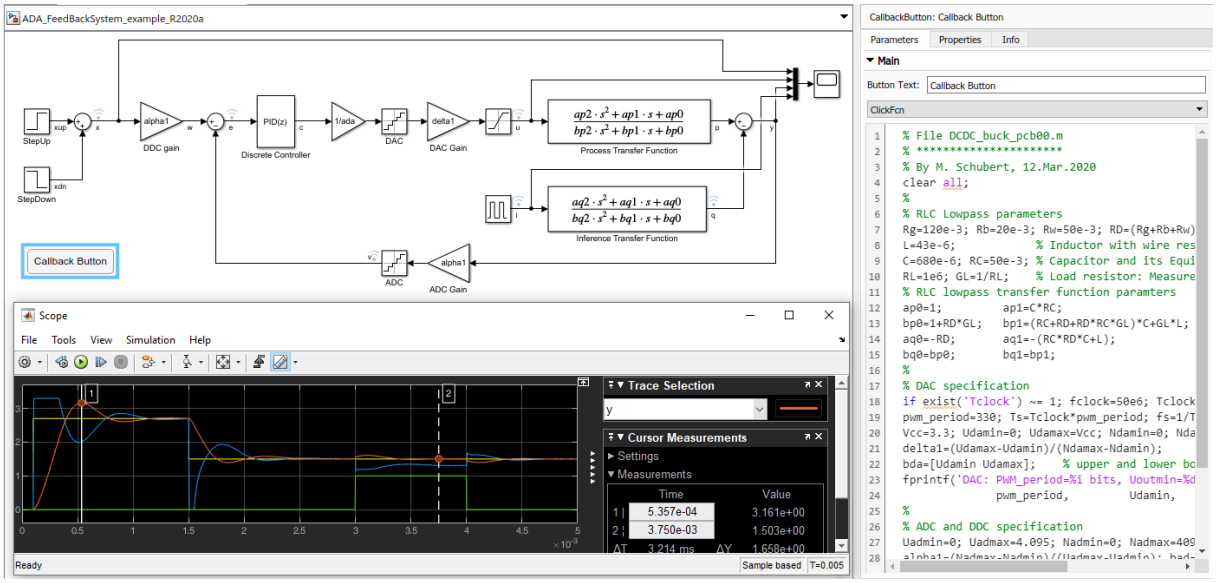


Fig. 1.4: Mixed analog/digital control loop example, will be tested during the class

The example in Fig. 1.4 can be downloaded from link "A/D/A Feedback System Example" from [1] for Matlab / Simulink [7] and will be run during the course start as *Simulink* test and *MDB* [7] demonstration.

1.5 References

[1] Martin J. W. Schubert, *Electronische Schaltungen und Systeme* (*Electronic Circuits and Systems*), available: https://hps.hs-regensburg.de/~scm39115/homepage/education/courses/ms_ess/ms_ess.htm

[2] V-Model, available: https://en.wikipedia.org/wiki/V-Model

[3] Agile software development, available: https://en.wikipedia.org/wiki/Agile_software_development

[4] Scrum software development, available: https://en.wikipedia.org/wiki/Scrum_(software_development)

[5] *Terasic, DE1*-SoC User Manual, Ref. F, available: https://hps.hs-regensburg.de/~scm39115/homepage/education/labs/Lab_ElectronicBoards/DE1-SoC_UserManual.pdf

[6] Martin J.W. Schubert, *Getting Started With DCDCbuck Board Rev. 10.02*, Practical Training at OTH Regensburg, available: https://hps.hs-regensburg.de/~scm39115/homepage/education/labs/Lab_ElectronicBoards/Lab_ElectronicBoards.htm

[7] *The MathWorks*, *Matlab / Simulink*, available: https://de.mathworks.com

[8] Model Based Design (MDB), available: https://en.wikipedia.org/wiki/Model-based_design

[9] *VHDL*, available: https://en.wikipedia.org/wiki/VHDL

[10] Intel, Cyclone V FPGAs, av.: https://www.intel.de/content/www/de/de/products/details/fpga/cyclone/v/article.html

[11] *C* programming language, av: https://en.wikipedia.org/wiki/C_(programming_language)

[12] Advanced eXtensible Interface, available: https://en.wikipedia.org/wiki/Advanced_eXtensible_Interface

[13] Ethernet, available: https://de.wikipedia.org/wiki/Ethernet