Pervasive Sensors and Actuators

COMP5047 – Lecture 06

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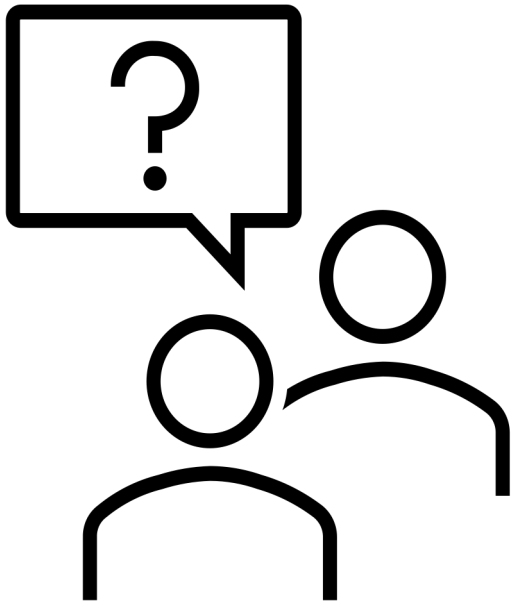
How we chose different components?



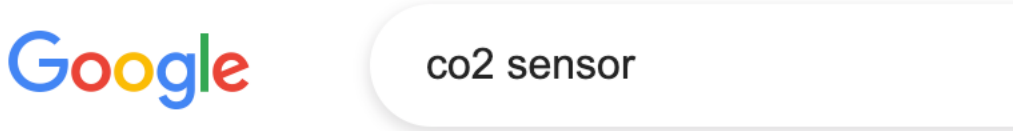
https://www.murata.com/en-global/products/sensor

Things to consider

- Application needs
  - What kind of functionality needed? Cost?
- Functional Specification
  - E.g. what to measure?, sensitivity?, bandwidth? Etc.
- Electrical Specification
  - E.g. operating voltage/current, power needs, etc.
- Communication Specification
  - What kind of communication exist, wired/wireless OR what type SPI, I2C, ADC, Bluetooth, etc.
- Safety/Risk
  - What can go wrong?

Measure CO2 in the Lecture Theatre

- What sensors are needed?



- Then go into details
  - Must read the data sheet

https://shop.m5stack.com/products/co2-unit-with-temperature-and-humidity-sensor-scd40

Measure CO2 in the Lecture Theatre

- Some data will be available up-front

Specification

Resources	Parameter
CO2 Measurement range	400 ~ 2000 ppm
CO2 Sampling accuracy	±(50 ppm + 5% of reading)
Temperature range	-10 - 60 °C
Humidity range	0 - 95 %RH
Communication protocol	I2C: 0x62
Net weight	7.54g
Gross weight	13.13g
Product dimensions	48mm x 24mm x 16mm
Package size	134mm x 61mm x 16.3mm
Housing material	Plastic (PC)

https://shop.m5stack.com/products/co2-unit-with-temperature-and-humidity-sensor-scd40

Measure CO2 in the Lecture Theatre

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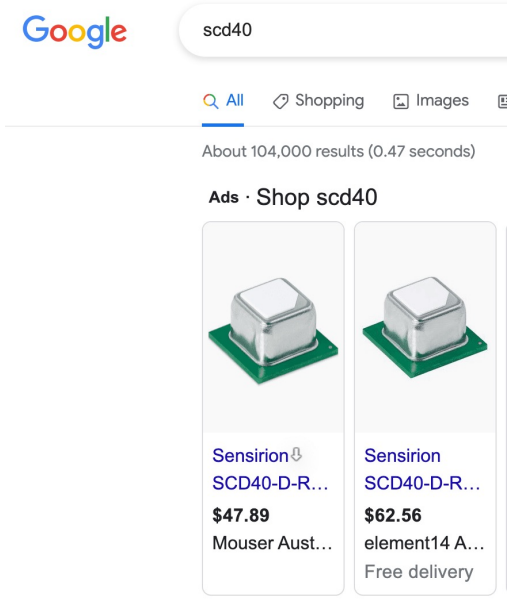
CO2 Unit	SCL	SDA	5V	GND
M5Core(PORT A)	GPIO22	GPIO21	5V	GND
M5Core2(PORT A)	GPIO22	GPIO21	5V	GND
M5Atom(PORT A)	GPIO32	GPIO26	5V	GND
M5StickC/Plus(PORT A)	GPIO33	GPIO32	5V	GND
M5Station(PORT A1,A2)	GPIO33	GPIO32	5V	GND

https://docs.m5stack.com/en/unit/co2

Measure CO2 in the Lecture Theatre

- But go further to the data sheet



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Measure CO2 in the Lecture Theatre

- But go further to the data sheet

SENSIRION

SCD4x

Breaking the size barrier in CO_2 sensing

Features

- Photoacoustic NDIR sensor technology PASens®
- Smallest form factor: 10.1 x 10.1 x 6.5 mm³
- Reflow solderable for cost effective assembly
- Large output range: 0 ppm – 40'000 ppm
- Large supply voltage range: 2.4 – 5.5 V
- High accuracy: ±(40 ppm + 5 %)
- Digital I²C interface
- Integrated temperature and humidity sensor
- Low power operation down to < 0.4 mA avg. @ 5 V, 1 meas. / 5 minutes

Lets Look at the Datasheet!

https://sensirion.com/media/documents/C4B87CE6/627C2DCD/CD_DS_SCD40_SCD41_Datasheet_D1.pdf

Think Holistic

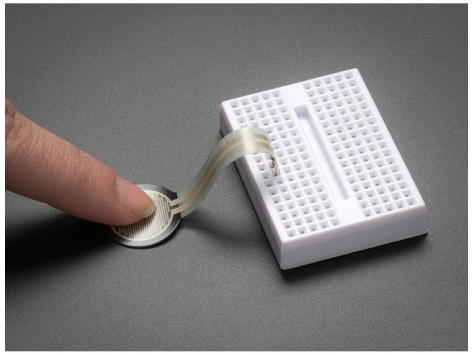
- Figure out what microcontroller you use
- **Make sure your device/network choices match that**
  - **Or vice versa**
- Find out other needs
  - Power (battery), other components needed

Interfacing with Peripherals

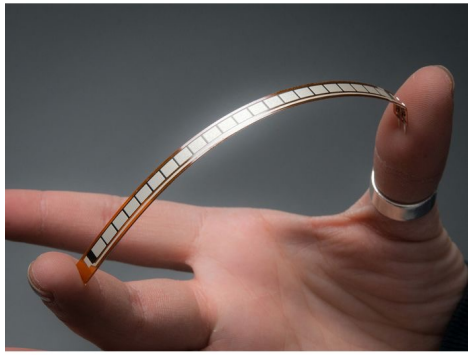
- Find out the method of interfacing
  - ADC, I2C, SPI, PWM, Bluetooth, etc.
- Design connectivity
  - Figure out how to connect / topology / electrical
- Configure the device
  - Some devices support configuration

Some ADC sensors

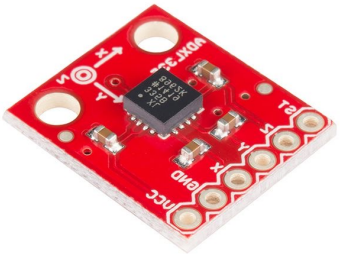
- How can we connect them?



Force-Sensitive Resistor (FSR)



Flex sensor



Accelerometer - ADXL335

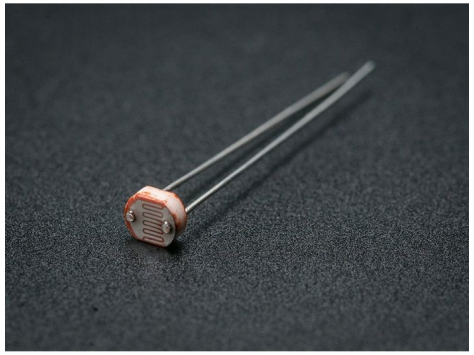


Photo cell (CdS photoresistor)

https://core-electronics.com.au/

Some ADC sensors

- Some makes a voltage output
  - can directly connect to ADC

ANALOG DEVICES

Small, Low Power, 3-Axis ±3 *g* Accelerometer

ADXL335

FEATURES

3-axis sensing
Small, low profile package
4 mm × 4 mm × 1.45 mm LFCSP
Low power : 350 µA (typical)
Single-supply operation: 1.8 V to 3.6 V
10,000 *g* shock survival
Excellent temperature stability
BW adjustment with a single capacitor per axis
RoHS/WEEE lead-free compliant

APPLICATIONS

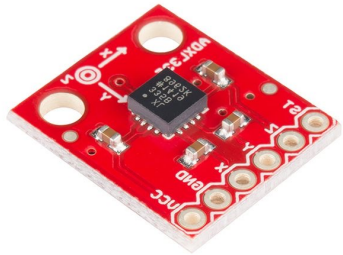
Cost sensitive, low power, motion- and tilt-sensing applications
Mobile devices
Gaming systems
Disk drive protection
Image stabilization
Sports and health devices

GENERAL DESCRIPTION

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the C_X, C_Y, and C_Z capacitors at the X_{OUT}, Y_{OUT}, and Z_{OUT} pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

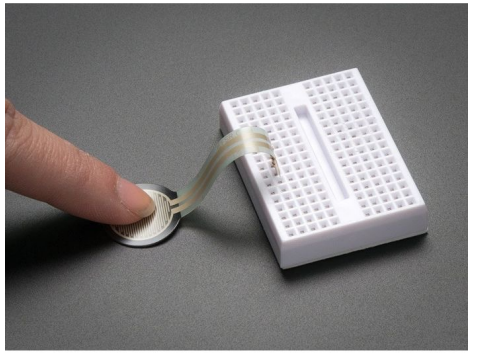


Accelerometer - ADXL335

https://core-electronics.com.au/

Some ADC sensors

- Some makes a change in electrical characteristics
  - Resistance, current or capacitance change
  - Resistance: You need to use a voltage divider (Ohm's law)

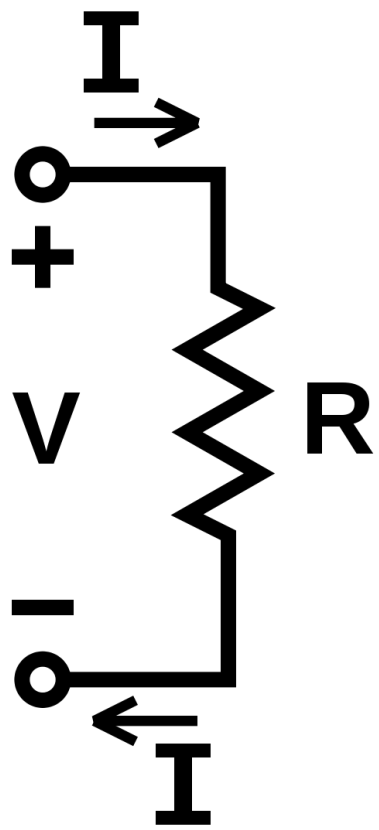


Force-Sensitive Resistor (FSR)

https://core-electronics.com.au/

Some ADC sensors

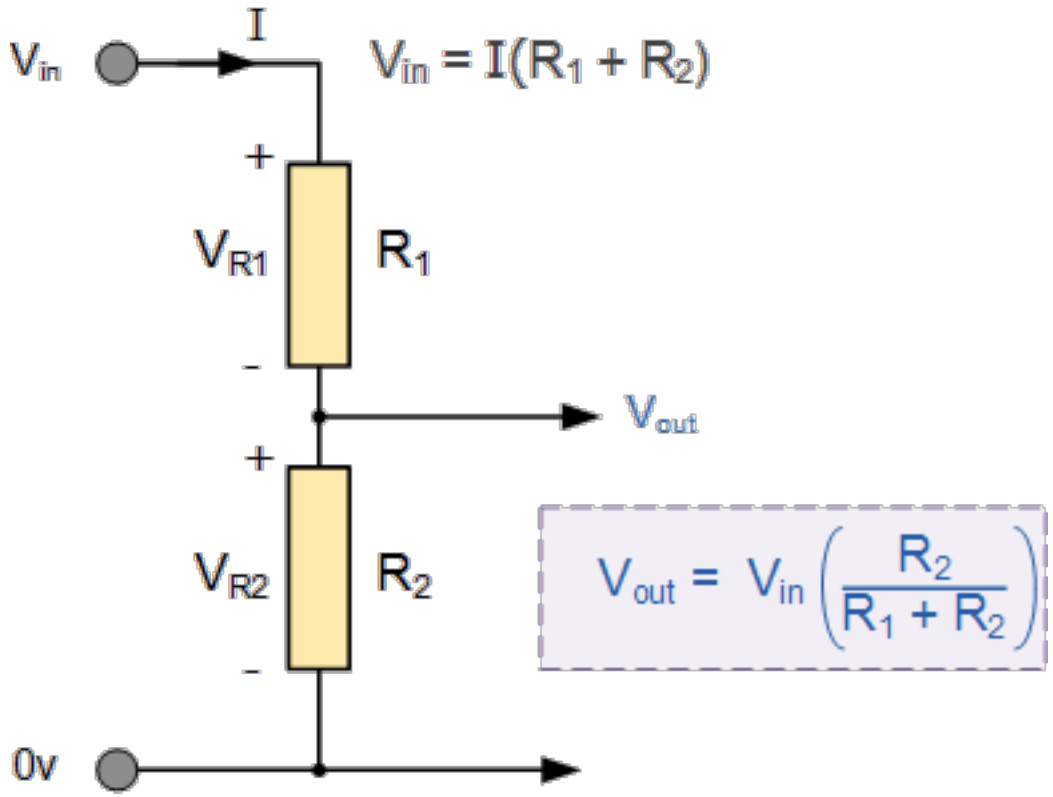
- Ohm's law



$$V = IR$$

R = 3kOhm
V = 3.3V
I?

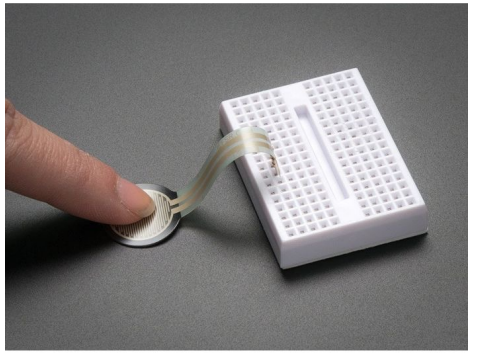
I = V /R
= 3.3 / 3000
= 0.0011 A
= 1.1mA



https://www.electronics-tutorials.ws/resistor/res_3.html

Some ADC sensors

- Lets goto the Datasheet



Force-Sensitive Resistor (FSR)

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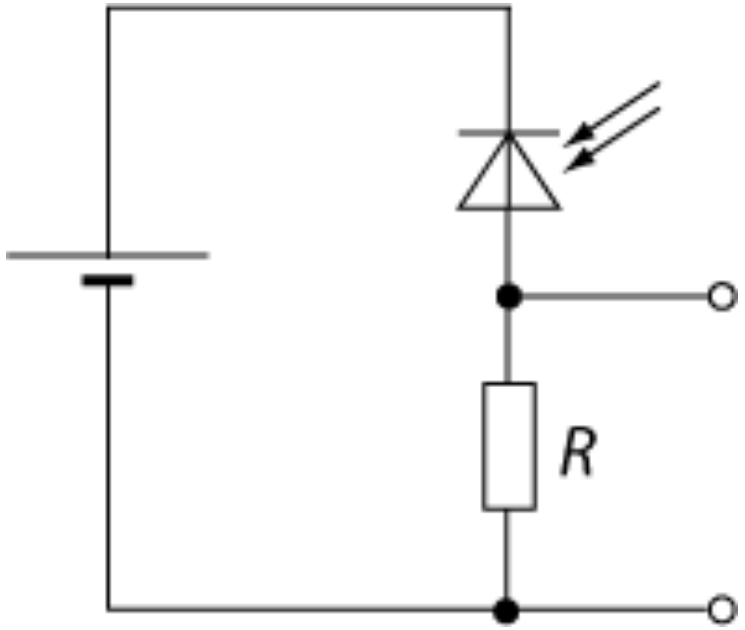
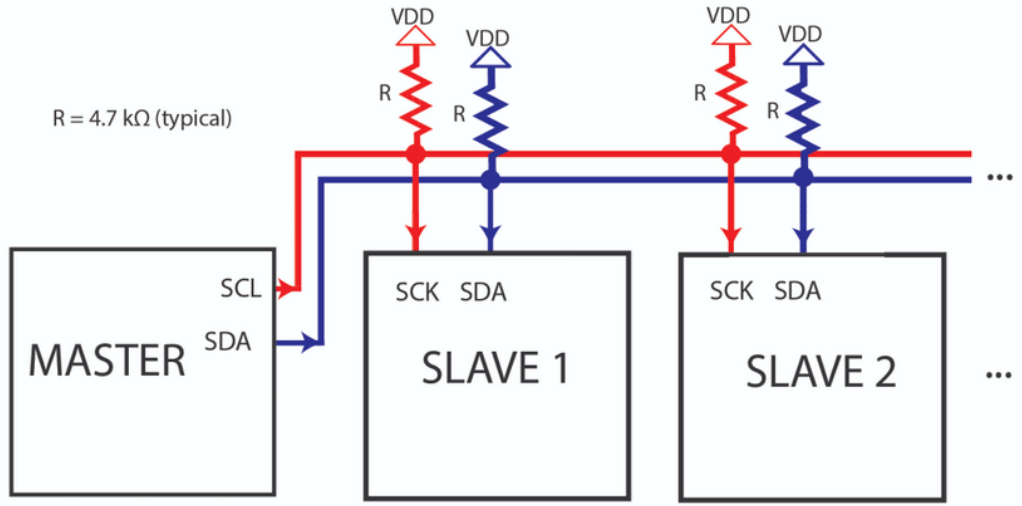
Some ADC sensors

- Homework
  - See how photodiode works



Digital Interfaces (I2C, SPI, etc.)

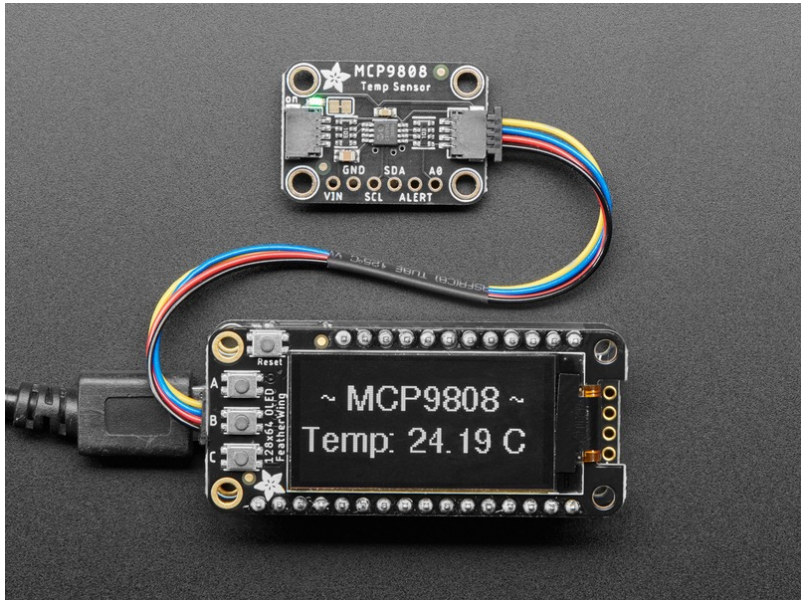
- Consider requirements
  - There are maximum supported clock rates (not same as sampling rate)
  - Maximum devices / length that can be connected
- Electrical requirements
  - E.g. Pull Ups in I2C



ResearchGate

Digital Interfaces / Configuration

- I2C
  - MCP9808 temperature sensor data sheet
  - Lot of configuration
    - But you can find libraries



https://learn.adafruit.com/adafruit-mcp9808-precision-i2c-temperature-sensor-guide/overview

Wireless Networks

- Many things to configure
  - Power settings
    - E.g. BLE
  - Connection settings
    - BLE connection settings / WiFi IP settings etc.
  - Managing disconnections

Summary

- Understand different types of peripherals
- Learn how to read and interpret datasheets
- Making appropriate design choices and configurations

Image https://www.dnsstuff.com/

Next Week Prep

- Install Node-RED locally
  - https://nodered.org/docs/getting-started/local
- Run a sample sketch
- Figure out how to import and export your sketches (formatted)