

Instrumentation



Humidity, gas and light intensity Measurement

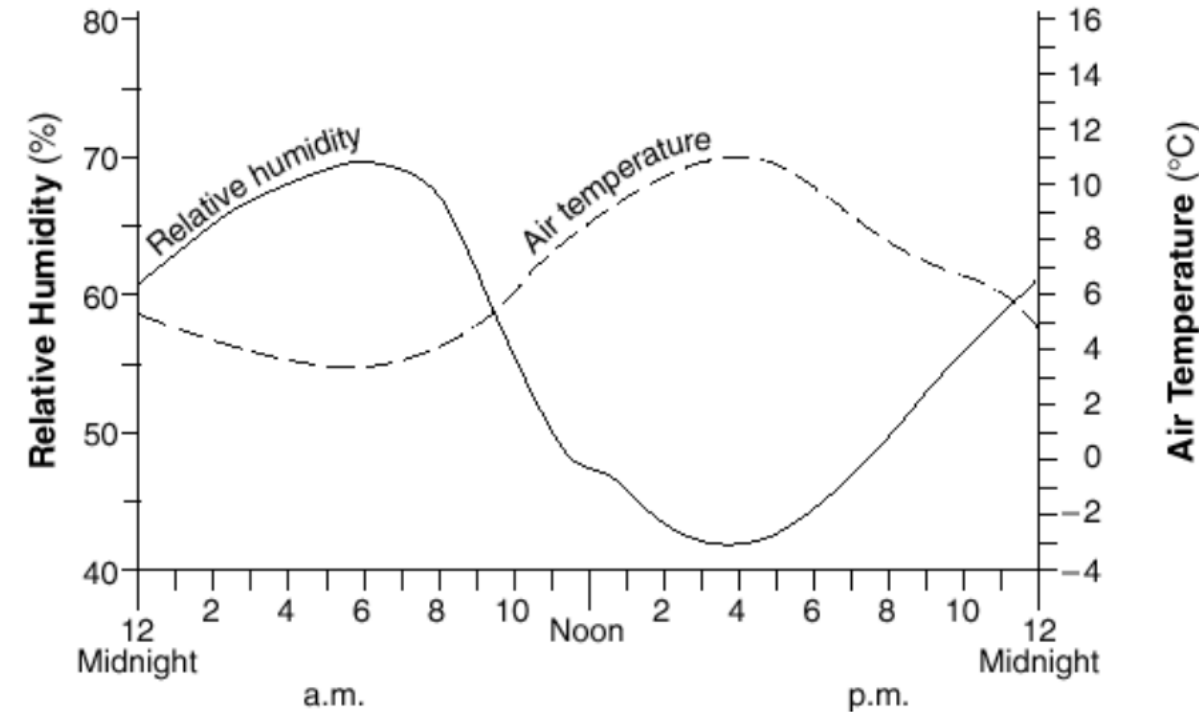
Course Instructor: Mohammad Reza Nayeri

Spring 2022

Humidity Sensors

- **Hygrometers**

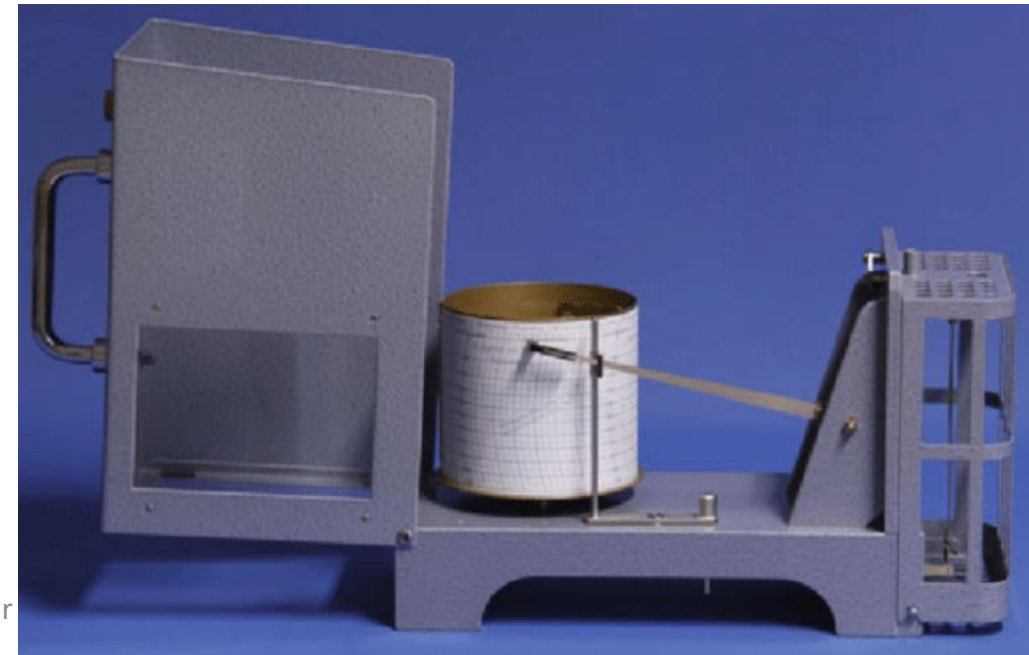
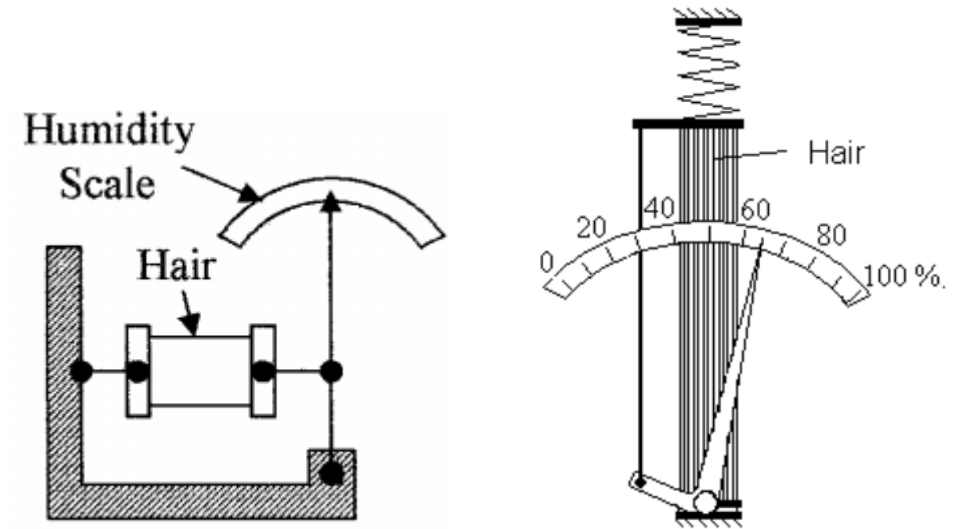
- Materials such as hair, skin and thin strips of wood change their length as they absorb water.
- The change in length is directly related to the humidity.
- Such devices are used to measure relative humidity from 20 to 90 percent, with accuracies of about ± 5 percent.
- Operating temperature range is limited to less than 70°C .



Humidity Sensors

- **Hygrometers**

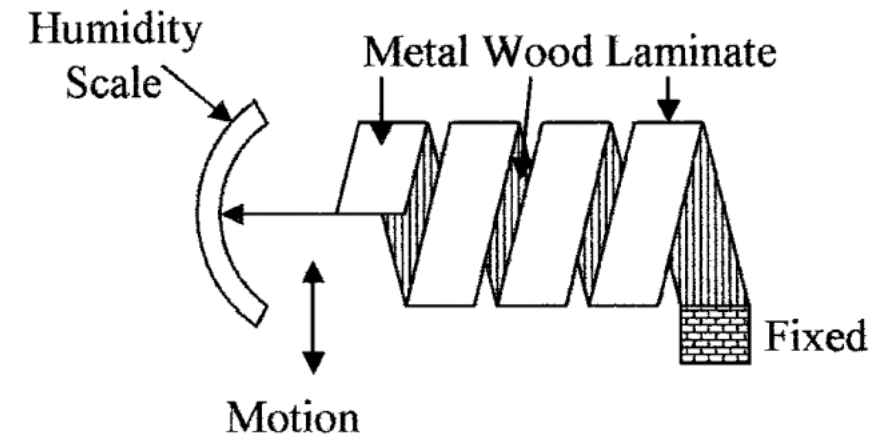
- Hair hygrometer is the simplest and oldest type of hygrometer.
- It is made using hair. Human hair lengthens by 3 percent when the humidity changes from 0 to 100 percent.
- The change in length can be used to control a pointer for visual readings or a transducer such as a LVDT for an electrical output.
- The hair hygrometer has an accuracy of about 5 percent for the humidity range 20 to 90 percent.
- The temperature range 5 to 40°C.



Humidity Sensors

- **Hygrometers**

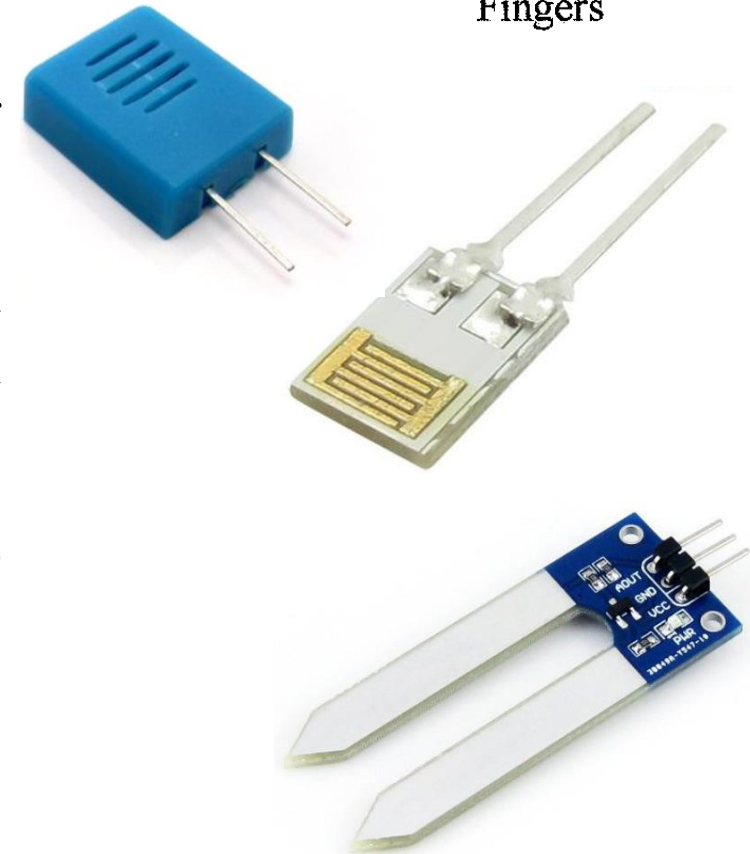
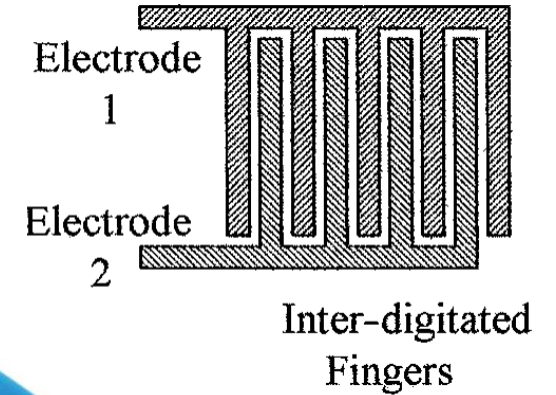
- Laminate hygrometer is made by attaching thin strips of wood to thin metal strips forming a laminate.
- The laminate is formed into a helix.
- As the humidity changes the helix flexes due to the change in the length of the wood. One end of the helix is anchored, the other is attached to a pointer.



Humidity Sensors

- **Hygrometers**

- **Resistive hygrometer** or resistive humidity sensors consist of two electrodes on an insulating substrate.
- Electrodes are coated with a hydroscopic material (one that absorbs water such as lithium chloride).
- The hydroscopic material provides a conductive path between the electrodes; the coefficient of resistance of the path is **inversely** proportional to humidity.
- Change from 2 to 98 percent will typically give a resistance change from 10 M Ω to 1 k Ω .

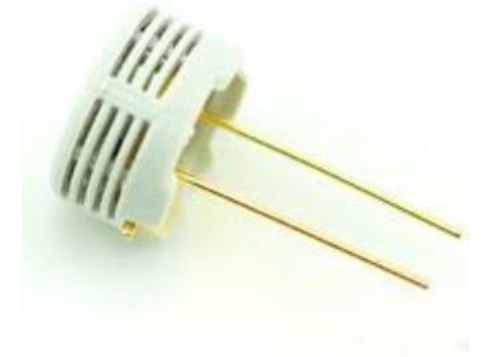
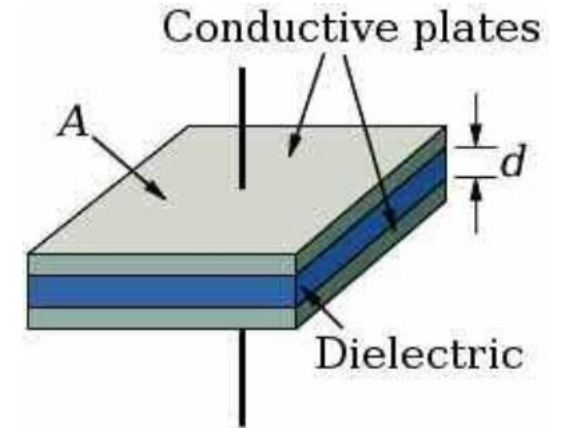


Humidity Sensors

- **Hygrometers**

- **Capacitive hygrometer**

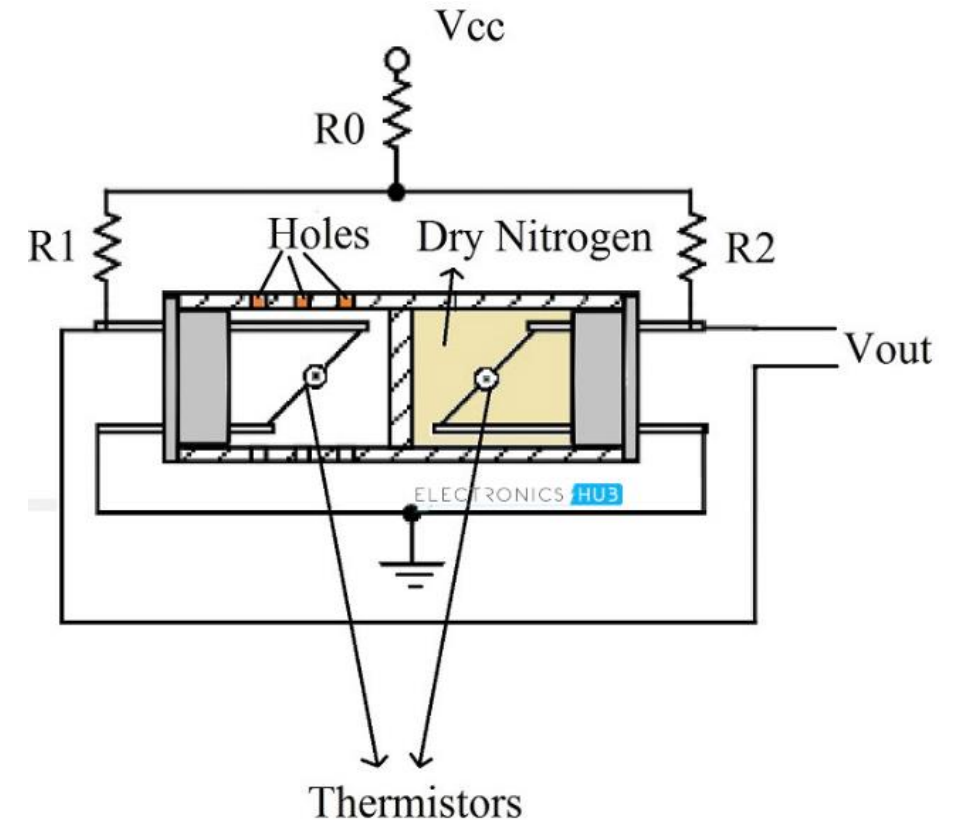
- The dielectric constant of certain thin polymer films changes **linearly** with humidity.
- The capacitive device has good longevity, a working temperature range of 0 to 100°C.
- The capacitive device has fast response time, and can be temperature compensated to give an accuracy of ± 0.5 percent over the full humidity range.



Humidity Sensors

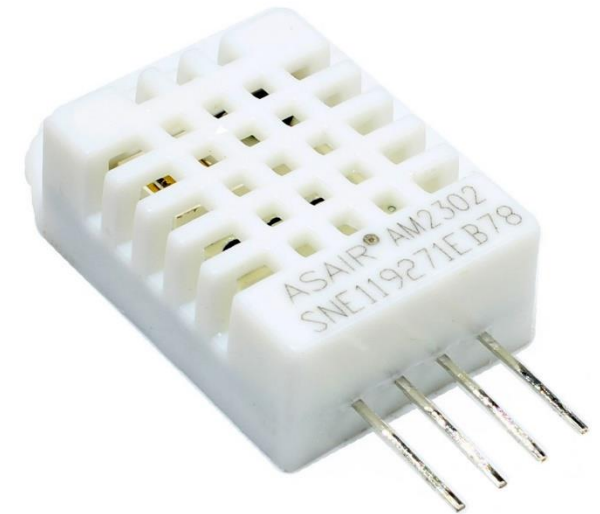
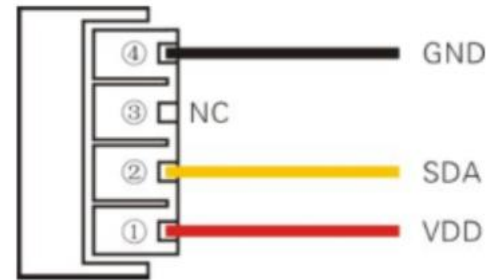
- **Hygrometers**

- **Piezoelectric or sorption** hygrometers use two piezoelectric crystal oscillators.
- One is used as a reference and is enclosed in a dry atmosphere, and the other is exposed to the humidity to be measured.
- Moisture increases the mass of the crystal which decreases its resonant frequency.
- By comparing the frequencies of the two oscillators, the humidity can be calculated



Humidity Sensors

- AMS2302 Module

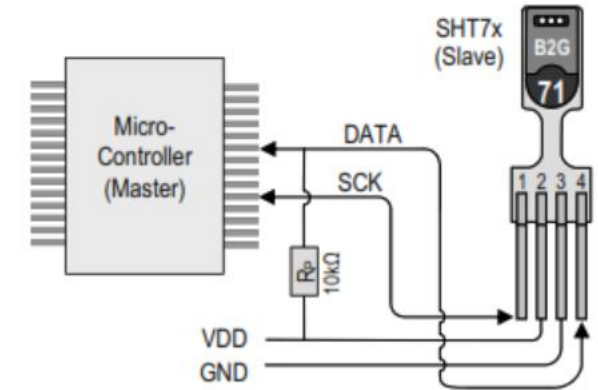


Parameter	Condition	min	typ	max	Unit
Resolution			0.1		%RH
Range		0		99.9	%RH
Accuracy ^[1]	25°C		± 2		%RH
Repeatability			± 0.3		%RH
Exchange		Completely interchangeable			
Response ^[2]	1/e(63%)		<5		S
Sluggish			<0.3		%RH
Drift ^[3]	Typical		<0.5		%RH/yr

Parameter	Condition	min	typ	max	Unit
Resolution			0.1		°C
			16		bit
Accuracy			± 0.5	± 1	°C
Range		-40		80	°C
Repeat			± 0.2		°C
Exchange		Completely interchangeable			
Response	1/e(63%)		<10		S
Drift			± 0.3		°C/yr

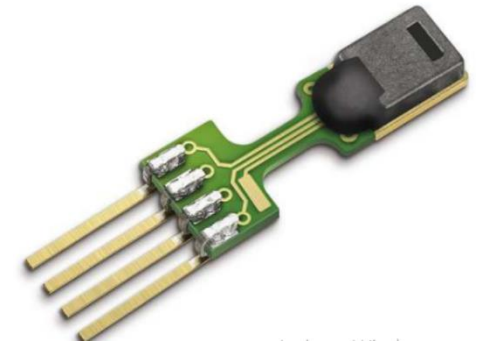
Humidity Sensors

- SHT7x Module**

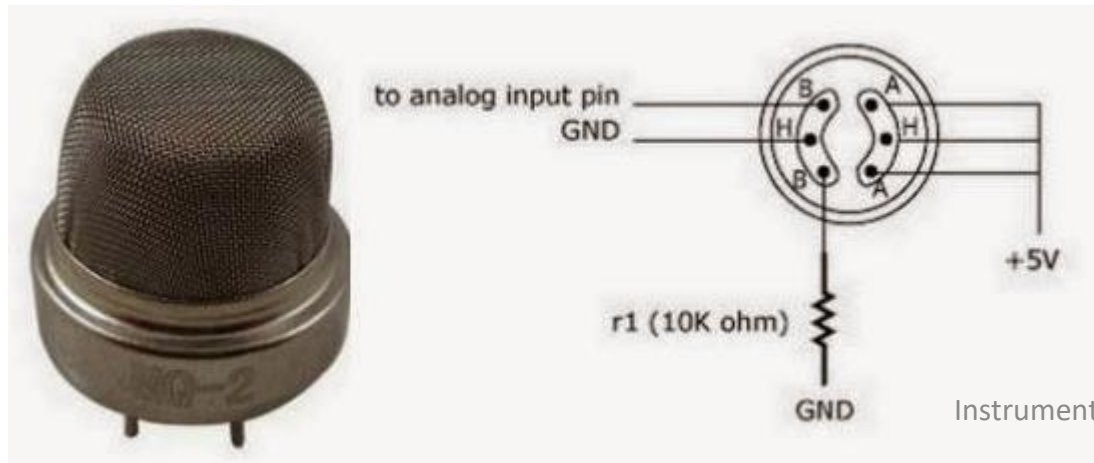
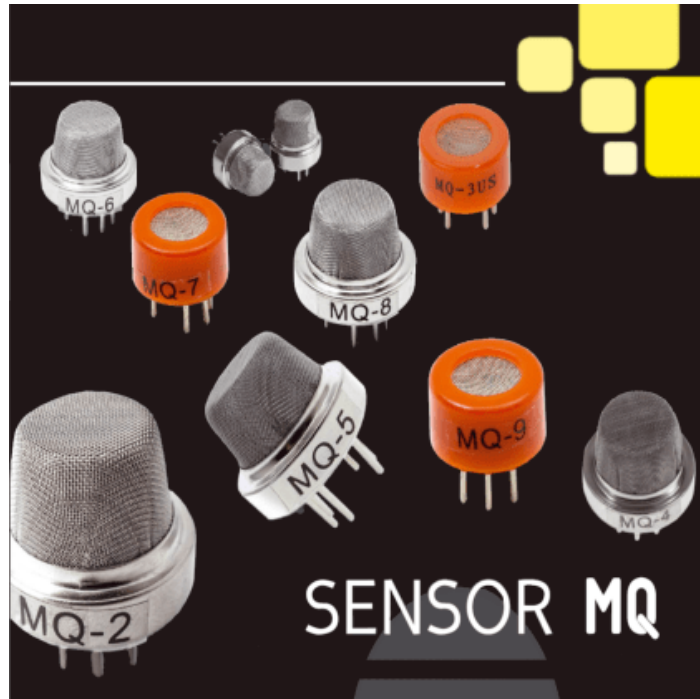


Parameter	Condition	min	typ	max	Units
Resolution ¹		0.4	0.05	0.05	%RH
		8	12	12	bit
Accuracy ² SHT71	typ		±3.0		%RH
	max	see Figure 2			
Accuracy ² SHT75	typ		±1.8		%RH
	max	see Figure 2			
Repeatability			±0.1		%RH
Hysteresis			±1		%RH
Nonlinearity	raw data		±3		%RH
	linearized		<<1		%RH
Response time ³	tau 63%		8		s
Operating Range		0		100	%RH
Long term drift ⁴	normal		< 0.5		%RH/yr

Parameter	Condition	min	typ	max	Units
Resolution ¹		0.04	0.01	0.01	°C
		12	14	14	bit
Accuracy ² SHT71	typ		±0.4		°C
	max	see Figure 3			
Accuracy ² SHT75	typ		±0.3		°C
	max	see Figure 3			
Repeatability			±0.1		°C
Operating Range		-40		123.8	°C
		-40		254.9	°F
Response Time ⁶	tau 63%	5		30	s
Long term drift			< 0.04		°C/yr



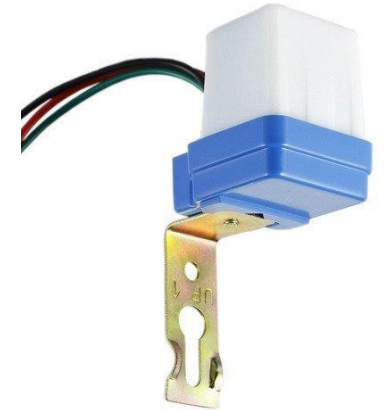
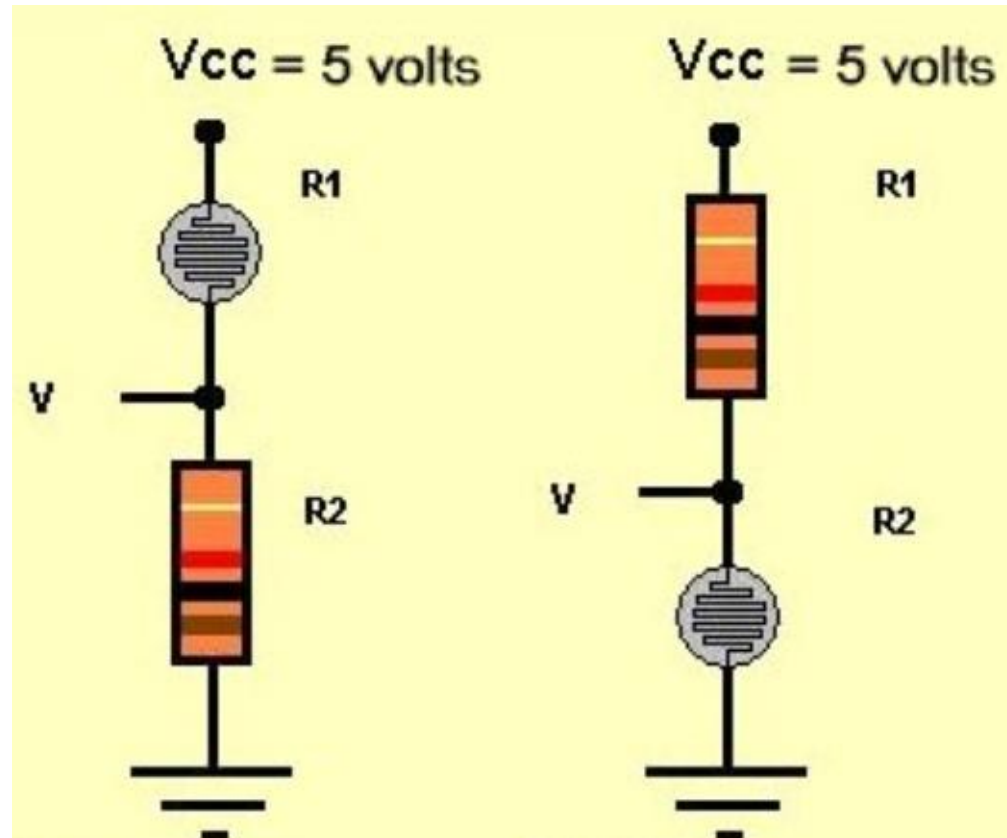
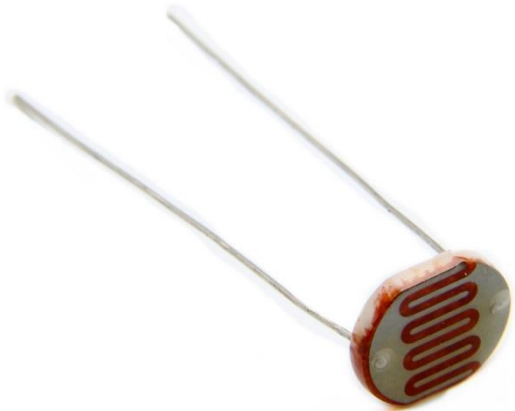
Gas Sensors



Semiconductor sensor for Flammable gas, Plastic or Metal cover	
Model	Target Gas
MQ-2	General combustible gas
MQ-3	Alcohol
MQ-4	Natural gas, Methane
MQ-5	LPG, Natural gas, Coal gas
MQ-6	LPG, Propane
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 O ₃
MQ135	Air Quality Control (NH ₃ , Benzene, Alcohol, smoke)
Semiconductor sensor for Toxic gas	
MQ136	Sulfureted Hydrogen (H ₂ S)
MQ137	Ammonia (NH ₃)
MQ138	VOC (Mellow, Benzene, Aldehyde, Ketone, Ester)

Light Intensity Sensors

PHOTOCELL (10-20K)



Light Intensity Sensors

MLX75305

- Converts light intensity to voltage
- Operating temperature -40 up to 125degC
- Supply voltage range 3V to 5.5V
- 2 mA Static Power Supply Current

