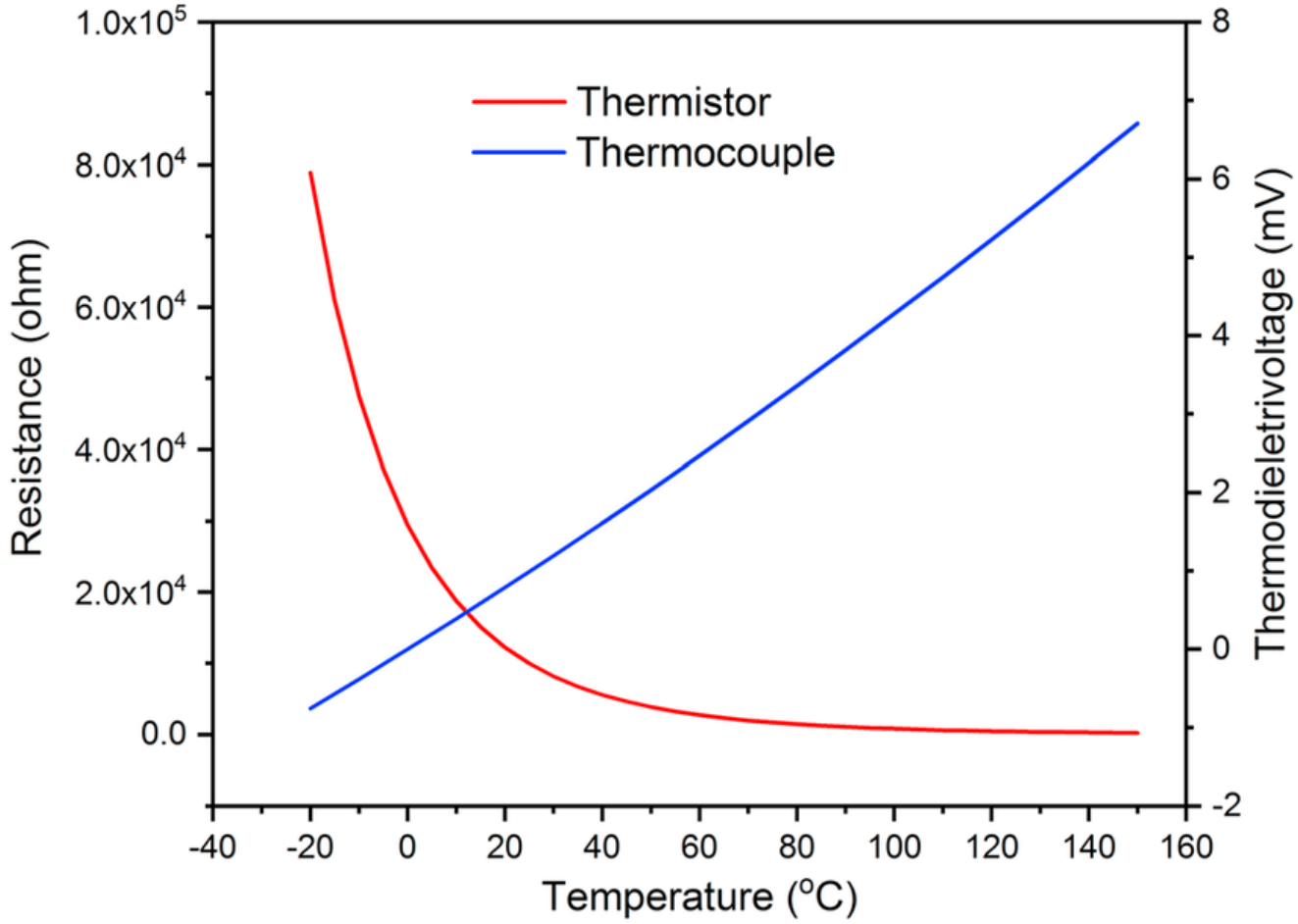
Sensors

What is a sensor?

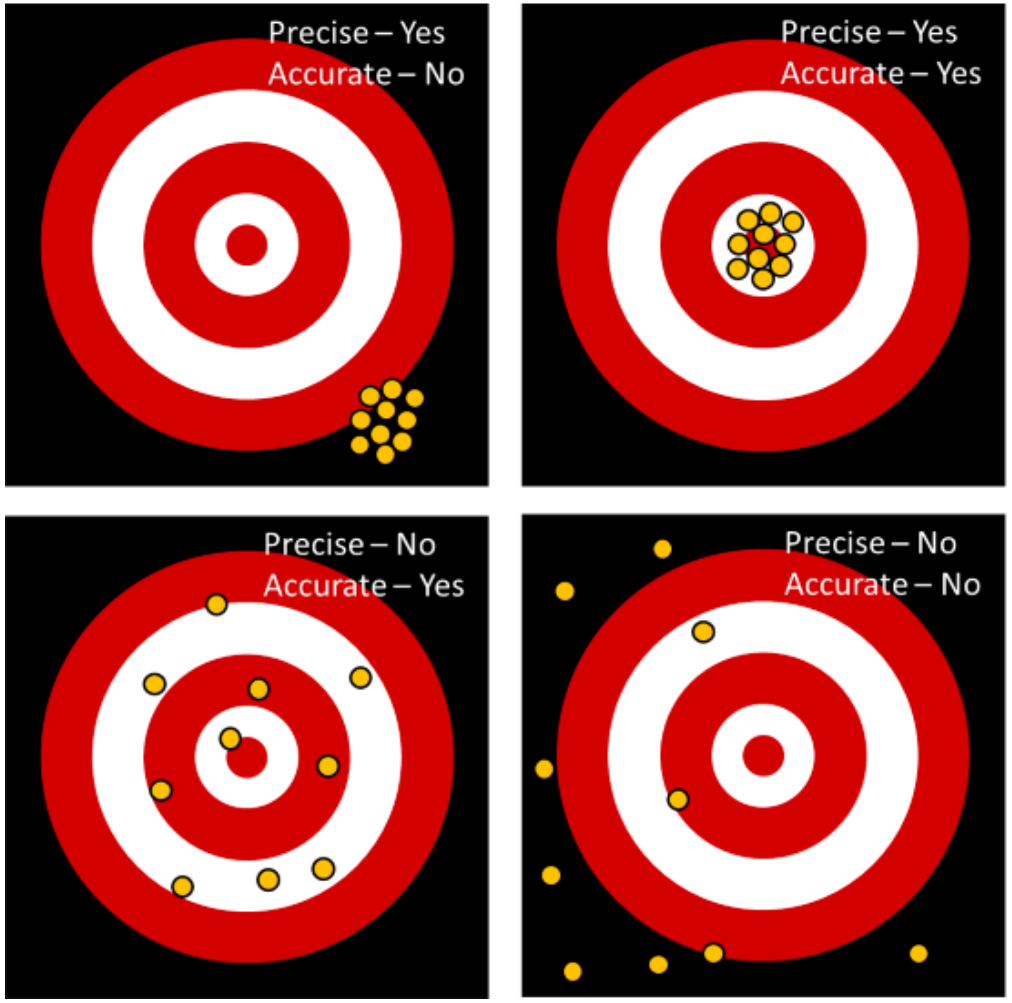
- Allows IoT devices to “sense”
  - Physical stimulus
  - Electrical output (voltage)
- Example: temperature
- Response curve
  - Usable range
  - Non-linearity



https://www.researchgate.net/publication/327106090_Development_and_Application_of_the_Heat_Pulse_Method_for_Soil_Physical_Measurements

Precision and accuracy

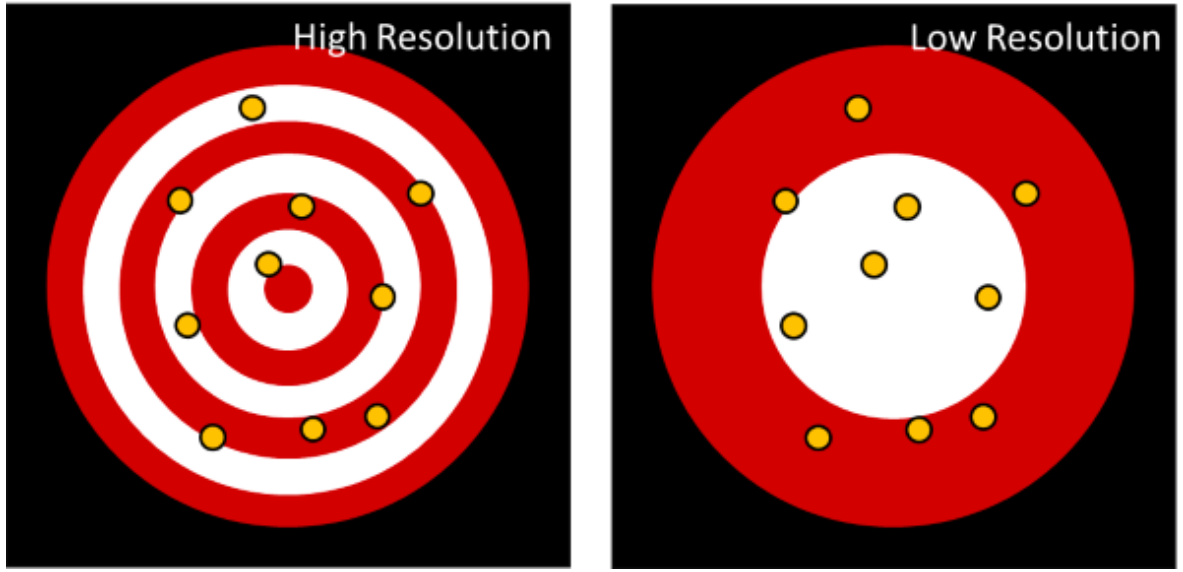
- Accuracy
  - proximity to real value
  - compensated in software (offset)
- Precision
  - repeatability of reads
  - compensated in time (averaging)



https://control.com/technical-articles/what-is-the-difference-between-accuracy-precision-and-resolution/

Noise and Resolution

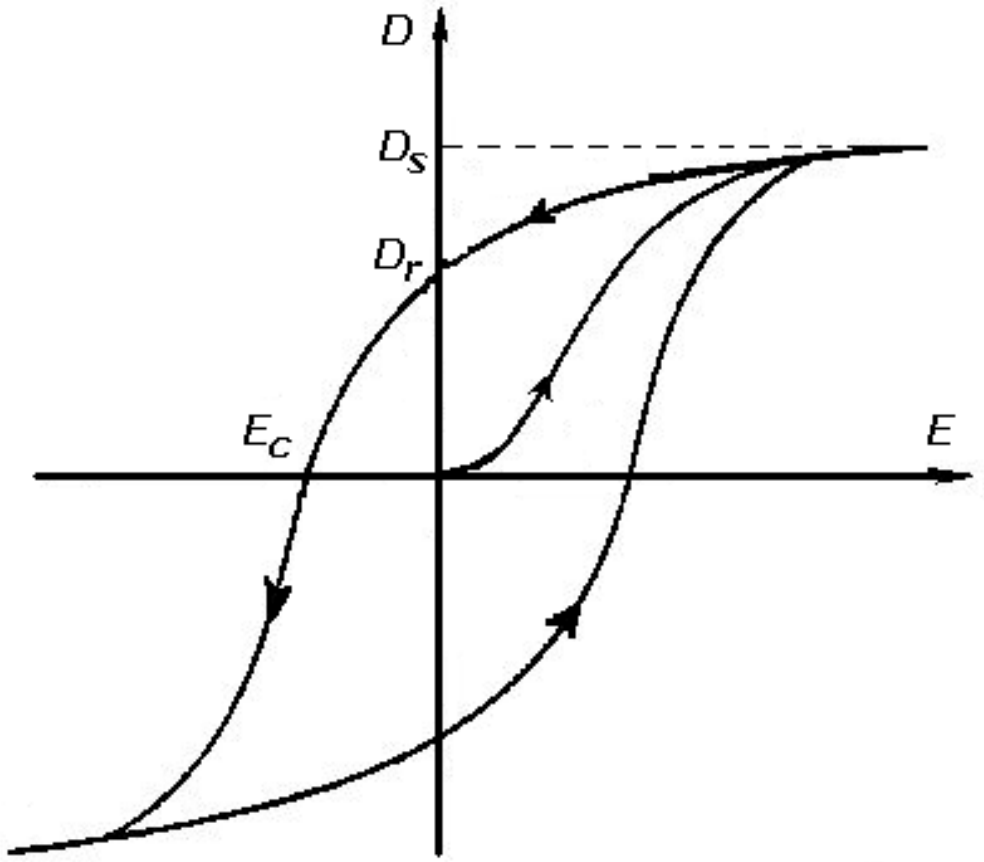
- Noise
  - from temperature, radio waves etc.
  - induces reading fluctuations
- Usable resolution
  - range / noise
  - expressed in bits



https://control.com/technical-articles/what-is-the-difference-between-accuracy-precision-and-resolution/

Other sensor characteristics

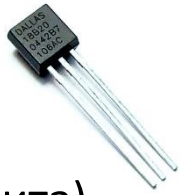
- Direct vs Indirect measurement
  - e.g. travel time -> distance
- Speed (samples/s)
- Warm up time
- Hysteresis
- Drift (in time)



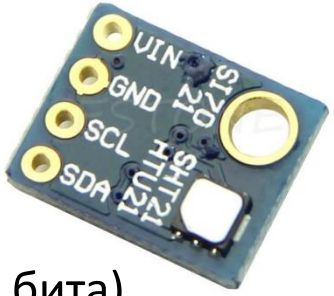
https://en.wikipedia.org/wiki/Hysteresis

Temperature / Humidity

- Температура
  - DS18B20
    - Точност: +/- 0.5º
    - Резолюция: 0.06 (12 бита)
    - Протокол: 1-Wire
    - Повече от 10 сензора на един пин
    - -20º : 80º
    - 3 лв



- Температура/Влага
  - SI7021
    - Точност: +/- 0.3º
    - Резолюция: 0.01 (14 бита)
    - Протокол: I2C
    - 1 Сензор на шина
    - -25º : 125º
    - 5 лв

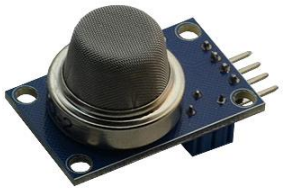


- Температура/Влага/Налягане
  - BME280
    - Точност: +/- 0.5º
    - Резолюция: 0.01 (14 бита)
    - Протокол: I2C
    - 2 Сензор на шина
    - -25º : 125º
    - 9 лв

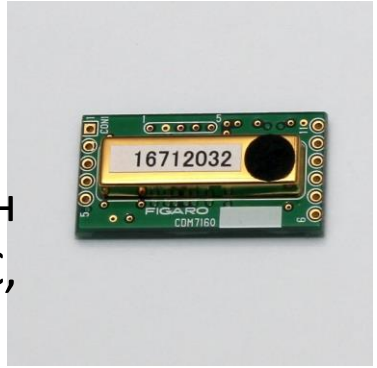
- Температура
  - PT100
    - Протокол: Съпротивление
    - -20º : 500º
    - 2 лв

Carbon dioxide

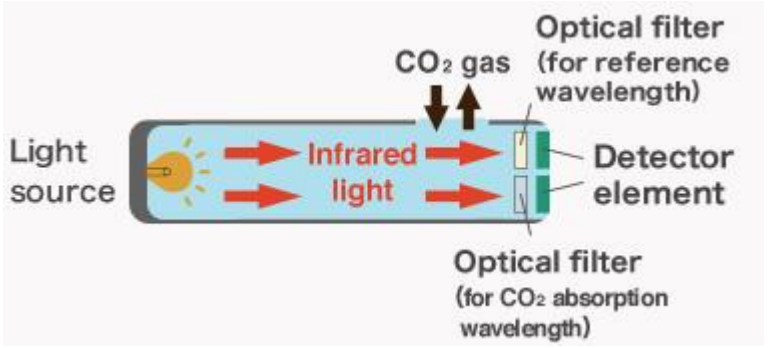
- MQ135
  - Тип: Електро химичен
  - Консумация: 150 ма
  - Точност: +/- 30%
  - Протокол: Съпротивление
  - Цена: 5 лв



- Figaro CDM7160
  - Тип: NDIR
  - Консумация: 8 ма
  - Точност: +/- 4%
  - Фабрично калибриран
  - Протокол: Сериен, I2C, PWM
  - Цена: 100 лв

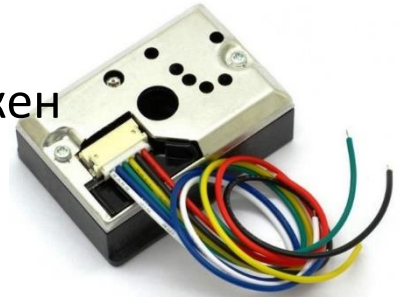


- Cubic CM1106
  - Тип: NDIR
  - Консумация: 60 ма
  - Точност: +/- 5%
  - Калибрация от околен въздух
  - Протокол: Сериен
  - Цена: 60 лв



Dust and particulate matter

- Sharp gp2y1010au0f
  - Тип: Оптичен
  - Прокол: сложен
  - Цена: 5 лв

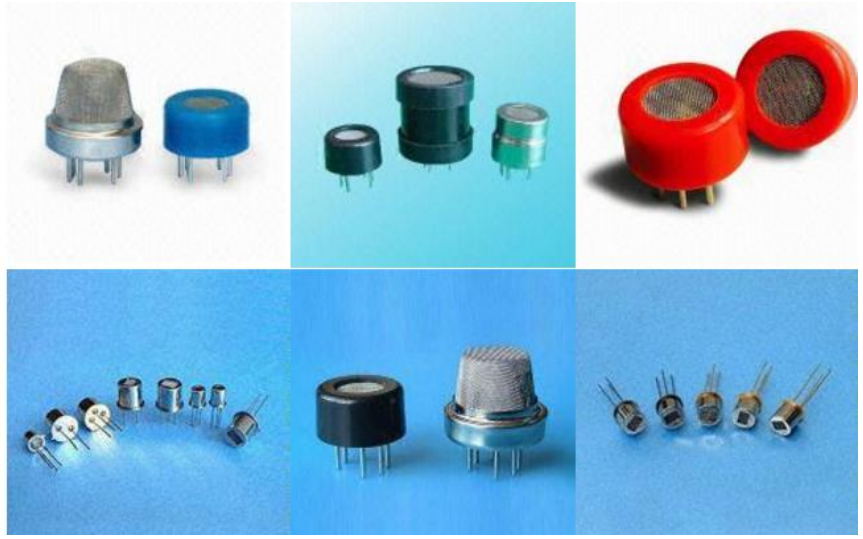


- Cubic PM2005
  - Тип: Лазерен
  - Протокол: I2C
  - Цена: 80 лв

- DSM510a
  - Тип: Оптичен
  - Протокол: ?
  - Цена: 15лв

Gases (*MQ Series)*

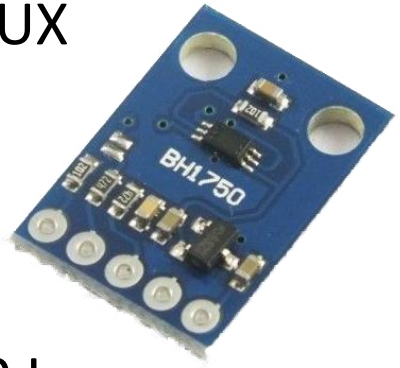
- Long preheat
- High power consumption
- Dependency to Temperature/Humidity



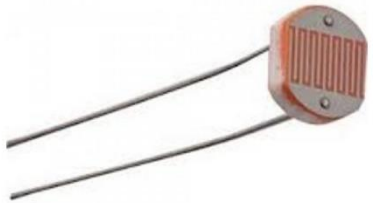
Semiconductor sensor for Flammable gas, Plastic or Metal cover	
Model	**Target Gas**
MQ-2	General combustible gas
MQ-3	Alcohol
HOT MQ-4	Natural gas, Methane
MQ-5	LPG, Natural gas, Coal gas
MQ-6	LPG, Propane
HOT MQ-7	Carbon Monoxide (CO)
MQ-8	Hydrogen
MQ-9	CO and Combustible gas
MQ216	Natural gas\Coal gas
MQ306A	LPG, Propane
MQ309A	Carbon Monoxide (CO), Flammable Gas
MQ303A	Alcohol
MQ131	Ozone O3
MQ135	Air Quality Control (NH3,Benzene,Alcohol,smoke)
Semiconductor sensor for Toxic gas	
MQ136	Sulfureted Hydrogen (H2S)
MQ137	Ammonia (NH3)
MQ138	VOC (Mellow, Benzene, Aldehyde, Ketone, Ester)

Light

- BH1750
  - 1-120,000 LUX
  - I2C
  - 3 лв
- TSL2561
  - 0.1 – 60,000 Lux
  - + IR Light
  - I2C
  - 4 лв



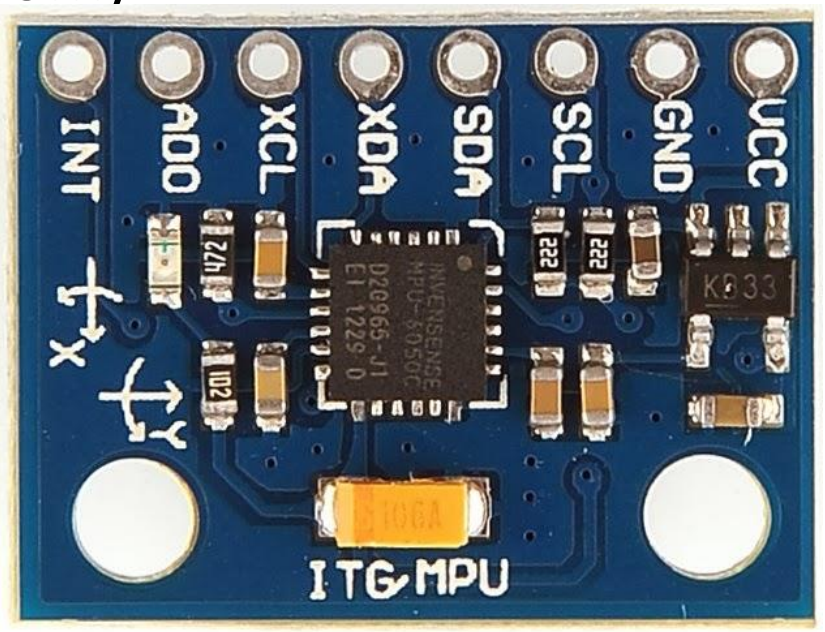
- LDR (Light Dependent Resitor)
  - ??? LUX
  - Resistive Voltage Devider
  - 0.2 лв



- Ultra Violet Light
- InfraRed – (remote control)
- Color Sensor (RGB)

Accelerometer/Gyroscope/Magnetometer

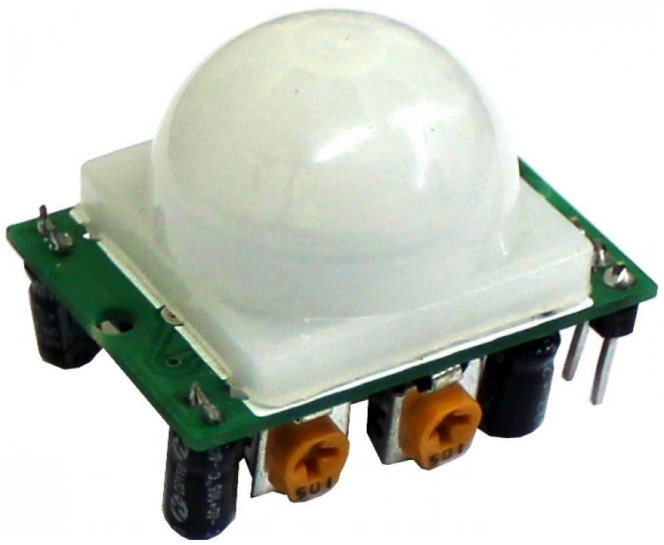
- MPU6050 – 6 DOF (Degrees Of Freedom)
  - Accelerometer / Gyroscope
- MPU-9250 9-DOF – 9 DOF
  - + Magnetometer / Compass
- Communication
  - SPI
  - Internal DSP (Digital Signal Processor)
- Info: How do accelerometers work



https://diyhacking.com/arduino-mpu-6050-imu-sensor-tutorial/

Human presence sensors

- PIR Sensor (2 лв)
  - Moving humans



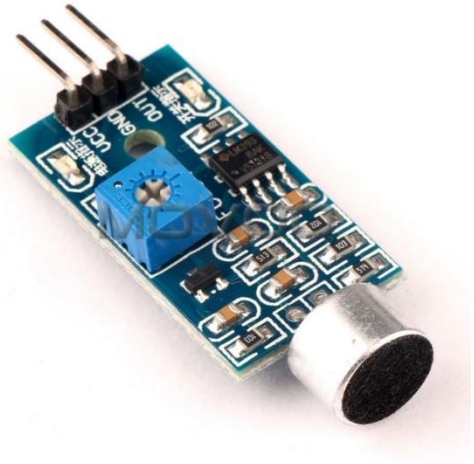
- Omron D6T (60 лв)
  - Stationary humans

- Microwave radar
  - Approaching humans

Distance / Sound

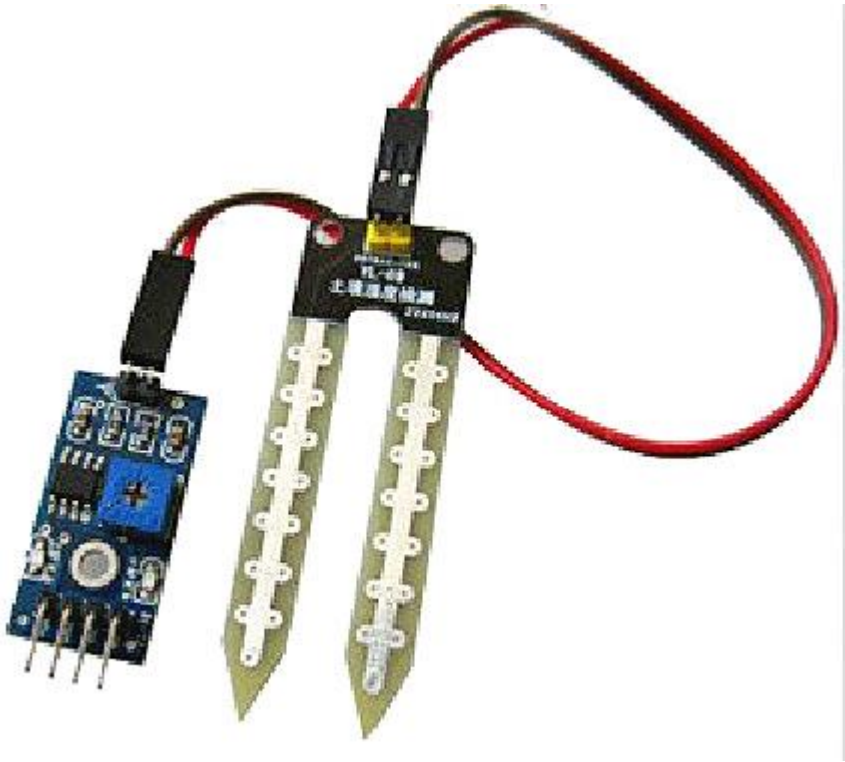
- HC-SR04
  - ултразвук

- Voice Recognition
- Noise Sensor
  - звук



Soil moisture

Resistive / capacitive

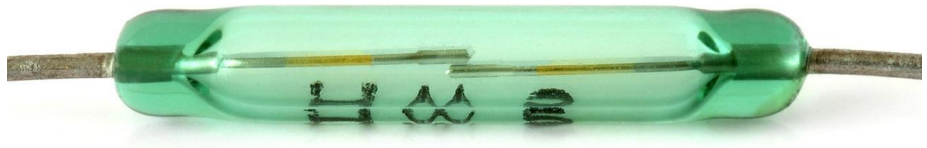


TDR / FDR (reflectometry)

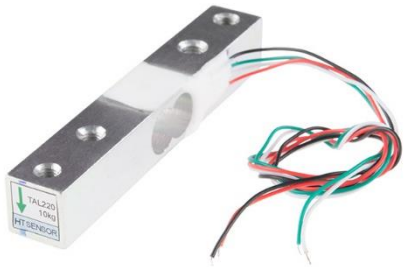
https://harvest.com/products/sensors/soil/acclima-tdr-315h/

Others

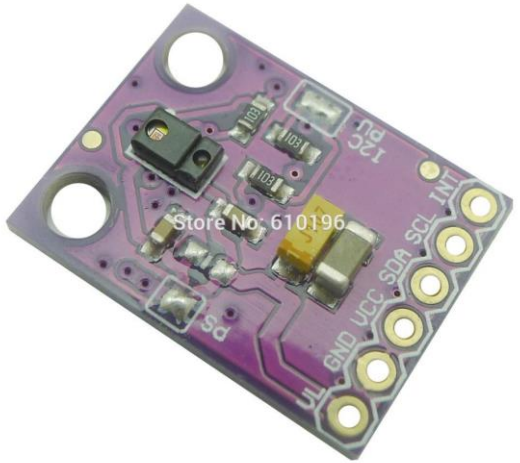
- Reed Switch (Magnetic Switch)



- Load Cell (Тегло)



- Gesture Sensor (APDS9960)
  - UP, DOWN, LEFT, RIGHT, FAR, NEAR



And even more

- Lightning
- Radiation (Geiger-Mueller tube)
- Current sensor (shunt, current transformer)
- Heart Rate Sensor
- Line Follower
- GPS
- RFID / NFC
- Anemometer

THE ROBINSON ANEMOMETER.

Exercises