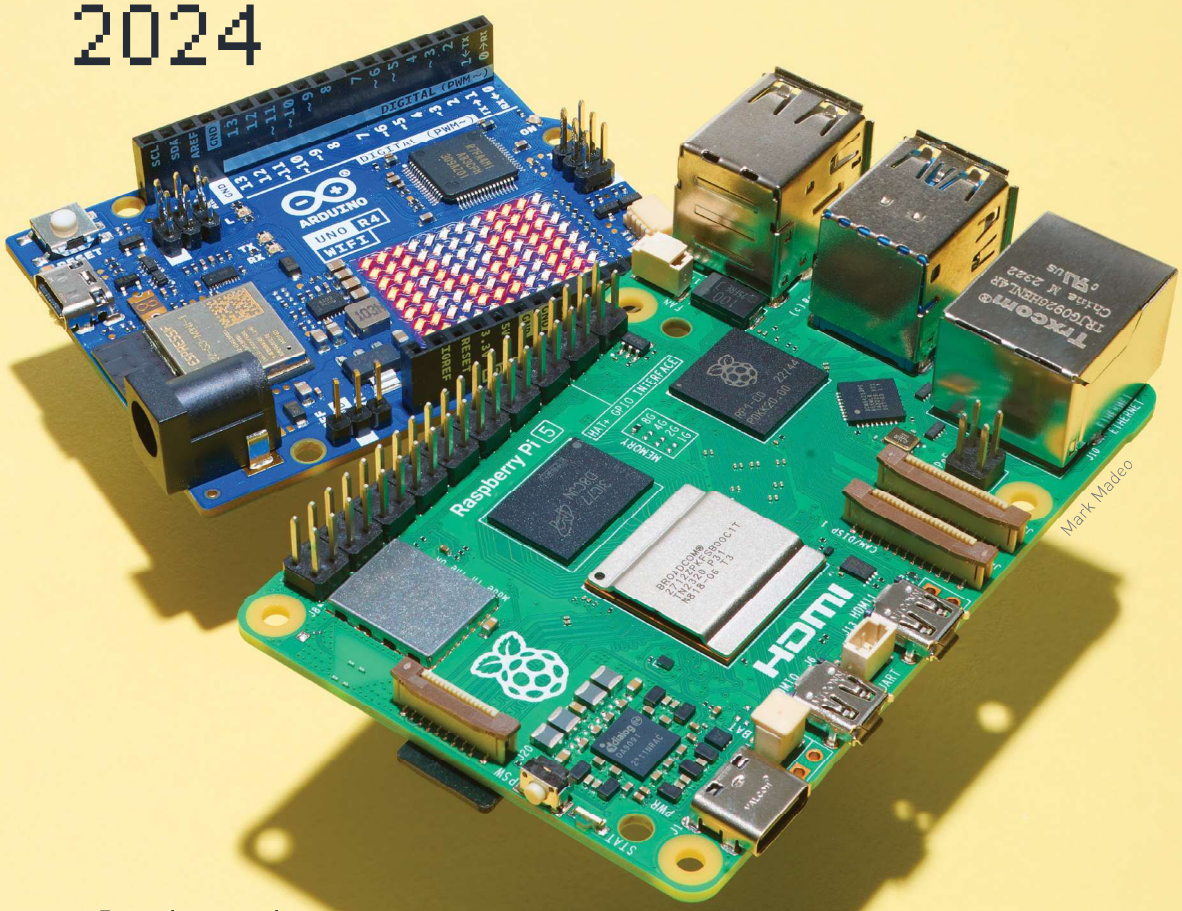
Make:

THE ORIGINAL

GUIDE TO BOARDS

2024



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BOARDS ARE BACK

We've said it before, but we're so glad we can say it again — there's never been a better time to be a maker. A Cambrian explosion of microcontrollers and single-board computers has errupted into this 2024 *Make:* Guide to Boards, overflowing with a quantity and variety of new gear we haven't seen in years.

Read on for our comparison of 81 true workhorses, exciting newcomers, fun specialty boards, and beastly high-performance hardware for your most challenging AI, 3D, or video needs.

HAPPY DAYS ARE HERE AGAIN

Makers, rejoice — the era of broad component shortages, kicked off by the Covid-19 pandemic, has come to a close. Parts are flowing into factories once more, and devices like single-board computers are readily available at retail. Companies are even launching new flagship designs, after more than two years of struggles: Arduino released its massively upgraded Uno R4 in June, and Raspberry Pi shipped the powerful new Raspberry Pi 5 in October (see both on the opposite page).

"We are definitely well on the other side of the shortage," Adafruit's Limor "Ladyada" Fried tells us. "There are probably [many] parts that are still being sluggish but we are far from the nadir of not being able to source crystals or diodes. That sucked!"

CEO Eben Upton recalls it as "the first time in the history of Raspberry Pi that we've experienced a sustained shortage," which saw supplies constrained for two years — a serious blow to all, from hobbyists all the way up to car manufacturers. "Lessons learned: hold larger buffer stocks of components, though realistically there was no way we could afford to hold a buffer large enough to smooth this one out," Upton says, "and get in closer contact with your suppliers, and your customers, to help make the most of the supply available."

"We definitely should not have trusted some vendors who kept promising 'No, no, we will ship your order next month,' and that dragged on for a year," Fried adds. "Many boards did get revised to ditch older chips, and we did focus on new designs with the chips we could get. A heterogeneous market is to our benefit: if

MICROCONTROLLERS (MCU)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
Adafruit ATtiny1616 Breakout with Seesaw	$5	1.2"×0.5"	Arduino IDE, C/C++	20MHz	8-bit ATtiny1616 (single-core AVR)	16kB Flash, 2kB RAM, 256 byte EEPROM
Adafruit ESP32-S2 Feather with BME280 Sensor	$25	2.1"×0.9"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S2 (single-core Tensilica LX7)	128kB flash, 320kB RAM, 4MB SPI flash and 2MB PSRAM
Adafruit ESP32-S2 TFT Feather	$25	2.1"×0.9"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S2 (single-core Tensilica LX7)	128kB flash, 320kB RAM, 4MB SPI flash and 2MB PSRAM
Adafruit ESP32-S3 Feather	$18	2.1"×0.9"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 4MB SPI flash and 2MB PSRAM or 8MB flash No PSRAM
Adafruit Feather M0 with RFM95 LoRa Radio 900MHz (RadioFruit)	$35	2.0"×0.9" ×0.3"	CircuitPython, Arduino IDE	48MHz	ATSAMD21G18 (single-core Cortex-M0)	256kB flash, 32kB RAM
Adafruit Feather RP2040 with DVI	$15	2.1"×0.9"	CircuitPython, MicroPython, Arduino IDE, C/C++ SDK	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 8MB SPI flash
Adafruit Feather RP2040 Scorpio ★NEW & NOTABLE★	$15	2.0"×0.9" ×0.3"	CircuitPython, MicroPython, Arduino IDE, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 8MB SPI flash

every chip company is ADI, TI, or ST, suddenly there's not a lot of 'second sourcing' possible! The nimble mammals definitely won where the dinos struggled."

And the outlook for those new flagships? Uno R4 stocks are deep — for now — at Arduino, DigiKey, and other distributors. "Raspberry Pi 5, like all new products, will likely see demand outstrip supply for a period," Upton admits, "but we are allocating 100% of production to the enthusiast and education market, and we hope there will be getting on for a million units in people's hands by the end of the year."

—Gareth Halfacree

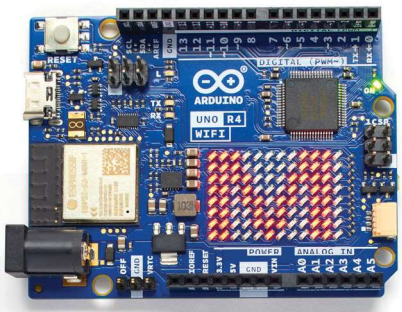
Explore the new and notable boards within DigiKey's Innovation Hub Boards Explorer. Use this immersive web experience to compare, view, and get more information on each board.

Digital Pins	Analog Pins	Radio	Video	Input Voltage	Battery Connection	Operating Voltage
12	5 PWM, 9 ADC	–	–	2V–5V	–	5V (3.3V via Jumper)
21	14 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
21	14 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
21	14 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
20	8 PWM, 10 ADC, 1 DAC	LoRa	–	3.3V–5V	✓	3.3V
21	16 PWM, 4 ADC	–	DVI	3.3V–5V	✓	3.3V
21	16 PWM, 4 ADC	–	–	3.3V–5V	✓	3.3V

RASPBERRY PI 5

Berry-branded beast board!

With 2x–3x the performance of the previous generation, faster CPU, GPU, Wi-Fi, USB, and microSD, the new Raspberry Pi 5 represents a giant leap forward for the credit-card-sized SBC. Custom RP1 silicon offloads I/O from the application processor for the first time, and the dual 4Kp60 outputs and PCIe 2.0 support mean desktop-class performance starting at just $60! Oh, and did we mention it has *a power button*?!



ARDUINO UNO R4 WIFI

Back better with new (LED ma)trix!

Originally announced at Maker Faire, the Arduino Uno is probably the single most recognizable dev board in the makerverse. And now it's back, more powerful than ever, thanks to a partnership with Renesas. The 32-bit RA4M1 Cortex-M4 MCU trounces earlier 8-bit models, while retaining the 5V operating voltage required for compatibility with over a decade and a half of shields. And with Wi-Fi via an ESP32-S3 coprocessor, plus a built-in 12×8 LED matrix, this board might be the only *one* you need!

Mark Madeo, Adobe Stock-royyimzy

Make: GUIDE TO BOARDS 2024

MICROCONTROLLERS (MCU)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
Adafruit Matrix Portal S3	$20	2.5"×1.7"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 8MB SPI flash and 2MB PSRAM
Adafruit Metro ESP32-S3 with 16MB Flash 8MB PSRAM	$25	2.71"×2.1"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 16MB SPI flash and 8MB PSRAM
Adafruit Metro M7 with AirLift ★NEW & NOTABLE★	$30	2.8"×2"	CircuitPython	500MHz	32-bit iMX RT1011 (single-core Cortex-M7)	128kB RAM, 8MB SPI flash
Adafruit Metro RP2040	$15	2.71"×2.1"	CircuitPython, MicroPython, Arduino IDE, C/C++ SDK	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 16MB SPI flash
Adafruit QT Py ESP32-C3	$10	0.9"×0.7"	Arduino IDE, MicroPython, ESP-IDF	160MHz	32-bit ESP32-C3 (single-core RISC-V)	4MB Flash, 400kB SRAM, 8kB SRAM (RTC)
Adafruit QT Py S3 with 2MB PSRAM ★NEW & NOTABLE★	$13	0.9"×0.7"	CircuitPython, ESP-IDF, Arduino IDE	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 4MB SPI flash and 2MB PSRAM
Adafruit RP2040 Feather ThinkInk	$18	2.1"×0.9"	CircuitPython, MicroPython, Arduino IDE, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 8MB SPI flash
Adafruit RP2040 Prop Maker Feather	$20	2.1"×0.9"	CircuitPython, MicroPython, Arduino IDE, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 8MB SPI flash
Arducam Pico4ML	$26	0.9"×2.0"	MicroPython	133MHz	32-bit RP2040 (dual-core Cortex M0+)	2MB flash, 264kB RAM
Arduino Giga R1 WiFi	$73	3.98"×2.1"	Arduino IDE, MicroPython, C/C++	480MHz (Cortex-M7), 240MHz (Cortex-M4)	32-bit STM32H747XI (single-core Cortex-M7, single-core Cortex-M4)	2MB flash, 1MB RAM
Arduino Nano 33 BLE Sense Rev2	$41	1.8"×0.7"	Arduino IDE	64MHz	32-bit Nordic nRF52840 (single-core Cortex-M4F)	1MB flash, 256kB RAM
Arduino Nano ESP32 ★NEW & NOTABLE★	$20	0.71"×1.77"	Arduino IDE	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 16MB SPI flash
Arduino Nicla Voice	$114	0.9"×0.9"	Arduino IDE, C/C++	64MHz (Cortex-M4), 48MHz (Cortex-M0)	32-bit nRF42832 (single-core Cortex-M4), NDP120 (single-core Cortex-M0, HiFi 3 DSP, Syntiant Core 2 NDP)	512kB flash, 64kB RAM, 16MB SPI flash, 48kB RAM on NDP120
Arduino Portenta C33	$64	2.6"×1"	Arduino IDE, MicroPython, C/C++	200MHz	32-bit R7FA6M5BH2CBG (single-core Cortex-M33)	2MB flash, 512kB RAM, 16MB SPI flash
Arduino Portenta H7	$114	2.6"×1.0"	Arduino IDE, MicroPython, JavaScript, TensorFlow Lite, Mbed OS	480MHz (Cortex-M7), 240MHz (Cortex-M4)	32-bit STMicro STM32H747XI (dual-core Cortex-M7, M4 coprocessor)	2MB/16MB Int/Ext Flash, 1MB/8MB Int/Ext RAM
Arduino Uno R4 WiFi ★NEW & NOTABLE★	$28	2.71"×2.1"	Arduino IDE, C/C++	48MHz (Cortex-M4), 240MHz (Xtensa LX7)	32-bit RA4M1 (single-core Cortex-M4), 32-bit ESP32-S3 (dual-core Xtensa LX7)	256kB flash, 32kB RAM (384kB flash, 512kB RAM on ESP32)
BBC micro:bit V2	$18	2"×1.6"	JavaScript, MicroPython, CircuitPython, C++	64MHz	32-bit Nordic nRF52833 (single-core Cortex-M4F)	512kB flash, 128kB RAM
BeagleBoard.org BeagleConnect Freedom	$29	2.2"×2.1" (exc. antenna)	MicroPython, Zephyr, Greybus	48MHz (Cortex-M4F), 25MHz (MSP430)	32-bit CC1352P7 (single-core Cortex-M4F), 16-bit MSP430F5503 (single-core MSP430)	704kB flash, 144kB RAM on Cortex-M4F, 4kB RAM, 32kB flash on MSP
DFRobot Beetle RP2040	$7	1.06"×0.79"	MicroPython, CircuitPython, Arduino IDE, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	264kB SRAM, 2MB SPI flash

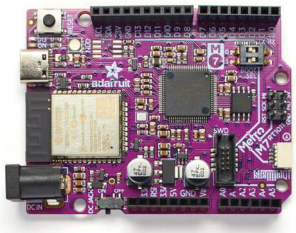
Digital Pins	Analog Pins	Radio	Video	Input Voltage	Battery Connection	Operating Voltage
6	4 PWM, 4 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
30	14 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
24	14 PWM, 6 ADC, 1 DAC	–	–	5V–12V	–	3.3V
24	16 PWM, 4 ADC	–	–	3.3V–5V	–	3.3V
13	6 PWM, 5 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	–	3.3V
13	13 PWM	Wi-Fi, Bluetooth Low Energy	–	3.3V–5V	–	3.3V
21	16 PWM, 4 ADC	–	24-pin ePaper display connector	3.3V–5V	✓	3.3V
21	16 PWM, 4 ADC	–	–	3.3V–5V	✓	3.3V
26	16 PWM, 3 ADC	–	0.96" 160×80 color LCD	5V–5.5V	–	3.3V
76	12 PWM, 12 ADC, 2 DAC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	6V–24V	–	3.3V
14	14 PWM, 8 ADC	Bluetooth Low Energy	–	5V–21V	–	3.3V
14	5 PWM, 8 ADC	Wi-Fi, Bluetooth Low Energy	–	6V–21V	–	3.3V
10	12 PWM, 2 ADC	Bluetooth Low Energy	–	5V	–	1.8V–3.3V
22 (78 on high-density connector)	7 PWM, 7 ADC, (10 PWM, 8 ADC on high-density connector)	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
22 (78 on high-density connector)	7 PWM, 7 ADC, (10 PWM, 8 ADC on high-density connector)	Wi-Fi, Bluetooth	MIPI DSI Host & MIPI D-PHY	3.7–5V	✓	3.3V
14	6 PWM, 6 ADC, 1 DAC	Wi-Fi, Bluetooth Low Energy	12×8 LED matrix	6V–24V	For RTC Only	5V (3.3V for ESP32)
19	3 PWM, 6 ADC	Bluetooth	–	3V–5V	✓	3.3V
12	2 PWM, 2 ADC	Bluetooth Low Energy, IEEE 802.15.4, Sub-GHz	–	3.3V–5.5V	–	3.3V
8	8 PWM, 2 ADC	–	–	3.3V–5V	–	3.3V

New & Notable

SEEED XIAO ESP32S3 SENSE

Miniature ML for minimal moolah!

Dual-core 240MHz MCU? Check. 8MB each of PSRAM and flash? Yep. Built-in Wi-Fi/BLE, and charger? Uh-huh. Onboard camera and microphone? You got it. Must be huge, right? Nope! This $14 ML-capable marvel somehow packs all of this and more into the classic 21×17.5mm Xiao form factor.



ADAFRUIT METRO M7

Maxed-out Metro with M7 muscle!

Adafruit's Metro line represents their take on Arduino's Uno form factor, although they have been steadily outpacing their roots with increasingly powerful 32-bit MCUs. The M7, named for its beefy 500MHz Arm core, represents the zenith of this evolution, and a special red DigiKey/NXP collab edition replaces the ESP32 coprocessor with a microSD slot for just $20!

PARTICLE PHOTON 2

IoT at the speed of light!

Particle is back with a whole new Photon, and we've seen the light! Starting with the ever-popular Feather form factor, the Photon 2 adds a 200MHz Cortex-M33 MCU, dual-band Wi-Fi (2.4 and 5GHz), BLE 5.3, and best of all, Particle's class-leading IoT platform — free for most makers.

MICROCONTROLLERS (MCU)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
DFRobot FireBeetle 2 ESP32-S3	$20	1"×2.36"	MicroPython, Arduino IDE, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Tensilica LX7)	384kB flash, 512kB RAM, 16MB SPI flash, 8MB PSRAM
M5Stack CoreS3 ★NEW & NOTABLE★	$60	2.13"×2.13" ×0.62"	Arduino IDE, UIFlow	240MHz	32-bit ESP32 (dual-core Tensilica LX7)	16MB flash, 520kB SRAM, 8MB PSRAM
Meadow F7v2	$50	1.9"×0.9"	Meadow.OS	216MHz (Cortex-M7), 240MHz (ESP32)	32-bit STM32F7 (single-core Cortex-M7), ESP32 coprocessor	64MB flash, 32MB RAM
Microchip AVR-IoT Cellular Mini	$69	3.2"×0.93"	Arduino IDE	24MHz	8-bit AVR128DB48 (single-core AVR)	128kB flash, 16kB SRAM, 512B EEPROM, 512kB SPI EEPROM
Microchip AVR64DD32 Curiosity Nano	$25	2.4"×0.8"	Atmel Studio, MPLAB X, Arduino IDE	24MHz	8-bit AVR64DD32 (single-core AVR)	64kB flash, 8kB RAM, 256 bytes EEPROM
OpenMV Cam RT1062	$130	1.8"×1.4"	MicroPython	600MHz	32-bit WT1062 (single-core Cortex-A7)	16MB SPI flash, 1MB SRAM, 32MB SDRAM
Particle Photon 2 ★NEW & NOTABLE★	$18	2.1"×0.9"	Particle Device OS	200MHz	32-bit RTL8721DM (single-core Cortex-M33)	2MB flash, 3MB RAM
Pimoroni Badger 2040	$17	3.4"×1.9"	Arduino IDE, MicroPython, C/C++	133MHz	32-bit RP2040 (dual-core Cortex-M0+)	2MB SPI flash, 264kB SRAM
Pimoroni Interstate 75	$16	1.9"×1.2"	Arduino IDE, MicroPython, CircuitPython, C/C++	133MHz	32-bit RP2040 (dual-core Cortex-M0+)	2MB SPI flash, 264kB SRAM
Pimoroni Plasma 2040	$15	1.9"×1.1"	MicroPython, CircuitPython, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	2MB QSPI flash, 264kB RAM
Pimoroni Tiny 2040	$7 (2MB), $9 (8MB)	0.90"×0.72"	Arduino IDE, MicroPython, CircuitPython, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	8MB SPI flash, 264kB RAM
Pixelblaze V3 Standard	$39	1.35"×1.56"	Arduino IDE, ESP-IDF, Pixelblaze Pattern Language	240MHz	32-bit ESP32 (dual-core Xtensa LX6)	4MB SPI flash, 520kB RAM (8kB in RTC)
PJRC Teensy 4.0	$24	1.4"×0.7"	Arduino IDE with Teensyduino extension, CircuitPython	600MHz	32-bit NXP iMX RT1062 (single-core Cortex-M7)	2MB flash, 1MB RAM, 1kB EEPROM (Emulated)
PJRC Teensy 4.1	$32	2.4"×0.7"	Arduino IDE with Teensyduino extension, CircuitPython	600MHz	32-bit NXP iMX RT1062 (single-core Cortex-M7)	8MB flash, 1MB RAM, 4kB EEPROM (Emulated)
Raspberry Pi Pico W	$6	2"×0.827"	Arduino IDE, MicroPython, CircuitPython, FreeRTOS, RT-Thread, Rust, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	2MB flash, 264kB RAM
Seeed SenseCAP Indicator D1	$49	3.7"×3.8"	Arduino IDE, MicroPython, CircuitPython, ESP-IDF, C/C++	240MHz (ESP32-S3), 133MHz (RP2040)	32-bit ESP32-S3 (dual-core Tensilica LX7), 32-bit RP2040 (dual-core Cortex-M0+)	384kB flash, 512kB SRAM, 8MB SPI flash (ESP32-S3), 264kB SRAM, 2MB SPI flash (RP2040)
Seeed Wio Tracker 1110 ★NEW & NOTABLE★	$30	2.6"×1.9"	Arduino IDE	64MHz	32-bit Nordic nRF52840 (single-core Cortex-M4F)	1MB flash, 256kB RAM
Seeed Xiao ESP32C3 ★NEW & NOTABLE★	$5	0.8"×0.7"	Arduino IDE, CircuitPython	160MHz	32-bit ESP32-C3 (single-core RISC-V)	4MB flash, 400kB SRAM
Seeed Xiao ESP32S3	$7	0.8"×0.7"	Arduino IDE, MicroPython, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	384kB flash, 512kB SRAM, 8MB SPI flash, 8MB PSRAM

Digital Pins	Analog Pins	Radio	Video	Input Voltage	Battery Connection	Operating Voltage
26	8 PWM, 20 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
6	–	Wi-Fi, Bluetooth Low Energy	2.0 320×240 RGB LCD, 680×480 RGB camera	USB 5V, DC 9V-24V	✓	3.3V
24	12 PWM, 6 ADC, 2 DAC	Wi-Fi, Bluetooth Low Energy	SPI	3.3V–12V	✓	3.3V (5V-tolerant digital IO)
22	6 ADC	LTE-M/NB-IoT Modem (150MB data included)	–	3.3V–5V	✓	3.3V
12	8 PWM, 8 ADC	–	–	5V	–	1.8V–5V
14	4 PWM, 1 ADC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	3.6V–5V	✓	3.3V
20	5 PWM, 6 ADC	Wi-FI, Bluetooth Low Energy	–	5V	✓	3.3V
–	–	–	2.9" E Ink, 296×128	3V–5V	✓	3.3V
3	3 PWM, 3 ADC	–	RGB LED matrix connector	5V	–	3V
3	3 PWM, 3 ADC	–	–	5V	–	3.3V
12	12 PWM, 4 ADC	–	–	3V–5.5V	–	3.3V
12	5 ADC	Wi-Fi	–	5V	–	3.3V
40	31 PWM, 14 ADC	–	–	3.6V–5.5V	–	3.3V
55	35 PWM, 18 ADC	–	–	3.6V–5.5V	–	3.3V
26	16 PWM, 3 ADC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	1.8V–5.5V	–	3.3V
2 (via Grove), 8 (via USB-C)	1 ADC (via Grove)	Wi-Fi, Bluetooth Low Energy	3.95" Color Touchscreen, 480×480	5V	–	3.3V
3 (via Grove)	1 ADC (via Grove)	Wi-Fi (Location Only), Bluetooth Low Energy, LoRaWAN	–	5V	✓	3.3V
11	11 PWM, 4 ADC	Wi-Fi, Bluetooth Low Energy	–	5V	–	3.3V
11	11 PWM, 9 ADC	Wi-Fi, Bluetooth Low Energy	–	4.2V–5V	✓	3.3V

New & Notable

ADAFRUIT FEATHER RP2040 SCORPIO

Feisty Feather pumps out pixels!

It's Scorpio season year-round with this clever Feather from Adafruit. Thanks to the RP2040's programmable input/output (PIO), the Scorpio can blast LED-driving data through eight outputs simultaneously, via the magic of DMA (direct memory access) — leaving all of your MCU cycles available for other tasks.

M5STACK CORES3

Happy digital fastcore!

This brilliant little box is the perfect core for all your projects! With a built-in 2" 320×240 touchscreen and camera, IMU, proximity sensor and magnetometer, plus microSD card and RTC, you might not need anything else! An integrated speaker and amp plus a 240MHz ESP32-S3 MCU make this adorable unit anything but normcore!

SEEED XIAO ESP32C3

Xiao ya like me now?

We're enamored with the itty-bitty Xiao form factor, and this variant in particular, due to its 160MHz RISC-V MCU with built-in Wi-Fi and BLE 5! Programmable in Arduino, MicroPython, and CircuitPython, this thumbnail-sized phenom is a steal at just $5, antenna included!

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MICROCONTROLLERS (MCU)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
Seeed Xiao ESP32S3 Sense ★NEW & NOTABLE★	$14	0.8"×0.7" ×0.6"	Arduino IDE, MicroPython, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	384kB flash, 512kB SRAM, 8MB SPI flash, 8MB PSRAM
Solder Party RP2040 Stamp	$12 ($18.50 with carrier)	1"×1"	Arduino IDE, MicroPython, CircuitPython, FreeRTOS, RT-Thread, Rust, C/C++	133MHz	32-bit RP2040 (dual-core Cortex M0+)	8MB Flash, 264kB RAM
SparkFun Artemis Global Tracker	$400	2"×2.5"	Arduino IDE	48MHz (96MHz turbo)	32-bit Artemis (single-core Cortex-M4F)	1MB SPI flash, 384kB SRAM
SparkFun AzureWave Thing Plus	$50	3.05"×0.9"	Arduino IDE, C/C++	200MHz	32-bit AW-CU488 (single-core Cortex-M33, single-core Cortex-M23)	512kB RAM, 4MB SPI flash, 4MB PSRAM
SparkFun Datalogger IoT — 9DoF	$75	1.66"×2"	Arduino IDE, MicroPython, ESP-IDF	240MHz	32-bit ESP32 (dual-core Xtensa LX6)	448kB flash, 520kB SRAM
SparkFun Thing Plus Matter — MGM240P	$25	2.3"×0.9"	Simplicity Studio IDE	39MHz	32-bit EFR32MG24 (single-core Cortex-M33)	1536kB flash, 256kB SRAM
SparkFun Thing Plus — NINA-B306	$80	2.03"×3.27"	Arduino IDE	64MHz	32-bit NINA-B306 (single-core Cortex-M4F)	1MB flash, 250kB SRAM
ThingPulse ePulse Feather	$15	2.3"×0.96"	Arduino IDE, MicroPython, CircuitPython, ESP-IDF	240MHz	32-bit ESP32-D0WD-V3 (dual-core Xtensa LX6)	448kB flash, 520kB RAM, 8MB SPI flash, 8MB PSRAM
Unexpected Maker FeatherS2 Neo	$25	2.1"×0.9"	CircuitPython, MicroPython, Arduino IDE, ESP-IDF	240MHz	32-bit ESP32-S2 (single-core Xtensa LX7)	128kB flash, 320kB RAM, 4MB SPI flash, 2MB PSRAM
Unexpected Maker FeatherS3	$22	2.1"×0.9"	MicroPython, CircuitPython, Arduino IDE, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	384kB flash, 512kB RAM, 16MB SPI flash, 8MB PSRAM
Unexpected Maker ProS3	$24	2.1"×0.7"	MicroPython, CircuitPython, Arduino IDE, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	384kB flash, 512kB RAM, 16MB SPI flash, 8MB PSRAM
Unexpected Maker TinyPICO V3	$20	0.71"×1.26"	Arduino IDE, MicroPython, CircuitPython, ESP-IDF	240MHz	32-bit ESP32 (dual-core Xtensa LX6)	4MB SPI flash, 520kB SRAM, 4MB PSRAM, 8kB SRAM (RTC)
Unexpected Maker TinyS3	$20	1.4"×0.7"	MicroPython, CircuitPython, Arduino IDE, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	384kB flash, 512kB RAM, 8MB SPI flash, 8MB PSRAM
Wemos Lolin C3 Pico	$5	1"×1"	MicroPython, CircuitPython, Arduino IDE, ESP-IDF	160MHz	32-bit ESP32-C3 (single-core RISC-V)	384kB flash, 400kB RAM, 4MB SPI flash
Wemos Lolin S3 Mini	$5	1.35"×1"	Arduino IDE, MicroPython, ESP-IDF	240MHz	32-bit ESP32-S3 (dual-core Xtensa LX7)	T 384kB flash, 512kB RAM, 4MB SPI flash, 2MB PSRAM K

SINGLE-BOARD COMPUTERS (SBC)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
Arduino Portenta X8 ★NEW & NOTABLE★	$239 ($574 with Max Carrier)	1"×2.6"	Yocto Linux	1.8GHz (Cortex-A53), 480MHz (Cortex-M7), 400MHz (Cortex-M4), 240MHz (Cortex-M4)	64-bit NXP i.MX8M Mini (quad-core Cortex-A53, Cortex-M4 coprocessor), STM32H747Xi (Cortex-M7, Cortex M4)	2GB LPDDR4 RAM, 16GB eMMC
BeagleBoard.org BeaglePlay	$99	3.15"×3.15"	Debian 11	1.4GHz	64-bit Sitara AM625 (quad-core Cortex-A53), PowerVR Rogue AXE-1-16 GPU, Cortex-M4F, dual-core PRU coprocessors	2GB DDR4 RAM. 16GB eMMC

Digital Pins	Analog Pins	Radio	Video	Input Voltage	Battery Connection	Operating Voltage
11	11 PWM, 9 ADC	Wi-Fi, Bluetooth Low Energy	OV2640 1600×1200 camera sensor	4.2V–5V	✓	3.3V
30	16 PWM, 4 ADC	–	–	1.8V–5.5V	✓	3.3V
5	5 PWM, 5 ADC	Bluetooth Low Energy, Iridium Satellite Transceiver, GNSS Receiver	–	4.2V–5V	✓	3.3V
30	11 PWM, 7 ADC	Wi-Fi	–	3.3V–5V	✓	3.3V
14	3 ADC	Wi-Fi	–	3.3V–6V	✓	3.3V
13	13 ADC	Bluetooth Low Energy, IEEE 802.15.4	–	3.3V–5V	✓	3.3V
8	6 ADC	Bluetooth Low Energy, IEEE 802.15.4	–	3.3V–5V	✓	3.3V
20	20 PWM, 13 ADC, 2 DAC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	3.3V–6V	✓	3.3V
22	22 PWM, 13 ADC, 2 DAC	Wi-Fi	5×5 LED matrix	3.3V–5V	✓	3.3V
21	14 PWM, 13 ADC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	3.3V–5V	✓	3.3V
27	14 PWM, 14 ADC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	3.3V–5V	✓	3.3V
14	14 ADC, 2 DAC	Wi-Fi, Bluetooth Low Energy	–	5V	✓	3.3V
17	14 PWM, 9 ADC	Wi-Fi, Bluetooth, Bluetooth Low Energy	–	3.3V–5V	–	3.3V
12	12 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	3.3V–5V	✓	3.3V
27	14 PWM, 6 ADC	Wi-Fi, Bluetooth Low Energy	–	3.3V–5V	–	3.3V

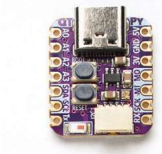
Digital Pins	Analog Pins	Radio	Video	Ethernet On Board	Input Voltage	Operating Voltage
22	4 PWM, 8 ADC	Wi-Fi, Bluetooth	–	–	5V	3.3V
10	1 PWM, 1 ADC	Wi-Fi, IEEE 802.15.4 SubGHz	HDMI, OLDI	✓	5V	3.3V

New & Notable

DFROBOT LATTEPANDA SIGMA

Burly bear brags it's best of the beasts!

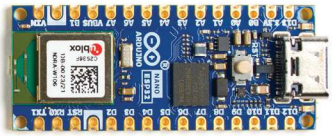
Beast boards are beating back baby boards in every battle this year, and this panda-powered predator is the fiercest amongst them. With an i5-1340P CPU and up to 32GB of LPDDR5 RAM, gobs of I/O, and an Arduino-compatible ATmega32U4 co-processor, the LattePanda Sigma earns its self-coined title of most powerful hackable single-board server.



ADAFRUIT QT PY S3

ILYSM, S3 QT Py!

From bijou to behemoth, this year's boards are all over the size scale. The QT Py S3 is Adafruit's Xiao-compatible 240MHz ESP32-S3-powered lil' dynamo, with the added benefit of a SparkFun Qwiic-compatible STEMMA QT I²C connector for solderless prototyping in Arduino or CircuitPython!



ARDUINO NANO ESP32

Is that you, NORA-W106?

The Nano ESP32 represents the highest-profile example of a new partnership with Espressif, featuring an ESP32-S3 and 16MB of flash in Arduino's diminutive Nano form factor. In addition to being compatible with the company's eponymous IDE, this board is ideally suited to the new Arduino Lab for MicroPython and Arduino IoT Cloud.

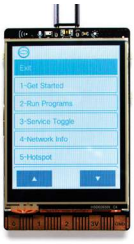
SINGLE-BOARD COMPUTERS (SBC)

Board Name	Price	Dimensions	Software	Clock Speed	Processor	Memory
BeagleBoard.org BeagleV-Ahead	$149	3.8"×2.4"	Yocto Linux, Fedora, Ubuntu	2GHz (C910), 1GHZ (NPU)	64-bit T-Head TH1520 (quad-core RV64GCV), Imagination BXE-4-64 GPU, 4 TOPS NPU	4GB LPDDR4 RAM, 16GB eMMC
DFRobot LattePanda 3 Delta	$279	4.91"×3.07"	Windows 10, Windows 11, Linux	2GHz (2.9GHz boost)	64-bit Intel Celeron N5105 (quad-core x86-64), ATmega32U4 coprocessor	8GB LPDDR4 RAM, 64GB eMMC
DFRobot LattePanda Sigma ★NEW & NOTABLE★	$579 (16GB), $629 (32GB)	5.74"×4.02"	Windows 10, Windows 11, Linux	3.4GHz (E cores), 4.6GHz (P cores)	64-bit Intel Core i5-1340P (quad-core x86-64 Performance cores, eight-core x86-64 Efficiency cores), Iris XE 80 EU GPU, ATmega32U4 coprocessor	16GB or 32GB LPDDR5 RAM
DFRobot Unihiker ★NEW & NOTABLE★	$80	2.03"×3.27"	Debian 10 Linux	1.2GHz (RK3308), 108MHz (RISC-V)	64-bit RK3308 (quad-core Arm Cortex-A35). 32-bit GD32VF103C8T6 (single-core RISC-V)	512MB LPDDR3, 16GB flash (RK3308), 64kB flash, 32kB SRAM (RISC-V)
Google Coral Edge TPU Dev Board	$130 (1GB), $170 (4GB)	3.5"×2.4"	Mendel Linux (Debian based)	1.3GHz	64-bit NXP i.MX8MQ (quad-core Cortex-A53), Cortex-M4F, GC7000 Lite GPU, Edge TPU coprocessor	1GB/4GB LPDDR4 RAM, 8GB eMMC
Hackboard 2	$175 (4GB), $225 (8GB)	4.72"×3.15"	Microsoft Windows 10 Pro, Debian 9 (subtract $24)	2.8GHz	64-bit Intel Celeron N4020 (dual-core x86-64)	4GB/8GB LPDDR4 RAM, 64GB eMMC
Hardkernel Odroid-N2L	$69	2.7"×2.2"	Ubuntu, Android 9	2.2GHz (Cortex-A73), 2GHz (Cortex-A53)	64-bit S922X (quad-core Cortex-A73 and dual-core Cortex-A53), Mali-G62 6EE GPU	4GB LPDDR4 RAM
M5Stack CM4Stack	$199	2.32"×1.81"	Various including Python, C/C++, Rust, etc.	1.5GHz	64-bit BCM2711 (quad-core Cortex-A72), Videocore VI GPU	4GB RAM, 32GB eMMC
Nvidia Jetson AGX Orin Developer Kit	$1,999	4.3"×4.3"	Ubuntu-based JetPack SDK	2.2GHz	64-bit Nvidia CPU (12-core Cortex-A78AE), 2,048-CUDA-core 64-Tensor-core Ampere GPU, 2x NVDLA v2, Programmable Vision Accelerator V2 coprocessors	64GB LPDDR5 RAM, 64GB eMMC
Nvidia Jetson Orin Nano Developer Kit	$499	3.94"×3.11"	Ubuntu-based JetPack SDK	1.5GHz	64-bit Nvidia CPU (six-core Cortex-A78AE), 1024-core Ampere GPU with 32 Tensor cores	8GB LPDDR5 RAM
Pine64 Star64	$90	5.24"×3.54"	Yocto Linux, Armbian, NixOS	1.5GHz	64-bit StarFive JH7110 (quad-core RV64GC), Imagination BXE-4-32 GPU	8GB LPDDR4, 16MB flash
Radxa Rock Pi 4 Model C+	$69	3.35"×2.13"	Debian 10, Ubuntu 20.04, Android 7/9/10/11, OpenSuSE, more	2GHz (Cortex-A72), 1.6GHz (Cortex-A53)	64-bit Rockchip RK3399 (dual-core Cortex-A72, quad-core Cortex-A53) CPU, Mali T860MP4 GPU	4GB LPDDR4 RAM
Raspberry Pi 4 Model B	$35 (1GB), $45 (2GB), $55 (4GB), $75 (8GB)	3.4"×2.2"	Raspberry Pi OS, Raspbian, Ubuntu 21.04/22.04, RISC OS, Windows 10 IoT, more	1.5GHz (CPU), 500MHz (GPU)	64-bit Broadcom BCM2711 (quad-core Cortex-A72), VideoCore VI GPU	1GB/2GB/4GB/8GB LPDDR4 RAM
Raspberry Pi 5 ★NEW & NOTABLE★	$60 (4GB), $80 (8GB)	3.4"×2.2"	Raspberry Pi OS	2.4GHz (CPU), 800MHz (GPU)	64-bit Broadcom BCM2712 (quad-core Cortex-A76), VideoCore VII GPU, RP1 Southbridge	4GB/8GB LPDDR4x RAM
Raspberry Pi Zero 2 W	$15	2.56"×1.18"	Raspberry Pi OS, Raspbian, Ubuntu 21.04/22.04, RISC OS, Windows 10 IoT, more	1GHz (CPU), 400MHz (GPU)	64-bit Broadcom BCM2837 (quad-core Cortex-A53), VideoCore IV GPU	512MB LPDDR2 RAM
Seeed Odyssey STM32MP135D	$35	3.35"×2.2"	Yocto Linux, Buildroot	1GHz	32-bit STM32MP135D (single-core Cortex-A7)	512MB DRAM
Seeed reComputer J1020 V2	$279	5.12"×4.72"	Ubuntu-based JetPack SDK	1.43GHz	64-bit Carmel ARM CPU (quad-core Cortex-A57), 128-CUDA-core Maxwell GPU	4GB LPDDR4 RAM, 16GB eMMC
StarFive VisionFive 2	$55 (2GB), $65 (4GB), $85 (8GB)	3.94"×2.83"	Debian, Fedora, Ubuntu	1.5GHz	64-bit StarFive JH7110 (quad-core RV64GC), Imagination BXE-4-32 GPU, Tensilica VP6 DSP, NVDLA, Neural Network coprocessors	2GB/4GB/8GB LPDDR4 RAM
Udoo Vision X7	$419	3.93"×2.83"	Windows 10, Windows 8.1, Linux, Android	1.6GHz	64-bit Intel Atom x7-E3950 (quad-core x86-64), Intel HD Graphics 500 GPU, ATmega32U4 coprocessor	8GB LPDDR4 RAM

Digital Pins	Analog Pins	Radio	Video	Ethernet On Board	Input Voltage	Operating Voltage
69	7 PWM, 7 ADC	Wi-Fi, Bluetooth	Micro-HDMI, DSI	✓	5V	3.3V
23	7 PWM, 12 ADC	Wi-Fi, Bluetooth	HDMI, DisplayPort, Embedded DisplayPort	✓	12V	3.3V
23	7 PWM, 12 ADC	–	HDMI, Embedded DisplayPort, USB-C	✓	12V	3.3V
19	5 PWM, 6 ADC	Wi-Fi, Bluetooth	2.8" capacitive touchscreen, 240×320	–	5V	3.3V
28	3 PWM	Wi-Fi, Bluetooth	HDMI, MIPI DSI	✓	5V	5V
28	2 PWM	Wi-Fi, Bluetooth	HDMI, Embedded DisplayPort	–	12V	GPIO 5V; 3.3V
25	2 ADC	–	HDMI, DSI	–	7.5V–16V	3.3V (ADC 1.8V max)
–	–	Wi-Fi, Bluetooth 5.0, Bluetooth Low Energy	2" ST7789V2 LCD, 320×240	✓	12VDC/100–240VAC	3.3V
28	2 PWM	Wi-Fi, Bluetooth	DisplayPort	✓	19V (USB PD)	3.3V
28	2 PWM	Wi-Fi	DisplayPort 1.2	✓	12V	3.3V
26	2 PWM	Wi-Fi, Bluetooth	HDMI, DSI	✓	12V	3.3V
27	1 PWM, 1 ADC	Wi-Fi, Bluetooth	2 Micro-HDMI, MIPI DSI	✓	5V	3.3V
26	4 PWM	Wi-Fi, Bluetooth	2 Micro-HDMI, Composite, MIPI DSI	✓	5V	3.3V
26	4 PWM	Wi-Fi, Bluetooth	2 Micro-HDMI, 2 MIPI DSI	✓	5V (USB PD)	3.3V
26	4 PWM	Wi-Fi, Bluetooth	Mini-HDMI	–	5V	3.3V
28	–	–	LCD 40p FPC	✓	5V	3.3V
28	2 PWM	–	HDMI, DisplayPort	✓	12V	3.3V
28	2 PWM	Wi-Fi, Bluetooth	HDMI, 2 MIPI DSI	✓	5V	3.3V
18	7 PWM, 12 ADC	–	MiniDP++, Embedded DisplayPort	✓	12V	5V

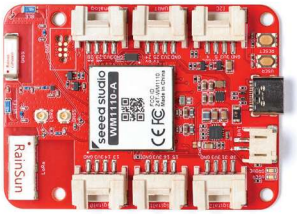
New & Notable

DFROBOT UNIHIKER



Single-board sherpa!

Wherever you're headed on the great trail of life, DFRobot's Unihiker might be the ideal companion. With a built-in 2.8" touchscreen, Wi-Fi and Bluetooth, and a mic, light sensor, accelerometer, and gyroscope onboard, this SBC will keep your projects headed in the right direction. Plus DFRobot provides a ton of built-in software and great documentation.



SEEED WIO TRACKER 1110

Multi-mode mapper and monitor!

The Wio Tracker 1110 features the same indoor/outdoor positioning and tracking tech as Seeed's consumer-ready SenseCAP T1000 — LoRa, GPS, Wi-Fi and Bluetooth sniffing — plus six Grove connectors, a built-in accelerometer, and environmental sensors to monitor temperature and humidity!

ARDUINO PORTENTA X8

With Pi...tenta HAT carrier?!

While the Pico encroaches into Arduino's MCU domain, the Portenta X8 could be seen as a shot back at Raspberry Pi, with a powerful i.MX 8M Mini running Linux. The surprise announcement of the Portenta HAT Carrier escalates things even further, giving the X8 a Pi form factor and compatible headers!

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