ECE3411

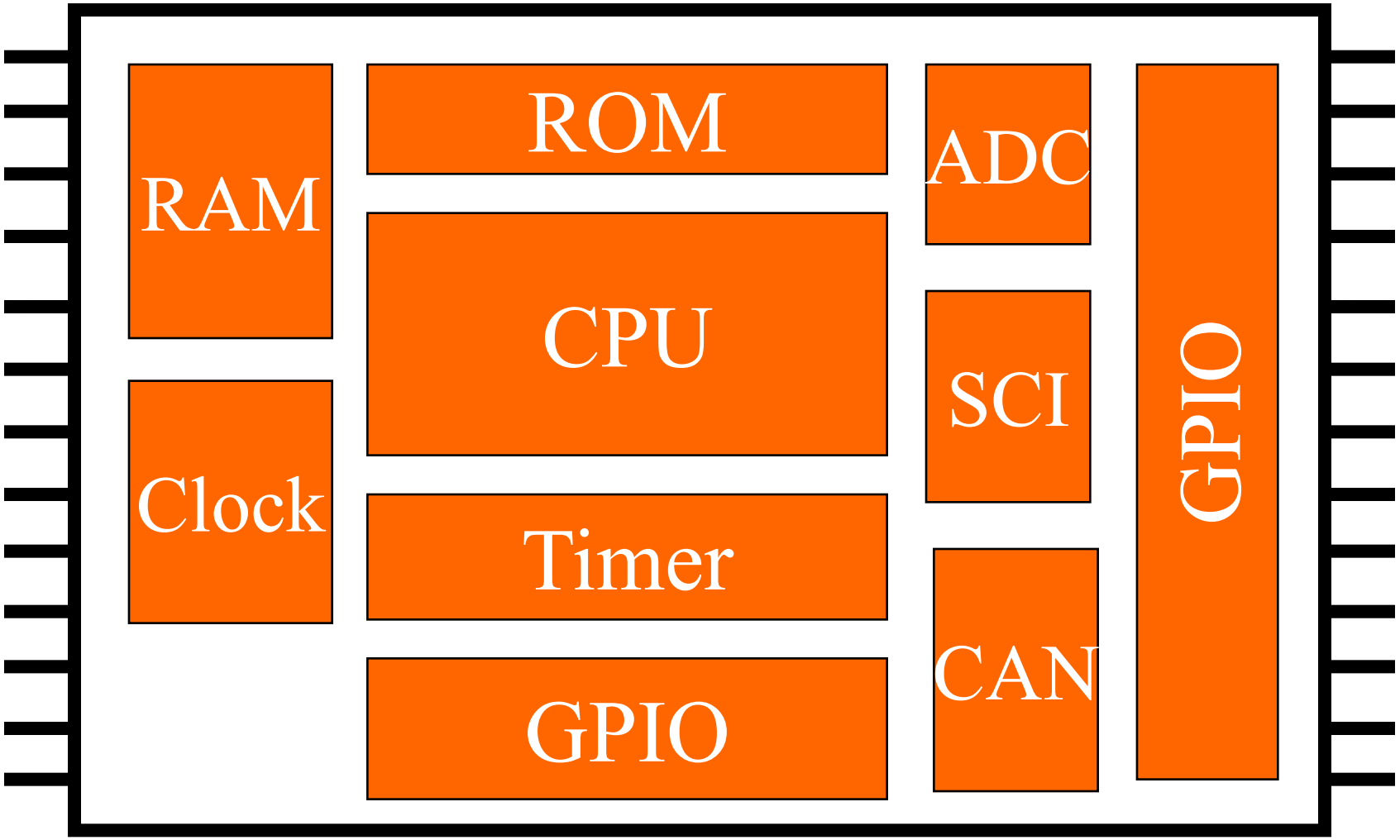
Lecture#1a

Introduction to Microcontroller

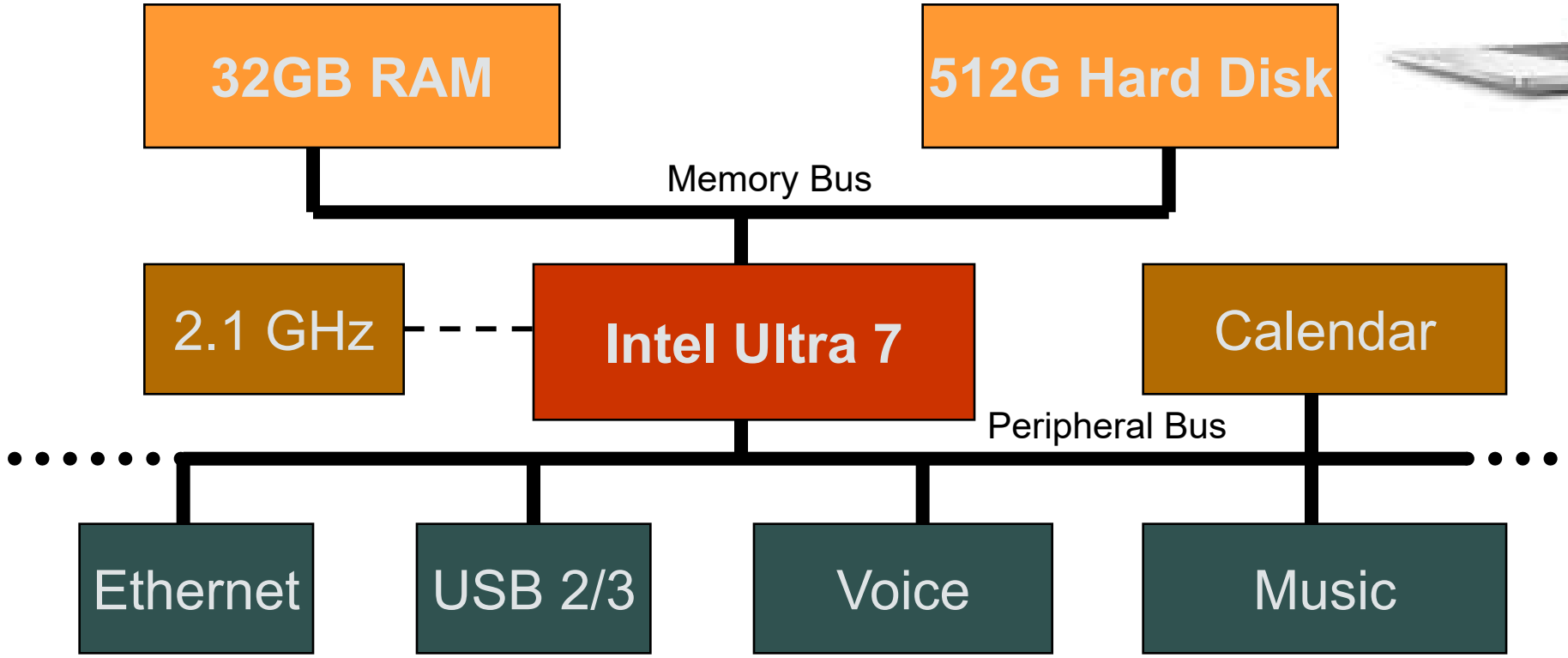
Sung Yeul Park
Department of Electrical & Computer Engineering
University of Connecticut
Email: sung_yeul.park@uconn.edu

Slides adopted from Marten van Dijk, Syed Kamran Haider, and John Chandy

Microcontroller Structure

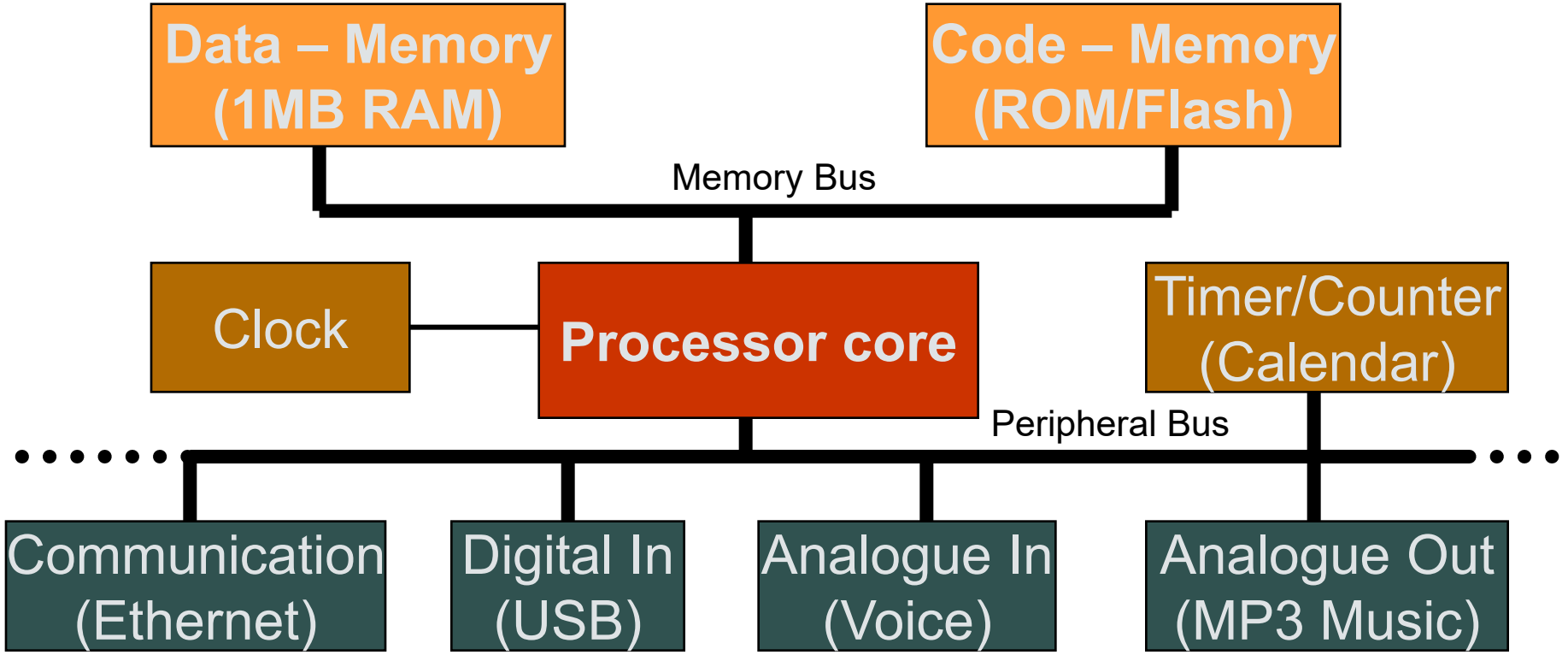


What is your personal computer specification?



Microcontroller

Microcontroller = Processor core + Memory + Peripherals



Case Study : Micro-mouse

Watch the video and list five peripherals discussed.
For each, explain its function within a microcontroller.

http://www.youtube.com/watch?v=peEpkRIKDEs&NR=1

Question 1: What is the main role of the CPU in a microcontroller?

A. Store permanent data

B. Control external devices directly

C. Execute program instructions and control operations

D. Provide power to the system

Question 2: What type of memory stores the firmware in a microcontroller?

A. RAM

B. ROM

C. EEPROM

D. Cache

Question 3: Why is RAM important in a microcontroller?

A. It stores the operating system

B. It holds the program code permanently

C. It temporarily stores data during execution

D. It controls the clock speed

Question 4: What is the function of I/O interfaces in a microcontroller?

A. To store sensor data

B. To execute instructions

C. To communicate with external devices

D. To generate clock signals

Question 5: What does the clock signal do in a microcontroller?

A. Stores time and date

B. Synchronizes internal operations

C. Controls memory access

D. Powers the CPU

Microcontroller Applications

Digital Power Supply

Provides control, sensing, PFC, and other functions

Optical Networking

Control of laser diode

Printer

Print head control

Paper path motor control

Evaluating Other Segments

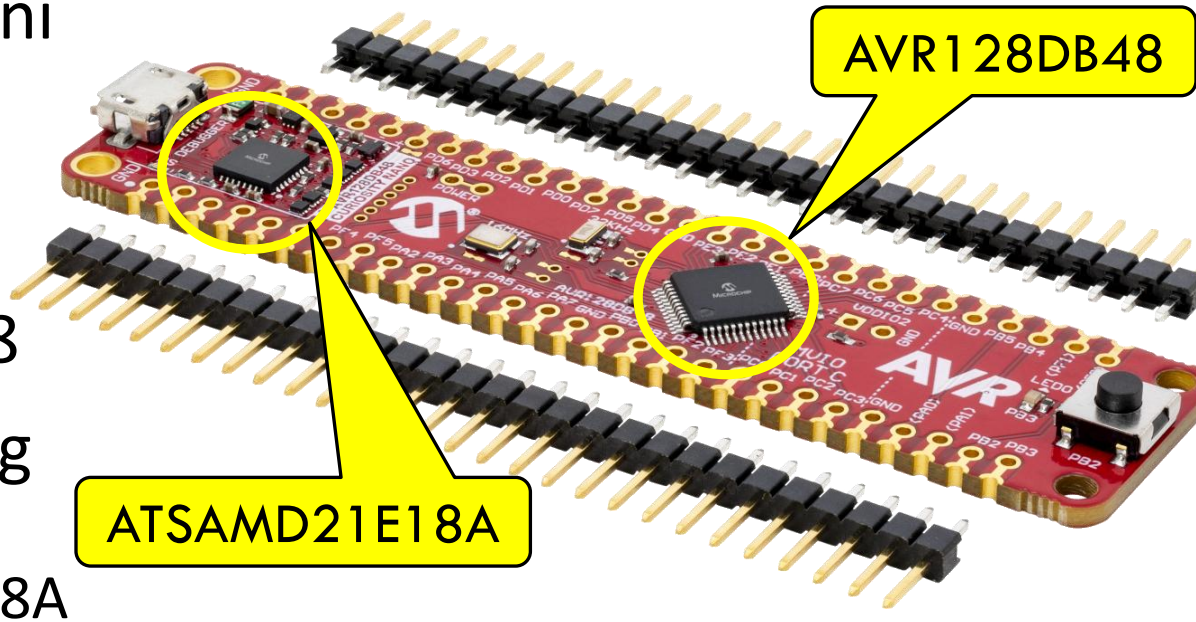
e.g.. Musical Instruments

Non-traditional Motor Control

Many new cool applications to come

AVR128DB48 Curiosity Nano Board

- The AVR128DB48 Curiosity Nano Mini evaluation board provides a development platform for the Microchip AVRDB Microcontroller.
- Target Microcontroller: AVR128DB48
- On-board Programming & Debugging capability using Atmel Studio
  - Debugger Microcontroller: ATSAMD21E18A
- USB connectivity
- Headers & Connectors for accessing target microcontroller's I/O pins

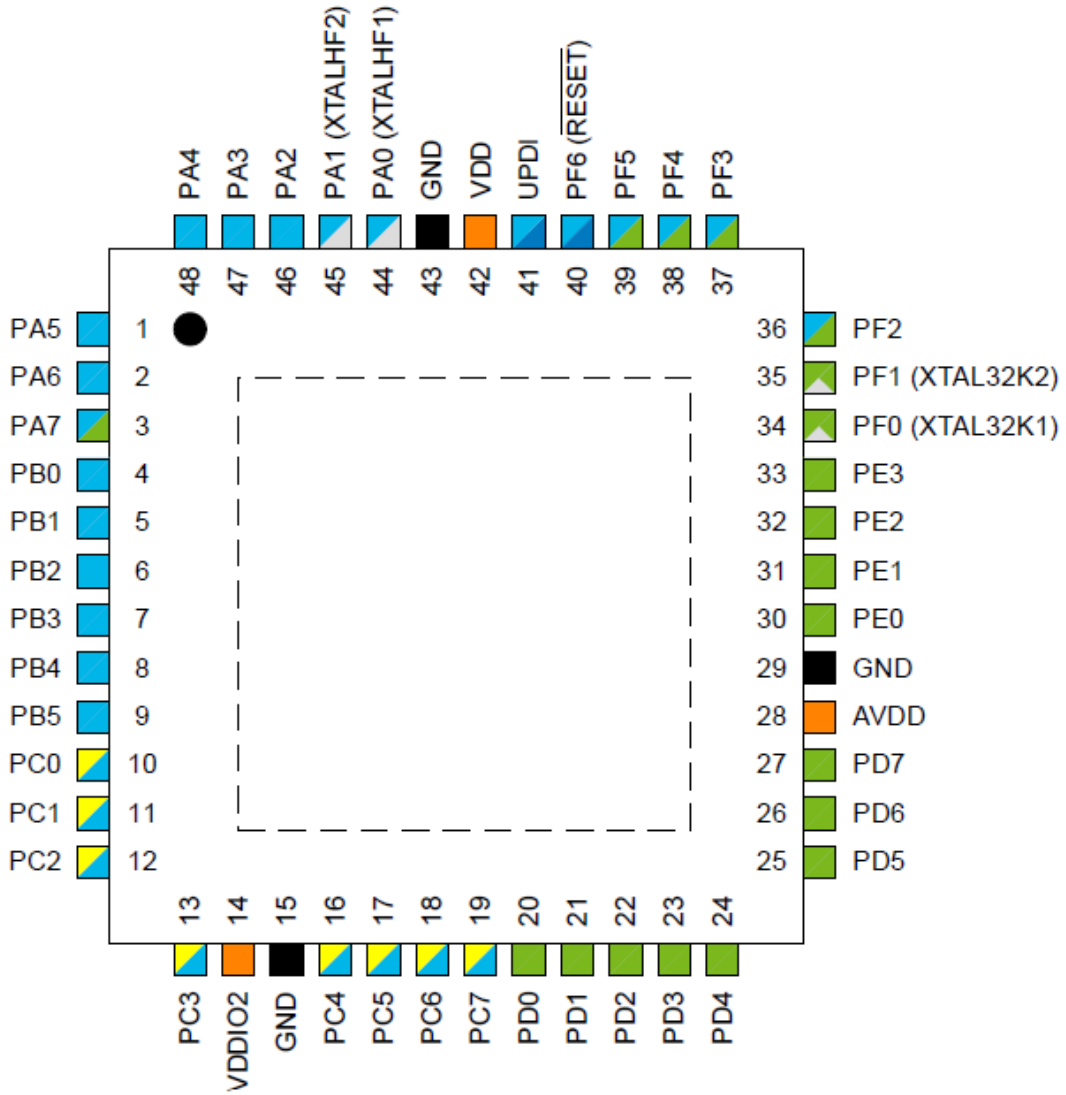


AVR128DB48

- High Performance, Low Power Microchip® AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 24MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 128KBytes of In-System Self-Programmable Flash program memory
  - 512 Byte EEPROM
  - 16K Bytes Internal SRAM
  - Write/Erase Cycles: 1,000 Flash/100,000 EEPROM
  - Data retention: 40 years at 55°C
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security

AVR128DB48

- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator or external crystal
  - External and Internal Interrupt Sources
  - Three Sleep Modes: Idle, Standby, Power-down
  - Unique Device ID
- I/O and Packages
  - 41 Programmable I/O Lines
  - 48-pin TQFP
- Operating Voltage: 1.8 - 5.5V
- Temperature Range: -40°C to 125°C
- Speed Grade: 4 - 24MHz @ 1.8 - 5.5V
- Power Consumption at 4MHz, 3.0V, 25°C
  - Active Mode: 1.0 mA
  - Power-down Mode: 170 µA
  - Standby Mode: 0.65 µA



AVR128DB48 Features

- Peripheral Features
  - Peripheral Touch Controller
  - One 12-bit Timer/Counter
  - Six 16-bit Timer/Counters
  - Real Time Counter
  - Two PWM Channels
  - 13-channel 12-bit ADC with Temperature Measurement
  - On-chip Analog Comparator
  - 10-bit DAC
  - Three on-chip op-amps
  - Five Programmable Serial USARTs
  - Two Master/Slave SPI Serial Interfaces
  - Two Byte-oriented 2-wire Serial Interfaces (Phillips I2C compatible)
  - Programmable Watchdog Timer
  - Interrupt and Wake-up on Pin Change

AVR128DB48 Features

	AVR128DB28	AVR128DB32	AVR128DB48	
Pins	**28**	**32**	**48**	**64**
Max. frequency (MHz)	24	24	24	24
16-bit Timer/Counter type A (TCA)	1	1	2	2
16-bit Timer/Counter type B (TCB)	3	3	4	5
12-bit Timer/Counter type D (TCD)	1	1	1	1
Real-Time Counter (RTC)	1	1	1	1
USART	3	3	5	6
SPI	2	2	2	2
TWI/I^2C	1(1)	2(1)	2(1)	2(1)
12-bit differential ADC (channels)	1 (9)	1 (13)	1 (18)	1 (22)
10-bit DAC (outputs)	1 (1)	1 (1)	1 (1)	1 (1)
Analog Comparator (AC)	3	3	3	3
Zero-Cross Detector (ZCD)	1	1	2	3
Op amp (OP)	2	2	3	3
Configurable Custom Logic Look-up Table (CCL LUT)	4	4	6	6
Watchdog Timer (WDT)	1	1	1	1
Event System channels (EVSYS)	8	8	10	10
General Purpose I/O(2)	22/21(2)	26/25(2)	41/40(2)	55/54(2)
PORT	PA[7:0], PC[3:0], PD[7:1], PF[6,1,0]	PA[7:0], PC[3:0], PD[7:1], PF[6:0]	PA[7:0], PB[5:0], PC[7:0], PD[7:0], PE[3:0], PF[6:0]	PA[7:0], PB[7:0], PC[7:0], PD[7:0], PE[7:0], PF[6:0], PG[7:0]
External Interrupts	22	26	41	55
CRCSCAN	1	1	1	1
Unified Program and Debug Interface (UPDI)	1	1	1	1

How to be successful in class?

- **Prepare diligently before starting labs.** Read the data sheet and review lecture notes before starting on the labs.
- **Be actively engaged in your learning.** Ask questions during office hours, do all lab practice.
- **Make sure to anticipate unexpected distractions and finish your work early.** See syllabus for tentative dates. Pay attention to HuskyCT for changes
- **Ask for help during labs and office hours from the instructor and TA**
- **You are allowed to collaborate with colleague students only on lab practices but be prepared to explain what you did during demonstration. You can not collaborate on lab tests or quizzes**