

Microprocessors and - controllers

- [audiobook of data sheet ATtiny212_412](#)
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- [literature explaining working with AVR](#)s
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- [download platformio for vscode](#)

MCU

An **MCU** is a group of **microcontroller units** that share a common architecture, design, and often the same core features

- **ARM Cortex-M** is a popular MCU family, where multiple manufacturers like **STMicroelectronics**, **NXP**, and **Microchip** produce MCUs that are based on the ARM Cortex-M core.
- **AVR** is another MCU family, famously used in the **Arduino** platform.
- **PIC** is a family of MCUs from **Microchip Technology**, with a range of devices from small 8-bit controllers to more powerful 16-bit and 32-bit versions.

Within each MCU family, you'll typically see models that differ by features like:

- **Flash memory size**
- **RAM size**
- **Clock speed**
- **Number of GPIO pins**
- **Peripheral support** (e.g., UART, SPI, I2C, timers, etc.)

In-System Programming (ISP)

- the act of programming a microcontroller while it is already mounted on the board
- Contrary to Pre-Programming. You program the contro

CMSIS-DAP Devices are all devices that can write programs into a microcontroller's memory using JTAG or SWD. Ier before soldering it somewhere.

Available Controllers

At least 5 of each:

- SEEDSTUDIO XIAO SAMD21 NO HDRS
- SEEDSTUDIO XIAO ESP32C3 NO HDRS
- SEEDSTUDIO XIAO ESP32S3 NO HDRS
- SEED STUDIO XIAO RP2040 ARDUINO
- ATSAM11C14A-SSUT
- ATSAM21E18A-AUT
- ATTINY412-SSFR
- ATTINY1624-SSFR
- ATTINY3226-SU
- AVR128DB32-I/PT

| | Xiao RP2040 | Pico RP2040 | ESP32 C3 | ESP32 S3 | SAMD 21 | ATSA MD11 C14A- SSUT | ATSA MD21 E18A- AUT | ATTIN Y412- SSFR | ATTIN Y1624 -SSFR | ATTIN Y3226 -SU | AVR1 28DB3 2-I/PT |
|------------------------|-------------------------------|-------------------------------|-------------------------|----------------------------|--------------------------------|--------------------------------|-------------------------------|------------------------|-------------------------|------------------------|-----------------------------|
| Type | ARM Cortex M0+ 32Bit | ARM Cortex M0+ 32Bit | ESP- RISC-V 32Bit | Xtensa ® 32- bit LX7 | ARM- Cortex M0+ 32Bit | ARM Cortex- M0+ 32Bit | ARM Cortex M0+ 32Bit | AVR® RISC 8- bit | AVR® RISC 8- bit | AVR® RISC 8- bit | AVR® RISC 8- bit |
| Frequ ncy | 133MH z | 133MH z | 160 MHz | 240 MHz | 48MHz | 48MHz | 48MHz | 20MHz | 20MHz | 20MHz | 24MHz |
| SRAM | 264KB | 264KB | 400 KB | 8MB | 32KB | 4KB | 32KB | 256B | 2KB | 3KB | 16KB |
| onboar d memor y | 2MB | 2MB | 4MB | 8MB | 256KB | 16KB | 256KB | 4KB | 16KB | 32KB | 128KB |
| I/O- Pins | 11 | 26 | 11 | 11 | 11 | 12 | 26 | 6 | 12 | 18 | 25/26 (1x only In) |
| ADC | 4 | 3 | 3 | 9 | 11 | 5 | 6 | 6 | 9 | 15 | 13 |
| DAC | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| Packag e | | | | | | SOIC- 14 | TQFP- 32 | SOIC-8 | SOIC- 14 | SOIC- 20 | TQFP- 32 |

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|-----------------------|----------------|----------------|-------------|-------------|------------|-------------------------------|------------------------------|------------------------|-------------------------|-----------------------|-------------------------|
| Price | 4,68 \$ | 5 \$ | 4,99 \$ | 7,49 \$ | 5,4 \$ | 1,58 \$ | 4,03 \$ | 0,59 \$ | 1,01 \$ | 1,29 \$ | 2,06 \$ |
| FPU availab le? | | | | | | | | | | | |

RP2040 (Raspberry Pi Pico)

Toolchain:

- **Primary:** Pico SDK (C/C++), CMake
- **Alternatives:** Arduino IDE (via Arduino-Pico Core), MicroPython/CircuitPython

Workflow:

1. Write code in C/C++ or Python.
2. Build with CMake (Pico SDK) or Arduino IDE.
3. Flash via USB (UF2 bootloader) or SWD debugger (e.g., Picoprobe).

Efficiency Tips:

- Use Visual Studio Code with the Pico SDK extension for CMake integration.
- Leverage Picoprobe (a second Pico) for debugging.

ESP32 (Espressif)

Toolchain:

- **Primary:** ESP-IDF (C/C++), PlatformIO
- **Alternatives:** Arduino IDE (via ESP32 Core)

Workflow:

1. Develop in C/C++ (ESP-IDF) or Arduino framework.
2. Build with ESP-IDF CLI or PlatformIO.
3. Flash via USB (esptool.py) or OTA updates.

Efficiency Tips:

- PlatformIO streamlines ESP-IDF/Arduino workflows.
- Use ESP-Prog or JTAG for advanced debugging.

SAMD21/SAMD11 (Atmel/Microchip)

Toolchain:

- **Primary:** Atmel/Microchip Studio (C/C++)
- **Alternatives:** Arduino IDE (via SAMD Core)

Workflow:

1. Code in C/C++ (Microchip Studio) or Arduino.
2. Build and flash via USB (UF2 bootloader) or EDBG/SWD.

Efficiency Tips:

- Use Arduino IDE for simplicity; enable verbose upload for debugging.
- For low-level control, use CMSIS libraries in Microchip Studio.

Attiny/AVR128 (AVR Family)

Toolchain:

- **Primary:** AVR-GCC + AVRdude
- **Alternatives:** Arduino IDE (via ATTiny Core)

Workflow:

1. Write code in C/C++ or Arduino.
2. Compile with AVR-GCC or Arduino IDE.
3. Flash via ISP programmer (e.g., USBasp, Arduino-as-ISP).

Efficiency Tips:

- Use PlatformIO for project management.
- For tinyAVR (e.g., ATtiny85), optimize code size with `-Os` compiler flag.

General Workflow Optimization Tips

1. Unified Environments:

- **PlatformIO** (VS Code) supports all listed MCUs, reducing toolchain setup time.

- **Arduino IDE** (with board managers) simplifies entry-level development.
2. **Debugging Tools:**
 - **SWD/JTAG:** Use for RP2040, ESP32, SAMD21 (e.g., Segger J-Link, CMSIS-DAP).
 - **Serial Monitor:** Essential for ESP32/RP2040 debugging.
 3. **Version Control:**
 - Use `git` for code management; track dependencies (e.g., submodules for Pico SDK).
 4. **Automation:**
 - Write Makefiles or use PlatformIO scripts for CI/CD pipelines.

QFP mit Beinchen seitlich

TQFP ohne Beinchen

Soic-8 8 Beinchen

Punkt oder Kerbe kennzeichnen Pin 1

Putting code onto it

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Serial Peripheral Interface (SPI)

- A standard synchronous serial communication interface used for short-distance communication between a main device and one or more peripheral devices.
- synchronous (needs clock signal), serial communication
- multiple secondary devices are possible
- full-duplex
- pins:
 - MOSI (main out secondary in)
 - MISO (main in secondary out)
 - SCK (clock)
 - SS (secondary select): select which secondary device to communicate with

Serial Peripheral Data Interface (SPDI)

- do not find any source for it
- Good Article GERMAN

Joint Test Action Group (JTAG)

- electronics manufacturers committee
- they developed a protocol with the same name
- mostly used for programming ARM cores
- daisy-chaining possible
- pins
 - TMS: mode select
 - TCLK: clock
 - TDO: data out
 - TDI: data in
 - nRESET: reset (optional)

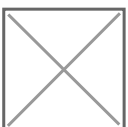


Serial Wire Debug (SWD)

- two-pin variant of the JTAG protocol -> replaced JTAG
- daisy-chaining not possible
- most common on newer ARM chips
- pins:
 - swdio: in/out
 - swclk: clock

Unified Program and Debug Interface (UPDI)

- proprietary
- single-wire,
- bi-directional, half-duplex
- asynchronous
- can use off-the shelf UART adapters
- used to program AVR microcontrollers released since 2016, ATTINY412, ATTINY164.
- more detailed blog article
- debugging is hidden behind a proprietary interface, but even though you can snoop on the protocol with just a serial adapter and even though the large scale structure of the protocol is known too
- even more detailed article
- i did not find out what part of the protocol actually is proprietary and what not.



Difference between microcontroller and -processor

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Programmierer:

ISP-Programmierer

AVRISP MKII



FabISP



JTAG-Programmierer

ATMEL-ICE



<http://pub.fabcloud.io/programmers/summary/>

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