

# Microcontrollers: History, Market, Programming and Fun

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- [History of transistors per chip](#) (2024, Nvidia GPU, 208 billion transistors)
- Terminology: [Microcontroller](#), [Single-Board Microcontroller](#), [Single-Board Computer](#)
- [Global Market](#) (2023, \$32 billion, ~25% Consumer/Telecom)
- [The Future of Hobby Electronics](#) (IoT, 3D Printing, Maker Movement, Physical Computing)
- [Raspberry Pi](#) -- [Home](#), [Hardware Series](#), [Hardware](#), [HATs & Bonnets](#), [Software](#) (+ many(!) apps)
- [Arduino](#) -- [Home](#), [Hardware](#), [Shields](#) (software below)
- [Adafruit](#) -- [Home](#), [Hardware](#) (software below)
- [Many other manufacturers](#)
- Where to start learning? My answer...
- [Adafruit Circuit Playground Express](#) (2016 intro, \$25, lots on 1 board, multi-language, good support)
  - Inputs: light, color, sound, temperature, motion, orientation, touch, infrared, buttons, switch, external analog/digital.
  - Outputs: 10 multi-color NeoPixel LEDs, sound, infrared, external analog/digital.
  - One-cable USB for power and programming, 3xAAA batteries for standalone.
  - [Microchip/Atmel ATSAM21G18 ARM Cortex M0](#) microcontroller: 48 MHz, 256KB Flash, 32KB RAM, 48 pins, 0.3" square, [block diagram](#) ([USB](#), [PWM](#), [USART](#), [I<sup>2</sup>C](#), [SPI](#), [LIN](#), [A/D](#), [D/A](#)...)
  - [Example Projects](#) and [Base Kit](#) that I purchased.
- **Programming and Integrated Development Environments (IDEs)**
  - [MS MakeCode for Adafruit](#) (demo, [JavaScript](#), used with two 9 year old grandchildren)
  - [Mu Python Editor](#) and [CircuitPython](#) (demo)
  - [Arduino IDE](#) (demo, [C](#) and [C++](#), compiled, fast, more complicated)
- Other Adafruit devices I have and can help with:
  - [Circuit Playground Bluefruit](#) (2019, Bluetooth, bigger/faster, less support)
    - [TFT Gizmo Display](#) (Thin Film Transistor, color, 240x240 pixels)
  - [Gemma M0 Microcontroller](#) (\$10!)
  - [Raspberry Pi 4](#) ([Vilros Starter Kit](#) I purchased, Pi 5 is newer / faster / more \$)
  - [30-NeoPixel Strip](#) (3 wires, Gnd/Vcc/Serial, 8 bits each red/green/blue per pixel)
  - [4x7-Segment Display](#) (4 wires, I<sup>2</sup>C interface)
  - [4x14-Segment Display](#) (4 wires, I<sup>2</sup>C interface)
  - [8x8 Bi-Color Matrix Display](#) (4 wires, I<sup>2</sup>C interface)
- Miscellany
  - 2017 IEVHFRA [Digital Electronics](#) presentation (from the SFCC class I teach)
  - [Heathkit ET-3400 Microprocessor Trainer on Groups.io](#) (1976, Motorola 6800, co-owner)