Introduction to µc

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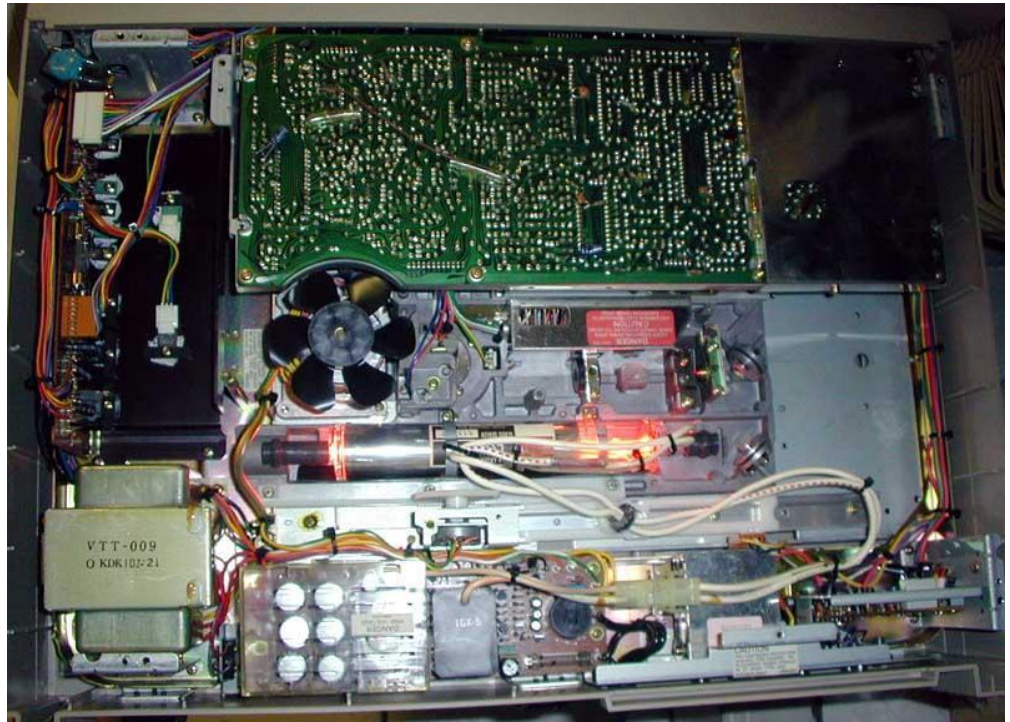
A Brief History

- Compare CD Player from the **1980s** and DVD Player made in the last few years
- CD Player circuit board is **densely** populated with **integrated circuits** (chips)
- DVD Player circuit board has **a lot of empty space**, contains two or three quite large chips



A Brief History

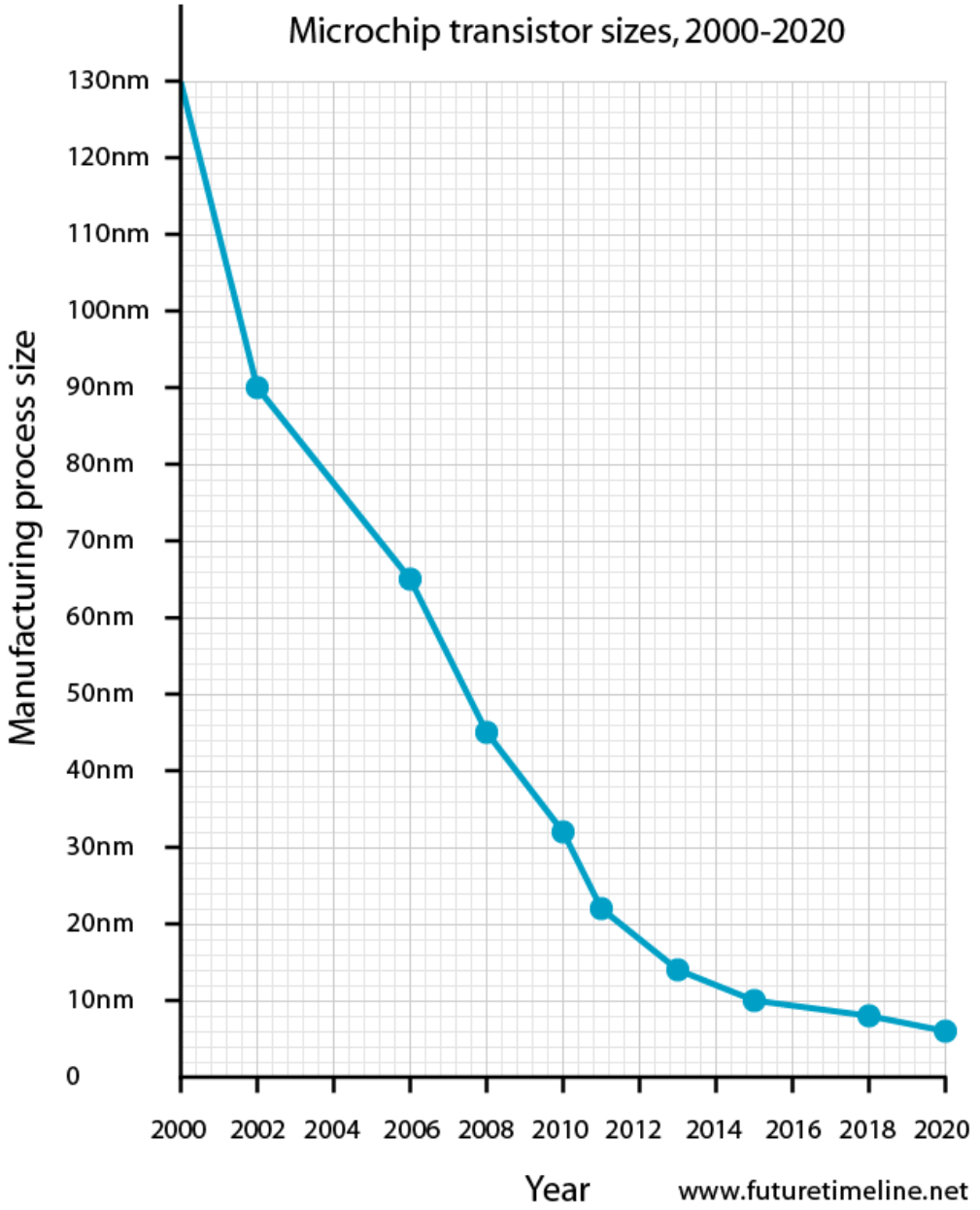
- Compare CD Player from the **1980s** and DVD Player
- CD Player circuit board is **densely** populated with **int**
- DVD Player circuit board has **a lot of empty space**, cc chips (*better quality and robustness*)

- This transformation is due to two main factors

❑ The increasing miniaturization of electronics and co

- *Transistor size in 1970s = 10 microns (human hair average a*
- *Transistor size in 2012 = 22 nanometers (in 2014 = 14 nanor*

❑ The progressive transition from **implementing** devic **implementing** them **in software** running on microco

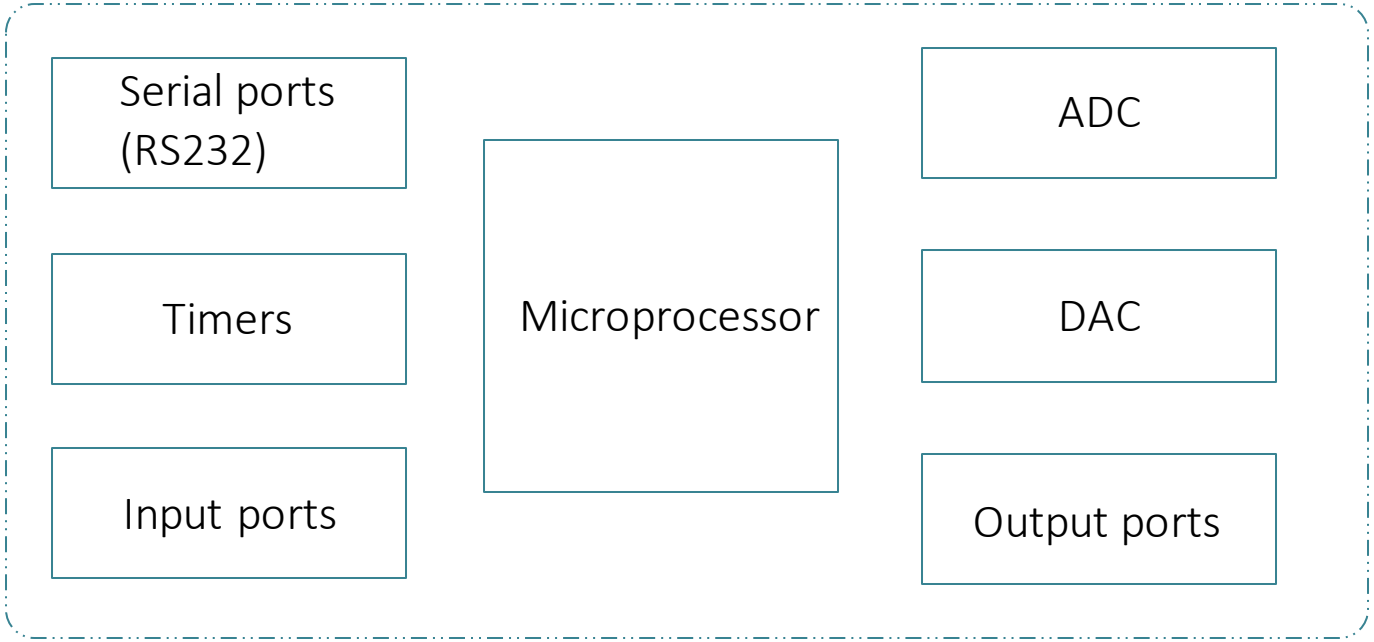


A Brief History

- Until the mid-1980s → a lot of chips on a board
- Starting in the early 1980s → **Microprocessors**
  - ❑ Chip count reduced
  - ❑ Reduced manufacturing costs and end-user price
  - ❑ Intel 8080, Zilog Z80 (The earliest **8-bit** microprocessors)
  - ❑ Maintenance cost reduced → using semiskilled labor instead of using skilled labor
- Microprocessors weren't a complete magic bullet for bringing down costs and complexity of product design
- **Problem?** → A large number of additional chips for I/O, Clocking, Address decoder and … surrounding the **µp**

A Brief History

- 1990s → more circuitry on one chip
- Separate external chips integrated with µp → this is called **microcontrollers (µc)**



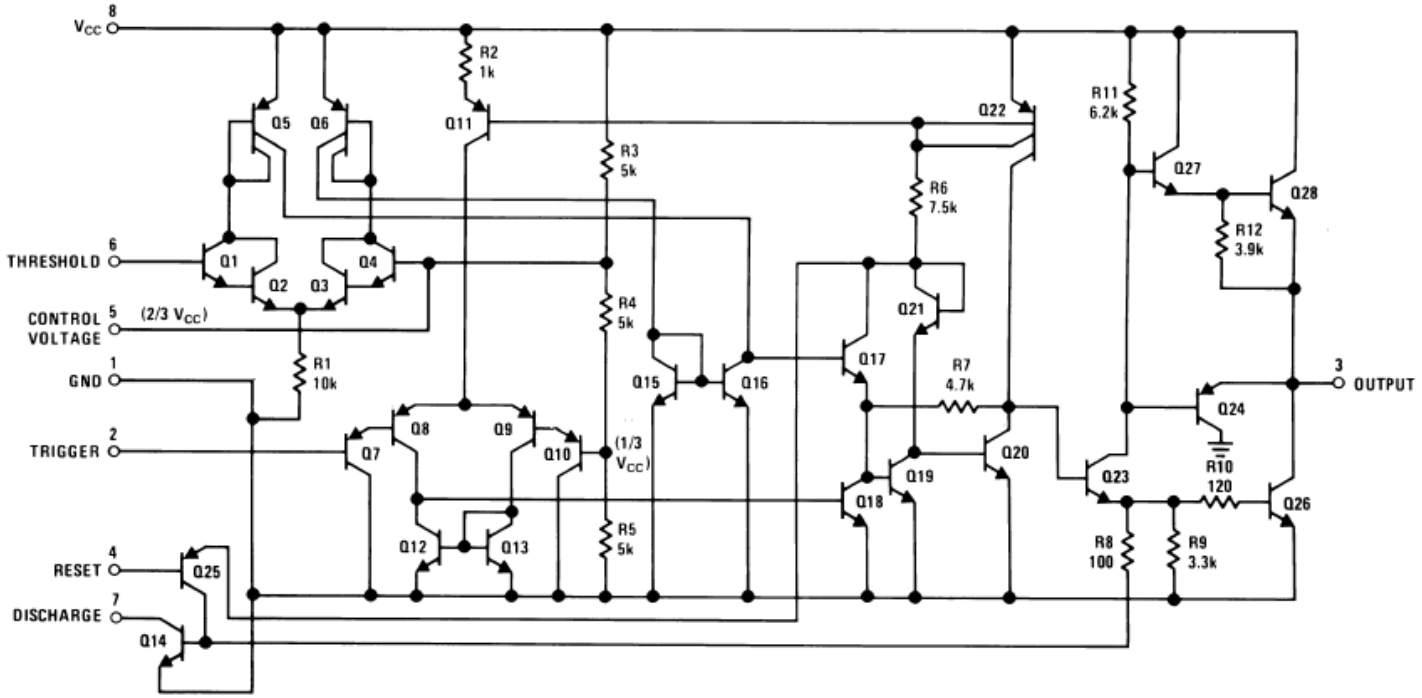
Microcontroller

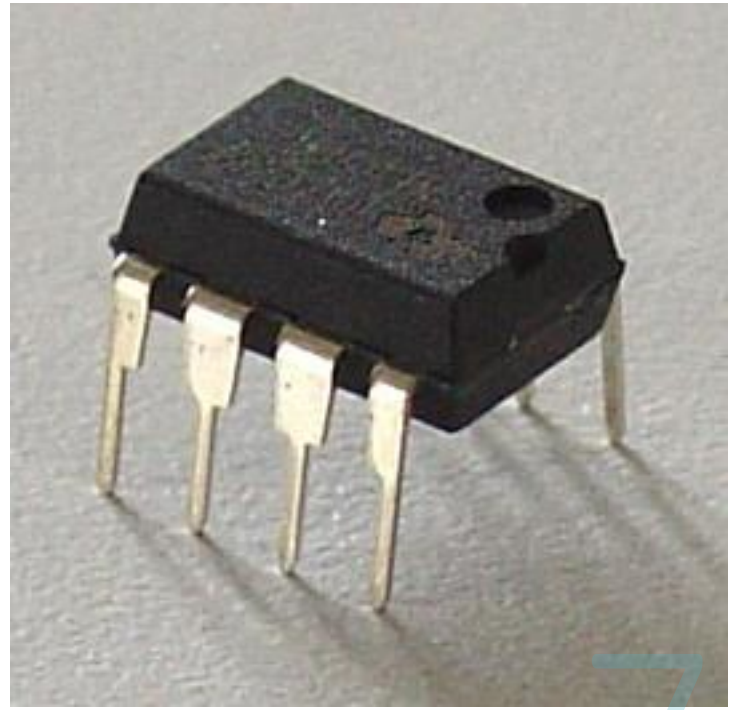
A Brief History

- Another example – Time Bomb Beep Generator

A Brief History

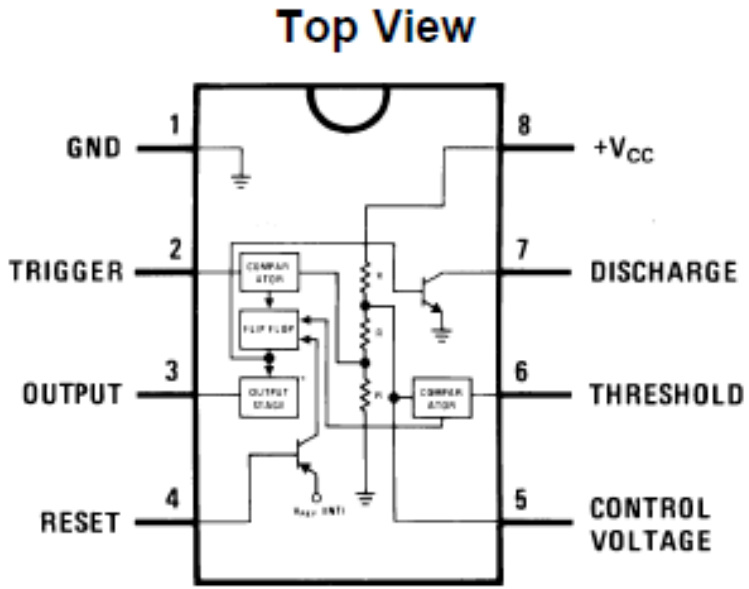
- Another example – Time Bomb Beep Generator
- Timer 555



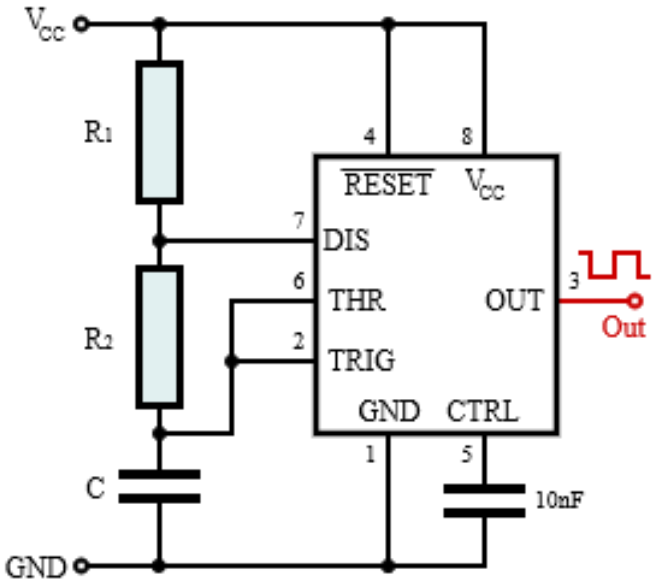


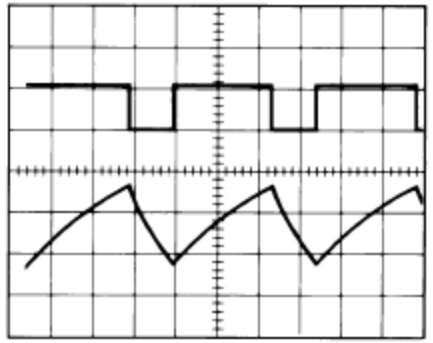
A Brief History

- Another example – Time Bomb Beep Generator
- Timer 555



ASTABLE OPERATION



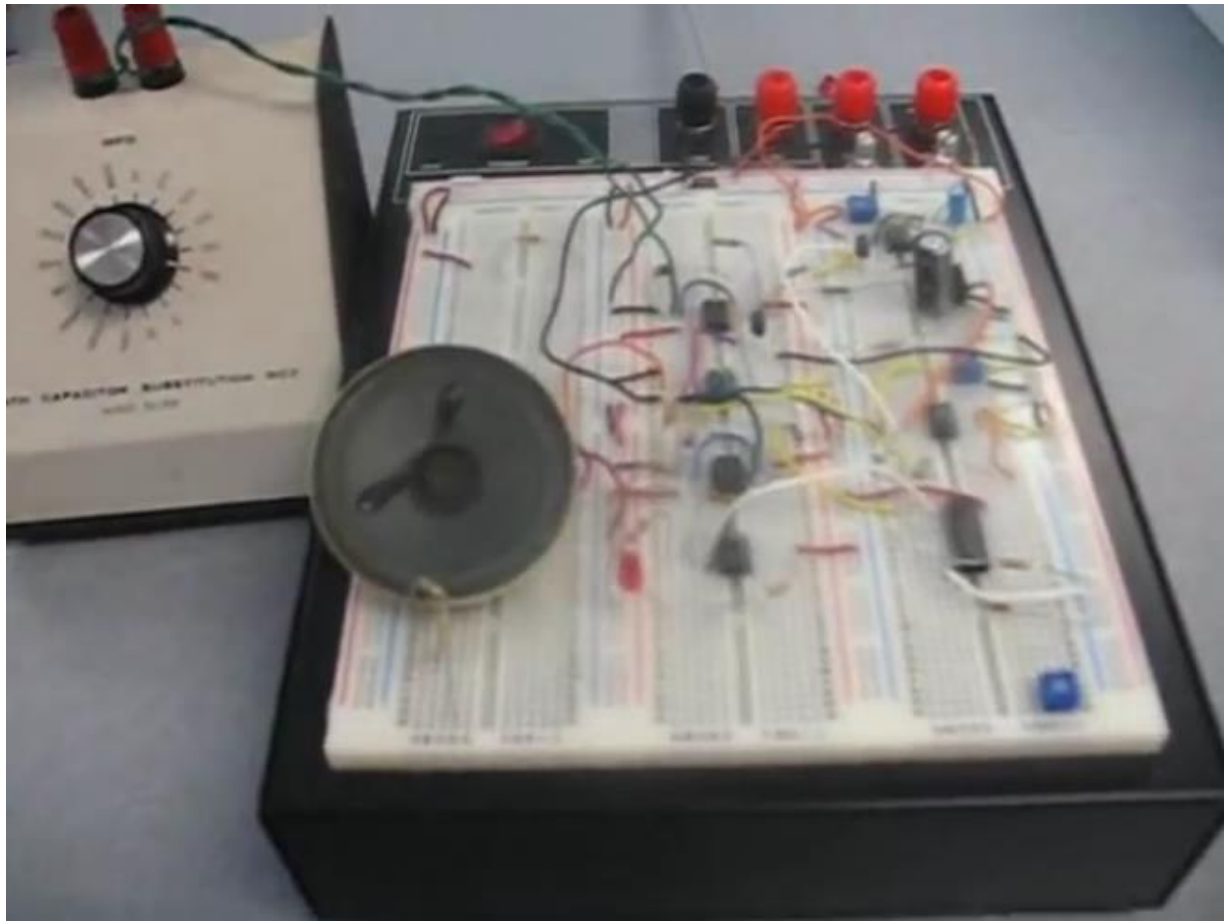


V_{CC} = 5V
TIME = 20µs/DIV.
R_A = 3.9kΩ
R_B = 3kΩ
C = 0.01µF

Top Trace: Output 5V/Div.
Bottom Trace: Capacitor Voltage 1V/Div.

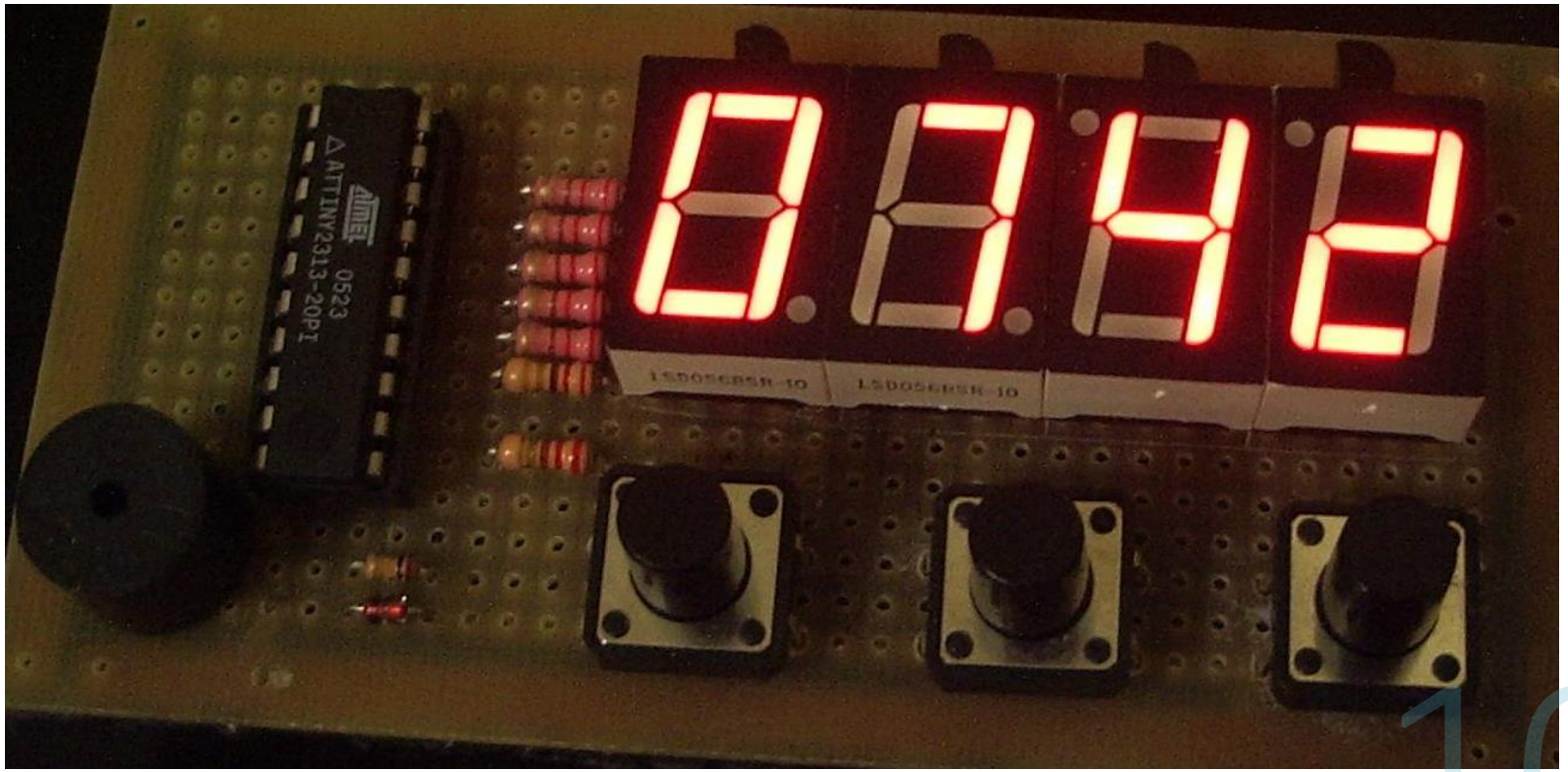
A Brief History

- Another example – Time Bomb Beep Generator
- Timer 555
- **Video** *555-Beep-Timer.mp4*



A Brief History

- Another example – Time Bomb Beep Generator
- Timer 555
- µc **AVR**



Why Microcontrollers?

- Why Should You Learn About Microcontrollers? → **Because they are fun!**
- The value of microcontrollers

They allow you to extend the benefits of computing into the **real world**

- Desktop Computers (PCs, Macs) **v.s.** Microcontrollers

❑ The desktop computer is essentially a **resource-rich computer** for **reliably processing** and **storing information** in a **networked world**.

❑ But, Do you want to be notified when your freezer fails?

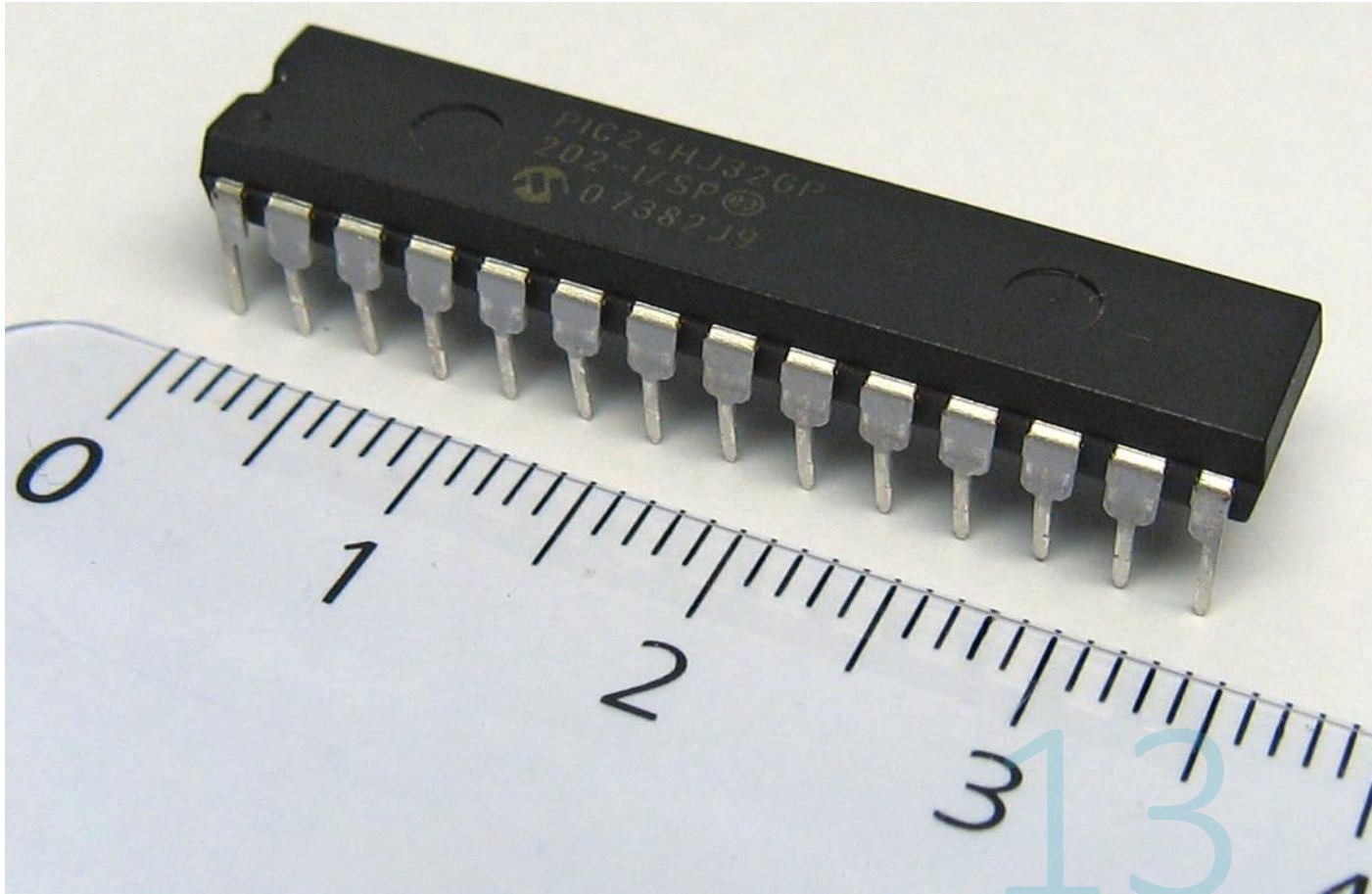
Why Microcontrollers?

- Desktop
  - General-purpose big-world stuff, Internet, e-mail, downloading and playing video, …
  - It has standard USB and serial ports can be used to talk to external microcontroller systems

- Microcontroller
  - Single-purpose stand-alone computer
  - It performs a particular small-world task, like controlling some lights, measuring the temperature, …
  - A microcontroller system doesn't have to be connected to a desktop machine
  - It can happily work as a complete single-purpose, simple, but still intelligent, stand-alone computer

Microcontrollers

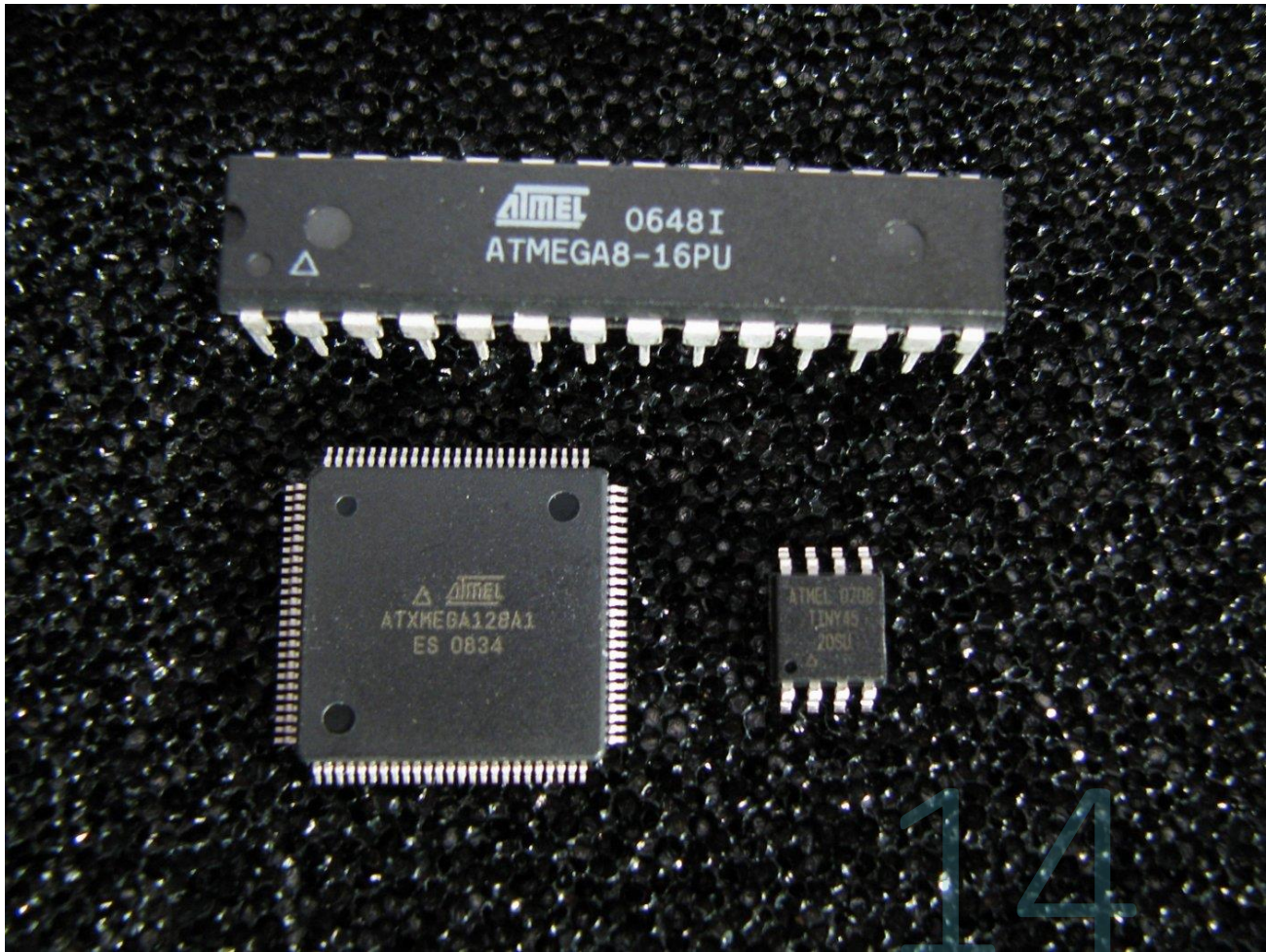
PIC (programmable Intelligent Computer)



Microcontrollers

PIC (programmable Intelligent Computer)

Atmel AVR Microcontroller



Microcontrollers

PIC (programmable Intelligent Computer)

Atmel AVR Microcontroller

ARM

Microcontrollers

PIC (programmable Intelligent Computer)

Atmel AVR Microcontroller

ARM

Why AVR?

- It is fast
- It is well designed (RISC)
- It is easy to use
- It is well supported
- It is cheap to buy
- Your Lab has only AVR!

AVR Primary Characteristics

Code compatibility between AVR micros (Same RISC processor core)

Chip diversity in AVR micro families

- Same core
- Different peripherals (ports, timers, amount of flash, RAM memory)
- Allows the designer to find the right trade-off between features and cost

It is Fast running almost each instructions is one cycle (RISC)

Open-Source Hardware

Why open source software?

Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design.

Video *What Is Open Source Hardware.flv*

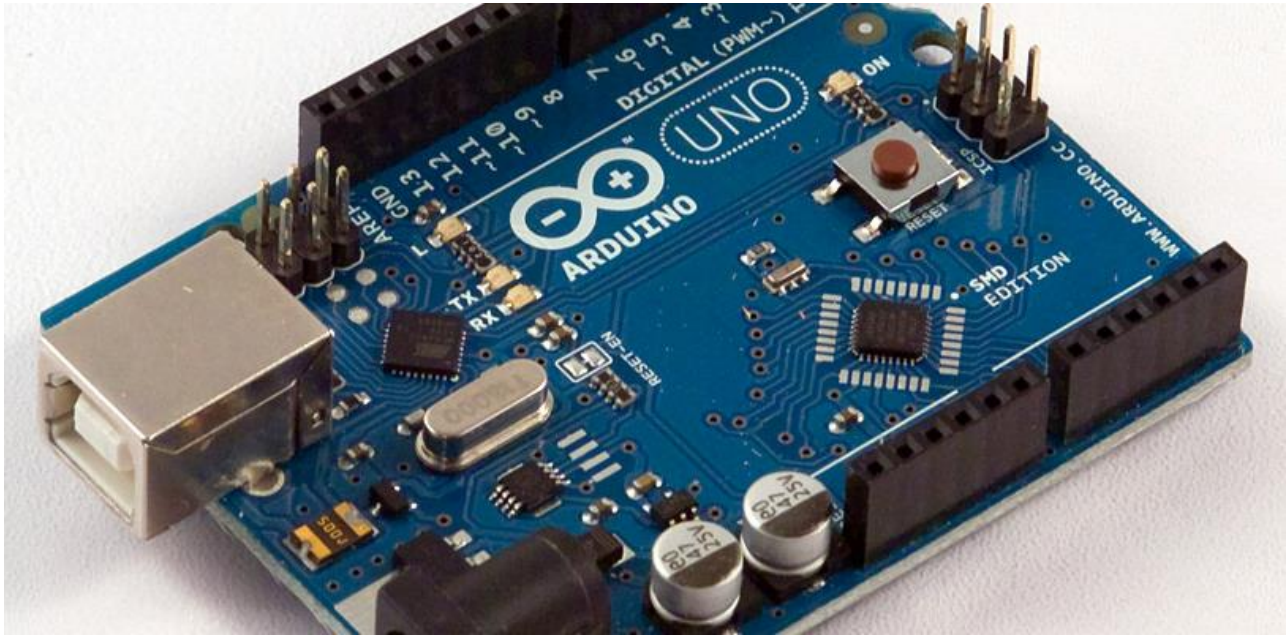
Single Boards for microcontrollers

Arduino

Netduino

Picuino

Raspberry Pi



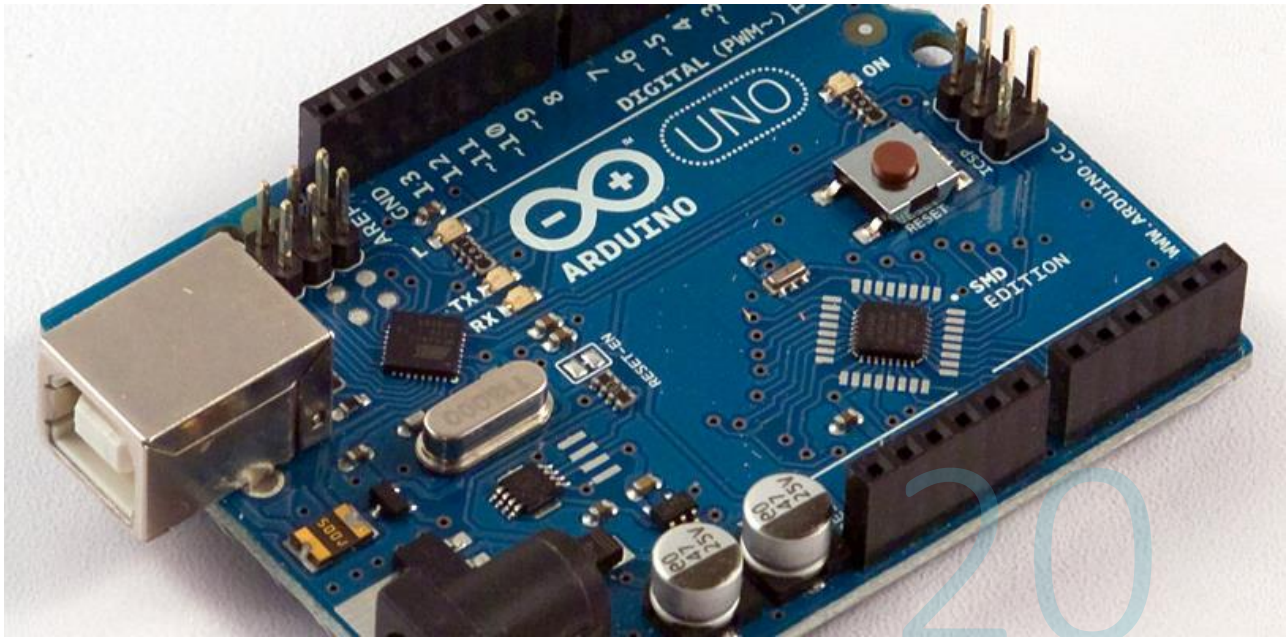
Single Boards for microcontrollers

Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for **anyone** making interactive projects.

Netduino

Picuino



Single Boards for microcontrollers

Raspberry Pi

The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video.

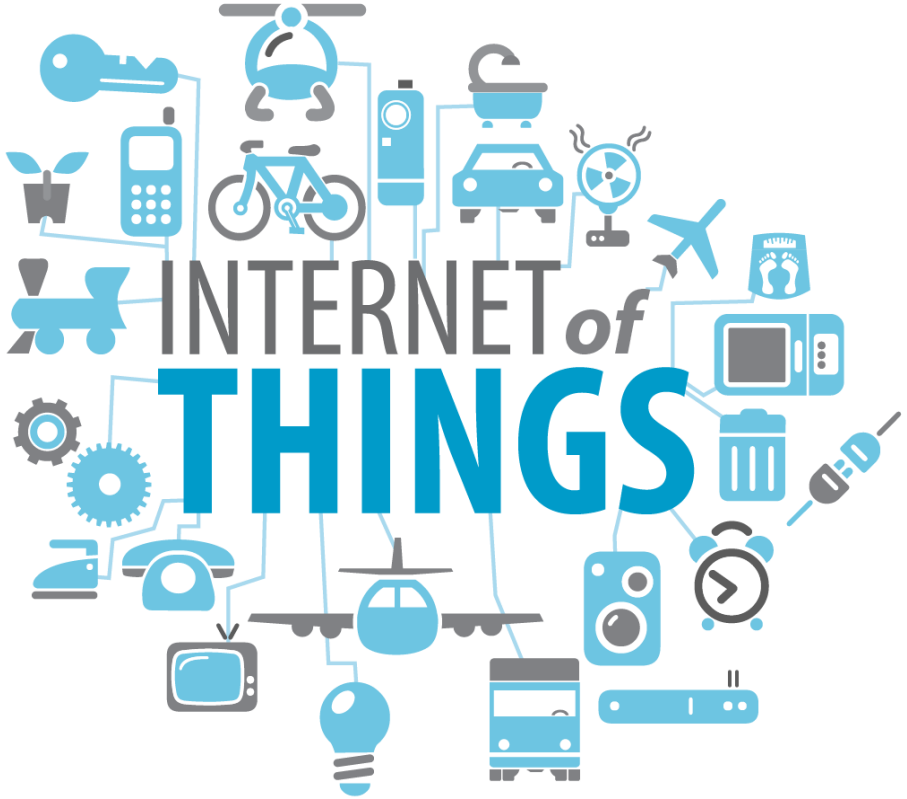
Video *The making of Raspberry Pi - CNET.flv*

Video *Comparing-the-Arduino-and-Raspberry-Pi.mp4*

Internet of Things!

The **Internet of Things** (**IoT**) refers to the interconnection of **uniquely identifiable embedded computing-like devices** within the existing Internet infrastructure.

Video What-is-The-Internet-of-Things.mp4

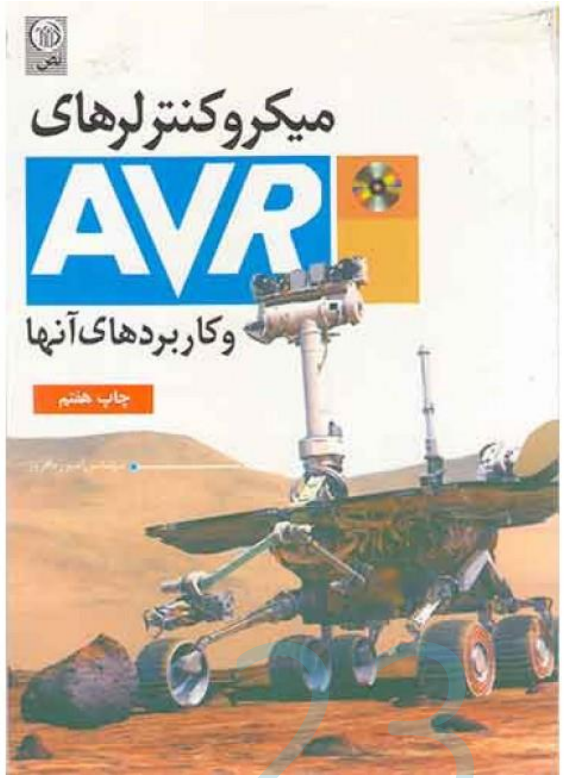


Course

Course Text Book

میکرو کنترلرهای AVR و کاربردهای آن ها، مهندس امیر ره‌افروز، انتشارات نص

Some Other texts! (Uploaded in Class Page)



Course page:

http://www.znu.ac.ir/members/gtavasoli/

Quiz: 20% - 30% (It is not fixed!)

Midterm Exam: 30 % - 40 % (It is not fixed!)

Final Exam: 40 % (It is not fixed!)