# IOT PROJECT 2020/2021

## CARBON MONOXIDE SENSOR


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# Summary

## ABSTRACT

Living in a city is very convenient under many points of view such as high-levels in education, services and entertainment but is also inconvenient in other ways.

In many heavily urbanized areas, particularly in the developing world such as China, India and Brazil, carbon monoxide detectors often register levels many times higher than accepted “safe” levels.

It is evident that we cannot list all the major cities in the world but we can for sure find a common term between all of them. Metropolis like London, Paris and New York are connected to Asian (mega) cities like Hong Kong, New Delhi and Tokyo because of pollution.

Since the 1970s, more and more people ( like scientists, politicians and workers ) started to get interested and sensible to the effects of pollution on human beings, for example, the verified correlation between the cancer and places in which smoking was allowed has led to anti-smoke laws.

But, how this problem is connected to our project?

Because as with every problem, the initial step is to recognize it understand its causes. How can you state, in an objective way, if the air of a place is unhealthy or not?

Well, indicators are a good way and, in particular, the Carbon Monoxide (**CO**) is considered by the scientists as one of the most polluting and dangerous chemical agents.

# SHORT INTRODUCTION

The main reason behind this idea has been stated in the previous section, now we must understand how it works. The device is attached to a balloon in order to make it “portable” and it will measure the concentration of this compound in several places (busy roads and traffic-free pathway).

The device will start keeping track of the carbon monoxide in the environment in which is, monitoring the gas levels by using a MQ7 sensor and, according to some threshold values, the color of the led changes.

It will receive this information as input and, if the level overtakes the maximum standard value, the led gets red, which indicates that a lethal dose of the gas is in the environment.

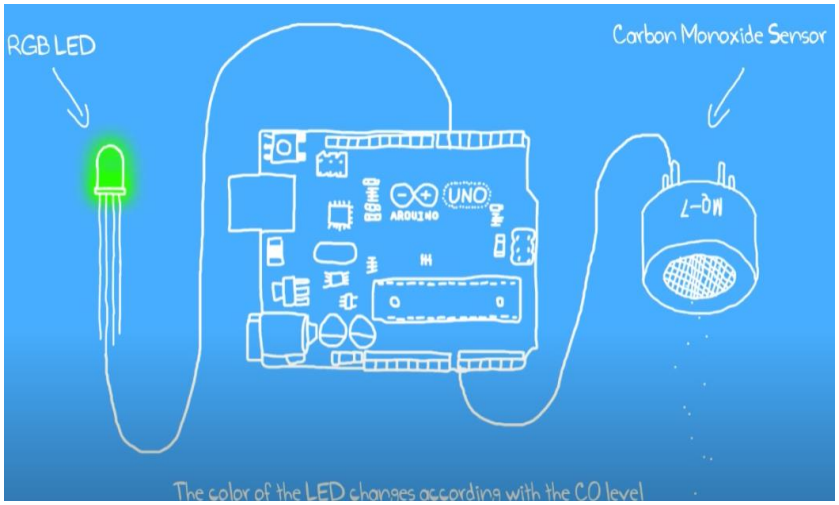
Obviously, we know that a trivial balloon will not fix this huge problem, so, why we use?

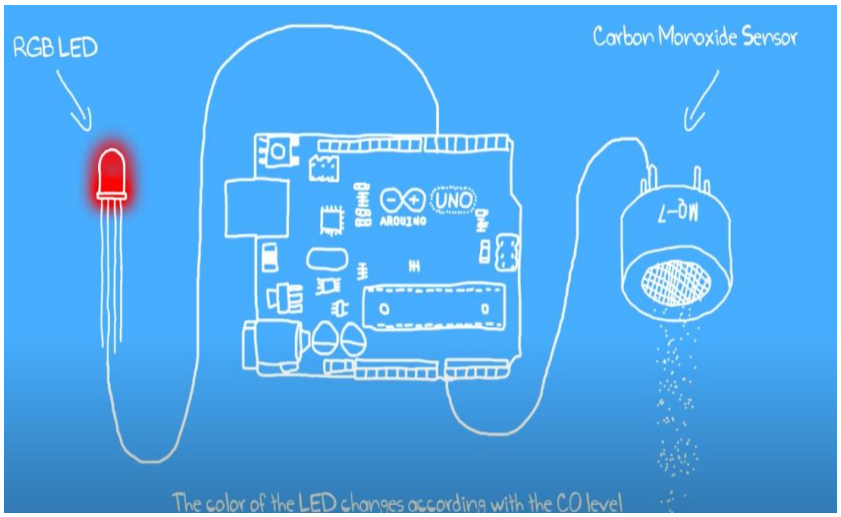
Being attached to a balloon, the sensor does not require to be set in a fixed position, so, it can be used either as domestic CO detector or you can use it in schools, offices, hospitals.

Because we would like to sensitize people on this issue through this simple, red balloon.

Here is a very intuitively schema that simulates what will happen:

In this case very low level of CO are detected so the LED will show the green light. In our case the MQ-7 sensor will be attached to the balloon in the air.




Instead in this case high level are monitored so the LED will pass to the red light. In this case we must avoid CO poisoning.

# USE CASES ( WHY IS USEFUL ? )

Carbon monoxide poisoning occurs when you breathe in too much carbon monoxide (CO), a colorless, odorless gas produced by the combustion of fuel.

Symptoms include headaches, dizziness, weakness, vomiting, chest pain, and confusion. The excessive exposure to CO can lead to severe heartbeat irregularities, seizures, unconsciousness, and even death.


Carbon monoxide poisoning will manifest with symptoms stemming from parts of the body that require oxygen most, namely the heart and the central nervous system (CNS). The initial symptoms typically include nausea, malaise, fatigue, and a dull but persistent headache.

As the CO continues to build up in the bloodstream, the depletion of oxygen in tissues will trigger an ever-worsening cascade of symptoms, including:

- Dizziness.
- Shortness of breath (dyspnea).
- Chest pain.
- Vomiting.
- Irregular heart rate (arrhythmia) or rapid heart rate (tachycardia).
- An unsteady gait.
- Confusion.
- Decreased rate of breathing

- Decrease heart rate.
- Delirium.
- Seizures.
- Unconsciousness.
- Death most often occurs as a result of respiratory arrest.

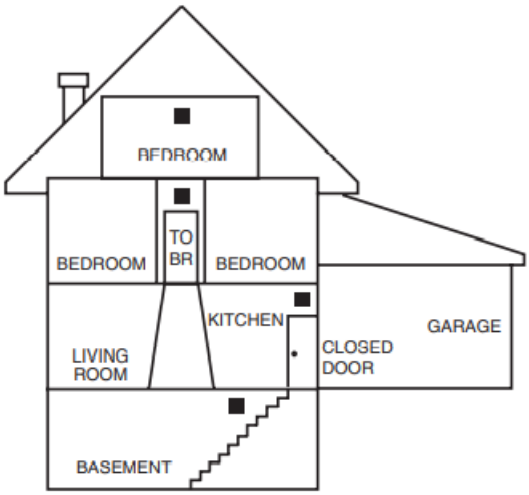
Even after a person has been treated for CO poisoning, there is a risk of long-term and even permanent neurological complications, including memory problems, irritability, depression, speech disturbances, partial vision loss, dementia, and Parkinson's disease-like symptoms.

**The most effective means of prevention in the home is a carbon monoxide alarm.**

Some recommended safety tips:

- Make sure your gas appliances are properly vented.
- Have your heating system, water heater, and any gas- or coal-burning appliance serviced by a technician every year.
- Never use an electrical generator inside the home, garage, or less than 6m from any window, door, or vent.
- Have your chimney checked and cleaned annually.
- Open the fireplace damper before lighting a fire and well after it has been extinguished.
- Never use a gas oven to heat your home.
- Never let a car idle in the garage.
- Know the symptoms of carbon monoxide poisoning.

Finally, we can state that since these sensors are not are not harmful to health, we can put them where we want also in our house, normally, this is a schema for a multilevel residence:



# STATE OF THE ART

A carbon monoxide detector is a device that detects the presence of the carbon monoxide (CO) gas to prevent carbon monoxide poisoning, which occurs from breathing air with high levels of CO.

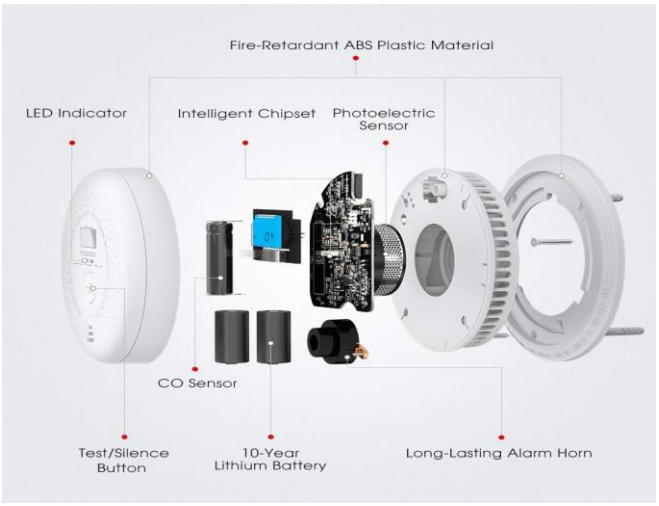
CO detectors are designed to measure CO levels over time and sound an alarm before dangerous levels of CO accumulate in an environment, giving people adequate warning to safely ventilate the area or evacuate.

It is important to notice that actually are sold combined version of both smoke and CO detectors, that's because, for example, in our home some common sources of CO include open flames, space heaters, water heaters and blocked chimney and, also, a car inside a garage.

The average cost of this type of device varies from $15 - $60 USD, but, some companies as Google are producing devices that detect CO, smoke and fire and then notify it on smartphone using your own wifi, in this case, the price is higher than $100 USD.

Most of the CO detector's market is focused on the household sector and several types of detectors have been developed in these years:

1) **Biomimetic sensors**: use a combination of color-changing liquids or gel-like elements to detect carbon monoxide:

2) **Semiconductor sensors**: created using wired circuits to monitor carbon monoxide:


3) **Electrochemical sensors**: generate currents that show the amount of carbon monoxide detected when the gas undergoes a chemical reaction:


# MORE ON CARBON MONOXIDE

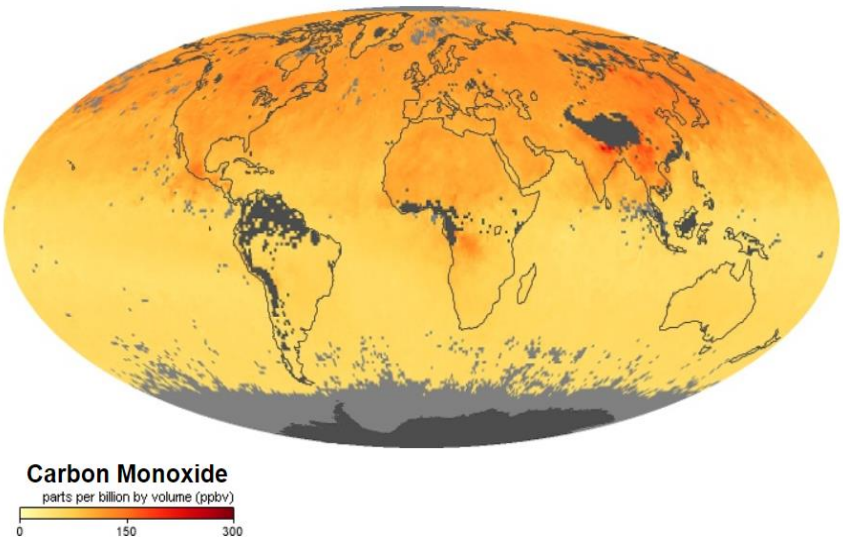
The map shows the average of global concentrations of tropospheric carbon monoxide at an altitude of about 12,000 feet. The data were collected by the MOPITT (Measurements Of Pollution In The Troposphere) sensor on NASA's Terra satellite.

Concentrations of carbon monoxide are expressed in parts per billion by volume (ppbv). A concentration of 1 ppbv means that for every billion molecules of gas in the measured volume, one of them is a carbon monoxide molecule.

Yellow areas have little or no carbon monoxide, while progressively higher concentrations are shown in orange and red. Places where the sensor didn't collect data, perhaps due to clouds, are gray. In different parts of the world and in different seasons, the amounts and sources of atmospheric carbon monoxide change. In **Africa**, for example, the seasonal shifts in carbon monoxide are tied to the widespread agricultural burning that shifts north and south of the equator with the seasons.

Fires are an important source of carbon monoxide pollution in other regions of the **Southern Hemisphere**, such as the Amazon and Southeast Asia. In the **United States**, **Europe**, and eastern **China**, on the other hand, the highest carbon monoxide concentrations occur around urban areas as a result of vehicle and industrial emissions. Fires burning over large areas in **North America** and **Russia** in some years can be an important source.

The MOPITT observations often show that pollution emitted on one continent can travel across oceans to have a big impact on air quality on other continents. Carbon monoxide is a trace gas in the atmosphere, and it does not have a direct effect on the global temperature, like methane and carbon dioxide do. However, carbon monoxide plays a major role in atmospheric chemistry, and it affects the ability of the atmosphere to cleanse itself of many other polluting gases. In combination with other pollutants and sunshine, it also takes part in the formation of lower-atmospheric ("bad") ozone and urban smog.




# LEGISLATIONS

On 31 January 2017, the European Union (EU) Commission adopted the Directive 2017/164 establishing new indicative occupational exposure limit values for a list of chemical agents.

In the USA, particularly in New York, California and Maine, the CO detectors must be installed in the households and other regulations about these devices affect at least 32 states. The devices can be placed both near the floor and near the ceiling since the density of the CO can change in the air.

Further, US and Canada have stipulated the writing of CO standards, which set the minimum level of CO that can be showed by displays at 30 ppm , while an alarm will not sound at CO concentration up to 70 ppm.

Below the table that shows some negative effects of the CO on the human body:

| CONCENTRATION OF "CO" IN THE AIR | SYMPTOMS ON HUMAN |
|---|---|
| 100 ppm (0,01%) | Light headache in 2-3 hours. |
| 400 ppm (0,04%) | Light headache in 1-2 hours, rising after 2-3 hours. |
| 1600 ppm (0,16%) | Headaches, dizziness and nausea in 20 minutes, dying within 2 hours. |
| 6400 ppm (0,64%) | Headaches and diarrhea in 1 or 2 minutes, death in 10-15 minutes. |
| 12800 ppm (1,28%) | Death in 1-3 minutes. |


## LIST OF COMPONENTS

BreadBoard - Half Size
$4.5 x Qty: 1

Arduino Uno
$23.38 x Qty: 1

Battery Holder - 4xAA
$1.74 x Qty: 1

Carbon Monoxide Sensor - MQ-7
$5.99 x Qty: 1

RGB Led Common Anode
$1.89 x Qty: 1

220 Ohm Resistor
$0.1 x Qty: 1

100 Ohm Resistor
$0.1 x Qty: 2

USB Cable A to B
$3.26 x Qty: 1

Gas Sensor Breakout Board
$0.95 x Qty: 1

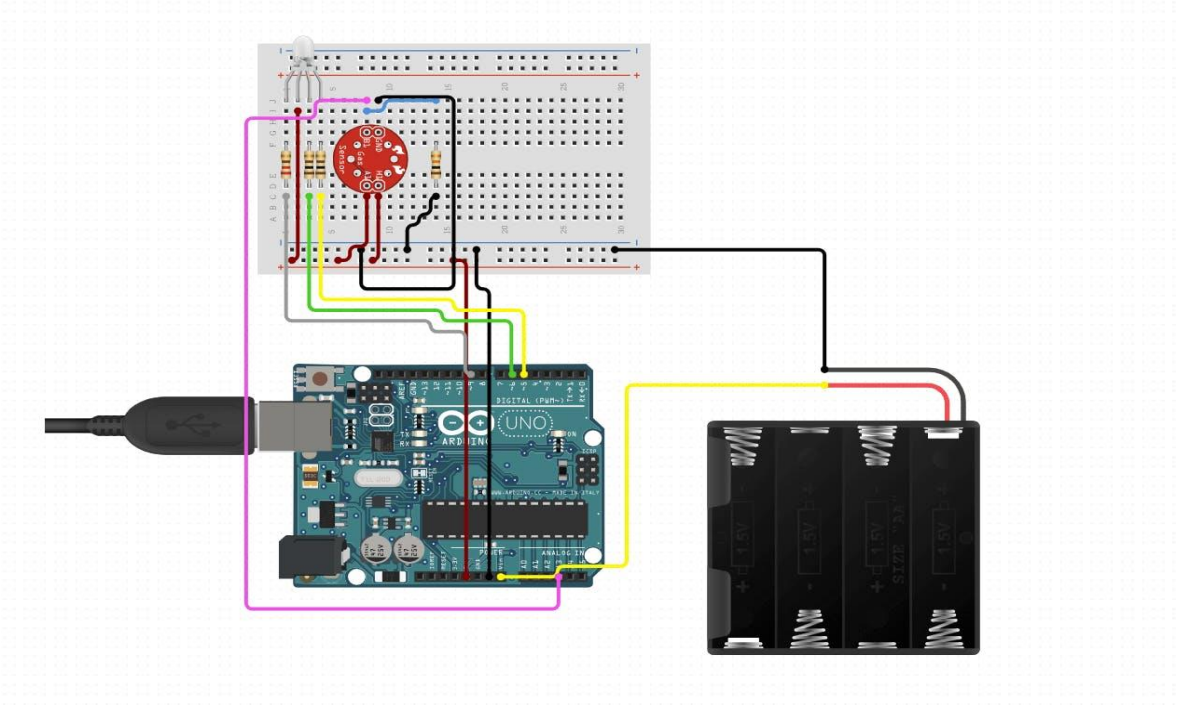
Jumper Wires Pack - M/M
$1.95 x Qty: 1

Male Headers Pack- Break-Away
$0.66 x Qty: 1

Red helium balloon
$0.20 Qty: 1

Ribbon cable – 6 wire (15ft)
$2.95 Qty: 1

# TECHNICAL STUDY



## ***Arduino Uno***

Arduino Uno is a microcontroller board based on the ATmega328P.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic

resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

## ***MQ-7 Gas Sensor***

Sensitive material of MQ-7gas sensor is SnO2, which with lower conductivity in clean air.


It makes detection by method of cycle high and low temperature and detect CO at low temperature (heated by 1.5V).

The sensor's conductivity gets higher along with the CO gas concentration rising.

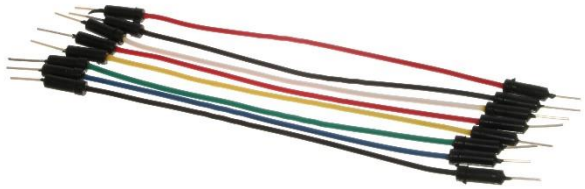
At high temperature (heated by 5.0V), it cleans the other gases adsorbed at low temperature.

## Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

## Connecting Wires

A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

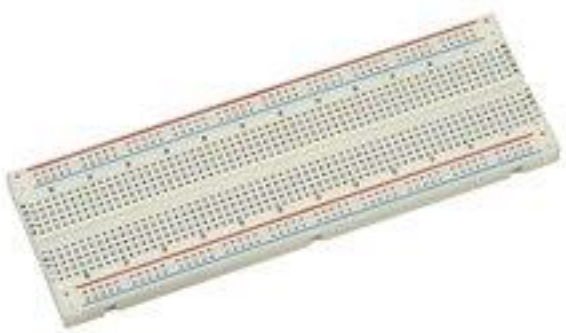


Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

## Breadboard

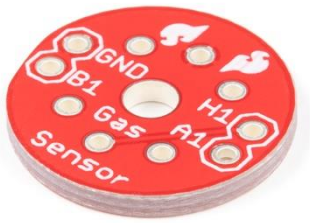
A breadboard is a construction base for prototyping of electronics.

The solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education.



## SparkFun Gas Sensor Breakout

This breakout board is designed to work with any of the MQ-series gas sensor, simplifying the interface from 6 to 4 pins that are broken out with a 0.1" spacing, making the board compatible with 0.1" headers and standard breadboards. The board has a diameter of 16.8 mm, which matches the diameter of the small (plastic) gas sensor packages, providing a more convenient, compact connection within the bounds of the sensor itself.

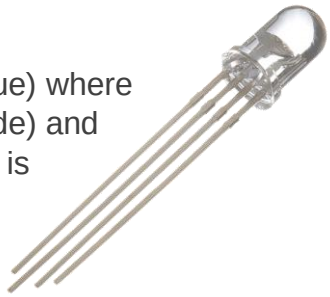



## USB-A to B

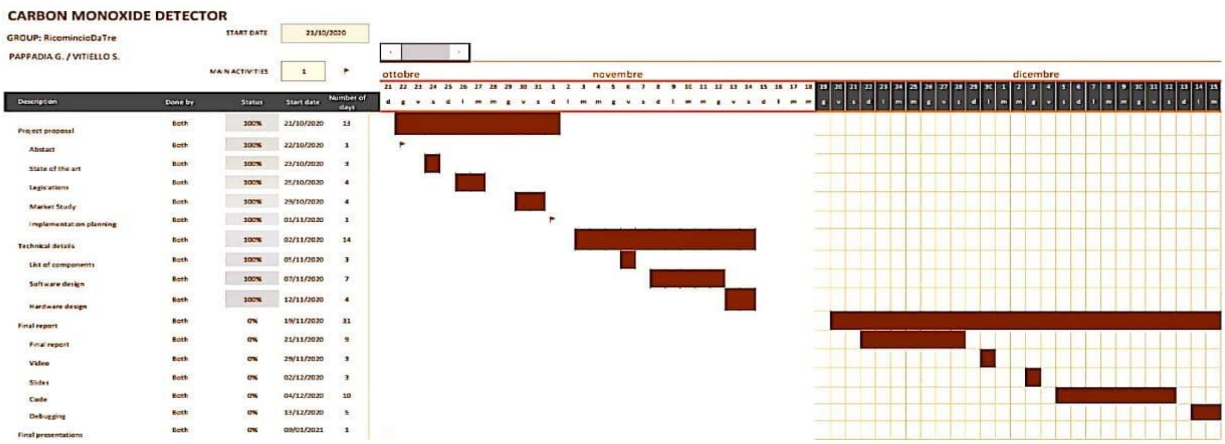
This cable features a standard Type-A USB connector on one end and a standard Type-B connector on the other. For example, you can plug the Type-A connector into your computer, then plug the Type-B connector into a device with a Type-B port. Printers and servers often have Type-B ports.

## RGB Common Anode

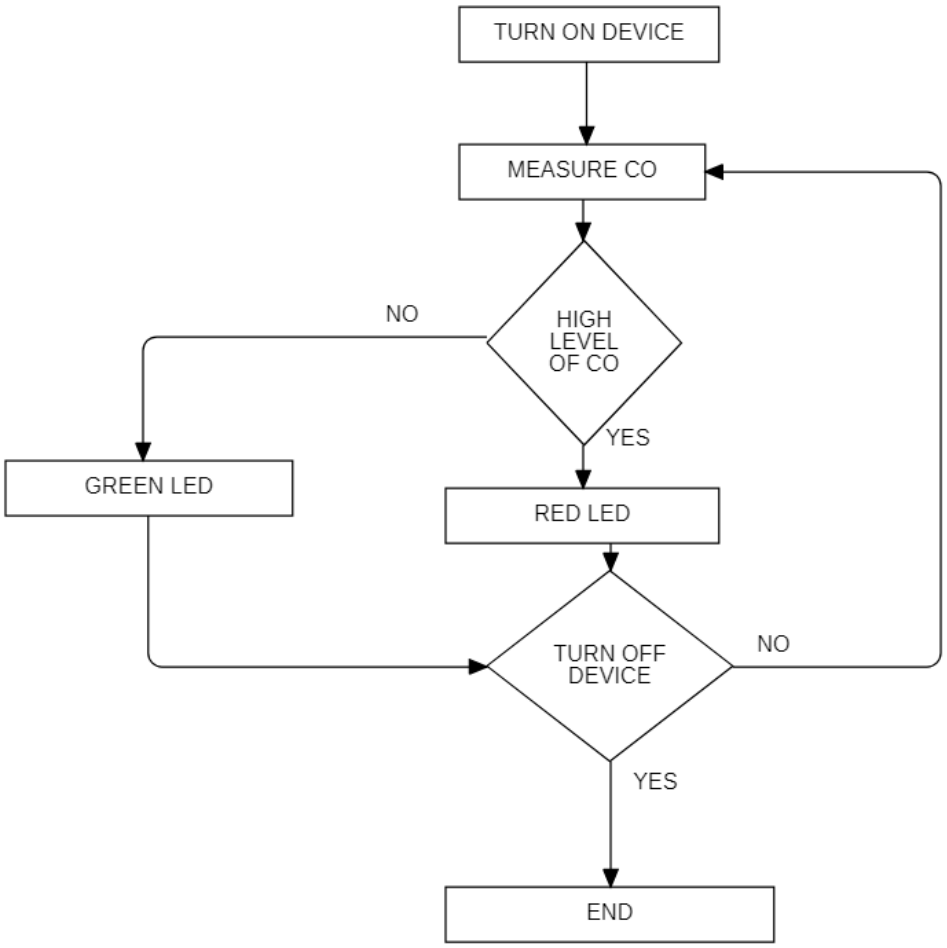
These LEDs have three tiny LEDs of 3 primary colors (red, green and blue) where a terminal is common for all. Some have common positive terminal (anode) and some have common negative terminal (cathode). When different voltage is applied to different LEDs, they make a mixture and produce several thousands of colors.



# GANTT DIAGRAM




# DIAGRAM



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