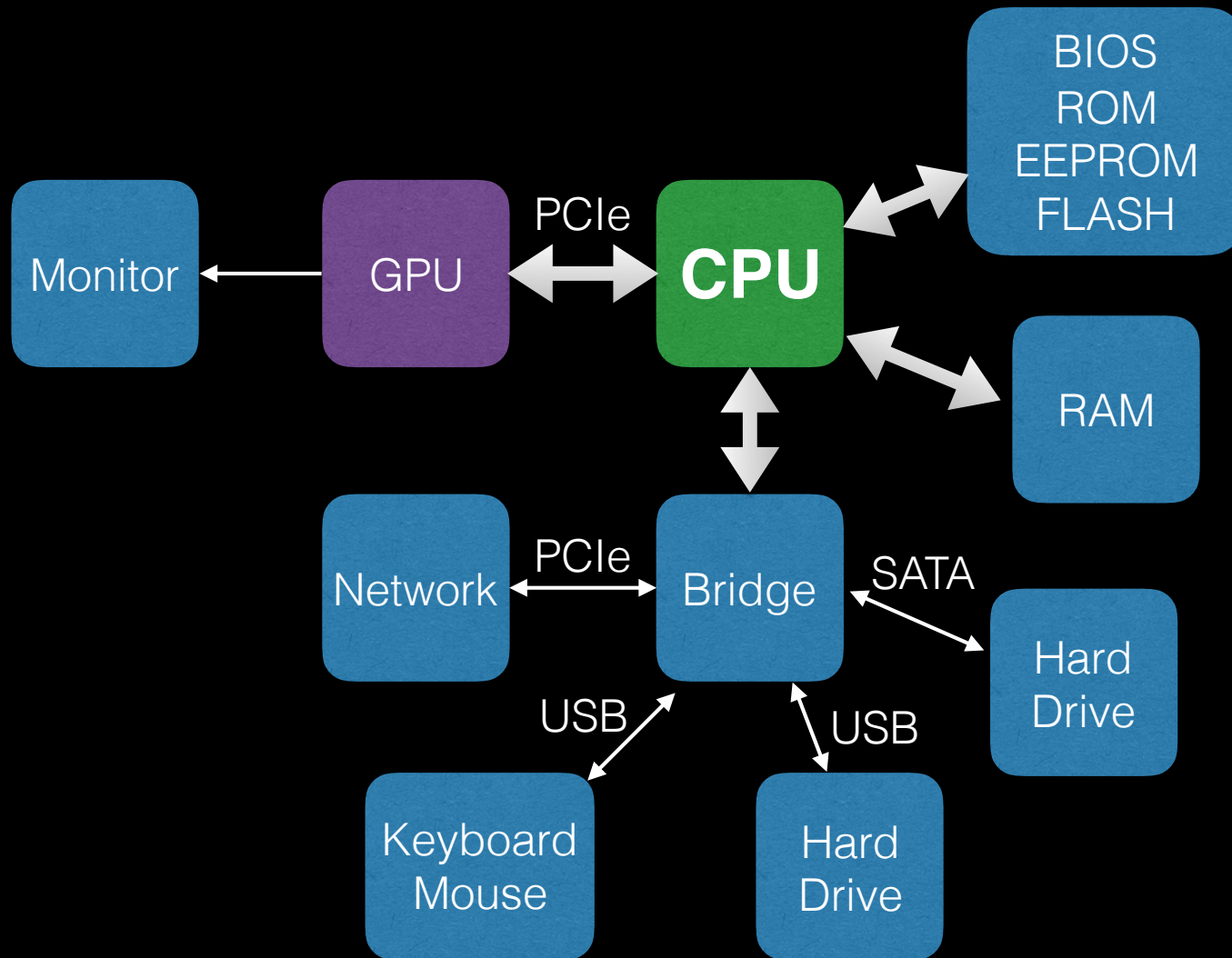


Lecture 12

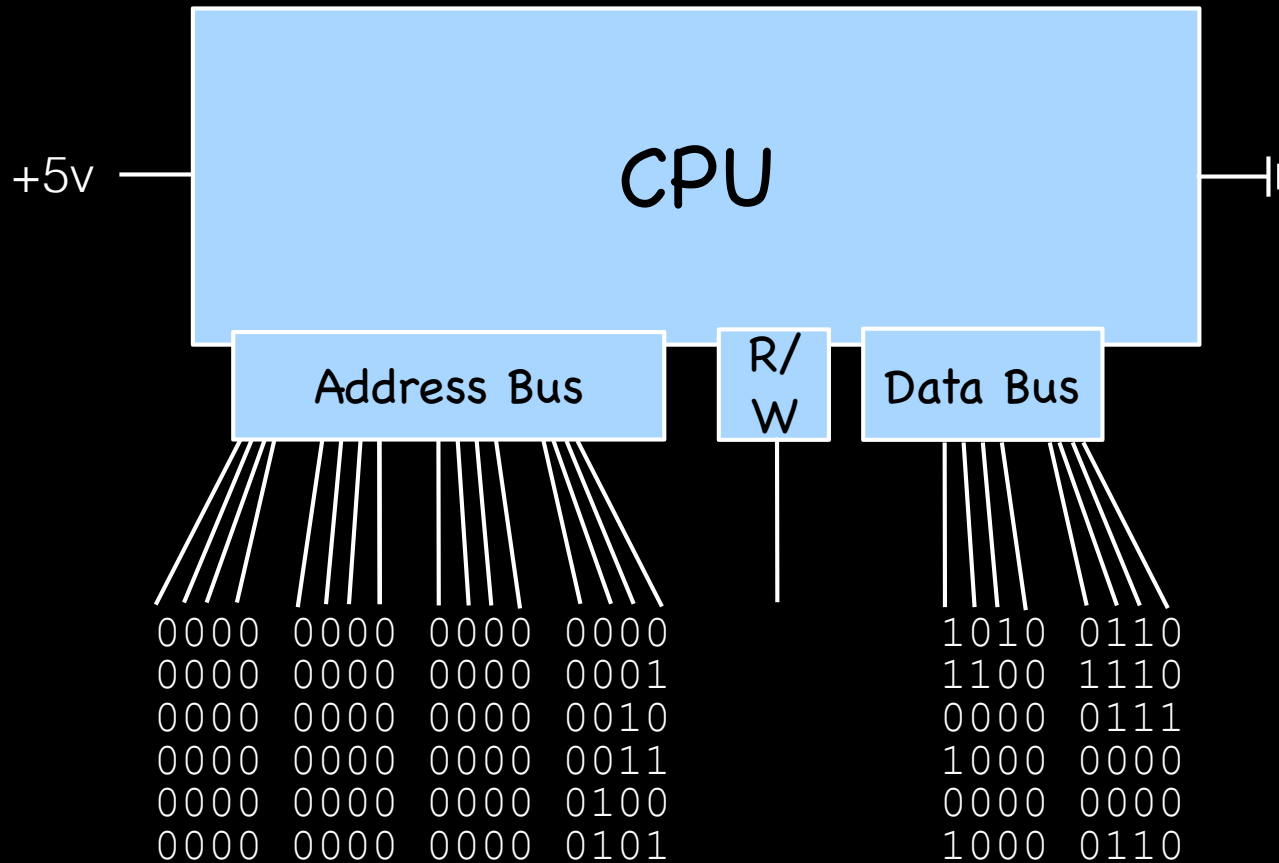
Controlling the Outside World







Prof. Steven Ludtke
N410.07, sludtke@bcm.edu

Inside a Computer






Digital Circuits









	Speed (Mb/s)	Range (m)	description	connector
PCIe (1x/16x)	250/4000	internal	16x mainly for video	
PCI (32/64)	133	internal	64 not widely used	
AGP (1x-8x)	266-2133*	internal	largely obsolete, for video	
network (10/100/1000)	1/12/120	100	1000=gigabit, 10G exists	
802.11 (a/b/g/n)	6/1/6/30	120/250	N is the new standard, most still use G	wireless
bluetooth	0.3	~10	short range device comm	wireless
IRDA	.01-1(?)	1	bluetooth instead	wireless
firewire/1394 (400/800)	50/100	4.5/?	external disks, video	
USB (1/2/3)	1.5/60/500	5/5/3	external disks, etc.	
Thunderbolt	2000	3	disks, monitors, etc.	
Parallel	1	15	pre-USB for printers	
Serial	0.01		old-style modems, specialty devices	
PS/2	n/a		keyboard & mouse	

Disk Interfaces

	Speed (Mb/s)	connector
SATA/SAS	300,600,1200	
SAS		
IDE/ATA	3-133	
Fibre Channel	100-400	optical, long range (>50km)
SCSI	5-640	many connectors, external short range


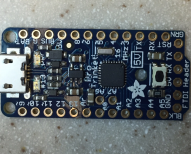
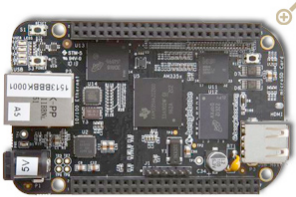

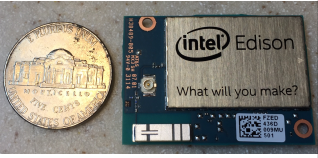
Video Interfaces

	HDCP	Description	Connector
HDMI	X	High definition (digital) consumer video	
DVI	X	Newer style computer video, digital, supports HDCP,	
VGA		Old style computer video, supports high resolution, but analog	
Component		Further improved quality, supports higher resolutions	
S-video		Improved quality, still 640x480	
Composite		Oldest style consumer video, poor quality, poor resolution (640x480)	

Making

- Computer controlled Mills and Lathes
- 3D Printer
 - <http://www.thingiverse.com/>
 - <http://3dprint.nih.gov/>
- Embedded processors
 - sensors
 - motors
 - displays

Embedded Computers

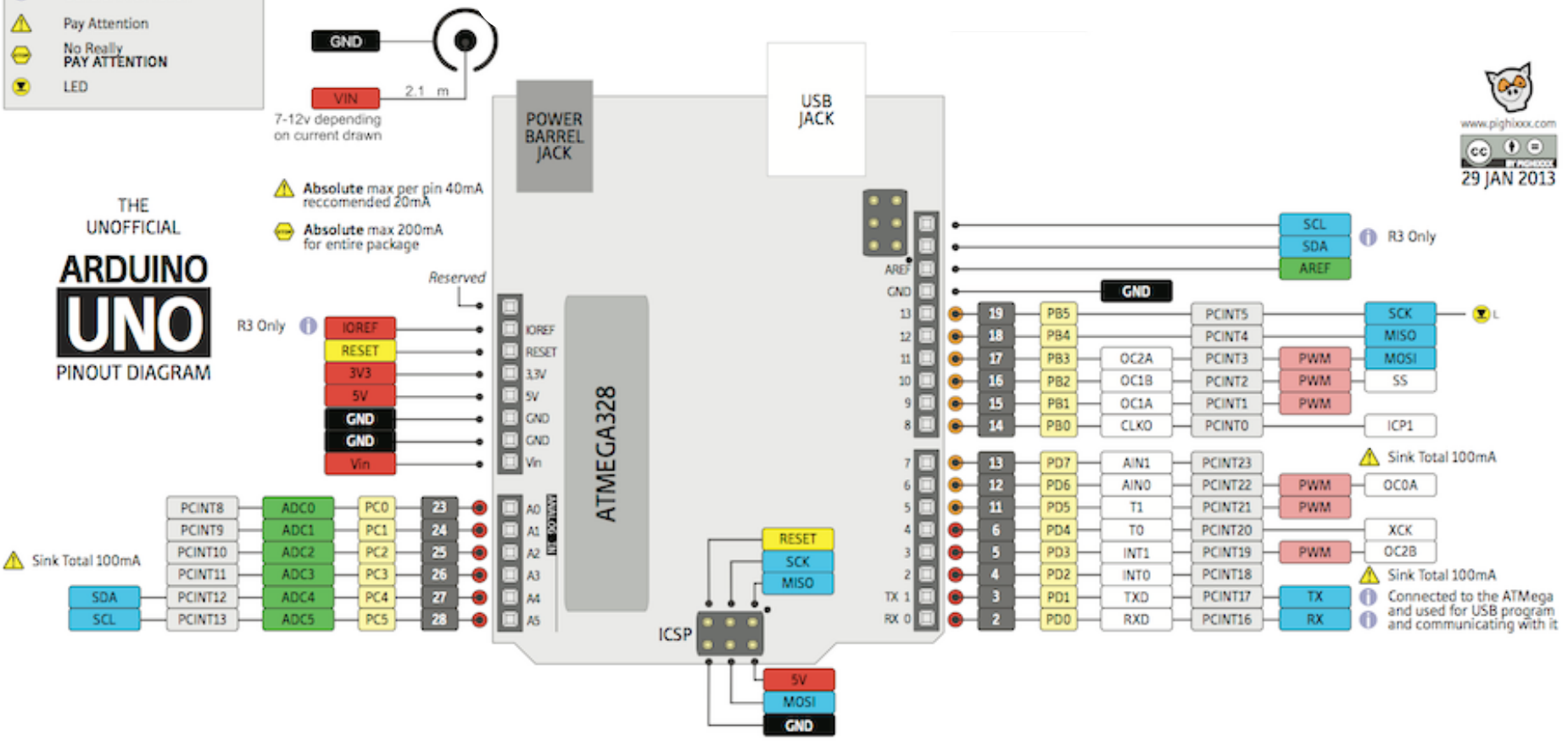
		OS	Speed	I/O	Cost
Arduino		None	8/16 Mhz	14-54 digital, 6-14 PWM, 6-16 analog + Shields !	\$6-65
Trinket Pro		None	16 Mhz	18 digital, 2 analog, 6 PWM, 1 SPI	\$9
BeagleBone Black		Linux + Ard I/O	1 Ghz	HDMI, Ethernet, 2 USB, 65 digital, 8 PWM, 4 timers, 7 analog, 4 serial, 2 I2C, 2 SPI	\$45
Raspberry Pi2		Linux	900 Mhz quad +	4 USB, HDMI, Vid, Audio, Ethernet, SD, Camera, GPIO, I2C, SPI	\$35
Intel Edison		Linux	Dual Core 500Mhz	WiFi, Bluetooth 4, I2C, SPI, 14 digital, 4 PWM	\$40

Arduino

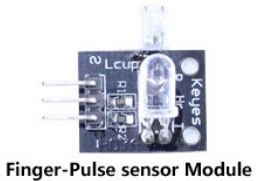
LEGEND

- GND GND
- POWER POWER
- CONTROL CONTROL
- PHYSICAL PIN PHYSICAL PIN
- PORT PIN PORT PIN
- ATMEGA328 PIN FUNC ATMEGA328 PIN FUNC
- DIGITAL PIN DIGITAL PIN
- ANALOG-RELATED PIN ANALOG-RELATED PIN
- PWM PIN PWM PIN
- SERIAL PIN SERIAL PIN
- ARDUINO PIN ARDUINO PIN

- Source Total 150mA
- Source Total 150mA
- i General Information
- ⚠ Pay Attention
- ⚠ No Really PAY ATTENTION
- ⚠ LED



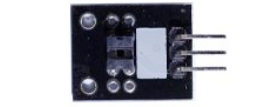
Sensors



Finger-Pulse sensor Module



Hall sensor Module



Light break sensor Module



Magnetic spring Module



RGB LED Module



Push button Module



Microphone sensor Module



Obstacle avoidance sensor Module



Digital-Temperature sensor Module



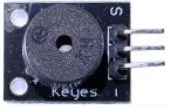
High-sensitive voice sensor Module



Humidity sensor Module



Laser-transmit Module



Passive Buzzer Module



Flame sensor Module

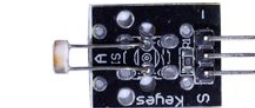


Photo resistor sensor Module



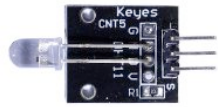
Metal touch sensor Module



Two-color commoncathode LED Module



Knock sensor module



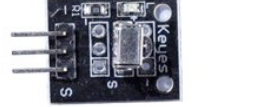
Colorful Auto-flash Module



Infrared-transmit Module



Hydrargyrum-switch sensor Module



Infrared-receive sensor Module



Tracking sensor Module



Tilt-switch Module



Shock-switch sensor Module



Common-cathode RED&GREEN LED Module



Linear-Hall Sensor Module



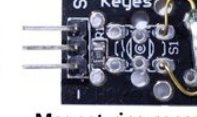
Rotate-encode Module



Relay Module



Active buzzer Module



Magnet-ring sensor Module



Joystick PS2 Module



18b20 temperature sensor Module



RGB LED Module



Analog-temperature sensor Module

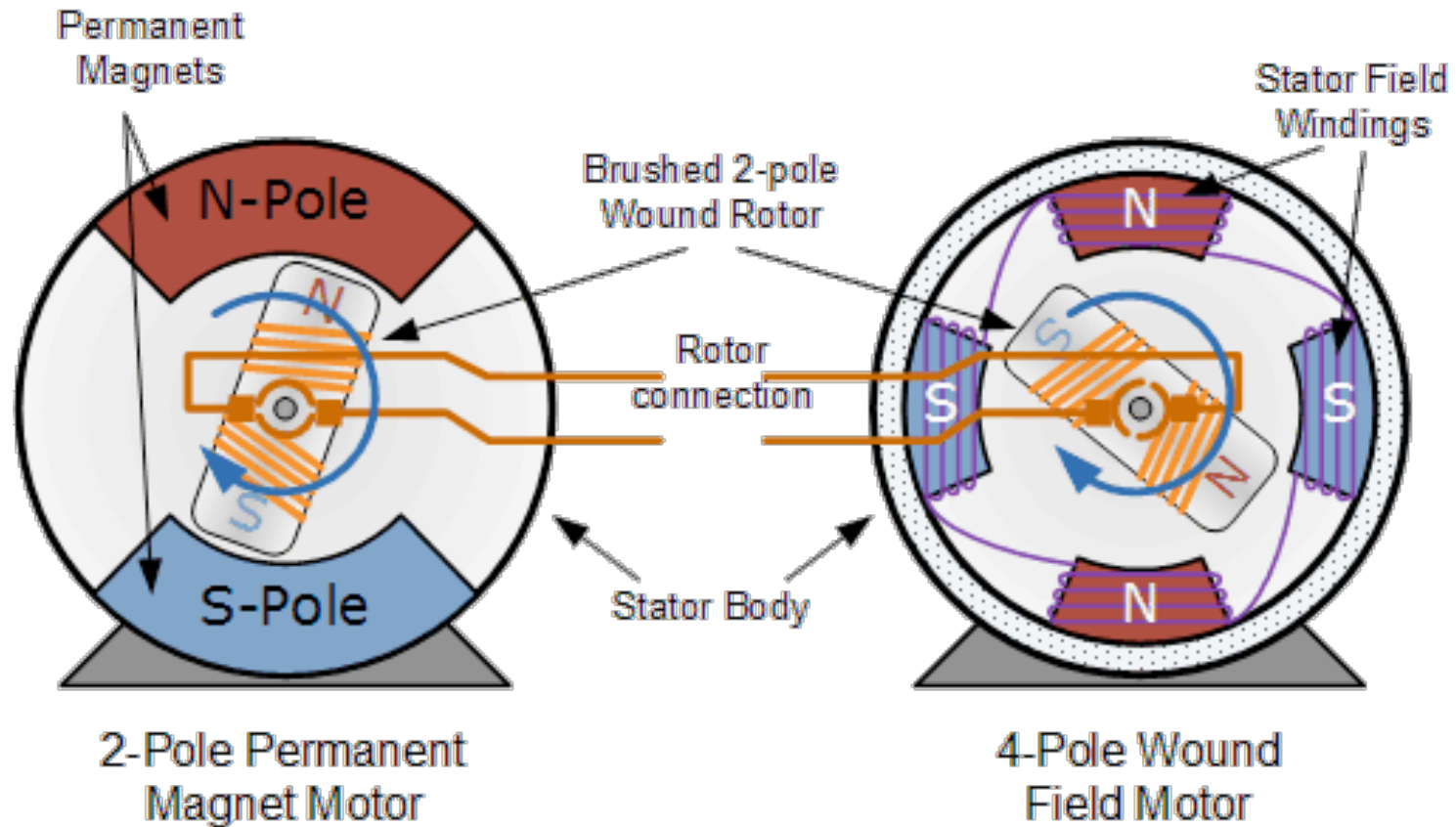


Magic-ring Module

Motors

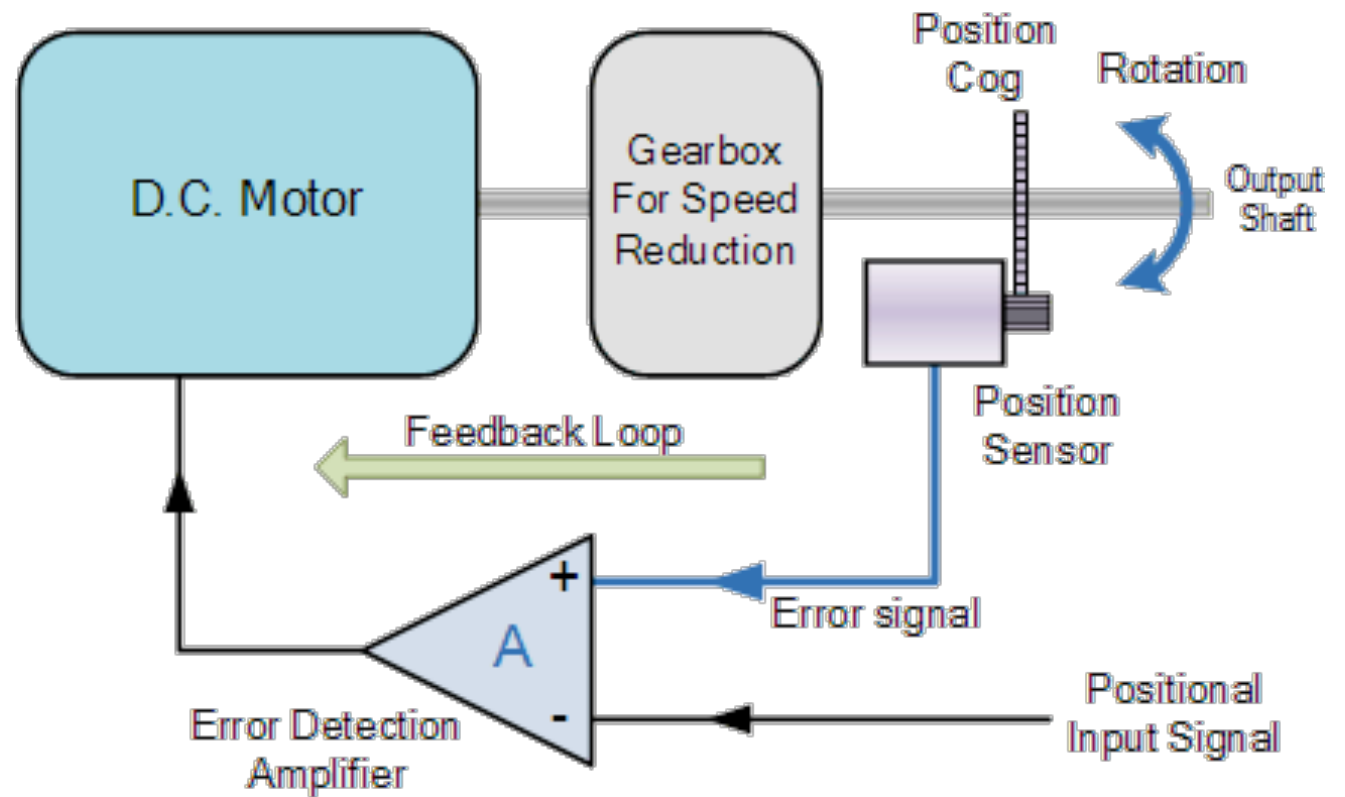
DC/AC Motor	Speed Control	Constant Voltage with Duty Cycle	1 PWM & Power Amp
Gearbox Motor	Speed Control	Same, but slower	1 PWM & Power Amp
Continuous Servo	Digital Speed Control	PWM Controls Speed	1PWM
Standard Servo	Control Angle	PWM Controls Angle	1PWM
Stepper	Digital Positioning	Stepping Sequence	Unipolar: 4 digital + Amp

Standard Motor



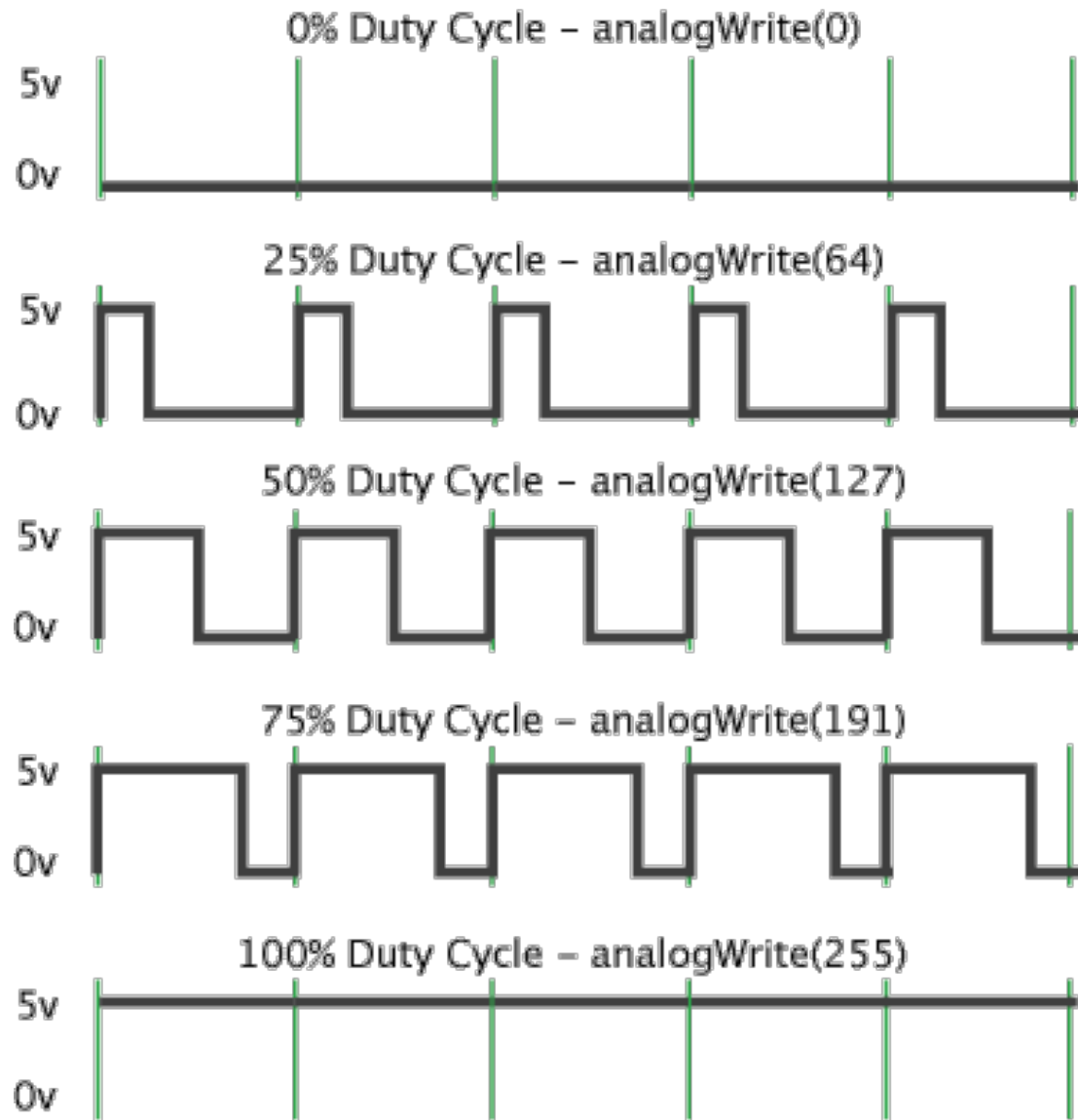
http://www.electronics-tutorials.ws/io/io_7.html

Servo Motor



PWM

Pulse Width Modulation



Raspberry Pi2

- The Raspberry Pi is a series of credit card-sized single-board computers developed in England, United Kingdom by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools and developing countries → \$35
- A 900MHz quad-core ARM Cortex-A7 CPU (~0.35 GFlops) Linux PC
- 1GB RAM
- 4 USB ports, HDMI, Ethernet
- 40 GPIO pins
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- VideoCore IV 3D graphics core

Raspberry Pi 2

GPIO Pinout Diagram

