

ESP32-C3-MINI-1 – the per-board brain (RISC-V MCU module)

Espressif · SMD module, PCB antenna · Wi-Fi + BLE · ~\$2

WHAT IT IS

A complete tiny microcontroller MODULE (the MCU + flash + RF + antenna on one shielded brick you reflow onto the board). Single-core 32-bit RISC-V at 160 MHz. It runs the firmware: reads the protocol, drives SPI/I2C, talks the RS-485 bus. Cheap enough to be "sacrificial."

KEY SPECS (what matters to us)

1× RISC-V @160 MHz · 4 MB flash · ~400 KB SRAM
Native USB-Serial/JTAG (program over USB-C, no extra chip)
~15 usable GPIO · 2× SPI · I2C · 2× UART · 6× ADC (noisy)
Wi-Fi + BLE 5 (we don't use RF on the wired bus – bonus)

SIGNALS / PINS WE USE

I00..10 = our SPI spine + RS-485 UART + DIP/LED
I018/I019 = native USB D-/D+ (the flashing port)
I09 = a BOOT strap (safe as a high-idling CS or DIP bit)
EN = reset (RC + button)

ELECTRICAL · GOTCHAS

On-chip ADC is noisy (~8–9 effective bits) → we read pots via an external SPI ADC instead. Boot strap is I09, NOT I00. USB-JTAG auto-enters download mode (esptool), so no BOOT button needed.

WHY IT'S IN OUR SYSTEM

Chosen as the standard per-board brain: every smart module (each CR unit + each expander) has its own. Cheap + auto-reset flashing + a product-realistic module form factor. Its few GPIO drove a real decision – SPI became the shared "spine" so everything (PCA, ADCs, RS-485) fits. The bigger S3 is used only where GPIO runs out.