

Credit card size Computers

With more and more advancement in technology in the consumer electronics domain, credit card sized computers or single board computers have become quite popular among both consumers and developers.

Single-Board Computer (SBC) is a complete computer built on a single circuit board, with microprocessor, memory, input/output (I/O) and other features required of a functional computer. SBCs are commonly made as demonstration or development systems, for educational systems, or for use as embedded computer controls.

Unlike a desktop personal computer, single board computers often do not rely on expansion slots for peripheral functions or expansion. They consist of everything on a single board itself. On the board, there are processor and all other necessary peripherals and circuitry as well. There are onboard ROM, RAM, flash storage, AV ports, Ethernet port, etc. This means that one board is sufficient to act as a full-fledged computer and they can also boot into an operating system (OS) like Linux, Android, etc. and operate like any other computer. Being lightweight and specific, they are found in smartphones, tablets and other consumer products.

These credit card sized computer, or SBCs are not as powerful as current day PCs, and hence do not produce much heat. They are designed to also consume less power.

All the electronic gadgets that we see around - Smartphones have one such single board computer inside them - their motherboard. Most of them will run Android and iOS.

Applications :

Single board computers were made possible by increasing the density of integrated circuits. A single-board configuration reduces a system's overall cost by reducing the number of circuit boards required and by eliminating connectors and bus driver circuits that would otherwise be used.

Single board computers are commonly defined across architectures : no slot and slot support.

Portability is one of the major features which attracts people in using such devices. These devices can be carried in your pocket everywhere. These devices are pretty intuitive to use as well. They consume less power and energy compared to traditional computers or large computers. Cost effective is also a major feature. Being low in cost, these products can reach a much larger part of community.

This also makes these devices suitable for developer applications as well for development of new apps, testing, debugging, hardware development, hacking, etc.

Examples:

As an end user (or consumer), examples are electronic gadgets.

As a developer, apart from gadgets, there are some notable single board computers available in market for both hardware & software development. Some of them include Raspberry Pi, The Beagles (Beagle Board, Beagle Board xM, Beagle Bone, Beagle Bone Black), LattePanda, MK802, CubieBoard, HackBerry, TinkeBoard, Intel Compute Card, BananaPi, etc.

There are lots of options available.

The most cost-effective and credit^{card} sized computers are Raspberry Pi and Beagle Bone.

Raspberry Pi :

Raspberry Pi is a credit-card-sized single board computer developed by UK based Raspberry Pi Foundation for the sole intention of teaching programming and basic computer science to school students and in developing countries. The original model became more popular than anticipated, selling outside the target market for uses such as robotics. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity and open design.

It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices.

It runs Linux on a 700MHz ARM processor, has two USB ports to connect the keyboard and mouse, supports video via HDMI and RCA, connects to the Internet via Ethernet port, storage handled by a SD card and is cheap as \$35.

The product had gone viral even before it was launched in February 2012. It is manufactured and sold by element14/Farnell, RS components and Egoman.

The cost is low because there are no overhead charges, just the manufacturing cost. It is the reason being Raspberry Pi Foundation is a non-profit organization aiming for charity and want their product to be available & affordable to everyone.

The low cost of Pi has led to several developers getting their hands on it and working out several interesting projects and hacks using it. Also the presence of GPIO (General Purpose Input/Output) pins on the board has lured many developers to use it for several physical computing projects which include hardware interfacing of electronics. Since it is open source, it has a huge community supporting it.

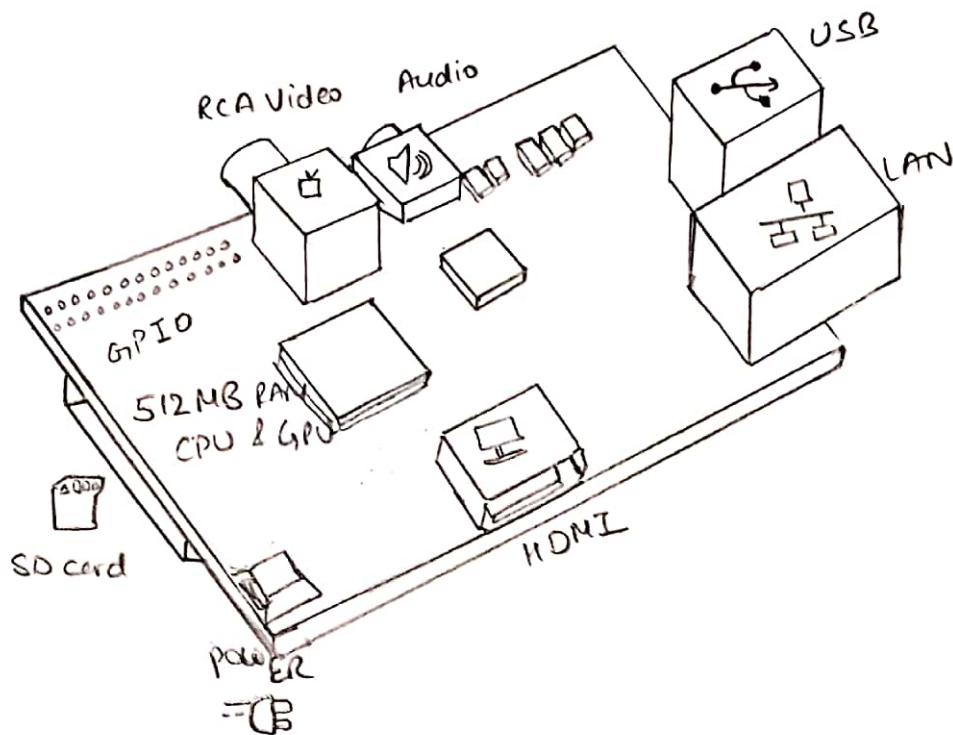
There are many models of Raspberry Pi since its initial release. They are:

Raspberry Pi (released 2012), Raspberry Pi 2 (released 2015), Raspberry Pi Zero (released 2015), Raspberry Pi 3 (2016), Raspberry Pi 4 (2019) and Raspberry Pi Pico (2021).

The latest released model is Raspberry Pi Pico which has RP2040 SoC with 264 KB memory which has no network connection. Its form factor is (21mm x 51mm) and has 26-pin GPIO.

The Raspberry Pi 4B (8GB) is one to be considered for end users for best experience. Nearly costing about \$75, it has 1.5 GHz, 4-core Broadcom BCM2711 (Cortex-A72) CPU paired with 8 gigs of RAM. It has 802.11 ac/Bluetooth 5.0 for networking and 2x USB 3.0, 2x USB 2.0, 1x Gigabit Ethernet and 2x micro HDMI ports.

Raspberry Pi Model B:



Raspberry Pi is powerful enough to drive a 1080p monitor and serve as a full-on desktop computer.

The Beagles:

Based upon ARM based processors from Texas instruments, the Beagles are a bunch of single board computers aimed at open source computing. The Beagles consists of four siblings - Beagle Board, BeagleBoard xM, BeagleBone and all new BeagleBone Black.

Beagle Board is \$125 single board computer, which contains the OMAP3538 SoC by TI based upon 720 MHz ARM Cortex-A8 processor. The cool thing about this board is that it has an on-board Digital Signal Processor (DSP) along with ARM processor. The TMS32044xx DSP by TI is pretty powerful and is used for processing analog/digital signals (like audio, video, etc). It has 512 MB SDRAM as well.

BeagleBoard xM is the successor of its elder sibling which is powered by AM37x SoC by TI based on 1GHz ARM Cortex-A8 processor. It has significant developments in the board design and specifications over the traditional BeagleBoard. It is powerful enough to give laptop like performance.

One of the best things about these boards is that they are open source and have good support from developer community. It has also developed an ecosystem by now.

Beagle Bone Black:

The Beagle Bone black is a \$45 mini-PC and is the most recent version of the Beagles and contains a TI Sitara AM355x ARM Cortex A8 processor running at 1GHz clock speed. It has the same pin layout as previous versions White BeagleBone. It has 512 MB DDR3 RAM and 2GB on-board flash storage which is used to boot any OS. By default, it comes with Linux Angstrom pre-loaded OS and can support different flavors of Linux and Android.

Similar to Raspberry Pi, it comes with one USB port, one micro USB port, a micro HDMI port, a micro SD card slot and a 10/100 Ethernet jack. Now unlike the 8 digital pins of Raspberry Pi, BeagleBone Black has 65 digital pins I/O pins, analog pins, SPI, I2C, PWM, timers and much more.

Some differences between Raspberry Pi & BeagleBone Black:

	Raspberry Pi	Beagle Bone Black	Remarks
Cost	\$35	\$45	
Processor	700 MHz Broadcom BCM2835 ARM11 (Overclocked till 1 GHz)	1 GHz TI Sitara AM3358 ARM Cortex A8	Even though both operate at same frequency (after R-Pi overclocked), ARM Cortex-A8 processor is 150% better in terms of performance than ARM11.
RAM	512 MB SDRAM	512 MB DDR3 RAM	DDR3 RAM is faster than SDRAM and consumes lesser power.
GPU	Videore IV with 1080p video encoder/decoder for H.264, MPEG2 and VC1	PowerVR SGX530 and no video encoder/decoder.	R-Pi can play 1080p Full HD videos smoothly but BBB can only 720p by BBB.
Storage	SD card slot	2GB onboard eMMC Flash storage and a micro SD card slot	BBB can run OS from its onboard Flash and its micro SD card can be used for additional storage. For R-Pi, it needs additional storage to boot up.
Ethernet	10/100 M	10/100 M	Both offer similar performance.

R-Pi

BBB

USB	2 host ports	1 client/1 host port(s)	2 host ports in R-Pi ensure that a USB keyboard and mouse can be connected directly, which is not possible for BBB. An external USB hub might be necessary on BBB.
Video	HDMI (1080p), Composite	Micro HDMI. (1280x1024) max	R-Pi has standard HDMI along with Composite RCA (AV) output supporting Full HD whereas BBB has a micro HDMI port with limited resolution and lacks AV port
Audio	Via HDMI, 3.5mm audio jack	Via HDMI only	A major limitation in BBB, extra hardware may be required to output audio when not using HDMI.
Power	Micro USB 5V or GPIO Header; 322 mA when idle. Rated at 700 mA	Micro USB 5V, GPIO header or DC Jack as well, 210-480 mA when idle.	BBB has an option to be powered up via a DC adapter along with no choice for USB. If more load is connected, to boards (like USB keyboard and mouse), it is suggested to go for higher rating power sources (like 1A or so).

	R-Pi	BBB	Remarks
Peripherals	8 GPIO pins, PWM, SPI, I2C, UART, CSI (Camera Serial Interface), DSI (Digital Serial Interface)	65 GPIO pins, SPI, I2C, UART, CAN, Timers, Analog, LCD, PWM	No match for BBB here, Unless you want to connect a camera module through the CSI port, BBB offers a lot more opportunities to hack. Ubuntu cannot run on R-Pi. Since it supports hardware with ARM v7 or higher, BBB is universal in this regard and has lot of options.
OS Support	Linux (supporting ARMv6).	Linux, Android	

So, it is clear that Beagle Bone Black has much more to offer than Raspberry Pi. As Beagle Bone Black has a better and faster processor & RAM, internal flash storage, an Ethernet port, a DC power jack, an excellent OS support with nearly all flavors of Linux and Android and lot of possibilities for hacking hardware.

On the flipside, it loses to Raspberry Pi as a teaching/learning resource and a media centre with limited video resolution & missing AV output & single USB port.

So, both devices are meant for different purposes. Raspberry Pi is primarily aimed at education whereas Beagle Bone Black is meant for developers.

LattePanda:

LattePanda is a SBC that can run full version of windows 10. It is turbocharged with an Intel Quad Core processor & has excellent connectivity, with three USB ports and integrated WiFi and Bluetooth v.4.0. It also includes an Arduino co-processor that enables you to master the physical world by controlling interactive devices that using thousands of plug and play peripherals.

LattePanda is different from Raspberry Pi and other boards as it supports complete Windows 10 system. With abundant software resources and a mature windows ecosystem, LattePanda gives your ideas more accessibility and power.

LattePanda Brings single board computers to a whole new level of power and performance. Turbocharged with an Intel Quad core 1.8 GHz processor Intel Cherry Trail Z8350 Quad Core, 2M Cache, 2-4 GB RAM DDR3L and storage capacity upto 64 GB, LattePanda can easily carry out image recognition, real time CNC control and more. Also, it is powered with Intel HD Graphics, 12 EUs @ 200-500 MHz, single channel memory.

LattePanda is not only a low cost regular windows computer - it also includes an Arduino co-processor, which means it can be used to control and sense the physical world when you add sensors and actuators. Whether you are a windows developer, an IoT dev, an interactive designer, robotics whizz or a maker, LattePanda can aid your creative process with physical computing projects.

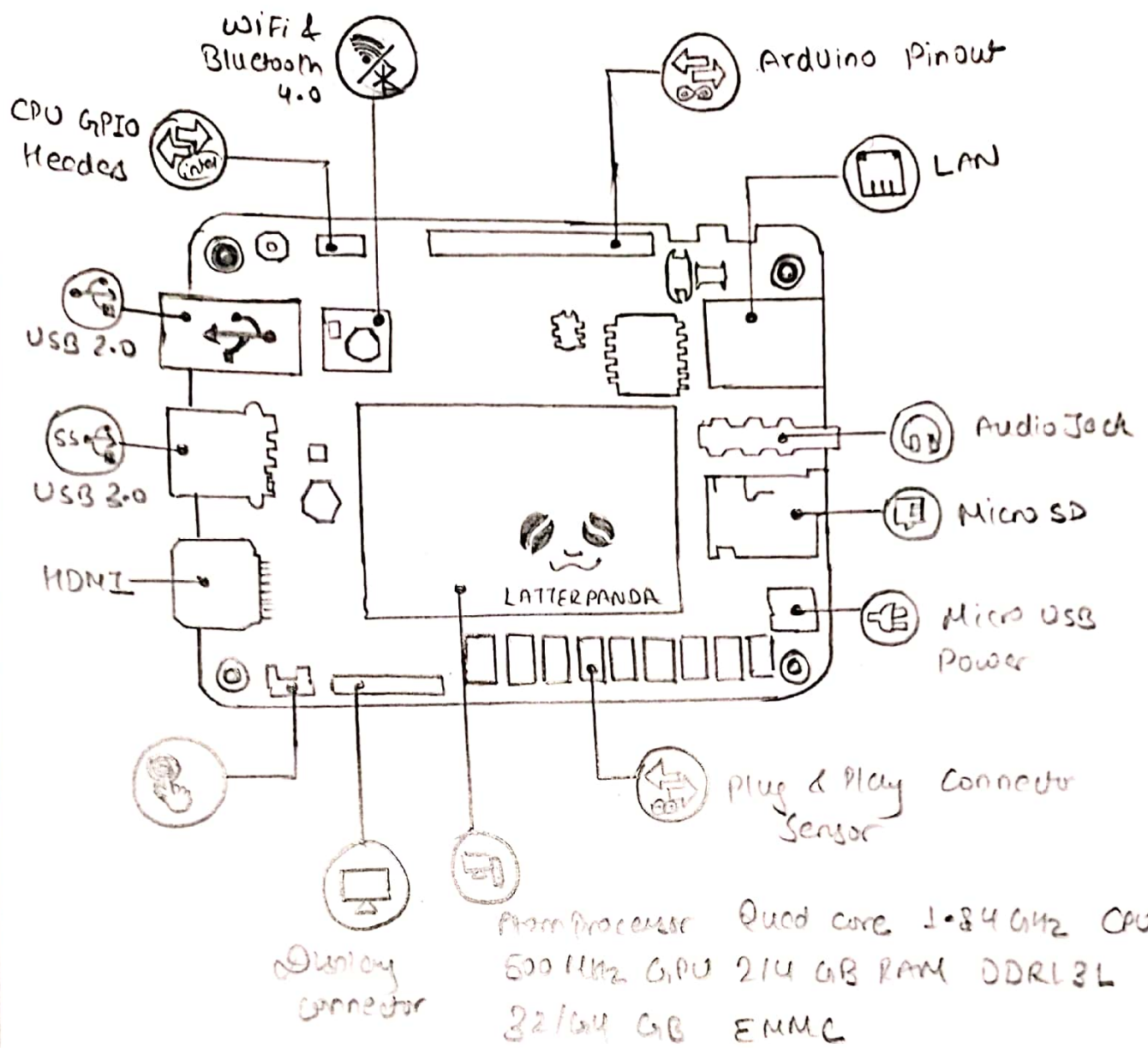


Fig. LattePanda SBC

There are WIFI and Bluetooth 4.0 embedded in the board and video output is through HDMI and MIPI-DSI. There is also an onboard touch panel overlay connector and it supports 100 Mbps Ethernet.

Tinker Board :

Tinker Board is a single board computer (SBC) in the size of credit card that offers class-leading performance while leveraging outstanding mechanical compatibility. The Tinker Board offers makers, IoT enthusiasts, hobbyists, PC DIY-enthusiasts and others a reliable and extremely capable platform for building and tinkering their ideas into reality.

With its powerful and modern quad-core ARM based processor - the Rockchip RK3288, Tinker Board offers significantly improved performance versus other popular SBC boards. Powered by an ARM based Mali-T764 GPU, Tinker Board's GPU and fixed function processors allow for a wide range of uses, including high-quality media playback, gaming, computer vision, gesture recognition, image stabilization and processing, as well as computational photography and more. It is also powered by 2GB Dual Channel DDR3 RAM.

For storage, it uses Micro SD (TF) card slot and RTL 6B LAN network card along with 802.11 b/g/n, Bluetooth V4.0 + EDR for internet and network connectivity.

Tinker Board is equipped with an I2S codec that supports upto 24-bit / 192 kHz audio. Its integrated audio jack supports audio output and a microphone in, without an extension module.

Tinker Board features standard maker connectivity options, including a 40-pin GPIO interface that allows for interfacing with a range of inputs. Tinker Board is equipped with one CSI MIPI connection for displays and touchscreens. The secondary CSI MIPI connection is for connection to compatible cameras allowing for computer vision & much more.

The integrated Wi-Fi and Bluetooth controller on the Tinker Board is shielded with a metal cone to ensure minimal interference and improved radio performance. An integrated IPEX antenna header allows for easy antenna replacement or upgrades. Tinker Board also features a full-size HDMI output. Additionally, it includes four USB 2.0 ports for extensive peripheral and accessory connectivity.

Its form factor is 3.37 inch x 2.125 inch (8.55 cm x 5.4 cm) weighing 55g.