Project design tutorial (I)

Design or project specifications

Divide the project or system into blocks or subsystems (top-down design) (hierarchical design)

Analogue subsystem
- Sensor models
- Sensor conditioners
- Amplifiers
- Filters

Mixed-signal subsystem
- A/D converter
- D/A converter
- V/F and F/V
- PWM

Digital subsystem
- LCD and 7-segment displays
- Keyboard and switches
- LED’s and indicators
- Communications (SPI, I2C, USART, etc)
- Memory banks
- Microprocessor

Project design tutorial (II)

Typical sensor analogue subsystem

Sensor
Pressure, temperature, speed, acceleration, etc.

Signal conditioner
Voltage references, operational amplifiers, transistors, etc.

High level, noise-less signal (output voltage) which is a function of the sensed magnitude
**Typical sensor analogue subsystem**

- **Sensor**
- **Signal conditioner**

Pressure, temperature, speed, acceleration, etc.

Voltage references, operational amplifiers, transistors, etc.

High level, noise-less signal (output voltage) which is a function of the sensed magnitude

**Project design tutorial (IV)**

**interfacing analogue signals**

- Signal V1(t)
- Signal V2(t)
- ... ...
- Signal V8(t)

From sensor subsystems

Analogue multiplexer

Sample & Hold

A/D converter

n-bit digital vector

A single chip or a microcontroller peripheral
Project design tutorial (V)

Designing electronic projects

Analogue or mixed-signal subsystem specifications

Values for all components

Circuit design

SPICE based simulation

Circuit works correctly?

demo or prototype board

Circuit works correctly?

Printed circuit board (PCB) design

PCAD software

Pre-production

NO

YES

NO

NO

NO

YES

FREE demos or professional software (Proteus-VSM)

microcontroller subsystem specifications

microcontroller (PIC, 8051, etc.)

hardware design

assembler or C programming

MPLAB HI-TECH, CCS, IAR, etc., C Compiler

SPICE based simulation

Circuit works correctly?

PCAD software

Pre-production

NO

YES

Circuit works correctly?

Circuit works correctly?

PCAD software
An example:
Initial design of an absolute pressure meter

- Specifications:
  - Pressure range from 900 hPa – 1100 hPa
  - 5 V power supply
- Data from the sensor datasheet
- Initial design of the sensor conditioner
- SPICE-based electrical simulation
- Microcontroller circuit and software design
- Prototyping

See the web page for details:
http://epsc.upc.edu/projectes/sed/unitats/unitat_1_1/Unitat_1_1.htm

Some concepts involved: physical quantities, sensors, instrumentation, electronic circuits, simulation, analogue-to-digital interfaces, PIC microcontrollers, C code compiler
Chapter 1: PLD’s

The theory basics and the classic 74 series (SSI & MSI)

The versatile GAL22V10 (~500 logic gates)

Altera CPLD MAX7128 & FLEX10k (2,5k – 70k logic gates)

Simple circuits & FSM

Programmable Logic Devices (SPLD)

Peripherals and circuits of medium complexity

Programmable Logic Devices (CPLD)

Circuit design, simulation and device programming using Schematics & VHDL

UP1

Chapter 1: PLD’s

LAB training for CPLD & FPGA systems


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Version 1, September 14 2000

9V Power Supply

JTAG Port

PS/2 Port

VGA Port

25.175MHz Oscillator

10K20’s 7Segment LEDs

ALTERA’s 10K20 FPGA

Flex 10K20’s External I/Os

CPLD dip switches

CPLD Push buttons

CPLD’s 7Segment LEDs

FPGA dip switches

FPGA Push buttons
CAD tools for digital electronic design systems

Chapter 2: µP & µC

Microchip PIC family of microcontrollers

Microchip MPLAB IDE

SPICE based interactive simulation of microcontroller circuits

PROTEUS VSM

Altium PCAD PCB

Printed Circuit Board design and prototyping

Circuit design, simulation and device programming using

Assembler & C

HI-TECH Lite C Compiler

PIC boards

Chapter 2: µP & µC

LAB training for microcontroller systems

PIC Millennium Board

PICDEM2 board

PICDEM 2 Demo Board

(http://www.elgarelectronics.co.uk/el_prod.html)
CAD tools for digital electronic design systems

Chapter 3: Systems on Programmable Chip (SoPC)

Professional applications in Telecommunications Systems and Telematics

PLD Altera NIOS system (>200k logic gates)

Altera Quartus II

SoPC Builder and device programming using Schematics & VHDL

Altera Nios SDK Shell

C compiler and Shell for NIOS processor (serial port interfaced)

Altium PCAD PCB

Printed Circuit Board design and prototyping

NIOS Development Board

LAB training for SoPC based in the Altera APEX EP20K200E FPGA (484 pin)
• You must simulate and use as many as possible CAD-EDA tools before lab prototyping

• EPSC has many software licenses for you to use

Find some examples in http://epsc.upc.edu/projectes/sed

Computer Aided Design (CAD)
Electronic Design Automation (EDA)