

EE 49

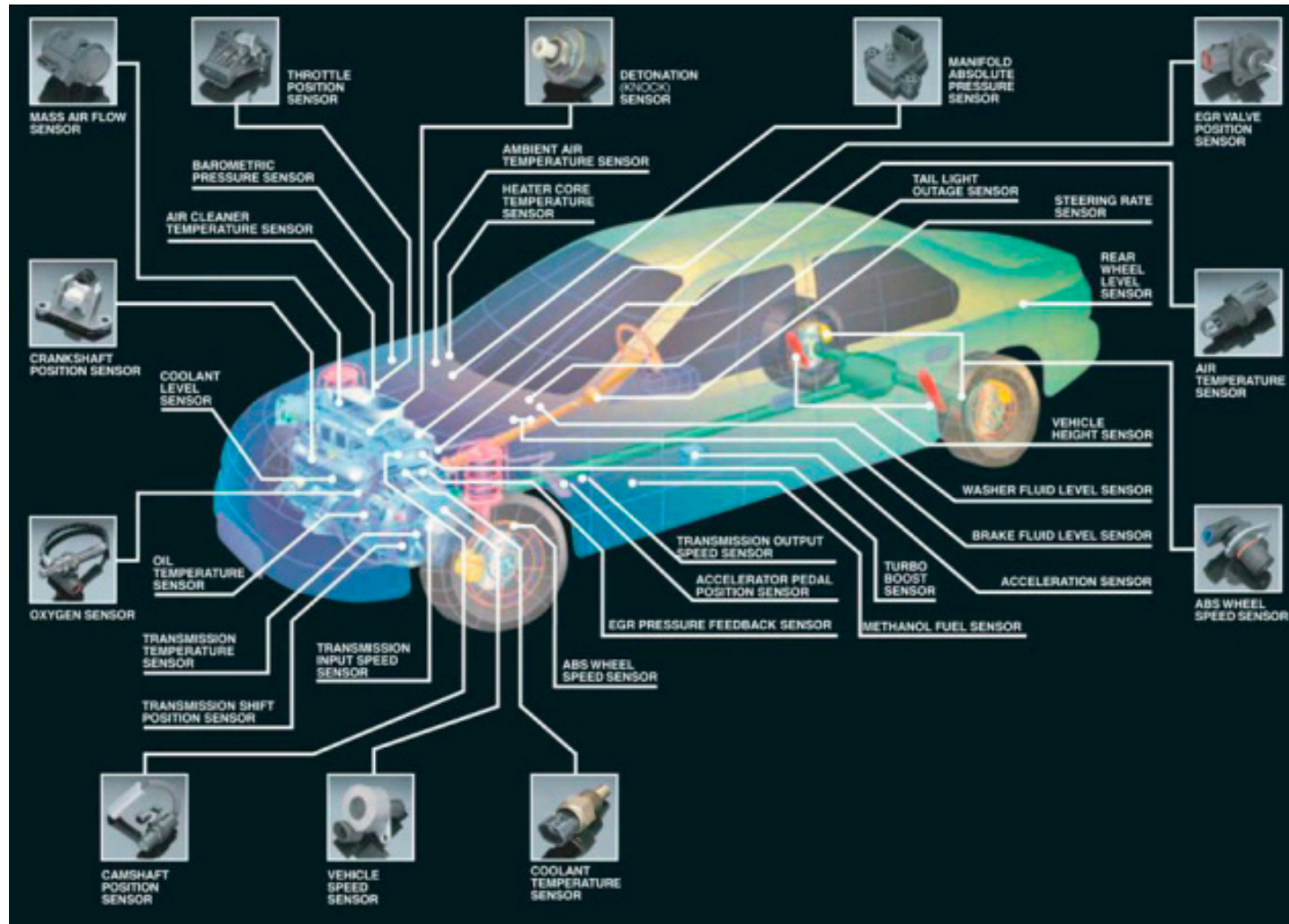
Electronics for IoT

Microcontroller Unit

Computer

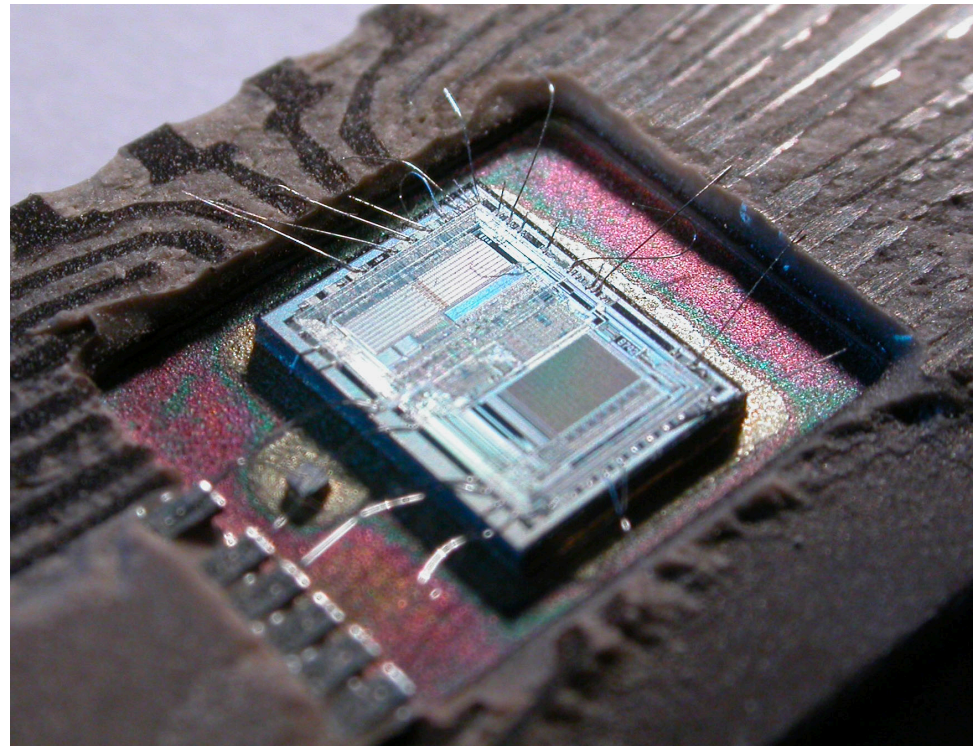
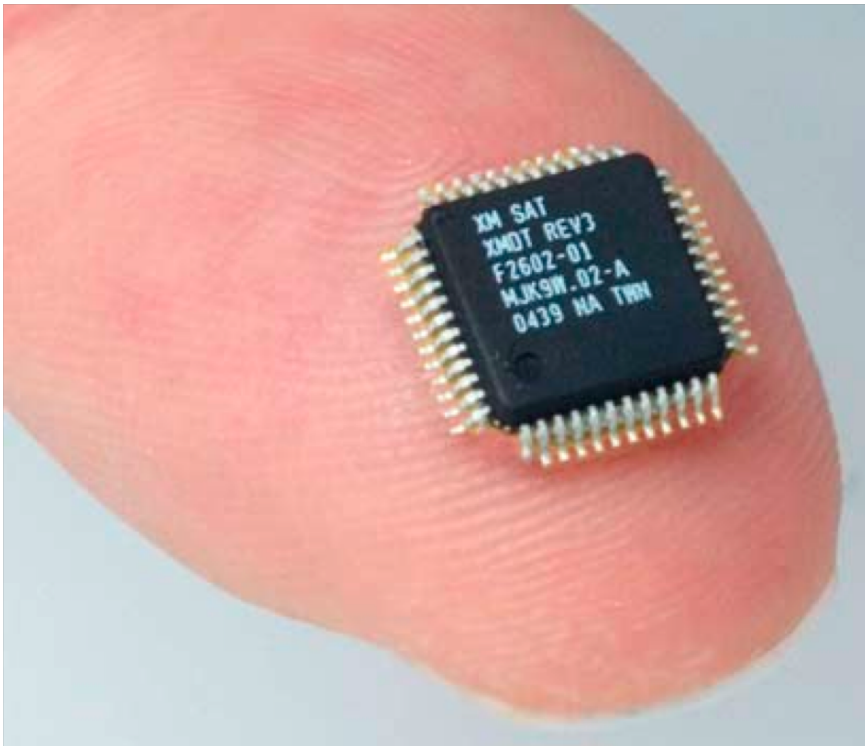


More Computers

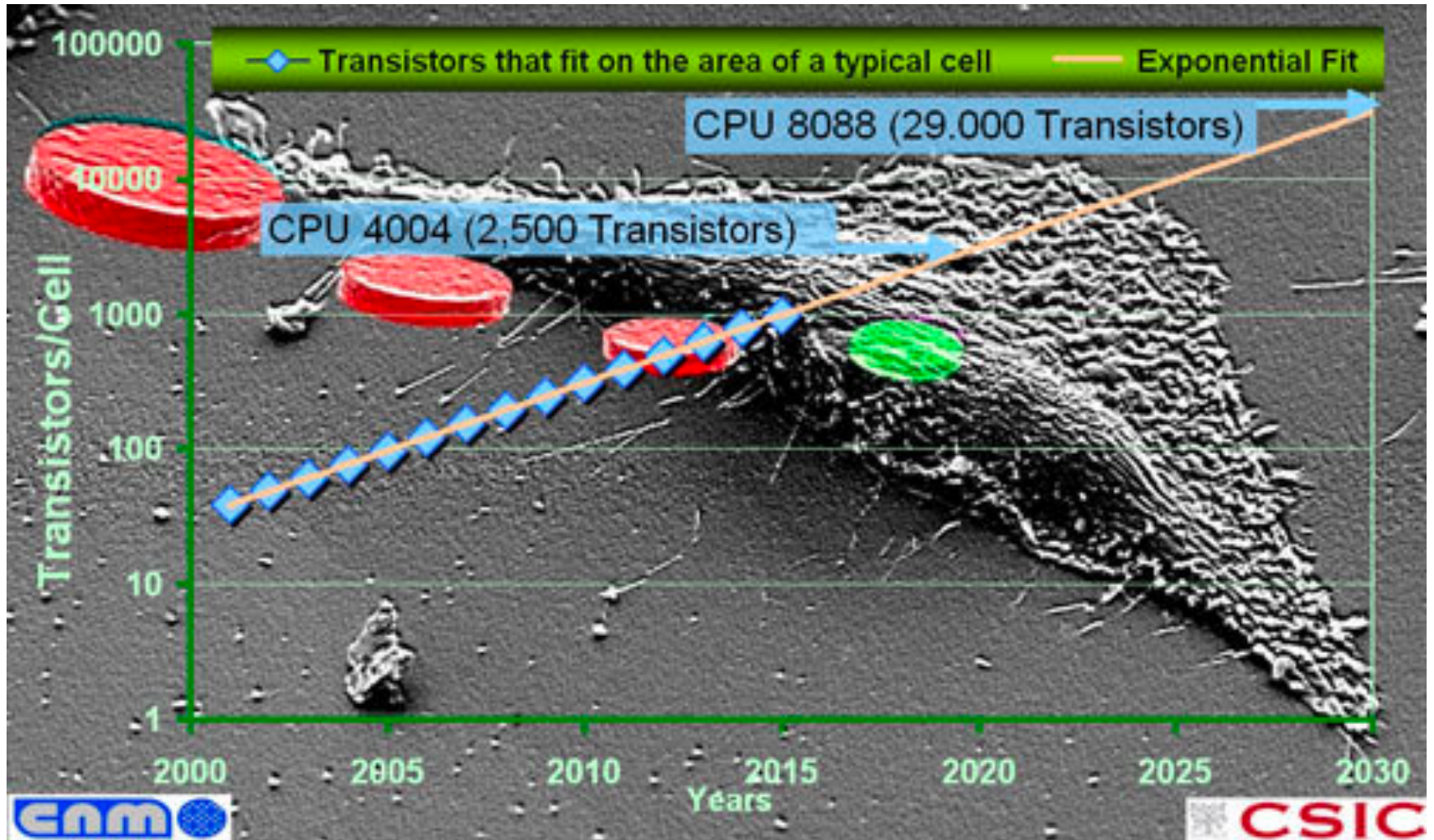


Microcontroller

A complete computer on a “chip”!



Transistor

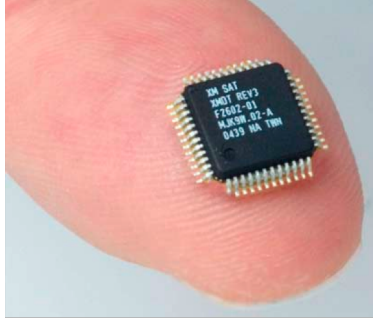


Microcontroller Blockdiagram

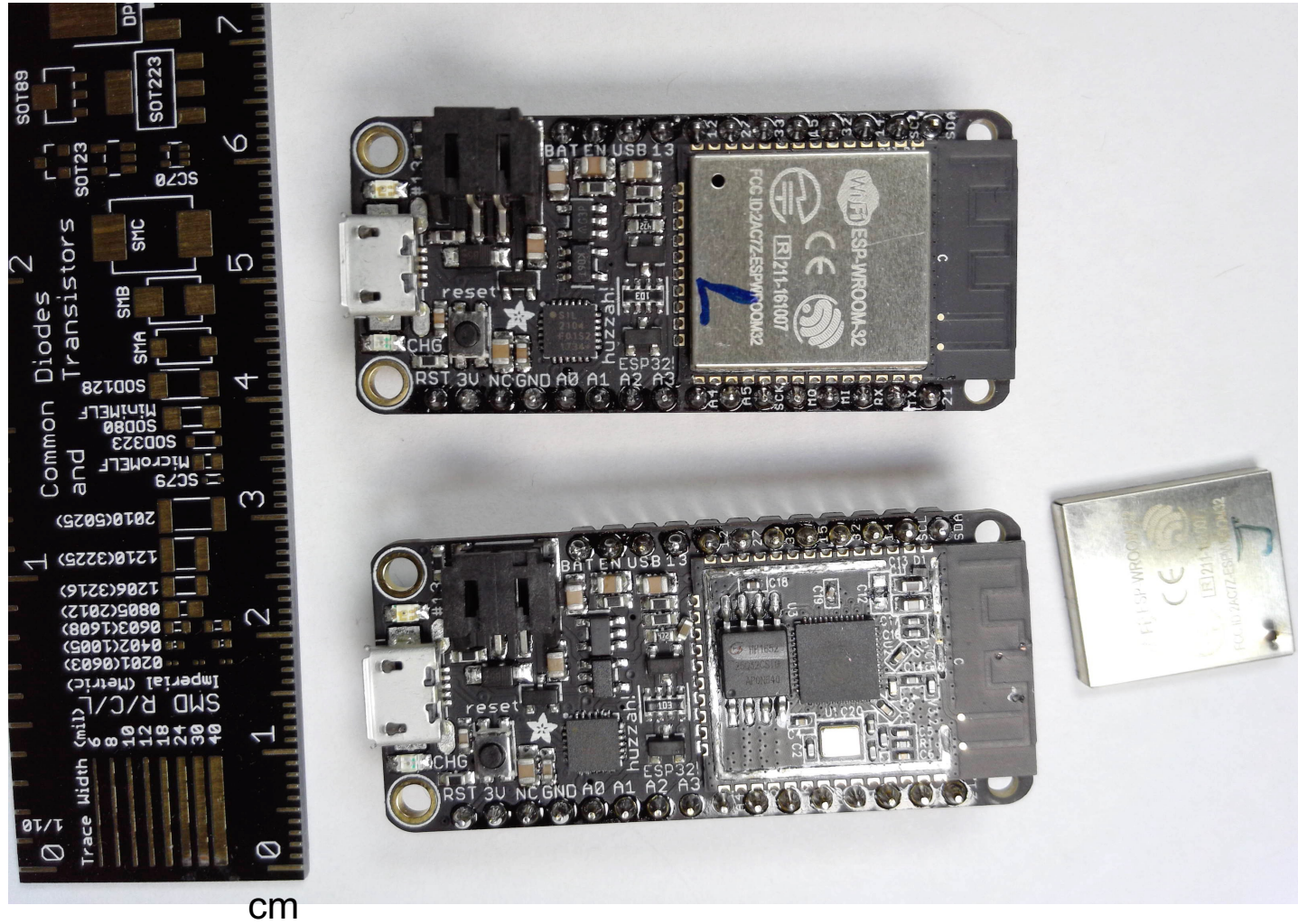
MCU

- Microcontroller Unit consists of
 - Datapath (compute)
 - Memory
 - IO

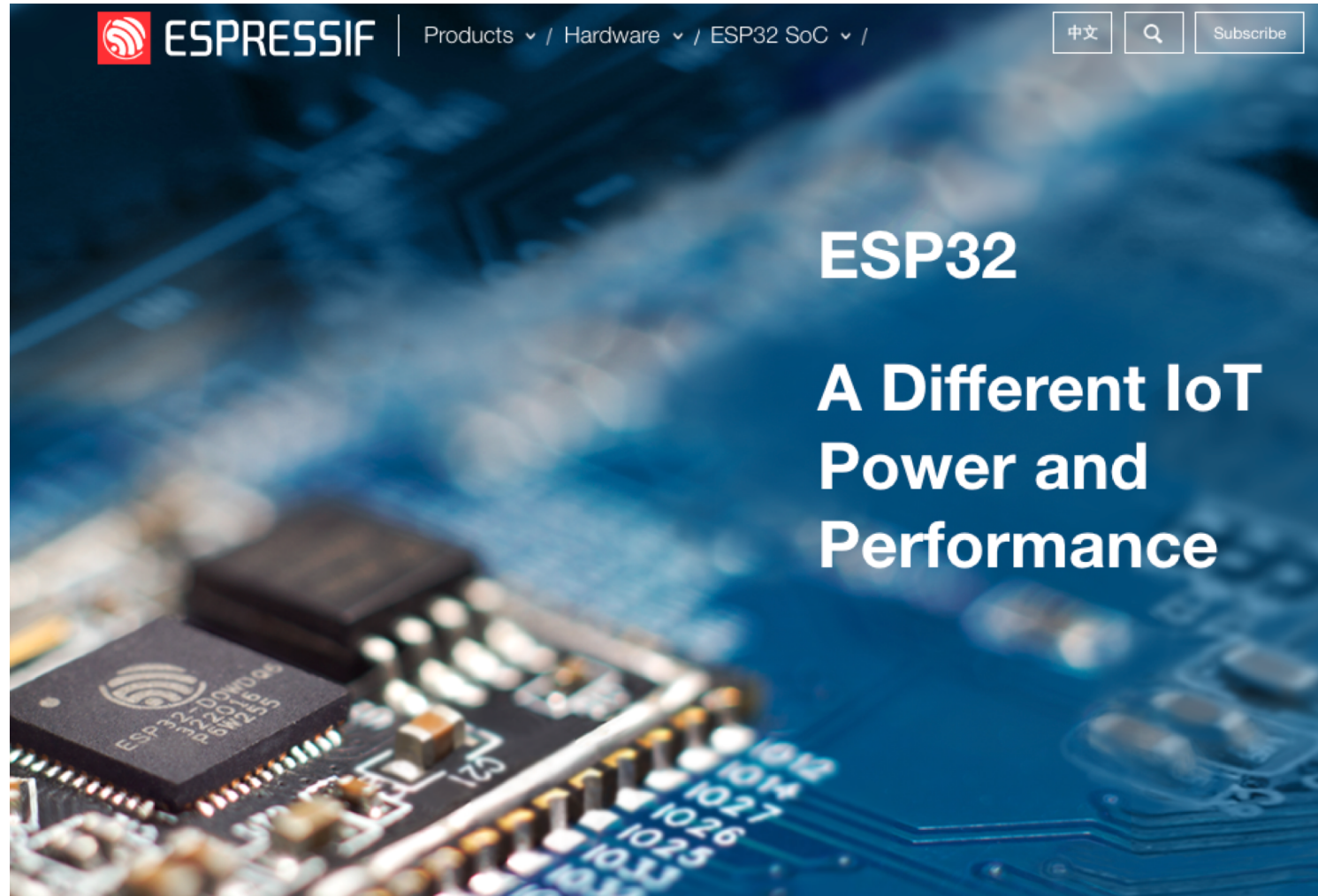
- MCU



EE49 MCU



Espressif – ESP32



ESP32 Datasheet

1 Overview

- 1.1 Featured Solutions
 - 1.1.1 Ultra-Low-Power Solution
 - 1.1.2 Complete Integration Solution
- 1.2 Wi-Fi Key Features
- 1.3 BT Key Features
- 1.4 MCU and Advanced Features
 - 1.4.1 CPU and Memory
 - 1.4.2 Clocks and Timers
 - 1.4.3 Advanced Peripheral Interfaces
 - 1.4.4 Security
- 1.5 Applications (A Non-exhaustive List)
- 1.6 Block Diagram

2 Pin Definitions

- 2.1 Pin Layout
- 2.2 Pin Description
- 2.3 Power Scheme
- 2.4 Strapping Pins

3 Functional Description

- 3.1 CPU and Memory
 - 3.1.1 CPU
 - 3.1.2 Internal Memory
 - 3.1.3 External Flash and SRAM
 - 3.1.4 Memory Map
- 3.2 Timers and Watchdogs
 - 3.2.1 64-bit Timers
 - 3.2.2 Watchdog Timers
- 3.3 System Clocks
 - 3.3.1 CPU Clock
 - 3.3.2 RTC Clock
 - 3.3.3 Audio PLL Clock
- 3.4 Radio
 - 3.4.1 2.4 GHz Receiver
 - 3.4.2 2.4 GHz Transmitter
 - 3.4.3 Clock Generator
- 3.5 Wi-Fi
 - 3.5.1 Wi-Fi Radio and Baseband
 - 3.5.2 Wi-Fi MAC
- 3.6 Bluetooth
 - 3.6.1 Bluetooth Radio and Baseband
 - 3.6.2 Bluetooth Interface
 - 3.6.3 Bluetooth Stack

- 3.6.4 Bluetooth Link Controller
- 3.7 RTC and Low-Power Management

4 Peripherals and Sensors

- 4.1 Descriptions of Peripherals and Sensors
 - 4.1.1 General Purpose Input / Output Interface (GPIO)
 - 4.1.2 Analog-to-Digital Converter (ADC)
 - 4.1.3 Hall Sensor
 - 4.1.4 Digital-to-Analog Converter (DAC)
 - 4.1.5 Touch Sensor
 - 4.1.6 Ultra-Lower-Power Co-processor
 - 4.1.7 Ethernet MAC Interface
 - 4.1.8 SD/SDIO/MMC Host Controller
 - 4.1.9 SDIO/SPI Slave Controller
 - 4.1.10 Universal Asynchronous Receiver Transmitter (UART)
 - 4.1.11 I²C Interface
 - 4.1.12 I²S Interface
 - 4.1.13 Infrared Remote Controller
 - 4.1.14 Pulse Counter
 - 4.1.15 Pulse Width Modulation (PWM)
 - 4.1.16 LED PWM
 - 4.1.17 Serial Peripheral Interface (SPI)
 - 4.1.18 Accelerator
- 4.2 Peripheral Pin Configurations

5 Electrical Characteristics

- 5.1 Absolute Maximum Ratings
- 5.2 Recommended Operating Conditions
- 5.3 DC Characteristics (3.3 V, 25 °C)
- 5.4 Reliability Qualifications
- 5.5 RF Power-Consumption Specifications
- 5.6 Wi-Fi Radio
 - 5.6.1 Bluetooth Radio
 - 5.7.1 Receiver – Basic Data Rate
 - 5.7.2 Transmitter – Basic Data Rate
 - 5.7.3 Receiver – Enhanced Data Rate
 - 5.7.4 Transmitter – Enhanced Data Rate
- 5.8 Bluetooth LE Radio
 - 5.8.1 Receiver
 - 5.8.2 Transmitter

6 Package Information

7 Part Number and Ordering Information

8 Learning Resources

- 8.1 Must-Read Documents

Memory

**Random Access Memory
(RAM)**

Flash Memory

Bit

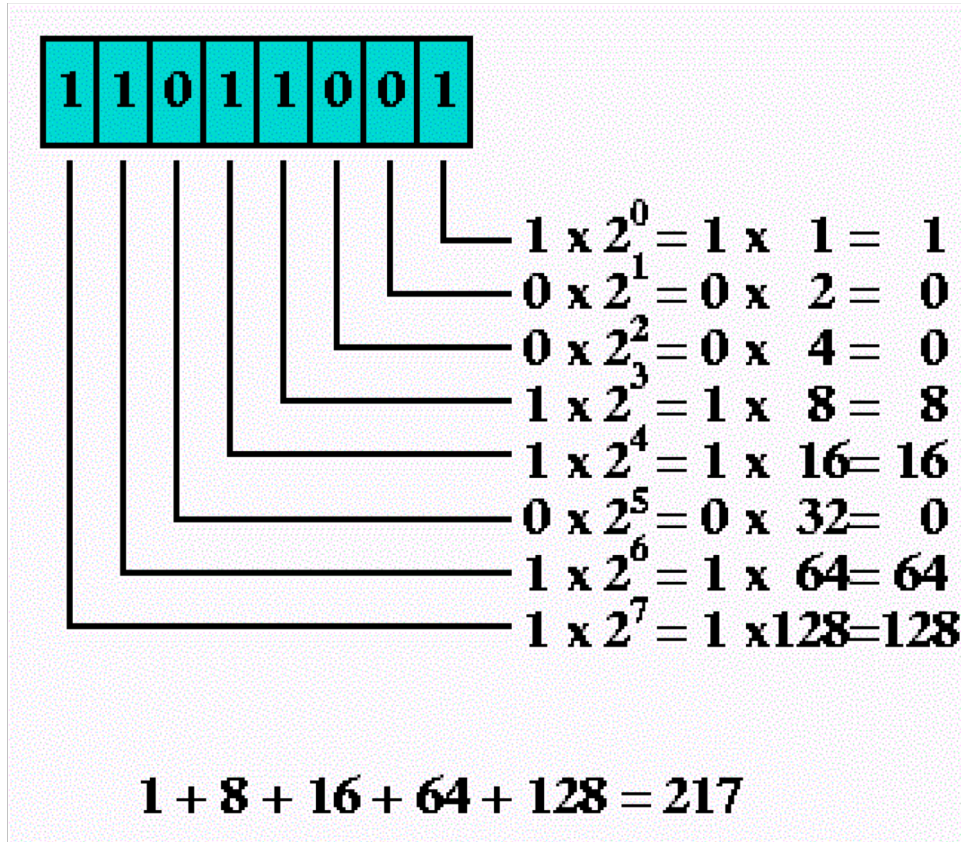
Binary Number

Byte, Word

Binary vs Decimal

Decimal Number	Binary Number
0	0
1	1
$2=2^1$	10
3	11
$4=2^2$	100
5	101
6	110
7	111
$8=2^3$	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
$16=2^4$	10000
17	10001
18	10010
19	10011
20	10100
21	10101
22	10110
23	10111
24	11000
25	11011
26	11100
27	11011
28	11100
29	11101
30	11110
31	11111
$32=2^5$	100000

Conversion



https://www.tutorialspoint.com/computer_fundamentals/computer_number_conversion.htm

Hexadecimal

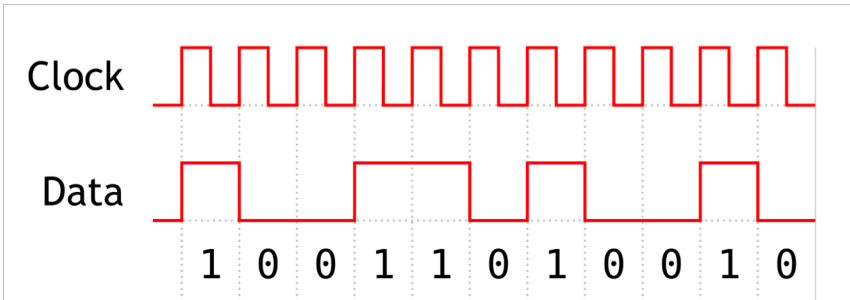
$$890234_{10} = 11011001010101111010_2$$

Decimal	Hexadecimal	Binary
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

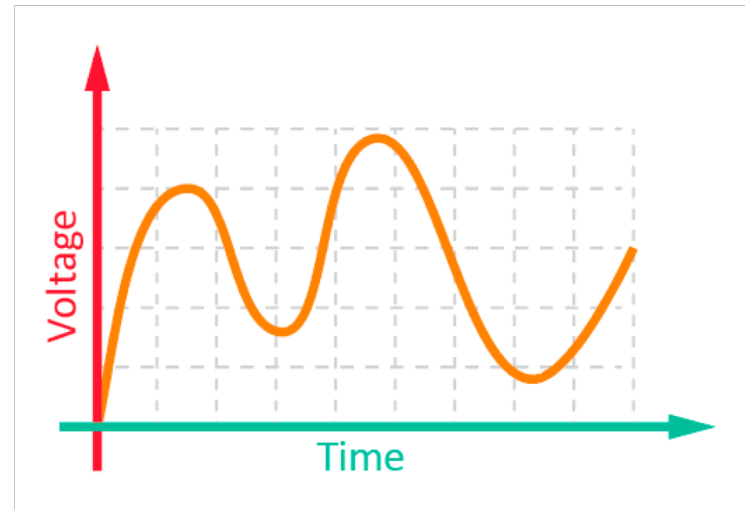
Volts and Bits

Digital versus Analog

Digital Signal



Analog Signal



Programming

MicroPython

- Python 3.4 syntax
- Same “core” libraries (e.g. math functions)
- Different specialty libraries
 - Talk to sensors
 - No functions for graphical user interface

Programming Setup

