

An introduction to Microcontrollers

What is a microcontroller?

- A microcontroller is an integrated circuit that is programmed to do a specific task.
- Microcontrollers are really just “mini-computers”.

Where do you find them?

- Microcontrollers are hidden in tons of appliances, gadgets, and other electronics.



- They're everywhere!

History of Microcontrollers

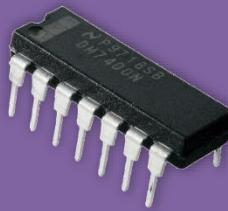


Vacuum Tube
1939

Transistor
1947



Logic Gate
1960

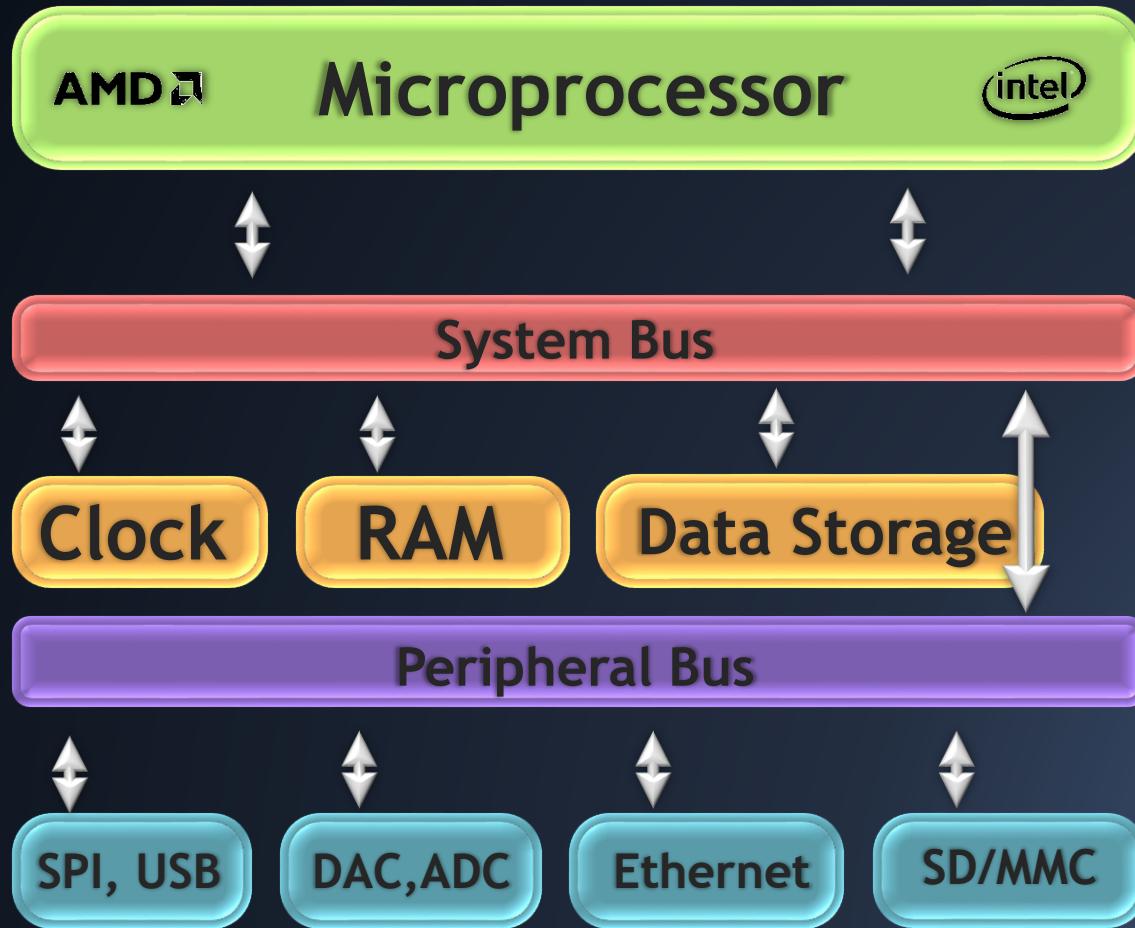


Microcontroller
1971

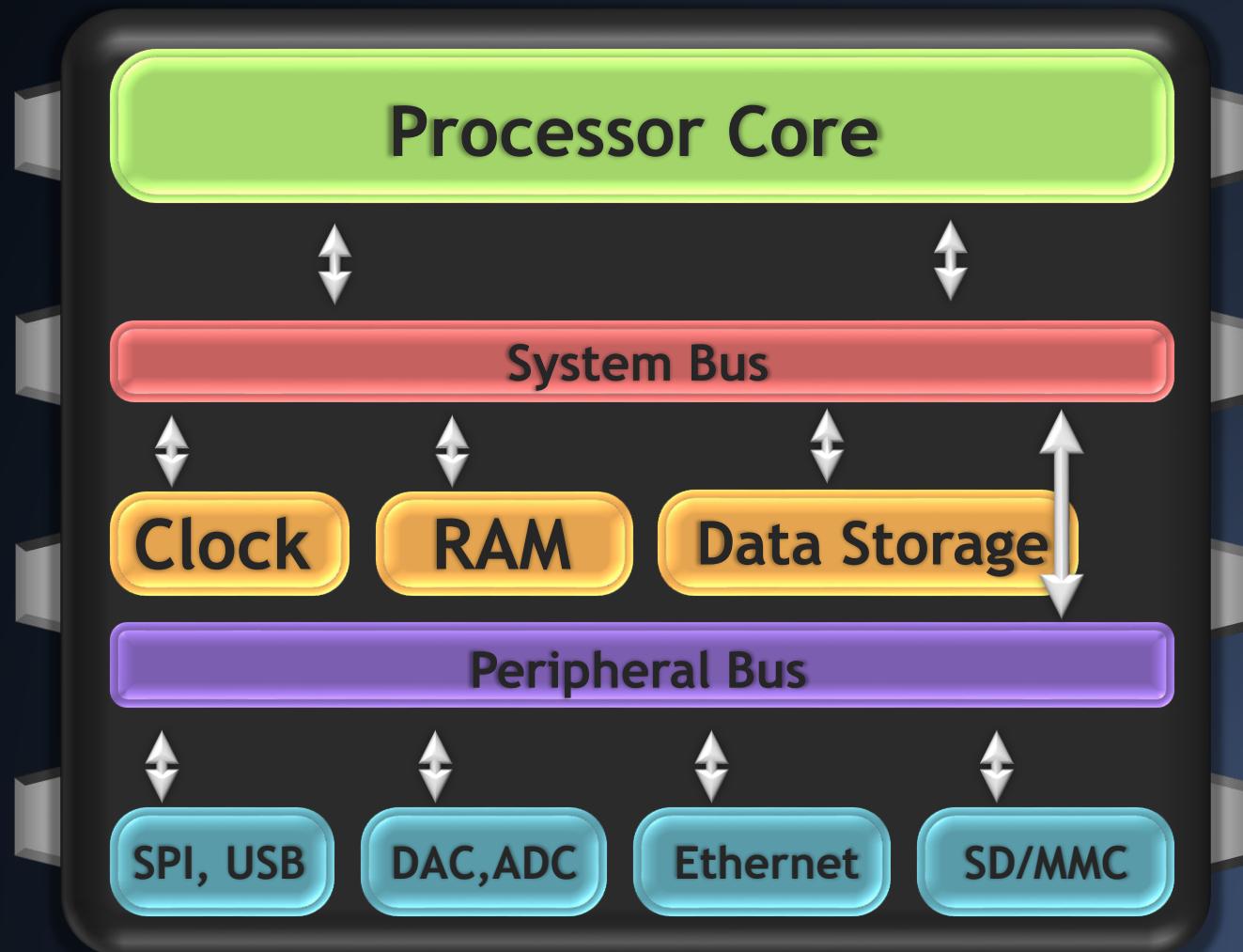


	Microprocessor	Microcontroller
Applications	General computing (i.e. Laptops, tablets)	Appliances, specialized devices
Speed	Very fast	Relatively slow
External Parts	Many	Few
Cost	High	Low
Energy Use	Medium to high	Very low to low
Vendors	  	   

Microprocessor



Microcontroller



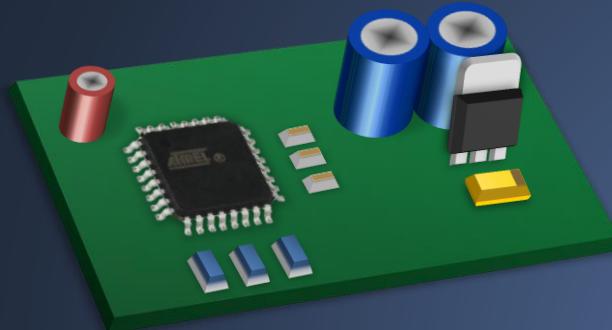
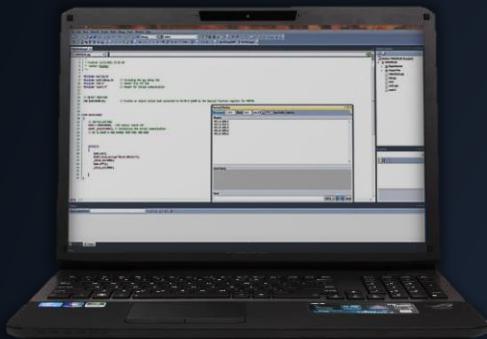
Basic Principles of Operation

- Microcontrollers are used for specific applications.
- They do not need to be powerful because most applications only require a clock of a few MHz and small amount of storage.
- A microcontroller needs to be programmed to be useful.
- A microcontroller is only as useful as the code written for it. If you wanted to turn on a red light when a temperature reached a certain point, the programmer would have to explicitly specify how that will happen through his code.

Microcontroller Programming

- 1.) Code is written for the microcontroller in an integrated development environment, a PC program. The code is written in a programming language. (e.g. C, BASIC or Assembly).
- 2.) The IDE debugs the code for errors, and then compiles it into binary code which the microcontroller can execute.
- 3.) A programmer (a piece of hardware, not a person) is used to transfer the code from the PC to the microcontroller. The most common type of programmer is an ICSP (In-circuit serial programmer).

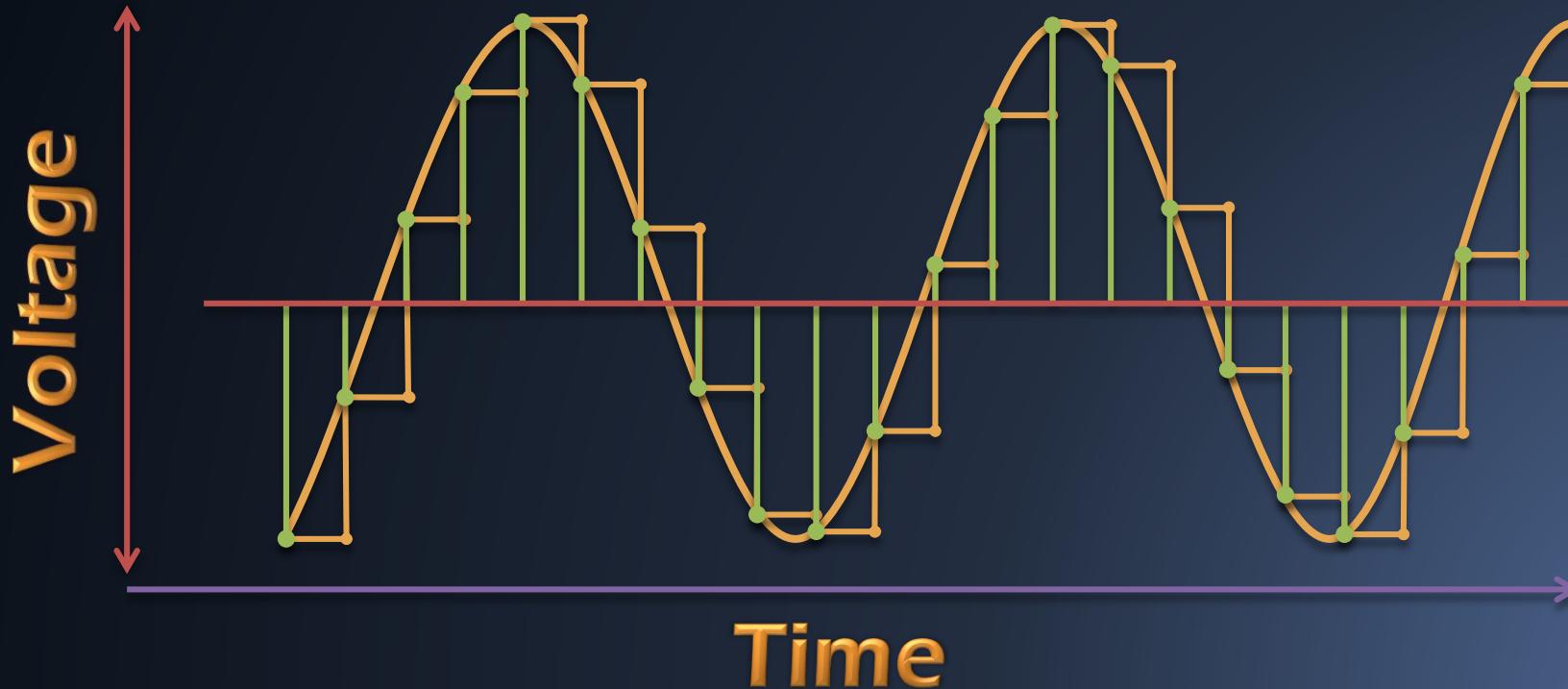
Microcontroller Programming



The Analog to Digital Converter (ADC)

- Just about every modern microcontroller contains an ADC(s).
- It converts analog voltages into digital values.
- These digital representations of the signal at hand can be analyzed in code, logged in memory, or used in practically any other way possible.

The Analog to Digital Converter (ADC)



The Analog to Digital Converter (ADC)

PTC Specifications:

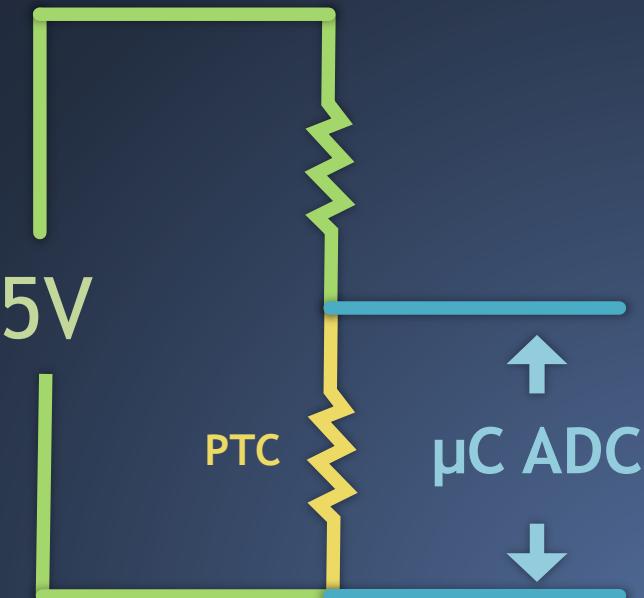
100Ω @ 25°C
+ 1Ω/ 1°C

(ex. @ 26°C, R = 101Ω
24°C, R = 99Ω

code

```
Void Loop ()  
  
voltage25C = 512  
voltageADC = ADC.input(pin1)  
  
ratio = voltageADC / voltage25C  
temperature = ratio * 25
```

A 10-bit ADC will represent a voltage between 0 to 5 as a number between 0 to 1024.



The Digital to Analog Converter (DAC)

- You guessed it! Microcontrollers have accompanying DACs.
- It does exactly the opposite function of an ADC. It takes a digital value and converts it into an pseudo-analog voltage.
- It can be used to do an enormous amount of things. One example is to synthesize a waveform. We can create an audio signal from a microcontroller. Imagine that!

Microcontroller Applications

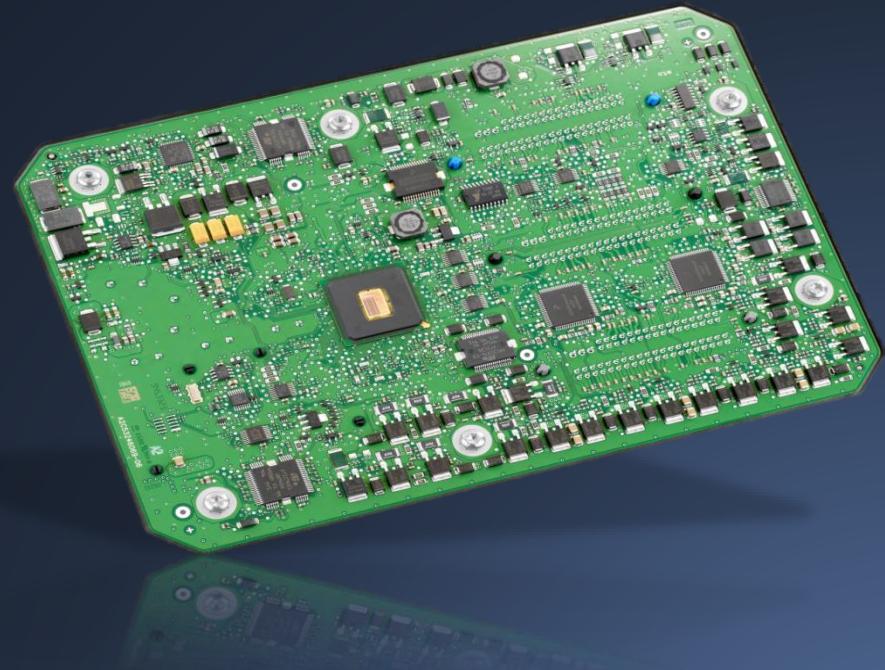
- This is the controller board for a washing machine. If a button is pushed or if a knob is turned, the microcontroller knows how to react to the event.

- Ex. If “start” is pushed, the microcontroller knows to switch a relay which starts the motor.



Microcontroller Applications

- This is the main controller from a Buick Regal. This board has several microcontrollers each for a specific task.
- Ex. A microcontroller may handle dashboard controls or it may even control something more complex like the ignition system.



Microcontroller Applications

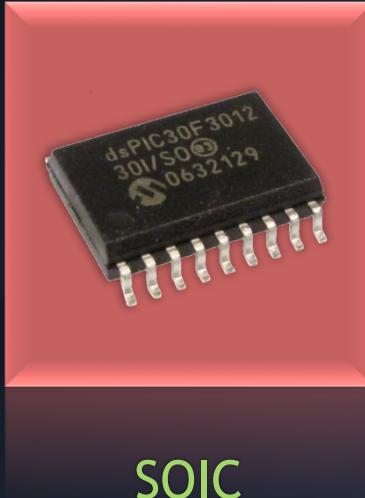
- Many robots use microcontrollers to allow robots to interact with the real world.
- Ex. If a proximity sensor senses an object near by, the microcontroller will know to stop its motors and then find an unobstructed path.



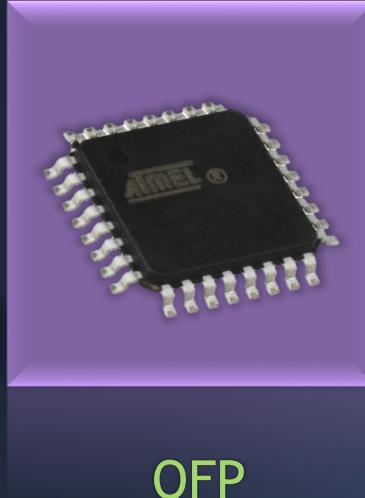
Microcontroller Packaging



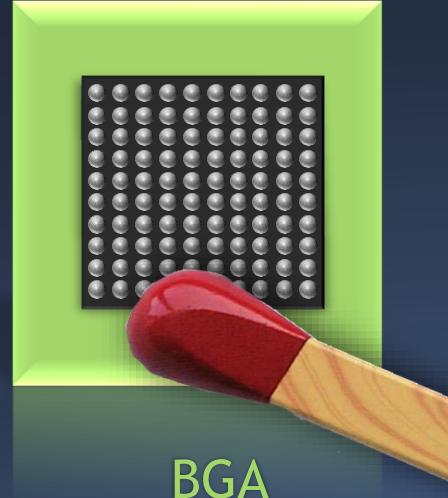
DIP
(Dual In-line Package)
Through hole
8 pins
9mm x 6mm
0.15pins/mm²



SOIC
(Small Outline IC)
Surface Mount
18 pins
11mm x 7mm
0.23pins/mm²



QFP
(Quad Flat Package)
Surface Mount
32 pins
7mm x 7mm
0.65pins/mm²



BGA
(Ball Grid Array)
Surface Mount
100 pins
6mm x 6mm
2.78pins/mm²

How can I get started?

- If you want to develop for microcontrollers, you can purchase a development board which includes a microcontroller and all of the necessary parts to get it working. (i.e. power supply and a USB interface)



Thank you

