ECE615 Mixed-Signal IC Design

Lecture1 Slides

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Mixed Signal IC Laboratory
Boise State University

Course Outline

Instructor : Vishal Saxena
Time : Tuesday and Thursday, 6:15 to 7:30 PM
Course dates : Tuesday, Jan 12 to Thursday, Apr 28
Location : MEC 309
Holidays : March 22 & 24, Spring break.
E-mail : vishalsaxena@u.boisestate.edu
Website : http://lumerink.com/courses/ECE615/s16/ECE615.htm

Course Topics

- Data Conversion and spectral estimation fundamentals
- Delta-Sigma modulator (DSM) architectures, decimation filters
- Discrete-time DSM design
  - System level design, noise budgeting, circuit optimization.
- Continuous-time (CT) DSM design
  - Effects of excess-loop delay and clock jitter in CT-DSMs
  - Tuning techniques for CT-DSMs.
- Flash ADCs and DACs employed in the CT-DSMs
- Bandpass and Complex DSMs.
- DAC mismatch error shaping

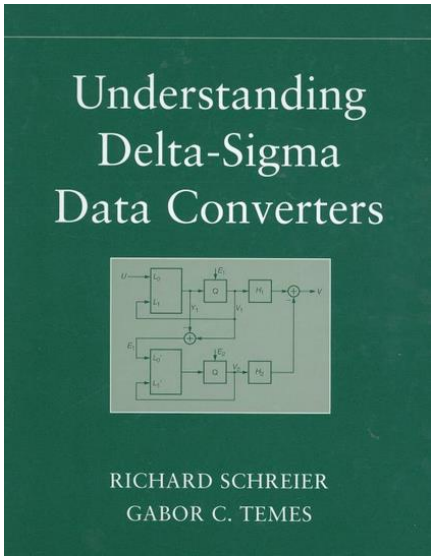
Prerequisites

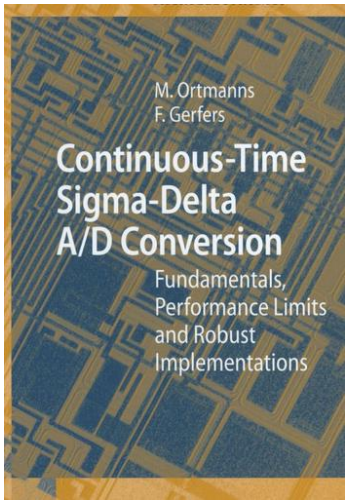
- Analog IC Design (ECE 511)
  - Op-amps, biasing, small-signal analysis.
- Digital Signal Processing
  - Fourier, DTFT, Laplace, z-transforms, poles and zeros.
- Basic knowledge of circuit simulation using Spice/Spectre and Matlab scripting.

- Transistor-level circuit details are covered in ECE 614
  - Fully-differential opamps, switched capacitor circuits, and noise analysis.
  - Lectures are available online

Textbook and References

- Understanding Delta-Sigma Converters – Richard Schreier and Gabor Temes, Wiley-IEEE Press, 2005.
  - CT Sigma-Delta ADC – Ortmanns
- Matlab Delta-Sigma Toolbox by R. Schreier available for download online. The toolbox manual is here.
- The complete reference list for delta-sigma modulators is available here.

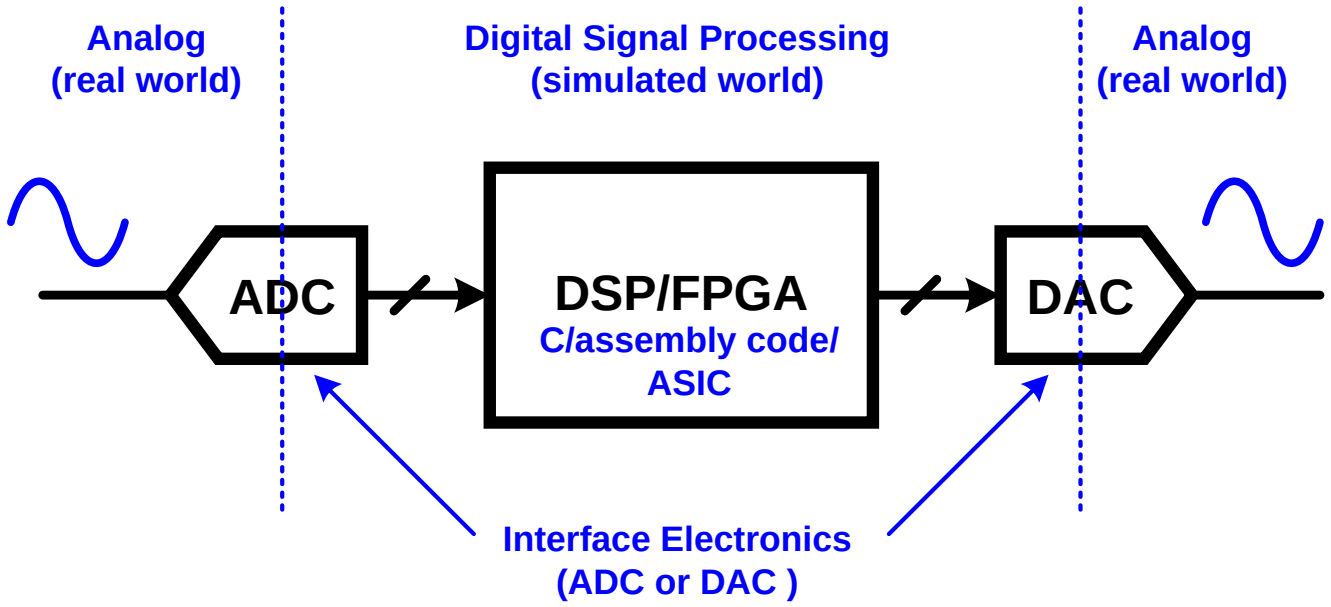




Course Pedagogy, Grading and Policies

- Combination of lecture notes, slides and simulation
  - Lecture notes will be posted online
  - Additional slides, Matlab code etc will also be posted.
- Workload (Grading)
  - Homeworks (25%): Weekly assignments combining Matlab and Spectre based design and simulation.
  - Midterm Exam (25%)
  - Project 1 (25%): Switched-capacitor delta-sigma modulator design.
  - Project 2 (25%): Continuous-time delta-sigma modulator design.
- Policies
  - Maximize learning!
  - No plagiarism, late work and net surfing in class.

Data Converters

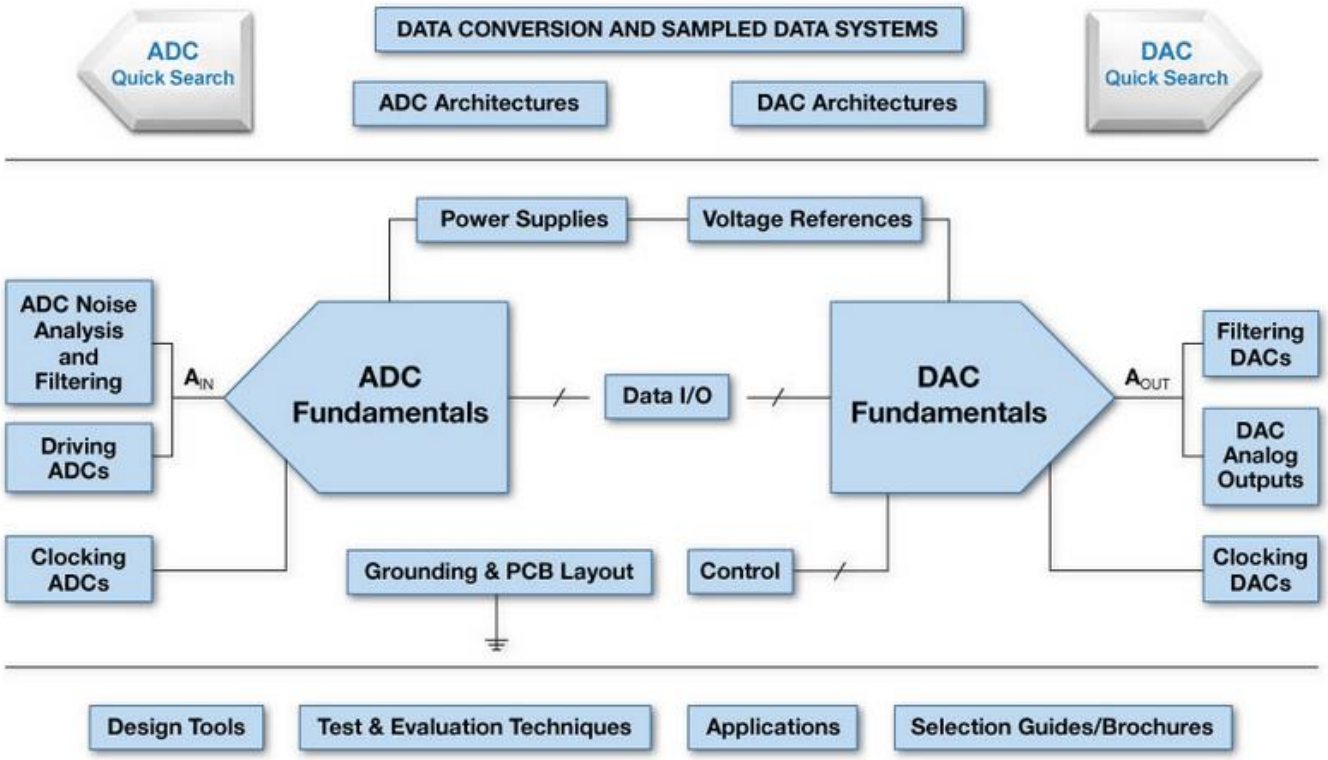


- Real world: Continuous-time, continuous-amplitude signals.
- Digital world: Discrete-time, discrete-amplitude signal representation.
- Interface circuits: ADC and DACs.
  - Varying speed and precision requirements.

Data Conversion Scenarios

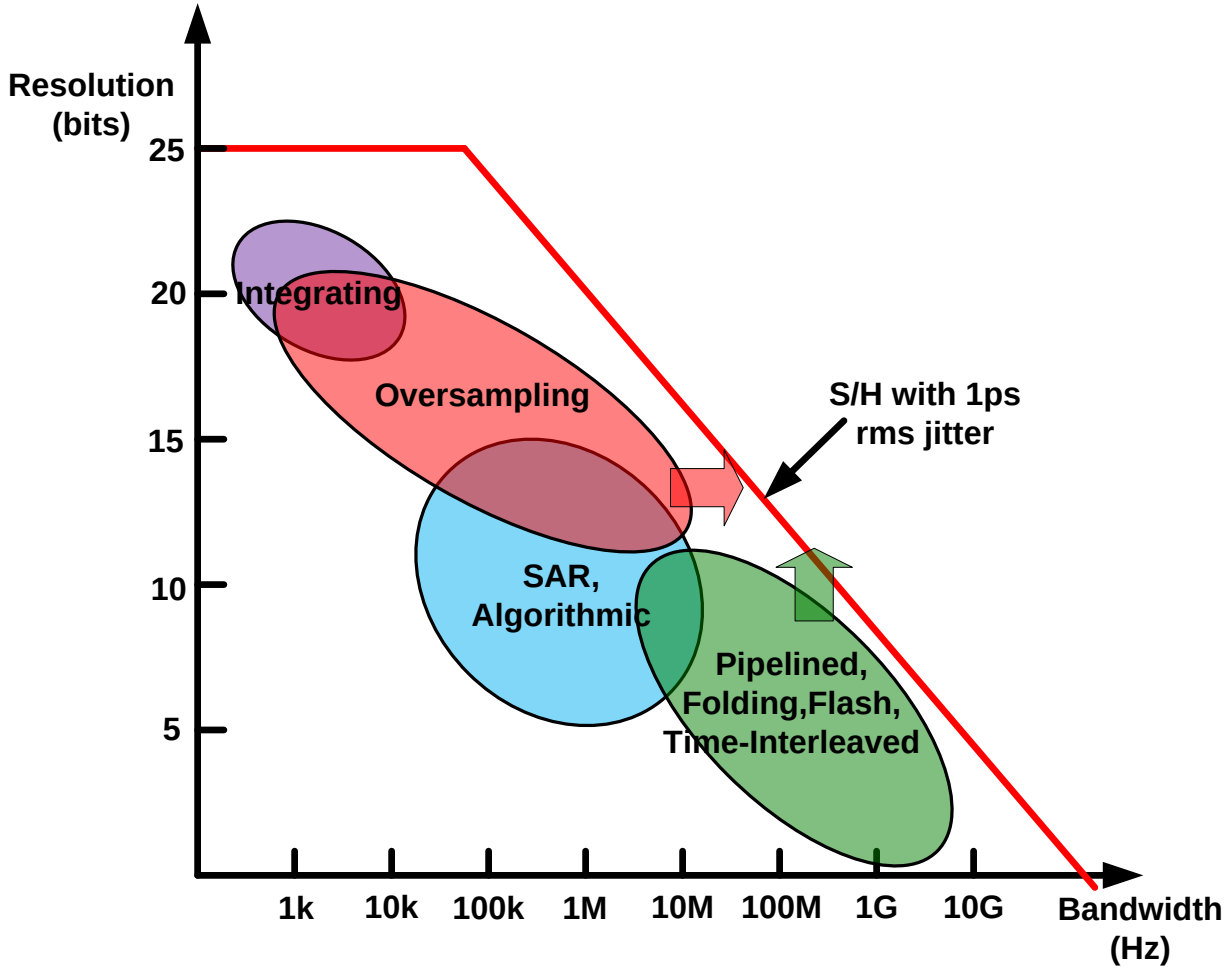
- Any application using a sensor and/or an actuator
  - Wireless: RF Rx and Tx chain
  - Twisted pair: ADSL modem
  - Coaxial: Cable modem
  - Serial/Optical links: 10G+ ADC for modulation and equalization
  - Audio Recording: 24-bit stereo ADCs
  - Audio players: stored data to speaker (audio DAC)
  - HDD read channel: Magnetic disk to microprocessor
  - Biomedical applications (e.g. sensing blood glucose level and actuating the insulin pump),.....
- Speed and resolution requirements vary with the application.

Data Converters

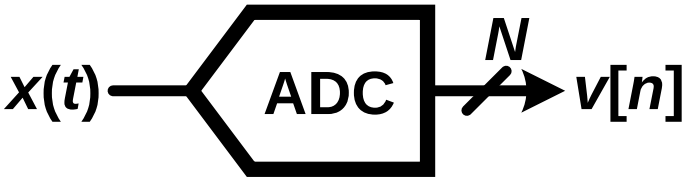


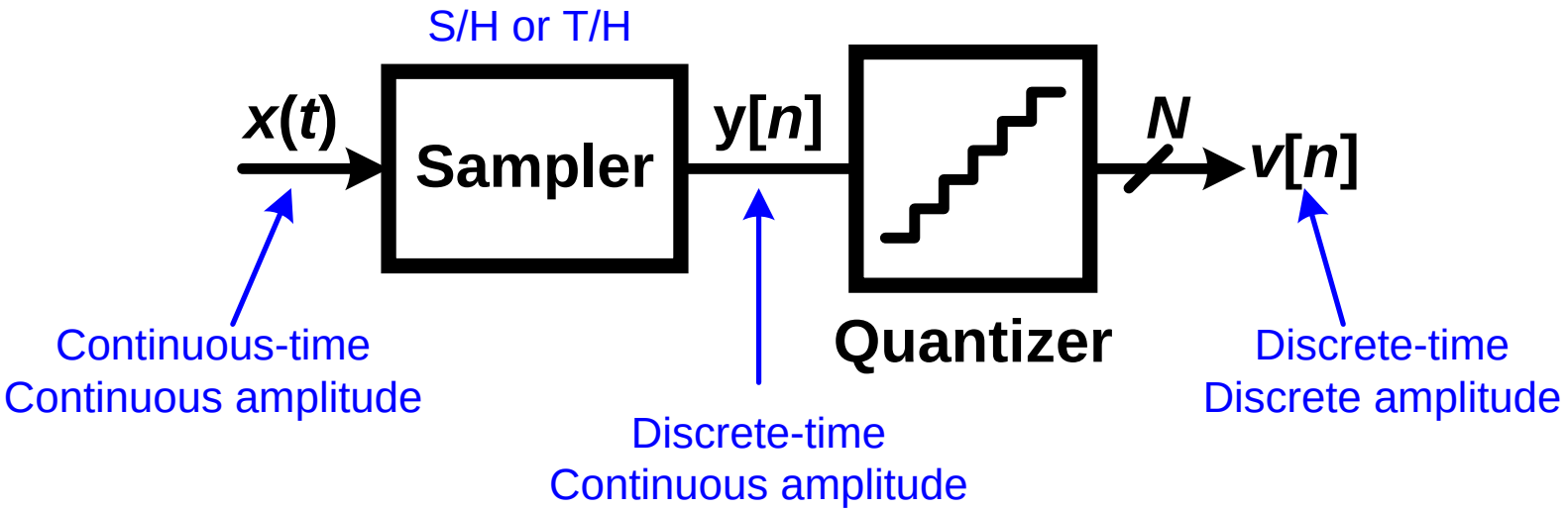
- http://www.analog.com/en/data-conversion-knowledge-resource/conversions/index.html

Analog to Digital Converter Architectures



Analog-to-Digital Converter (ADC)





Sampling Process

- Refer to lecture notes.