

Embedded Systems

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Single Board Computer

A single-board computer (SBC) is a complete computer built on a single circuit board, with microprocessor(s), memory, input/output (I/O) and other features required of a functional computer.

Types of SBC

High Performance

Low Power and Low Cost

Intel Embedded System

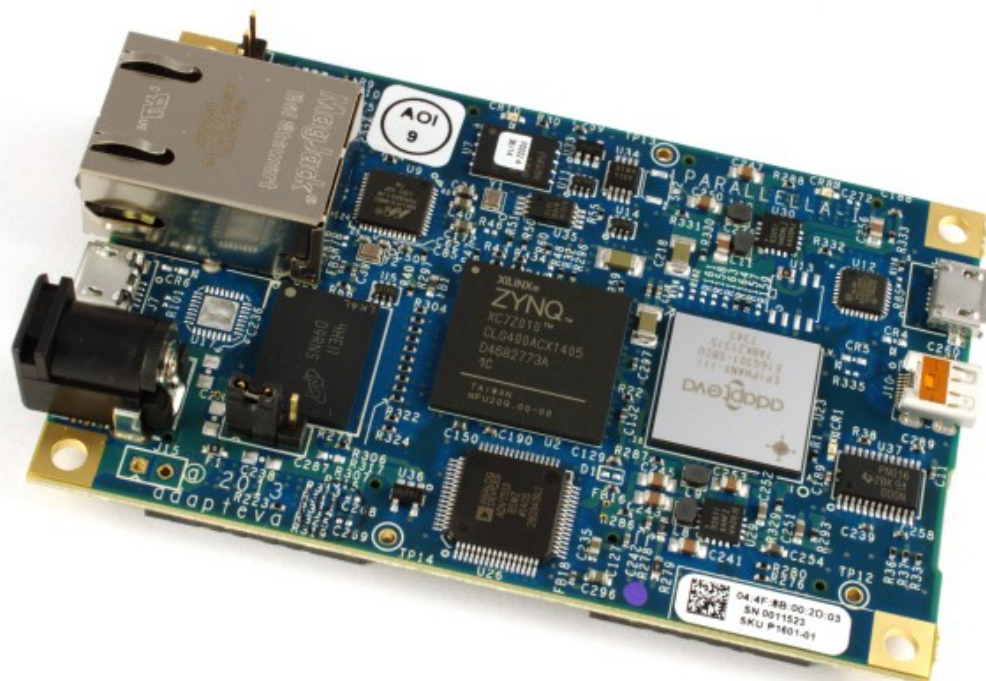
Atom Processor



Parallela

18-core credit card sized computer

- #1 in energy efficiency @ 5W
- 16-core Epiphany RISC SOC
- Zynq SOC (FPGA + ARM A9)
- Gigabit Ethernet
- 1GB SDRAM
- Micro-SD storage
- Up to 48 GPIO pins
- HDMI, USB (optional)
- Open source design files
- Runs Linux



Jetson GPU

GPU: NVIDIA Kepler "GK20a" GPU with 192 SM3.2 CUDA cores (upto 326 GFLOPS)

CPU: NVIDIA "4-Plus-1" 2.32GHz ARM quad-core Cortex-A15 CPU with Cortex-A15 battery-saving shadow-core.



ODROID

- * Samsung Exynos5422 Cortex™-A15 2Ghz and Cortex™-A7 Octa core CPUs
- * Mali-T628 MP6(OpenGL ES 3.1/2.0/1.1 and OpenCL 1.2 Full profile)
- * 2Gbyte LPDDR3 RAM PoP stacked
- * eMMC5.0 HS400 Flash Storage
- * 2 x USB 3.0 Host, 1 x USB 2.0 Host
- * Gigabit Ethernet port
- * HDMI 1.4a for display
- * Size : 83 x 58 x 22 mm approx.(including cooling fan)
- * Linux Kernel 4.9 LTS



RaspberryPi

Model Name	Release Date	CPU	RAM	Graphics	USB Ports	Power Requirements
Raspberry Pi 1 Model A	February 2012	700 MHz single-core	256 MB	Broadcom VideoCore IV	1	1.5 W
Raspberry Pi 1 Model B	February 2012	700 MHz single-core	256 MB	Broadcom VideoCore IV	2	3.5 W
Raspberry Pi 1 Model A+	February 2013	700 MHz single-core	256 MB	Broadcom VideoCore IV	1	1.0 W
Raspberry Pi 1 Model A+ Revision 2	N/A	700 MHz single-core	512 MB	Broadcom VideoCore IV		1.0 W
Raspberry Pi 1 Model B revision 2	August 2012	700 MHz single-core	512 MB	Broadcom VideoCore IV		3.5 W
Raspberry Pi 1 Model B+	February 2013	700 MHz single-core	512 MB	Broadcom VideoCore IV	4	3.0 W
Raspberry Pi 2 Model B	February 2015	900 MHz quad-core	1 GB	Broadcom VideoCore IV	4	4.0 W
Raspberry Pi Zero	November 2015	1,000 MHz single-core	512 MB	Broadcom VideoCore IV	1 OTG	0.8 W
Raspberry Pi 3 Model B	February 2016	1,200 MHz quad-core	1 GB	Broadcom VideoCore IV with higher clock speeds	4	4.0 W

RaspberryPi Hardware

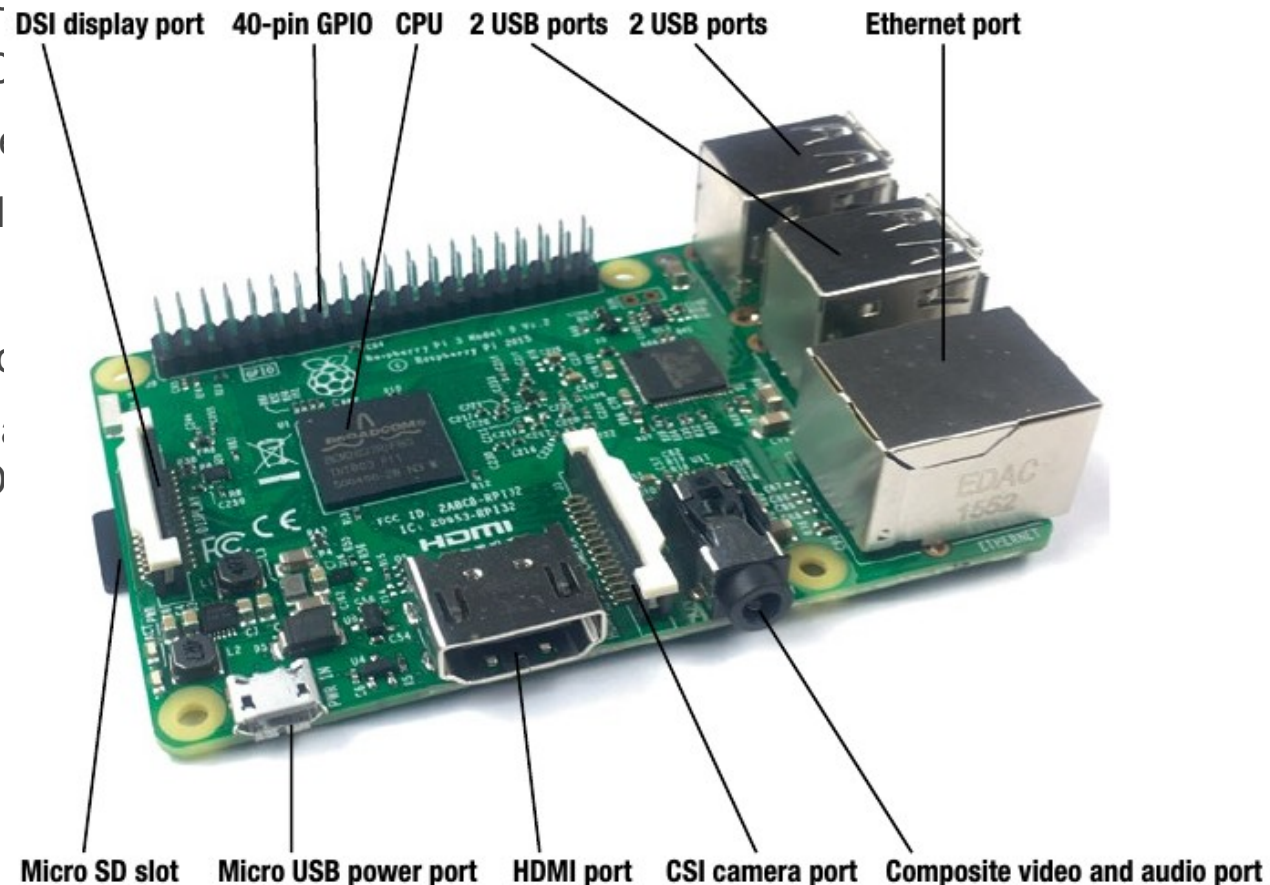
SoC: Broadcom BCM2837

- CPU: 4× ARM Cortex-A53, 1.2GHz
- GPU: Broadcom VideoCore IV
- RAM: 1GB LPDDR2 (900 MHz)
- Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless
- Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
- Storage: microSD
- GPIO: 40-pin header, populated
- Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

RaspberryPi Hardware

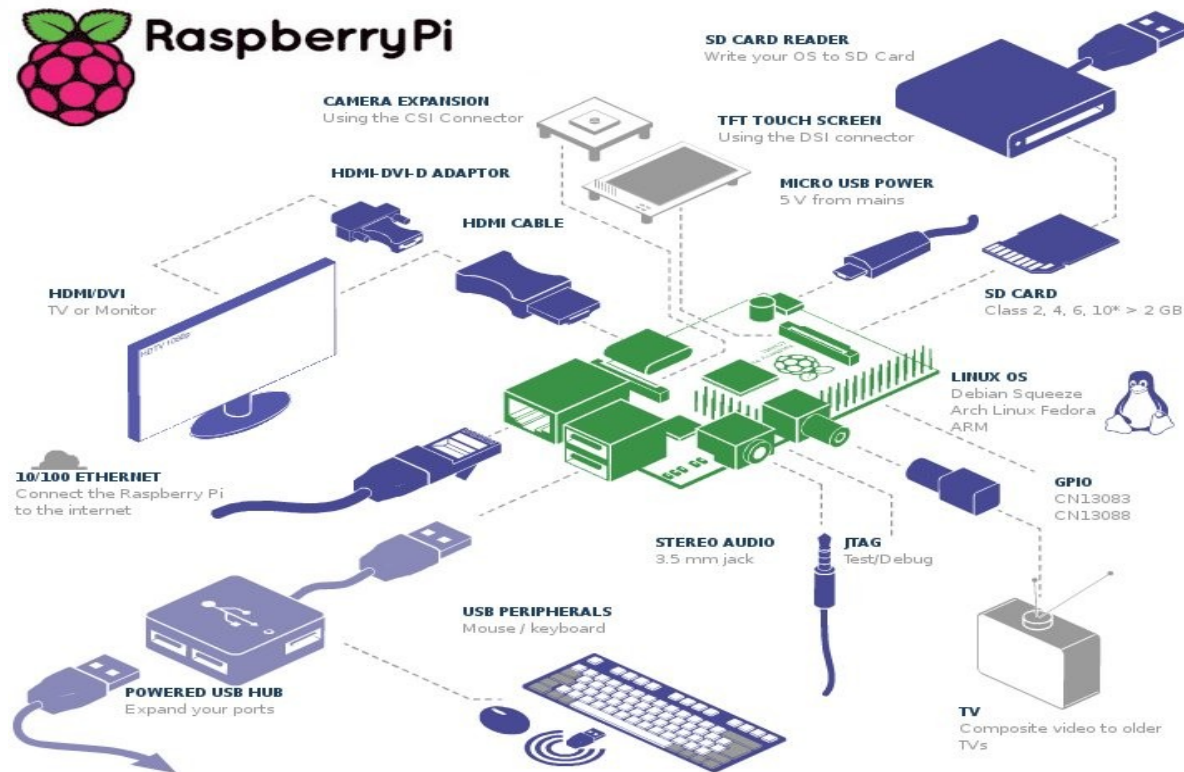
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- GPU: Broadcom VideoCore IV
- RAM: 1GB LPDDR2 (900MHz)
- Networking: 10/100 Ethernet
- Bluetooth: Bluetooth 4.1
- Storage: microSD
- GPIO: 40-pin header, pins 1-26
- Ports: HDMI, 3.5mm and 4-pin TRRS, USB
- Serial Interface (CSI), DSI



Brand	Models	CPU	RAM	+	Price	Type	Connectivity
Arduino	20+ and many clones (Spark, Intel, and so on)	ATmega, 8–64 MHz, Intel Curie, Linino	16 KB–64 MB	Largest community	~30 USD	RTOS, Linux, hobbyists	Pluggable extension boards (Wi-Fi, GPRS, BLE, Zigbee, and so on)
Raspberry Pi	A, A+, B, B+, 2, 3, Zero	ARMv6 or v7, 700 MHz -1.2 GHz	256–1 GB	Full Linux, GPU, large community	~5-35 USD	Linux, hobbyists	Ethernet, extension through USB, BLE (Pi3)
Intel	Edison	Intel Atom 500 MHz	1 GB	X86, full Linux	~50 USD	Linux, hobbyist to industrial	Wi-Fi, BLE
BeagleBoard	BeagleBone Black, X15, and so on	AM335x 1 GHz ARMv7	512 MB–2 GB	Stability, full Linux, SDK	~50 USD	Linux, hobbyist to industrial	Ethernet, extension through USB and shields
Texas Instruments	CC3200, SoC IoT, and so on	ARM 80 MHz, etc.	from 256 KB	Cost, Wi-Fi	<10 USD	RTOS, industrial	Wi-Fi, BLE, Zigbee
Marvell	88MC200, SoC IoT, and so on	ARM 200 MHz, etc.	from 256 KB	Cost, Wi-Fi, SDK	<10 USD	RTOS, industrial	Wi-Fi, BLE, Zigbee
Broadcom	WICED, and so on (also at the heart of the Raspberry Pis)	ARM 120 MHz, and so on	from 256 KB	Cost, Wi-Fi, SDK	<10 USD	RTOS, industrial	Wi-Fi, BLE, Zigbee, Thread

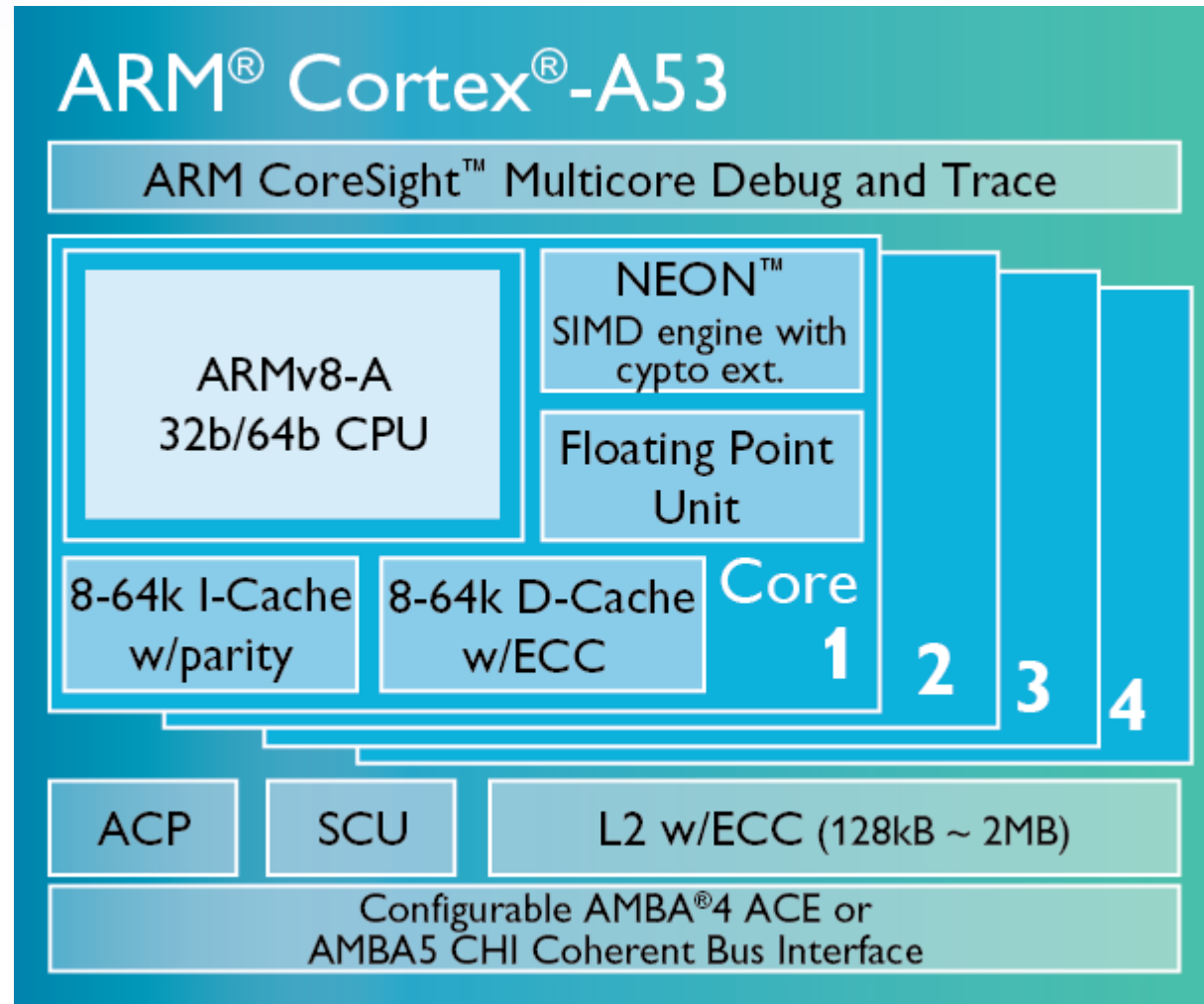
Architecture: RasPi



Using RPi





















Because it has an ARM cortex-a processor, it can run the full range of ARM GNU/Linux distributions, including Snappy Ubuntu Core, as well as Microsoft Windows 10.

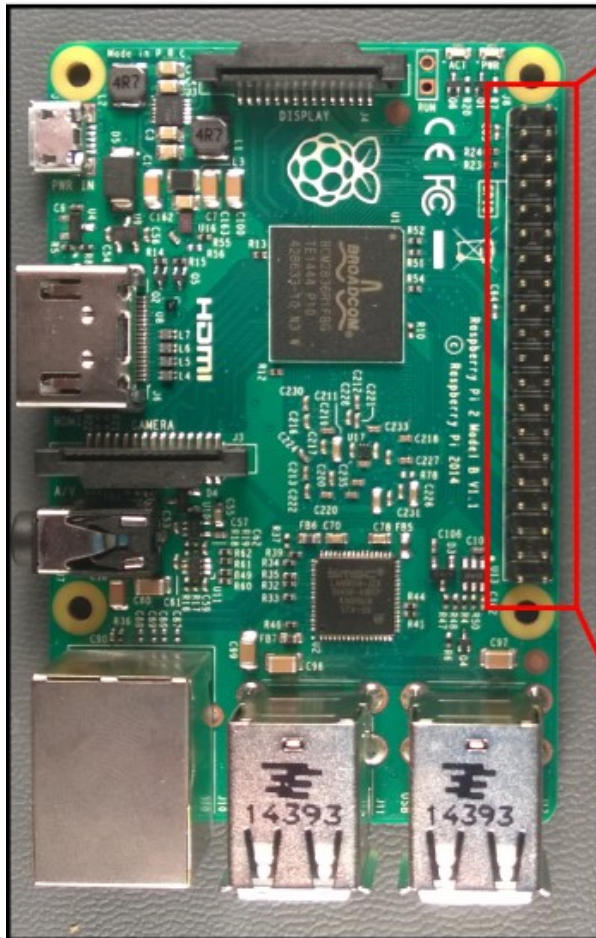
ARM Cortex-A53 Architecture



GPIOs: General Purpose Input Outputs

Raspberry Pi2 GPIO Header

Pin#	NAME		NAME	Pin#
01	3.3v DC Power		DC Power 5v	02
03	GPIO02 (SDA1 , I ² C)		DC Power 5v	04
05	GPIO03 (SCL1 , I ² C)		Ground	06
07	GPIO04 (GPIO_GCLK)		(TXD0) GPIO14	08
09	Ground		(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)		(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)		Ground	14
15	GPIO22 (GPIO_GEN3)		(GPIO_GEN4) GPIO23	16
17	3.3v DC Power		(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)		Ground	20
21	GPIO09 (SPI_MISO)		(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)		(SPI_CE0_N) GPIO08	24
25	Ground		(SPI_CE1_N) GPIO07	26
27	ID_SD (I ² C ID EEPROM)		(I ² C ID EEPROM) ID_SC	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12	32
33	GPIO13		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40



Alternate Function					Alternate Function
	3.3V PWR	1		2	5V PWR
I2C1 SDA	GPIO 2	3		4	5V PWR
I2C1 SCL	GPIO 3	5		6	GND
	GPIO 4	7		8	UART0 TX
	GND	9		10	UART0 RX
	GPIO 17	11		12	GPIO 18
	GPIO 27	13		14	GND
	GPIO 22	15		16	GPIO 23
	3.3V PWR	17		18	GPIO 24
SPI0 MOSI	GPIO 10	19		20	GND
SPI0 MISO	GPIO 9	21		22	GPIO 25
SPI0 SCLK	GPIO 11	23		24	GPIO 8
	GND	25		26	GPIO 7
	Reserved	27		28	Reserved
	GPIO 5	29		30	GND
	GPIO 6	31		32	GPIO 12
	GPIO 13	33		34	GND
SPI1 MISO	GPIO 19	35		36	GPIO 16
	GPIO 26	37		38	GPIO 20
	GND	39		40	GPIO 21

Raspi Usage and Applications

