



Electronic Circuits and Systems

(Elektronische Schaltungen und Systeme)

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1. Introduction and Overview

- 1.1 Organization of the course *ESS*
- 1.2 Project Management Methodologies

1.2.1 *V-Model* Oriented Project Management & Design Flow
 1.2.2 Agile Software Development

- 1.3 Main Example: Digitally Controlled DC/DC Buck Converter
- 1.4 Model Based Design (*MBD*) Example Using *Simulink*

- 1.5 References

2. Main Example: A Switch-Mode Converter

2.1 Switch-Mode Converter	2.1.1 Step-Down (Buck) Converter	2.1.1.1 Not Switching: Low Drop-Out Regulators (LDOS)
	2.1.1.2 Switch-Mode Buck Converter in Synchronous Operation	2.1.1.3 Asynchronously Operating Buck Converter
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	2.2.2 RLC Lowpass	2.2.3.2 Current Mode Control
	2.2.3 DC/DC Control Modes	2.2.3.3 Active Voltage Positioning (deutsch: Lastaufschaltung)
	2.2.4 A/D and D/A Converter	3.3.4.1 A/D Converter (<i>ADC</i>)
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		2.3.1.7 ADC Input Plug

3. A/D and D/A Conversion Modeling

- 3.1 D/A Converter Modeling
- 3.2 A/D Converter Modeling
- 3.3 Miscellaneous
 - 3.3.1 PWM DAC and ADC-Sampling Used For *DCDCbuck Rev.10* and 11
 - 3.3.2 Handling A/D and D/A Conversion within a Loop

4. Control Loops

4.1 LTI Feedback Loops	4.1.1 Linearity and Time-Invarianz (LTI)	4.1.1.1 Linearity
	4.1.1.2 Time-Invariance	4.1.1.3 Causality
	4.1.1.3 Causality	4.1.1.4 Stability
	4.1.2 Time-Continuous LTI Systems	4.1.2.1 Laplace variable $s \rightarrow \text{Matlab: } \text{tf}(av, bv) \rightarrow \text{Simulink}$
	4.1.3 Time-Discrete LTI Systems	4.1.2.2 Laplace models $\rightarrow \text{Matlab: } \text{bodeplot}(\dots) \rightarrow \text{Simulink}$
	4.1.4 Linear Feedback Loops	4.1.3.1 Phasor $z \rightarrow \text{Matlab: } \text{tf}(dv, cv, Ts), c2d, d2c$
		4.1.3.2 Sampling Criteria of Nyquist / Shannon
		4.1.3.3 Time-Discr. Filters in 1 st + 2 nd Canonic Direct Structure
		4.1.4.1 Signal and Noise Transfer Functions: <i>STF</i> , <i>NTF</i>
		4.1.4.2 <i>STF</i> , <i>NTF</i> Modeling Using <i>Matlab</i>
		4.1.4.3 The <i>Simulink</i> Control Loop Template

- 4.2 Fuzzy Logic as Non-Linear Control Loop Example

5. Analog PID Controllers

5.1 Locus of Poles and Stability	
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	5.2.3 Using Pole-Zero (Lead-Lag) System for Phase Margin Correction
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	5.2.5 PID Compensator Representations
5.3 Nesting Loops	5.3.1 Single 2 nd Order Loop: Voltage Mode Control DC/DC Converter
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6. Digitalization of Analog PID Controllers

6.1 Replacing $s \rightarrow z$	6.1.1 Backward-Euler Method	<i>Matlab: c2d, c2d</i>
	6.1.2 Forward-Euler Method,	
	6.1.3 Tustin's Bilinear Method	
6.2 Digital Controller	6.2.1 Summation of P, I, D Control Units, <i>Simulink: see</i> \rightarrow Model Based Design (<i>MBD</i>)	
	6.2.2 PID compensator as 2nd order system	

7. Embedded (Hardware/Software Codesign) Aspects

