Today's plan:

- Announcements
- Integer declaration
- Sensors – continuation
- Motors, Servos, etc
- Serial communication
- Controlling things with the microcontroller

Lecture test
during the first lecture after the midterm break (Feb 25)

I will bring to class or describe a MSP430 based system doing something. It will only use hardware covered in the manual (excluding part 9). You will have to specify all the connections and write a program in C which will run this system as shown. List of connections or photographed sketch on paper are both acceptable.

You will be using your computer with all the programs you have written or tested as well as any notes or texts and the lab manual and lectures. You will submit your program as a pdf file on Canvas when the time is up (no later). 10% penalty per minute!

Its all on the honor system, you will be expected to switch off any communication programs including email, texting and so on, on your computer and not to communicate with anybody or AI.

No labs or lectures next week

Test on Tuesday Feb 25th, 2024. Make sure that you have all you might need on your computer.

Before the next labs (week of February 24) please make sure to submit the plan for your project. We can discuss it during labs.

Confusion in int declaration

Int declaration for MSP means 16 bits integer.

If you want to make sure that a variable has certain length and is unsigned use for example:

uint8_t a=126; //a is an unsigned 8 bit integer

Notice that it can only represent the numbers between 0 and 255

or

uint16_t b=12600 ; //b is an unsigned 16 bit integer

It can represent the numbers between 0 and 65536

Math results on integers

- uint16_t b=a/100*1500;
- If a = 20 what is the result?
- 0 not 300!
- Use:
- uint16_t b=a*15; //instead!

Sensors and Actuators

Available sensors:

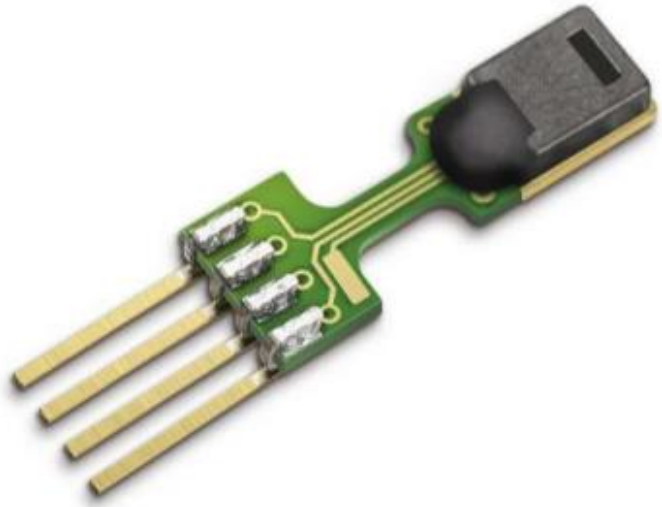
- Optical sensors
- Temperature
- Humidity
- Magnetic field
- Pressure
- Distance
- Position and bend
- Accelerometer
- Gyroscope
- Alcohol
- GPS
- Infrared
- Infrared camera sensor
- Heart beat and blood oxygenetion

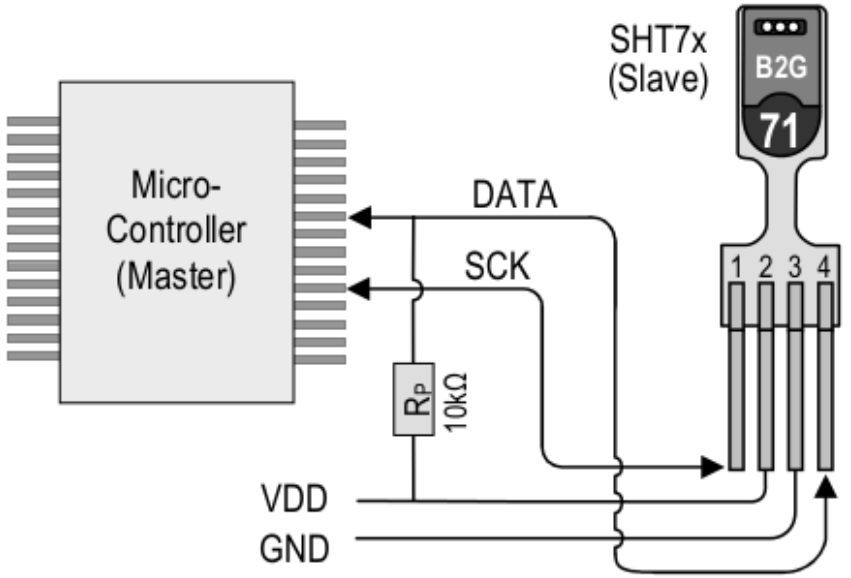
Actuators

- Servo motors
- Stepper motors
- DC motors
- Relays,
- Solenoids
- “Robot” platforms

SHT75 Temperature and Humidity Sensor

- Fully Calibrated
- Digital output
- Low power consumption
- Excellent long term stability
- two-wire serial interface.
- Accuracy +/- 0.5C



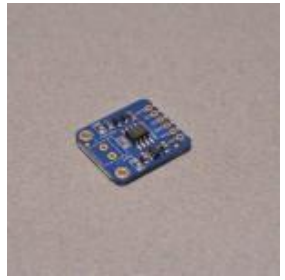


DS18B20 Temperature only

-Inexpensive,
- somewhat complicated interface
- high resolution 0.0625 degrees
- accuracy (+/- 0.5C)
- easy to multiplex many sensors

Also:

- Thermocouples
- Thermistors
- IR no contact sensor

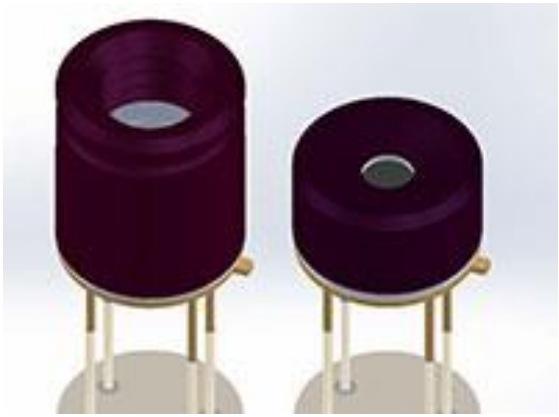



MLX90614:

Infrared camera sensor

MLX90640 FIR Sensor

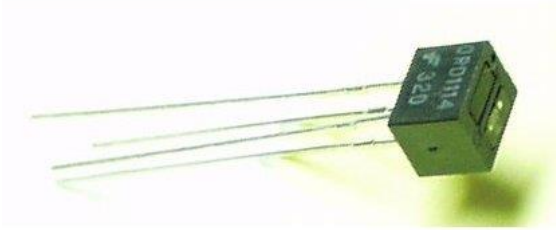
- Small size, low cost 32 pixel x 24 pixel IR array
- Easy to integrate
- Industry-standard 4 lead TO39 package
- Factory calibrated
- I^2C compatible digital interface
- Programmable frame rate 0.5 Hz to 32 Hz
- 3 V supply voltage
- 2 FOV options: 55° x 35° and 110° x 75°



Distance Sensors:

- Optical:

short range QRD1114,
medium range GP2D12



- Ultrasonic

Magnetic Field Sensors:

- Hall effect

on-off vs field measurement

- magneto-resistive
- magneto-inductive
- Compass modules

eg: Devantech CMPS03 compass module

Position Sensor:

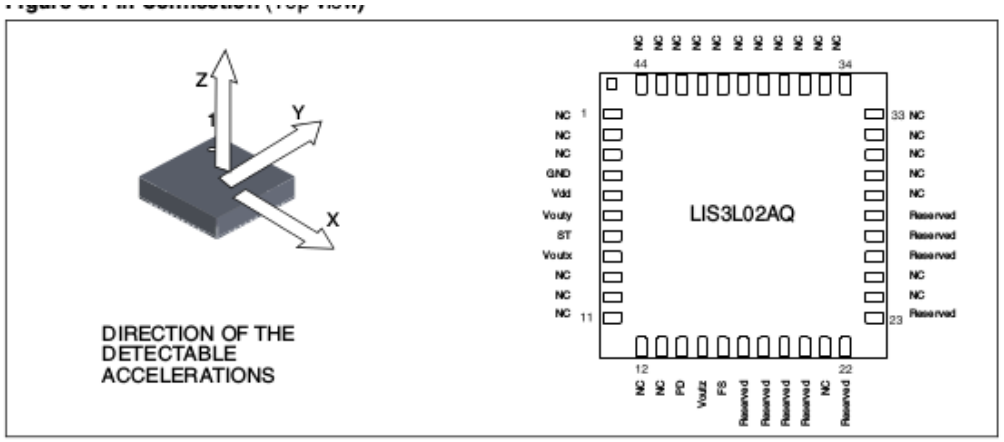
- Potentiometers (3/4 turn, 10 turn)
- Rotation sensor (unlimited turns)
- Linear potentiometers

Accelerometers, Gyroscopes:

- 1 axis, 2 axis, 3 axis

EG: MPU9150: 3 axis gyroscope,
3 axis accelerometer+ 3 axis magnetic field
I^2C interface for ~$10.

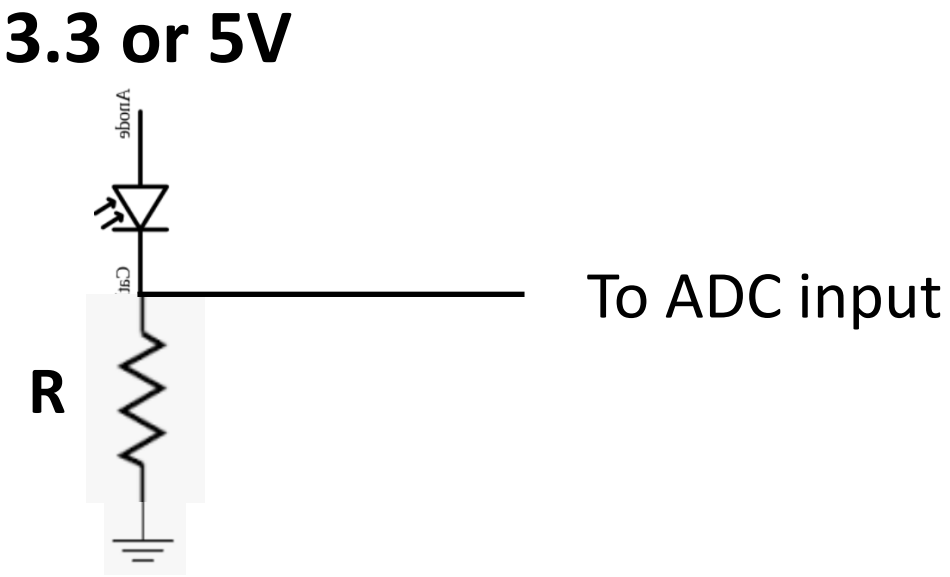
EG: LIS3L02AQ – 3 axis accelerometer with analog outputs.



Pressure Sensors

- Gas or liquid (MPX5100)
- Mechanical (IESF-R-5L)

Connecting resistive or current sensors



R the same order of magnitude
As the resistance range of the sensor

Heart Beat Monitor and Blood Oxygenation Sensor **MAX30102**

- The module is in your kit. You will work with it in the lab (part 9 in the manual).
- It can work as a Heart Beat monitor and Blood Oxygenation sensor.

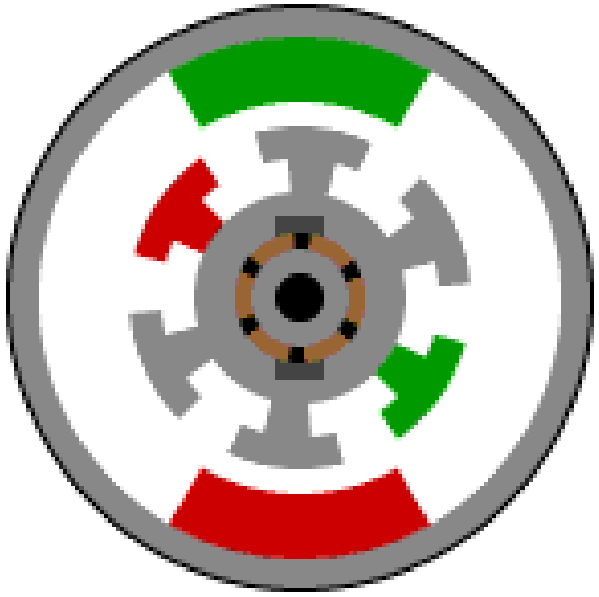
Addresable light strips

- https://www.adafruit.com/product/2842?length=1

Motors, Servos, etc

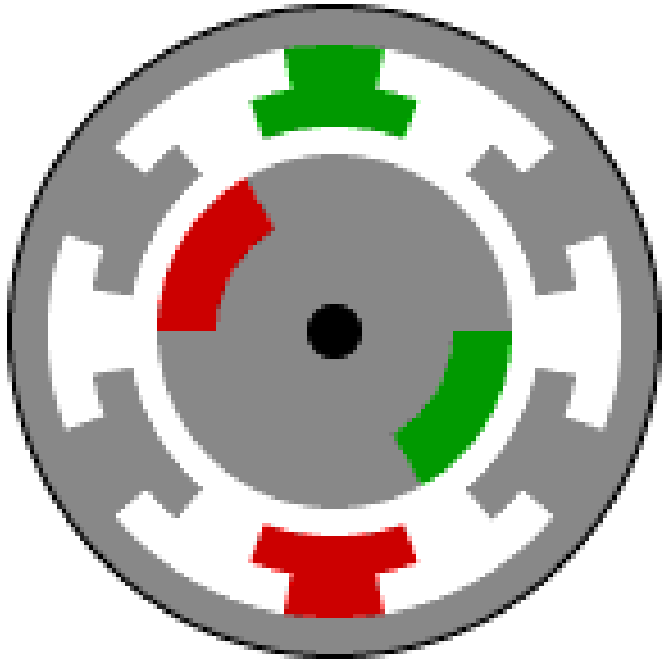
- AC and DC motors
- Stepper motors
- Servo motors
- Solenoids
- Relays
- Solid-state relays

Motors: DC motors



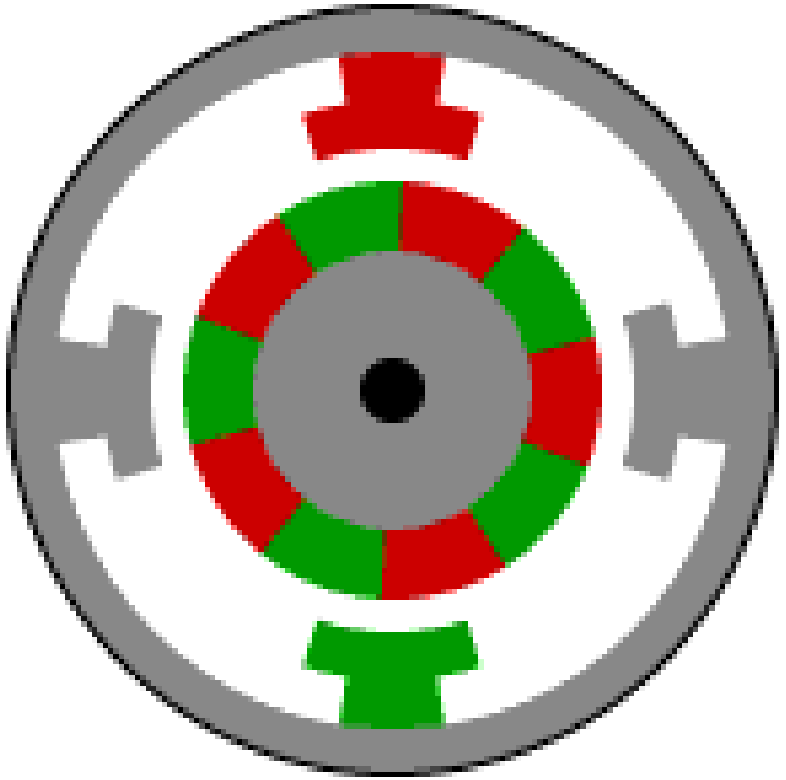
http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORDCTUT_WP

Motors: Brushless DC motors



http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORBLDCTUT_WP

Motors: Stepper motors



Fixed step size, often 200 steps per revolution.

http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORSTEPTUT_WP

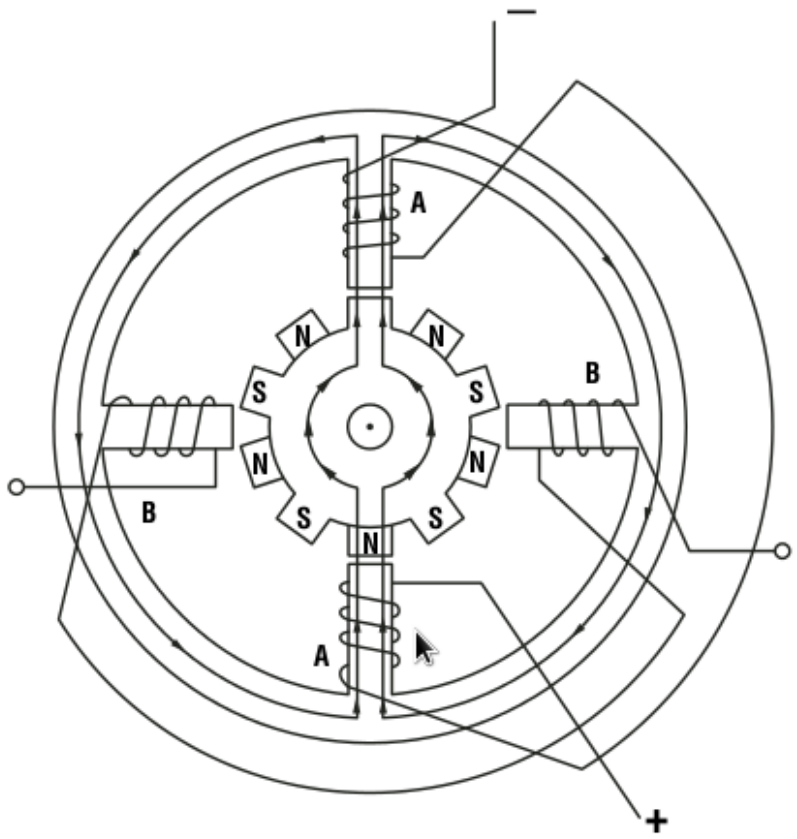
Motors: Servos

photo from Hobby Servo Fundamentals by Darren Sawicz

- precise position control
- One needs a PWM signal to specify position
- typical range of 0-180 degrees

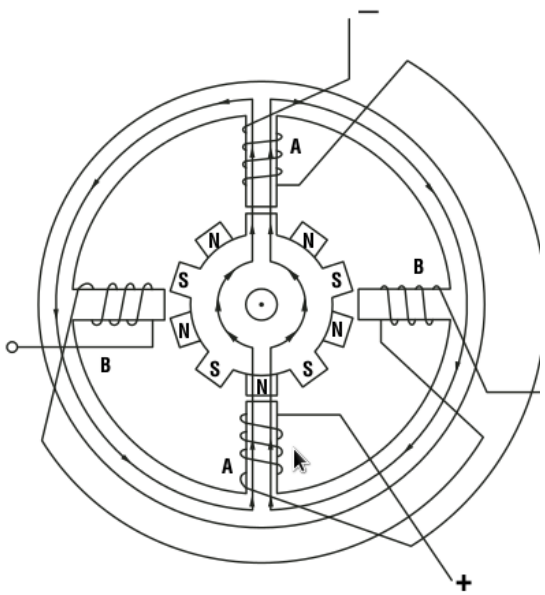
- contains a DC motor, gearing, a potentiometer, control electronics.
- The average PWM voltage is compared to the position, as measured by the potentiometer. The control electronics then drive the motor forward or backward to set the angle as requested.
- Typical PWM period of 20 ms with on time of ~1 – ~2 ms (1.5 ms is 'center'). Wire colours often: red = +5 V, black = ground, white = PWM control.
- Position depends on length of on-pulse.

Motors: Stepper motors

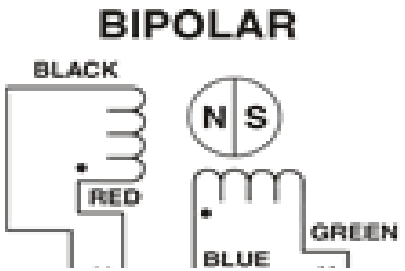


From: Introduction to Step Motors, Applied Motion Products. http://www.omega.ca/auto/pdf/REF_IntroStepMotors.pdf

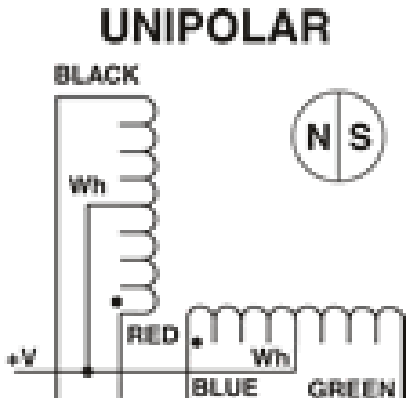
Motors: Stepper motors



Unipolar vs bipolar windings:



4 wires (usually)

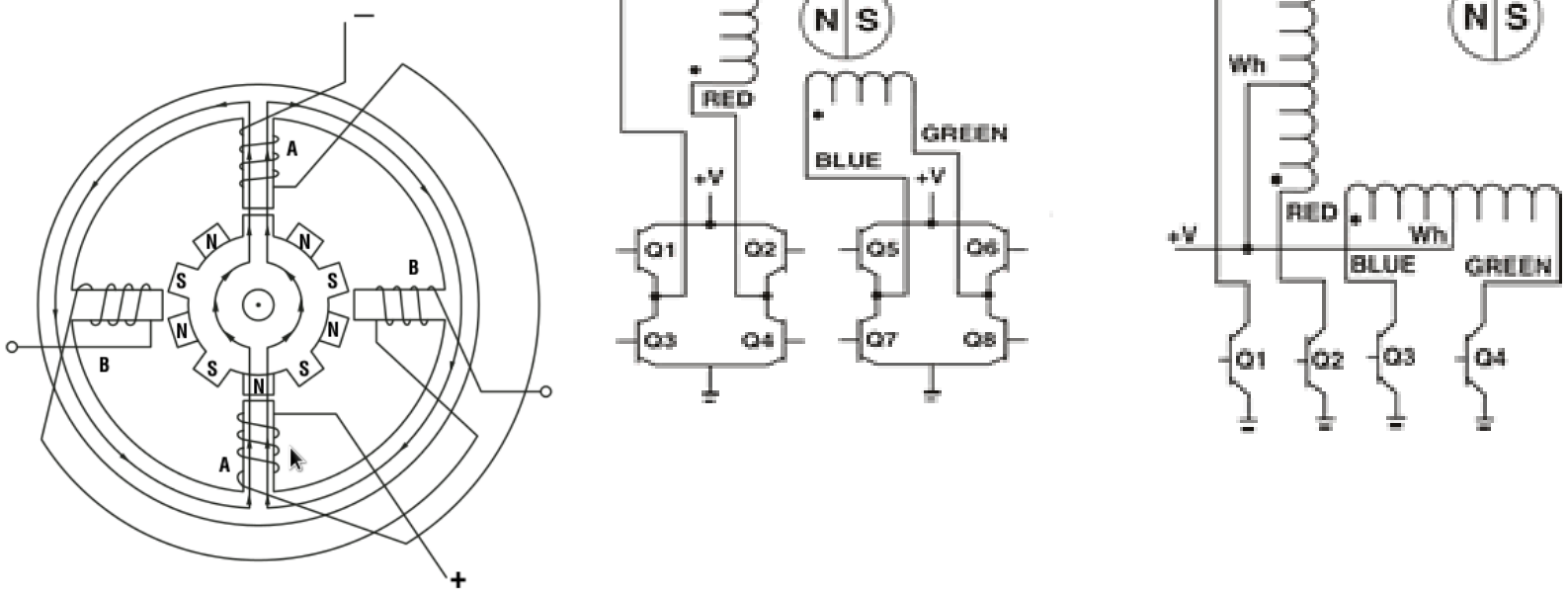


Unipolar stepper (5, 6 or 8 wires)

http://www.haydonkerk.com/Resources/StepperMotorTheory/tabid/192/Default.aspx

Motors: Stepper motors

Unipolar vs bipolar windings:



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“Robot” platforms