Raspberry Pi GPIO-Part 1

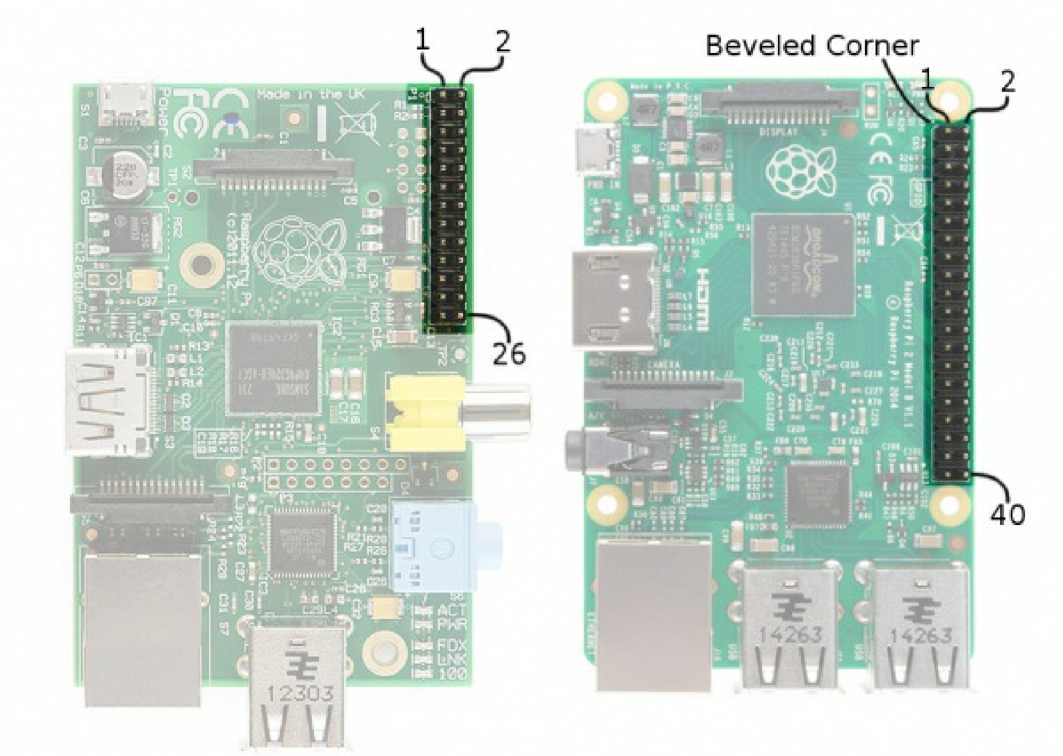
Your Raspberry Pi is more than just a small computer, it is a hardware prototyping tool! The RPi has **bi-directional I/O pins**, which you can use to drive LEDs, spin motors, or read button presses. To drive the RPi's I/O lines requires a bit or programming. You can use a variety of programing languages, but we decided to use a really solid, easy tools for driving I/O: **Python**.

Material needed

- Raspberry Pi 3 B
- Breadboard
- Jumper Wires(M/F)
- Momentary Pushbutton Switch
- 2 Resistors
- 2 LEDs

GPIO Pinout

Raspberry has its GPIO over a standard male header on the board. From the first models to the latest, the header has expanded from 26 pins to 40 pins while maintaining the original pinout.



There are (at least) two, different numbering schemes you may encounter when referencing **Pi pin numbers**:

1. **Broadcom chip-specific** pin numbers.
2. **P1 physical** pin numbers.

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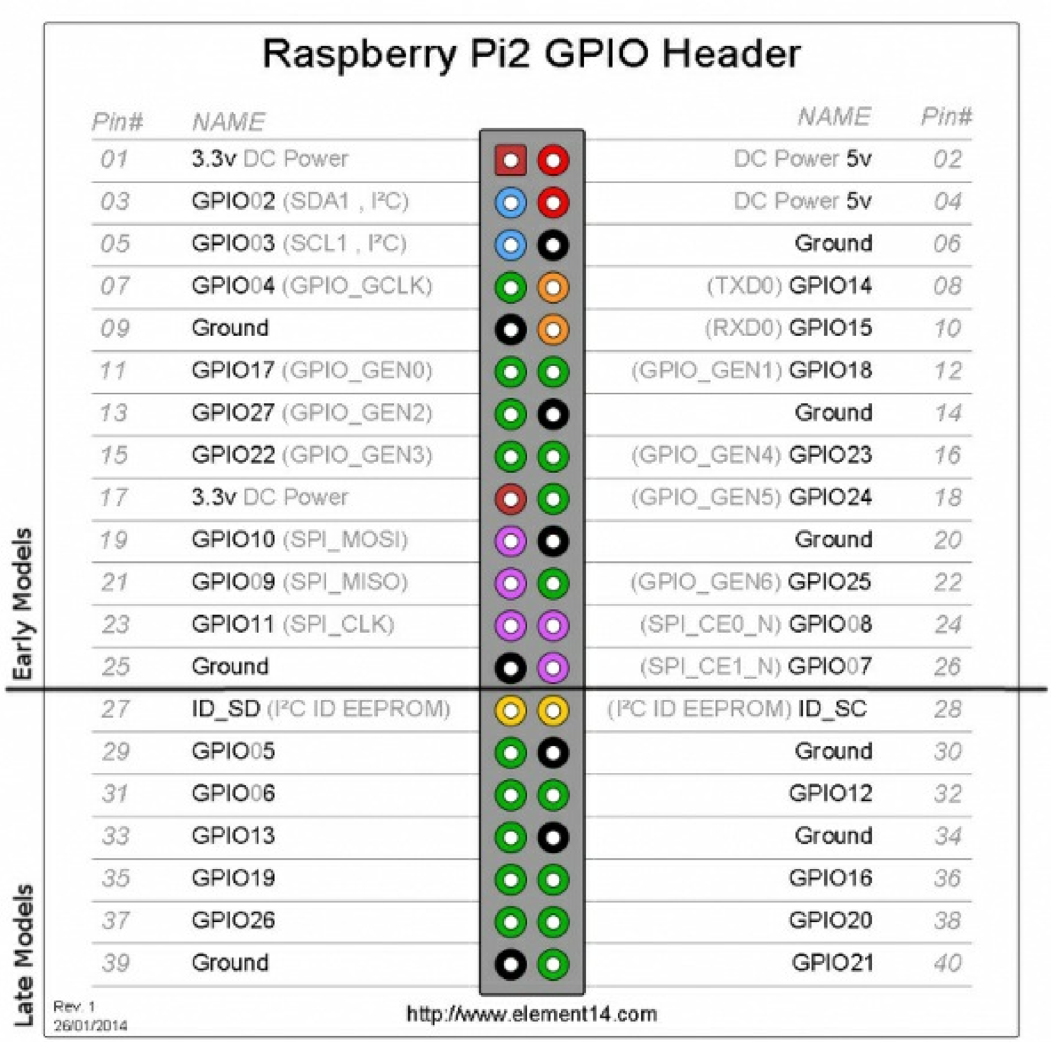
You can use use either number-system, but when you are programming how to use the pins, it require that you declare which scheme you are using at the very beginning of your program. We will see this later.

The next table shows all 40 pins on the P1 header, including any special function they may have, and their dual numbers:



In the next table we show other numbering system along with the ones we showed above: Pi pin header numbers and element14 given names: wiringPi numbers, Python numbers, and related silkscreen on the wedge. The Broadcom pin numbers in the table are relate to RPi Model 2 and later only.

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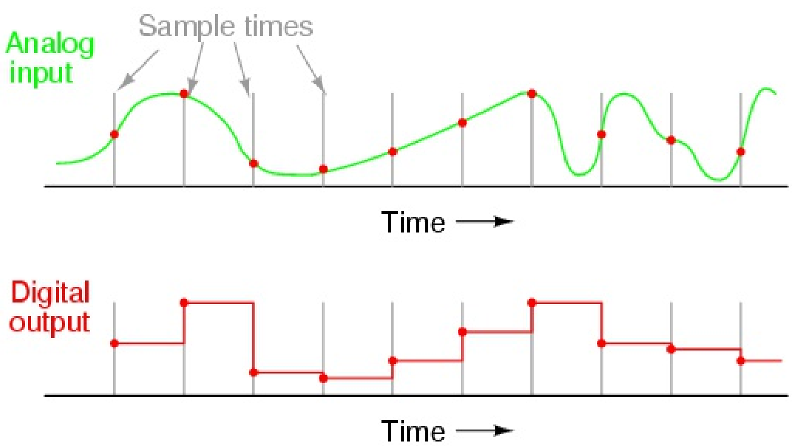
Wedge Silk	Python (BCM)	WiringPi GPIO	Name	**P1 Pin Number**		Name	WiringPi GPIO	Python (BCM)	Wedge Silk
			3.3v DC Power	**1**	**2**	5v DC Power			
SDA		8	GPIO02 (SDA1, I2C)	**3**	**4**	5v DC Power			
SCL		9	GPIO03 (SCL1, I2C)	**5**	**6**	Ground			
G4	4	7	GPIO04 (GPIO_GCLK)	**7**	**8**	GPIO14 (TXD0)	15		TXO
			Ground	**9**	**10**	GPIO15 (RXD0)	16		RXI
G17	17	0	GPIO17 (GPIO_GEN0)	**11**	**12**	GPIO18 (GPIO_GEN1)	1	18	G18
G27	27	2	GPIO27 (GPIO_GEN2)	**13**	**14**	Ground			
G22	22	3	GPIO22 (GPIO_GEN3)	**15**	**16**	GPIO23 (GPIO_GEN4)	4	23	G23
			3.3v DC Power	**17**	**18**	GPIO24 (GPIO_GEN5)	5	24	G24
MOSI		12	GPIO10 (SPI_MOSI)	**19**	**20**	Ground			
MISO		13	GPIO09 (SPI_MISO)	**21**	**22**	GPIO25 (GPIO_GEN6)	6	25	G25
		(no worky 14)	GPIO11 (SPI_CLK)	**23**	**24**	GPIO08 (SPI_CE0_N)	10		CD0
			Ground	**25**	**26**	GPIO07 (SPI_CE1_N)	11		CE1
IDSD		30	ID_SD (I2C ID EEPROM)	**27**	**28**	ID_SC (I2C ID EEPROM)	31		IDSC
G05	5	21	GPIO05	**29**	**30**	Ground			
G6	6	22	GPIO06	**31**	**32**	GPIO12	26	12	G12
G13	13	23	GPIO13	**33**	**34**	Ground			
G19	19	24	GPIO19	**35**	**36**	GPIO16	27	16	G16
G26	26	25	GPIO26	**37**	**38**	GPIO20	28	20	G20
			Ground	**39**	**40**	GPIO21	29	21	G21

This table shows that the RPi not only gives you access to the bi-directional I/O pins, but also Serial (UART), I2C, SPI, and even some PWM ("analog output").

Analog vs. Digital

Before starting with our practise, we will revise the difference between **analog** and **digital** signals. Both are used to transmit information, usually through **electric signals**. In both these technologies, the information, such as any audio or video, is transformed into electric signals. The **difference between analog and digital**:

- In **analog technology**, information is translated into electric pulses of varying amplitude.
- In **digital technology**, translation of information is into binary format (zero or one) where each bit is representative of two distinct amplitudes.



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Comparison chart

	Analog	Digital
Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
Waves	Denoted by sine waves.	Denoted by square waves.
Representation	Uses continuous range of values to represent information.	Uses discrete or discontinuous values to represent information.
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs, and other digital electronic devices.
Technology	Analog technology records waveforms as they are.	Samples analog waveforms into a limited set of numbers and records them.
Data transmissions	Subjected to deterioration by noise during transmission and write/read cycle.	Can be noise-immune without deterioration during transmission and write/read cycle.
Response to Noise	More likely to get affected reducing accuracy	Less affected since noise response are analog in nature
Flexibility	Analog hardware is not flexible.	Digital hardware is flexible in implementation.
Uses	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Applications	Thermometer	PCs, PDAs
Bandwidth	Analog signal processing can be done in real time and consumes less bandwidth.	There is no guarantee that digital signal processing can be done in real time and consumes more bandwidth to carry out the same information.
Memory	Stored in the form of wave signal.	Stored in the form of binary bit.
Power	Analog instrument draws large power.	Digital instrument drawS only negligible power.

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Cost	Low cost and portable.	Cost is high and not easily portable.
Impedance	Low	High order of 100 megaohm
Errors	Analog instruments usually have a scale which is cramped at lower end and give considerable observational errors.	Digital instruments are free from observational errors like parallax and approximation errors.

Suggested readings

- Pulse-Width Modulation – You can use PWM to dim LEDs or send signals to servo motors. The RPi has a single PWM-capable pin.
- Light-Emitting Diodes (LEDs) – To test the output capabilities of the Pi we will use some Leds.
- Switch Basics – To test inputs to the Pi, we will use buttons and switches.
- Pull-Up Resistors – The Pi has internal pull-up (and pull-down) resistors. These are very handy when you are interfacing buttons with the little computer.

References[1, 2]

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