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# DESIGN OF LOW POWER CARBON MONOXIDE DETECTOR

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***Abstract***

*Carbon monoxide is one of the poisonous gaseous in the world and this gas is monitored by using a equipmentthat we designed the circuit for this specific function. In such a way, the equipment performs it's operation and our aim is to perform the equipment with low power consumption when compare to the normal Carbon Monoxide detector, the coincell battery which gives long battery life and it is essential to use in this detector and also used in many devices. The installation cost is reduced and the system flexibility are increased and our main aim is to design a printed circuit board(pcb) in reduced size.*

## INTRODUCTION

Now a days there is lot of destructions and damages occurred due to an human error such case engineers are designed scientific equipment to overcome the human error in our project we are used the printed circuit board. Carbon monoxide is a poisonous gas which is due to incomplete burning of fuels. Combustion engines used in automobiles which can also produce Carbon Monoxide gas .CO sensors usedin industrial and building automation systems to warn users when it's unsafe. The system is more reliable to use in real time applications. The use of wireless sensor nodesincreases coverage area and reduces implementation cost and more flexible for further upgrades by eliminating wiringconnections. Due to the usage of battery powered systems, the maintenance cost for periodic battery replacement becomes prohibitive.

The system starts functioning only when the CO level rises to unsafe limits by generating periodic signal fromthenano-power system timer to the wireless MCU. It cancheck the sensor readings and send to the host indicating the status of the system. When the temperature varies with sensor output, the temperature sensor is used to adjust the CO level. Due to the nano-amp operation and the ultra-low power consumption of the MCU, a 10-year battery life from this CR2032 coin cell battery is achieved and detector performs effectively.

## PRINTED CIRCUIT BOARD

Printed Circuit Board (PCB) which electrically connects the electric and electronic componentsand mechanically supports by using conductive tracks, pads and features etched from sheet layers of copper laminated onto or between sheet layers of a non-conductive substrate.

In earlier days, all the electrical and electronic componentsareconnected with wires which increase the complexity and decrease reliability of the circuit; hence it is more complex tomanufacture very large circuits like motherboard.



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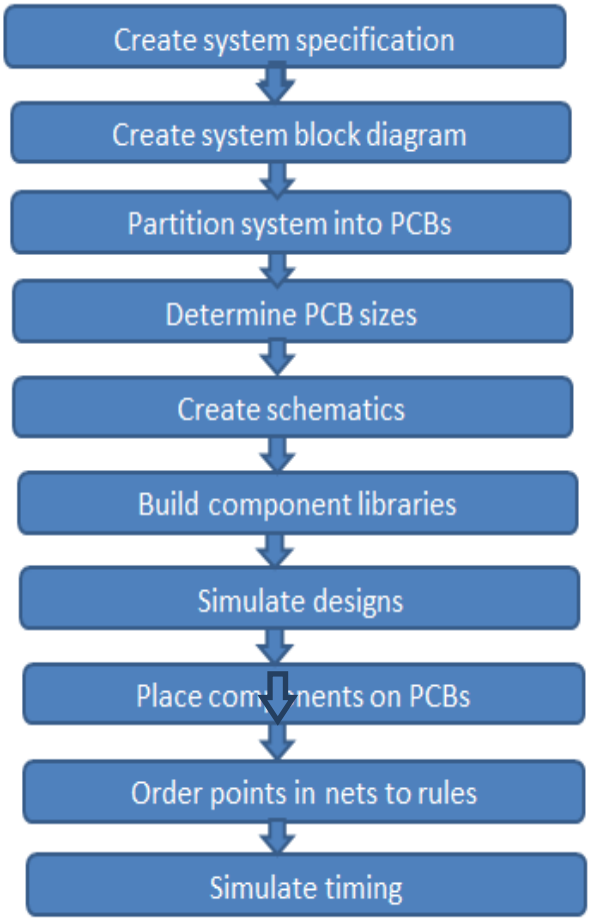
The first board was designed during the Second World War by USA around 1950s which is called as printed wired boards after that the first PCB board was designed during 1995 by micro via technology.

When the PCB is evolved all the components are connected without the help of wires, soit reduces thecomplexityoftheoverallcircuitmanufacturing.PCBisusedtoprovide power supply and interconnectivity between the components and these boardscanbecustomizedforanyspecificationsbased on theusersrequirements.

The real time applicationsof PCB can be found in many electronic devices like Television, Mobile phones. Computers components like Motherboard, Graphic cards and processors, etc. It is also used in many fields like medical devices, automotive industries, machineries, etc.

**DESIGN FLOW**



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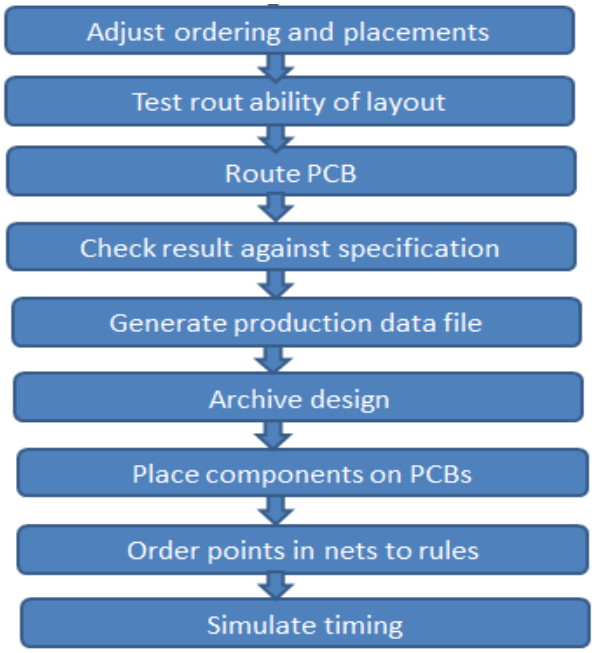


## DESIGN TOOLS

Computerbased tools have evolved to improve the speed and automate the design process. CAD tools are generally used to turn the electrical circuit described by the schematic into a physical packageor PCB. These tools are fed netlists, component lists, wiring rules and other layout information.

The computer softwares like allegro, eagle, altium and xpedition which are generally used for layout, ordering and placements.Among these software, Xpedition is very easy to learn and also we can create multiple layers using this software and also Low Power Carbon Monoxide Detector is designed in this software.

## SYSTEM ASSEMBLY

This design which consists of onenanopower operational amplifier, a CR2032 coin cell battery, nano power comparators, system timers, temperature sensors, electrochemical CO sensor and the multi-standard 2.4-GHz wireless Microcontroller (MCU) in which no wiring is required.



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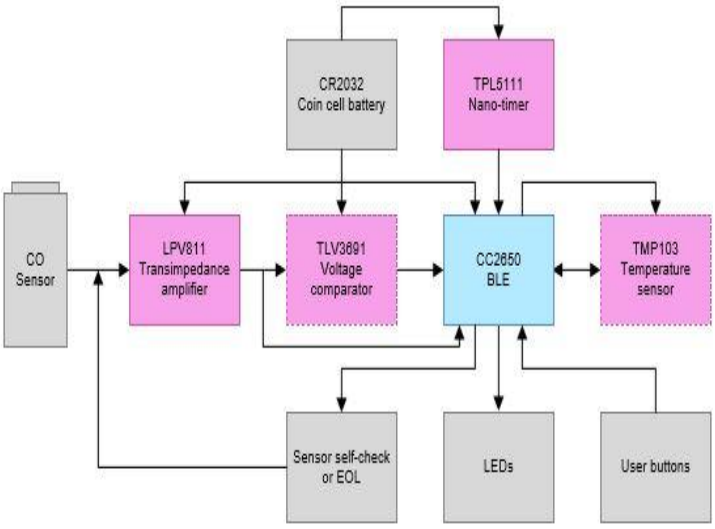
## BLOCK DIAGRAM




The CO sensor which gives nano-amp range current output, which is mainlyconverted into voltage then the voltage is amplified by usingtransimpedance amplifier (LPV811). Before passing the voltage to the comparator and convertor it is necessary to limit the noise bandwidth of the system. Whenever the fast changes in the gas concentration occur, the response of the system gets reduced due to this filtering function. In this design, LPV811 is used because it consumes low current (425nA).The TLV3691 Voltage comparator offers low quiescent current (150nA) and rail-to-rail inputs,a wide supply range. It's main function is to keep the MCU in lowest power shutdown mode and wakes the MCU when CO level rises above the safe limit level. The filtered version of the sensor output signal used as wakeup signal to the MCU. The CC2650 device is a 32-bit Arm processor and it is a wireless MCU which is generally used for remote control applications. It has very low active RF and low power mode current consumption that provides better battery lifetime. As the current requirement is low the system has an extremely long battery life. Figaro TGS5342 which is a two terminal electrochemical CO sensor has functions across multiple CO levels and sensor performs in several environmental conditions.In Low Power CO detector design we use TMP103 as a digital output temperature sensor which operates over range from -40ºC to +125ºC.This temperature sensor is suitable for power sensitive applications along with the multiple temperature zones.

## SENSOR POLARIZATIONAND SELF CHECK

When a sensor is stored for a long time without any connection between counter and working electrodes then the sensor becomes polarized. These kinds of polarized sensors may take few minutes or even hours to attain stability when they are in connection with the operating circuit.

A sensor becomes polarized when power is removed from the system and it can be avoided by placing a short circuit between the sensor electrodes. Sensor anti-polarization technique is achieved by using P-channel JFET. When the power is removed there is a short between the electrodes produced by the JFET.



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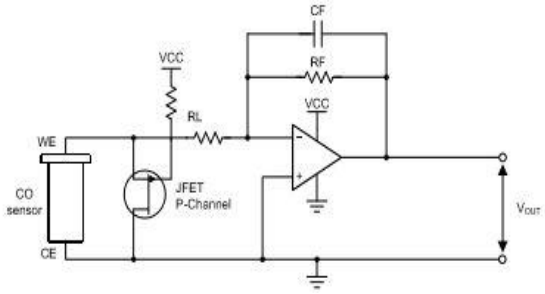
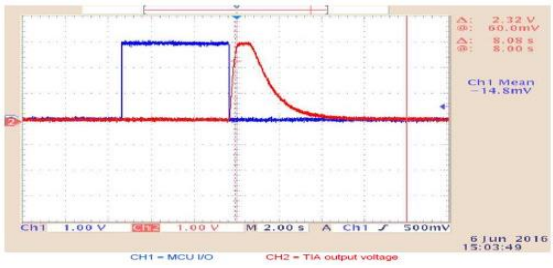



In this Carbon Monoxide detector design, Figaro TGS5342 sensor in which the functionality of this sensor iscontinuously monitored and it is helpful to report the host incase of any failures can be signalled. The self-check feature can be done by passing a small current (1µA) into the sensor for a short period (approximately four to five seconds) while the sensor is disconnected and then remove the test current again monitor the sensor response. Based on the sensor response to the test current that is passed to the sensor, the MCU determines when the sensor operations and some failure conditions such as loss of sensitivity, due to short-circuit and an open-circuit.

In such cases, a small amount of CO gas is spread over the area of the sensor; hence the TIA output voltage obtained is greater than 0 V. Note that the sensor response is same, except the TIA output settles down the voltage corresponding to the CO gas concentration instead of 0 V.




## TESTING AND RESULTS

The low power carbon monoxide system (CO) will support all the critical subsystem to measure an appropriate level of the carbon monoxide level in the surroundings with the help of that leakage of carbon monoxide will measured and intimated to the user.

## CONSUMPTION OF POWER

The main aim of this design is to implement the battery powered wireless CO sensor and system power consumption is critical. Mostly this design consumes very low power often only consumes some nano-amps of current. The limit may create problem during normal operation the current changes from nano-amp range to milliamprange at different points. There is an inrush of current when power given to the board, it can be prevented by using resolution of 10 mA. Also there will be some high peaks of current that were generated during the sensor test and transmission of data.TMP103 is inactive and TPL5111 remains active which provides interval to CC2560 for periodic tests. This system design which self-checks the gas sensors and CC2560 didn't goes shutdown because the memory contents will be lost and impossible to maintain the sequence of steps that are



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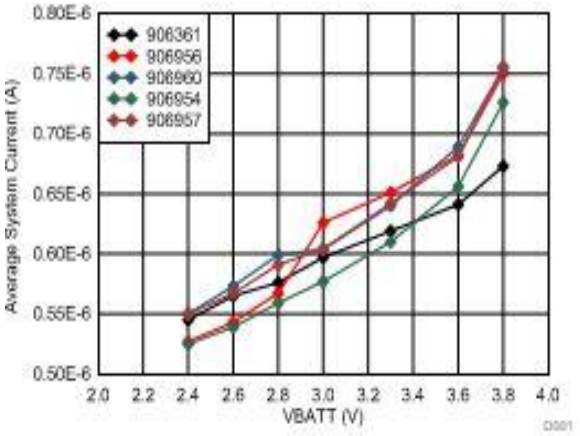
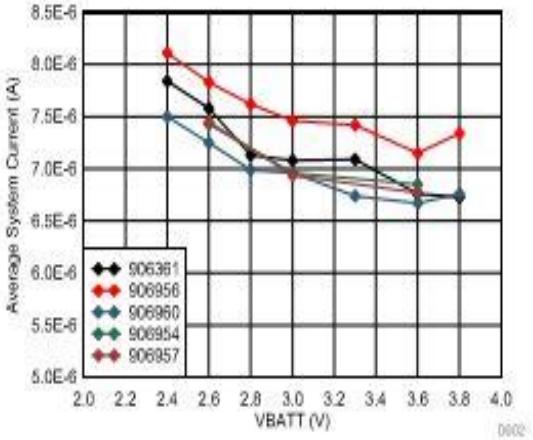
meant to be carried out in the system test. The comparator triggers the system to pre-alarm state.TMP103 only powered to measure the temperature and easier to correct the CO concentration for temperature. During this state there is no transmission of packets in CC2560.



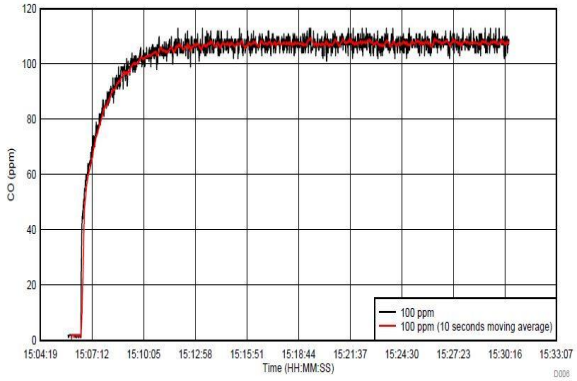

**Standby State Current Consumption Across System Voltage**




**Pre-Alarm State Current Consumption Across System Voltage**

## CO MEASUREMENT

The Carbon Monoxide around the area is measured by this PCB design using three different CO levels namely 100-, 200-, and 300-ppm gas levels.



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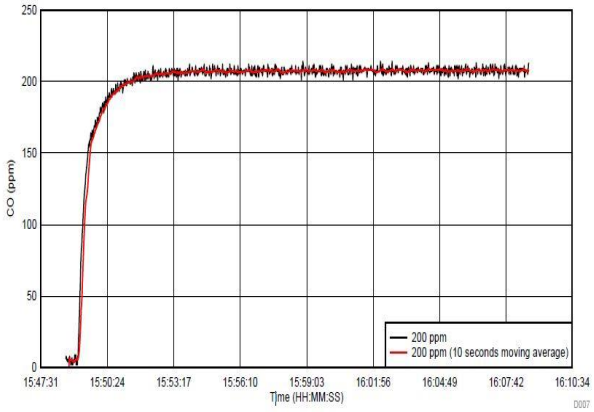
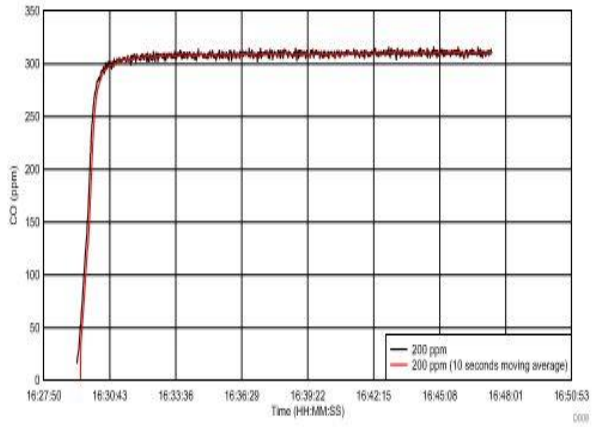
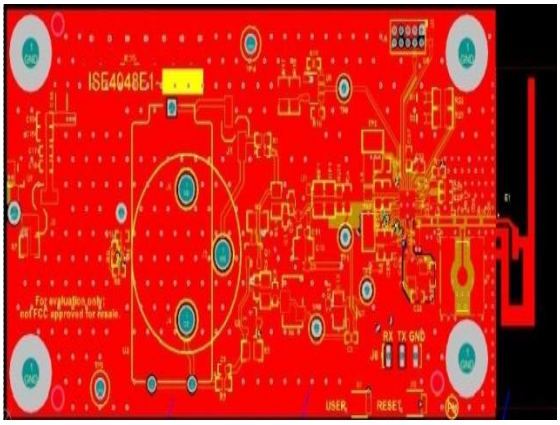



## GERBER GENERATION

For achieving better performance, this design of Low Power Carbon Monoxide Detector is made in a four-layer PCB.The top and bottom layers of the PCB generally used for signal routing and components placements. The second layer is GND whereas the third layer is for power rail routing. After the successful routing and designing of PCB, the gerber file is generated which is the layout of the entire PCB system design.



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## CONFORMAL COATING

If this detector is used in certain dusty or moisture places then it is compulsory for conformal coating of the board design to avoid the leakage paths due to these certain undesirable environmental conditions.

## CONCLUSION AND FUTURE WORK

Hereby we conclude that the layout of a Low power carbon Monoxide detector is designed using xpedition software. Many industries and automation systems depend on the CO sensors to detect the release of this poisonous CO gas and to warn users when CO reaches to unsafe level.In these systems we can use wireless sensor nodes which reduces the installation costs and makes these systems more flexible for further upgrades by eliminating the wires.

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