

SENSORPALOOZA



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rotormind.com

About me:

Freelance
EE/tinkerer

Ph.D. EE

“Recovering
Scientist”

Stupid art
things



Procept
Biorobotics

“Aquablation”
tissue resection
using high
pressure water
jet



SENSORPALOOZA

Photosensors

FRIDAY APRIL 13

Transmissive & Reflective Rotary Encoders Structured Light
Lidar IR & Visible Ambient Illumination Quadrature Colorimetric
Leap Motion Near-Field Mouse Serial Cameras OpenCV PIR Motion Kinect
Conductance Moisture Vidicon

SATURDAY APRIL 14

Chips & MEMS

Pressure Hall Effect Acceleration
Ultrasonic Current Sensing Accelerometers Quadrature Gear Tooth Sensors
Barometric Differential & Gauge Inductive Magnetic Compass Gyroscope
Bridge Amplifiers Ionization Scintillation Vacuum & Pirani Servo Feedback ECM & MEMS Microphones

Wild West

SUNDAY APRIL 15

Biosensors Temperature Force, Flex & Strain
Electrochemical Gas PPG Volumetric Pulse Oximetry Mass Flow
Thermistors Bioimpedance Pyroelectric Thermopile Microwave Doppler Load Cell
Strain Gauge Liquid Level Coriolis Ignition & Flame Bimetal Limit Switches
EEG: Emotiv Radiation



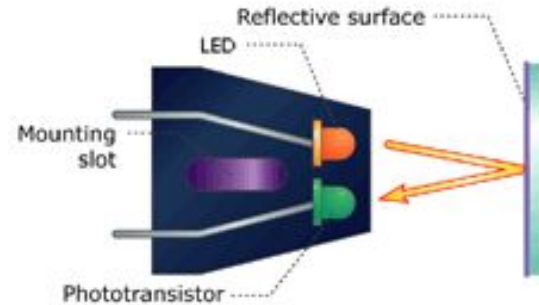
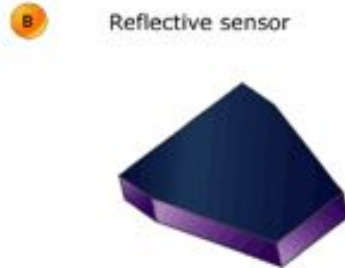
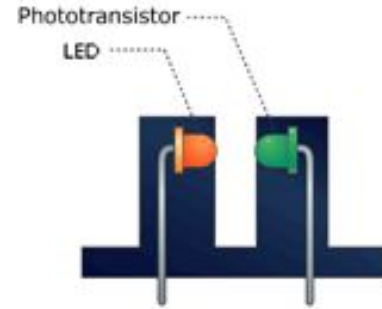
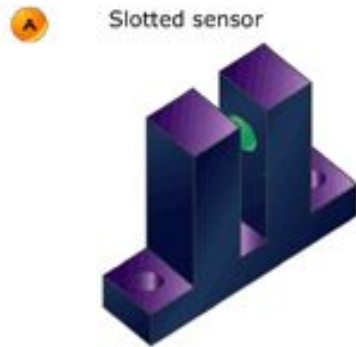
Optical

IR LED

IR phototransistor

Transmissive

Reflective



C Electrical schematic



Ommatid

2015 Pier 9 AIR

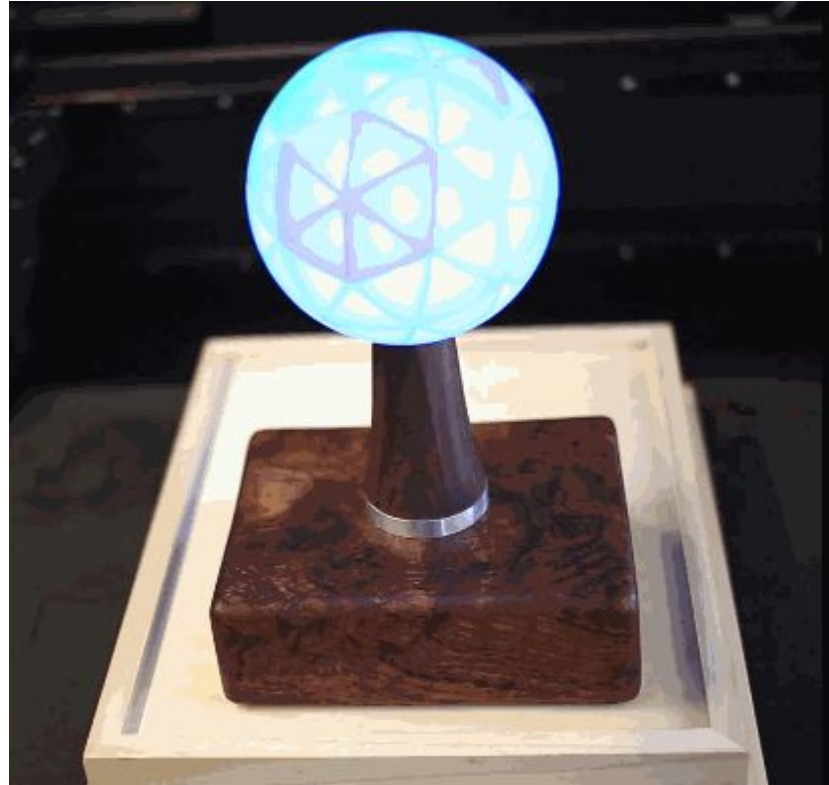
3D printed enclosure

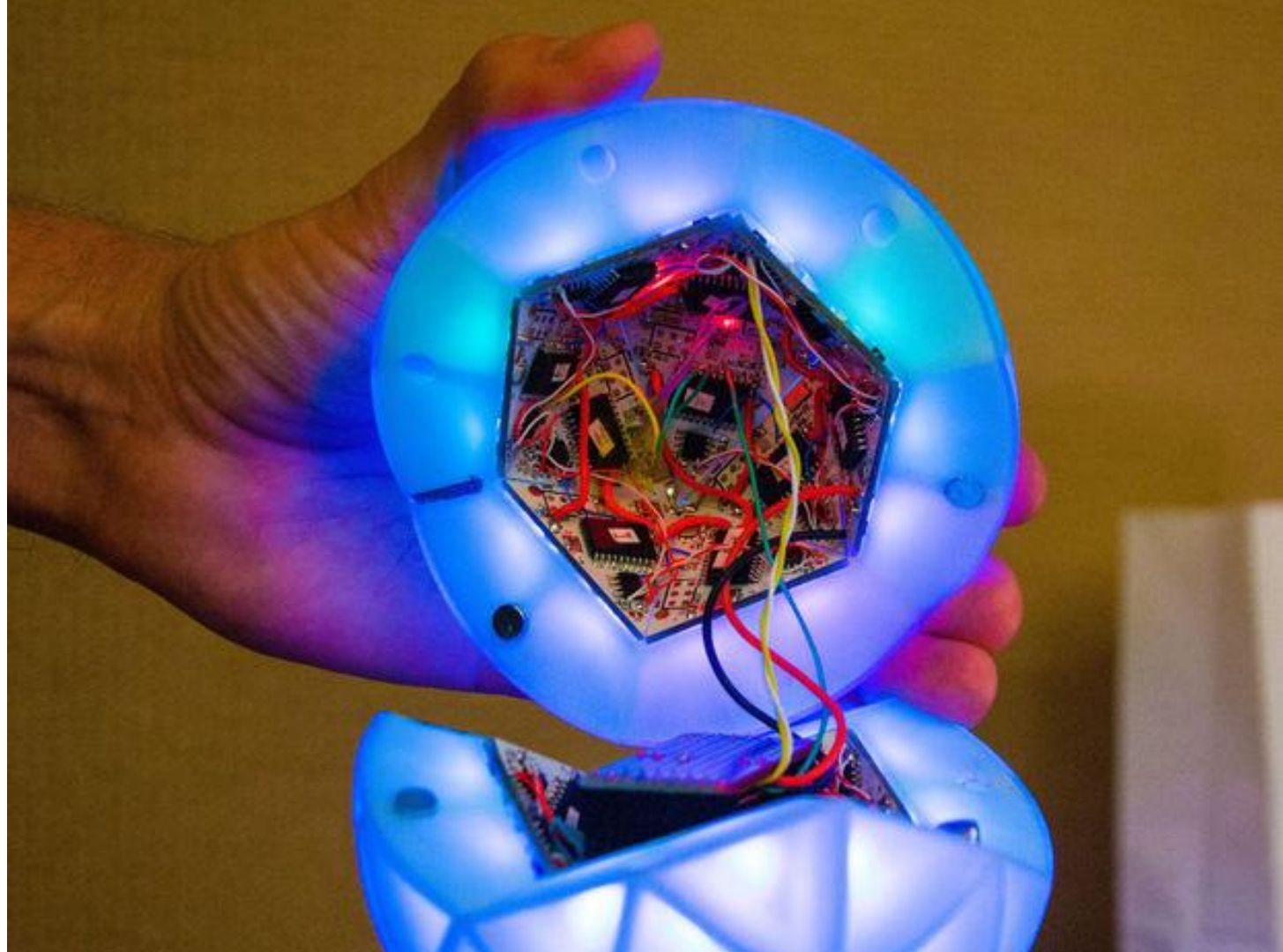
74 channels reflective IR sensors

74 channels full color LED

19 custom ATtiny circuit boards

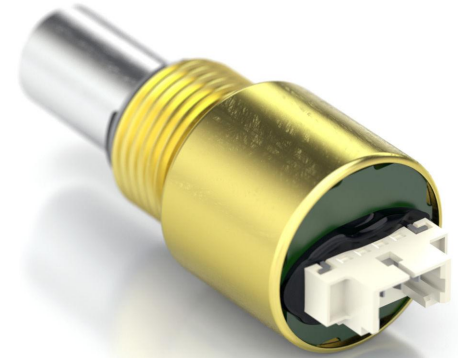
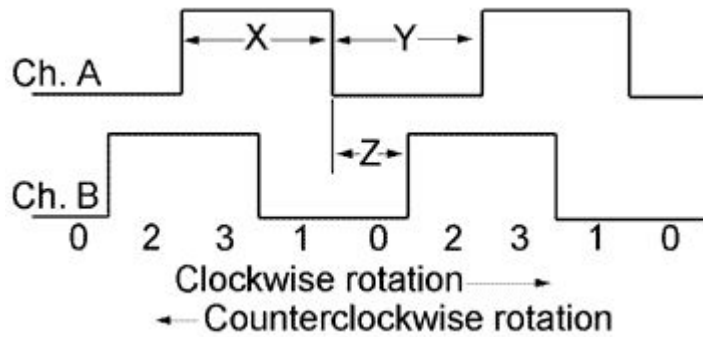
RPi host + Fdecandy LED drivers





Optical Encoders

Sense rotary angle or linear position



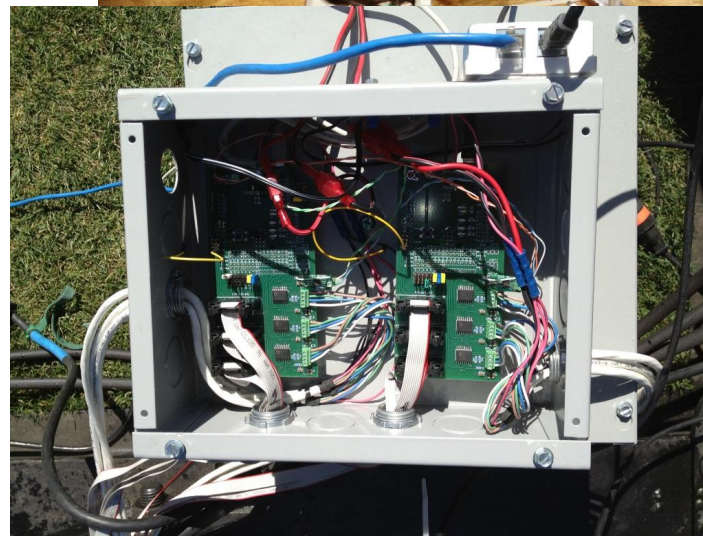
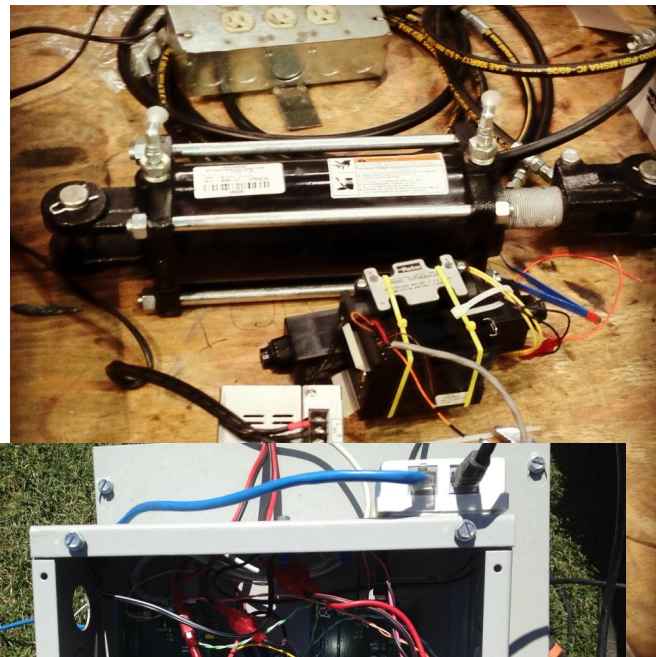
US Digital

WAVE

Coachella 2012
Charlie Gaden &
WAVE crew



WAVE

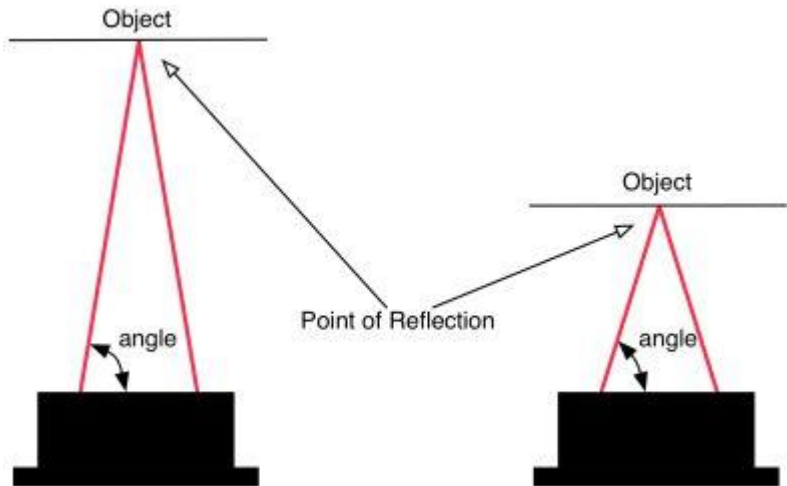


**Four 30-foot kinetic towers.
Hydraulically activated.
With flames.**



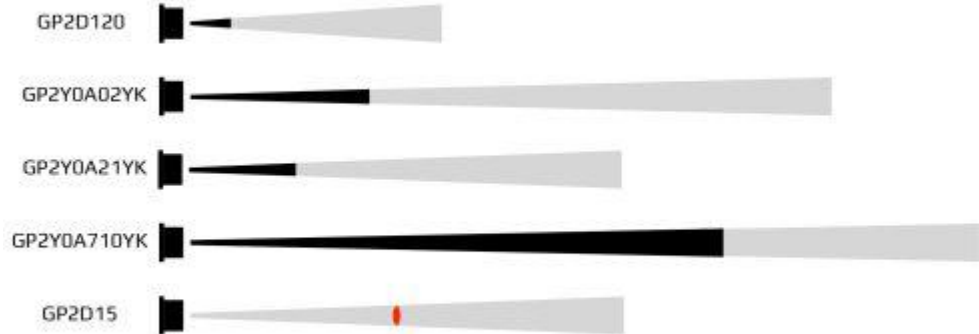


Sharp GP2X optical distance



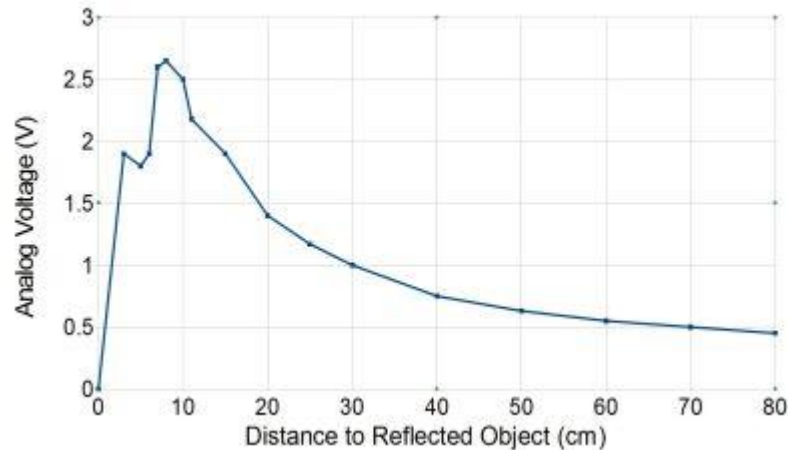
Acroname Quick Comparison Chart for the Sharp IR Rangers

1.5" 4" 8" 12" 24" 31.5" 40" 59.5" 216.5"



The end of the black notes the minimum detectable range. Objects closer than the minimum range will give incorrect readings. The end of the grey notes the maximum range. The red oval notes a fixed range; objects closer than this will return logic 1.

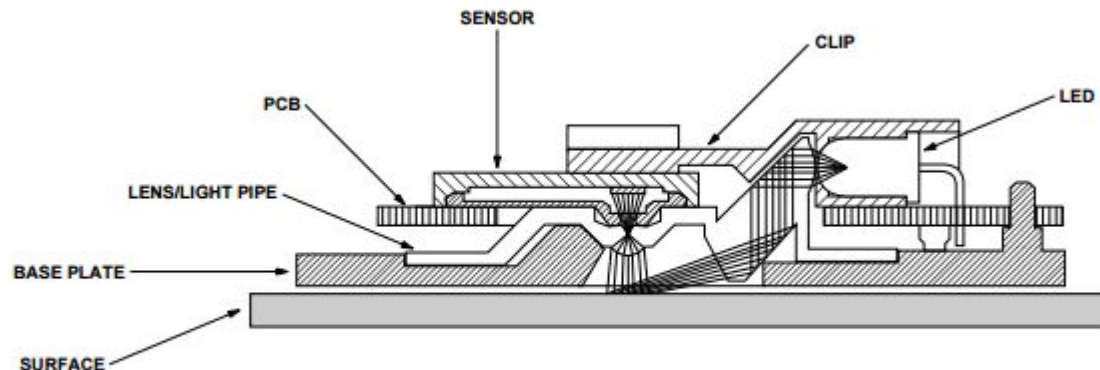
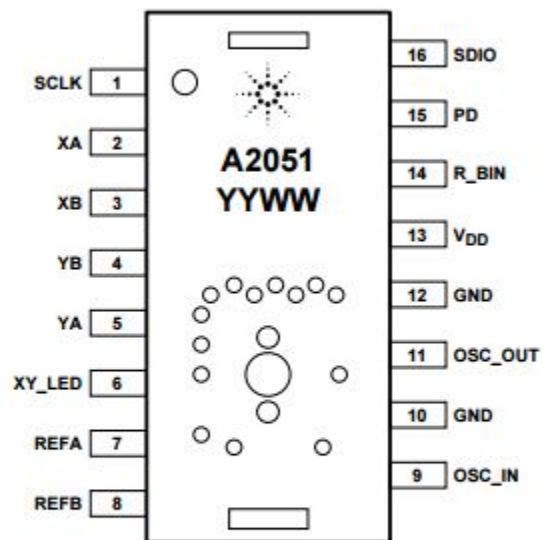
Maximum Range Minimum Range Fixed Range



Outline Drawing of ADNS-2051 Optical Mouse Sensor

Pinout

Pin	Pin	Description
1	SCLK	Serial port clock (input)
2	XA	XA quadrature output
3	XB	XB quadrature output
4	YB	YB quadrature output
5	YA	YA quadrature output
6	XY_LED	LED control
7	REFA	Internal reference
8	REFB	Internal reference
9	OSC_IN	Oscillator input
10	GND	System ground
11	OSC_OUT	Oscillator output
12	GND	System ground
13	V _{DD}	5.0 volt power supply
14	R_BIN	LED current bin resistor
15	PD	Power down pin, active high
16	SDIO	Serial data (input and output)



Vive Lighthouse

Alan Yates: Valve/HTC

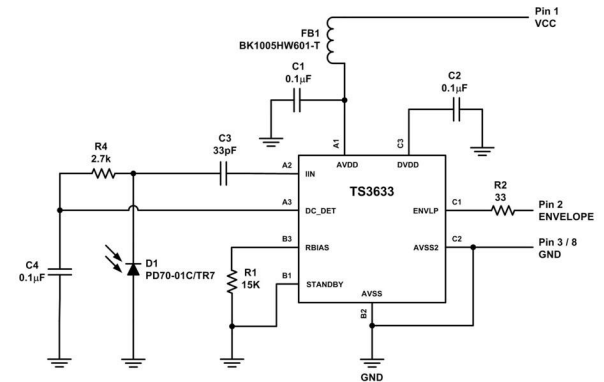
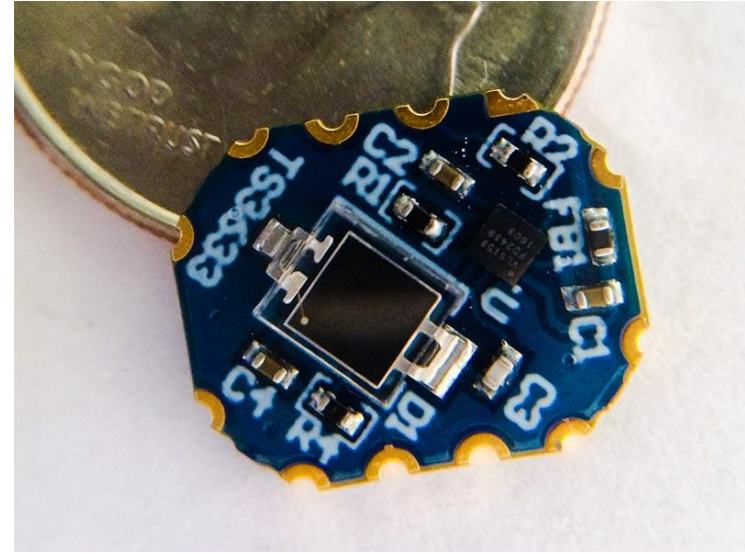
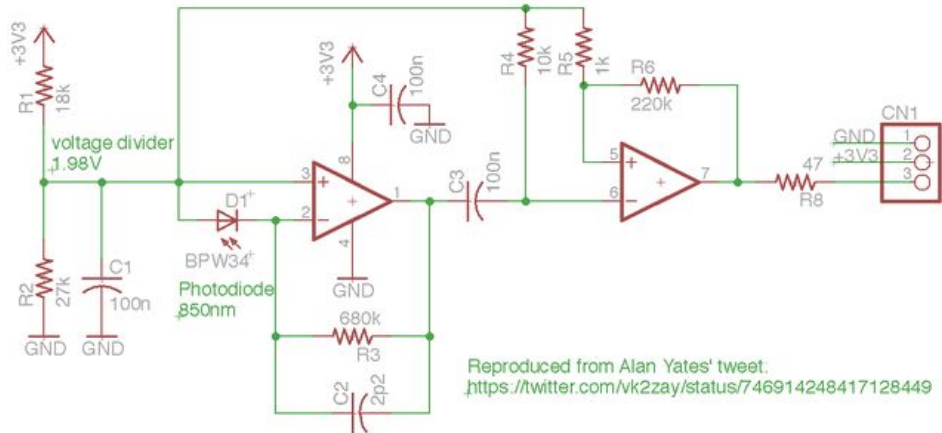
@vk2zay



Lighthouse Sensors

<https://www.triadsemi.com/>

Trammel Hudson @qrs



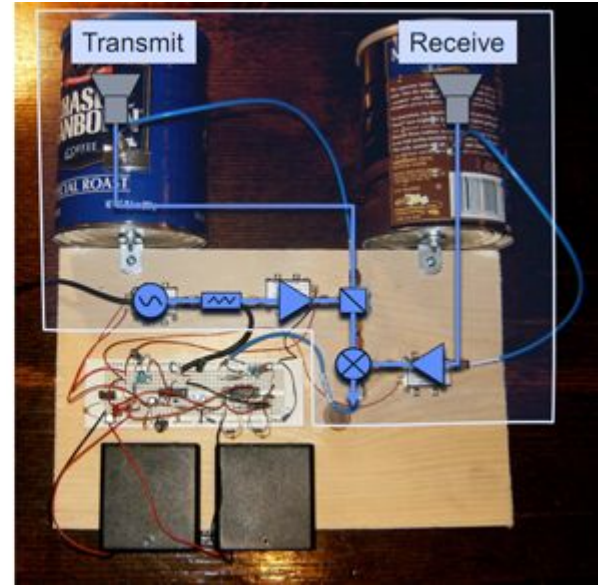
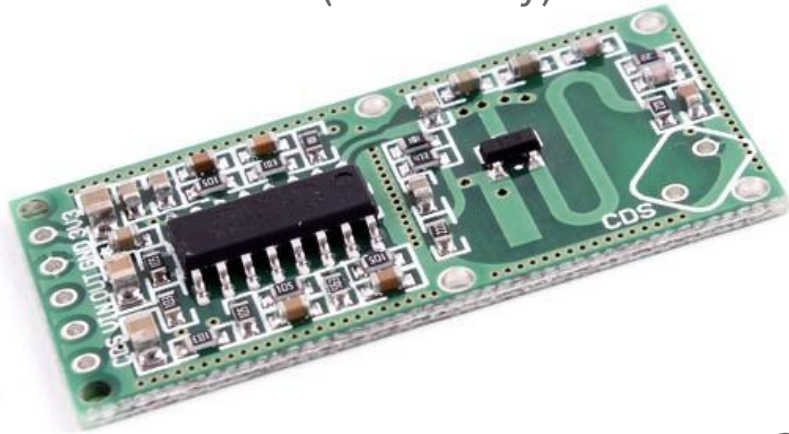
Ultrasonic ranging



Maxbotix

Microwave / Radar

RCWL-0516 (Hackaday)



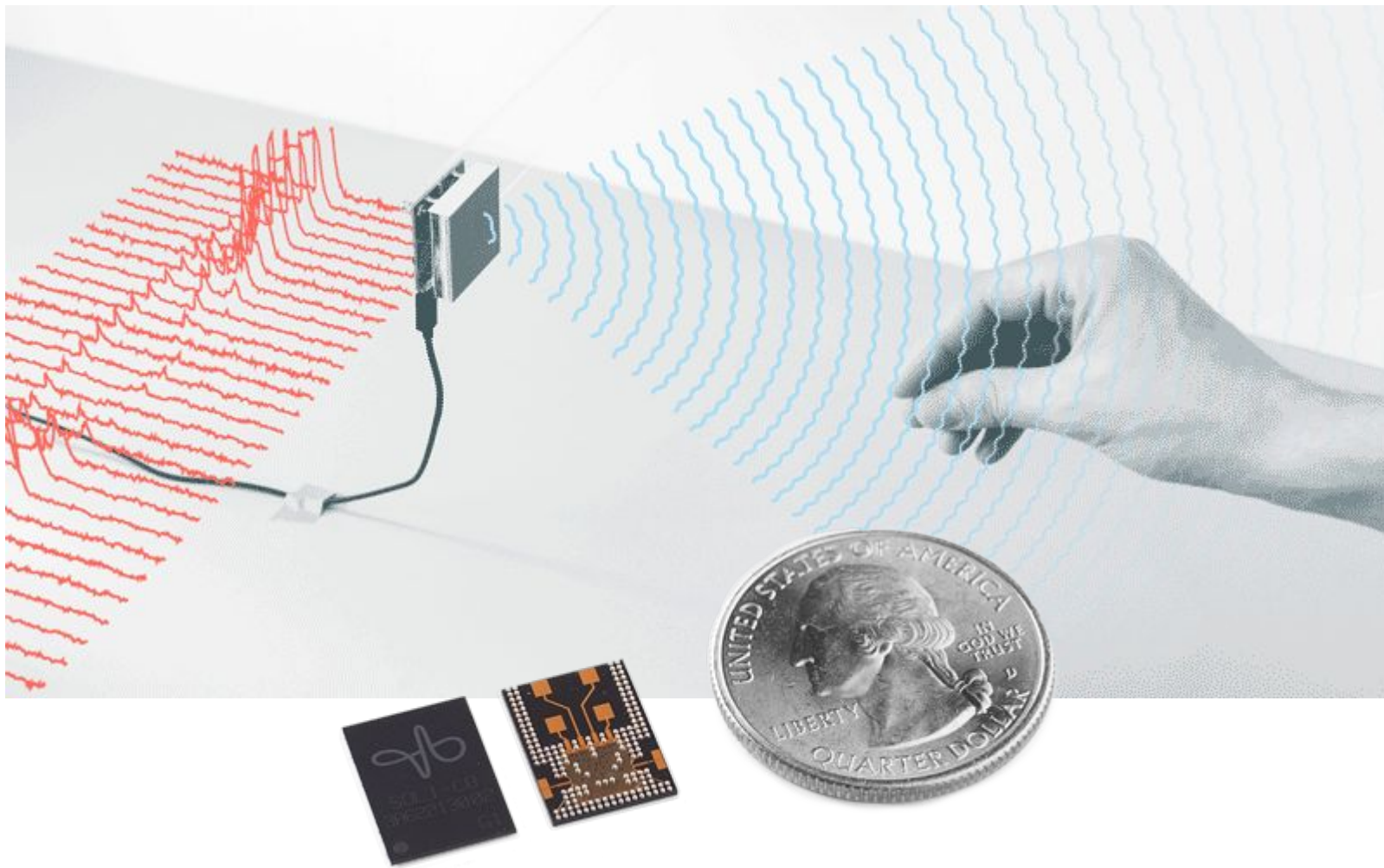
Coffee Can Radar (Make, IEEE Spectrum)

Soli

Microwave

Google ATP

Infineon



Lidar!

RPLIDAR \$450



Hokuyo UST-10LX
\$1700

Lidar-lite \$150



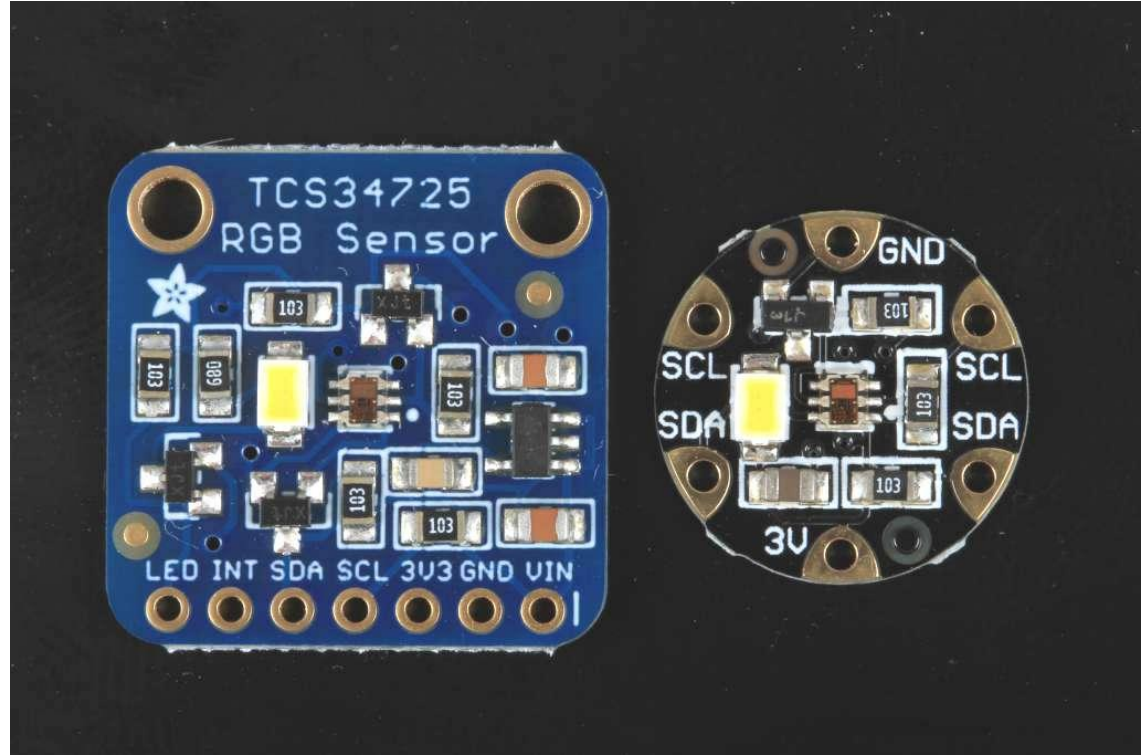
Light & color sensors

TCS34725

Adafruit breakout

Broadcom

APDS-9002 ambient
light sensor

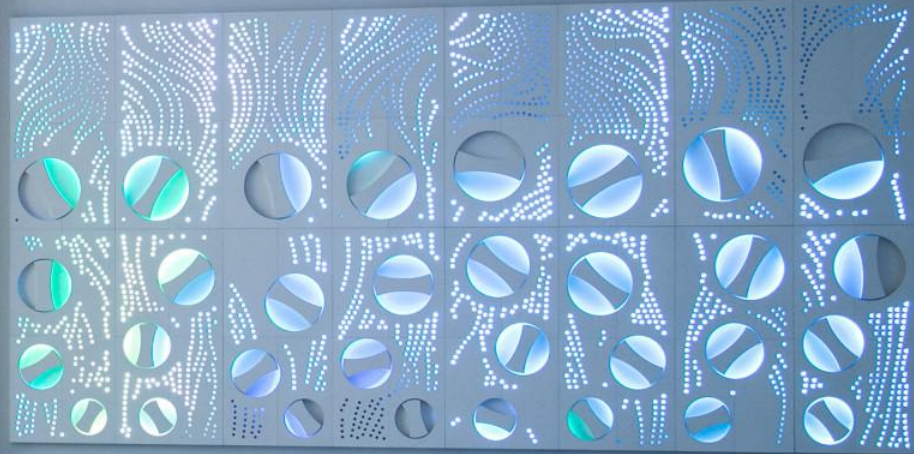


digi
PlaySpace™

WELCOME TO THE PLAYGROUND OF THE FUTURE.

tiff. BellLightbox

Scanlime "Forest"



Forest

Micah Elizabeth Scott

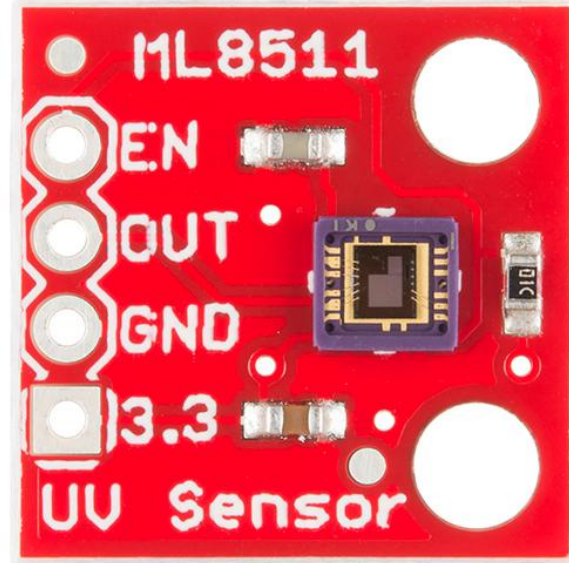
@scanlime

Absolute rotary
position from color
sensor



UV sensors

Hamamatsu FLAME SENSOR
UV TRON® R2868



Sparkfun

“Monkey on My Back”

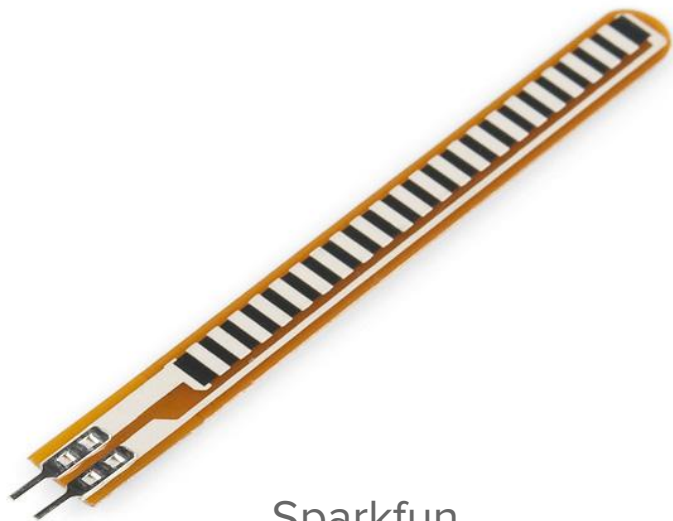
Kal Spelletich

Photo Credit:
Scott Beale/Laughing Squid





Flex and force:

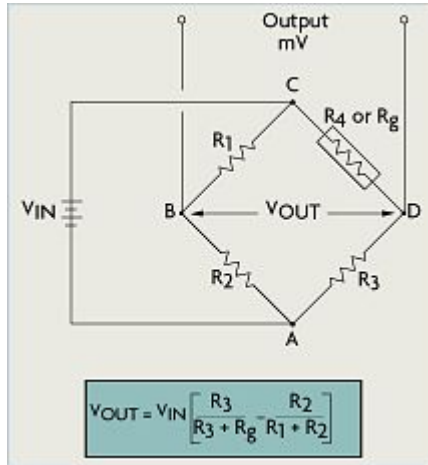
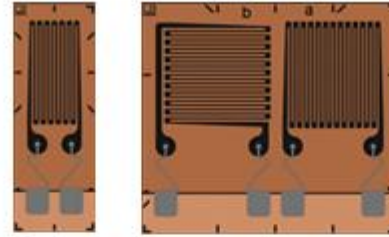


Sparkfun



Strain Gauge

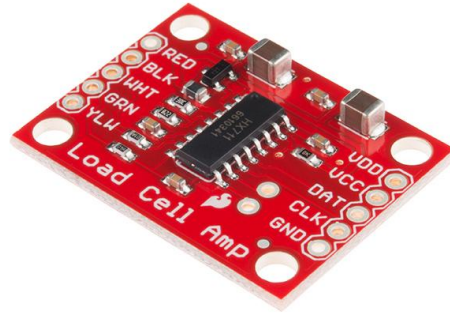
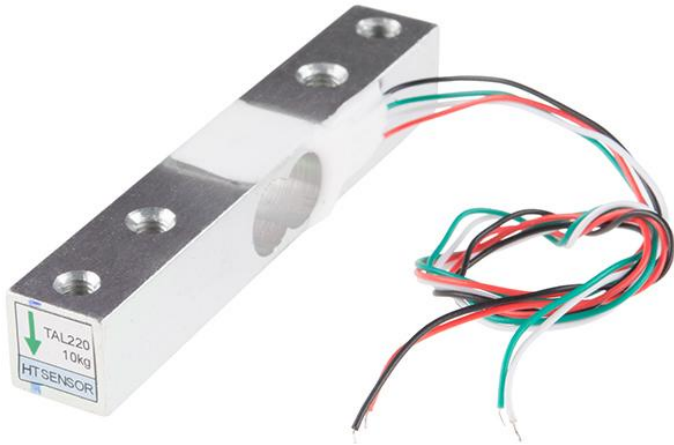
Classic strain gauge: bridge



omega.com

Force & Mass: Load Cells

Sparkfun:
HX711

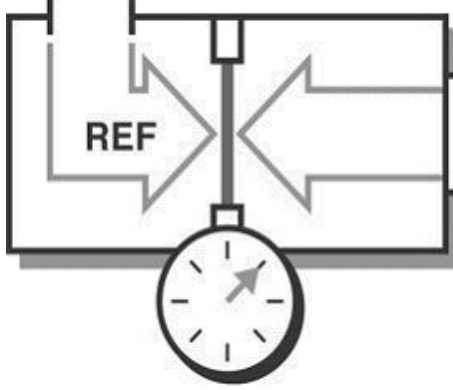
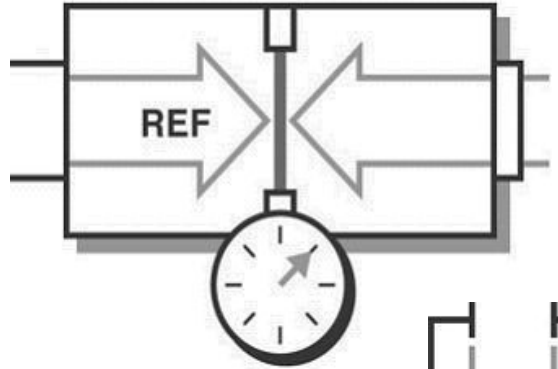
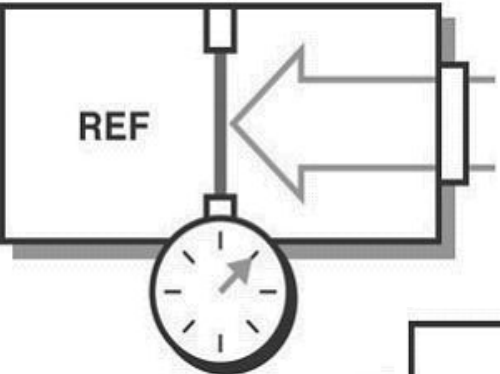


Kern

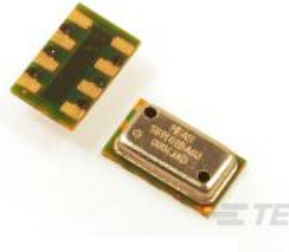


Pressure Sensors

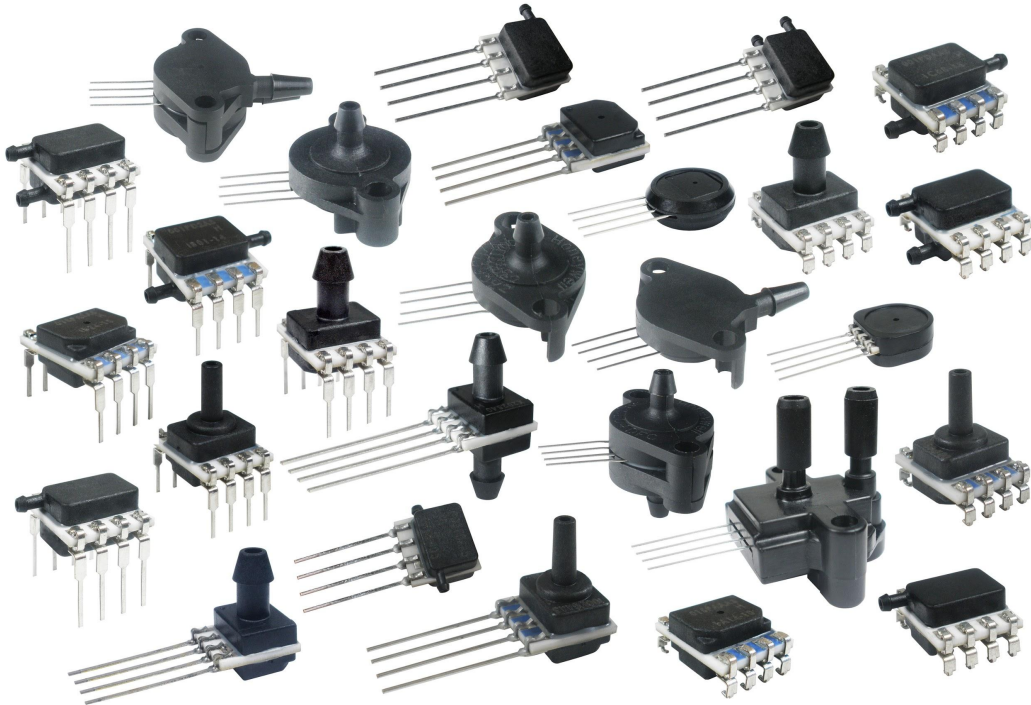
- Absolute
- Gauge
- Differential



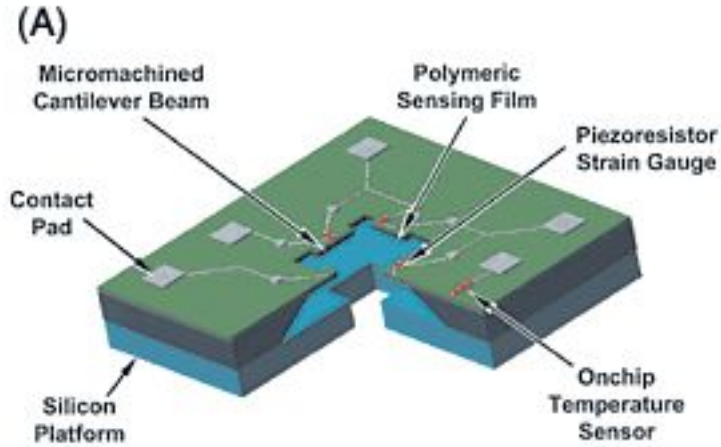
Pressure



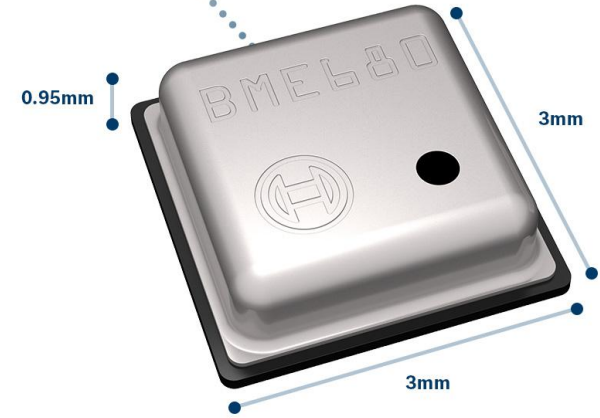
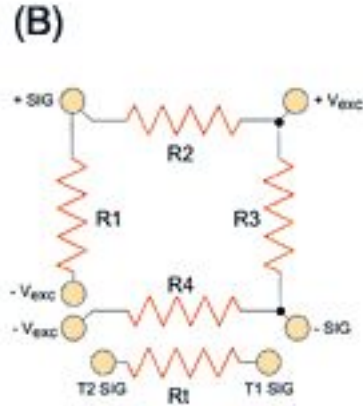
S5611-01BA03 - TE Connectivity



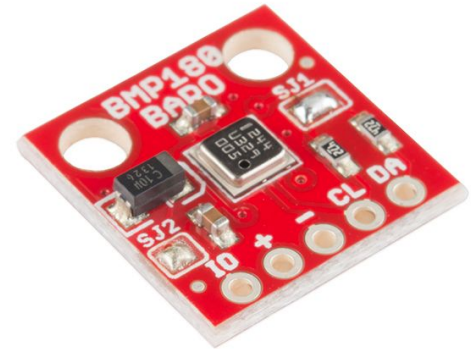
Mems Pressure



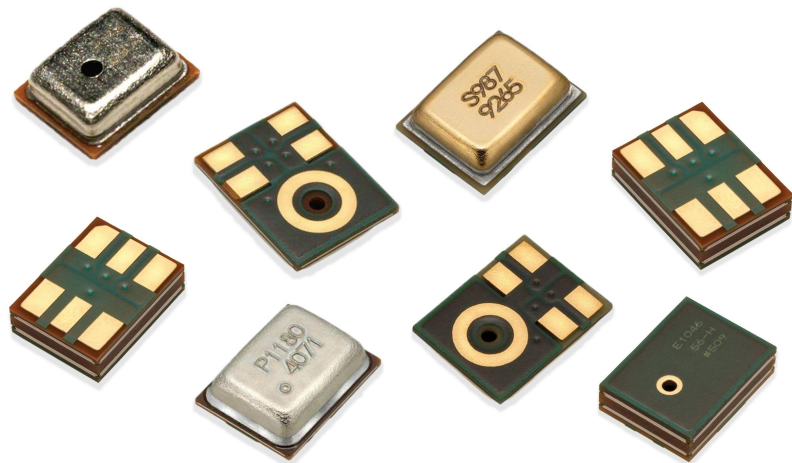
Die Size: 2 mm x 2 mm



BME680 Bosch Sensortech

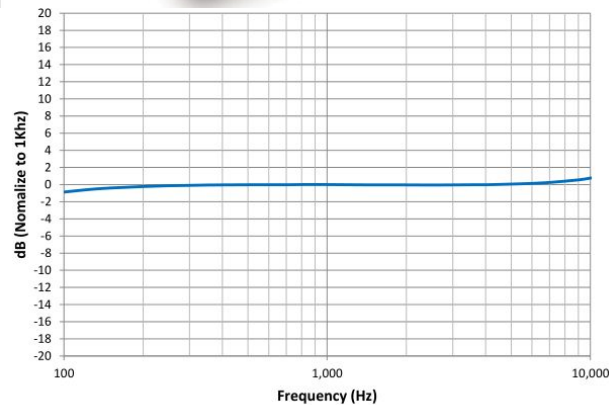
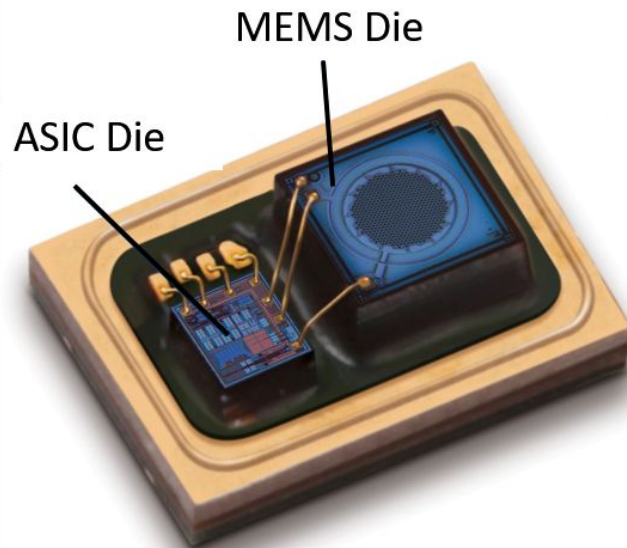


MEMs microphones



Infineon, Knowles, Omron

Akustika



Flow

Thermal

Hot-wire anemometer

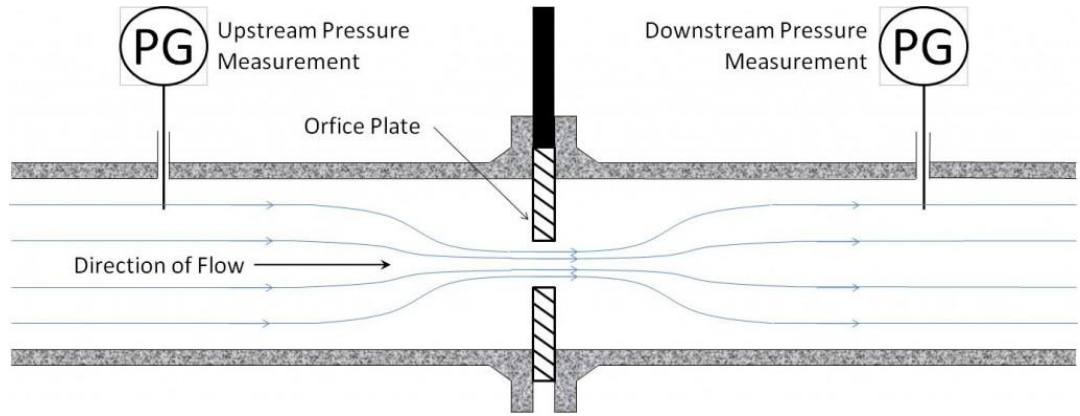
Differential pressure

Turbine

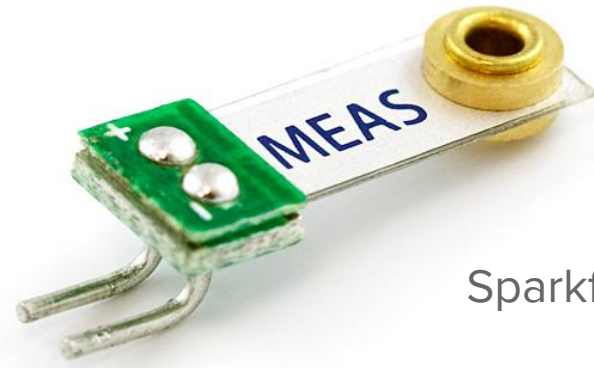
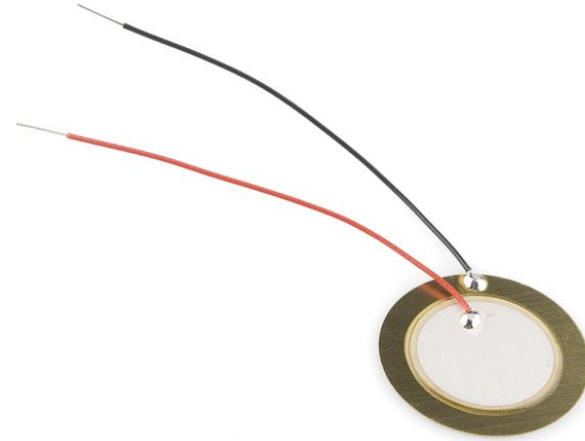
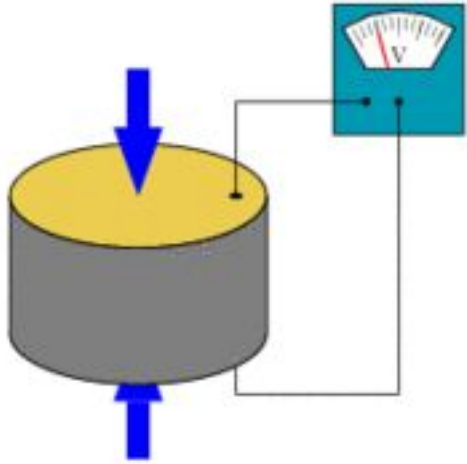
Coriolis (Mass Flow)

Ultrasonic Doppler

Rotameter



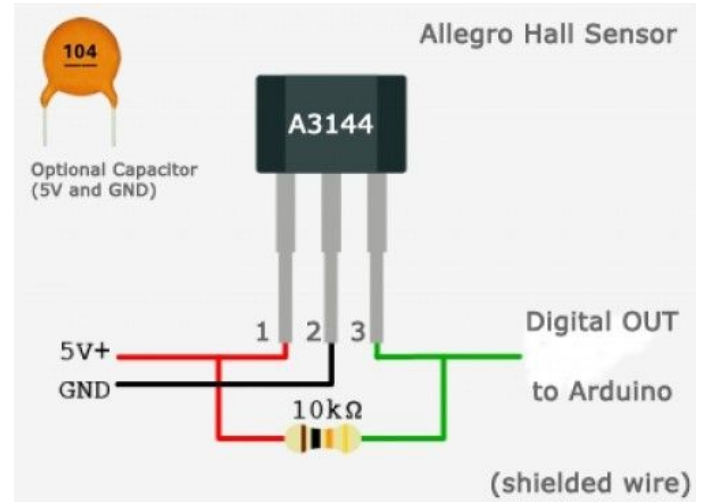
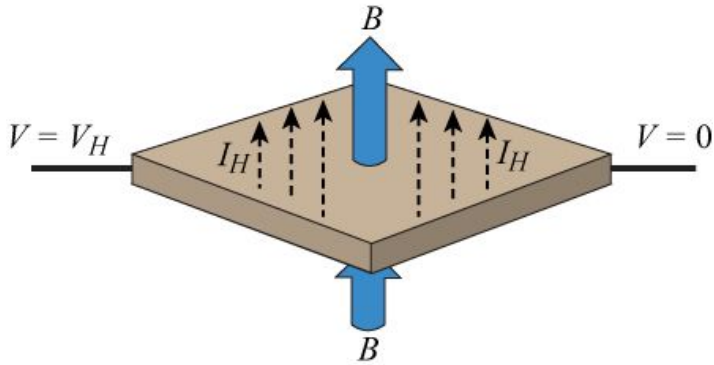
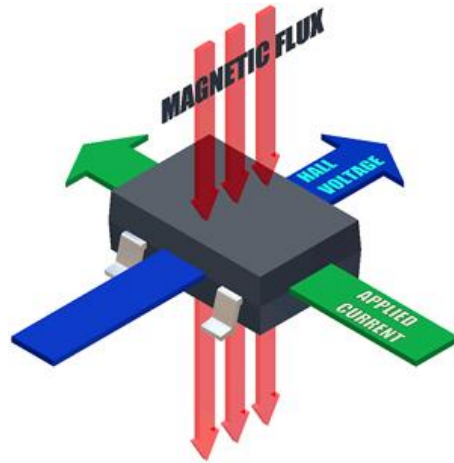
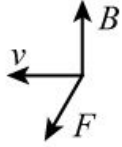
Piezo and vibration



Sparkfun

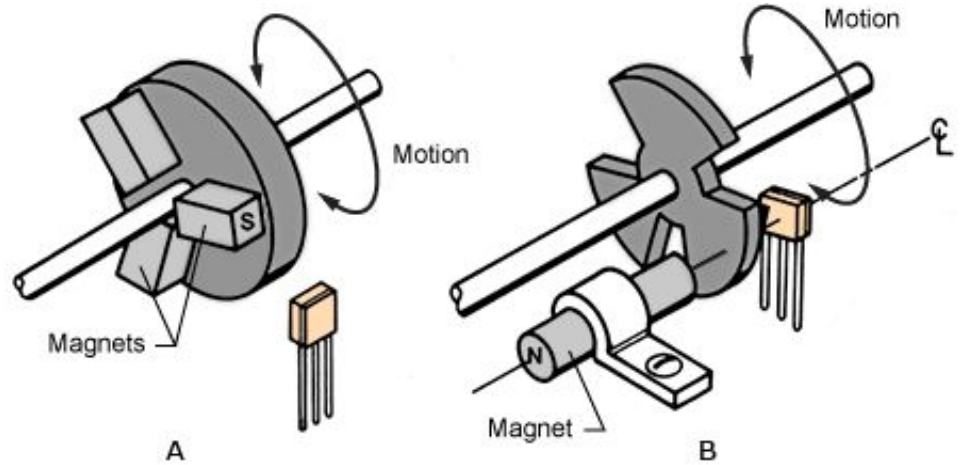
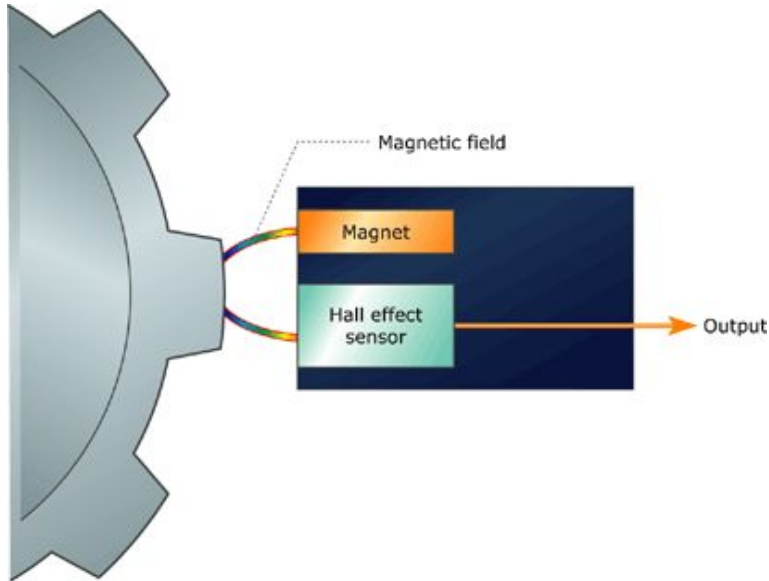
Hall Effect

$$\text{Lorentz Force}$$
$$\vec{F} = q \vec{v} \times \vec{B}$$



Hall Effect Applications: Rotation

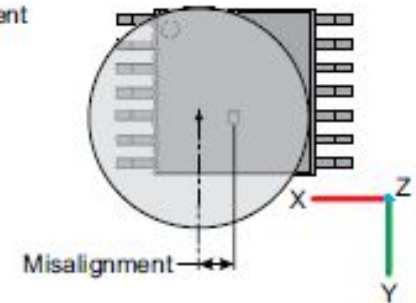
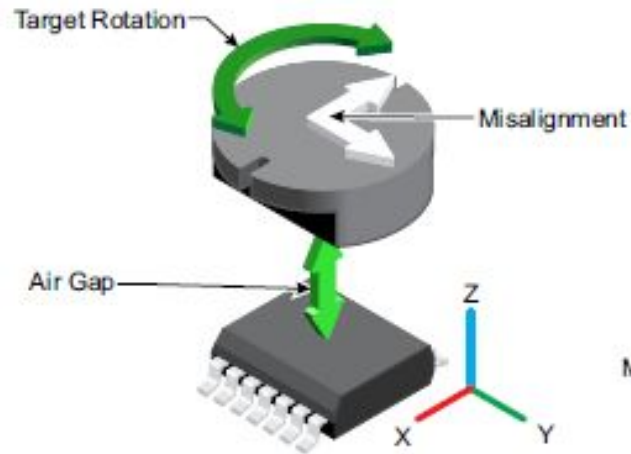
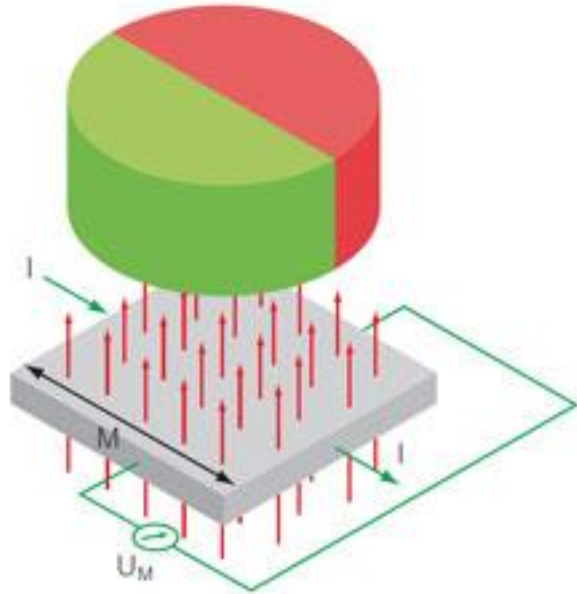
Gear tooth sensor: Melexis



Allegro

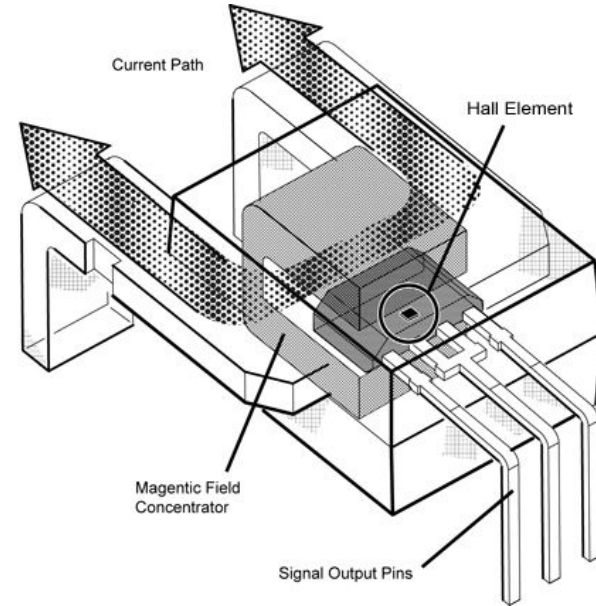
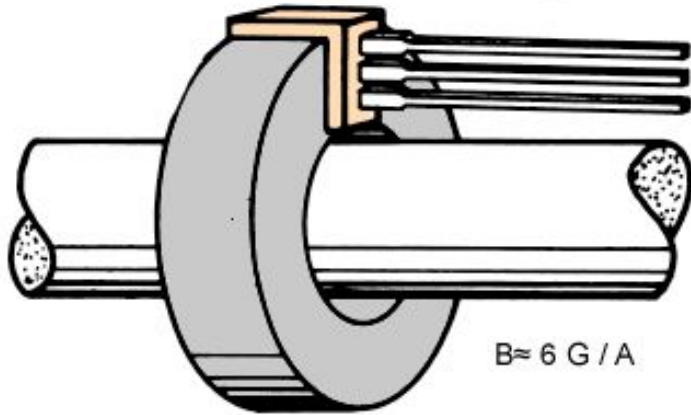
Hall Effect Applications: Angle

Shaftless encoders: Dynapar



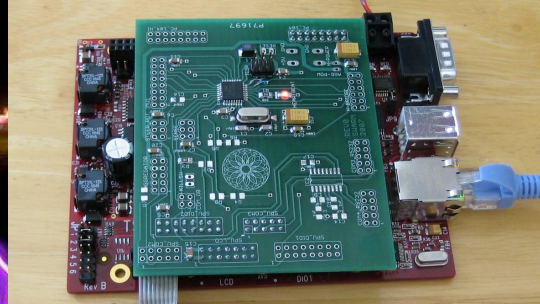
Hall Effect Applications: Current sense

$$\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$



Current sensing: Allegro

SWARM



Inside a **SWARM ORB**

Zigbee RF/Aggregator

LED illuminators

Sound module

GPS/Inertial Navigation

Linux SBC Kalman filter

Drive shaft and motor



Mems!

Yocto-3D:

3D Gyro

3D Accelerometer

3D magnetometer

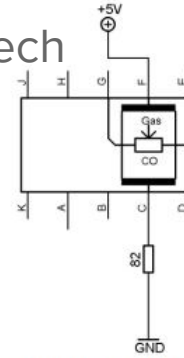
2D inclinometer

Sensor fusion

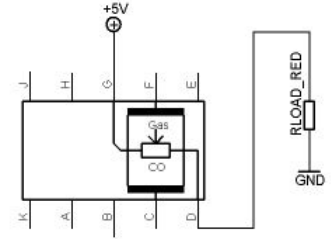


Gas sensors

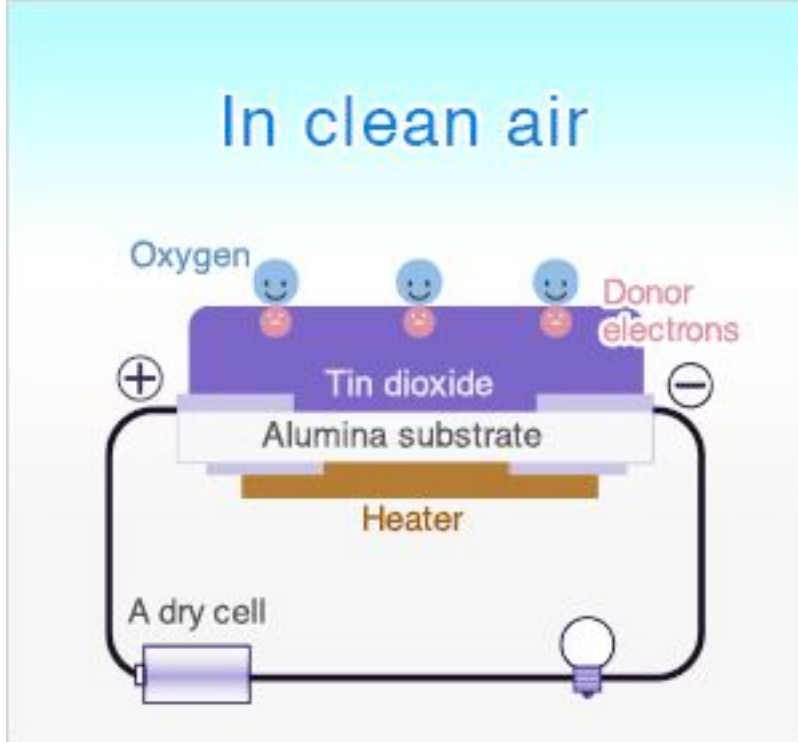
SGS Sensortech
MiCS5524



MiCS-5524 with recommended supply circuit (top view)



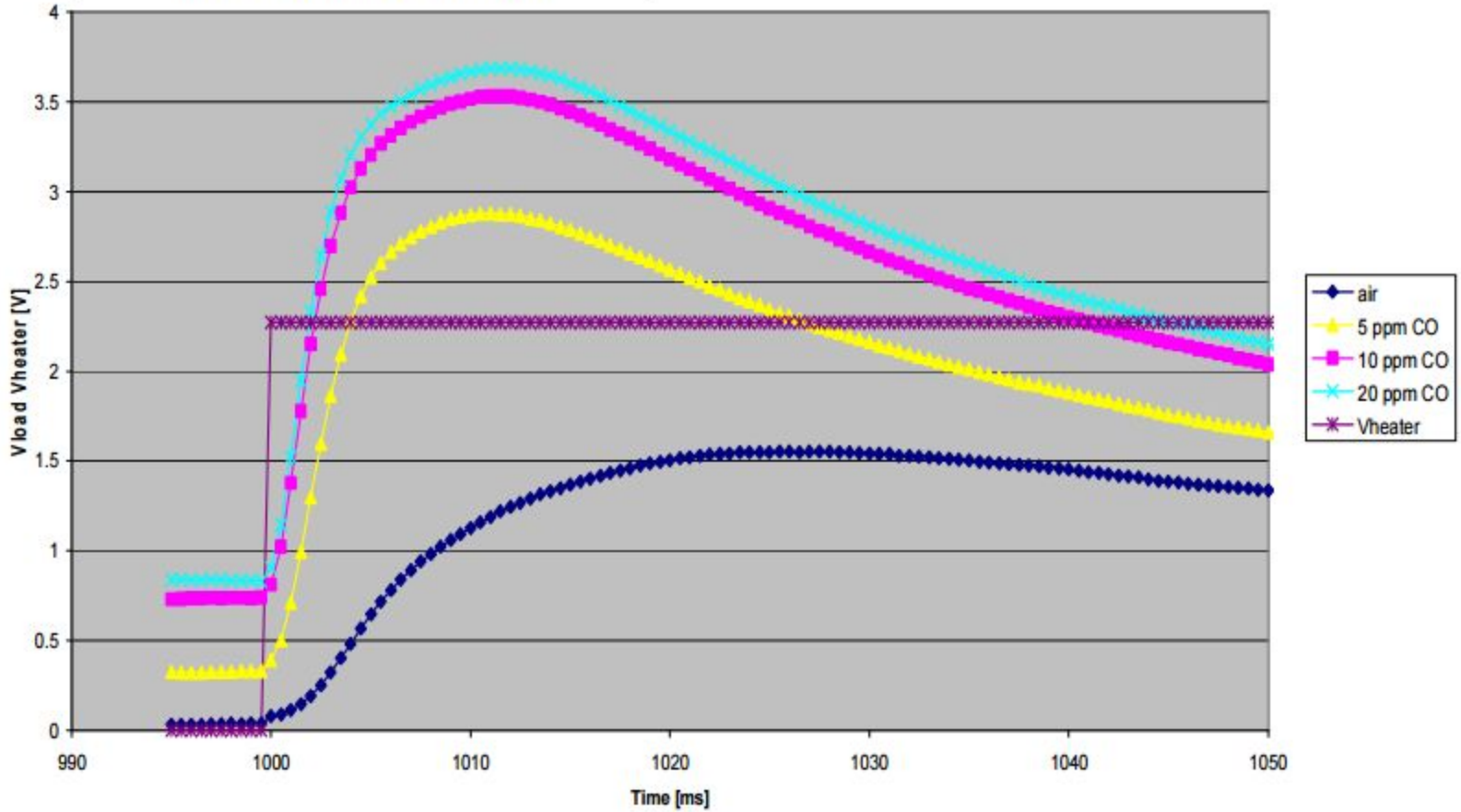
MiCS-5524 with measurement circuit (top view)



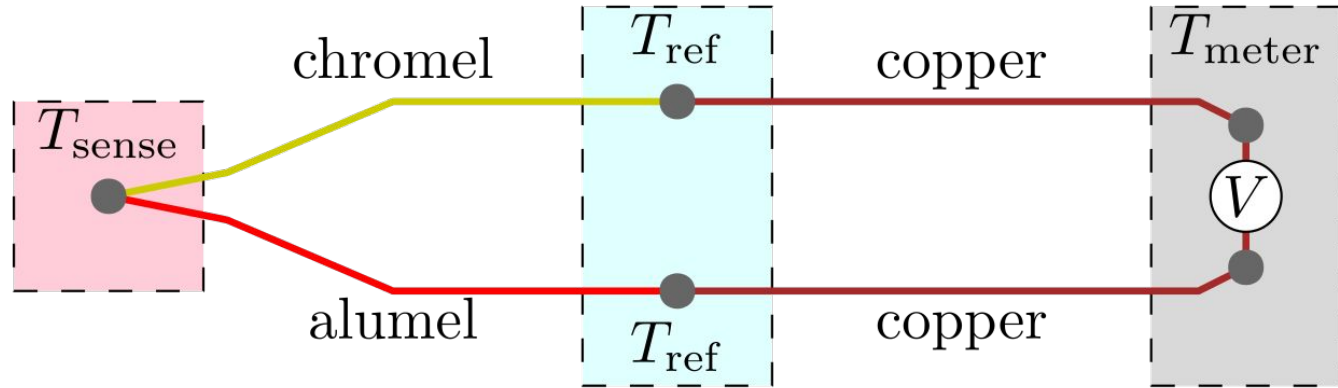
Seeed Studio



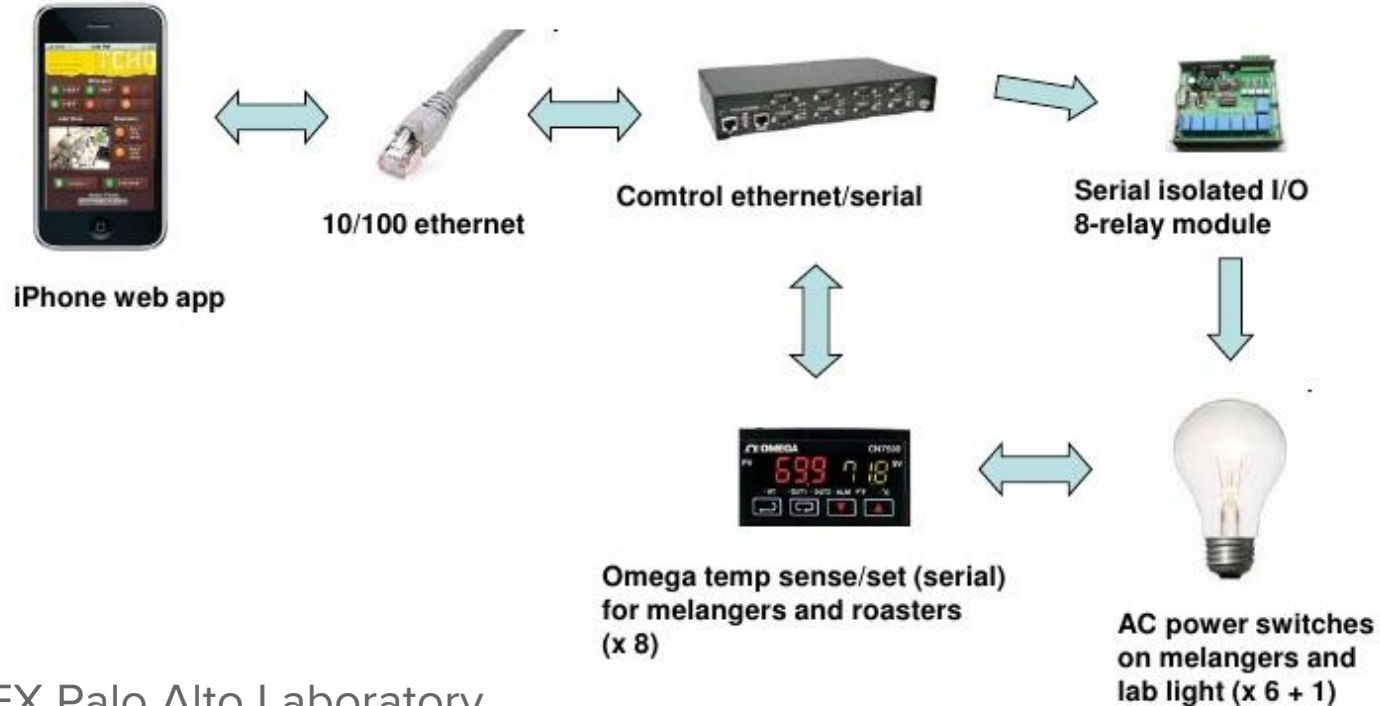
Behavior of MiCS-4512 RED with cold/hot cycle 1000-500 ms
at 350°C with 50% RH, 21°C sensor #82



Temperature: Thermocouple



Temperature: industrial sense & control



TCHO Chocolate & FX Palo Alto Laboratory

search results for "temperature controller"



Roll over image to zoom in

[Inkbird](#)

Inkbird ITC-106VH PID Temperature Thermostat Controllers, Fahrenheit & Centigrade, 100ACV - 240ACV, K Sensor, Solid State Relay for Sous Vide, Home Brewing (ITC-106VH + K + 40A SSR)

[7 customer reviews](#) | [8 answered questions](#)

Price: \$35.99

Sale: **\$30.59** | **FREE** One-DayDelivered tomorrow for **FREE** with qualifying orders over \$35. [Details](#)You Save: **\$5.40** (15%)**Buy 1, get 10% off** 1 Applicable Promotion(s) ▼**Only 18 left in stock - order soon.****Get it tomorrow, May 12.** Order within **3 hrs 15 mins** and choose **One-Day Shipping** at checkout.[Details](#)Sold by [Inkbird](#) and [Fulfilled by Amazon](#). Gift-wrap available.Color: **ITC-106VH + K + 40A SSR**

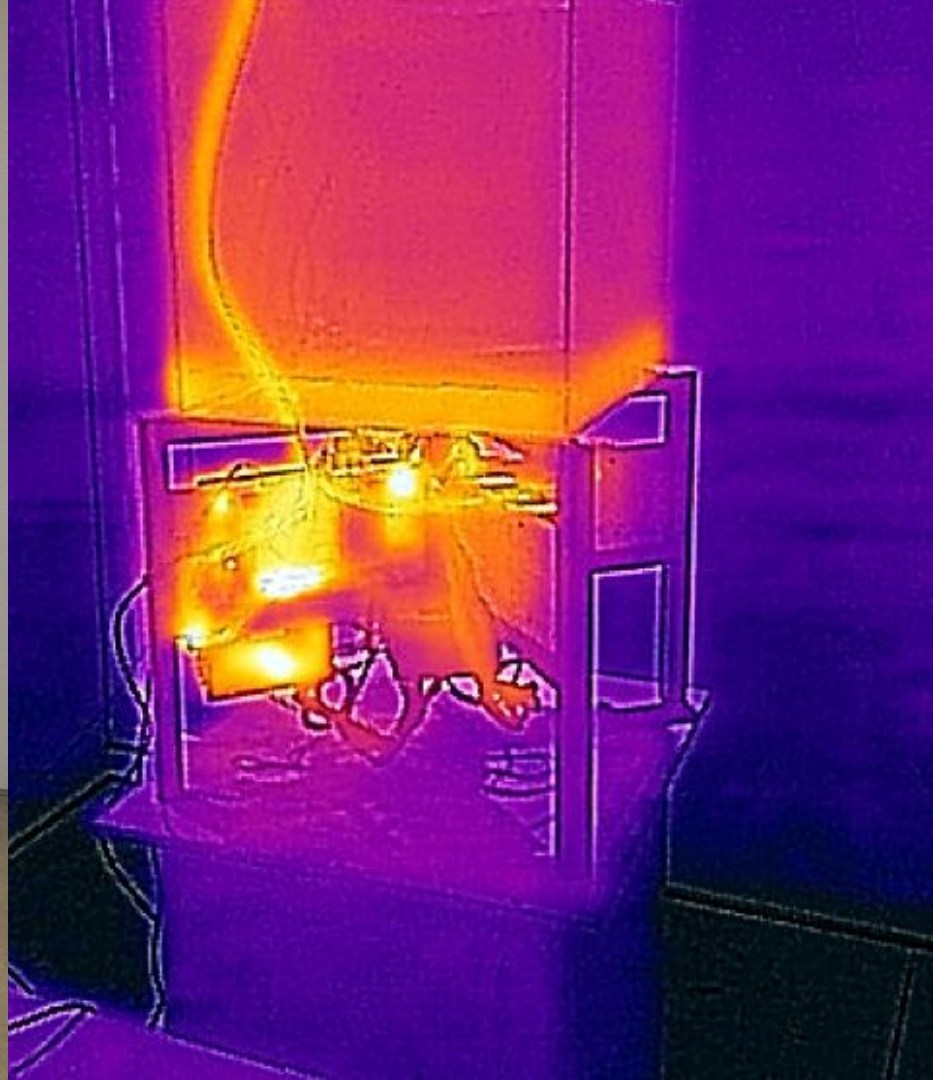
Mist Miner

Alexey Bulgakov

Urbanfaunazoo

Kadist Foundation





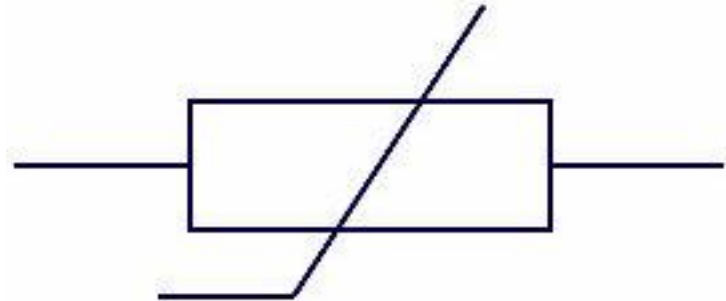
Temperature: Thermistor, RTD

NTC resistor

Linear variation with T

$$\alpha = \Omega/(\Omega \cdot ^\circ\text{C})$$

Silistor (silicon)



Thermistor Symbol

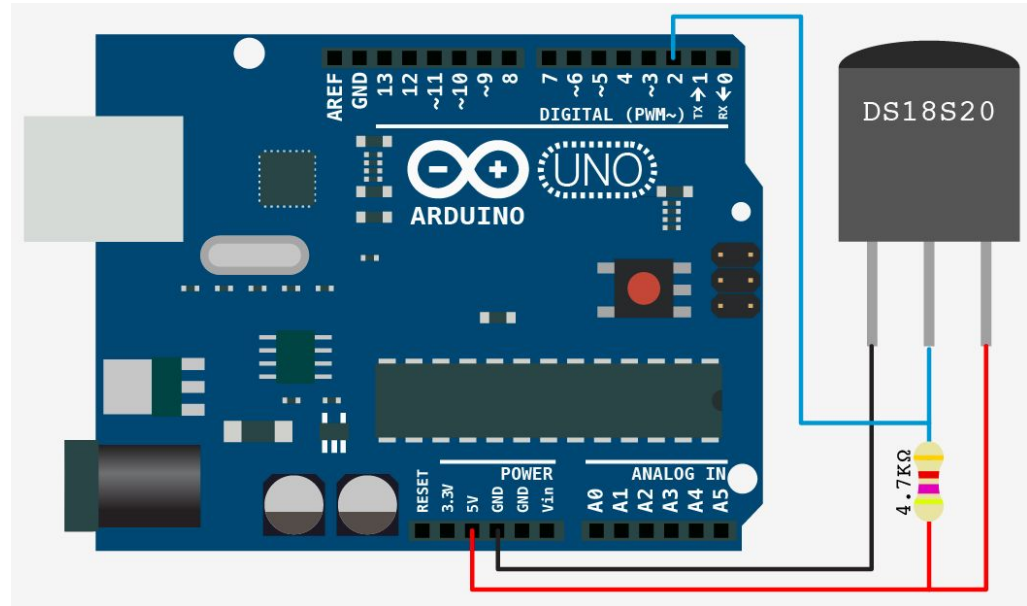
Temperature: digital

DS18S20 1-wire

Lots of I2C/SPI chips

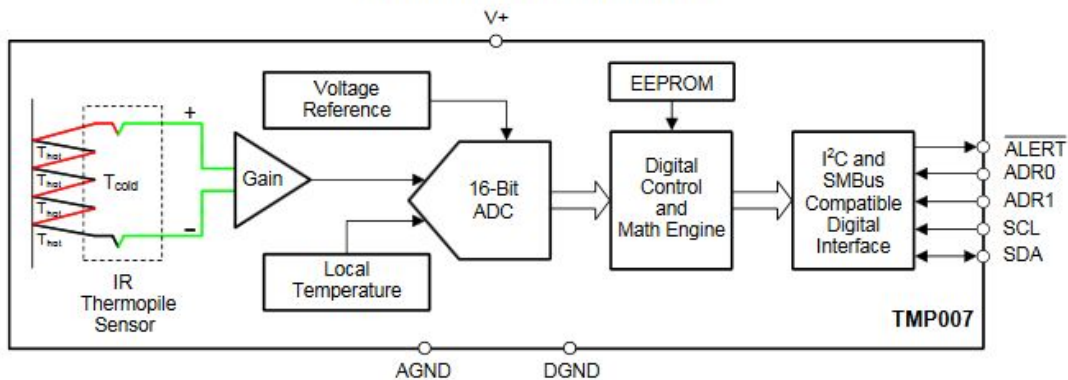
Built into most MEMS
pressure sensors

Many ICs have die temp

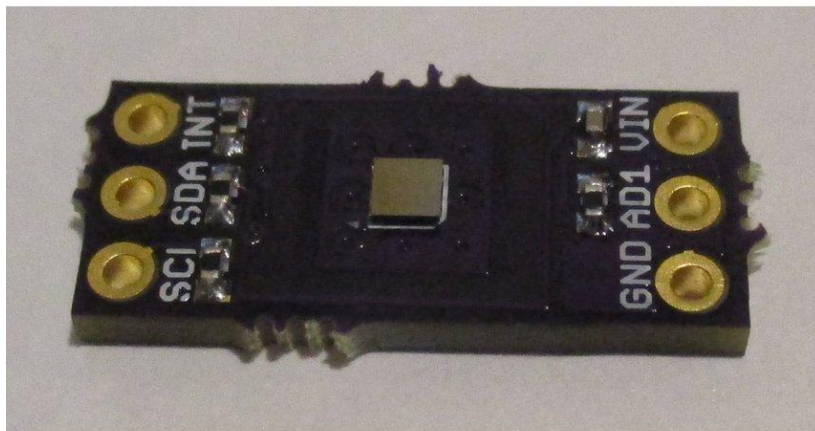
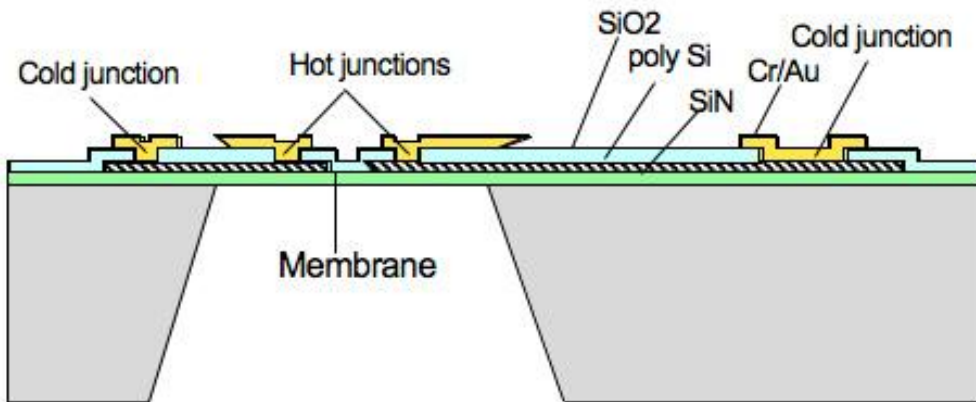


TI TMP007

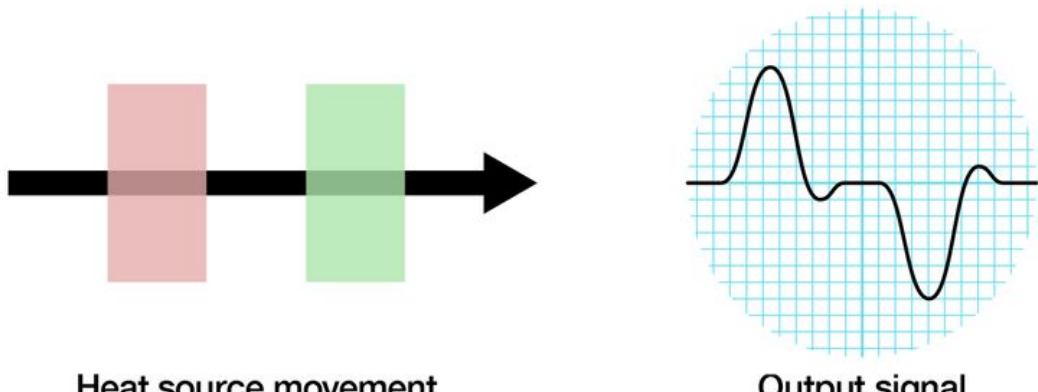
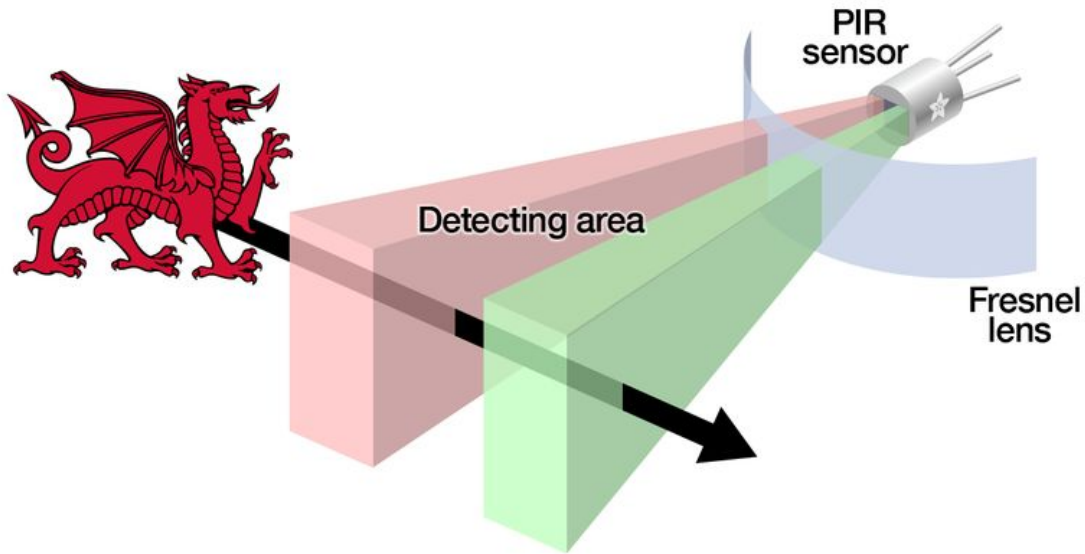
Functional Block Diagram



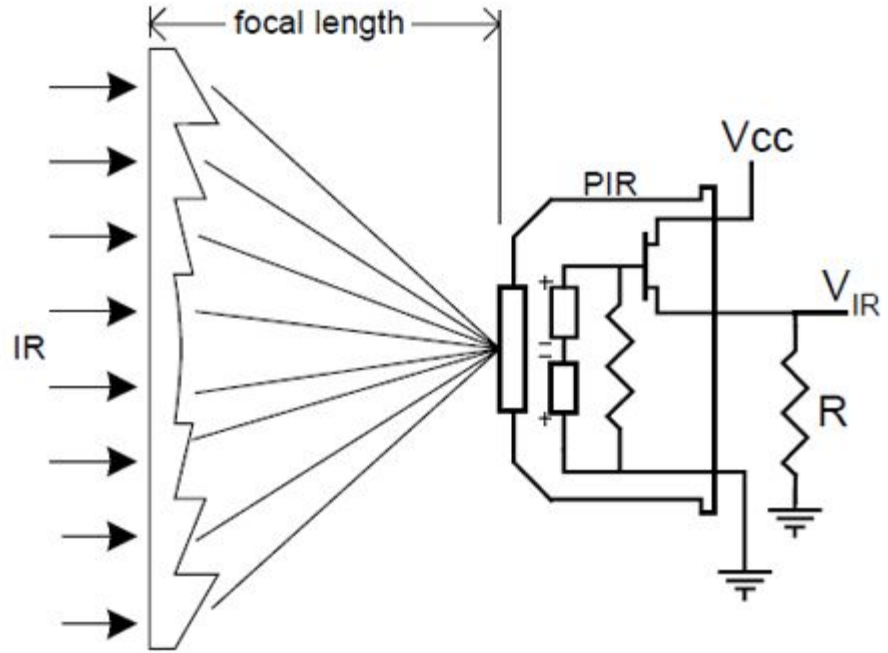
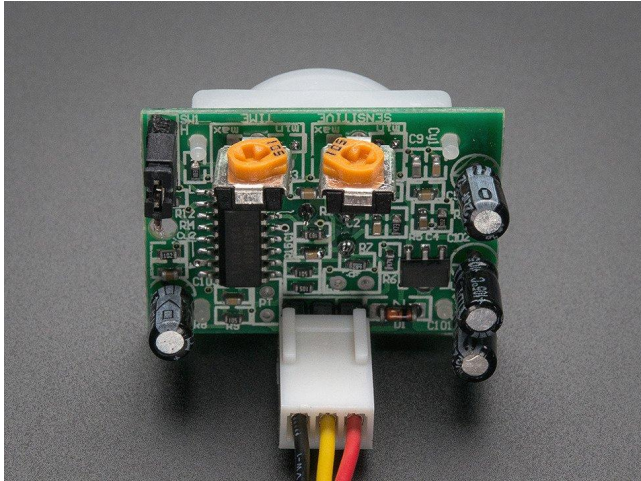
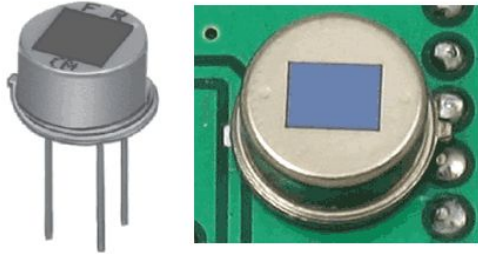
Sensor chip cross-section



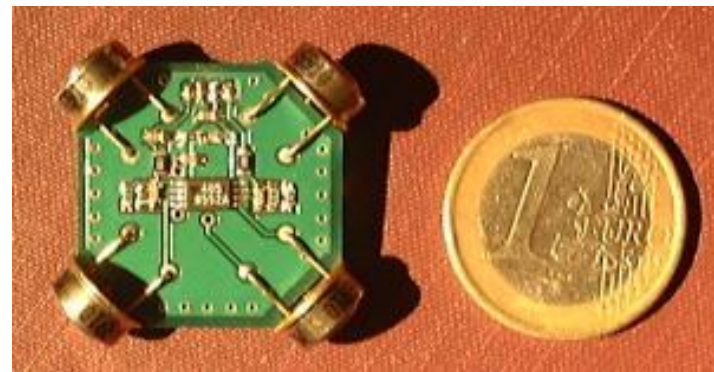
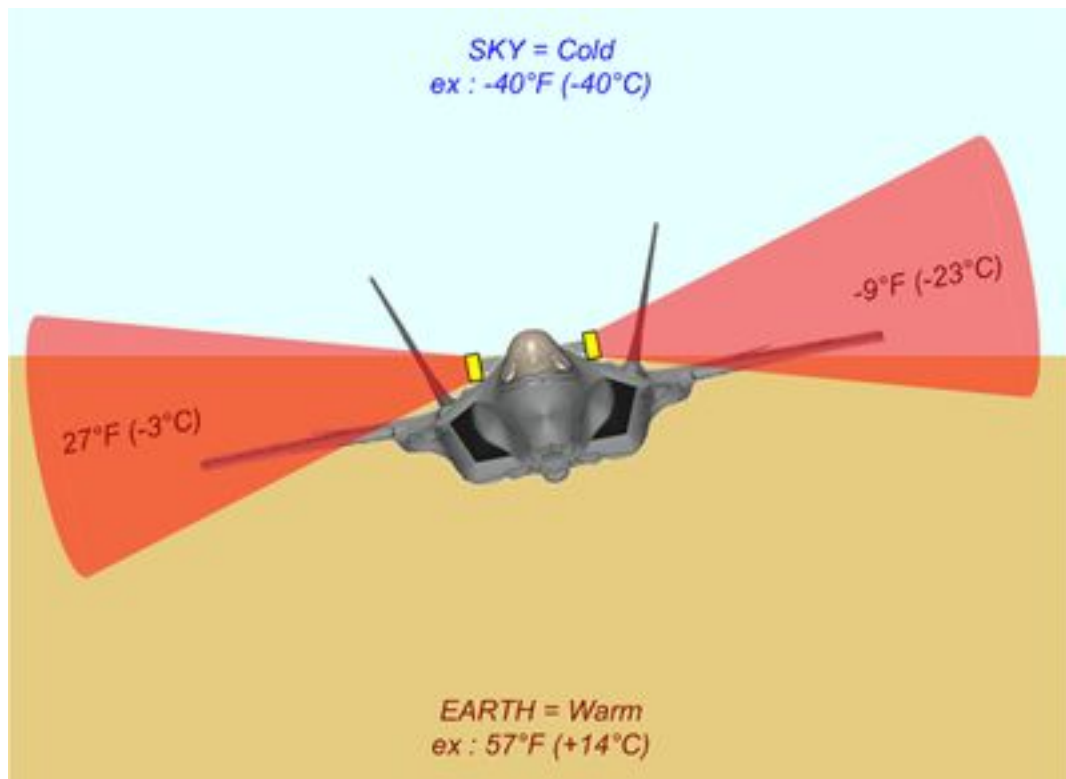
IR sensor: Thermopile



Thermopile (PIR)



Horizon sensing for drones



Paparazzi UAV

Biosensors -- Maybe next time...

PPG pulse & stress (photoplethysmogram)

IR/Visible pulse oximeters

GSR -- Galvanic Skin Resistance

EKG -- electrodes and amplifiers

EEG -- commercial and research solutions

Thank You!

SENSORPALOOZA



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