TINY AND MIGHTY: NEW DESKTOP COMPUTER FORM FACTOR

The tiny form factor pioneered by Raspberry Pi is now being emulated by Windows and Macintosh computers. The Pi running Linux is the low-cost champ; others may run the software you prefer to use.

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Introduction

A group of Cambridge University professors and engineers in Britain decided that the world needed an inexpensive programmable computer. One of the engineers, Eben Upton, designed a single-board computer which they called Raspberry Pi. It was introduced in 2012. It has done exactly what the builders hoped for: allow a new generation of people young and young-at-heart to learn computer programming at low cost. It has also become a multimedia computer.

In a December 2023 video interview on YouTube, Upton noted that the computer science school at Cambridge was receiving about 3 applications for each seat in the school before the Raspberry Pi was introduced. In 2023, the school received 18 applications per seat. That is one measure of Raspberry Pi's success in the United Kingdom.

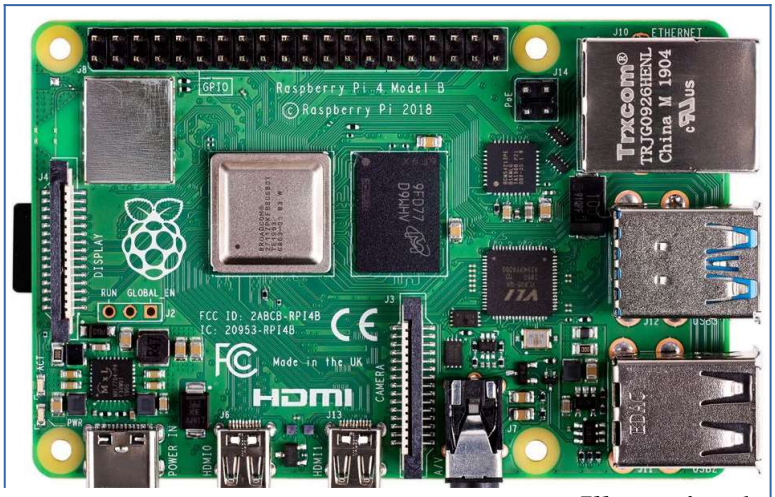

Illustration 1

Part of the pricing strategy was to sell the computer as a bare board, with no case, no storage and no power supply. You can see an example, a Raspberry Pi 4 with 2 gigabytes (GB) of RAM, in **illustration 1**. I found this board image on Microcenter's web site during January 2025. The price at the time was $40. Other varieties of each Pi model include 4 GB or 8 GB of RAM at somewhat higher prices.

A new Pi, model 5, has a much improved high-speed CPU. I tested one. It is now speedy enough for most common home computing purposes. Each Pi has 4 USB ports for storage, keyboard, and mouse, and two mini-HDMI ports for connection to a monitor. A model 500 contains the same hardware inside a keyboard, like a vastly more powerful version of a 1980s Commodore 64.

For an operating system and storage, each Pi has a microSD card socket. Free software called Raspberry Pi Imager is available for Windows and other computers to record the Raspbian Linux operating system on a microSD card to put in the Pi microSD socket. After that, the Pi can be powered up and it boots the Raspbian Linux operating system from the microSD card.

Each Pi includes two or four USB ports, one or two HDMI ports for connection to a monitor, as well as a power port. The Raspberry Pi model 2 board included a 3.5mm analog audio output socket, but in later models that socket was not included. Wi-Fi and Bluetooth are included on the board, as well as an RJ-45 socket for ethernet cable connection.

For storage beyond the limits of a microSD card, storage can be attached using one of the USB ports.

The Raspberry Pi 4 Model B board is 3.74 in x 2.76 in x 0.98 in. The height is due to the connectors stacked atop the board, including 4 USB-A sockets and one RJ-45 socket for an Ethernet cable. Cases are slightly larger.

Realistically, some purchasers, especially adults buying a Raspberry Pi as a gift for a student, want a bit more, such as a computer case to keep student fingers away from live electrical power.

So, third parties began packaging **Raspberry Pi kits** including the board, a power supply, a case, a mouse, and cables for connection to an HDMI monitor. Even a kit with bells and whistles costs far less than $200.

During Black Friday week 2024, I bought a Raspberry Pi 5 kit from Amazon. Pi 5 was the latest release at the time. That kit is shown in **illustration 2** which I obtained from Amazon's page for the kit. The kit includes a heat sink and a fan because Raspberry Pi 5 uses a new high-powered 64-bit CPU. Active heat management is necessary to prevent damage to the CPU and the graphics processor chip.

Illustration 2

The kit also includes a USB card adapter for connection of its microSD card to a computer USB port. The card can have the Raspian Linux 64-bit operating system installed by the Raspberry Pi Imager application running on Windows.

The Raspberry Pi product line has been very successful. Google reports that **60 million Raspberry Pi** computers have been sold worldwide.

The Raspberry Pi company does sell a mouse, and that mouse is sometimes included in the kits, but not in this kit. I had no problem with that lack of a Pi mouse, because I use a KVM switch to make my trackball connect with whatever computer I happen to be using.

Raspberry Pi 5 includes the Chrome web browser. I installed Firefox, which I prefer. I used the fast.com web site and found that the tiny Pi 5 can upload and download as fast as my Windows 11 tower.

I installed LibreOffice and tried it out It seems to work at full speed on Raspberry Pi 5.

Success encourage form factor emulation by Apple

I saw in 2024 that Apple has produced a Mac Mini that might be called tiny. The size is 5 x 5 x 2 in. You can see an example in **illustration 3**, which I found on Microcenter's web site.

Illustration 3

This Mac Mini incorporates a version of the Apple M4 system on-a-chip. That phrase system-on-a-chip means that the central processing unit (CPU), RAM, solid-state drive storage and graphics processor are all on a single chip. That M4 chip also includes a bit of Apple's neural net tech for AI. The system-on-a-chip design approach provides compactness, higher speed and reduced power consumption.

This Mac Mini model includes 16 GB of RAM and 512 GB of solid-state drive. Pricier models provide more RAM, more storage, and a CPU with more processing cores.

Apple did not emulate Raspberry Pi pricing. At Microcenter in January 2025, this Mac Mini cost more than $700. Its more powerful siblings cost much more than that. You can find much less expensive refurbished version on Amazon.

A tiny Windows computer

Yes, Intel has also developed a computer CPU and related hardware in a compact form factor option, and some computer makers are putting it to use. This is identified by Intel using the phrase **Next Unit of Computing (NUC).**

I found the GMKtec G3+ NUC computer depicted in **illustration 4** for sale on Amazon. Its physical size is 4.5 x 4.4 x 1.7 inches.

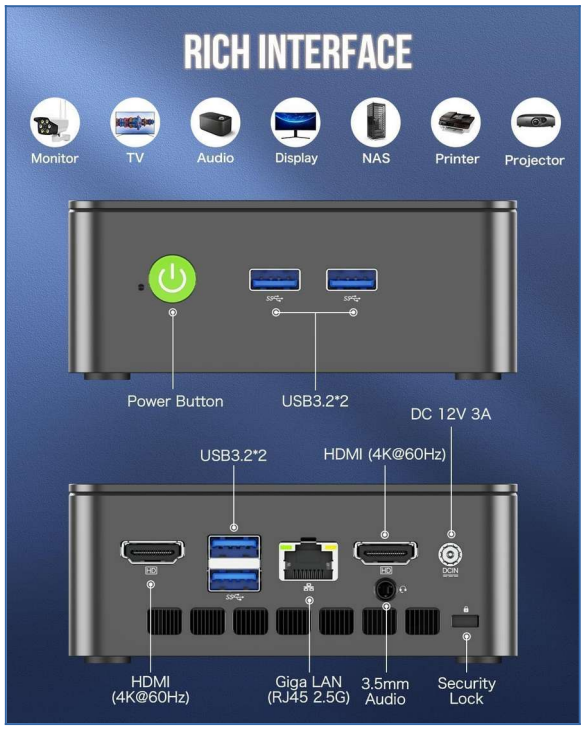

Illustration 4

The computer includes a Celeron-grade Intel N150 CPU, Windows 11 pre-installed, 8 GB RAM, a 256 GB SSD, and ports for peripherals identified in the illustration. It also includes WiFi 6 and Bluetooth 5.2.

The price is a bit less than $140 as of January 2025 on Amazon. That price competes with the Raspberry

Pi 5 kit I bought. The internal SSD adds NUC storage capacity unavailable in any off-the-shelf Raspberry Pi model.

There are Asus NUC computer models using an Intel i5 CPU, but those cost almost four times as much as this GMKtec model.

The appeal of the tiny form factor

When space is scarce, such as in an apartment or small townhouse, tiny has appeal. A monitor and keyboard might fit on a small table with difficulty, but at least the computer need not take up much room.

Some NUC computers even include a mount so that the computer can be attached to the back of the monitor.

The available ports are generous considering the tiny form factor.

The trade-offs are obvious.

Adding RAM to a tiny computer is almost certainly impossible. Upgrading internal graphics is almost impossible. Adding internal storage is almost certainly impossible. If you want those, you can consider buying a more expensive model of tiny computer.

Adding *external* storage can be done at relatively low cost by attaching a USB flash drive, USB hard drive or USB SSD, and through the home network using Network Attached Storage (NAS) or cloud storage.

Hardware hackers find a Raspberry Pi home

There are some entertaining and somewhat absurd videos on YouTube explaining how to add a board onto the top of a Raspberry Pi. Various boards are available. All known by the name HAT, an acronym for **Hardware Attached on Top**. There is a 40pin connector along one side of the Raspberry Pi board, known as GPIO (General Purpose Input/Output) that provides the necessary power and digital signal connections so that a HAT board can be used by the basic Raspberry Pi hardware and operating system. Should the user want to encase the combination of a HAT board with the Raspberry Pi, larger cases are available.

One YouTube video showed how to connect 4 terabytes of fast NVMe SSD storage to a Raspberry Pi 5 using a HAT board. The cost of that NVMe SSD dwarfs that of the Raspberry Pi 5 kit I bought. The PI can boot its operating system from the NVMe SSD far more quickly than it can from a microSD card.

There are several YouTube videos demonstrating how to connect to a Raspberry Pi a high-powered PCie graphics board designed for Windows PCs.

A few YouTube videos claim to demonstrate how to upgrade a Pi with 8 GB RAM to 16 GB RAM.

I leave my Raspberry Pi 5 up and running constantly, so improving its boot speed at high cost is not among my goals. The Pi graphics are already 4K resolution and that is good enough for my purposes.

ABOUT THE AUTHOR: John Krout is a retired software developer. He has been writing about and delivering presentations on interesting uses of personal computers since the early 1980s. In the 21st century, as digital tech became more powerful and widespread, he has also been writing and delivering presentations about interesting uses of smartphones, tablets, digital music, digital photography, Electric Vehicles (EVs) and Pluggable Hybrid Electric Vehicles (PHEVs). He lives in Arlington Virginia.