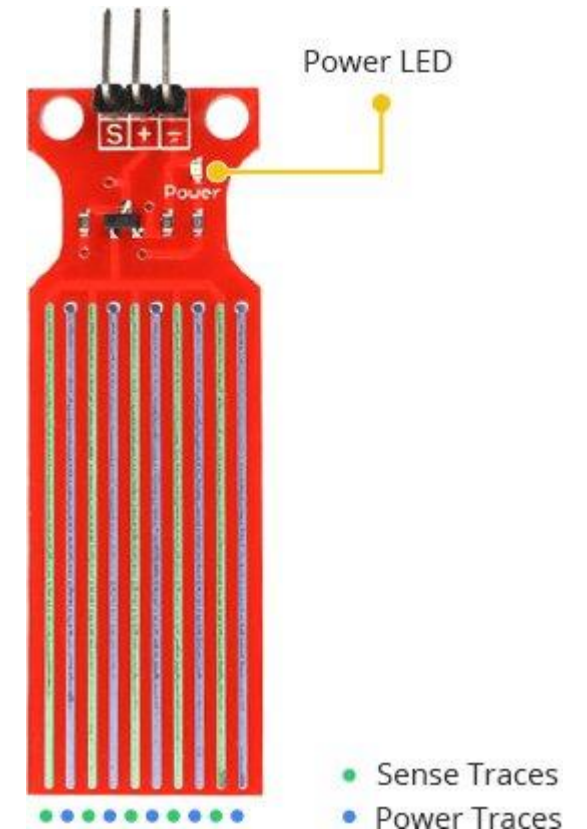


Examples of different types of sensors

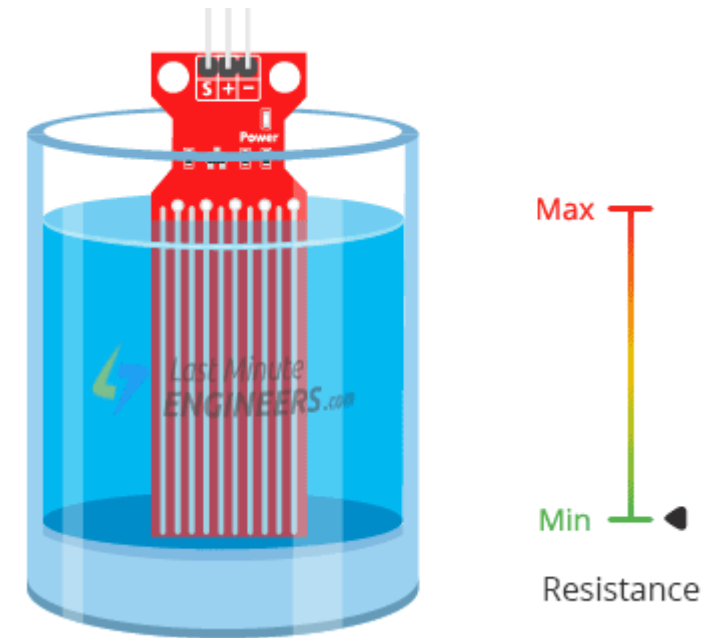
Water Level Sensor (Resistance)

- Presence of 10 exposed copper traces – 5 are power traces and 5 are sense traces
- One sense trace in between every two power traces
- These traces are bridged when submerged in water



Water Level Sensor working principle

- The parallel conductors act as a variable resistor and resistance varies according to water level
- Resistance inversely proportional to the height of the water
- More the immersion, better the conductivity and lower the resistance and vice versa
- Produces an output voltage according to resistance
- Issue: short lifespan as exposed to moist environment



Source: <https://lastminuteengineers.com/water-level-sensor-arduino-tutorial>

Optical water level sensor

infrared LEDs and phototransistors



Advantages: non-contact measurement, high accuracy, and fast response.

Disadvantages: Do not use under direct sunlight, water vapor will affect the measurement accuracy.

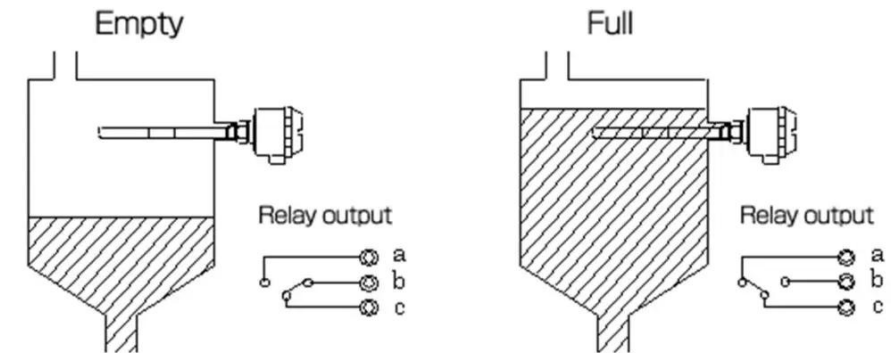
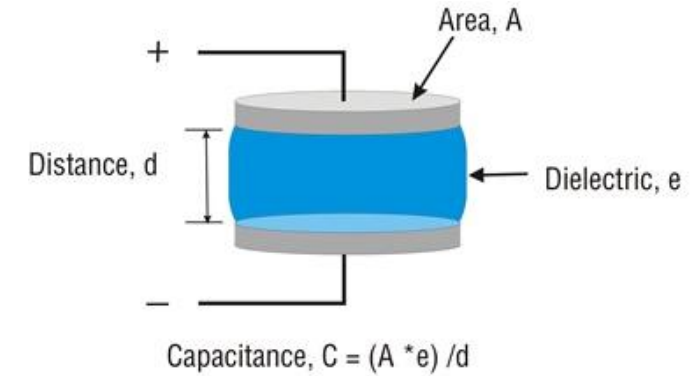
<https://www.renkeer.com/>

Capacitance liquid level sensor



Advantages: can be used to determine the rise or fall of the liquid in the container. By making the electrode and the container the same height, the capacitance between the electrodes can be measured. No capacitance means no liquid. A full capacitance represents a complete container.

Disadvantages: The corrosion of the electrode will change the capacitance of the electrode, and it needs to be cleaned or recalibrated.



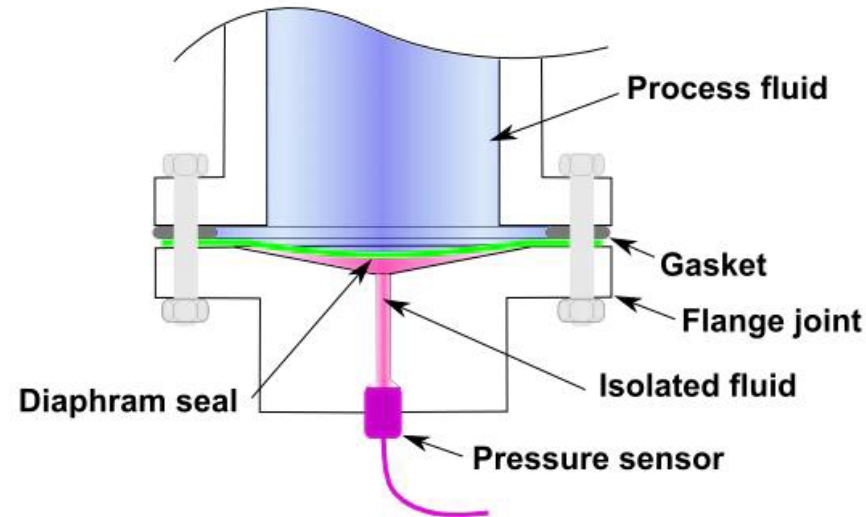
Tuning fork level sensor & Diaphragm liquid level sensor



resonant frequency.

Advantages: It can be truly unaffected by flow, bubbles, liquid types, etc., and no calibration is required.

Disadvantages: Cannot be used in viscous media.



Advantages: There is no need for power in the tank, it can be used with many types of liquids, and the switch will not come into contact with liquids.

Disadvantages: Since it is a mechanical device, it will need maintenance over time.

Float water level sensor & Ultrasonic liquid level sensor



Advantages: The float switch can measure any type of liquid and can be designed to operate without any power supply.
Disadvantages: They are larger than other types of switches, and because they are mechanical, they must be used more frequently than other level switches.

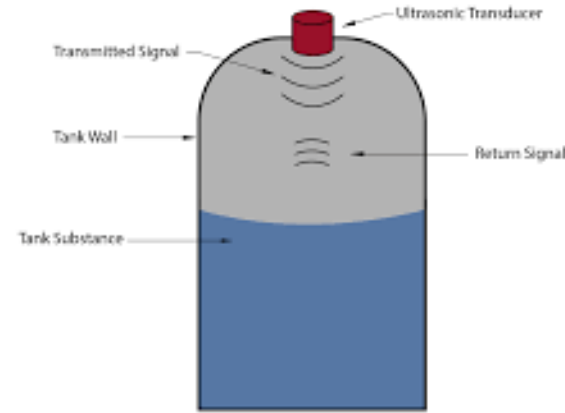


Figure 1: "Top-Down" Ultrasonic Sensor

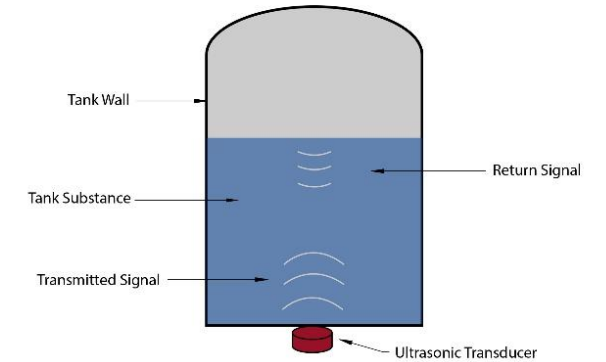
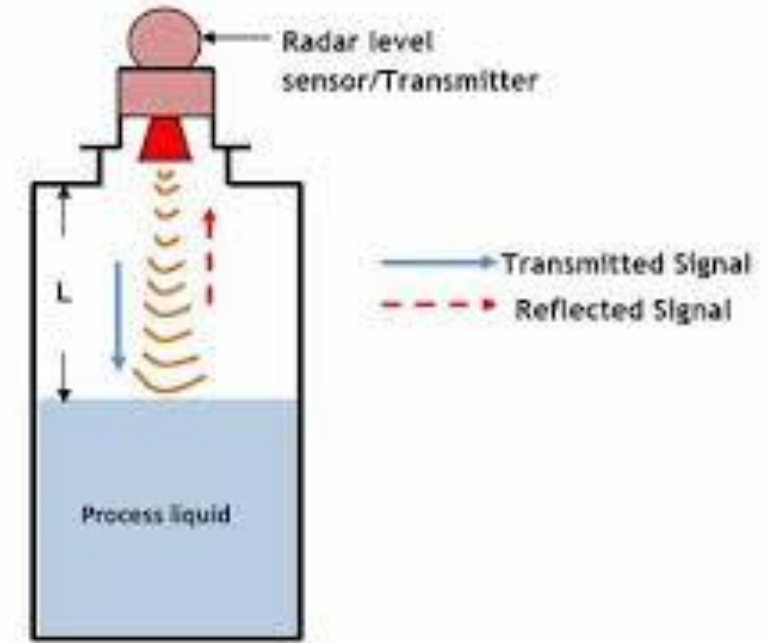


Figure 2: "Bottom-Up" Ultrasonic Sensor

Advantages: non-contact measurement, the measured medium is almost unlimited, and it can be widely used for measuring the height of various liquids and solid materials.

Disadvantages: The measurement accuracy is greatly affected by the temperature and dust of the current environment.

Radar level gauge



Advantages: wide application range, not affected by temperature, dust, steam, etc.

Disadvantages: It is easy to produce interference echo, which affects the measurement accuracy.

Ultrasonic

Natural Piezoelectric Materials



Quartz crystal
cluster from Tibet



Topaz



Sugar Cane



Tendon



DNA



Rochelle Salt



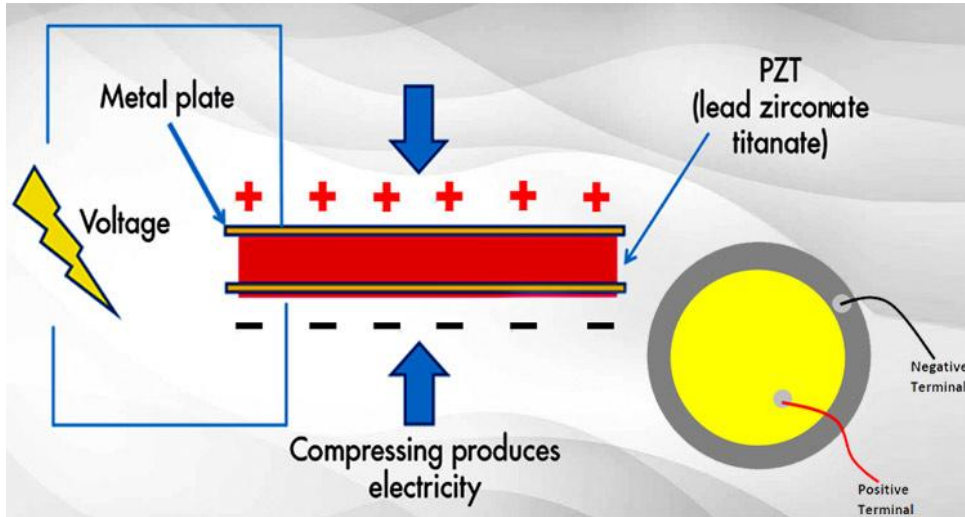
Schorl Tourmaline



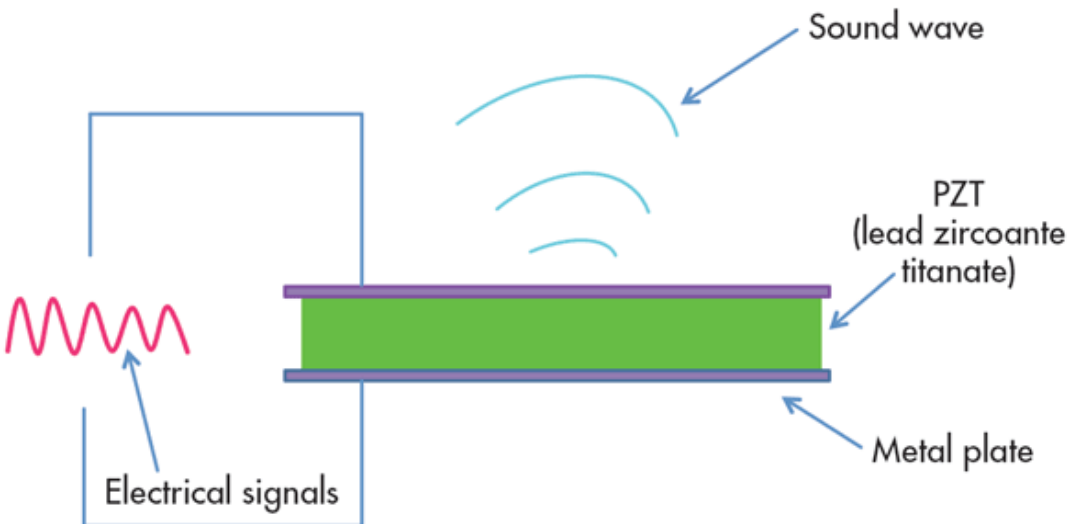
Dentine/ Enamel



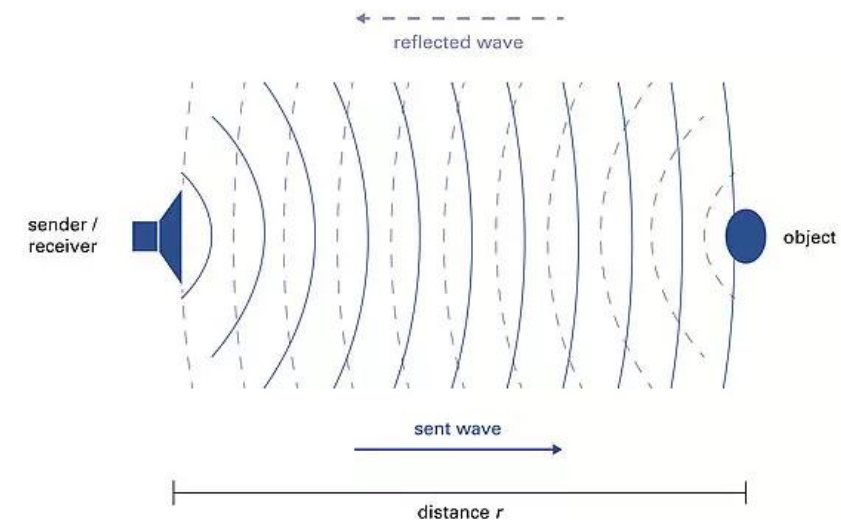
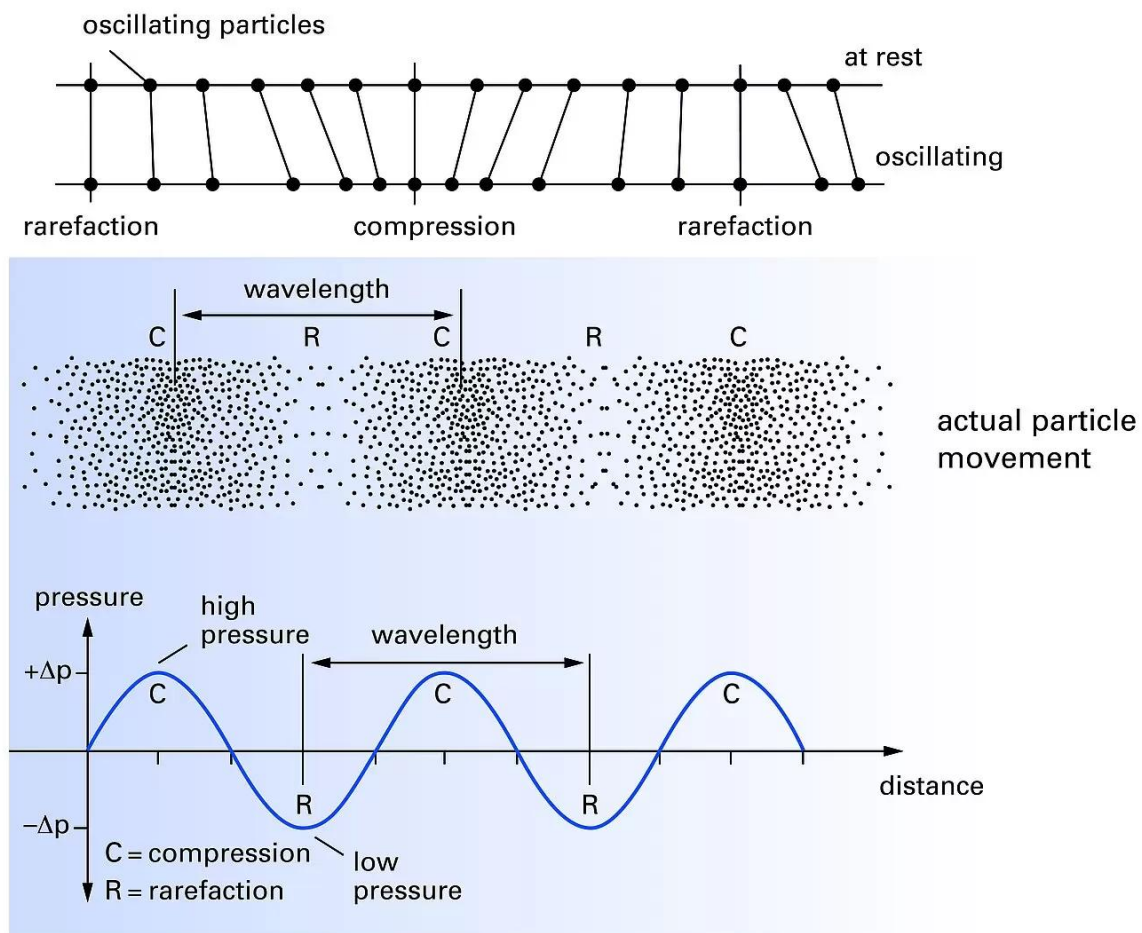
Bone



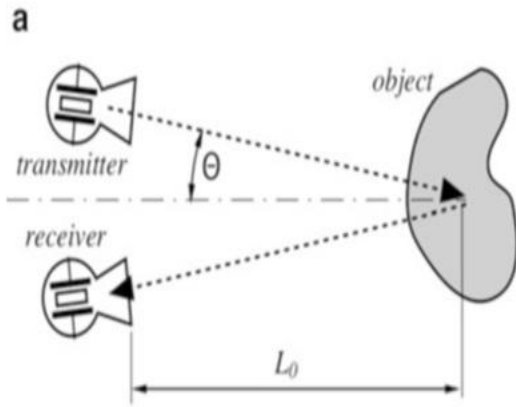
Applying mechanical energy to a crystal is called a direct piezoelectric effect which forces the excess negative and positive charges appear on opposite sides of the crystal face. The metal plate collects these charges, which can be used to produce a voltage and send an electrical current through a circuit.



Electrical energy applied to the crystal, shrinks and expands the crystal's structure. As the crystal's structure expands and contracts, it converts the received electrical energy and releases mechanical energy in the form of a sound wave.



Ultrasound - piezoelectric



Moving object: Doppler effect

$$L_0 = vt \cos \theta / 2$$

<https://www.youtube.com/watch?v=y2pAFuSciB4&t=5s>